

# Assessment of Rural Energy sources and Energy Consumption pattern in West Shewa and East Wellega Zones, Oromia Regional National state, Ethiopia

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**Abstract**— The study was conducted in West shewa and East wollega zones; Oromia Regional State with objective of the study is to identify the major rural source of energy consumption in the study area and to identify constraint and potential of energy use in the study area. About 141 Male and 39 Female households were interviewed by structured questionnaire and data were analyzed by descriptive statistics under SPSS software. The characteristic of rural Energy source utilization , the majority of respondent uses firewood about 91.1% and about 16.9% the respondent uses agricultural residue for the purpose of baking Enjera , Firewood is the first widely used energy source, about 57.2% of the respondent uses Firewood and about 22.8% of the respondent uses charcoal for the purpose of heating mostly. About 55% the respondents uses kerosene and the respondent's uses small size solar only about 20% for purpose of lighting. Electricity, battery cell, biogas was the lowest level energy sources of study area. In study area even if some rural HHs with access to electric service , they did not use for the purpose of Enjera baking as well as heating , only use for the purpose of lighting in study area. The main reasons for preference of biomass energy consumption in the study area is ease of access, cultural preference, cheap prices and the last reasons for choice biomass energy consumption is convenience when they used and no alternative source. Small HHs uses the available alternative energy technology like biogas, modern charcoal stove (leqach), Mirt stove, small size solar energy. Firewood and Agricultural residue were the potential energy sources in study area and unlike Agricultural research, lack of Research on Rural energy sources, lack of effective rural energy technology, socio-economic problem to accept available rural energy sources, lack of information where and how alternatives rural energy technology were identified as constraints of rural energy sources in study area. To fill these knowledge gap AERC, should be planned to introduce new Rural Energy sources and Woreda water, mine and energy office should disseminate the available alternative technologies for rural households.

**Keywords**— Agricultural residue, Alternative Energy source, Biomass, Firewood, Rural Energy source.

## I. INTRODUCTION

Energy is very crucial for daily life to meet human beings basic need such as cooking, boiling water, lighting and heating (WHO, 2006). There is a strong linkage between energy and the millennium development goals. According to World Bank (2009), energy service delivery, especially to the poor, contributes to achieving the millennium development goals

Most of the household in developing countries like Ethiopia continue to be dependent on traditional use of solid fuels (biomass) for cooking and heating, due to lack of access to electricity and modern energy sources. Consumption of traditional fuels has negative on environmental, economic and health impacts. The inefficient way people use energy is factor accreting deforestation. The main causes of deforestation in Africa are fuel wood collection, logging, agricultural expansion, and population pressure (Nebiyu, A.2009). Biomass fuel is very common in Ethiopia and fuels are mainly burned in inefficient open fires and traditional stoves.

For achieving sustainability in rural development with emphasis on livelihood and the means of enhancing the economic wellbeing of the poor households, it is necessary that affordable access to energy is provided to the households. Western oromia has problem of shortage of rain, drought, deforestation, hot temperature, Termite infection and etc. was increasing year to year. Those problems were decrease production and productivity, decrease income, loss saving poverty was developed at household level and decrease access of water availability (Annual Report of East Wolega Zone Disaster Prevention and preparedness office on ADPLAC, 2014). So the objective this study is to identify the major source of energy consumption in the study area and to identify constraint and potential of energy use. In selected zones, no systematic studies have been undertaken regarding the rural energy consumption behavior of households.

## II. METHODOLOGIES

### 2.1 Description of Study Area

The study was conducted in West shewa and East wollega zones, western part of Oromia Regional State. It has 18 and 17 districts respectively and located about 114 km and 331 km from Addis Abebe respectively (Fig. 1) map of study area.

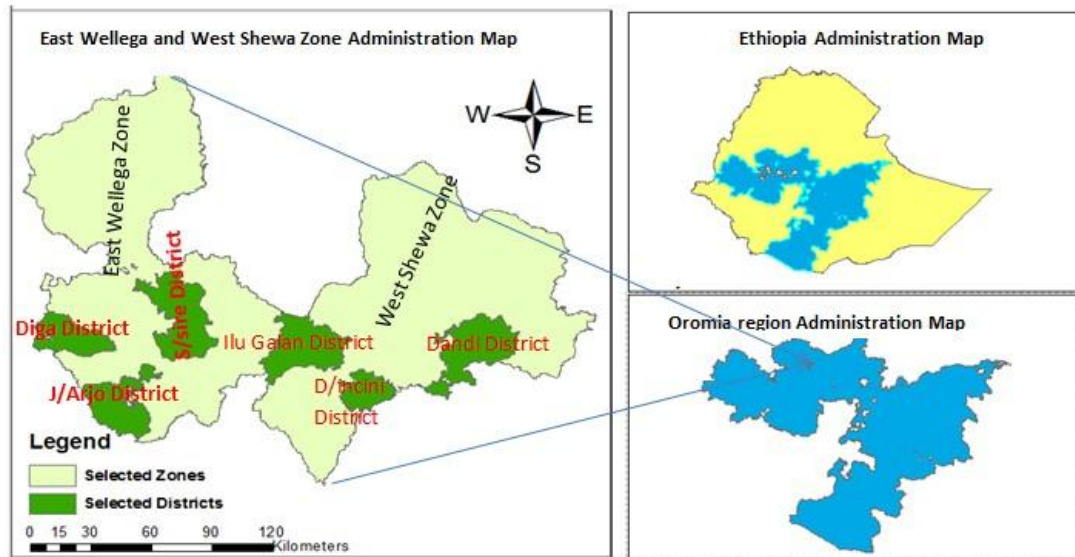


FIG. 1 MAP OF STUDY AREA

### 2.2 Sources of Data and Sampling design

In assessing the household energy sources and consumption patterns, the primary data were collected from the household heads of the study area through designed structured questionnaire. In this study, multistage sampling procedures were used to select the survey areas. At the first stage, East wollega and west shewa was selected randomly from western oromia. In the second stage, three woread as Sibire, Diga and Jima Arjoworedas' were selected from East wollega zone and Ilu galan, Dandi and Dire inciniworedas' were selected from West shewa purposively depending on HHs' source of energy were traditional inefficient biomass based. At third Stage two kebeles were selected from each woreada and at the end stage 180 HH were selected and interviewed randomly based on Probability Proportional to Size (PPSS). In this study, descriptive statistics such as, percentage, mean, standard deviation was used to summaries results. The statistical analysis data will be under taken by 20 version SPSS software.

## III. RESULT AND DISCUSSION

### 3.1 Rural Energy Source of the study area

Larger proportion of rural households are dependent on traditional fuels (biomass) dependent for baking Enjera and heating while some used other source of energy such as biogas, electricity, kerosene, battery cell for lighting, all of households are dependent on firewood source of energy and large proportion of respondent used Agricultural residue and kerosene source of energy consumption while and dung cake, charcoal and electricity are found lowest energy consumption in west shewa and east wollega zones of rural household (Table 1). The main reasons for preference of biomass energy consumption in the study area is ease of access (31.7%), cultural preference (30%) and cheap prices (21.1%) source of energy furthermore the least reasons for choice of rural households energy consumption is convenience when they used and No alternative source of 8.3% and 8.9% respectively. This is supported by research (Mekonnen and Kohlin, 2008), in Ethiopian, rural households have been dependent for centuries on two main solid fuels woody biomass and dung with kerosene used for lighting however electricity, and liquefied petroleum gas are possible alternative energy sources, they are hardly used at all in these rural areas due to high prices and lack of access. The characteristic of household Energy source utilization is shown (Table 2) the majority of respondent uses firewood about 91.1% and about 16.9% the respondent uses Agricultural residue for the purpose of baking Enjera. Firewood is the first widely used energy source, about 57.2% of the respondent uses Firewood and about 22.8% of the respondent uses charcoal for the purpose of heating mostly. About 55% the respondents uses kerosene and the respondents' uses small size solar only about 20% for purpose of lighting. Electricity, battery cell, biogas was the lowest

level energy sources of study area. In study area even if some rural HHs with access to electric service, they did not use for the purpose of Enjera baking as well as heating, only use for the purpose of lighting because of high cost of electricity which is not affordable for the rural people. Among the various fuels considered fire wood and Crop residue turned out to be the prominent energy sources of households in the study area. All households in sample use firewood as energy source self collected with small portion of it coming from the market (purchasing) (Table 3).

**TABLE 1**  
**PROPORTIONS OF HOUSEHOLD'S MAJOR ENERGY CONSUMPTION IN THE STUDY AREA**

Energy sources	N	Percent
Firewood	180	100
Crop Residue	11	62.8
Animal Dung cakes	36	20
Charcoal	36	20
Kerosene	111	61.7
Electricity	33	18.3
Small size solar	36	20
Battery cell	8	4.4
Biogas	3	1.66

*Source, Survey result 2017*

**TABLE 2**  
**PROPORTION OF ENERGY SOURCES CONSUMED BY HHs**

Energy Sources	Energy source consumed for different Activity by HHs					
	Enjera baking		Heating		Lighting	
	N	%	N	%	N	%
Fire wood	164	91.1	103	57.1	0	0
Agricultural residue	16	8.9	29	16.1	0	0
Firewood with Dung cake	0	0	5	2.8	0	0
Charcoal	0	0	41	28.9	0	0
Kerosene	0	0	0	0	99	55
Small size solar	0	0	0	0	36	20
Battery cell	0	0	0	0	8	4.4
Electricity	0	0	0	0	33	18.3
Biogas	0	0	3	1.5	1	0.6

*Source, Survey result 2017 N=Number HH reply*

**TABLE 3**  
**PLACE OF FIREWOOD COLLECTED BY HHs (N=166)**

Place of firewood collected	N	Percent HHs reply
Own farm	104	62.7
Community Forest	42	25.3
Free space	20	12

*Source, survey result 2017N=Number HH reply*

From HHs who self collected firewood, women and girls were found more and Women participate in the collection of fire wood.

About 62.7% of respondent collects fire wood from own farm and about 25.3% respondents collects from community forest but small portion about 12% of respondents collects from free space.

In the study, finding shown that ( Table 4) on average households traveled 0.5hr, with minimum and maximum 0.1hr and 2hr to collect firewood. They collect wood 2 to 3 times in a week. The fuel wood collection frequency depends on the family size and also on distance from the source. Large families require more wood to fulfill their domestic energy needs. Their fuel

wood demand doubles in winter season as compared to the summer season because they require more fuel wood for heating purposes. On average the respondents collect 3 times per week with minimum and maximum 1 time and 7 times per week. And on average it takes 1.3 hrs with minimum and maximum of 0.2 hrs and 6 hrs to collect fire wood for one trip.

TABLE 4

## DISTANCE TRAVELED, FREQUENCY PER WEEK AND TIME SPENT FOR FIREWOOD COLLECTION (N=166)

Variable	Minimum	Maximum	Mean	Std. deviation
Time traveled (Hrs)	0.1	2	0.5	0.36
Frequency collected per week	1	7	3	2.07
Time taken to collect for one trip (Hrs)	0.2	6	1.3	1.06

Source, survey result 2017N=Number HH reply

The main activities affected by fuel wood collection was, educational activities of the female, and Agricultural activities was the most affected activity.

### 3.2 Constraints of biomass energy consumption in studyarea

Biomass energy sources (Firewood and Agricultural residue) are dominant energy sources and energy potentials for Enjera baking and heating purpose in the study area. Kerosene and small size solar system was energy potentials for lighting. Even Biomass energy uses have certain Problems. The main problems using biomass energy was to smoky and causes eye disease and cough increased burden on women, Facilitate erosion on the farm, Deforestation are the major constraints biomass energy was identified.

### 3.3 Alternative Rural Energy Sources in studyarea

According to secondary data collected from west shewa and east wolega zone respective selected districts from each zones, The available alternative energy technology In study area were biogas, Improved charcoal stove ( leqach), Mirt stove, solar energy . About 111(61.7%) have no alternative energy sources like biogas, solar energy and improved charcoal stove, mirt Enjera stove, electricity but about 69(38.3%) have such like alternative energy (Table 5). For respondent who have no alternative Energy sources, the possible reason why they have no alternative energy sources are, lack of cost, lack accessibility, lack of awareness on alternative energy source and lack of interest on to get alternative energy source. Accordingly the rank correlation analysis between two zones show that the relation of the causes of 80% similarity reasons of not have alternative energy sources (Table 6).

TABLE 5

## ALTERNATIVE ENERGY SOURCES IN STUDY AREA (N=69)

Alternative Energy Source	N	Percent
Biogas technology	4	5.8
Small size Solar Energy	30	43.5
Mirt Enjera stove	6	8.3
Improved charcoal stove	5	7.2
Electricity	20	29
Mirt Enjera stove and Electricity	3	4.3
Biogas , Mirt Enjera stove and Electricity	1	1.4

Source, survey result 2017 N=Number HH reply

TABLE 6

## RANK CORRELATION ANALYSIS BETWEEN TWO ZONES

Reason	East Wolega zone			Di <sup>2</sup>
	Rank	Rank	Rank	
Lack of cost	1	1	0	0
Lack of Accessibility	2	2	0	0
Lack of awareness	3	4	-1	1
Lack of interest to get	4	3	1	1

Source, survey result 2017

Rank correlation analysis between two zones

$$r = \frac{1-6}{(n2-1)} = \frac{1-6*2}{4(16-1)} = 1-\frac{12}{15} = 1-0.2 = 0.8=80\%$$

In this study, also finding shown that (Table 7), almost all a households, about 87%, 90% and 88% of respondents in the study do not have access to training on biogas technologies, solar energy and improved charcoal stove and mirt Enjera stove respectively. From this could conclude that biomass energy sources is the dominant fuel sources by both households with no and with access to alternative energy sources in the study area implying that burden on biomass (wood, dung and Agricultural residue) energy sources which leads to environmental problem and subsequent reduction in agricultural productivity.

**TABLE 7**  
**ABOUT TRAINING OF ALTERNATIVE ENERGY SOURCES**

Alternative Energy Sources	HHs with technology (N=69)				HHs without technology (N=111)				Total (N=180)			
	Yes		No		Yes		No		Yes		No	
	N	%	N	%	N	%	N	%	N	%	N	%
Biogas Technology	17	24.6	52	74.6	7	6.3	104	93.7	24	13	156	87
Solar Energy	11	15.9	58	84.1	7	6.3	104	93.7	18	10	162	90
Improved charcoal stove and mirt Enjera stove	10	13.2	59	86.8	11	9.9	100	90.1	21	11	159	88

*Source, survey result 2017 N=Number HH reply, %= Percent*

### 3.4 Comparison of Households with no and with Access to Alternative Rural Energy in studyarea

The result of this study reveals that mean age of the household is 38 and 42 years of old for households with no and with access to Alternative rural energy source fuel respectively, the mean comparison of households with no and with access to alternative rural technology in terms of age was significant ( t-value= 2.113, sig. 0.036). In similar way, the sex of the household head, households with no access and with access energy source 78 percent. These imply that the mean difference observed in terms of sex statistically not significant (t-value=0.019, sig. 0.985). About 61 percent of households with no access to alternative rural energy are literate household head while households with access to alternative rural energy account 78 percent household heads are literate. This difference is statically significant at 5%. This implies that literate headed households are consumed more alternative rural energy of energy than illiterate headed households. the average time in hour from the household's home to the Farmers training center for households with no and with access to alternative rural energy is 0.56Hr (34 min) and 50hr(30 min.) respectively; this mean difference is statistically in significant at 5% (t-value=-0.665 sig-value = 0.50 ). The mean time in hour from the households' home to health extension center for households with no access to modern fuel is about 0.47hr (28min); the mean distance traveled by households with access to modern fuel is 0.43hr (26min). This difference is also statistically insignificant at 5% ( t-value= -0.859 Sig -value= 0.392) (Table8).

**TABLE 8**  
**COMPARISON OF HOUSEHOLDS WITH NO AND WITH ACCESS TO MODERN FUEL**

Socio-demographic character	Mean			
	With no access	With access	t-value	Sig-value
Age	38	42	2.11	0.036*
Family size	6	7	1.32	0.189
Time taken to travel FTC	0.56hr	0.5hr	-0.665	0.5
Time taken to travel health extension center	0.47hr	0.43hr	-0.859	0.392
Educational level of household			2.9	0.004*
Sex of household			0.19	0.985
Place of cooking			0.295	0.004*

*Source, surveyresult2017 \* statically significant at5%*

### 3.5 Constraints of Rural Energy Sources in Studyarea

In study area, the constraints of rural energy sources were identified and prioritized in order to importance by farmers in study area. Table17 indicate that about 40% of respondent reply lack of Manufacturer on alternativerrural energy source,

Lack of effective alternative rural energy sources (33.8%) socio-economic problems to accept available rural energy technology (12.7%), lack of information where and how alternative energy sources (7.5%), unlike, Agricultural input, lack of research on alternative energy sources (12.5%), are the major constraints identified.

#### IV. CONCLUSION

The characteristic of household Energy source utilization, the majority of respondent uses firewood about 91.1% and about 16.9% the respondent uses crop residue for the purpose of baking Enjera. Firewood is the first widely used energy source, about 57.2% of the respondent uses Firewood and about 22.8% of the respondent uses charcoal for the purpose of heating mostly. About 55% the respondents uses kerosene and the respondent's uses small size solar only about 20% for purpose of lighting. Electricity, battery cell, biogas was the lowest level energy sources of study area. In study area even if some rural HHs with access to electric service, they did not use for the purpose of Enjera baking as well as heating, only use for the purpose of lighting in study area.

The main reasons for preference of biomass energy consumption in the study area is ease of access (31.7%), cultural preference (30%) and cheap prices (21.1%) source of energy furthermore the least reasons for choice of rural households energy consumption is convenience when they used and No alternative source of 8.3% and 8.9% respectively

Among the various fuels considered fire wood and Crop residue turned out to be the prominent energy sources of households in the study area. All households in sample use firewood as energy source with small portion of it coming from the market (purchasing). HHs who self collected firewood, women and girls were found more about 51.8% and followed by Women participates in the collection of fire wood. The finding reveals that on average households traveled 0.5hr, with minimum and maximum 0.1hr and 2hr to collect firewood. They collect wood 2 to 3 times in a week. The fuel wood collection frequency depends on the family size and also on distance from the source. Large families require more wood to fulfill their domestic energy needs, so they collect 2 to 3 times in a week. Their fuel wood demand doubles in winter season as compared to the summer season because they require more fuel wood for heating purposes. On average the respondents collect 3 times per week. And on average it takes 1.3hrs with minimum and maximum of 0.2 hrs and 6hrs to collect fire wood for one trip The main activities affected by fuel wood collection was, educational activities of the female, and Agricultural activities was the mostly affected activity. The main problems using firewood was to smoky and causes eye disease and cough, increased burden on women, facilitate erosion and deforestation

About 111(61.7%) have no alternative energy sources like biogas, solar energy and improved charcoal stove, mirt Enjera stove, electricity but about 69 (38.3%) have such like alternative energy sources. The possible reason why they have not alternative energy sources are, lack of cost, lack accessibility, lack of awareness on alternative energy source and lack of interest on to get alternative energy source. according to rank to correlation analysis between two zones show that the relation of the causes of 80% and this can be similarity reasons of not have alternative energy sources Firewood and crop residue is dominant energy sources and energy potentials for Enjera baking and water heating in the study area. In same the way kerosene and small size solar system was energy potentials for lighting

In study area, the constraints of rural energy sources were identified and prioritized in order to importance by farmers in study area. About 39.1% of respondent reply lack of manufacture on alternative rural energy source, socio-economic problems to accept available rural energy technology (33.2%), Lack of effective alternative rural energy sources(15.6%), unlike, Agricultural input, lack of research on alternative energy sources (12.5%), are the major constraints identified.

#### RECOMMENDATION

The heavy dependence and inefficient utilization of biomass resources of energy have resulted in high depletion of firewood, crop residue, dung and charcoal in the East wolega and west shewa zone. Rural household should adopt of improved stove that contribute to reducing burden on biomass reducing burden on biomass. Almost all a household do not have access to training on alternative technologies like biogas, solar heating and Improved charcoal stove and mirt Enjera stove to fill this gap Woreda water, mineral and energy office should train Rural household on alternative rural Energy source and disseminate the available alternative technologies.

In addition, the result shows that households spent significant amount of time for fuel collection. And also, all a household do not have access to training on alternative technologies like biogas, solar heating and Improved charcoal stove and mirt Enjera stove. To fill these knowledge gap Woreda energy office should train rural household alternative technologies and disseminate the available alternative technologies and AERC, should be planned to introduce new Rural Energy sources and.

Although there is introduction of biogas for few rural households used for only lighting , but they do not used for baking Enjera because lack of Biogas mitad. So Agricultural engineering research center should introduce Biogas mitad helps to reduce burden on biomass sources of energy.

#### ACKNOWLEDGMENT

My special thanks and limitless appreciation go to Mr. GutuBirhanu Center manager of Bako Agricultural Engineering Research center for moral support and Mr. Elias Agesa Head of Procurement, Finance and Property Administration, for facilitation of the finance and vehicles to do this research.

I also thank the enumerators Mr. AliyiAbdulah, Mr. GemachisaYedata and Mr. Esra'elMelaku for their participation in the collection of the field data and information.

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