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# DETERMINANTS OF ALTERNATIVE ENERGY TECHNOLOGIES ADOPTION AND ENERGY SOURCE CHOICE OF RURAL HOUSEHOLDS IN BAMBASI DISTRICT, BENSHANGUL GUMUZ, ETHIOPIA

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***ABSTRACT***

*Like many other developing countries, Ethiopia has faced with critical energy access and supply problems. The purpose of this study is to investigate factors that affect households' adoption decision of alternative energy technologies and energy source choice. The research was applied both quantitative and qualitative methods of data collection to investigate the issues under question. Quantitative data was collected directly from respondents using semi-structured questionnaire. Qualitative information of the study was obtained through interview and focus group discussions. Discussion was conducted with technologies' adopter and non-adopter households and also modern energy users. The study used descriptive statistics, frequency and percentages, and the study was used SPSS software version 20 to analysis data. Binary logistic and multinomial logit model was use to investigate the factors that determine household alternative energy technology adoption and choice between firewood, solar energy and biogas. The results indicate that education level, age, family size, annual income, distant of market services, access to credit service and awareness of household have significant effect on household's adoption of alternative energy technology. The study also shows as education level, annual income, total livestock, primary occupation and access to credit service significantly affect household's energy choice.*

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***Key words:  Determinant, Household, Alternative, energy, technology, Adoption, Choice***

## INTRODUCTION

Energy, the capacity to do work, is the backbone of any development activity. It is an essential input for all kinds of development activity and without developing the sector it is difficult to seek the development of other sectors (UN, 2010). Sources of energy can be categorized as renewable and non-renewable. The former has a capacity to be refilled after its use which includes hydropower, solar, wind, and geothermal energy; and, the later one has no capacity to replenish which encompasses fossil fuels and nuclear energy (IEA, 2010).

Energy poverty at household level is explained by two indicators: lack of access to electricity and the reliance on the traditional use of biomass for cooking (IEA, UNDP and UNIDO, 2010). It is estimated that 1.4 billion people around the world have no access to electricity with 85% of them are living in rural areas; and, 2.7 billion people i.e., 40% of the global population rely on traditional biomass energy for cooking (IEA, 2010). Energy sources for most developing countries are traditional biomass energy mainly in a form of firewood, charcoal, tree leaves, crop residue and animal dung (ibid). Over 620 and 730 million people in sub-Saharan Africa countries (almost two-thirds of the population) do not have access to electricity and clean cooking facilities respectively (IEA, 2014). This implies the heavy reliance on traditional biomass energy sources for cooking mostly fuel wood and charcoal (ibid). It is projected that 1.2 billion people around the globe will have no access to electricity and traditional biomass use is anticipated to increase to 2.8 billion people in the year 2030 (IEA, 2014

Access to modern and efficient energy is a necessary especially in developing countries (UN, 2010). This is due to modern energy services play a decisive role in reducing poverty, improve health status of peoples, enhance gender equality and promote sustainable management of natural resources (IEA, 2010). Despite the available huge potential, the utilization of modern and alternative energy sources remained untapped in most developing countries (IEA, 2014).

Benishangul Gumuz Regional State is one of the well-endowed with forest resources, but degraded through time due different factors. Among the factors one of the main factors that lead to forest degradation is use of fire wood. According to Semene Bessie (2015) finding, firewood is one of the factors for forest degradation that leads climate change. This is because most of the population, particularly native people of the region use traditional source of

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energy/fire/ and traditional cooking stoves which is unable to save fuel wood. In addition to climate change, this leads the people of the region, especially women to health problems such as lung disease and sight problems.

Like many other developing countries, Ethiopia has faced with critical energy access and supply problems. It was estimated that only 23% of country's population have access to electricity, of which 86% is urbanities and 14% is rural residents (GTZ, 2015). Most of Ethiopian households, especially, those who live in rural areas prefer firewood because it is available freely or with least cost and this extensive utilization of forest has led the depletion of tree stock of the country i.e., 15 % (ENA, 2015). Energy poverty exacerbates in rural part of the country. From the total of rural residents in the country, more than 95% meets their daily energy need from unclean and traditional energy sources (GTZ, 2015). In the study area, biomass energy source especially firewood constitutes the greater portion of domestic energy supply for both rural and urban areas followed by dung and charcoal consumption. Electric supply in the district is limited to urban centers of the district.

Different empirical studies have been conducted so far on the determinants of households' energy technology adoption and energy source choice in Ethiopia. Empirical studies for instant by Alemu and Köhlin, (2009), examined determinates of fuel choice of households in major Ethiopian cities, using panel data collected in 2000 and 2004. Another study by Yonas et al., (2015) also tried to investigate factors that determine households cooking fuel choice and energy transition in urban Ethiopia using panel data by employing multinomial model. Again another study by Alemu and Köhlin, (2009) investigated the determinants of rural households' to use dung as a fuel and manure; and also, determinants of woody biomass and dung as a household fuel sources. There are also studies conducted by (Dawit, 2008; Alemu and Köhlin, 2008; Yonas et al, 2013; Yonas et al, 2015 and Gebreegziabher et al. 2012).

Thus, in addition to analyzing factors affecting adoption of alternative energy technologies, this study may contribute to fill the aforementioned gap by identifying factors affecting rural households' energy source choice focusing on utilization of modern energy sources. The main purpose of this study is to investigate factors that affect households' adoption decision of alternative energy technologies and energy source choice.

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## RESEARCH METHODOLOGY

### Description of the Study Area

Bambasi district is one of the 20 Districts in the Benishangul-Gumuz Region of Ethiopia. It is bordered by the Mao-Komo special district on the southwest, Asossa district in the northwest, Oda Buldigilu in the northeast, and by the Oromia Region in the southeast. Bambasi has a longitude and latitude of 9°45′N- 34°50′E and 9.750°N- 34.733°E respectively with an elevation of 1668 meters above sea level.

### Data Source

The primary data of the study was collected directly from technology adopters and non-adopters' households. And, it was also obtained through key informant interview and focus group discussions. The secondary sources were Woreda's Finance and Economic Development and Energy Offices, alternative energy technology dissemination report and other documents.

### Sample Size Determination, Sampling Technique and Procedures

The sample size for household survey was determined on the total number of rural households in the selected rural kebeles (Dabus, motsa, Jamatsa, Mendere 55, Budaselga, Selama Dabus, Sonka, Wemba, Garabiche Welega, Garabiche Metema, shobora and mender 44). Accordingly, the sample size for collecting primary data from households for the purpose of this study was determined by using the following formula (Yamane, 1967) and 369 sample households were used for the study.

Bambasi woreda was purposely selected for the study because it was selected as one pilot woreda by Mining and Energy Bureau for expanding using of alternative energy technologies. According to the information obtained from Mining and Energy Bureau, Bambasi woreda is a well-known for its large number of cattle as compared with other Weredas, but the biogas energy technology utilization of rural households is very low as compared with the number of cattles. So, the wereda was selected to identify the major problems those make unable rural households to use the technology. Since there is large number of populations including refugees came from other border countries in the woreda those use forest wood for cooking food and as source of energy, it was selected to know the awareness of the households to use the technology to the save the forest of the woreda. In addition to these, the well-known forest of the region called Anbessa Chaka which is located in the woreda is deforested and decreased from time to

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time mainly due to using of tradition source of energy/fire/ and traditional stoves need excess fuel wood. So, the wereda was selected to find solutions for such problems that lead to climate change and health problems.

From a total of 38 kebeles of the woreda, 12 /twelve/ Kebeles was selected using simple random sampling method. Finally, using the calculated sample size, all randomly selected kebeles was included in the study with their total number of households. The study participants from each kebele were included in the study using probability proportional to their size (PPS). Each individual technology user and non-user will be selected using simple random sampling method.

**Data Processing and Analysis**

Quantitative data obtained through survey questionnaire was entered in to computer for analysis using Statistical Packages for Social Science (SPSS) software. The analysis part was conducted using both descriptive and econometric analysis. The binary logit and multinomial model were analyzed using SPSS 20.



**Descriptive Analysis**

Descriptive statistics means, standard deviations, frequency and percentages was used using SPSS software version 20. In addition to this, the statistical significances and the association of the dummy and continuous variables with the dependent variable were tested using chi-square and t-test.

**Econometric Model Specification**

Both binary and multinomial logistic regressions were used to estimate the relationship between dependent and independent variables of the study. Binary logistic regression model is used when the dependent variable is articulated in two categories and multinomial logistic regression model is useful when the dependent variable is expressed by more than two categories (Gujarati, 2004).

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**Model Specification**

**Binary Logistic Model**

Following Gujarati, 2004, the decision to use a specific alternative energy type can be explained as follows:

$$P_i = E(Y = 1/Xi) = \frac{1}{1+e^{-(\beta 1+\beta 2Xi)}}(1)$$

In the logistic distribution equation, $P_i$ is the probability of adopting alternative energy technology, *xi* are the explanatory variables like demographic factors and socio-economic characteristics of a household that determine the probability of the respondents to be belonged either from adopter or non-adopter group of the technology; and, *i* is an individual household observation.

When β 1+β2*Xi* in Equation 1 is replaced by $Z_i$, Equation 2 is obtained

$$p_i = \frac{1}{1+e^{-Zi}} = \frac{e^z}{1+e^z}(2)$$

$Z_i$ is between - ∞ and + ∞, and $P_i$ is between 1 and 0. When $P_i$ shows the possibility of adopting alternative energy technology, the possibility of this event for non-adopter is 1- $P_i$. Then, the probability of each individual respondent to be belonging among non-adopter group can be explained as in Equation 3 as follows:

$$1 - Pi = \frac{1}{1+e^{Zi}}(3)$$

Equation 4 is obtained by dividing the adopter by non-adopter:

$$\frac{Pi}{1-Pi} = \frac{1+e^{Zi}}{1+e^{-Zi}} = e^{Zi} \quad (4)$$

When the natural logarithm of both sides of the equation is written, Equation 5 is obtained:

$$Li = \ln\left(\frac{Pi}{1-Pi}\right) = Z_i = \beta_1 + \beta_2 X_{\ i} + \beta_2 X_2 \ldots\ldots \beta nXn(5)$$

Where Pi = is a probability of being an adopter of alternative energy technology ranges from 0 to 1

Zi = is a function of "n" explanatory variables (regressors) (x) and when the disturbance term ui is considered the logit model becomes:

$Z(i) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \ldots \beta_n X_n + ui$ ….....(6)

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$\beta_0$= is an intercept

$\beta_1$, $\beta_2$, $\beta_3$.....$\beta_n$ are the slopes of the equation in the model

Li = is the log of the odds ratio, which is not only linear in Xi but also linear in the parameters

Xi = is the vector of relevant household characteristics

If the error term (Ui) is brought in, the Logit model becomes:

$Zi=\beta_0 +\beta_1 age +\beta_2 sex + \beta_3 housholdsize+ \beta_4 education + \beta_5 lnincome + \beta_6 TLU+\beta_7 landsize +\beta_8 distancemarket+ \beta_9 amountcredit + \beta_{10} training +ui$.....(7)

**Multinomial Logistic Model**

An individual is assumed to choose energy source that maximizes the expected utility and following Deshmukh (2014), the $i^{th}$ individual's decision to choose a specific energy type can be explained as follows:

$Y_{ij} = X_i\beta_j + \varepsilon_{ij}$----------(1)



where, j= is the number of energy source in the choice set ( in our case, we have three energy source categories)

$X_{ij}$=characteristics of an individual which includes all the variables such as socio- economic, demographic and institutional factors which may affect the energy source choice of households.

$\beta_j$is a vector of the estimated parameter

Let Y be the dependent variable energy choice for cooking and lighting from the set of modern, mixed and traditional energy sources.

Let $Pr(Y_i=j)$ the probability of choosing energy source for cooking and lighting.

Finally, the probability of an individual i choose from alternative j will be estimated using multinomial estimator model as follows:

$$\Pr(Y_i = j) = \frac{\exp(x_i\beta_j)}{\sum_{i=1}^{4}\exp(x_i\beta_j)}$$----------(2)

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**Variables Definition and Working hypothesis**

Binary logit and multinomial logistic model were used to explain the determinant of rural household alternative energy technology adoption and choice.

**Dependent variables of the model**

- Alternative energy technology adoption –This is a dummy dependent variable of the model.
- Alternative energy technology choice –this continuous dependent variable of the model the number of energy source in the choice set

**Independent variable**

Based on literature reviewed and experience the following independent variables were hypothesized. Independent variables that were assumed to be factors in determining the alternative energy technology adoption and choice

**Table 1 summary tables for variable code, type, value and definition of dependent variables**

| Variable code | Variable type | Relationship b/n dependent and independent variables | Variable Definition and measurement |
|---|---|---|---|
| AGEHH | Continuous | _ | Age of the household head 1, 2, 3 …… |
| SEXHH | Dummy | + | Sex of household head 1= male,0= female |
| EDULEVELHH | Continuous | + | Education level of household in year of schooling 1, 2, 3 …… |
| FAMSIZHH | Continuous | _ | Family size of the household head 1, 2, 3 …… |
| MARSTATUSHH | Continuous | _ | Marital status of household |
| INCOMHH | Continuous | + | Annual income of household head in birr |

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| | | | |
|---|---|---|---|
| TLIVSTOKHH | Continuous | + | Total livestock holding in TLU |
| PRIOPPOHH | Dummy | + | Primary occupation of households |
| DISMARK | Continuous | _ | Average distances Household travelled to marketing center measured in km |
| ACESCRED | Continuous | + | Accessibility of credit for household if 1= yes ,0= No |
| AWARALTENECH | Dummy | + | Awareness of households if 1= yes ,0= No |
| SOPARTHH | Dummy | + | Social participation of household if 1= yes ,0= No |

## RESULTS AND DISCUSSION

### Overview of socio-economic profile of respondents

Table 2 shows that a total of 369 households were covered in this study. The sex, age, marital status, family size, level of education and primary occupation of sampled household heads were assessed as demographic characteristics. With regard to the sex composition of household heads, 84.0% of household heads were male-head while the remaining 16.0% of them were female-headed households. With regards to age composition of household heads, survey result illustrates that 42.8%, 32.2% and 24.9% of household heads were between 18-30 years of age, between 40-65 years of age and above 65 years of age respectively. With regard to marital status composition of household head, majority (90.5%) of the household heads were married while 2.4%, 3.3 % and 3.8 % of them were single, winnowed and divorced and respectively. With regard to family size of households, 37.7%, 37.9%, and 24.4% of households were with 1-5, 5-8 and above family sizes respectively. With regard to the education level of household heads, 29.8 %, 53.4%, 10.3% and 6.5% of household heads were with no education level, primary education level, and secondary education level and above education level respectively (Table 1). Agriculture is the predominant occupation for the majority of people in rural Ambo district. Among the sampled household heads, majority (90.5 %) of household heads were primarily engaged in farming activities while the remaining household heads were engaged with merchant/trader, civil servant and other respectively (Table 1).

The summarized table below 42.2%, 35.8% and 20.1% households earn an annual income of 5000 ETB, 6000-10000ETB and above respectively. With regarding distance from market

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center 28.2%,53.4 % and 18.4 % of household home is <5k, 5-10 km and above 10km far from the market center respectively. The table 3 shows that as the majority of (73.4 %) of households have awareness alternative energy uses whereas the remaining 26.6% has not awareness on alternative energy uses. The majority (55%) of households respond that as there is no accessibility of credit service and 45% of households respond that as there is accessibility of credit service to alternative energy technology adoption. About 80.8% of household participate on social activities (like edir, equb etc.) and the remaining are not participating.

**Table 2 Demographic, economic and access to facilities of rural household of the study area (n=369)**

| | | **Frequency** | **Percentage** |
|---|---|---|---|
| Sex of households | Female | 58 | 16 |
| | Male | 311 | 84.0 |
| Age of households | 18-39 | 158 | 42.8 |
| | 40-65 | 119 | 32.2 |
| | Above | 92 | 24.9 |
| Marital status of households | Married | 334 | 90.5 |
| | Unmarried | 9 | 2.4 |
| | Widowed | 12 | 3.3 |
| | Divorced | 14 | 3.8 |
| Education level of households | Illiterate | 110 | 29.8 |
| | Primary school | 197 | 53.4 |
| | Secondary school | 38 | 10.3 |
| | Above | 24 | 6.5 |
| Family size of household | 1-5 | 139 | 37.7 |
| | 5-8 | 140 | 37.9 |
| | above | 90 | 24.4 |
| Household's Primary occupation | Farmer | 334 | 90.5 |
| | Trader | 21 | 5.7 |

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| | | | |
|---|---|---|---|
| | civil servant | 14 | 3.8 |
| Annual income of households | 5000 | 163 | 44.2 |
| | 6000-10000 | 132 | 35.8 |
| | Above | 74 | 20.1 |
| Household's number livestock | No | 27 | 7.3 |
| | <5 | 91 | 24.4 |
| | 5-10 | 201 | 54.5 |
| | Above | 50 | 13.6 |
| Distance to Market in KM | <5 | 104 | 28.2 |
| | 5-10 | 197 | 53.4 |
| | Above 10 | 68 | 18.4 |
| Awareness of households on alternative energy uses | No | 98 | 26.6 |
| | Yes | 271 | 73.4 |
| Response of household's access to credit service | No | 203 | 55.0 |
| | Yes | 166 | 45.0 |
| Response of households on social participation | No | 71 | 19.2 |
| | Yes | 298 | 80.8 |

Source: Field survey, 2019

**Dissemination status/distribution/ of alternative energy sources and Household head's attitude towards adoption of alternative energy technology**

This section presents the results on household head's attitude towards adoption of alternative renewable energy sources like biogas and solar as measured based on a criterion scale designed specifically to answer research question. However, in this study (53.7%) confirmed of respondents adopted renewable energy sources (like solar and biogas) while 46.3) % do not adopted. This result shows that as the distribution of alternative energy technology among household is limited. This implies that the method of introducing renewable alternative energy sources (fuel saving stoves, solar and biogas) in the study area, that includes intensive

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promotional and awareness campaigns has given the beneficiaries an opportunity to see, feel and experience the benefits of alternative renewable energy sources (fuel saving stov, solar and biogas) and have belief and trust on the existing and future development of the technology.

**Table 3 Distribution of alternative energy sources and households' attitude towards adoption of alternative energy sources (n=369)**

| | | Frequency | Percentage |
|---|---|---|---|
| Household alternative energy technology adoption level | Non adopter | 171 | 46.3 |
| | Adopter | 198 | 53.7 |
| | Total | 369 | 100.0 |

Source: Field survey, 2019

**Results of econometric model analysis on determinants of alternative energy technology**

As indicates in Table 4, the education level of household head has positively significant effect on the decision of adoption of alternative energy technology at 5% level of significance. When household head age is increased by one; the probability of adoption of alternative energy technology (fuel saving stov/biogas/solar power) will be increased by 77.2%. The age of household head has negatively significant effect on the decision of adoption of alternative energy technology at 5% level of significance. When household head age is increased by one; the probability of adoption of alternative energy technology (fuel saving stov/biogas/solar power) will be decreased by 19.6%.



The family size of household head has negatively significant effect on the decision of adoption of alternative energy technology at 5% level of significance. When household family size is increased by one; the probability of adoption of alternative energy technology will be decreased by 98%. Supported by similar research by Walekhwa *et al.* (2009) attest that the probability of a household adopting renewable energy source (biogas technology) increases with decreasing age of head of household. Similarly, household annual income has positively significant effect on the decision of adoption of alternative energy source positively at 5% level of significance. This implies that household's annual income is increased by one; the probability of adoption of renewable energy source will be increased by 71.5% (Table 5). In similar way, the distant from household's home to market services had significant effect on the decision of adoption of renewable energy source negatively at 5% level of significance. When household head's market distance is increased by one; the probability of adoption of alternative energy source will be decreased by 91.5%. Access to credit service has positively significant effect on the

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decision of adoption of renewable energy source positively at 5% level of significance. This implies that household's awareness is increased by one; the probability of adoption of alternative energy source will be increased by 93.1%.

Similarly, awareness of household on alternative energy technology has positively significant effect on the decision of adoption of renewable energy source positively at 5% level of significance. This implies that household's awareness is increased by one; the probability of adoption of alternative energy source will be increased by 95% (Table 5). Households during focus group discussion also suggest that as most of households have no awareness on the benefit of alternative energy. Attari et al (2010) provide evidence on households' misperceptions about energy use or savings. They suggest that there is relatively little knowledge regarding the effectiveness of different energy saving measures. Such limited knowledge is likely to determine the probability to invest in energy efficiency and renewable. Indeed, when consumers are aware of potential energy savings, the probability of investing in energy conservation measures increases (Scott 1997).

**Table 4 Determinants of alternative energy technology adoption at household level**

| Variables | Coefficient | Standard error | p-value | Odd ratio |
|---|---|---|---|---|
| EDULEVEL | .772 | .185 | .000** | 2.163 |
| FAMSIZ | -.980 | .222 | .0001** | .273 |
| AGEHHS | -.196 | .216 | .043** | .822 |
| SEXHHS | .128 | .384 | .739 | 1.137 |
| MARSTATUS | -.078 | .223 | .727 | .925 |
| INCOMHHS | .715 | .195 | .0002** | 2.043 |
| TLIVSTOKHHS | .098 | .167 | .558 | 1.103 |
| PRIOPPO | .503 | .330 | .128 | 1.654 |
| DISMARK | -.915 | .232 | .004** | .401 |
| ACESCRED | .931 | .294 | .002** | 2.538 |
| AWARALTENECH | 0.950 | .371 | .002** | 3.195 |
| SOPART | .698 | .426 | .101 | 2.011 |
| Constant | .237 | 1.095 | .829 | 1.268 |

** indicates significant at 5%: Source: Field survey, 2019

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**Factors that influence household's energy source choice**

The summarized table below shows as 38.5%, 30.1%, 19.5%, and 11.9% households chose firewood, solar energy, biogas and energy saving stoves as energy source respectively.

**Table 5 Types of alternative energy sources choice of rural households in the study areas**

| Households energy choice | N | Percentage |
|---|---|---|
| Fire wood | 142 | 38.5% |
| Solar energy | 111 | 30.1% |
| Biogas | 72 | 19.5% |
| Energy saving stov | 44 | 11.9% |
| Total | 369 | 100% |

Source: Field survey, 2019

Table 6 shows multinomial logit results of solar energy and biogas as compared to traditional energy source (fuel wood). Out of the ten examined explanatory variables, only five were statistically significant at the 5% confidence level. Theoretical expectation was that an increase in the level of education of households has a positive effect on the choice of solar energy and biogas, and the results also show that an increase in the level of education of household positively affects household choice of solar energy and biogas at the 5% confidence level. Age was expected to be a significant factor in determining household fuel choice. The results show that the age of have negative coefficients for solar and biogas. Their p-values are however not significant at 5% confidence level.

The positive estimated coefficients for whether or not the annual income of households supports the study's theoretical expectation that if a household annual income will be more likely to use solar energy and biogas. The p-value of solar energy and biogas is statistically significant at 5% indicating that there is enough evidence to believe that increase in household's annual income is likely to make a household change from using firewood to solar energy and biogas. In fact, the odds ratio shows that the probability of changing from firewood to solar energy and biogas with increase in household income is five (5) times greater for solar energy and biogas. In the conceptual framework, it was argued that a household annual income the household is more likely to use solar energy and biogas.

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It was expected that the nature of occupation of household could have a positive influence on energy choice of households away from firewood. The result in summarized table below shows that as the primary occupation of household positive affect household choice of solar energy and significant at 5%. Unfortunately, it has also positive relationship with household choice of biogas but not significant. Specifically, household who are employed in office jobs (white-collar jobs) were thought to be more likely to use solar and biogas. This was because they are more likely to make more money than their counterpart blue-collar workers (mostly farmers). A possible explanation of the positive relationship between white-collar employment and better energy choice is that households are generally underpaid regardless of their occupation.

The result also shows that as the number of livestock of households has positive relation with household choice of solar energy and biogas from traditional energy source/firewood and as it is statistically significant at the 5% confidence level. This means as the total number of households increase the energy choice of the household shift from traditional source to solar energy and biogas.

The summarized result in table 7 also shows that as the accessibility of credit for households has positive relation with household choice of solar energy and biogas from traditional energy source/firewood. It is statistically significant for choice of solar energy and not significant for the choice of biogas at the 5% confidence level. This means as the total number of households increase the energy choice of the household shift from traditional source to solar energy and biogas.



**Table 6 Multinomial Logit Analysis for solar and biogas as compared to fire wood user Respondents**

| **Solar energy** | | | | **Biogas** | | | |
|---|---|---|---|---|---|---|---|
| **Variables** | **Coefficient** | **p-value** | **Odd ratio** | **Variables** | **Cofficient** | **p-value** | **Odd ratio** |
| Intercept | -13.262 | .000 | 13.964 | Intercept | -7.965 | .002 | 9.072 |
| EDULEVEL | 2.637 | .012** | 1.323 | EDULEVEL | 2.205 | .035** | .297 |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FAMSIZ | .280 | .659 | .658 | FAMSIZ | -1.216 | .060 | .938 |
| AGEHHS | -.419 | .478 | .597 | AGEHHS | -.064 | .910 | 1.095 |
| SEXHHS | -.516 | .427 | .887 | SEXHHS | .091 | .879 | .982 |
| MARSTAT | -.120 | .744 | 3.747 | MARSTATUS | -.019 | .949 | 2.225 |
| INCOMHH | 1.321 | .001** | 5.798 | INCOMHHS | .800 | .032** | 5.307 |
| TLIVSTOK | 1.758 | .000** | 6.392 | TLIVSTOKHHS | 1.669 | .000** | 2.843 |
| PRIOPPO | 1.855 | .001** | 4.468 | PRIOPPO | 1.045 | .089 | 3.159 |
| ACESCRE | 1.497 | .032** | 8.538 | ACESCRED | 1.150 | .072 | 3.825 |
| AWARNALTECHO | | .183 | 13.964 | AWARNALTECHO | 1.342 | .338 | 9.072 |

Energy saving stov has been dropped from the analysis

*** *** Statistically Significant at 5% Confidence Level: Source: Field survey, 2019

Table 7 shows a binary logit analysis of firewood and solar energy. Firstly, biogas has been dropped from the analysis because households that chose it as their preferred energy source were comparatively fewer. Firstly, biogas has been dropped from the analysis because households that chose it as their preferred cooking fuel were comparatively fewer. Secondly, it has been dropped to allow for the analysis of choice differences between firewood and biogas since they are close substitutes. The summarized result in table 8 shows that as education level, primary occupation, access to credit and awareness of household positively estimated and family size of household is negatively estimated and it is statistically significant at 5% confidence level. Their odds ratios are similarly strong. Key informants of the study area told that as educated households are more awarred than that of illiterate on which of the technology is the better as compared with firewood and they can also easily choose the one which they want. Respondents during focus group discussion revealed that as lack of accessibility to credit service and lack of awareness on the benefits of alternative energy technology and how to use the energy source is the major problem in the study area.

**Table 7 Binary Logit Analysis for solar energy as Compared to Firewood**

| Variables | Coefficient | p-value | Odd result |
|---|---|---|---|
| EDULEVEL | 1.453 | .015** | 4.276 |
| FAMSIZ | -1.863 | .000** | .155 |

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| | | | |
|---|---|---|---|
| AGEHHS | .460 | .233 | 1.583 |
| SEXHHS | -.801 | .245 | .449 |
| MARSTATUS | -.102 | .774 | .903 |
| INCOMHHS | .123 | .751 | 1.131 |
| TLIVSTOKHHS | .466 | .182 | 1.593 |
| PRIOPPO | 1.353 | .014** | 3.871 |
| ACESCRED | 1.307 | .022** | 3.695 |
| AWARNALTENECHO | 2.815 | .000** | 16.696 |
| SOPART | -1.257 | .081 | .284 |
| Constant | -1.390 | .470 | .249 |

** P-Values are statistically significant at 5% Confidence Level:

Source: Field survey, 2019.

## CONCLUSION AND RECOMMENDATION

This study reveals a set of important factors that determine household alternative energy source and their energy choice. The study shows that as household Education level, income of household, access to credit and awareness of rural household positively affect and household family size, age and distance from market negatively affect alternative energy source adoption at significant level of 5%.The study shows that as household Education level, income of household, total number of livestock, primary occupation and access to credit service positively affect alternative energy technology choice of rural households in the study area at significant level of 5%. In the study district, with respect to renewable energy source adopter households were more advantages in terms of contribution to reducing environmental pollution and minimize burden on biomass fuels, economical energy source, saves time of women and children and reduce smoke/ashes as compared to non-adopters.

On the basis of what have been concluded from the current study, the following recommendations have been forwarded:

- Development planers (both governmental and non-governmental) organizations must be designed sustain efficient production and use of traditional energy as well as transition to the efficient use of clean modern energy is crucial for addressing socio-economic and environmental problems.
- Additionally, both governmental and non-governmental organizations must be encouraged, promoted, implemented, and demonstrated by full-scale plan especially for use in remote

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rural areas. Since rural electrification is unlikely to resolve the energy problems of scarcity of firewood in rural village of the study area.

- Development planers should be work at grass root level for scale up renewable alternative energy sources. Since, the most bottle neck in expansion of renewable alternative energy sources in the study area were fail to adopt because they fail to understand their immediate use and inadequate information.

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