Gaia Association

Holistic Feasibility Study of a National Scale-up Program for Ethanol Cookstoves and Ethanol Micro Distilleries in Ethiopia

Assessment of Cooking Energy in Households, Commercial Enterprises and Social Institutions in Ethiopia

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Executive Summary

Sustainable and reliable supply of cooking fuel to the households, enterprises and institutions is one of the major critical issues of the energy sector in Ethiopia. Current practice of biomass cooking fuel harvesting is not sustainable in Ethiopia; it has already resulted in negative environmental and health consequences. Being aware of the fact, the government of Ethiopia gives due emphasis on wide scale dissemination of clean and energy efficient cookstoves, and introduction of alternative cooking fuels from renewable sources. Accordingly, the energy sector program for 2010 to 2015 and beyond planned to disseminating energy efficient cookstoves, introducing modern fuels such as biomass briquettes, sustainably produced charcoal, and biofuels.

This paper is one of the components of a wider study which has an overall objective to contribute to the development of the bio-ethanol sub-sector in Ethiopia by analysing the feasibility of ethanol micro distilleries and ethanol fuel for cooking. The specific objective of this assignment is to provide a comprehensive analysis of the Ethiopian cooking market including fuels and devices in use, consumption and expenditures, consumer preferences and willingness to pay, estimate market size for ethanol fuel and stove, analyse the cooking fuels and devices competitive landscape, distribution channels, and mapping out of key stakeholders and their roles and potential contributions in ethanol fuel and stove market development.

Primary and secondary data on cooking fuel consumptions and expenditures were collected and analyzed by Gaia Association using various information collection tools. Primary data was collected from households, enterprises and institutions from all regions using standard questionnaires. A total number of 4521 households, 694 businesses and 25 institutions (12 Universities, 9 hospitals and 4 schools) were covered by the survey. Focus group discussions, market surveys for fuel and stakeholders' interviews were also conducted. Policy documents of relevant sectors of the economy were also reviewed. This report is prepared based on the survey findings and other secondary sources.

The national energy policy of Ethiopia very much supports development and utilization of ethanol fuel for cooking as long as it is produced and used in environmentally benign manner. Even though the energy policy addresses most of the current energy issues, implementation limitations are widely observed in the energy sector development. While the policy clearly puts the policy instruments supportive to the realization of RETs, communication and coordination with sector organizations requires further improvement. Necessary institutional capacity building works are lugging behind rendering required institutional supports unavailable to facilitate and implement identified policy instruments. The reflection of this has been manifested in the effort towards the development of biofuels themselves and their conversion and end-use technologies. Inconsistent treatment of some renewable energy technologies is observed. Energy conversion technologies and end-use devices for solar and wind resources are benefiting from favourable import taxes while technologies for conversion and utilization of biomass and biofuels are not.

Clean cooking with clean fuels such as ethanol helps to realize one of the main health policy priorities, the development of environmental health, which gives special attention to health needs of families particularly to women and children. Promotion of ethanol fuel use for cooking also supports the education policy and strategies as it provides alternative clean cooking energy source to the school feeding programs and higher education institutions where food preparation is mostly done with traditional fuels in unsustainable manner. The five years Growth and Transformation Plan, and the Climate Resilient Green Economy strategies promote cleaner and environmentally sustainable fuels, ethanol fuel use for household cooking is not explicitly mentioned even though it fulfils all the requirements of sustainability.

The national program for improved cookstoves development and promotion aims at implementation of the short term target outlined in CRGE which is the deployment of nine million fuel efficient cookstoves. The program should also give more emphasis to liquid biofuels and stoves along with dissemination of fuel efficient fuelwood stoves.

Energy use in Ethiopia predominantly relies on biomass resources. Major energy demand in the household sector is mainly for cooking and baking. Households both in rural and urban areas mainly depend on biomass fuels for their cooking and baking activities. According to the national statistics, biomass is used by 99% of rural and 84% of urban households for cooking (CSA 2012). Firewood is the prominent biomass fuel used by the households. Other biomass such as dung and agri-residue contribute to a relatively smaller portion of the cooking energy demand. Next to firewood, charcoal is the second most important cooking fuel used by 17.5% of the households in Ethiopia. It is primarily a fuel for the urban households. According to CSA, only less than 1% of rural household in Ethiopia use charcoal as a major source of cooking energy. Kerosene, as a major source of cooking fuel, is used by about 5% of the urban households, mainly by those in major urban areas. It should be noted that the figure for the percentage of households that use a particular type of cooking fuel in the CSA data is for the households that use the fuel as a major source of cooking energy. This means that more households than stated by CSA could possibly use a mix of other fuels in addition to their major fuel. Households obtain fuelwood either by purchase, collection or both. About 45% of urban households and 4% of rural households purchase fuelwood (CSA, 2012).

Survey findings

Fuels and stoves in rural households

The findings of the survey show that fuelwood and charcoal are respectively used by about 96% and 41% of the rural households. Charcoal usage by the rural households is the highest in Tigray (77%) and the lowest in Oromia (25%). Charcoal usage by the rural households includes not only the purchased ones but also left over embers from firewood burning. Moreover, this percentage also includes households that use charcoal in different amounts and frequencies of use. About 75% of rural households entirely depend on collected fuels for cooking while those who purchase only account for 22%. The survey also shows that women do much of the fuel collection followed by female children each traveling an average distance of over 25 to 30 km and spending 20 to 30 hours in a month. On average, all members of a rural family make about 26 trips a month, travel about 90 km and spend over 80 hours. About 25% of rural households purchase cooking fuels. On average, the rural households could spend about ETB 504 annually to buy cooking and baking fuels. This is about 3% of their total expenditure.

Major fuels for cooking and baking in rural areas, in the order of importance, are fuelwood, charcoal, BLT and dung. Fuelwood is used for baking and cooking as well while charcoal is entirely used for cooking only. BLT and crop residues are used by about 30% of the rural households for cooking and baking.

The average annual biomass fuels consumption by a rural household, in terms of wood equivalent, is about 2,321 kg per year. Minimum consumption is observed in households in Dire Dawa (1,642 kg/year) and the maximum is in Amhara (2,768 kg/year). This, on average, is translated into a daily per capita consumption about 1.3 kg. Hence, the annual woody biomass consumption by rural households for cooking and baking is estimated at about 34 million tons of wood equivalent. Use of kerosene and LPG for cooking in rural households is not common. Only less than 2% of the total rural households in all the regions use kerosene for cooking. Average consumption of kerosene by those rural households that use the fuel is about 14.6 liters per year.

About 72% of the rural households in all regions own and use Open fire for cooking. Open fire is used the least in Tigray where only 25% of them use it. Charcoal stoves are the second important stoves for cooking for the rural households. It is almost entirely used for cooking, boiling and reheating cooked foods. Metal charcoal stoves and all clay charcoal stoves are the most common charcoal stove used by about 17% of the rural households in all regions. Lakech charcoal stove is used by about 9% of the rural households. High penetration rate of Lakech is observed in rural households in Amhara (18%) and Benishangul (20%). Ownership and use of Upesi, Tikikil and electric stoves for cooking in rural areas is very small; they are owned only by 5%, 0.1% and 1% the households respectively.

Open fire is also the most important baking fuel. Next to Open fire, traditional enclosed firewood stove is the second widely used stove and owned by about 20% of the rural households for baking. Ownership of Mirt and Gonzie by the rural households is 4% and 1% respectively. Regional level ownership and usage of Mirt stove is about 10% in Amhara, 4% in Oromia and Benishangul, and 2% in Hariri and Dire Dawa. Ownership of Gonzie stove by the rural households is 4% in Amhara and 7% in Benishangul. The focus group discussion also indicates that Mirt and Lakech charcoal stoves are the most prominent of all improved cookstove in rural households.

Fuels and stove in urban households

The results of the survey show that charcoal and firewood are used by about 91% and 70% of the urban households respectively. Charcoal usage (including embers left over from firewood burning and) by the urban households in any amount and frequency is the highest in Tigray (99%) and the lowest in Harari (77%). Over 90% of the urban households entirely depend on purchased fuels for cooking. On average, an urban households spends about ETB 1,278 on cooking/baking fuel per year which is about 18% of the total expenditure.

The three most widely used fuels for preparation of food in the urban households are charcoal (91%), fuelwood (70%) and electricity (31%). Charcoal is the most important fuel for the urban households. It is primarily used for cooking than baking which includes cooking, coffee or tea boiling, food reheating and water boiling. Next to charcoal, fuelwood is the second most important fuel followed by electricity. Use of fuelwood in urban households is mainly for baking as 70% of the urban households that use fuelwood use it for baking purpose.

Use of other biomass fuels such as BLT, dung and crop residues by the urban households is only 8%, 3% and 2% respectively. An urban household, on average, annually consumes about 2,645 kg of biomass fuels in wood equivalent. This is translated to 1.9 kg of fuelwood consumption per person per day. Lowest consumption of fuelwood is in Hariri (1.5 kg per person per day). The annual woody biomass consumption by urban households for cooking and baking is estimated at about 11.3 million tons of wood equivalent.

Electricity is used for both cooking and baking by the urban households. In recent years, most urban households are increasingly using electricity for cooking as prices of other fuels such as kerosene, LPG and charcoal are continuously rising while that of electricity has been constant in the last eight years. Comparison of use of electricity for cooking shows that the percentage of urban households that use electricity for cooking grew from 2.4% in 2004 to 6.2% in 2011 (WMS, CSA 2004 and 2011). Electricity usage for cooking and baking is the highest in Addis Ababa. About 70% of households in Addis Ababa use electricity for either cooking, baking or both. On the other hand, none of the surveyed urban households in Gambella use electricity for cooking or baking.

Kerosene consumption for cooking by urban households is decreasing. Percentage of households that use kerosene for cooking decreased from 14% in 2004 to 5% in 2011 (CSA, 2004, CSA 2011). The survey also shows that only less than 9% of the urban households use kerosene for cooking. However, highest user of kerosene are households in Addis Ababa (20%) while the lowest users are households in Tigray and Gambella (3%). Average kerosene consumption by the urban households is about 3.8 liters per year which costs them about ETB 70.

Charcoal stoves are the most prominent stoves used by over 90% of the urban households in the surveyed regions. Of the three types of charcoal stoves, Lakech charcoal stove has the highest penetration rate of 41% in urban households. Next to Lakech, traditional metal charcoal stoves and all clay charcoal stoves penetrated into about 33% and 21% of the urban households respectively. Next to charcoal stoves, Open fire is the second most widely used cooking stove used by 27% of the urban households. Electric stoves are used by about 25% of urban households for cooking in the surveyed regions. Ownership and use of electric cookstoves (such as hot plates and ring stoves) is the highest in Addis Ababa (48%). Ownership and use of traditional enclosed stoves (4%), Upesi (2%) and Tikikil (0.5%) for cooking is limited only too few percentage of the urban households surveyed.

Stoves used for baking purposes in urban households include Open Fire, Traditional Enclosed Stoves, Gonzie and electric mitad. Open fire is the most prominent baking stove used by 41%% of urban households. In most of the regions ownership and use of Open fire for baking is between 40% and 70%. However, only about 15% of the surveyed households in Addis Ababa and none of them in Tigray use Open fire for baking. Traditional enclosed firewood stoves and electric stoves are used by about 22% of the urban households. Highest ownership of Traditional enclosed firewood stoves is in Gambella (90%) and in Tigray (60%). Electric stoves for baking is used by about 50% of households in Addis Ababa. Mirt and Gonzie stoves are used only by 5% and 1% of the urban households surveyed.

Fuels and stoves in institutions

Institutions considered under this study are universities, hospitals, schools with feeding programs and correctional facilities. During this study primary data was collected from a total number of 21 institutions including 12 universities, 9 hospitals and 4 schools with feeding programs.

The major cooking fuel in institutions is fuelwood. Next to fuelwood, electricity is the second most important fuel. More than half of the institutions studied use electricity for cooking and baking. The total annual fuelwood consumption by institutions for cooking only is estimated at 52 thousand tons per year. Open fire, electric stoves and enclosed fuelwood stoves are most common stoves in institutions.

Fuels and stoves in Enterprises

A total number of 694 hotels, restaurants and cafeterias were surveyed under this project. Charcoal is the major fuel used by 82% of the enterprises. Fuelwood and electricity are the second and third most important fuels used by 56% and 51% of the enterprises respectively. Charcoal is the most preferred fuel for cooking (70%) while fuelwood is for baking (38%). Electricity is also used by 25% and 31% of the enterprises for baking and cooking respectively.

Preferences for fuels and stoves by consumers

For households, the three most compelling factors for their preferences of fuels and stoves are price of fuel, availability of fuel, and smokelessness. Choices of fuel and stoves for institutions are mainly governed by availability of fuels, cooking speed, cleanliness and smoke level. Unlike households and enterprises, neither price of fuel nor stove was mentioned by the institutions as a major factor that determines their preferences. For enterprises availability of fuel, its cooking speed and cleanliness are factors that determine their preference for fuels and stoves. Availability and cleanliness of stoves and fuels are common factors for households, enterprises and institutions to determine their preference for fuels and stoves.

Price competitiveness of ethanol

At current price of ETB 13.99 per litre, ethanol is price competitive to LPG, kerosene and charcoal but not to electricity and fuelwood.

Potential market for ethanol fuel and stove

Major drivers for adoption of new stoves and fuels for households are price of fuels and stoves, availability of fuel, and convenience of use which includes safety, cleanliness, smoke free and speed of cooking. Households who depend on collected fuels for much of their cooking fuel requirement may not be able to afford a shift towards cleaner and costly fuels such as ethanol.

Because of change of fuel prices and availability, there is a changing trend in the choice and use of cooking fuels by households. There is a shift from use of petroleum fuels (kerosene and LPG) for cooking to charcoal and electricity.

The market potential for ethanol fuel use for cooking and ethanol stoves is estimated for households, enterprises and institutions. The current potential demand for ethanol from all sectors is estimated at 474 million litres per year of which 84% is from the household sector (18% rural and 65% urban). The current demand for ethanol cooking fuel from institutions is only about 1% of the total. The current demand for ethanol stoves is estimated at about 1.8 million. Urban households constitute nearly 80% of the demand for the stoves. Demand forecast for ethanol from all sectors for 2030 is estimated at about 780 million litres per year.

Sector	Demand for single burner	Demand for double burner	Both Single & Double burners	Effective demand for ethanol/year	Equivalent Firewood displaced/year	CO_2 reduction potential/year
	Thousands	Thousands	Thousands	Million Litre	Million Ton	Million Ton
Rural Households	131	177	308	86	0.49	0.91
Urban households	502	892	1,393	310	1.78	3.27
Enterprises	21	44	65	71	0.41	0.75
Institutions	5		5	6.8	0.034	0.06
Total				474	2.72	5.0

At current demand estimation, the potential of ethanol to reduce CO2 emission is about 5 million tons per year. Depending on the intensity of biomass harvest for fuel, use of ethanol for cooking has the potential to save from 100 to 200 thousands of hectares of forests annually.

Distribution models that worked for modern fuels should also work for ethanol fuel. Modern fuels are distributed from filling stations/neighbourhood pumps (i.e. for kerosene), and specialized outlets and supermarkets (i.e. LPG distributers). Fuels are available in different quantities either in litres for kerosene or different size bottles for LPG. Ethanol fuel dissemination can also follow the same trend. Neighbourhood pumping point might require high volume sales to be effective and might not be a choice at earlier stage of marketing the fuel. However, selling the fuel in specialized outlets and supermarkets in quantities that customers want. Volumes of ethanol that households want in a single purchase, based on responses of participants on the focus group discussion is between 5 to 10 litres. Most enterprises, however, want larger volume of purchase. The survey result shows that 55% of the enterprises prefer to purchase ethanol fuel in volumes higher than 10 litres. Supermarkets and small shops in towns would be effective for wide scale distribution of ethanol stove.

1 Introduction

1.1 Background

Ethiopia is a home for 87 million people living in an area of 1.1 million square kilometres. The population is growing at 2.6% annually and it is expected to reach 102 million by 2020. Ethiopia has a predominantly agricultural economy and 81% of the population lives in rural areas directly or indirectly employed in agriculture and other related activities[1].

The Real Gross Domestic Product (GDP) of Ethiopia for 2011/12 was Birr 507.4 billion with a nominal GDP per capita of USD 510. The main economy of the country is based on the service and agriculture sector each correspondingly contributing 45% and 44% to the GDP. The industry sectors accounts for 11.5% of the GDP. Annual general inflation for the year 2011/12 was 34%. The balance of trade has always been negative for Ethiopia. The overall balance of payment in 2011/12 recorded a deficit of USD 972 million[2].

Energy consumption in Ethiopia predominantly relies on biomass fuels which account for 92% of the total national energy consumption. Total energy consumption from all sources for 2010 was 30,439,552 toe. The household sector accounted for 93% of the total energy consumption of which 99% came from biomass. Transport sector accounted for 5.6% of the total energy consumption followed by Industry and construction which together accounted for 0.83%. The share of the service sector in the energy consumption was 0.9% of which 75% was obtained from biomass[3].

One of the most critical energy sector issues at the moment is to ensure a sustainable and reliable supply of cooking fuel to the households and enterprises. Current practice of fuelwood harvesting for cooking is not sustainable in Ethiopia and its negative environmental and health consequences are immense. Studies indicated that if current trend of firewood management continued, the demand for firewood will rise by 65% deforesting an area of 9 million hectare of forestland between 2010 and 2030[4]. The government of Ethiopia believes that wide scale dissemination of clean and energy efficient cookstoves, and making substitute cooking fuels from renewable energy sources available to consumers would curb the foreseen disaster. To this effect, the energy sector development program for 2010 to 2015 provided due consideration to cooking energy demand and planned to address issue by disseminating energy efficient cookstoves, introducing modern fuels such as biomass briquettes, sustainably produced charcoal, and biofuels[5].

Cookstoves that have been widely disseminated in the country are mainly improved fuelwood cookstoves. Various types of improved firewood cookstoves, locally manufactured or imported ones, are being promoted by government, several development partners and private enterprises. Promotion of alternative cooking fuels such as electricity, briquetted biomass fuel and liquid biofuels has been limited. Electric cookstoves manufacturing and distribution is mainly done by the private sector. Current electricity tariff has given an opportunity for electric cookstoves to be competitive to solid biomass fuel. Adoption of electric cookers by households has been the highest than ever. Even though biofuels, particularly ethanol, is given due consideration by government, coordination among the various promoters need further

[1] CSA, Population Projection of Ethiopia for all Regions at Woreda level from 2014-2017, August 2013
[2] National Bank of Ethiopia, Annual Report for 2011/12.
(http://nbebank.com/admin/filesystem/index.php?news=156) Accessed date 14 August 2014
[3] Ministry of Water, Irrigation and Energy, Energy Balance for years 2005/06 to 2009/10, August 2011.
[4] Ethiopian Climate Resilient Green Economy, Green Economy Strategy, 2011
[5] Ministry of Water and Energy, 2011. Strategic Plan for 2011 to 2015.

improvement to ensure reliable supply of the fuel and appropriate cookstoves with prices affordable to consumers. The most economical application of ethanol need to be well understood by major stakeholders. The current market for ethanol is mainly for gasoline blending. Better understanding of the economic, social and environmental benefits of various applications of ethanol will help pragmatic allocation of it to various end uses.

Efforts in promoting wide scale dissemination of ethanol for household cooking has been hindered by unreliable or unpredictable supply of fuel, high cost of stove and fuel that disfavour its use for cooking[6]. Competitive marker for ethanol currently is demand for gasoline blending which may go from 7 to 15 million litres per year with an annual demand growth rate of about 7%. If biodiesel development from plant oil starts, transesterification process may demand up to 1.6 million litres per annum (Kassa, 2007). Demand for ethanol in the automotive fuel could be a threat for its use for cooking in the short term. However, the medium to long term expansion plan of sugar industries for the supply of ethanol could make sufficient ethanol available for cooking. Supply side of ethanol fuel can also be enhanced through distributed production using micro distilleries. A preliminary assessment for viability of alternative feedstock and small scale production of ethanol using micro distilleries was conducted[7]. The study indicated that production of ethanol from molasses is the most viable option and its price can be competitive to LPG and kerosene. Knowledge of alternative feedstock for ethanol production is limited and estimation of true cost of ethanol requires a thorough assessment for availability and seasonality of feedstock as well.

1.2 Objectives

General Objective

The overall objective of the Project is to contribute to the development of the bio-ethanol sub-sector in Ethiopia by analysing the feasibility of ethanol micro distilleries and ethanol fuel for cooking.

Specific Objectives

The specific objective of the assignment is to provide a comprehensive analysis of the Ethiopian cooking market including:

- Fuels and devices in use,
- Consumption and expenditures,
- Consumer preferences and willingness to pay,
- Estimate market size for ethanol fuel and stoves,
- Analyse the cooking fuels and devices competitive landscape,
- Distribution channels, and
- Mapping out of key stakeholders and their roles and potential contributions in ethanol fuel and stove market development.

[6] Mekonnen Kassa, 2007. Business plan for ethanol cooking fuel and Dometic CC stove market Development in Addis Ababa, Ethiopia, Partners Consulting and Information Service, January 2007.
[7] Feasibility Assessment for Ethanol Micro Distillery in Ethiopia, ERG, January 2012

2 Methodology

This assignment is part of a comprehensive feasibility of assessment for the Ethanol Micro Distillery in Ethiopia. This component of the study mainly focuses on the estimation of the demand and viability of ethanol use for cooking in the households, businesses and institutions.

Qualitative and quantitative data were collected from households, enterprise and institutions.

1. The study is conducted in households, institutions and businesses using a standard questionnaire based survey. It was conducted in a total number of 4521 households, 694 businesses and 25 institutions (12 Universities, 9 hospitals and 4 schools). The samples were proportionally distributed in all Regions in the country covering both urban and rural settlement. The purpose of this survey was to collect data on energy use (cooking, baking, lighting,); energy supply and access constraints (such as biomass fuel collection time and effort by women and girls); exposure to indoor air pollution and other health hazards; and to determine the market potential for use of ethanol as household cooking fuel including the ability and willingness to pay for improved cookstoves and ethanol stoves. See Annex for the questionnaire.

2. Focus group discussions (FGD) were used to gather mainly qualitative data on energy access issues in the surveyed areas. The objective of the discussions was to get insight into household energy use, supply and issues related to household cooking.

3. Market survey for fuels was done in all the Wereda capitals where the surveys were conducted for the household energy survey. Local market surveys were carried out to collect information on local weight and volume measures, and fuel prices. Local weight measurements were used to convert weights in local measures from the household energy survey into standard weight and volume measures (kg, litres). Price data is used to evaluate and compare the cost of energy supply to households and other users. See Annex for data collection forms.

4. Stakeholder interview –Relevant Federal and Regional government organization including Ministries, Regional and Wereda level agencies (Water and Energy, Agriculture, etc) were consulted regarding energy issues and options in the Weredas. This was done using a pre-prepared discussion check list (see Annex).

3 Review of Policies, strategies and plan

A. Review of Policies

i. National Energy Policy

The first Ethiopian National Energy Policy that has been followed thus far was formulated in 1994. Being cognizant of the limitation of the policy to address the current energy situation, the Government of Ethiopia drafted an updated Energy Policy in February 2013. The rationale for the need to update the energy policy was to align energy sector development strategies to the current national development strategies, and also to give emphasis to the development and utilization of renewable energy sources that support the climate resilient green economy strategy of the country. The updated energy policy has clearly put directions to guide energy sector development strategies and plans to meet the growing and changing energy demand of the citizens by taking technological advancements that make new fuels and energy conversion technologies into consideration.

The main energy policy goal is to ensure the availability, accessibility, affordability, safety and reliability of energy services to support accelerated and sustainable social and economic development and transformation of the country. Increased use of modern energy sources to the extent of making the country a regional hub for development and utilization of renewable energy resources is articulated as one of the major strategies that would ensure energy security and environmental sustainability. The Energy Policy clearly stated the need for developing renewable energy resources and substitution of fossil fuels and traditional energy use in the household and other sectors of the economy. Strengthening of the energy sector governance and establishment of strong energy institutions are also given due attention under the new energy policy of the country.

Major energy issues that the updated energy policy aims to highlight and address includes:

- *Energy scarcity*
- *High dependence and unsustainable use of biomass resources*
- *Wasteful and inefficient energy production, transportation and utilization*:
- *Low institutional, human and technological capacity*:
- *Low private sector participation*
- *High dependence on imported petroleum fuels*
- *Climate change impacts on national development and energy sector strategy issues*
- *Weak enforcement* of Standards and Regulations
- Inadequate transfer of technology and localization

The policy acknowledges that delivery of alternative energy supplies would help increase the national energy supply mix and also reduce the burden on the biomass resources. In terms of biomass resource development, the updated policy clearly puts the objectives and the policy instruments to help development and efficient utilization of solid biomass and modern biomass fuels including bio-ethanol.

Major policy instruments that are stated in the energy policy included active engagement of energy cooperatives and the private sector in sustainable energy service delivery, enhancement of renewable energy production and conversion. Introduction of small, medium and large scale bio-fuel processing technologies through enhancement of the transfer and adoption of efficient and cleaner energy technology is one of the highlights of the policy instruments. For acceleration of

wide scale dissemination of renewable energy technologies and to make them affordable for the majority of the citizens, the policy has put favourable import duties on renewable energy conversion technologies and end-use devices as one of the policy instruments. In order to ensure reliability of supply, efficient and safe utilization of energy technologies and resources, the policy highlighted the need for establishment and enforcement of standards and quality control. For better formulation and implementation of energy policies, and improvement of their operational efficiency and effectiveness, the energy policy emphasized on the need for strengthening the capacity of energy sector governance institutions.

Specific policy instruments for the development and utilization of biofuel (bioethanol) include:

- *Introduction of small, medium and large scale bio fuel processing technologies.*
- *Encouragement of the development of local capacities for bio energy equipment and appliance manufacturing*
- *Enhancement of technology transfer for bio energy technologies including second generation bio-fuel processing.*
- *Support to the private sector for its involvement in productions of bio energy technologies.*
- *Expand the production of ethanol to ensure security of supply and as substitute for imported petroleum fuels. Introduce diverse household energy alternative fuels and technologies such as improved and efficient lighting technologies, domestic biogas, electricity, biofuels, solar cookers, and kerosene end-use devices.*
- *Promote alternative fuels for rural areas: bio-fuels, biogas, solar cookers, and electricity.*
- *Enhance bio-fuels development*
- *Facilitate the use of efficient household service and industrial sector appliances and technologies for bio energy, electricity and others.*

Ethanol development and use for household cooking is very much in line with the national energy policy provided that it is produced and utilized in environmentally benign manner. Ethanol development and supply improves the energy supply mix enhancing supply reliability and security, increases development and utilization of indigenous renewable energy resources by shifting away from traditional energy use to modern energy sources, helps improve energy efficiency in use, and, increases local dependency for the supply of modern energy sources. Small scale ethanol development encourages participation of local communities and the private sector in the energy sector development program of the country.

Even though the updated energy policy addresses most of the current energy issues, implementation limitations are widely observed in the energy sector development. While the policy clearly puts the policy instruments supportive to the realization of RETs, communication and coordination with sector organizations is lacking. Necessary institutional capacity building works are lugging behind rendering required institutional supports unavailable to facilitate and implement identified policy instruments. The reflection of this has been manifested in the effort towards the development of biofuels themselves and their conversion and end-use technologies. Inconsistent treatment of renewable energy technologies is also widely observed. Energy conversion technologies and end-use devices for solar and wind resources are benefiting from favourable import taxes while technologies for conversion and utilization of biomass and

biofuels are not[8]. Ethanol being an indigeous renewable energy source, the production and end use technoloiges of which should also be treated like solar and wind technoloiges. Communication gaps between implementing institutions is the primary reasons for limitations for proper implementation of policy instruments. Necessary standards and quality control mechanisms for renewable energy sources/fuels and conversion technologies should be put in place so that the policy objectives would be maintained. Institutions established to set regulations for products standards and qulities need the necessary capacity builidng support to facilitate and ensure reliable supply of energy services.

ii. Health Policy

Relevant health policy statements

The government of Ethiopia has adopted its Health Policy in September 1993. The Health Policy of Ethiopia emphasizes the importance of achieving access to a basic package of primary health care services by all groups of the population through decentralized state of governance. The health policy stipulates that the health services should include preventive, promotive and curative components. Components of the health policy also include promotion and strengthening of inter-sectoral activities, and promotion of attitudes and practices conducive to the strengthening of national self-reliance in health development by mobilizing and maximally utilizing internal and external resources.

One of the main health policy priorities that emphasis is given to is the development of environmental health with special attention given to health needs of families particularly to women and children. The general strategy of the health sector gives emphasis to:

1. **Promotive and preventive activities** to prevent environmental pollution with hazardous chemical wastes, and control common endemic and epidemic communicable and nutritional diseases using appropriate general and specific measures.

2. **Inter-sectoral collaboration** in developing measures to improve the quality of housing and work premises for health

3. **Health Education** to bring attitudes of responsibility for self-care, assurance of safe environment, personal hygiene and healthy environment, participation of community health development, and discourage harmful traditional practices

Promotion of ethanol fuels for household cooking helps achieve major Health Policy objectives related to environmental health as it improves the quality of house and work premises for health and addresses health needs of women and children who are most exposed to hazardous indoor air pollution and burns during cooking with traditional fuels.

[8] A directives for duty tax exemption for renewable energy technologies passed to Ethiopian Revenues and Customs Authority listed Solar and Wind technologies with the balance of system but not included technologies for biomass and biofuels (Source: Directive for duty free exemption for RETS, Letter dated 07/04/2002 EC (16Dec2010), Ref.No. - ማኢ.30/47/1..

iii. Education and Training Policy

The government of Ethiopia issued its Education and Training Policy in 1994. The primary objective of the Policy is to achieve universal primary education by the year 2015. Other most relevant objectives of the Education and Training Policy are:

Specific Objectives

1. To develop and enrich students' inquisitive ability and raise their Creativity and interest in aesthetic.
2. To enable both the handicapped and the gifted learn in accordance with their potential and needs.
3. To satisfy the country's need for skilled manpower by providing training in various skills and at different levels
4. To make education, training and research be appropriately integrated with development by focusing on research.
5. To make education a supportive tool for developing traditional technology, and for utilizing modern technology.
6. To provide education that can produce citizens who possess national and international outlook on the environment, protect natural resources and historical heritages of the country.

In order to achieve the objectives of the Education and Training Policy, a multi-year education sector development program (ESDP) has been formulated and implemented through a series of five-year programs. One of the main components of the ESDPs has been the food for education program in school, which the government implements in partnership with the United Nations World Food Programme. School feeding program started by the World Food Program in 1994 in war affected zones and most food insecure areas of Ethiopia. Through the Education Sector Development Programmes school meal programs are extended further to areas with chronic food insecurity, lower enrolment and higher gender disparity. Currently the program covers six regions including Afar, Amhara, Oromiya, SNNPR, Somali and Tigray in over 1,300 schools.

Expansion of higher education institutions has increased through a series of education sector programmes to increase access to higher education. Currently, there are over 32 higher education institutions with boarding facilities distributed in all regions of the country.

Promotion of ethanol fuel development and utilization is in-line with the education policy as it provides alternative clean cooking energy source that helping the realization of the school feeding programs and promoting cleaner cooking fuels in higher education institutions where food preparation is mostly done with traditional fuels in unsustainable manner.

B. Energy sector strategies and plans and the relevance for ethanol production and use for cooking

i. The Growth and Transformation Plan (2010 – 2015)

Biofuels development and utilization is given due emphasis in the first Growth and Transformation Plan (GTP) of Ethiopia. Regarding development of ethanol the GTP target to increase production to nearly 189 million litres at the end of the planning year. The strategy plan envisages development of large scale sugar industries by the government and the private sector

which would also produce the targeted amount of ethanol. As an implementation strategy the GTP also promotes distributed production of brogues at farmers scale in rural areas.

Ethanol is primarily considered for transport fuel in the plan but it is also inferred from the plan that it can be one of the alternative sources of cooking energy which would reduce deforestation, indoor air pollution and also contribute to saving working time of women and children wasted for searching, collection and transportation of cooking fuels.

ii. Ethiopia's Climate Resilient Green Economy (CRGE)

Degradation of forest resources due to unsustainable harvest of biomass for cooking is one of the major problems identified in the CRGE. The household energy sector particularly cooking energy situation has been identified as an opportunity to make significant environmental and social impacts by reducing the demand for fuelwood which would, in turn, reduced emissions and unsustainable harvest of biomass resources.

To achieve this, the strategies devised are wide scale dissemination of fuel efficient cookstoves and shift to other alternative cooking energy sources with less carbon intense fuels. The CRGE has put deployment of 9 million clean and efficient cookstoves as its short term target for 2016. The long term target of the CRGE is 2030 and envisages a deployment of 31 million clean and efficient cookstoves[9]. Among clean cookstoves, electric, biogas and Liquefied Petroleum Gas (LPG) are explicitly mentioned as alternative energy sources. However, even though it is not explicitly mentioned in the CRGE, use of ethanol as cooking energy would address issues of efficient utilization of the resources, clean cooking and alternative renewable energy source development and use.

iii. National Program for Improved Cookstoves Development and Promotion in Ethiopia

The program intends to support the dissemination of 9 million improved cookstoves in Ethiopia up to 2016 through building sustainable and vibrant market for improved cookstoves and institutional capacity[10]. The goal of the program is to contribute to realization of the Climate Resilient Green Economy (CRGE) vision of reducing emissions from deforestation and forest degradation and ensuring access to clean energy. With regard to cooking energy, the CRGE has put a short term and a long term targets. The short term target, defined to time period up to 2016, seeks to deploy 9 million stoves while the long term target (for 2030) aspires dissemination of 31 million clean and efficient cookstoves. The program for ICS development and promotion is an investment plan designed to achieve the short term target outlined in CRGE which is the deployment of nine million fuel efficient cookstoves.

iv. The Biofuels strategy of Ethiopia

To ensure sustainable development and utilization of biofuel, the Government of Ethiopia released the biofuels development and utilization strategy. The Biofuels strategy provides an

[9] Federal Democratic Republic of Ethiopia, Ethiopia's Climate Resilient Green Economy, Green Economy Strategy, 2010

[10] Ministry of Water, Irrigation and Energy, National Program for Improved Cookstoves Development and Promotion in Ethiopia, November 2012.

implementation guideline in order to ensure the achievements of the national energy policy objectives while avoiding unintended consequences.

A Biofuel Development and Utilization Strategy has been formulated by the Ministry of Mines and Energy in October 2007. The overall objective of the strategy is to facilitate adequate production of biofuel from indigenous resources so as to substitute imported petroleum and export excess products.

The strategy is formulated based on principles that development of biofuels should not have unintended consequences on food security, land access, the environment, cultural values and the economy. The strategy has also clearly outlined the need for participation of local communities (farmers, pastoralists and the private sector) in development of biofuels so that they can be beneficiaries of the development. The biofuels strategy document identified some energy crops such as sugarcane, jatropha, castor and palm trees as potential feedstock for ethanol and plant oil production for energy use. Other appropriate feedstock can also be considered as long as they fulfil the sustainability criteria emphasized under this strategy and the general environmental policy of Ethiopia. The biofuels strategy, however, provides greater emphasis for utilization of biofuels, particularly ethanol, mainly in the transport sector while the household sector is deemed more economically feasible and a technically viable option. The strategy needs to see the best possible options of using biofuels and accordingly provide the necessary support for wide spread use of them. When strategies are not aligned to the policy objectives, unintended results could happen. Ethanol fuel, as an indigenous and renewable energy resource, is intended to substitute petroleum. In action, however, policy instruments such as pricing disfavour ethanol. In the price structure of fuels, kerosene is exempted from value added tax while ethanol is not. This will affect the market development effort for ethanol in the household sector. Hence, price setting for ethanol for cooking fuel use should be consistent and in support of the policy.

The current five-year strategic plan of the Ministry of Water, Irrigation and Energy sets the direction and targets for the energy for the period 2011-2015. This plan forms part of the Growth and Transformation Plan (GTP). The main actions and targets for the power sector include increasing generation capability for grid by four times from 2 GW to 8 GW, doubling the length of the distribution network, and doubling the number of customers on the grid. The other major plans are to provide access to electricity to 3 million households and institutions through PV systems, disseminating 9 million improved cook stoves, and increasing production and use of liquid biofuels[11].

[11] Ministry of Water and Energy, 2011. Strategic Plan for 2011 to 2015 (Amharic)

4 The Energy Sector

Energy resources in Ethiopia are predominantly of renewable sources consisting of hydropower (45 GW), wind (100 GW), geothermal (7 GW), bio energy (96 M.tons yield/year) and solar energy (5.5 kWh/m^2per day)[12]. Known reserves of coal and natural gas resources are estimated to about 320 million ton and 4.7 tons of cubic foot respectively[13]. The country heavily relies on bioenergy resources to meet its energy demands. However, development of other renewable resources, principally hydropower and wind is now growing rapidly, and these are expected to supply a growing share of the energy demand in the future.

Ethanol from molasses is a new fuel introduced in Ethiopia a decade ago. It has been increasingly produced and used mainly as transport fuel blended with gasoline. Its use as a household cooking is limited but continuously increasing. The average annual ethanol production by the sugar factories from 2009 to 2013 has been about 8 million litres. About 97% of the ethanol produced during these years was consumed as transport fuel. The remaining 3% has been shared among various uses including beverages, clinical applications and cooking fuel in the households. Use of ethanol for cooking fuel has been between 250 to 600 thousand litres annually[14]. According to information from Ethiopian Sugar Corporation, ethanol production in 2014 has reached 27 million litres. On completion of on-going expansions of existing sugar estates and planed development for new ones would increase annual production of ethanol over 134 million litres by end of 2016. This would provide surplus ethanol than the existing market can absorb.

4.1 Cooking fuel supply and consumption

Major energy demand in the household sector is mainly for cooking and baking. Households both in rural and urban areas mainly depend on biomass fuels for their cooking and baking activities. Biomass is used by 99% of rural and 84% of urban households for cooking[15] (CSA 2012). Firewood is the prominent biomass fuel used by the households. Other biomass such as dung and agri-residue contribute to a relatively smaller portion of the cooking energy demand.

Table 4.1 Percentage of households by region and type of cooking fuel use (WMS, CSA 2012)

Region	Firewood		Charcoal		Kerosene		Electricity		Others	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Country	63.31	90.85	17.54	0.23	4.93	0.17	6.18	0.01	8.04	8.74
Tigray	77.95	84.16	1.04	0.2	0.66	0.1	13.3	0.09	7.05	15.45
Afar	69.37	94.69	26.51	3.48	0.2	0	0.7	0	3.22	1.83
Amhara	78.49	82.2	13.66	0.38	2.53	0.06	0.85	0	4.47	17.36
Oromia	74.44	94.07	9.87	0.12	2.3	0.35	3.33	0	10.06	5.46
Somali	42.22	94.76	54.08	1.04	0.16	0	0	0	3.54	4.2
Benishangul	86.85	98.85	5.63	0.39	0.77	0	0.66	0	6.09	0.76
SNNP	80.96	96.45	9.13	0.05	1.56	0	1.01	0	7.34	3.5
Gambella	79.36	99	13.18	0.14	0.14	0	0.14	0	7.18	0.86
Harari	30.03	98.16	48.58	0	12.51	0.33	4.7	0	4.18	1.51
Addis Ababa	20.72	0	36.57	--	14.52	0	17.78	0	10.41	--

[12] Ministry of Water, Irrigation and Energy

[13] Ethiopian Institute of Geological Survey, Minerals Exploration and Potential Estimation Core Process under Ministry of Mines, (EIGS-MEPE)

[14] MWIE, Biofuels Directorate, July 2014

[15] CSA, WMS, 2012. Statistical Report for 2011, Vol. 2.

Dire Dawa	32.53	96.93	47.39	0.33	13.73	1.75	0.27	0	6.08	0.99

Next to firewood, charcoal is the second most important cooking fuel used by 17.5% of the households in Ethiopia. It is primarily a fuel for the urban households. Only less than 1% of rural household in Ethiopia use charcoal. Unlike firewood, the percentage of charcoal using rural households greatly varies among the regions. More rural households in Amhara, 3.5%, use charcoal for cooking as compared to less than 1% in the other regions. Charcoal usage in the Eastern part of Ethiopia is higher with about 50% of urban households in Somali and Hariri using it.

Kerosene is used by about 5% of the urban households, mainly in Addis Ababa, Dire Dawa and Hariri. Compared to other regions, relatively higher percentage of urban household in Addis Ababa (18%) and Tigray (13%) use electricity for cooking. Use of non-traditional fuels, kerosene and electricity, is primarily limited by access to the fuels and their relative price differences to traditional fuels.

Mode of acquisition of firewood by urban and rural households is distinct. Over 95% of rural households obtain their firewood by free collection. On the contrary most urban households purchase firewood. With the exception of households in Dire Dawa, Benishangul and Somali, the proportion of urban households that purchase firewood is greater in all the other regions.

Table 4.2 Proportion of purchased firewood by the households (WMS, CSA 2012)

Region	Urban	Rural
Country	71%	4%
Tigray	73%	6%
Afar	59%	1%
Amhara	67%	6%
Oromia	72%	3%
Somali	43%	4%
Benishangul	42%	2%
SNNP	73%	3%
Gambella	56%	0%
Harari	50%	1%
Addis Ababa	85%	0%
Dire Dawa	30%	4%

5 Demographic and Socio-economic characteristics of households in the surveyed Regions

Demographic and socio-economic characteristics of households

A forecast by CSA indicated that the population of Ethiopia in 2014 is estimated at 88 million. About 81% of the population is rural. The three largest regions, Oromia, Amhara and SNNP, constitute about 80% of the population of the country. Average households size is 4.7 with a minimum of 4.2 in Addis Ababa and a maximum of 6.5 in Somali. In general, rural household size is slightly larger than that of urban households.

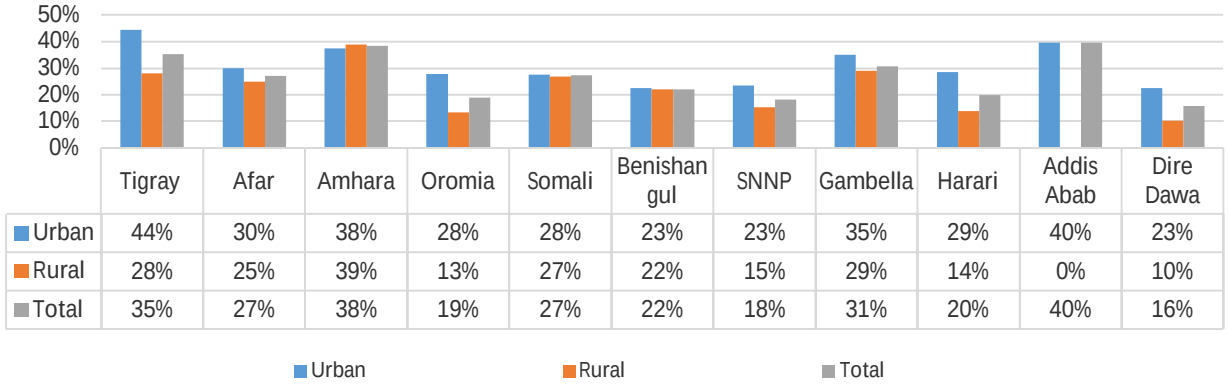
Table 5.1 Population in 2014 by region and settlement[16]

Region	Population			No. of Households			Household size		
	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural
Tigray	4,960,003	1,200,000	3,760,000	1,136,900	341,762	811,046	4.4	3.5	4.6
Afar	1,678,000	289,000	1,389,000	296,716	71,573	230,499	5.7	4.0	6.0
Amhara	20,018,988	3,127,000	16,892,000	4,609,151	911,600	3,744,448	4.3	3.4	4.5
Oromia	32,815,995	4,647,000	28,169,000	6,826,741	1,218,316	5,646,329	4.8	3.8	5.0
Somali	5,307,002	763,000	4,544,000	815,241	124,939	690,528	6.5	6.1	6.6
Benishangul	975,998	189,000	787,000	216,166	50,587	168,632	4.5	3.7	4.7
SNNP	17,837,005	2,707,000	15,130,000	3,703,843	650,922	3,086,471	4.8	4.2	4.9
Gambella	396,000	124,000	272,000	84,983	31,394	54,804	4.7	3.9	5.0
Harari	226,000	125,000	101,000	57,194	35,523	21,845	4.0	3.5	4.6
Addis Ababa	3,195,000	3,195,000	--	764,031	764,031	--	4.2	4.2	--
Dire Dawa	427,000	268,000	159,000	95,386	62,263	32,466	4.5	4.3	4.9
Special Woredas	116,001	41,000	75,000	21,331	8,848	12,765	5.4	4.6	5.9
Country	87,952,992	16,675,000	71,278,000	18,627,682	4,271,759	14,499,834	4.7	3.9	4.9

The result of the survey conducted during this study indicated that considerable proportion of the households, between 16% and 40%, are female headed. Percentages of female headed households are generally higher in urban settlements than in rural. Highest proportion of female headed households are observed in Addis Ababa closely followed by households in Amhara and Tigray Regions. Harari households have lower percentage of female headed households.

[16] CSA, Population Projection of Ethiopia for all Regions at Woreda level from 2014-2017, August 2013

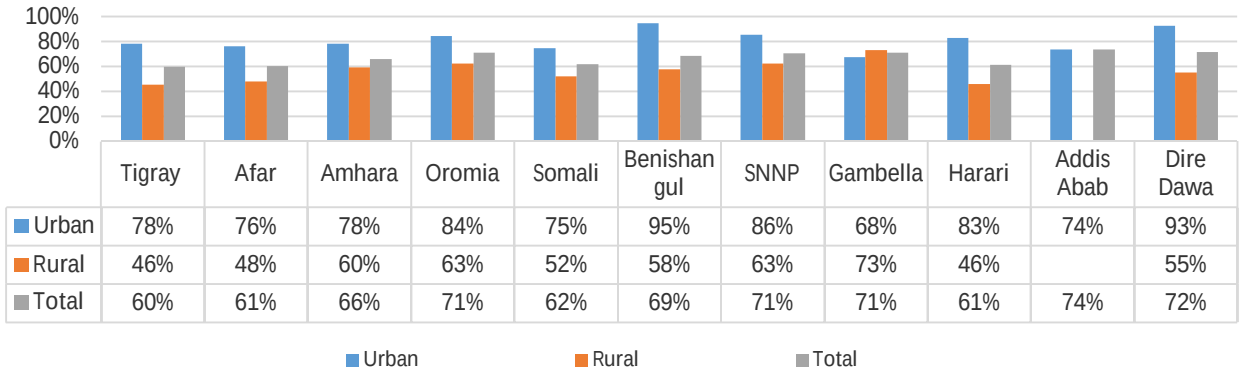
Figure 5.1 Distribution of female headed households by region and settlement



	Tigray	Afar	Amhara	Oromia	Somali	Benishangul	SNNP	Gambella	Harari	Addis Abab	Dire Dawa
Urban	44%	30%	38%	28%	28%	23%	23%	35%	29%	40%	23%
Rural	28%	25%	39%	13%	27%	22%	15%	29%	14%	0%	10%
Total	35%	27%	38%	19%	27%	22%	18%	31%	20%	40%	16%

The majority of the household heads in the surveyed areas are able to read and write. Over 70% of the household heads in Addis Ababa, Dire Dawa, Oromia, SNNP and Gambella read and write. The percentage of household heads who read and write is higher in urban areas than in rural areas.

Figure 5.2 Distribution of households by head of households who are able to read and write



	Tigray	Afar	Amhara	Oromia	Somali	Benishangul	SNNP	Gambella	Harari	Addis Abab	Dire Dawa
Urban	78%	76%	78%	84%	75%	95%	86%	68%	83%	74%	93%
Rural	46%	48%	60%	63%	52%	58%	63%	73%	46%		55%
Total	60%	61%	66%	71%	62%	69%	71%	71%	61%	74%	72%

Survey results indicated that average land holding size of the surveyed households is between 0.5 and 1 hectare. Land holding size is generally greater in rural households except in Amhara and Somali regions where rural land holding size are less than a third of a hectare. This also explains why employment in household farms in these regions provided less employment opportunity.

Table 5.4 Average land hold size of household in the surveyed region by settlement (hectares)

Region	Urban	Rural
Tigray	0.04	0.53
Afar	0.01	0.80
Amhara	0.03	0.61
Oromia	0.10	1.12
Somali	0.71	0.28
Benishangul	0.13	0.76
SNNP	0.11	1.08
Gambella	0.13	1.11
Harari	0.07	1.00
Addis Ababa	0.00	--
Dire Dawa	0.03	0.67

Gaia Association, Ethanol feasibility Survey, 2014

According to HCE (CSA, 2012), average total annual expenditure of households in Ethiopia ranged from ETB 9,168 in the first quintile to ETB 32,351 in the fifth quintile. Annual household expenditure in the lowest quintile was under ETB 12,000. Average expenditure of a household in the most affluent segment of the population was over three times higher than the average expenditure of a household in the lowest wealth group of the first quintile.

Table 5.6 Household Expenditure Quintiles (Country Level)[17]

Quintile	% of hh	Annual Household Expenditure (Birr)		
		Lower Limit	Upper Limit	Range
1	20	9,167.69	12,329.87	3,162.18
2	20	12,329.88	18,046.62	5,716.74
3	20	18,046.63	23,306.08	5,259.45
4	20	23,306.09	29,774.83	6,468.74
5	20	29,774.84	32,351.26	2,576.42

HCE, CSA 2012

Total average household expenditure significantly varies by region and settlement. Total expenditure is higher in urban households compared to that of rural households. In certain regions such as SNNP, Dire Dawa, and Gambella the difference between urban and rural households is larger than the other regions. Among rural households, highest total average expenditure of about ETB 24,400 was observed in rural Amhara while the least was in rural Dire Dawa. Average expenditure of ETB 48,868 by urban households in SNNP was the highest from all regions.

[17] CSA, HCE Survey 2010/11, Analytical Report, October 2012

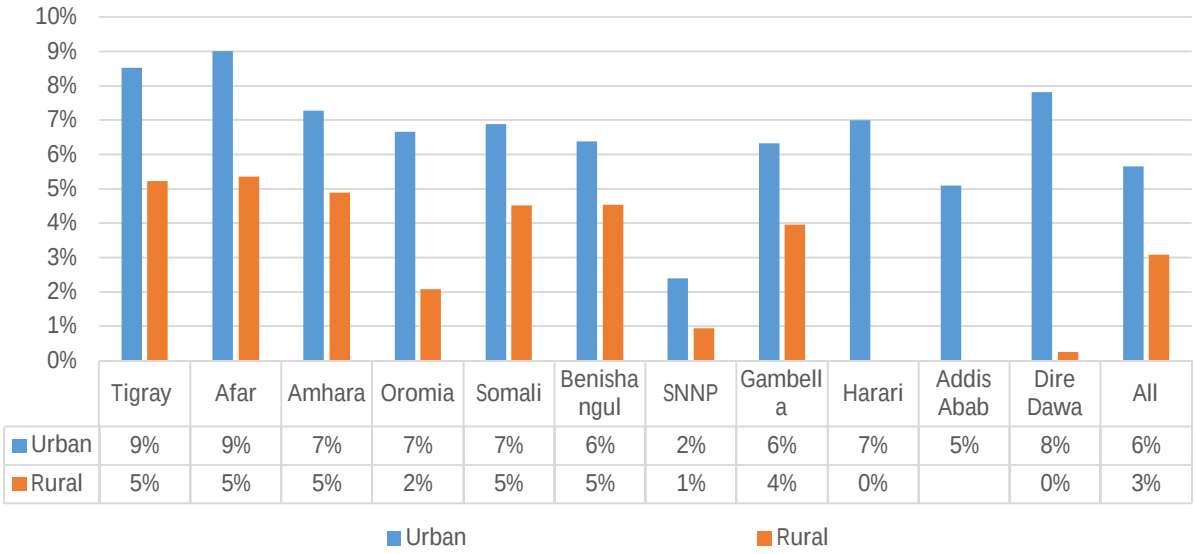
Table 5.7 Average total expenditure of households on cooking and baking fuels by region (ETB/year)

Region	Urban			Rural		
	Other	Cooking Fuel	Total	Other	Cooking Fuel	Total
Tigray	16,618	1,549	18,167	14,731	813	15,544
Afar	15,643	1,548	17,190	14,021	794	14,815
Amhara	16,090	1,263	17,353	19,177	988	20,165
Oromia	16,984	1,213	18,197	13,771	292	14,063
Somali	15,172	1,120	16,293	11,914	565	12,478
Benishangul	15,649	1,067	16,716	13,832	656	14,489
SNNP	42,071	1,036	43,107	17,220	163	17,383
Gambella	24,802	1,677	26,480	14,333	590	14,924
Harari	12,984	978	13,963	11,782	-	11,782
Addis Ababa	19,314	1,039	20,353	-	-	-
Dire Dawa	18,041	1,530	19,572	9,361	24	9,384
All	21,356	1,278	22,634	15,818	504	16,322

Gaia Association, Ethanol feasibility Survey, 2014

The proportion of expenditure on cooking fuel to the total average expenditure is about 6% and 3% for the urban and rural households respectively.

Figure 5.3 Percentage of expenditure on cooking fuel over total household expenditure



	Tigray	Afar	Amhara	Oromia	Somali	Benishangul	SNNP	Gambella	Harari	Addis Abab	Dire Dawa	All
Urban	9%	9%	7%	7%	7%	6%	2%	6%	7%	5%	8%	6%
Rural	5%	5%	5%	2%	5%	5%	1%	4%	0%		0%	3%

Proportion of expenditure on cooking fuels was relatively higher for households in Tigray and Afar. This might be due to scarcity of cooking fuels such as firewood and charcoal. However, in SNNP, the proportion of expenditure on cooking fuels over total expenditure was the minimum.

Table 5.8a Annual total expenditure of urban households by expenditure quintiles and region

Region	Urban Household Expenditure Quintiles				
	1	2	3	4	5
Tigray	7730	12267	15604	20040	30598
Afar	7958	12896	15777	20027	28127
Amhara	7942	12259	15883	19925	33441
Oromia	8411	12513	15824	20140	31920
Somali	9199	11901	15945	19878	28626
Benishangul	7786	12420	15673	19861	28742
SNNP	8520	12654	15884	19990	30867
Gambella	6650	12089	15332	20660	36895
Harari	9327	12102	15858	19256	27360
Addis Ababa	8383	12475	15791	20289	32246
Dire Dawa	10528	12362	16000	19679	31713
All	8403	12358	15779	19977	30958

Gaia Association, Ethanol feasibility survey 2014

Table 5.8b Annual total expenditure of rural households by expenditure quintiles and region

Region	Rural Household Expenditure Quintiles				
	1	2	3	4	5
Tigray	8142	12392	15881	20357	29177
Afar	6454	12224	16170	19531	32588
Amhara	7415	12387	15687	19933	48765
Oromia	8349	12361	15730	19890	30304
Somali	8134	12154	15749	19953	26317
Benishangul	7467	12186	15488	20357	30361
SNNP	8321	12421	15913	19895	32491
Gambella	7934	12116	16009	20176	28117
Harari	8554	12756	15876	19906	28321
Dire Dawa	6943	12522	15855	18554	23092
All	7771	12352	15836	19855	30953

Gaia Association, 2014

6 Technical analysis on current use of cooking fuels and devices

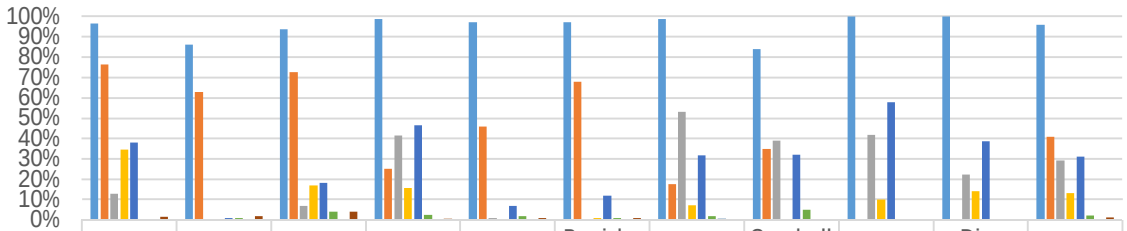
This section of the report discusses the current use of cooking fuels and cooking devices by the households, social institutions and enterprises in both rural and urban areas surveyed. It mainly deals with the types of main cooking and baking fuels, how they are acquired, amount spend for cooking fuels, consumers preferences for existing fuels and devices for various end uses.

6.1 Cooking fuels and stoves in rural households

6.1.1 Cooking fuel supply and expenditure in rural household

Current use of fuels and cookstoves by the households in the rural areas surveyed very much depend on availability and price of fuels. Even though there is significant variation in the types of fuels use among the regions, fuelwood is the most widely used fuel for cooking and baking. On average, about 96% of the rural households in all the regions use fuelwood. Next to fuelwood, charcoal is the second most common fuel for the rural households. The survey result shows that about 41% of the rural households use charcoal mainly for non-baking end uses. However, it should be noted that the CSA result for percentage of charcoal user rural households in 2011 was only 0.23%. Higher percentage figure of charcoal user rural households in the survey could be due to consideration of households that use left-over embers from fuelwood burning as charcoal. Moreover, the CSA data considers only household that use the particular fuel as main cooking fuels. It does not seem to include households as users of the fuel if the fuel is not a major cooking fuel for them.

Figure 6.1.1 Distribution of rural households by type of fuels used for cooking and baking



	Tigray	Afar	Amhara	Oromia	Somali	Benishangul	SNNP	Gambella	Harari	Dire Dawa	All
Fuelwood	97%	86%	94%	99%	97%	97%	99%	84%	100%	100%	96%
Charcoal	77%	63%	73%	25%	46%	68%	18%	35%	0%	0%	41%
BLT	13%	0%	7%	42%	1%	0%	53%	39%	42%	22%	29%
Dung	35%	0%	17%	16%	0%	1%	7%	0%	10%	14%	13%
Crop residue	38%	1%	18%	47%	7%	12%	32%	32%	58%	39%	31%
Kerosene	1%	1%	4%	3%	2%	1%	2%	5%	0%	0%	2%
LPG	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
Electrcity	2%	2%	4%	1%	1%	1%	0%	0%	0%	0%	1%

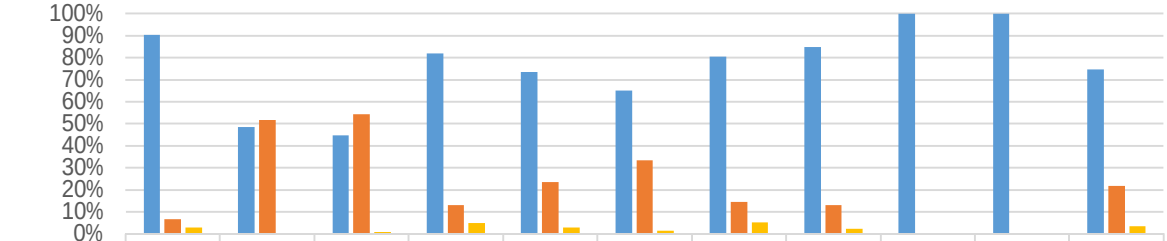
Charcoal usage by the rural households is the highest in Tigray (77%) and the lowest in Oromia (25%). Rural households obtain charcoal mostly from the left over embers from firewood burning to use it for coffee or tea boiling. Crop residues and Branches, leaves and twigs (BLT) are used almost by a third of the rural households even though use of crop residues is available only seasonally. Use of other fuels is limited in rural areas. Even though the average of dung using households in all regions is only 13%, more

than a third of the households in Tigray use it. Use of kerosene, LPG and Electricity by the rural households for cooking is not significant.

Mode of cooking fuel acquisition by the rural households

All rural households collect their cooking fuels even though the proportion of collected fuel varies. Almost all households in Tigray and all in Hariri and Dire Dawa obtain their cooking fuels by collecting. All rural households in Dire Dawa and Hariri collect their cooking fuels while it is only less than half of the households in Afar and Amhara regions do. Average percentage of households in all regions that purchase fuel is about 20%. Highest distribution of households that purchase their cooking fuel is in Afar (52%) and Amhara (54%).

Figure 6.1.2 Distribution of rural households by mode of fuel acquisition



	Tigray	Afar	Amhara	Oromia	Somali	Benishangul	SNNP	Gambella	Harari	Dire Dawa	All
Collect	90%	48%	45%	82%	74%	65%	80%	85%	100%	100%	75%
Purchase	7%	52%	54%	13%	24%	33%	14%	13%	0%	0%	22%
Both	3%	0%	1%	5%	3%	2%	5%	2%	0%	0%	3%

Fuel collection is quite a cumbersome task. Rural family members spend significant time and effort to travel, collect and carry cooking fuels. The results of the survey shows that women do much of the fuel collection followed by female children each on average traveling over 25 km spending from 20 to 26 hours in a month.

Table 6.1.1 Frequency of fuel collection, time spent and distance travelled by rural household for fuel collection per month

Carrier type	Rural		
	Number of trips	Hours spent	Distance traveled (km)
Woman	9.00	26.20	28.95
Man	4.51	10.94	16.66
Female children	6.42	20.30	25.76
Male children	5.71	22.50	18.70
Total	25.63	79.94	90.07

Cooking fuels collection is primarily a task for women and children which takes much of their quality time that could better be spent on learning and doing activities that can develop the livelihood assets of the families. Cooking fuel collection takes from 4% to 8% of the family time. On average, members of a rural family make about 25 trips a month, travel about 80 km and spend about 90 hours.

In addition to collection, some households also purchase their cooking fuels. The amount they spend on purchased fuel and the proportion of purchased to collected fuels varies significantly between regions.

Rural households in Hariri and Dire Dawa entirely depend on collected cooking fuels. Expenditures on cooking and baking fuels for households in each expenditure quintile is presented in Table 6.1.2

Table 6.1.2 Estimation of average annual expenditure on cooking/baking fuels by **rural** households by expenditure quintiles (ETB/year)

Region	Q1	Q2	Q3	Q4	Q5
Tigray	426	648	831	1,065	1,526
Afar	346	655	866	1,046	1,746
Amhara	363	607	769	977	2,390
Oromia	174	257	327	414	630
Somali	368	550	713	903	1,191
Benshangul-Gumz	338	552	702	922	1,375
SNNPR	78	116	149	186	304
Gambella	314	479	633	798	1,112
Harari	-	-	-	-	-
Dire Dawa	17	31	40	47	58
All	240	381	489	613	955

Households in the first quintile (lowest), on average, spend about ETB 240 per year while those in the fifth quintile (highest) spend about ETB 955.

The focus group discussions conducted in rural areas where the survey was conducted also confirms that significant percent of rural households use charcoal as their secondary fuel. The proportion of firewood used for baking varies between 50% and 80% in the rural households depending on the amount of charcoal they use for cooking. Due to increasing protection of forests, firewood collection has become more and more difficult. Participants of the focus group discussion in almost all regions confirm that commercialization of cooking fuel has become more common in rural areas.

Responsible member of the household for cooking

In all the regions women and female children are primarily responsible for preparation of food for the family. Hired cooks that account for 2% of the responsible persons in the rural households for cooking are always female. In only less than 1% of the surveyed rural households that men are involved in cooking.

Table 6.1.3 Persons responsible for cooking in the rural households

Region	Hired cook/maid	Woman of the house	Woman & fem. children	Man of the house	All members equally
Tigray	0%	82%	17%	1%	1%
Afar	0%	91%	9%	0%	0%
Amhara	6%	79%	14%	1%	1%
Oromia	0%	83%	16%	0%	0%
Somali	0%	90%	10%	0%	0%
Benishangul	1%	83%	13%	1%	2%
SNNP	1%	78%	20%	0%	1%
Gambella	0%	73%	20%	6%	1%
Harari	0%	62%	38%	0%	0%
Dire Dawa	2%	65%	33%	0%	0%
All	2%	81%	17%	1%	0%

6.1.2 Rural household cooking and baking fuel use by end-use type

Rural households use different fuels for different purposes. Major fuels used for preparation of food in the rural households are fuelwood, charcoal, BLT (branches, leaves and twigs) and dung. Fuelwood is the major fuel used by 96% of the rural households in the surveyed regions.

Table 6.1.4 Distribution of rural households that use fuelwood by end use

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	81%	97%	66%	65%	55%
Afar	68%	86%	59%	64%	60%
Amhara	63%	94%	55%	39%	36%
Oromia	94%	99%	85%	87%	87%
Somali	60%	97%	50%	60%	60%
Benishangul	63%	97%	63%	53%	47%
SNNP	97%	99%	96%	95%	95%
Gambella	82%	71%	84%	84%	78%
Harari	100%	100%	86%	100%	100%
Dire Dawa	100%	100%	80%	100%	100%
All	83%	96%	76%	73%	71%

Of the total amount of fuelwood consumed by the rural households about 43% is used for cooking (including cooking, water boiling, re-heating and coffee/tea boiling) while the remaining 57% is for baking. The proportion of fuelwood use for cooking and baking is pretty much consistent among the households in different regions.

Table 6.1.5 Proportion of fuelwood use for cooking and baking by the rural households

Region	Cooking	Baking
Tigray	41%	59%
Afar	43%	57%
Amhara	45%	55%
Oromia	39%	61%
Somali	37%	63%
Benishangul	47%	53%
SNNP	42%	58%
Gambella	56%	44%
Harari	37%	63%
Dire Dawa	42%	58%
All	43%	57%

Next to fuelwood, charcoal is the second most important cooking fuel for the rural households. It is used by about 40% of the rural households. Not all charcoal that rural households consume is obtained by purchase. Most rural household use the embers left from burning fuelwood as charcoal. Charcoal is mainly used for cooking than baking. However, some households may use it to bake flat bread (*kitta*) or kocho on metal pans or clay plates.

Table 6.1.6 Percentage of rural household that use charcoal by end use

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	77%	0%	53%	59%	76%
Afar	62%	5%	49%	56%	63%
Amhara	70%	1%	46%	60%	73%
Oromia	24%	1%	17%	19%	25%
Somali	46%	1%	36%	45%	46%
Benishangul	66%	0%	39%	51%	68%
SNNP	17%	1%	12%	13%	18%
Gambella	35%	3%	28%	28%	35%
Harari	0%	0%	0%	0%	0%
Dire Dawa	0%	0%	0%	0%	0%
All	40%	1%	28%	33%	41%

BLT and crop residues, being used by 30% of the households, are the third widely used fuels. However, crop residues are available seasonally and their use is limited only in certain months of the year.

Table 6.1.7 BLT use by end use type by the rural households

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	8%	13%	7%	7%	8%
Afar	0%	0%	0%	0%	0%
Amhara	6%	7%	4%	4%	4%
Oromia	32%	42%	31%	31%	31%
Somali	0%	0%	0%	0%	1%
Benishangul	0%	0%	0%	0%	0%
SNNP	51%	53%	49%	46%	45%
Gambella	31%	39%	31%	31%	31%
Harari	32%	42%	36%	32%	32%
Dire Dawa	8%	22%	8%	8%	8%
All	25%	29%	23%	23%	22%

The survey results indicate that the average annual biomass fuel consumption by a rural household is about 2,321 kg per year. Minimum per capita consumption is observed in Dire Dawa and Afar (0.9 kg/day), and the maximum is in Amhara (1.7 kg/day).

Table 6.1.8a Biomass fuels consumption & expenditure for cooking and baking fuels by rural households

Region	Fuelwood (kg/year)	Charcoal (kg/year)	Wood equivalent (kg/year)	Per capita consumption (kg/day)	Expenditure (ETB/year)
Tigray	929	183	1,843	1.1	813
Afar	1,070	159	1,866	0.9	794
Amhara	1,702	213	2,768	1.7	975
Oromia	1,910	56	2,189	1.2	263
Somali	1,953	120	2,555	1.1	565
Benishangul	1,196	174	2,064	1.2	656
SNNP	2,457	40	2,659	1.5	155
Gambella	1,791	91	2,245	1.2	556
Harari	2,383	-	2,383	1.4	-
Dire Dawa	1,616	5	1,642	0.9	24
All	1,800	104	2,321	1.3	489

Several factors such as availability of fuel, food and sufficient income determine cooking fuel consumption.

The daily per capita consumption of woody biomass fuels in rural areas is about 1.3 kg. To avoid double counting, only purchased charcoal is considered in determining total biomass consumption. Rural households on average spend about ETB 489 per year for cooking and baking fuels. Hence, the annual woody biomass consumption by rural households for cooking and baking is estimated at about 34 million tons of wood equivalent.

Table 6.1.8b Estimated total biomass consumption by rural households per year by region

Region	Number of households	Biomass consumption In wood equivalent (kg/household/year)	Total biomass consumption In wood equivalent (Million Ton/year)
Tigray	811,046	1,843	1.5
Afar	230,499	1,866	0.4
Amhara	3,744,448	2,768	10.4
Oromia	5,646,329	2,189	12.4
Somali	690,528	2,555	1.8
Benishangul	168,632	2,064	0.3
SNNP	3,086,471	2,659	8.2
Gambella	54,804	2,245	0.1
Harari	21,845	2,383	0.1
Dire Dawa	32,466	1,642	0.1
Country	14,487,068	2,321	34

Use of kerosene and LPG for cooking in rural households is not common. The survey results show that less than 2% of the total rural households in all the regions use kerosene for cooking. This figure is still higher than the 0.17% percentage indicated by CSA (WMS, 2012) for rural households that use kerosene for cooking in 2011. The survey shows that the average consumption of kerosene by those rural households that use kerosene was about 14.6 liters per year.

Table 6.1.9 Annual average kerosene consumption and expenditure by rural households for cooking

Region	(Lt/year)	(ETB/year)
Tigray	-	-
Afar	-	-
Amhra	0.79	12.83
Oromia	1.44	29.80
Somali	-	-
Benishangul	-	-
SNNP	0.46	8.21
Gambela	1.80	34.20
Harari	-	-
Dire Dawa	-	-
Average	0.77	14.60

Table 6.1.10 Average annual expenditure on cooking/baking fuels by the rural households (ETB/year)

Region	Cooking/Baking Fuel (ETB/year)	Percentage over total expenditure
Tigray	813	5%
Afar	794	5%
Amhara	988	5%
Oromia	292	2%
Somali	565	5%
Benishangul	656	5%
SNNP	163	1%
Gambella	590	4%
Harari	-	0%
Dire Dawa	24	0%
All	504	3%

On average, the rural households spend about ETB 504 annually to buy cooking and baking fuels. This is about 3% of their total expenditure.

6.1.3 Stoves Ownership in Rural Households

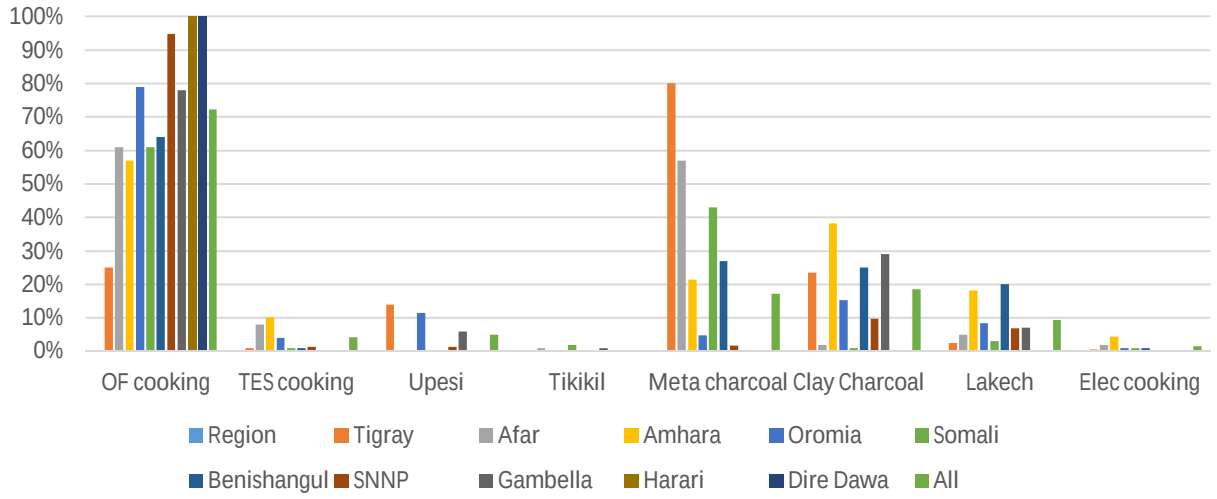
Households in the surveyed regions use various types of stoves for cooking and baking. Solid biomass fuels mainly firewood and charcoal are primary fuels used by the rural households. The types of stoves used include Open fire, traditional enclosed stoves for both cooking and baking. Metal charcoal stoves are the most common type among the charcoal stoves. Electric and kerosene stoves are used only by very few households.

Open fire, also called three-stone stove, is the most widely used stove by the rural households surveyed almost in all regions. Households in Hariri and Dire Dawa do almost all their cooking and baking using Open fire.

Cooking stoves

Open fire (OF) for cooking is used by 72% of the rural households in all regions. Open fire is used the least in Tigray where only 25% of them use it. Charcoal stoves are the second important stoves for cooking for the rural households. It is almost entirely used for cooking, boiling and reheating cooked foods. Only very few rural households in Afar (5%) and Gambella (3%) use charcoal stoves for baking. Metal charcoal stoves and all clay charcoal stoves are the most common charcoal stove being used by about 17% of the rural households in all regions. About 9% of the rural households use Lakech charcoal stove. About 80% of the surveyed rural households in Tigray use metal charcoal stoves. Lakech is used by about 18% and 20% of the rural households in Amhara and Benishangul respectively.

Figure 6.1.3 Cooking stoves ownership and use by the rural households



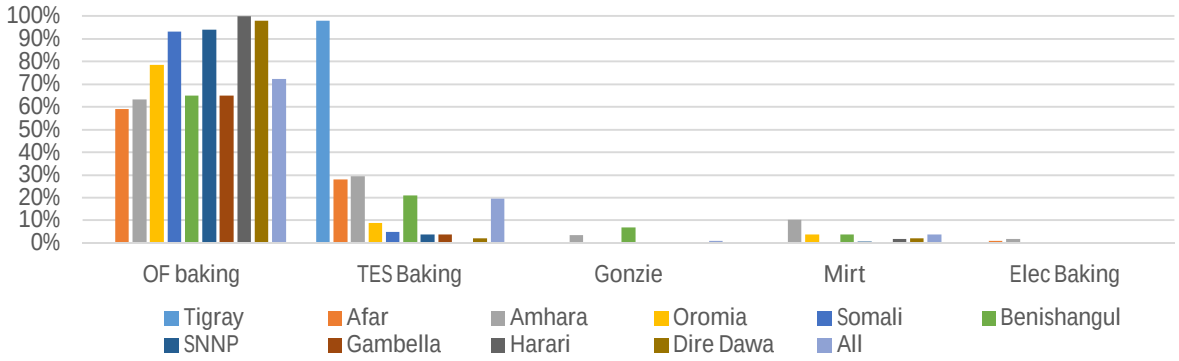
The rural households surveyed in Hariri and Dire Dawa do not use charcoal at all for either cooking or baking. Table 6.1.12 shows usage of charcoal stoves for various end uses.

Ownership and use of Upesi, Tikikil and electric stoves for cooking in rural areas is very small; they are owned by 5%, 0.1% and 1% the households respectively. Upesi stoves are promoted in rural areas in Tigray, Oromia and Amhara for cooking and are respectively owned by 14%, 11% and 6% of the rural households surveyed. Tikikil stove is owned only by less than 2% of the surveyed rural households in Somali region.

Baking stoves

The widely used baking stove in all the regions except in Tigray is Open fire (OF). About 72% of the rural households use Open fire for baking. In Tigray, Traditional Enclosed Stoves (TES) are most common baking stoves (98%). Ownership of other stoves such as Gonzie, Mirt and electric mitad by the rural households is limited.

Figure 6.1.4 Baking stoves owned and used by the rural households surveyed



Flexibility of Open fire in terms of space utilization, ability to adjust for various end uses and sizes, and that it is a no cost and accessible stove makes it easier for households to own and use it. When affordable

alternatives cookstoves are not available, Open fire is usually the only known solution for most of the households. Rural households use Open fire for both cooking and baking.

Table 6.1.11 Open Fire stove use by rural households by endues type

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	25%	1%	17%	18%	18%
Afar	61%	59%	54%	58%	58%
Amhara	57%	63%	49%	35%	32%
Oromia	79%	78%	69%	73%	73%
Somali	61%	93%	50%	60%	60%
Benishangul	64%	65%	60%	52%	46%
SNNP	95%	94%	94%	92%	94%
Gambella	75%	65%	78%	78%	70%
Harari	100%	100%	80%	100%	100%
Dire Dawa	100%	98%	80%	100%	100%
All	72%	72%	65%	64%	63%

Being used by 20% of the rural households, traditional enclosed firewood stove (TES) is the second most widely used baking stove in the surveyed areas. Table 6.1.13 shows ownership and use of traditional enclosed stoves. This stove is very common in Tigray than any other place. About 98% of the rural households in Tigray use Traditional enclosed stove primarily for baking. In Afar and Amhara nearly 30% of the households use TES.

Other types of cookstoves, which are mainly improved stoves, are used only by very few households in the surveyed areas. Mirt and Gonzie are used by 4% and 1% of the rural households in all regions. Mirt is an enjera baking stove promoted by regional energy and agriculture Bureaus in several regions in the country. Regional level ownership and usage of Mirt stove is about 10% in Amhara, 4% in Oromia and Benishangul, and 2% in Hariri and Dire Dawa. Gonzie is a stove which can be used for both cooking and baking. Its usage by the rural households is 4% in Amhara and 7% in Benishangul. The focus group discussion also indicates that Mirt and Lackech charcoal stoves are the most prominent of all improved cookstove in rural households.

Table 6.1.12 Charcoal stoves use by rural households by endues type

	Metal Charcoal Stove					Clay Charcoal Stove					Lakech Charcoal Stove				
Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	80%	0%	61%	65%	80%	24%	0%	19%	19%	13%	3%	0%	2%	2%	2%
Afar	56%	4%	43%	50%	57%	2%	1%	2%	2%	2%	5%	0%	5%	5%	5%
Amhara	21%	0%	15%	18%	21%	37%	0%	28%	33%	38%	18%	0%	8%	15%	18%
Oromia	4%	0%	3%	4%	5%	14%	0%	10%	11%	15%	8%	0%	6%	6%	8%
Somali	43%	0%	35%	42%	43%	1%	0%	1%	1%	1%	3%	0%	1%	3%	3%
Benishangul	23%	0%	16%	22%	27%	25%	0%	18%	21%	25%	19%	0%	8%	11%	20%
SNNP	2%	0%	1%	1%	2%	10%	0%	7%	8%	10%	7%	0%	5%	4%	7%
Gambella	0%	0%	0%	0%	0%	29%	3%	25%	25%	29%	7%	0%	4%	4%	7%
Harari	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Dire Dawa	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
All	17%	0%	12%	15%	17%	18%	0%	14%	16%	18%	9%	0%	5%	7%	9%

Figure 6.1.13 Traditional enclosed firewood stove use by the rural households in the surveyed areas.

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	1%	98%	1%	1%	1%
Afar	8%	28%	6%	8%	3%
Amhara	10%	29%	5%	6%	4%
Oromia	4%	9%	3%	2%	2%
Somali	1%	5%	0%	0%	0%
Benishangul	1%	21%	1%	1%	1%
SNNP	1%	4%	1%	1%	1%
Gambella	0%	4%	1%	1%	0%
Harari	0%	0%	0%	0%	0%
Dire Dawa	0%	2%	0%	0%	0%
All	4%	20%	3%	2%	2%

6.1.4 Cookstoves Use in Rural Households

Frequency of cookstoves and fuels use

Most widely used stoves in the rural households are fuelwood stoves and charcoal stoves. Frequency of stove usage by the households varies greatly among the regions. Firewood stoves are used more than once in a day in 50% to 100% of the rural households. Households that use charcoal stoves more than once in a day range from none to about 60%.

Table 6.1.14 Frequency of cooking fuels/stoves use in the rural households

Region	Fuelwood			Charcoal		
	More than once/day	Once/day	Less than3 time/week	More than once/day	Once/day	Less than3 time/week
Tigray	64%	6%	13%	57%	12%	16%
Afar	45%	9%	40%	56%	6%	1%
Amhara	43%	12%	10%	60%	11%	3%
Oromia	84%	7%	5%	17%	6%	3%
Somali	63%	4%	0%	47%	1%	0%
Benishangul	55%	7%	4%	51%	7%	8%
SNNP	83%	6%	7%	13%	3%	2%
Gambella	84%	1%	0%	25%	7%	3%
Harari	100%	0%	0%	0%	0%	0%
Dire Dawa	100%	0%	0%	0%	2%	0%

Stove price

Cookstoves that the rural households use are mostly self-built Open fire and enclosed traditional stoves which do not cost households in cash. Charcoal stoves are rather purchased. Prices of charcoal stoves are mostly under ETB 100. Over 90% of the rural households paid under ETB 100 to acquire their charcoal stoves.

Table 6.1.15 Distribution of rural households by amount they pay for charcoal stoves

Region	Price range			
	< 50 Birr	50-100 Birr	101-200 Birr	201-500 Birr
Tigray	77%	23%	1%	0%
Afar	38%	53%	9%	0%
Amhara	63%	34%	3%	0%
Oromia	61%	36%	3%	0%
Somali	47%	51%	2%	0%
Benishangul	44%	44%	10%	2%
SNNP	53%	39%	7%	1%
Gambella	74%	23%	3%	0%
Harari	0%	0%	0%	0%
Dire Dawa	100%	0%	0%	0%

Life span of stoves

User-built stoves usually last longer as users continuously service them as required. Charcoal stoves, depending on the quality of materials they are made up with, may last for several years. In about 80% to 90%

of the rural households, the charcoal stoves they purchased are aged from one to two years. In less than 5% of the households the charcoals stoves they have are over 4 years of age.

Table 6.1.16 Distribution of rural households by life span of charcoal stoves they use

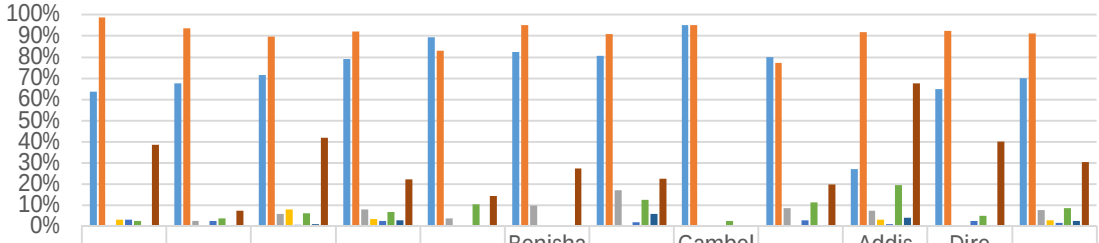
Region	Stove life span				
	< 12 Months	12-24 Months	25-36 Months	37-48 Months	> 48 Months
Tigray	30%	47%	10%	4%	9%
Afar	53%	36%	5%	3%	3%
Amhara	54%	37%	5%	2%	3%
Oromia	45%	45%	8%	1%	2%
Somali	36%	53%	11%	0%	0%
Benishangul	40%	38%	17%	3%	2%
SNNP	56%	37%	4%	3%	1%
Gambella	51%	40%	6%	0%	3%
Harari	0%	0%	0%	0%	0%
Dire Dawa	100%	0%	0%	0%	0%

6.2 Cooking fuels and stoves in urban households

6.2.1 Cooking fuel supply and expenditure in urban households

Like the rural households, cookstove and cooking fuel usage in urban households very much depend on availability and price of both fuel and stoves. Unlike the rural household, charcoal is the most widely used cooking fuel by the urban households. According to the survey results, on average, over 90% of the urban households in all regions use charcoal mainly for cooking purposes rather than for baking. The CSA result for 2011 shows only 17.5% of the urban households use charcoal. Note that CSA data is of households that use charcoal as main fuel only.

Figure 6.2.1 Distribution of urban households by type of fuels used for cooking and baking



	Tigray	Afar	Amhara	Oromia	Somali	Benishangul	SNNP	Gambella	Harari	Addis Ababa	Dire Dawa	All
Fuelwood	64%	68%	72%	79%	89%	83%	81%	95%	80%	27%	65%	70%
Charcoal	99%	94%	90%	92%	83%	95%	91%	95%	77%	92%	93%	91%
BLT	0%	3%	6%	8%	4%	10%	17%	0%	9%	8%	0%	8%
Dung	3%	0%	8%	3%	0%	0%	0%	0%	0%	3%	0%	3%
Crop residue	3%	3%	1%	3%	0%	0%	2%	0%	3%	1%	3%	2%
Kerosene	3%	4%	6%	7%	11%	0%	13%	3%	11%	20%	5%	9%
LPG	0%	0%	1%	3%	0%	0%	6%	0%	0%	4%	0%	3%
Electrcity	39%	8%	42%	22%	14%	28%	23%	0%	20%	68%	40%	31%

Fuelwood is the second important fuel and is used by about 70% of the urban households. In some regions such as Addis Ababa fuelwood is used only by 27% of the households while in other regions such as Gambella and Somali over 90% of the urban households use it.

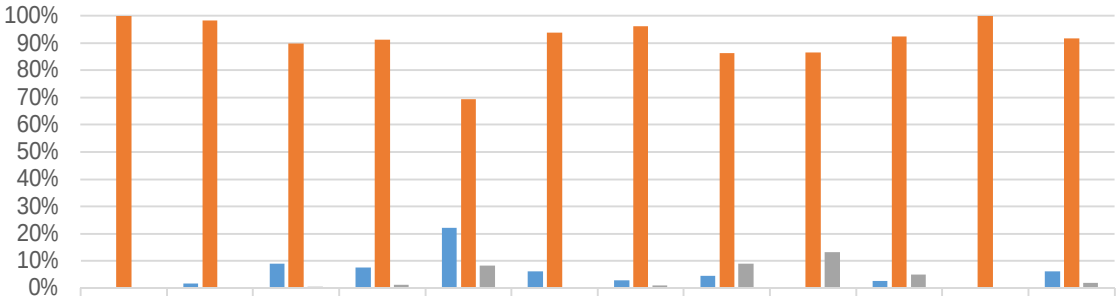
Electricity, being used by about a third of the urban households, is the third most important cooking/baking fuel. Percentage of urban households that use electricity is the highest in Addis Ababa (68%) while none of the urban households in Gambella use it for cooking.

The results of the survey for the percentage of households that use a particular fuel is higher than that of the CSA data for 2011. This difference is mainly as the CSA data is of the percentage of households that use a particular fuel as a major fuel while this study considers all households that use a particular fuel at any rate of use.

Mode of cooking and baking fuel acquisition by the urban households

Unlike the rural households, over 90% of the urban households purchase their cooking fuels. In Somali, about 30% of the urban households collect their cooking fuel.

Figure 6.2.2 Distribution of urban households by mode of cooking fuel acquisition



	Tigray	Afar	Amhara	Oromia	Somali	Benishangul	SNNP	Gambella	Harari	Addis Abab	Dire Dawa	All
Collect	0%	2%	9%	8%	22%	6%	3%	5%	0%	3%	0%	6%
Purchase	100%	98%	90%	91%	69%	94%	96%	86%	87%	92%	100%	92%
Both	0%	0%	1%	1%	8%	0%	1%	9%	13%	5%	0%	2%

Those urban households that collect cooking fuels are required to travel longer distances and spend more time to acquire freely collected cooking fuels. Even though fuel collecting households in urban areas are very few in number, family members engaged in fuel collection suffer the most.

Cooking fuel collection

The survey result shows that women and female children do most of the fuel collection activity. The survey result shows that, on average, a rural household members travel a total distance of 1.35 km in about 2 fuel collection trips spending about half an hour per month.

Table 6.2.1 Frequency of fuel collection, time spent and distance travelled by urban households per month

Carrier type	Urban		
	No. trips	Hours spent	Distance traveled (km)
Woman	0.62	0.16	0.26
Man	0.32	0.06	0.29
Female children	0.40	0.12	0.32
Male children	0.47	0.20	0.48
Total	1.81	0.53	1.35

Even though few urban households collect their cooking fuels, most households purchase. Urban households' expenditure on cooking and baking fuels by expenditure quintile is presented in Table 6.2.2 below. Urban households in the first expenditure quintile on average pay about ETB 475 for cooking fuels while those in the fifth quintile spend about ETB 1,749 per year.

Table 6.2.2 Estimation of average annual expenditure on cooking fuels by urban households by expenditure quintiles (ETB/year)

Region	Q1	Q2	Q3	Q4	Q5
Tigray	659	1,046	1,330	1,708	2,608
Afar	716	1,161	1,420	1,803	2,532
Amhara	578	892	1,156	1,450	2,434
Oromia	560	834	1,055	1,342	2,127
Somali	633	818	1,097	1,367	1,969
Benshangul-Gumz	497	793	1,001	1,268	1,835
SNNPR	205	304	382	480	742
Gambella	421	766	971	1,309	2,337
Harari	653	848	1,111	1,349	1,917
Addis Ababa	428	637	806	1,036	1,646
Dire Dawa	823	967	1,251	1,539	2,480
All	475	698	891	1,128	1,749

Household members responsible for cooking in urban households

In all the regions women and female children are primarily responsible for preparation of food for the family. Hired cooks that account for 2% of the responsible persons in the rural households for cooking are always female. In only less than 1% of the surveyed households that men are involved in some sort of cooking in the rural households.

Like the rural households women are responsible for preparation of food for the family in urban households as well. Women and female children are responsible for cooking in over 95% of the urban households.

Table 6.2.3 Persons responsible for cooking in urban households

Region	Hired cook/maid	Woman of the house	Woman & female children	Man of the house	All members equally
Tigray	1%	92%	6%	1%	1%
Afar	5%	86%	8%	0%	1%
Amhara	10%	71%	17%	1%	1%
Oromia	3%	81%	16%	0%	0%
Somali	1%	81%	17%	0%	0%
Benishangul	3%	92%	5%	0%	0%
SNNP	4%	73%	21%	2%	0%
Gambella	5%	60%	33%	3%	0%
Harari	3%	77%	20%	0%	0%
Addis Ababa	5%	74%	20%	1%	0%
Dire Dawa	3%	72%	26%	0%	0%
All	5%	77%	17%	1%	0%

6.2.2 Household cooking fuel use by end-use type (cooking and baking)

The three most widely used fuels for preparation of food in the urban households are charcoal (91%), fuelwood (70%) and electricity (31%). Charcoal is the most important fuel for the urban households. It is primarily used for cooking than baking which includes cooking, coffee or tea boiling, food reheating and water boiling.

Table 6.2.4 Charcoal use by end use type in urban households in the surveyed regions

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	99%	1%	85%	89%	98%
Afar	94%	3%	75%	75%	89%
Amhara	87%	2%	55%	68%	90%
Oromia	89%	2%	71%	78%	92%
Somali	82%	0%	59%	64%	83%
Benishangul	95%	0%	68%	80%	95%
SNNP	88%	3%	79%	80%	91%
Gambella	90%	0%	90%	90%	95%
Harari	77%	0%	49%	54%	77%
Addis Ababa	90%	2%	63%	72%	92%
Dire Dawa	93%	8%	78%	83%	93%
All	89%	2%	70%	76%	91%

Next to charcoal, fuelwood is the second most important fuel followed by electricity. Use of fuelwood in urban households is mainly for baking.

Table 6.2.5 Fuelwood use by end use type in urban households in the surveyed regions

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	6%	64%	5%	5%	3%
Afar	31%	68%	28%	26%	26%
Amhara	40%	72%	30%	23%	12%
Oromia	38%	79%	36%	26%	19%
Somali	36%	89%	32%	38%	33%
Benishangul	20%	83%	13%	8%	8%
SNNP	45%	81%	49%	41%	32%
Gambella	45%	95%	8%	8%	5%
Harari	34%	80%	37%	40%	31%
Addis Ababa	15%	27%	12%	4%	2%
Dire Dawa	10%	65%	8%	8%	10%
All	32%	70%	29%	23%	17%

Of the total amount of fuelwood consumed by the urban households about 30% is used for cooking (including cooking, water boiling, re-heating and coffee/tea boiling) while the remaining 70% is for baking.

Table 6.2.6 Proportion of fuelwood use for cooking and baking by the urban households

Region	Cooking	Baking
Tigray	37%	63%
Afar	35%	65%
Amhara	45%	55%
Oromia	26%	74%
Somali	31%	69%
Benishangul	14%	86%
SNNP	30%	70%
Gambella	19%	81%
Harari	29%	71%
Addis Ababa	36%	64%
Dire Dawa	15%	85%
All	29%	71%

The focus group discussions conducted in urban areas also show that the greater portion of firewood goes for baking instead of cooking. The participants of the focus group discussions also confirm that the proportion of fuelwood used for baking can be as high as 70% depending on the amount of charcoal, electricity and kerosene use for cooking.

Use of other biomass fuels such as BLT, dung and crop residues by the urban households is only 8%, 3% and 2% respectively. Urban households on average consume about 2,645 kg of woody biomass fuels in

wood equivalent which costs them about ETB 1,207 per year. This is translated to 1.8 kg of biomass consumption per person per day.

Table 6.2.7a Biomass fuels consumption & expenditure for cooking and baking fuels by urban households

Region	Fuelwood (kg/year)	Charcoal (kg/year)	Wood equivalent (kg/year)	Per capita consumption (kg/day)	Expenditure (ETB/year)
Tigray	2,477	274	3,849	3.0	1,549
Afar	699	313	2,266	1.6	1,548
Amhara	1,187	270	2,535	2.0	1,235
Oromia	1,335	234	2,505	1.8	1,131
Somali	1,447	208	2,490	1.1	1,044
Benishangul	1,010	268	2,347	1.7	1,067
SNNP	1,311	256	2,592	1.7	964
Gambella	1,475	258	2,764	1.9	1,677
Harari	1,125	170	1,974	1.5	874
Addis Ababa	1,984	149	2,729	1.8	866
Dire Dawa	2,382	275	3,755	2.4	1,502
All	1,430	243	2,645	1.9	1,207

Lowest consumption of biomass in wood equivalent is in Harari while the maximum is in Dire Dawa.

Based on the results of the survey, the annual woody biomass consumption by urban households for cooking and baking is estimated at about 11.3 million tons of wood equivalent.

Table 6.1.7b Estimated total biomass consumption by rural households per year by region

Region	Number of households	Biomass consumption In wood equivalent (kg/household/year)	Total biomass consumption In wood equivalent (Million Ton/year)
Tigray	341,762	3,849	1.3
Afar	71,573	2,266	0.2
Amhara	911,600	2,535	2.3
Oromia	1,218,316	2,505	3.1
Somali	124,939	2,490	0.3
Benishangul	50,587	2,347	0.1
SNNP	650,922	2,592	1.7
Gambella	31,394	2,764	0.1
Harari	35,523	1,974	0.1
Addis Ababa	764,031	2,729	2.1
Dire Dawa	62,263	3,755	0.2
Country	4,262,910	2,645	11.3

Electricity is used for both cooking and baking by the urban households. In recent years, most urban households are increasingly using electricity for cooking as prices of other fuels such as kerosene, LPG and charcoal are continuously rising while that of electricity has remained constant in the last eight years.

Comparison of use of electricity for cooking shows that the percentage of urban households that use electricity for cooking grew from 2.4% in 2004 to 6.2% in 2011[18].

Table 6.2.8 Electricity use by end use type in urban households in the surveyed regions

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	6%	39%	6%	4%	1%
Afar	8%	6%	6%	8%	4%
Amhara	42%	34%	35%	36%	26%
Oromia	22%	22%	18%	21%	17%
Somali	11%	14%	11%	9%	11%
Benishangul	23%	28%	23%	23%	23%
SNNP	19%	23%	18%	18%	14%
Gambella	0%	0%	0%	0%	0%
Harari	17%	20%	9%	17%	17%
Addis Ababa	46%	68%	32%	44%	31%
Dire Dawa	28%	40%	25%	28%	18%
All	25%	31%	20%	23%	17%

It should be noted that none of the urban households in Gambella were using electricity for either cooking or baking. However, as much as 70% of the households in Addis Ababa use it for baking.

Kerosene consumption for cooking by urban households is decreasing. Percentage of households that use kerosene for cooking decreased from 14% in 2004 to 5% in 2011 (CSA, 2004, CSA 2011). The survey shows that only less than 9% of the urban households use kerosene for cooking. However, highest user of kerosene are households in Addis Ababa (20%) while the lowest users are households in Tigray and Gambella (3%). Average kerosene consumption by the urban households is about 3.8 liters per year which costs them about ETB 70.

Table 6.2.9 Annual average kerosene consumption by urban households for cooking

Region	(Lt/year)	(ETB/year)
Tigray	-	-
Afar	-	-
Amhara	1.7	28.2
Oromia	3.9	81.3
Somali	4.0	76.5
Benishangul	-	-
SNNP	4.1	71.9
Gambella	-	-
Harari	5.5	104.2
Addis Ababa	10.8	172.8
Dire Dawa	1.5	28.5
Average	3.8	71.4

Total expenditure on cooking and baking fuels by the urban households, on average, is about ETB 1,278 per year. The amount that households spend varies between regions. Urban households in Tigray, Afar, Gambella and Dire Dawa pay over ETB 1,500 annually. The average expenditure on cooking and baking fuels in all regions accounts for about 6% of their total household expenditure.

[18] CSA, Welfare Monitoring Surveys for 2004 and 2011.

Figure 6.2.10 Average annual expenditure on cooking and baking fuels by urban households

Region	Cooking/baking Fuels (ETB/year)	Percentage over total expenditure
Tigray	1,549	9%
Afar	1,548	9%
Amhara	1,263	7%
Oromia	1,213	7%
Somali	1,120	7%
Benishangul	1,067	6%
SNNP	1,036	2%
Gambella	1,677	6%
Harari	978	7%
Addis Ababa	1,039	5%
Dire Dawa	1,530	8%
All	1,278	6%

Participants of the focus group discussions also confirm that charcoal is the major cooking fuel followed by electricity. Use of kerosene is decreasing over time as the price of it is increasing.

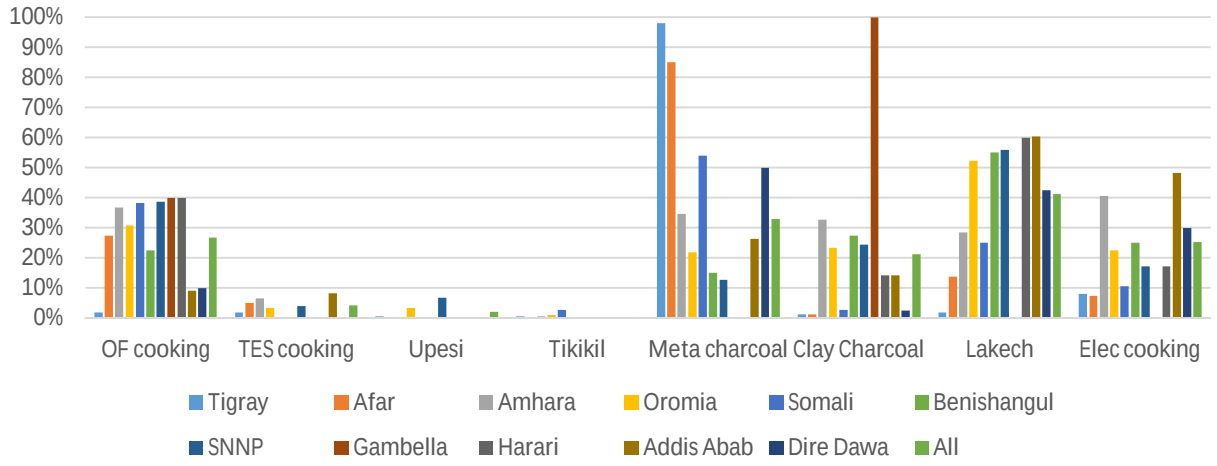
6.2.3 Cookstoves Ownership in Urban Households

Stoves in the households are generally categorized as cooking and baking stoves. Some stoves are also used for cooking, baking, boiling and re-heating.

Cooking stoves

Cooking stoves that are used by the urban households are Open fire, traditional enclosed stoves (TES), Upesi, Tikikil and the charcoal stoves. Open fire and TES are traditional cookstoves while Tikikil and perhaps Upesi are improved for energy efficiency. There three major types of charcoal stoves. The metal charcoal stove and clay charcoal stoves which are traditional while Lakech charcoal stove is an improved one.

Figure 6.2 3 Cooking stoves ownership in urban households



Charcoal stoves are the most prominent stoves used by over 90% of the urban households in the surveyed regions. Of the three types of charcoal stoves, Lakech charcoal stove has the highest penetration rate of 41% in urban households. Next to Lakech, traditional metal charcoal stoves and all clay charcoal stoves penetrated into about 33% and 21% of the urban households respectively. Except in Tigray, Afar, Amhara and SNNP regions, where traditional metal charcoal stove is most common, Lakech charcoal stove is generally the most widely used charcoal stove in the other regions. In Gambella, however, the traditional clay charcoal stoves are almost entirely used by all urban households. Table 6.2.12 shows percentage of households by ownership and usage of the different types of charcoal stoves.

Next to charcoal stoves, Open fire is the second most widely used cooking stove used by 27% of the urban households. In most of the regions, from 30% to 40% of the urban households use Open fire for cooking (Table 6.2.10). However, ownership and usage of Open Fire as a cooking stove is the least in Tigray (2%) and Addis Ababa (9%).

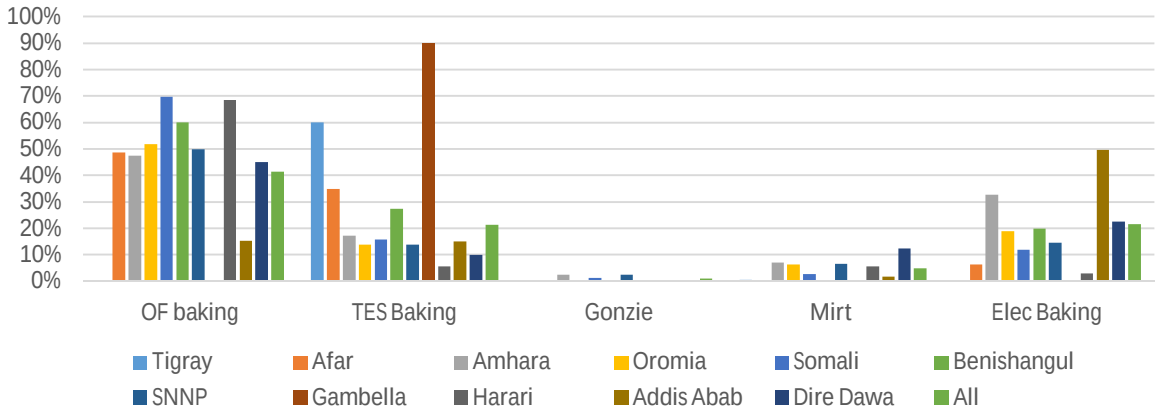
Electric stoves are also widely used in the urban households (25%) in the surveyed regions. Electric cookstoves ownership and use varies greatly among the regions. In Addis Ababa, where it is commonly used, 48% of the households use it for cooking. In Tigray and Afar only 8% of the households own electric stoves. In Gambella, none of the surveyed urban households use electric stoves for either cooking or baking. Ownership and use of electric stoves by the surveyed urban households is shown in Table 6.2.13.

Ownership and use of traditional enclosed stoves (4%), Upesi (2%) and Tikikil (0.5%) for cooking is limited only to few percentage of the urban households surveyed. Ownership of Upesi stove in the urban households is 7% in SNNP and 3% in Oromia. Ownership of Tikikil stove was only reported by less than 3% of the surveyed urban households in Somali region.

Baking stoves

Stoves used for baking purposes in urban households include Open Fire (OF), Traditional Enclosed Stoves (TES), Gonzie and electric mitad. Some stoves such as Open fire, TES and Gonzie stoves can be used for both cooking and baking.

Figure 6.2.4 Baking stoves used by the urban households



Open fire is the most prominent baking stove used by 41%% of urban households. In most of the regions ownership and use of Open fire for baking is between 40% and 70%. However, only about 15% of the surveyed households in Addis Ababa and none of them in Tigray use Open fire for baking. Traditional enclosed firewood stoves and electric stoves are used by about 22% of the urban households. Highest ownership of Traditional enclosed firewood stoves is in Gambela (90%) and in Tigray (60%). Electric stoves for baking is used by about 50% of households in Addis Ababa.

Mirt and Gonzie stoves are used only by 5% and 1% of the urban households surveyed. Ownership of Mirt stove was about 13% in Dire Dawa, and between 6 to 7% in Amhara, Oromiya, SNNP and Hariri. In Somali and Addis Ababa, only less than 3% of the surveyed households own Mirt.

Table 6.2.11 Open Fire stove use by urban households by endues type

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	2%	0%	1%	1%	0%
Afar	28%	49%	25%	23%	24%
Amhara	37%	48%	28%	22%	12%
Oromia	31%	52%	30%	22%	18%
Somali	34%	70%	32%	38%	34%
Benishangul	23%	60%	18%	13%	13%
SNNP	35%	50%	39%	32%	25%
Gambella	40%	0%	3%	3%	0%
Harari	31%	69%	37%	40%	29%
Addis Ababa	9%	15%	9%	4%	2%
Dire Dawa	10%	45%	8%	8%	10%
All	27%	41%	25%	19%	15%

Table 6.2.12 Charcoal stoves use by urban households by endues type

Region	Metal Charcoal Stove					Clay Charcoal Stove					Lakech Charcoal Stove				
	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	98%	0%	84%	86%	97%	1%	0%	1%	1%	1%	2%	0%	1%	1%	1%
Afar	85%	3%	68%	68%	85%	1%	0%	1%	1%	1%	14%	0%	11%	11%	14%
Amhara	34%	1%	21%	25%	35%	33%	0%	23%	29%	33%	28%	0%	14%	19%	28%
Oromia	21%	0%	18%	20%	22%	23%	0%	19%	21%	23%	52%	0%	39%	43%	52%
Somali	54%	0%	37%	41%	54%	3%	0%	1%	1%	3%	25%	0%	20%	22%	25%
Benishangul	15%	0%	10%	15%	15%	28%	0%	25%	28%	28%	55%	0%	33%	38%	55%
SNNP	13%	0%	12%	12%	13%	23%	0%	22%	23%	24%	56%	1%	51%	48%	55%
Gambella	0%	0%	0%	0%	0%	98%	0%	98%	98%	100%	0%	0%	0%	0%	0%
Harari	0%	0%	0%	0%	0%	14%	0%	6%	6%	14%	60%	0%	37%	43%	60%
Addis Ababa	26%	1%	19%	21%	24%	13%	1%	10%	11%	14%	58%	2%	39%	47%	60%
Dire Dawa	48%	3%	35%	40%	50%	3%	3%	3%	3%	3%	43%	5%	40%	43%	43%
All	33%	0%	26%	28%	33%	21%	0%	17%	19%	21%	41%	0%	30%	33%	41%

Table 6.2.13 Electric stoves use by urban households by endues type

Region	Cooking	Baking	Water Boiling	Re-heating	Coffee/tea boiling
Tigray	8%	0%	8%	7%	3%
Afar	8%	6%	6%	6%	4%
Amhara	41%	33%	34%	36%	26%
Oromia	22%	19%	19%	21%	18%
Somali	11%	12%	11%	11%	11%
Benishangul	25%	20%	25%	25%	25%
SNNP	17%	15%	15%	16%	13%
Gambella	0%	0%	0%	0%	0%
Harari	17%	3%	6%	17%	17%
Addis Ababa	48%	50%	37%	48%	33%
Dire Dawa	30%	23%	25%	30%	23%
All	25%	22%	21%	24%	18%

6.2.4 Cookstoves Use in Urban Households

Frequency of cookstove/fuels use

Even though frequency of stove usage by the households varies between the regions, the most widely used stoves in the rural households are charcoal stoves, electric stoves and fuelwood stoves. Charcoal stoves are used more than once in a day in over 70% of the households in most of the regions. Firewood stoves are used more than once in a day in 20% of the urban households in more than 50% of the regions. Households that use charcoal stoves more than once in a day range from none to about 60%.

Table 6.2.14 Frequency of cooking fuel/stove use in the urban households

Region	Fuelwood			Charcoal			Electricity for cooking		
	More than once/day	Once Per day	Less than3 time/week	More than once/day	Once/day	Less than3 time/week	More than once/day	Once/day	Less than3 time/week
Tigray	3%	1%	4%	94%	4%	1%	9%	1%	2%
Afar	15%	9%	45%	89%	8%	0%	3%	3%	3%
Amhara	16%	11%	22%	70%	20%	2%	35%	7%	1%
Oromia	22%	10%	35%	72%	19%	3%	17%	4%	3%
Somali	42%	5%	0%	70%	13%	0%	9%	3%	0%
Benishangul	13%	25%	45%	58%	38%	5%	13%	5%	8%
SNNP	22%	10%	24%	80%	13%	3%	9%	5%	8%
Gambella	53%	3%	0%	95%	3%	0%	3%	0%	0%
Harari	40%	3%	0%	57%	20%	0%	14%	3%	0%
Addis Ababa	5%	10%	18%	53%	30%	11%	20%	22%	5%
Dire Dawa	23%	5%	0%	93%	3%	0%	23%	8%	0%

Stove price

For fuelwood, most of the stoves that the urban households use are self-made stoves such as Open fire and traditional enclosed stoves. Cookstove prices indicated in the Table below are mainly for charcoal stoves. In nearly 90% of the household's prices of the charcoals stoves they own are less than ETB 100. About 10% to 20% of the household paid between ETB 100 and ETB 200 for their charcoal stoves.

Table 6.2.15 Distribution of urban households by amount they pay for charcoal stoves

Region	Price range			
	< 50 Birr	50-100 Birr	101-200 Birr	201-500 Birr
Tigray	50%	46%	4%	0%
Afar	14%	71%	14%	0%
Amhara	45%	44%	11%	0%
Oromia	35%	49%	16%	0%
Somali	52%	42%	7%	0%
Benishangul	35%	63%	3%	0%
SNNP	27%	48%	25%	0%
Gambella	87%	13%	0%	0%
Harari	11%	74%	15%	0%
Addis Ababa	26%	56%	16%	2%
Dire Dawa	21%	69%	10%	0%

Life span of stoves

User-built stoves usually last longer as users continuously service them as required. Charcoal stoves, depending on the quality of materials they are made up with, may last for several years. In about 10% to 20% of the rural households, the charcoal stoves they purchased are aged about one year. About 50% of the stoves were two years old. Very few stoves last over four years.

Table 6.2.16 Distribution of urban households by life span of charcoal stoves they use

Region	Stove life span				
	< 12 Months	12-24 Months	25-36 Months	37-48 Months	> 48 Months
Tigray	21%	48%	14%	2%	14%
Afar	42%	52%	6%	0%	0%
Amhara	39%	46%	8%	3%	4%
Oromia	34%	52%	10%	3%	2%
Somali	35%	59%	6%	0%	0%
Benishangul	40%	45%	5%	3%	8%
SNNP	46%	45%	7%	1%	1%
Gambella	79%	18%	3%	0%	0%
Harari	11%	56%	33%	0%	0%
Addis Ababa	33%	50%	11%	3%	3%
Dire Dawa	13%	67%	15%	3%	3%

6.3 Cooking fuels and stoves in institutions

Institutions considered under this study are those with mass cooking services. It includes universities, hospitals, schools with feeding programs and correctional facilities. During this study primary data was collected from a total number of 21 institutions: 12 universities, 9 hospitals and 4 schools with feeding programs. Several types of stoves including Open Fire, enclosed mud or brick stoves, improved fuelwood stoves such as Mirt, Institutional Rocket Stoves, and others, charcoal stoves, electric cookers and boilers, LPG and biogas stoves were observed in the institutions studied.

6.3.1 Cooking fuel supply and expenditure in institutions (mode of acquisition, fuel price, expenditure)

Fuelwood is the main source of cooking and baking fuel in institutions. Most institutions fully depend on fuelwood for their entire cooking. Next to fuelwood, electricity is the second most important source of energy which primarily is used for baking injera and bread. Some universities and hospitals use electric cookers and boilers for cooking as well. However, due to unreliable supply of electricity, almost all institutions have fuelwood backup stoves for baking and cooking as well.

Institutions such as universities, hospitals and prisons usually bid out their supply of fuelwood to private suppliers. The bid is usually for supply of fuelwood for a specified period of time. However, in schools with feeding programs, communities around the school are responsible to supply fuelwood for preparation of food for students[19]. Of the four schools visited during this assessment period three of them collect their fuelwood.

Very few institutions, particularly correctional facilities and hospitals, use kerosene for cooking. However, with increasing price of kerosene most of them are shifting towards fuelwood.

Fuelwood price varies in different places. Depending on distance from fuelwood source to supply points, delivered price of fuelwood mostly ranges between ETB 500 and ETB 800 per cubic meter[20]. This is translated to a fuelwood price of ETB 1.00 to ETB 1.60 per kilogram. Mekele Hospital

[19] Ministry of Education
[20] Authors interview with administration of Jimma University and Federal Correctional facilities

reported to have used charcoal and LPG for cooking at prices of ETB 3/kg and ETB 97.50/kg respectively. Based on primary and secondary data collected from various sources, annual fuelwood consumption for cooking in major institutions in the country is shown in Table 6.3.1.

Table 6.3.1 Fuelwood consumption for cooking in institutions.

Type of institution	[21]Fuelwood Consumption per person served/day (kg/d)	No. days per year	Estimated number of persons served	Total fuelwood consumption (Ton/year)
Schools with feeding programs	0.034	300	670,000	6,834
Universities-regular students	0.193	288	222,459	12,387
Universities-summer students	0.193	60	61,621	715
Correctional facilities	0.313	365	94,445	10,790
Hospitals*	0.193	4.35	469,494	395
[22]Military camps (active frontline personnel)	0.313	365	182,500	20,850
Total			1,700,519	51,970

Annual fuelwood consumption for cooking only by institutions mentioned about is estimated at about 52 thousand tons. Communal cooking in refugee settlements are also other major consumers of cooking and baking fuels.

6.3.2 Cookstoves Ownership in Institutions

Fuelwood stoves are ubiquitous in institution for both cooking and baking purposes. Some institutions have enclosed woodstoves with long chimneys. Electric cookers, boilers and ovens are also used by some universities and hospitals with modern kitchens. However, due to frequent power outages they mostly rely on their fuelwood stoves. Some institutions such as Universities, usually outsource their supply of bread and injera to enterprises. Institutions which do not outsource their supply of injera mostly use electricity and Mirt stove. Both of these stoves are initially designed for household use and their life span in institutional application is very much limited. Electric injera stoves may last for a couple of years in institutions with minor maintenance requirements such as replacement of the heating elements. Mirt stoves deteriorate rather quickly with the intensity of use in institutions. In most institutions Mirt stoves are mostly out of shape and their fuel saving potential is highly deteriorated. Electric and firewood ovens are used for baking bread. Kerosene with gravity fed burners and LPG are also used by some institutions. Availability of the fuel and price determines the extent of use of these fuels and stoves.

Major issues with existing cooking and baking fuels in institutions are supply reliability, air pollution in the kitchens, and price of fuels. With current price of electricity, with an average flat rate tariff of ETB 0.6 per kWh, most institutions would like to rely on electricity for most of their baking. Unreliability of power supply is one of the factors that limits them from using it. Secondly, electric cookers and boilers for non-baking endues are imported and supplied to institutions. Lack of spare parts and proper maintenance services are main challenges that institutions such as universities are facing when cooking with electricity.

[21] Various sources from Ministry of Education, Ministry of Health, University of Jimma, Federal correctional facilities, Human rights protection, 2012)

[22] http://www.globalfirepower.com/country-military-strength-detail.asp?country_id=ethiopia Accessed date: 10 September 2014.

6.4 Cooking fuels and stoves in enterprises

A total number of 694 enterprises were surveyed in all the regions. Selection of type of enterprises for the survey focused on those that are involved in food preparation. The survey included hotels, restaurants and cafeteria (tea rooms) almost in equal proportion.

Table 6.4.1 Distribution of enterprises by type of businesses

	Hotels	Restaurants	Café/tea room
Total	30%	36%	34%

The survey covered enterprises at various levels. About 70% of the enterprises surveyed have a monthly revenues of less than ETB 1,200. About 7% of them have sales revenues over ETB 4,000 per month.

Table 6.4.2 Distribution of enterprises by amount of monthly sales revenue

Monthly sales revenue	Total
Less than ETB 400	31%
ETB 401 to 1200	38%
ETB 1,201 to 2,000	11%
ETB 2,001 - 4,000	12%
ETB 4,001 to 8,000	5%
Over ETB 8,001	2%

The enterprises surveyed have an average number of 6 permanent and 3 causal workers of which about 60% are female.

Table 6.4.3. Average number of workers in the enterprises

Region	Permanent	Causal	% of Female
Tigray	2	4	75%
Afar	2	1	62%
Amhara	6	4	69%
Oromia	8	3	51%
Somali	5	2	60%
Benishangul	4	3	49%
SNNP	8	1	49%
Gambella	1	1	66%
Harari	4	3	58%
Addis Ababa	7	2	60%
Dire Dawa	5	3	60%
All	6	3	59%

6.4.1 Cooking fuel supply

Solid biomass fuels, mainly charcoal and fuelwood, constitute the largest share of cooking fuel supply in enterprises. Electricity is increasingly being used for cooking and baking. Charcoal is the most important cooking fuel being used by 82% of the enterprises surveyed. Distribution of enterprises that use charcoal varies from 100% in Benishangul to 65% in Addis Ababa.

Next to charcoal, fuelwood is the second most important cooking and baking fuel that enterprises use. On average, about 56% of the enterprises surveyed use fuelwood. In some of the regions such as SNNP as many as 80% of the enterprises depend mainly on fuelwood.

Table 6.4.4 Distribution of enterprises by type of fuel they use for cooking, boiling, heating and baking

Type of fuel	Fuelwood	Charcoal	Kerosene	LPG	Electricity
Tigray	8%	95%	0%	5%	37%
Afar	63%	100%	0%	3%	0%
Amhara	45%	68%	11%	33%	71%
Oromia	57%	84%	9%	36%	56%
Somali	67%	90%	3%	20%	40%
Benishangul	70%	100%	0%	0%	0%
SNNP	78%	89%	8%	24%	55%
Gambella	27%	100%	0%	0%	3%
Harar	57%	80%	20%	17%	57%
Addis Ababa	64%	65%	15%	35%	57%
Dire Dawa	67%	87%	3%	13%	53%
Total	56%	82%	9%	24%	51%

About 50% of enterprises use electricity for cooking and baking. Enterprises that use electricity for cooking is higher in Amhara (77%). However, none of the enterprises surveyed in Afar and Benishangul, and only 3% in Gambella use electricity for cooking. LPG is the third widely used cooking fuel. About 24% of enterprises use it for cooking. It should be noted that only very few or none of the enterprises surveyed in Gambella, Benishangul, Afar and Tigray use kerosene and LPG.

6.4.2 Cooking fuel use by end-use type

Major cooking fuel in enterprises is charcoal. It is used by 70% of them. Fuelwood and electricity are used by 46% and 31% of them respectively. LPG is used by 23% of enterprises.

Table 6.4.5 Distribution of enterprises by type of fuel they use for cooking

Region	Fuelwood	Charcoal	Kerosene	LPG	Electricity	BLT
Tigray	3%	85%	3%	3%	12%	2%
Afar	47%	100%	0%	3%	0%	0%
Amhara	38%	56%	10%	33%	53%	1%
Oromia	44%	77%	8%	36%	40%	0%
Somali	33%	77%	3%	20%	20%	3%
Benishangul	70%	90%	0%	0%	0%	0%
SNNP	67%	76%	7%	22%	32%	5%
Gambella	20%	93%	3%	0%	3%	0%
Harar	53%	60%	17%	17%	23%	0%
Addis Ababa	56%	45%	15%	33%	35%	0%
Dire Dawa	40%	77%	3%	17%	20%	0%
Total	46%	70%	8%	23%	31%	2%

The results of the survey show that BLT and kerosene are the least important fuels for the enterprises surveyed. However, in Harar and Addis Ababa, about 15% of the enterprises use kerosene for cooking.

Fuelwood and electricity are most important baking fuels used by the enterprises. It is also a common practice for enterprise to outsource their injera and bread supplies. Nearly 40% and 25% of the enterprises respectively use fuelwood and electricity for baking.

Table 6.4.6 Distribution of enterprises by type of fuel they use for Baking

Region	Fuelwood	Charcoal	Kerosene	LPG	Electricity	Crop residue	Dung	BLT	Other
Tigray	18%	0%	0%	0%	63%	0%	0%	0%	3%
Afar	40%	13%	0%	0%	0%	0%	0%	0%	0%
Amhara	26%	2%	1%	5%	35%	0%	1%	0%	1%
Oromia	40%	2%	0%	2%	27%	1%	0%	1%	4%
Somali	67%	0%	0%	0%	27%	0%	0%	0%	0%
Benishangul	70%	0%	0%	0%	0%	0%	0%	0%	0%
SNNP	58%	3%	0%	1%	17%	1%	1%	6%	1%
Gambella	37%	0%	0%	0%	0%	0%	0%	0%	0%
Harar	33%	0%	0%	7%	40%	0%	0%	0%	0%
Addis Ababa	21%	5%	1%	2%	11%	3%	0%	0%	0%
Dire Dawa	60%	3%	0%	3%	27%	0%	0%	0%	0%
Total	38%	3%	0.3%	2%	25%	1%	0%	1%	1%

7 Drivers of cooking fuel choice and trends in the cooking fuel market

7.1 Rural and Urban households

Choices of fuels and stoves by users depend on the attributes of fuels and stoves. According to the results of the survey, attributes of fuels and stoves that user's value most are cooking speed, availability of fuel at affordable price, smokelessness and cleanliness. Stove price and test of food are also mentioned by some users as determinants to their choices of fuels and stoves.

Households have both positive and negative comments about the current stoves and fuels that they use. Users prefer to work with fuelwood as it is fast to cook with and that the fuel is also easily available and affordable.

Table 7.1.1Top three reasons ranked first and second by the households for liking fuelwood

Attributes	Ranked first	Ranked second
Cooking speed (fast)	26%	15%
Fuel inexpensive	25%	23%
Good fuel availability	18%	17%

However, the fact that it is smoky and difficult to keep kitchen clean makes firewood a less preferred fuel by users. Some households still feel current price of fuelwood is expensive.

Table 7.1.2 Top three reasons ranked first and second by the users for not liking fuelwood

Attributes	Ranked first	Ranked second
Smoke	35%	25%
Dirty	30%	30%
Fuel is expensive	16%	16%

Charcoal is another important fuel used by the households. Users prefer to cook with charcoal as it does not produce smoke and that it is available. Some also reported that cooking with charcoal makes the food test better and is also clean to work with. Others see charcoal as an expensive, smoky and dirty fuel.

Table 7.1.3 Top three reasons ranked first and second by the households for liking charcoal

Attributes	Ranked first	Ranked second
No smoke	22%	20%
Good fuel availability	14%	14%
Food tests good	14%	
Clean to work with		12%

Table 7.1.4 Top three reasons ranked first and second by the households for not liking charcoal

Attributes	Ranked first	Ranked second
Fuel is expensive	44%	39%
Smoke	17%	13%
Dirty	15%	14%

Even though kerosene is not widely used by the households surveyed, those who use it like it because of its fast cooking speed, cleanliness to work with and that the stove is durable. Nevertheless, about 40% of the users feel that prices of the fuel and the stove are expensive, and that the fuel is smoky.

Table 7.1.5 Top three reasons ranked first and second by the households for liking kerosene

Attributes	Ranked first	Ranked second
Fast	55%	18%
Stove is durable	17%	17%
Clean to work with	11%	11%

Table 7.1.6 Top three reasons ranked first and second by the households for not liking kerosene

Attributes	Ranked first	Ranked second
Fuel is expensive	40%	39%
Smoke	31%	24%
Stove is expensive	8%	8%

Electricity is the cleanest of all cooking fuels. Users prefer electricity to other fuels because of its cleanliness, that it is not expensive nor smoky. Power interruption, however, is one of the major drawbacks that makes users not to fully rely on it. Some users also feel prices of electricity and electric stove are expensive.

Table 7.5.7 Top three reasons ranked first and second by the households for liking electricity

Attributes	Ranked first	Ranked second
No smoke	35%	34%
Electricity is not expensive	24%	24%
Clean to work with	15%	15%

Table 7.5.8 Top three reasons ranked first and second by the households for not liking electricity

Attributes	Ranked first	Ranked second
Electricity interruption	64%	64%
Electricity is expensive	24%	24%
Stove is expensive	7%	24%

For households, the three most compelling factors for their preferences of fuels and stoves are price of fuel, availability of fuel, cleanliness and smokelessness. When it comes to price, households are rather sensitive to a fuel price than a stove price. Price of stove as a concern was mentioned as a primary factor to determine preferences of stove /fuel use only for a kerosene stove and was mentioned only by 8% of the households.

7.2 Institutions

Choices of fuel and stoves for institutions are mainly governed by availability of fuels, cooking speed, cleanliness and smoke level. Unlike households and enterprises, either price of fuel or stove was not mentioned by many of them as a major factor that determines their preferences.

Most institutions heavily rely on fuelwood for most of their cooking and baking. Their preference for fuelwood is primarily because of its reliability of supply and speed of cooking even though cleanliness and smoke are major concerns for them[23]. For most of the institutions surveyed cooking energy and related issues are concerns of first priority. The three most important attributes of their existing stoves are related to cooking speed, cleanliness and smoke.

7.3 Enterprises

Enterprises preferred to use fuelwood mainly because of its high fire power or cooking speed and that it is easily available. However, about 40% of the enterprises feel that the current price of fuelwood is expensive. The major concern of the enterprises in using fuelwood for cooking and baking is its impact on health. About 84% of enterprises reported that they have health concern on using fuelwood.

Table 7.3.1 attributes of existing cooking fuels and stoves most liked by enterprises

Fuel type	Sufficient Power	Easily available	Inexpensive	Easy to use	Lasts longer	Other
Fuelwood	49%	46%	12%	36%	6%	9%
Charcoal	32%	32%	7%	42%	19%	13%
Electricity	0%	91%	92%	36%	13%	23%
LPG	0%	100%	100%	60%	15%	4%
Kerosene	0%	100%	100%	27%	29%	3%

Half of the enterprises that use electricity and charcoal feel that prices of these fuels are expensive. Despite frequent power interruptions, about 90% of the enterprises that use electricity for cooking did not report it as supply reliability problem.

Table 7.3.2 attributes of cooking fuels and stoves most disliked by enterprises

Fuel type	Fuel expensive	Supply not reliable	No enough power	Not safe	High storage cost	Health concern/safety	Other
Fuelwood	38%	9%	4%	33%	9%	84%	3%
Charcoal	51%	11%	14%	24%	8%	12%	3%
Electricity	51%	0%	0%	30%	0%	26%	3%
LPG	25%	0%	0%	56%	2%	63%	4%
Kerosene	0%	0%	0%	47%	8%	37%	8%

About a third of the enterprises like charcoal because it provides sufficient power for cooking and that fuel is available. However, about 50% of them feel the current price of charcoal is expensive.

From 40% to 50% of the enterprises are dissatisfied or highly dissatisfied with their existing fuelwood and charcoal fuel/stoves. Only from 25% to 35% of the enterprises surveyed are satisfied with their current fuels and stoves.

Table 7.3.3 Level of satisfaction of enterprises with current cooking/baking fuels and stoves

Fuel type	Highly Satisfied	Satisfied	Indifferent	Dissatisfied	Highly dissatisfied	I don't know
Fuelwood	2%	23%	21%	46%	7%	0%
Charcoal	3%	32%	23%	37%	4%	0%

[23] Interviews with kitchen administrators in universities and correctional facilities.

7.4 Price competitiveness of ethanol to other cooking fuels

Cost of cooking is determined by the cost of fuels and stoves, the efficiency and durability of stoves. The governing factor for cost of cooking is, however, the cost of fuels which weighs over 90% of the cost of cooking. With prices of cooking fuels obtained from the survey, cooking with electricity is the cheapest. Next to electricity, the cheapest cost of cooking is fuelwood with Tikikil stove followed by charcoal with Lakech stove. Cooking with ethanol costs less than cooking either with kerosene or LPG.

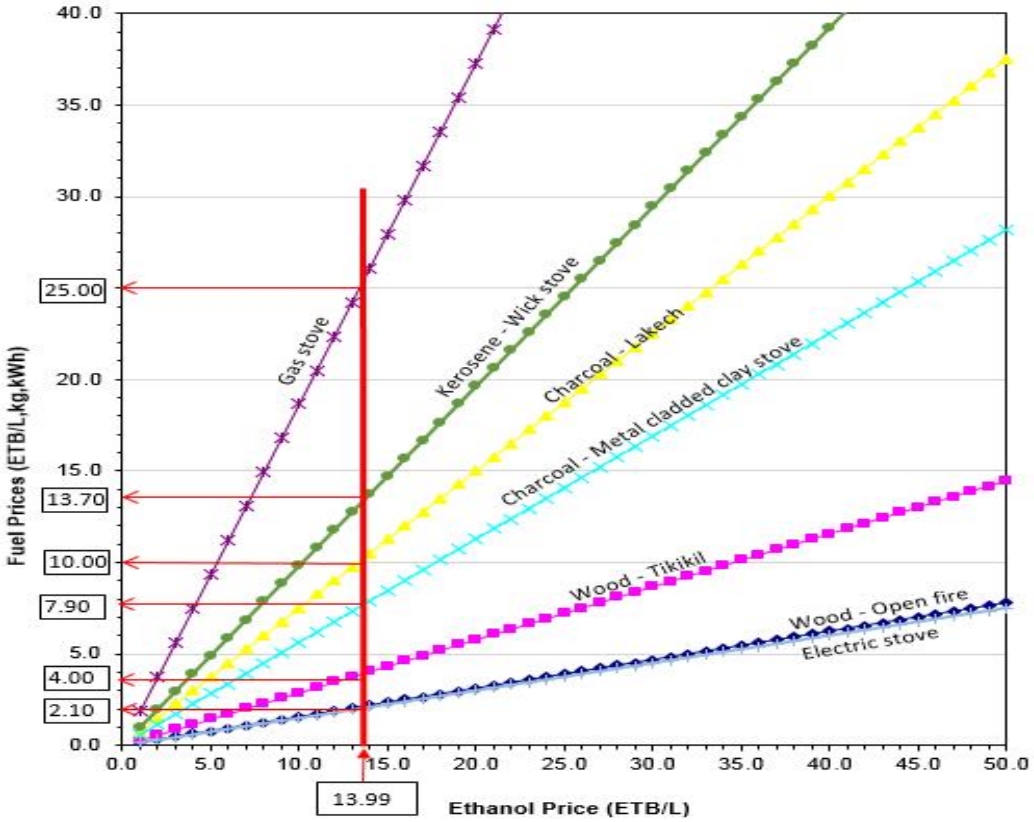
Table 7.1 Comparison of cost of cooking with various stoves and fuels

3795 MJ useful energy/household - year	*Fuel*	Wood	Wood	Charcoal	Charcoal	Ethanol	LPG	Kerosene	Electricity
	Stove	Open Fire	Tikikil	Lakech	Traditional Metal	CC	Single burner	Wick stove	Single burner
	Unit	kg	kg	kg	kg	Liter	kg	Liter	kWh
Energy content of fuel	MJ/(kg,lt,kWh)	16	16	27	27	24.8	44.7	35.3	3.6
Retail price of fuel	ETB/(kg,lt,kWh)	1.37	1.37	4.50	4.50	13.99	97.50	18.96	0.60
Stove life	Year	10	3	3	2	10	10	5	5
Stove efficiency	%	14%	26%	40%	30%	58%	60%	40%	60%
Stove price	ETB	-	225	100	30	1,000	3,000	150	350
Useful energy cost	**ETB/MJ**	**0.61**	**0.36**	**0.43**	**0.56**	**1.03**	**3.79**	**1.35**	**0.31**
Energy cost	ETB/MJ	0.61	0.33	0.42	0.56	0.97	3.64	1.34	0.28
Stove Cost	ETB/MJ	0.000	0.026	0.012	0.005	0.05	0.16	0.01	0.03
Ratio to the least cost stove and fuel		2.0	1.2	1.4	1.8	3.4	12.4	4.4	1.0
Rank		5	2	3	4	6	8	7	1
Percentage cost of stove per use fuel energy		0%	7%	3%	1%	5%	4%	1%	9%
Percentage cost of fuel per use fuel energy		100%	93%	97%	99%	95%	96%	99%	91%

Note: Fuel prices are in the survey areas.
Lower Heat Values of fuels are used in the calculations
Prices of fuels and stoves are taken from the Ethanol Feasibility Assessment Survey, Gaia Association, 2014
Flat rate tariff of EEPCO is considered for electricity price per kWh

Cost of cooking is sensitive to fuel prices. Figure 7.1 shows competitiveness of ethanol fuel for cooking with different fuels and stoves at various prices. At current retail price of ethanol, ETB 13.99/liter, price of fuelwood up to ETB 4.00/kg is competitive if used with Tikikil stove. A similar comparison with Lakech charcoal stove, shows charcoal price up to ETB 10.00/kg is competitive with cooking with ethanol. Cooking with electricity is the cheapest as the price of electricity and the cost of stoves currently available on the market are low. Electricity prices up to ETB 2.10/kWh still makes cooking with electricity the least cost option.

Figure 7.1 Price elasticity for cooking with different fuels and stoves



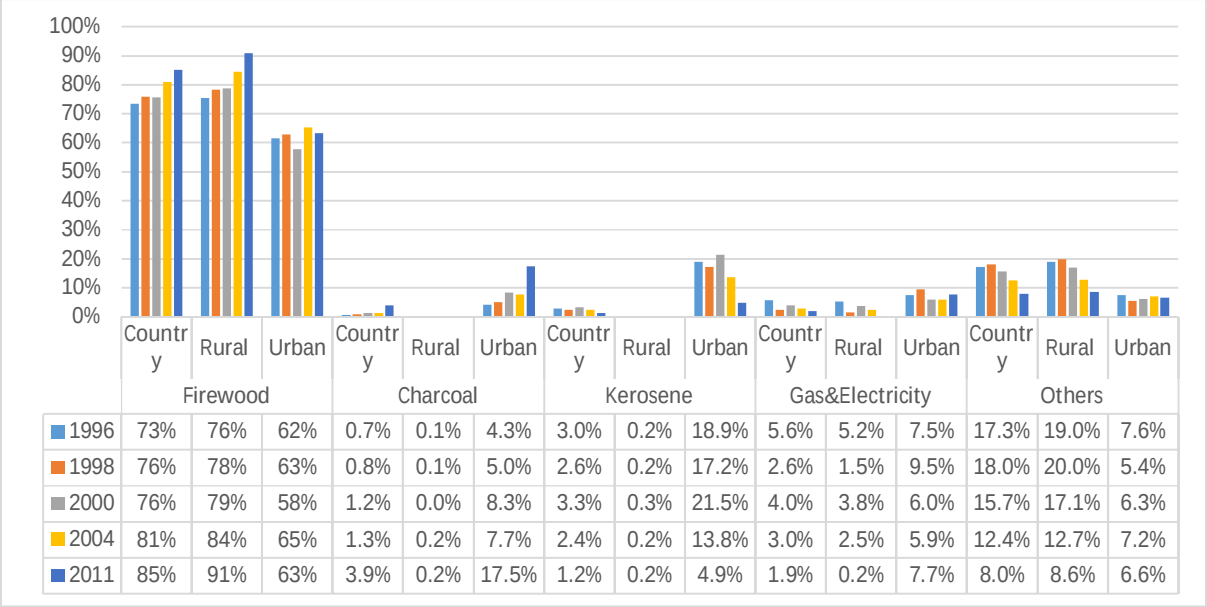
8 Potential market for ethanol fuels and stoves in households, institutions and businesses

Market size for cookstoves is determined by several factors including the demand, availability, prices and attributes of the fuels and stoves. Trends for cooking fuels demand have changed over the years due to availability and prices of fuels. The survey results show that households and enterprises are more sensitive to fuel prices than institutions are. The major concern of institutions and enterprises is availability of appropriate cookstoves that serve their purposes.

8.1 Trends in cooking fuel market in households

Cooking and baking fuels use has been changing over the years. Availability and price of cooking fuels are primary factors that determine households' choices of cooking fuels. Since access to petroleum fuels and electricity is limited or non-existent, biomass is the primary source of cooking energy for the rural households. According to CSA, percentage of rural households that use firewood as primary fuel is increasing over the years while it is almost constant for urban households. Percentage of charcoal user households on the other hand increases for both urban and rural households. This is also confirmed by increasing number of charcoal retail depots in the neighbourhood of urban households. Percentage of kerosene user households is significantly decreasing in urban areas. This is compensated by an increased percentage of households that use electricity for cooking.

Figure 8.1.1 Trends in cooking fuel use by urban and rural households 1996 - 2011 (CSA, WMS 2012)

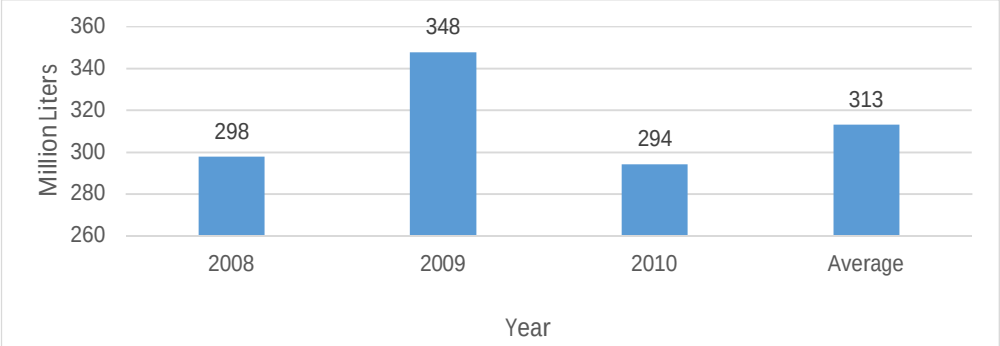


	Firewood			Charcoal			Kerosene			Gas&Electricity			Others		
	Country	Rural	Urban	Country	Rural	Urban	Country	Rural	Urban	Country	Rural	Urban	Country	Rural	Urban
1996	73%	76%	62%	0.7%	0.1%	4.3%	3.0%	0.2%	18.9%	5.6%	5.2%	7.5%	17.3%	19.0%	7.6%
1998	76%	78%	63%	0.8%	0.1%	5.0%	2.6%	0.2%	17.2%	2.6%	1.5%	9.5%	18.0%	20.0%	5.4%
2000	76%	79%	58%	1.2%	0.0%	8.3%	3.3%	0.3%	21.5%	4.0%	3.8%	6.0%	15.7%	17.1%	6.3%
2004	81%	84%	65%	1.3%	0.2%	7.7%	2.4%	0.2%	13.8%	3.0%	2.5%	5.9%	12.4%	12.7%	7.2%
2011	85%	91%	63%	3.9%	0.2%	17.5%	1.2%	0.2%	4.9%	1.9%	0.2%	7.7%	8.0%	8.6%	6.6%

CSA data aggregated the percentage of gas and electricity user households. Observation of the market and anecdotal information indicate an opposite trend in the use of both fuels – an increase in electricity usage for cooking and a decreasing trend in the use of gas (liquefied petroleum fuel). This can also be inferred from increased availability of table top electric ring stoves, both imported and locally manufactured ones, in super markets and local shops. Moreover, the number of household connected to grid electricity is increasing as electricity extension in previously non-electrified areas and electricity intensification in already electrified areas increased in the past 10 years. Hence, the aggregated percentage figure for gas and electricity user households in Figure above does not show the true percentage of gas and electricity user households.

Trends in kerosene supply show that the annual kerosene consumption for cooking and lighting in the country on average is about 313 million liters.

Figure 8.1.2 Annual kerosene distribution for cooking and lighting from 2008 to 2010



8.2 Potential market for ethanol fuel and stove in rural households

Major drivers for adoption of new stoves and fuels for households are price of fuels and stoves, availability of fuel, and convenience of use which includes safety, cleanliness, smoke free and speed of cooking. Households who depend on collected fuels for much of their cooking fuel requirement may not be able to afford a shift towards cleaner and costly fuels such as ethanol.

Only 25% of the rural households and about 75% of urban households purchase cooking fuels. Even though over 90% of the households wish to use ethanol, it will not be an affordable fuel for the majority of them. The cost of fuel collection in terms of time and effort could be worth of significant money. However, opportunities to readily convert the time and effort they could have saved by using efficient cookstoves and cleaner fuels in to cash are almost nil in most cases. Some affluent households afford and want to pay for fuels and stoves that are clean and efficient. As the survey result indicated, between 45% and 50% of the households surveyed are willing to pay the full cost of an ethanol cookstove upfront.

Table 8.2.1 Percentage of rural households who want to pay for an ethanol cookstove

	Rural	Urban
Total number of rural households	14,487,084	4,262,927
Households interested to use ethanol	92%	91%
Percent of hhds who want to pay 100% cash for stove	45%	51%
Percent of hhds who want to pay Cash + 6 month credit scheme	36%	37%
Percent of hhds who want to pay Cash + 1 year credit scheme	19%	12%

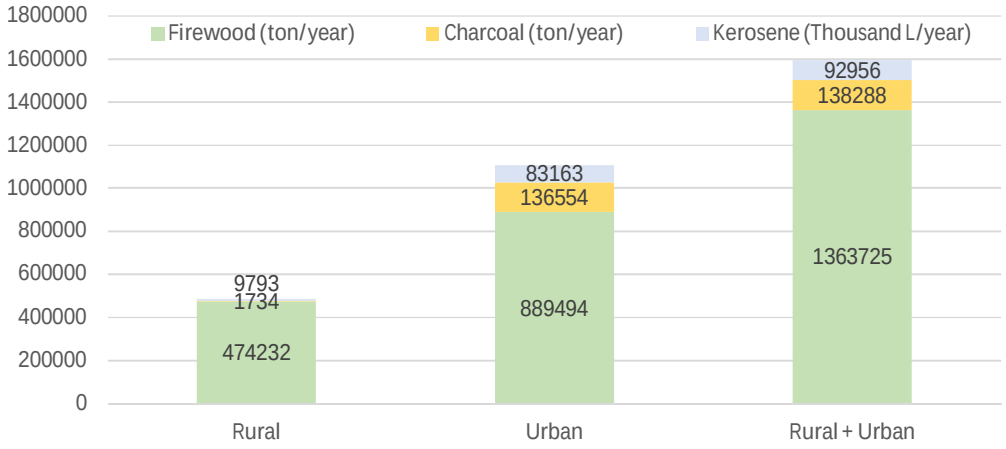
As shown in Section 7.4, over 90% of the cost of cooking is the cost of fuel. Households could make a one-time payment to acquire a cookstove. But, if the fuel is more costly than the cost of fuels that they are currently using, they may not be able to use the stove. Hence, potential market for ethanol could be all households that currently use kerosene for cooking, 50% to 75% of charcoal user households, and about 2% rural households and 25% of urban households that use firewood for cooking. Since electricity is much cheaper and not less in convenience of use compared to ethanol, it is very unlikely for those households that use electricity for cooking to shift to ethanol. Table 8.1.2 shows the assumptions and number of households that could be potential market for ethanol fuel for cooking.

Table 8.2.2 Assumption and potential number of households that will use ethanol for cooking

Assumptions for percentage of households shifting to ethanol				
	Firewood	Charcoal	Kerosene	Electricity
Rural	2%	50%	100%	0%
Urban	23%	75%	100%	0%
Percentage of households by type of fuel used for cooking				
	Firewood	Charcoal	Kerosene	Electricity
Rural	90.9%	0.2%	0.2%	0.0%
Urban	63.3%	17.5%	4.9%	6.2%
Number of Households shifting to ethanol				
	Firewood	Charcoal	Kerosene	Total
Rural	263,462	16,675	24,650	304,787
Urban	622,024	561,950	209,316	1,393,290
Rural + Urban	885,486	578,625	233,966	1,698,076

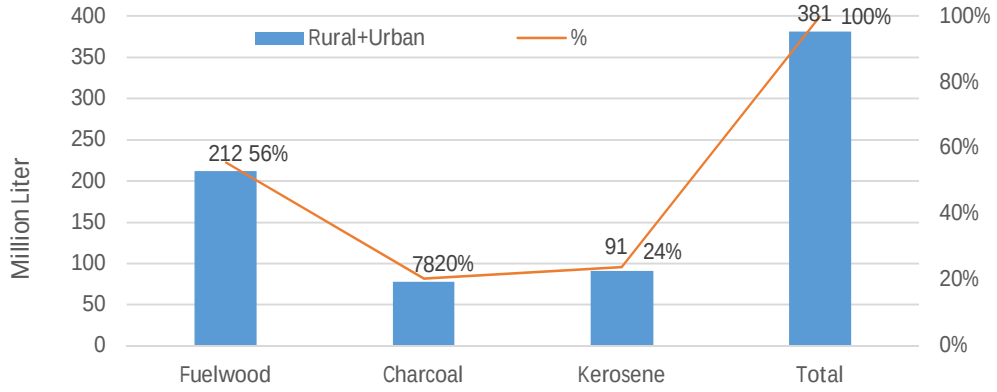
The number of households, in both rural and urban areas, that will potentially shift from their current cooking fuel to ethanol is estimated to be about 1.7 million.

Figure 8.1.1 Potential substitution of fuelwood, charcoal and kerosene at current year



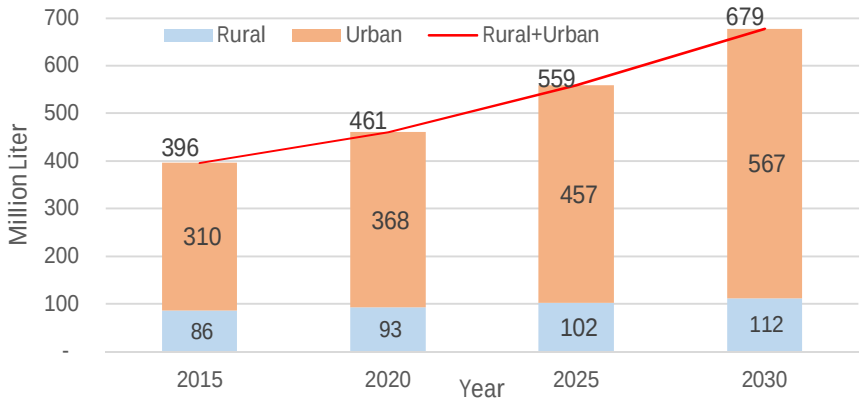
The potential for ethanol to substitute firewood, charcoal and kerosene at the current year is about 1.4 million ton of fuelwood, 138 ton of charcoal and 93 million liters of kerosene.

Figure 8.1.2 Ethanol demand for cooking fuel by type of fuel to be substituted



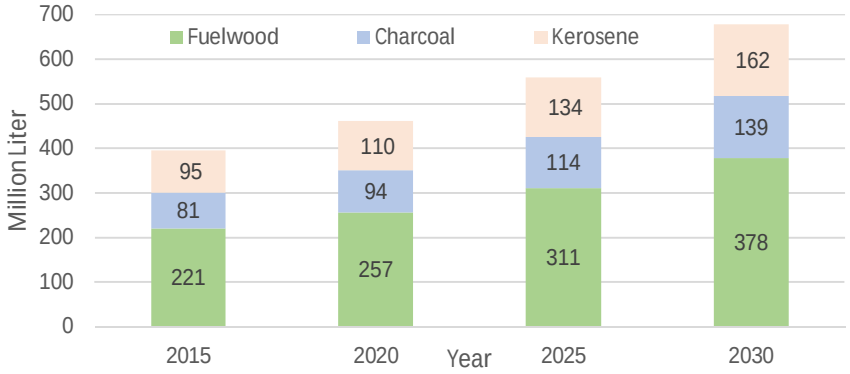
The potential demand for ethanol as cooking fuel by the rural and urban households for the current year is estimated at 381 million liters. Over 56% of the demand for ethanol comes from fuelwood substitutions, while the demand from charcoal and kerosene substitution is 20% and 24% respectively. Demand forecast for ethanol is shown in Table below.

Figure 8.1.3 Ethanol demand forecast between 2015 and 2030



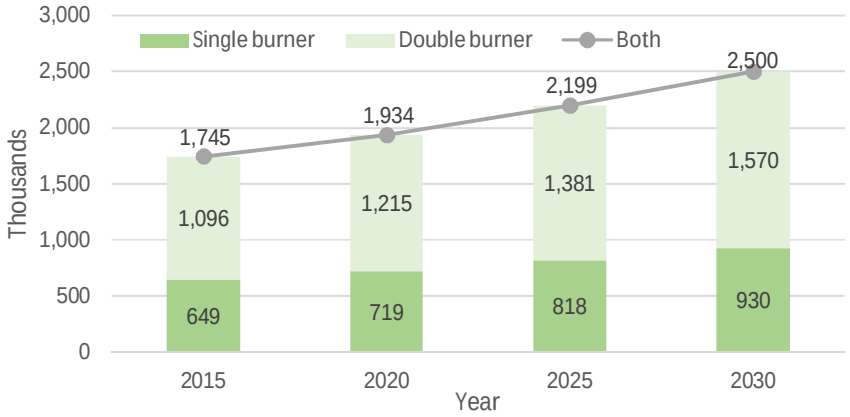
The demand for ethanol as cooking fuel by 2015 is estimated at about 396 million liter a year. By 2030, about 679 million liter of ethanol might be needed for household cooking.

Figure 8.1.4 Ethanol demand for cooking by type of fuel to be displaced



Demand for single and double burner stoves was determined based on the preferences of households. About 43% rural and 36% urban households preferred a single burner ethanol stove. On the other hand, 58% of rural and 64% of urban households chose the double burner stove.

Figure 8.1.5 Demand projection for single and double burner ethanol stove by households



The total potential demand for ethanol stoves by 2015 is estimated at about 1.7 million of which 37% is for single burner stoves. By 2030 the total demand for ethanol stoves may reach 2.5 million.

8.3 Potential market for ethanol fuel and stove in institutions

Institution with catering services incudes universities, schools with feeding programs, hospitals and correctional facilities are potential markets for ethanol fuel and cookstoves. Other training institutions and communal cooking places such as those in refugee settlements are also potential market.

Table 8.3.1 Number of institutions with cooking services and estimated cooking energy consumption

Type of institution	Number of institutions	Total fuelwood consumption (ton/year)	Ethanol fuel needed to substitute fuelwood (Liter/year)
Schools with feeding programs	1187	6,834	1,139,000
Public Universities-regular students	34	12,387	2,064,422
Public Universities-summer students		715	119,134
Correctional facilities	119	10,790	1,798,312
Hospitals	197 hospitals/ 4088 Clinics	395	65,807
Military camps (active frontline personnel)		20,850	1,000,786
Total		51,970	8,661,627

An estimated amount of 52 thousand tons of fuelwood can be substituted annually with 8.7 million liters of ethanol in schools, universities, hospitals, correctional facilities and military camps. The potential market for ethanol fuel can be higher if the demand from refugee settlements with communal cooking facilities and other training institutions are added. However, not all institutions purchase their cooking fuels. Almost all schools with feeding programs do not purchase cooking fuel. Cooking fuel supply to the school is the responsibility of communities around the schools. In reality, it is the students who bring firewood to school for cooking. Since rural schools do not have budget for cooking fuel, they may not be considered as a market for ethanol fuel in the short to medium terms. Hence, the demand for ethanol fuel can be estimated at about 7.5 million liters per year.

Cooking with ethanol, at current market price of cooking fuels, is competitive even to the fuelwood. However, ethanol stove for institutional application is not yet available in the market and the price of which is not known. Stoves and pot sizes that institutions use varies from 60 liter to 200 liter. Universities, military camps and correctional facilities most use 100 to 200 liter capacity pots. Ethanol stoves that would be supplied to these institutions should be able to provide sufficient fire power in the range of 10 to 15 kW. This was also one of the concern of institutions surveyed. If suitable stove is available, many of the institutions surveyed are willing to adopt ethanol for cooking fuel.

Table 8.3.2 Percentage of institutions that are interested to use ethanol for cooking

Type of institutions	Percent interested to use ethanol
Universities	92%
Hospitals	89%
Schools	75%

Considering 90% of the institutions (but leaving out schools) that are willing to adopt ethanol for cooking, the estimated effective demand for ethanol fuel in institutions is about 6.8 million liters annually.

The number of persons served in all institutions is estimated at 1.7 million. However, leaving out 0.67 million students in school feeding programs, which usually get their supply of fuel wood by collection rather than purchase, the net number of persons served will be about 1 million. Number of stoves needed for institutions can be estimated by number of pots needed for cooking one meal in an institutions. Pot sizes in institutions vary from 50 liter to 200 liter capacities but the average can be assumed at 100 liter. Conservatively assuming one 100 liter pot (i.e. 1 stove) to serve 200 persons, the total number of pots or stoves needed to serve 1 million persons is about 5,000. At a price of ETB 10,000, the market potential for ethanol stoves would be about ETB 50 million.

8.4 Potential market for ethanol fuel and stove in businesses

There are over 126,115 enterprises that are engaged in food service businesses (hotels and restaurants) in urban areas in the country[24]. These enterprises spend an average amount of ETB 985 per year on energy.

Table 8.4.1 Enterprises that are interested to use ethanol for cooking

Region	% interested to use
Tigray	90%
Afar	93%
Amhara	98%
Oromia	98%
Somali	93%
Benishangul	70%
SNNP	99%
Gambella	90%
Harar	100%
Addis Ababa	96%
Dire Dawa	100%
Total	96%

About 96% of the enterprises surveyed were willing to use ethanol stove. Of those who want to adopt ethanol as cooking fuel, about 32% of them are willing to pay between ETB 600 to 750 for a single burner stoves while the remaining 68% are willing to pay between ETB 1,000 and ETB 1,200 for a double burner stoves.

Table 8.4.2 Enterprises willing to pay for double and single burner

Regions	Single burner (ETB 600 - 750)	Double burner (ETB 1000-1200)
Tigray	13%	87%

[24] CSA, Distributive trade and services 2009, March 2011

Afar	3%	97%
Amhara	21%	79%
Oromia	34%	66%
Somali	82%	18%
Benishangul	20%	80%
SNNP	44%	56%
Gambella	29%	71%
Harar	33%	67%
Addis Ababa	20%	80%
Dire Dawa	69%	31%
Total	32%	68%

However, even though most of the enterprises are willing to pay over ETB 600 for an ethanol stove, only 52% of them are willing to pay ETB 10 or more for a liter of ethanol. This will bring the effective demand for ethanol to about 63,000 enterprises. In the current year, the demand for a single burner stove is about 20 thousand and for that of the double burner is about 43 thousand. Annual ethanol demand from these enterprises is estimated at about 69 million liters conservatively assuming an average consumption of 3 liters of ethanol per day. This assumption is taken considering that each of these enterprises on average cook food for 10 to 15 persons per day.

Table 8.4.2 Prices that enterprises want to pay for a liter of ethanol fuel

Price range per liter	Percent of enterprises
Less than ETB 5.00	5%
ETB 6 to 8	15%
ETB 9 to less than 10	28%
ETB 10 to less than 15	35%
ETB 15 to 20	11%
More than ETB 20	6%

Most of the enterprises prefer to pay a one-time cash payment (63%). About 28% of them want a 6 month credit scheme for half of the stove price while 8% of then want a one-year credit scheme.

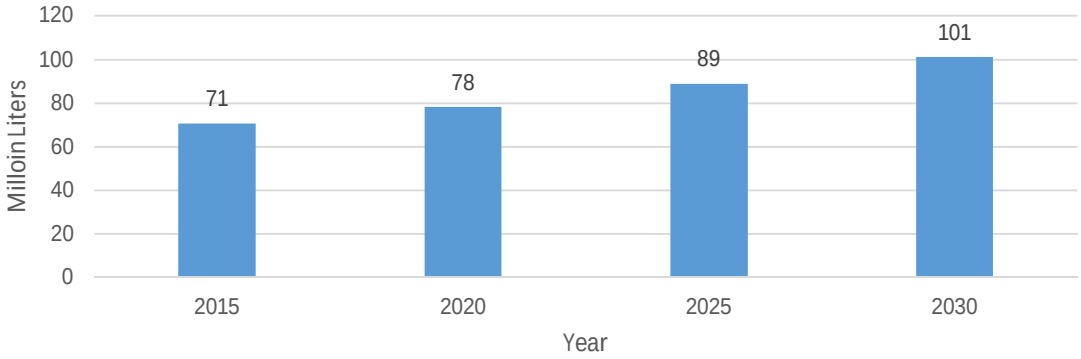
The total demand for ethanol stoves by enterprises in 2015 is estimated to reach about 65 thousand stoves. Demand projection for ethanol stove is shown in Table 8.4.3.

Table 8.4.3 Projection of demand for ethanol for cooking

Burner type	2015	2020	2025	2030
Single burner	20,670	22,905	26,041	29,607
Double burner	43,924	48,673	55,338	62,916
Both	64,593	71,578	81,379	92,523

Demand for ethanol for cooking by enterprises estimated to grow from 71 million liters in 2015 to over 100 million liters in 2030.

Figure 8.4.1 Demand projection for ethanol for cooking by enterprises


120
100
80
60
40
20
0
Milloin Liters
71
78
89
101
2015
2020
2025
2030
Year

9 Potential for emissions reduction and forest saving from ethanol use for cooking

Environmental and social benefits of using ethanol for cooking is immense. Reduction of greenhouse gas emissions by displacing biomass fuels and avoidance of air pollution in the households due to cooking are highly valued environmental and social benefits that clean cooking with ethanol could bring. It also contributes to efforts towards deforestation as it displaces firewood which would otherwise be obtained from cutting down of trees.

9.1 Emissions reduction potential of ethanol use for cooking

Use of ethanol for cooking fully displaces biomass fuels, primarily fuelwood and charcoal, currently used by households, institutions and enterprises. Table 9.1 summarizes the effective demand for ethanol fuel and stoves from the different sectors and also estimates the corresponding carbon dioxide (CO_2) reduction potential from each sector. The amount of CO_2 that can be potentially reduced from all the sectors is about 5 million tons annually. It should be noted that, until some time, there may not be sufficient ethanol supply to meet the estimated demand even after the completion of the currently planned sugar factories.

Table 9.1 Estimated demand for ethanol & CO_2 reduction potential of ethanol use for cooking (2014/15)

Sector	Demand for single burner	Demand for double burner	Both Single & Double burners	Effective demand for ethanol/year	Equivalent Firewood displaced/year	CO_2 reduction potential/year
	Thousands	Thousands	Thousands	Million Litre	Million Ton	Million Ton
Rural Households	131	177	308	86	0.49	0.91
Urban households	502	892	1,393	310	1.78	3.27
Enterprises	21	44	65	71	0.41	0.75
Institutions	5		5	6.8	0.034	0.06
Total				474	2.72	5.0

9.2 Contribution of ethanol cooking fuel to deforestation

If ethanol is used for cooking in the scale discussed above, the annual potential for saving forests is estimated at about 211 and 101 thousand hectares of sustainably harvested or clear felled forest respectively.

Table 9.2 Estimates of forest saving by displacing fuelwood and charcoal by ethanol

Sector	Equivalent Firewood displaced/year	Forest saved/year (Sustainable harvest)	Forest saved/Year (Clear felled)
	Ton	Thousand hectare	Thousand hectare
Rural Households	0.49	38	18
Urban households	1.78	138	67
Enterprises	0.41	32	15
Institutions	0.034	3	1
Total	2.72	211	101

**Woody biomass yield from Clear felled forest = 26.8 t/ha; and from sustainable harvest forest 12.9t/ha*[25]

[25] Million Bekele, Forest Plantations and Wood Lots in Ethiopia, A Platform for Stakeholders in African Forest, African Forest Forum, 2011

9.3 Contribution of ethanol cooking fuel to indoor air pollution reduction

Household air pollution due to burning of solid biomass fuels is one of the major killers in third world countries. About 2.8 billion people in developing countries use solid biomass fuels. This number has not changed in 25 years. The result of which is estimated at 3.9 million premature deaths annually[26]. The situation is the same in Ethiopia too.

In Ethiopia, solid biomass fuels are the main source of cooking energy in households, institutions and businesses. The health impact due to CO_2 emissions and particulate matters during cooking is responsible for death of 56,700 annually. The World Health Organization also evaluated the burden of disease attributable to solid fuel use in Ethiopia at 4.9% (WHO, 2007). Cooking discriminately affects women as they are primarily responsible for the preparation of food in the households. The survey result also confirms that women are the primary cook in all the surveyed households. Households are aware of the benefits of clean cookstoves and fuels as it comes out to be one of the major factors that determine their purchase decisions.

[26] Kirk R. Smith (2014). In Praise of Power, Volume 345, Issue 6197, Science: Sciencemag.org, Published by AAAS, 8 August 2014

10 Existing distribution models for ethanol fuel and alcohol stove

Markets and distribution methods for cooking fuel and devices vary for different fuels and devices. Settlements types, urban and rural, also determined current distribution methods. There are distinct distribution models for fuels (fuelwood, charcoal, etc) and associated cookstoves.

10.1 Most common distribution models for fuels and stoves

10.1.1 Description of current cooking fuel distribution models

A. Traditional fuel distribution

Commercial traditional fuels mainly include fuelwood, charcoal and BLT. Dung is also commercialized in urban areas. Fuelwood supply methods vary depending on the volume of purchase.

Firewood suppliers

i. Retailers of construction poles and split firewood

The most common selling place for fuelwood for households is small retail places for construction poles and split firewood which are usually located in the neighbourhoods. Such retail places normally cover supplies to households from one or two Kebeles. Since they are retailing in small volumes with price under ETB 5.00 per bundle they are the most expensive places to buy fuelwood. However, households that use fuelwood for cooking/baking prefer such types of fuel distribution models as they usually do not have sufficient storage space and budget to buy in larger volumes.

Availability of such types of retail market places is reducing over time in urban areas. This has been confirmed by participants in the focus group discussions in Addis Ababa. One of the reasons that some households in the centre of the city motioned for not using firewood is absence of nearby suppliers for firewood. On the contrary, fuelwood selling places in rural areas are increasing as commercialization of cooking fuel is increasing and control on free collection is getting tighter in rural areas.

Figure 10.1 Neighbourhood firewood and charcoal retail market

ii. Fuelwood peddlers in small fuelwood market places

Fuelwood peddlers are those who carry around bundles of fuelwood themselves or on donkey backs. These are mainly observed in rural villages and smaller towns where market places for cooking fuels are set only on market days during the week. Usually they peddle around households on their way to main market center. If they don't get their fuels sold in the villages they end up in fuel markets in the towns. These are usually farmers selling fuelwood as side business.

iii. Firewood logs depots

Firewood log depots are those who buy in large volumes and sell still large volume consumers such as bakeries and restaurants. There are found only in urban areas, usually larger cities, and are not very many of them. They sell firewood logs in cubic meters. The prices of firewood from such places is lower compared to small retailers.

iv. Large volume firewood suppliers

These are firewood suppliers which supply to large institutions such as universities, correctional facilities and hospitals where mass cooking takes place. Usually, they get into supply contract for a quarter or a year. These suppliers buy live trees from plantations and supply in several lorry loads. Price of firewood from these suppliers is the lowest.

Charcoal suppliers

There are primarily three levels of charcoal suppliers in the supply chain from producers to final consumers. The first level of charcoal suppliers are producers, then wholesalers and retailers.

i. Charcoal Producers

They are entirely located in rural areas. These producers can be individuals whose primary employment is farming but produce charcoal as a side business to supplement their income. Their production capacity can be as small as 10 sacks or less per month. On the other hand, producers whose main business is charcoal production and sales produce charcoal on a daily basis. These producers sell charcoal mostly to wholesalers but consumers can also buy from them if they can be easily accessed.

ii. Charcoal wholesalers

Wholesalers for charcoal usually buy from multiple charcoal producers and sell in bulk for retailers and distributers. They are very common in major charcoal producing areas such as in Gewane in Afar Region. Their main sells is for distributers who come with light trucks and buy hundreds of sacks of charcoal to supply to retailers in major urban areas. Any quantity of sales is available for own consumption or sales.

Figure 10.2 Charcoal wholesalers in Gewane, Afar region

iii. Charcoal retailers

The charcoal retail market in common in in urban areas. Retailers can be in a form of charcoal depots where sales is only in sacks or in small neighbourhood markets which locally are called '*Gullit*' where sales as small as 1 kg in small plastic bags is available. Retailers in small bags buy charcoal in a sack or two from charcoal depots and sell in small retails to low income households who are not able to pay for a sack of charcoal. Price of charcoal is much higher when purchased in small retails than in sacks. It has been observed in recent years that the number of charcoal distribution depots in towns is increasing and now several of them are available in the neighbourhoods.

B. Non-traditional fuel distribution

Non-traditional cooking fuels mainly include kerosene, LPG and ethanol.

Kerosene is now available only in petroleum fuel stations. However, in rural towns where consumers buy kerosene for lighting, small shops purchase in barrels from petroleum stations to retail in units less than a litre. In the past few years, five to ten years before, petroleum companies were encouraged to set up pumping stands for kerosene in the neighbourhood. Most of them are not available now as more households shifted away from kerosene to other fuels.

LPG is sold to consumers through retailers. Petroleum companies sell LPG in different size containers only to registered and licensed distributer located in different areas in major cities. These retailers can be outlets for LPG sales only or super markets and some petroleum fuel stations. In the past, it was common for LPG outlets to provide delivery service to their clients. However, with the scarcity of the fuel this is not observed in recent years.

Ethanol as cooking fuel is known and used only by very few households in Addis Ababa. It has also been promoted and used in refugee settlements but fuel supply was not commercial. Commercial ethanol fuel supply for cooking is available only from two or three fuel distributors which are located in Addis Ababa. These distributors are known only by those customers who purchased the ethanol cookstoves from them. Each one of these ethanol fuel distributors have only one outlet. One of the reasons mentioned by the distributor for not having several distribution points is unreliability of ethanol fuel supply from the sugar factories.

10.1.2 Current cookstoves distribution models

Like cooking fuels, distribution models for cookstoves is also determined mainly by the type of cookstove and settlements. Cookstove types can be broadly categorised as traditional, improved and modern cookstoves.

Traditional cookstove can be commercial or self-built ones. Commercial traditional stoves are mostly charcoal stoves made with clay or metal. Clay charcoal stoves are usually available in rural markets for rural consumers almost entirely sold by potters who produce them. Metal charcoal stoves are available in shops almost in all markets in different sizes, qualities and prices. Shops gets them either directly from producers in cities or from wholesalers.

Improved cookstoves are energy efficient cookstoves that burn traditional fuels such as firewood, charcoal and other solid biomass fuels. Improved stoves usually have promoters behind them. Distribution models vary depending on the type of stove, its size and installation requirements. Stoves which are off-the shelf type and easy to carry, such as charcoal stoves, are usually sold from shops. Lakech improved charcoal stove is an example. Producers sell their products from the production place or distribute their products to shops. On the other hand, high mass stoves which require certain procedures for installation are usually sold and installed by the producers themselves. Major hurdles for mass dissemination of such type of stoves is limited availability of transport service and access roads. The fact that they are high mass, usually made from mud or concrete, made them fragile.

Hence, the market for high mass stoves are limited to areas around the producers themselves. Examples are *Mirt* and *Gonzie* stoves produced from concrete and fired clay respectively. Improved firewood stoves for cooking might be carry-and-go type but distribution models that worked well for the improved charcoal stoves did not work. An example is Tikikil improved firewood cookstove. Some producers tried supermarkets and shops in towns as outlets for Tikikil but did not work as customers that come to supermarkets and shops do not use firewood for cooking. Households that use firewood for cooking are usually located in rural or sub-urban areas. Appropriate distribution channels to reach these markets should be sought for Tikikil and other household size improved firewood stoves to be successfully disseminated.

Modern cookstoves are mainly those that work with LPG, kerosene and electricity. Distribution models for these stoves is mainly through shops and supermarkets. These stoves are main cooking devices used by urban households. Shops and supermarkets are ideal outlets for such products. Ethanol stoves can also be categorized as modern cookstoves and same distribution models that work for modern cookstoves can be useful for its widespread use if both the stove and the fuel are well promoted.

10.2 Limitations of current cooking fuels and stoves distribution models

Successful distribution models are those that help wide scale commercial dissemination of cookstoves and fuels. These are models for dissemination of modern cookstoves and fuels, traditional fuels including charcoal and firewood, and traditional and improved charcoal stoves. The common characteristics that these distribution models have in common are product types which are easy to transport, outlets located where the customers are, and prices that are to the customers' ability to pay. Availability of fuels in different retail sizes make the fuels reach every segment of the market. This works well for traditional fuels as well as non-traditional fuels.

The unsuccessful models also have similar attributes. The first and most important to note is selling product in area where there is no need for it. An example is selling firewood stove in urban supermarket and shops. Closed down of neighbourhood pumping stations for kerosene shows a decline in the demand of kerosene by consumers. Marketing fragile high mass stoves in rural areas where transportation is not available or make the stoves liable for breakage during transportation is another limitation of the dissemination model. High mass stoves such as Mirt is well disseminated in Addis. A study conducted by GIZ in 2009 indicated that as much as 10% of the households in Addis Ababa Adopted *Mirt* stove[27]. This is a high figure for an area where much of the baking is done with electricity.

10.3 Promising distribution models for wide scale adoption of ethanol fuels and stove

Ethanol fuel and stove are categorized under modern fuels and cookstoves as attributes of the fuel and the stove resemble more to modern fuels/stoves. Distribution models that worked for modern fuels should also work for ethanol fuel. Modern fuels are distributed from filling stations/neighbourhood pumps (i.e. for kerosene), and specialized outlets and supermarkets (i.e. LPG distributers). Fuels are available in different quantities either in litres for kerosene or different size bottles for LPG. Ethanol fuel dissemination can also follow the same trend. Neighbourhood pumping point might require high volume sales to be effective and might not be a choice at earlier stage of marketing the fuel. However, selling the fuel in specialized outlets and supermarkets in quantities that customers want. Volumes of ethanol that households want in a single purchase, based on responses of participants on the focus group discussion is between 5 to 10 litres. Most enterprises, however, want larger volume of purchase.

[27] GIZ SUN Energy, Household Energy Baseline Survey in Addis Ababa,2009

The survey result shows that 55% of the enterprises prefer to purchase ethanol fuel in volumes higher than 10 litres.

Table 10.1 Preferences of enterprises for volume of ethanol fuel in a single purchase

Regions	Amount of fuel want to buy once (Liter)				
	0.5	1	2	10	More than 10
Tigray	2%	28%	17%	30%	23%
Afar	0%	10%	7%	40%	43%
Amhara	0%	5%	3%	25%	67%
Oromia	1%	6%	6%	16%	72%
Somali	0%	4%	4%	21%	71%
Benishangul	0%	0%	14%	14%	71%
SNNP	2%	8%	13%	26%	51%
Gambella	0%	0%	0%	50%	50%
Harar	0%	7%	10%	13%	70%
Addis Ababa	1%	2%	16%	42%	40%
Dire Dawa	0%	7%	3%	17%	73%
Total	1%	7%	9%	27%	55%

Supermarkets and small shops in towns sell kerosene, electric and LPG stoves. Same distribution outlets would be effective for wide scale distribution of ethanol stove.

11 Key stakeholders in cooking market

Ethanol fuel and stove marketing involves several players including fuel and stove producers and suppliers, consumers, and technology promoters and regulators from various sectors of the economy. Ethanol fuel use for cooking involves the agriculture sector on the crop growing side, the Ministry of Industry on sugar processing and ethanol distillation, the Ministry of Trade on the pricing and selling of the fuel, and the private sector on the manufacturing and retailing of cookstoves and fuels. Promoters of ethanol fuel use for cooking requires engagement of relevant regional government organizations including Bureaus of Energy, Health, Agriculture, and Women's Affairs. Civil societies and NGOs will also have key roles to play to make successful dissemination of ethanol fuel and cookstoves to consumers by providing necessary supports on the fuel and stove supply chain. On the consumer side, it involves households, enterprises such as hotels and restaurants, and institutions including schools, health institutions, universities, training facilities, correctional facilities, military camps and refugee centers.

A. Ministry of Water, Irrigation and Energy (MoWIE)

MoWIE is the mandated government organization for matters related to energy production and use. The ministry has Directorates responsible for handling issues related to cooking energy supply and use. Alternative Energy Technology Development and Promotion Directorate of the Ministry is in charge of improved cookstoves development and promotion in the country. It also has a research wing for research and development of various types of alternative energy technologies including cookstoves. The directorate has played a leading role in the national cookstove programs which lead development of several types of efficient cookstoves which are now widely disseminated throughout the country. The research and development center under this Directorate, beside design and development of improved cookstoves, also provides technical assistance for cookstove developers and promoters in determining the performance of cookstoves in terms of fuel consumption and level of emissions. Working together with Regional Bureaus of Energy, Agriculture and Health, the Directorate provides technical assistance and capacity building supports to private entrepreneurs such as micro and small enterprises that are involved in production and dissemination of improved cookstoves. Regional Bureaus of Agriculture and Health through their rural extension channels educate consumers about environment and health benefits associated with cooking energy use. They also promote clean and energy efficient cooking by including such technologies in their extension packages.

The Biofuels Development Coordination Directorate of the MoWIE plays a coordination role in biofuels development and use for various end uses including use of biofuels for transport and cooking fuel. It plays a major role in price setting and allocation of biofuels for household cooking by lobbying and providing useful information to relevant government organizations including the Ministry of Trade, Ministry of Industry and the Ethiopian Sugar Corporation.

MoWIE under its strategic plan for 2011 to 2015 devised a National Improved Cookstove Program which sets a target for dissemination of nine million cookstoves all over the country. The Ministry has developed an investment plan to reach its target by the end of the planning period. The investment plan shows that the Ministry has several development partners to work with including government organizations, bilateral organizations, NGOs, and the private sector.

B. Ministry of Industry

The primary role of the Ministry of Industry is to provide support to medium and large, and growing medium industries. The ministry provides technical support to the sugar industries when required. However, all public sugar industries under Ethiopian Sugar Corporation are under the direct supervision of the Prime Minister's Office.

Micro distilleries and clean cookstove manufacturing enterprises the investment capital of which is over 1.5 million can be under the regulation of the Ministry of Industry. Development of Micro and Small Enterprises (MSE) and supports to them is under the Ministry of Construction.

C. Ministry of Trade

Major roles of the Ministry of Trade in relation to fuel supply are provision of fuel supply license, price regulation and quality control. The Ministry of Trade regulates petroleum fuel prices and controls quality as well. It closely works with Ethiopian Petroleum Enterprise, Ethiopian Sugar Corporation and petroleum companies. Ethanol fuel price is set by the Ministry of Trade. The Bio fuels Development Coordination Directorate of the MoWIE provides the necessary information and advise which help the Ministry of Trade to determine ethanol fuel price.

D. Ministry of Health and regional Health Bureaus

The health sector moto in Ethiopia is "Prevention is better than cure". Preventive health is the major focus under the health policy of Ethiopia. Core activities of the Ministry of Health and Regional Health Bureaus are related to educating and equipping communities with knowledge, skill and technologies necessary to help prevent disease. One of the top prevalent diseases in Ethiopia is related to respiratory health which mainly is either caused or aggravated by air pollution in dwelling places. The main cause for indoor air pollution is high concentration of smoke in unventilated cooking place. In most rural and urban households cooking takes place in the living rooms and exposes household members to high level of air pollution. The Housing Package is one of the 16 items in the Rural Health Extension Package which deals with unhealthy living environment[28]. Among several other household items and techniques that help instill healthy living environment in the houses, smokeless kitchen through use of clean and improved cookstoves are promoted. Regional Bureaus of Health work closely with Women's Affairs Offices at regional and Woreda level.

E. Ministry of Women, Youth and Children, and Regional Bureaus of Women's Affairs

The Gender Affairs Directorate is in charge of mainstreaming gender issues in the planning and implementation of projects and programs in government organizations. Ethiopian Women Development and Change Package is a section under the Gender Affairs Director which is responsible to deal with problems of rural women. Cooking energy supply and use is recognized by the Ministry as one of the major problems that affect rural women and children. The Ministry closely works with Woreda level Women Development Army to promote and disseminate clean and energy efficient cooking technologies in rural areas. Regional Women's Affairs Bureaus closely work together with Regional Energy Bureaus in the manufacturing and dissemination of improved cookstoves.

F. Ethiopian Standards and Conformity Agency (ESCAE)

Standards and Conformity Agency a public enterprise under the Ministry of Science and Technology. ESCAE inspects and certifies imported or locally manufacture products for their conformity to the standards set by the Ethiopian Standard Agency for the products. Energy related services that ESCAE

[28] Ministry of Health, Building and Maintaining Healthful House Extension Package, February 2004.

provides are inspection and certifying of electrical appliance and fittings. Discussions are underway with MoWIE and Ethiopian Standards Agency to establish standards for improved cookstoves.

G. Ethiopian Sugar Corporation

Ethiopian Sugar Corporation under its five year strategic plan emphasized the production and supply of energy from the bi-products of sugar, bagasse and molasses[29]. Enhanced production and supply of ethanol is one of the priorities of the Corporation. It targeted to produce 44,340 cubic meter of ethanol by the end of the 2015 from the expansion projects of the existing sugar factories and the new ones that will be constructed. Even though much of the ethanol is planned for gasoline blending for transport fuel, the Corporation believes that there will be sufficient amount for cooking fuel as well.

Table 11.1 Plan for Annual Ethanol Production for 2017 in (thousand cubic meter)[30]

No.	Factory/ Project	2005 (achievement)	2006 (plan)	2007 (plan)
1	Fincha	7.6205	20.00	20.00
2	Metehara	7.063	10.2	12.50
3	Wonji Shoa	-	-	10.299
4	Tendaho	-	11	40.4
5	Kesem	-	-	10.20
6	Arjo Dedessa	-	-	-
7	Beles 1	-	-	12.70
8	Beles 2	-	-	6.00
9	Kuraz 1	-	-	22.50
10	Others	-	-	-
	Total	**14.68**	**41.2**	**134.60**

Communication and Marketing Directorates of the Corporation emphasized that the demand for ethanol is high and growing. Current production cannot meet demand for various users. Much of the ethanol is used for gasoline blending. Remaining amount will be shared among uses for cooking fuel, beverage industry, ink and pharmaceutical factories. The demand for ethanol fuel is high therefore the current supply couldn't satisfy the local demand. Distribution quota for various applications is determined by the Ministry of Industry. Policy level decision may be required to ensure sufficient allocation and appropriate pricing ethanol for household cooking purposes.

In 2006 EFY about 27 million litres of ethanol was produced with a plan to blend 18 to 20 million litres and the remaining for distribution to various users. Of the seven million litres, 2 million was allocated for cooking fuel. However, of the 2 million litres allocated only about 13% of it was distributed by the three distributers of ethanol for cooking fuel (Makobu, Moges and Gaia Association). Ethiopian Sugar Corporation had two categories of prices for ethanol – one for gasoline blending and the other for other uses. Since mid 2013, Ministry of Trade intervened to make the price of ethanol ETB 9.37 before VAT.

Table 11.2 Amount of ethanol distributed and price to cooking fuel use

Year (E.C.)	Amount (litre)	Price with VAT (ETB/litre)[31]	Price without VAT (ETB/litre)
2004	263,500	8.74	7.60

[29] Ethiopian Sugar Industry Profile
[30] Ethiopian Sugar Corporation, Communication Directorate
[31] Two ethanol price figures for the year of 2005 and 2006 is because of having different price index within the same year

2005	600,520	8.74 (10.78)	7.60 (9.37)
2006	256,800	10.78	9.37

Prices in brackets are retail prices to consumers.

Currently the factory get price of ethanol for distributers before VAT is ETB 9.37 per litre. Retail price of ethanol to consumers is ETB 13.99 per litre.

H. Development Bank of Ethiopia (DBE)

DBE is established primarily to finance investments that are in line with the GoE's priority development areas. It provides short, medium and long-term investment loans and technical assistance to viable projects.

DBE has set up a fund to promote private sector investment in clean energy technologies including cookstoves, renewable energy technology based rural electrification projects. It also provides credit lines to MFIs who can use funds to lend to end users and energy micro-entrepreneurs. Individual loan up to a maximum of USD 2,500 is permitted with interest rate of 8.25%.[32] Credit lines with DBE includes loans for adaptation of off-grid renewable energy technologies such as solar home systems by rural households, import of renewable technologies for rural electrification and for setting up of manufacturing plants. Proportion of loan to equity is 70% with 100% collateral requirements for the loan amount. Loan applications require business plans prepared according to the template provided by the bank. A formal approval from Ministry of Water, Irrigation and Energy is also needed. For adaptation of renewable energy technologies in off-grid areas, the bank provides loan up to 95% of the investment to consumers organized in cooperatives. Consumers are required to make only 5% down payment. Two sources of funding made financing for renewable energy technology possible at DBE. The first one is the Rural Electrification Fund (REF) which is mainly targets off-grid rural consumers to get access to electricity through renewable energy technologies. So far, about 450 rural electricity cooperatives benefited from this source of finance. The second source of funding is from the World Bank. The World Bank channeled USD 20 million through DBE. This line of credit is available for private entrepreneurs and Micro Finance Institutions. It can be accessed for importing of renewable energy technologies or setting up of a manufacturing plant.

I. Development partners

Several development partners, NGOs and bilateral organization, provide both technical and financial assistance to the development and dissemination of renewable energy technologies including clean and improved cookstoves. GIZ ECO, Gaia Association, the Horn of Africa Regional Environment Center and Network (HoAREC) are organizations whose major activity is promotion of clean and improved cookstoves and fuels to consumers.

GIZ ECO is has been operational since 1998 and is one of the major players in the dissemination of improved firewood stoves for households, businesses and institutions. GIZ ECO operates in Tigray, Amhara, Oromia and SNNP regions. It provides technical support in the design, development, promotion of cookstoves and private sector development.

Gaia Association is a local non-governmental organization established in 2003 mainly to promote clean cooking through use of bioethanol. Gaia Association works in partnership with government organization and the private sector for the promotion and dissemination of the Dometic Clean Cookstove that burn ethanol clean and safe.

[32] DBE, Mr. Eyob

HoAREC is part of the Addis Ababa University and mainly engaged in practical applications of energy and environmental technologies for practical solutions. It is a network and cooperation of five countries in the horn of Africa. Among other activities, improved cookstoves is one of the areas that HoAREC works.

J. Private sector

Moges Hailesilassie General Metal and Engineering Enterprise (MHGME) – has been in ethanol stove production and fuel distribution since 2002. The local ethanol stove produced by MHGME is low cost and proven for its performance.

Makobu Enterprise – among other business activities, is engaged in selling ethanol cookstoves and fuels to households. The Enterprise imported a few Dometic Clean Cookstoves to test the market with anticipation of setting up of a local manufacturing plant.

Major problems stated by the enterprises are related to supply reliability of ethanol for household cooking, price of the fuel and the market.

12 Recommendations

The recommendations below are for effective marketing and wide spread use of ethanol as a household cooking fuel:

Policy and organizational issues

- One of the limitations for widespread use of ethanol for cooking is unreliability and unpredictability of ethanol supply for cooking fuel. Ethanol is used as a transport and cooking fuel, and also for other industrial and clinical application. Use of ethanol for cooking is one of the best use of the resource in terms of economic, social and environmental benefits. Allocation of ethanol for cooking fuel should take all these factors in to consideration. Better understanding of the economic, social and environmental benefits of various applications of ethanol will help pragmatic allocation of it to various end uses.

- Biomass resources including ethanol are indigenous renewable energy resource. Technologies that are used for the production and conversion of these resources should be considered as technologies used for the conversion of other renewables such as solar and wind. Biomass technologies such as improved/clean fuelwood or ethanol cookstoves and distilleries do not get favourable taxation. Tax as a policy instrument should be consistent with the policy that promotes a technology. According to the energy policy, technologies that are used for production and use of renewable energy resources, should get favourable taxation on import duty and pricing. Biomass production and conversion technologies such as improved/clean cookstoves, ethanol distilleries and others are not treated equally in the implementation of the policy. Ministry of Water, Irrigation and Energy as a responsible sector organization for development and promotion of renewable energy technologies should closely work with Ministry of Finance and Economic Development, Ethiopian Revenues and Customs Authority and Ministry of Trade to resolve this issue.

- There are several types of cookstoves in the market that are different in performance, usability and safety. Technologies that are either imported or locally manufactured should meet minimum standard to ensure safety, efficiency and functionality in order to be promoted through national development programs. Sector organizations such as Ministry of Water, Irrigation and Energy in collaboration with other responsible regularity institutions such as Standards and Conformity Agency and Ethiopian Energy Agency should establish minimum acceptable standard for performance and safety.

- Institutions established to set regulations for products standards and qualities need to get necessary capacity building support to facilitate dissemination and ensure sustainability.

- Cooking energy programs and strategies such as the national program for improved cookstoves also needs to explicitly promote and implement utilization of ethanol as a cooking fuel.

Distribution models for ethanol fuels and stoves

- Distribution models that worked for modern fuels should also work for ethanol fuel. Petroleum fuels are distributed from filling stations/neighbourhood pumps (i.e. for kerosene), and specialized outlets and supermarkets (i.e. LPG distributers). Fuels are available in different quantities either in litres for kerosene or different size bottles for LPG. Ethanol fuel dissemination can also follow the same trend. Neighbourhood pumping points might require high volume of sales to be cost effective and might not be a choice at earlier stage of

marketing ethanol for cooking. However, selling the fuel in specialized outlets and supermarkets in quantities that customers want would meet customers' requirements. Volumes of ethanol that households want in a single purchase, based on survey results and responses of participants on the focus group discussion is between 5 to 10 litres. Most enterprises, however, want larger volume of purchase. The survey result shows that 55% of the enterprises prefer to purchase ethanol fuel in volumes higher than 10 litres.

- Supermarkets and small shops in towns would be effective for wide scale distribution of ethanol stove.

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5		Ministry of Health	
6		Ethiopian Sugar Corporation	
7	Ato Shewngizaw	Jimma University, Institute of Technology	Instructor/ researcher
8	Ato Eyob	Development Bank of Ethiopia	REF and RET Loans advisor

Annexes

Annex 1 – Fuel prices

A1.1 – Fuelwood- Weight conversion factor and prices by carrier type

Weight (kg/carrier)	Tigray	Afar	Amhara	Oromia	Benishangul	SNNP	Gambella	Average
Women	29.57	36.33	29.73	26.15	22.26		20.80	28
Man	34.42	30.40	24.19	22.45	26.22	23.20	26.00	25
Child	15.33	12.80	12.52	12.71	12.60			13
Donkey		126.00	41.00	35.26	48.43		114.40	47

Region	Tigray	Afar	Amhara	Oromia	Benishangul	SNNP	Gambella	All
Price (ETB/kg)	1.87	1.54	1.29	1.21	1.44	1.38	1.72	1.37

A1.2- Charcoal – Weight conversion factor and prices of by container type

Charcoal - Load per carrier type

Weight (kg/carrier)	Tigray	Afar	Amhara	Oromia	Benishangul	SNNP	Gambella	All
Large sack	35.0	38.3	33.2	29.6	28.0	26.3	24.2	31.2
Medium sack	25.9	20.0	22.4	19.4	0.0	19.2		21.4
Small sack	14.0	14.6	13.4	10.9				12.9
Other (retail)		0.8	1.5					1.3

Charcoal price

Region	Tigray	Afar	Amhara	Oromia	Benishangul	SNNP	Gambella	All
Price (ETB/kg)	4.40	4.68	4.49	4.36	3.57	3.27	5.83	4.50

A1.3 Kerosene price

Region	Average Price in Birr/Lt
Tigray	21.0
Afar	18.3
Amhra	16.2
Oromia	20.7
Benishangul Gumuz	
SNNP	17.8
Gambela	
All	19.0