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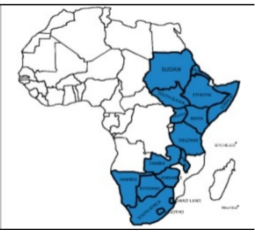

# Factors Influencing Choice of Clean and Non-Clean Energy Sources for Lighting by Households in Geita, Tanzania

[1]Neema A. Mwangu, [2]Siamarie Lyaro*

[1,2] Eastern Africa Statistical Training Centre, P.O. BOX 35103 Dar Es Salaam, Tanzania
*Corresponding Author Email: siamarie.lyaro@eastc.ac.tz

*KEYWORDS*

*Energy sources, Logistic regression*

*ABSTRACT*

*Utilization of clean-energy sources for lighting among households vary among regions of Tanzania such that at least half of all households in Geita region do not use clean energy sources for lighting. Following this situation, the study was undertaken to analyze factors influencing choice of clean and non-clean energy sources for lighting by households in Geita, Tanzania so as to ultimately formulate strategies for promoting sustainable use of clean and modern energy use by households. The study used secondary data of Tanzania Households Budget Survey 2017/2018 from the National Bureau of Statistics. Results showed that location of households, gender, and education level, household's expenditure and occupation had significant effect on choice of energy sources utilized. The study recommends to the government the need to formulate strategies for improving accessibility and affordability of clean energy sources for lighting in remote and under-privileged areas in the country, and as well as formulate mechanisms for monitoring and evaluating sustainable utilization of clean energy sources by households*

## 1.0 Introduction

Energy is the heart of development, energy makes possible the investment, innovation, and new industries that are the engines of jobs, inclusive growth, and shared prosperity for entire economies. Clean energy can help countries mitigate climate change, build resilience to volatile price, and lower energy cost (World Bank, 2023). Generally, household energy services are required for a variety of purposes. It is required for lighting, heating, cooking and for use in electrical appliances. This usage is commonly referred to as household energy consumption and is defined as the energy consumed in homes to meet the needs of households. Based on usage, household energy includes solar energy, fuel wood, dung, agricultural residues, charcoal, kerosene, Liquefied Petroleum Gas (LPG) and electricity (Adamu, 2020).

According to United Nations (United Nation, 2023), Sustainable Development Goal 7 is a global goal to "ensure access to affordable, reliable and modern energy for all by 2030" which is key to the development of agriculture, business, communication, education, health care and transportation. The world continues to advance towards sustainable energy targets but not fast enough. At the current pace, about 660 million people still lack access to electricity and close to 2 billion people will still rely on polluting fuels (non-clean fuels) and technologies for cooking by 2030 (United Nation, 2023). In 2021, 71% of the global population had access to clean cooking fuels and technologies, up from 64% in 2015. The region with the lowest access rates was sub Saharan Africa, where progress towards clean cooking has failed to keep pace with growing population (United Nation, 2023).

Tanzania has a high and mostly untapped potential for renewable energy sources. The only resource significantly in use is hydropower at a large scale. Additionally, small hydropower has good potential and is particularly feasible in rural areas. Biomass resources are mostly exploited in traditional, but unsustainable ways though there remains great potential due to large amounts of organic waste generated from the agricultural sector. Solar energy is abundant with initial efforts being undertaken to exploit this resource through both off-grid and grid-connected solutions. Wind resources have been assessed with results showing promise with plans for developments underway (Tanzania Final Energy Report, 2018). Primary energy demand per capita was 0.45 ktoe in 2009. The residential sector contributes most to energy consumption in the country (72% in 2009), mainly due to the large amounts of biomass consumed for heating, lighting and cooking. Further development of the national electricity grid, Leading to improved electricity services for households would reduce this consumption greatly. Small-scale energy efficiency projects have been conducted in the country, for example aggregated purchasing schemes for energy-efficient electrical equipment (Tanzania Final Energy Report, 2018).

Tanzania has abundant and diverse indigenous energy resources that are yet to be fully exploited. 78.4% of the total population has access to the grid electricity while households connected are 37.7%. The households electrified by solar photovoltaic technology are 30.4% (Rural Energy Agencies, 2020). Tanzania has promising levels of solar energy, ranging between 2,800 and 3,500 hours of sunshine per year and a global horizontal radiation of 4–7 kWh per m2 per day. Solar radiation is particularly high in the central region of the country.

The HBS 2017/18 results show that about one out of three (29.1%) of households in Tanzania Mainland connected to grid electricity (TANESCO). The percentage of households connected to grid electricity is largest in Dar es Salaam (79.9%) followed by Other Urban Areas (55.3%) and

Rural Areas (10.4%). Moreover, about a quarter (26.5%) of all households are using solar as source of energy for lighting. In Tanzania Mainland, 29 percent of households use electricity as the main source of energy for lighting, followed by torch or rechargeable lamp (27.5%), solar power (26.5%) and kerosene (wick lamps) (7.0%). The percentage of households using electricity as the main source of energy for lighting in Urban Areas is more than six times (63.1%) than that of Rural Areas (10.4%). Dar-es-Salaam region has the largest percentage of households (80.1%) using electricity as their main source of energy for lighting while Geita is among of the regions with low clean energy consumption for lighting, 11.6 percent use electricity, 26.4 percent use solar while 0.8 percent use acetylene lamp. The remaining percentage used for non-clean energy while the highest energy consumed in Geita region is 53.4 % use touch/rechargeable tools for lighting (HBS, 2020).

Geita region is among of bottom three regions when it comes to utilization of clean energy for lighting such that at least 60% of households utilize non-clean energy for lighting (HBS, 2020). As clean energy helps countries mitigate climate change, build resilience to economic factors such as volatile price, and lower energy cost (World Bank, 2023). This means that with time, household's energy choice moves from traditional (mainly-non-clean energy sources) to transitional to modern fuels (mainly clean energy sources) due economic factors (income) and non-economic factors such as technology access, and geographical location as per Energy Ladder theory (Kroon et al., 2011). Furthermore, choice of energy sources utilized by households depends also on non- economic such as education level, age, employment status of the head of household, family size, gender of the head of household, availability of different energy choices, reliability, and economic factors such as affordability, and expenditure per capita (Danlami et al., 2015; Mangula et al., 2019; Onyekuru et al., 2020; Adamu et al.,2020; Wassie et al., 2020; Ahmar et al., 2022; Baraya et al., 2023; Debebe et al., 2023).

However, above studies did not report about the marginal effect of predictors on the dependent variable in relation to the choice of clean and non-clean energy sources for lighting. Therefore, the present study is designed to fulfill the identified gap by analyzing factors influencing choice of clean and non-clean energy sources utilized for lighting, and as well as studying the marginal effect of predictors on the dependent variable when utilizing clean and non-clean energy sources for lighting to harness overall attainment of SDG 7.

## 2.0 Material and Methods

### 2.1 Study Area

The study area is Geita region which is among of Tanzania's 31 administrative regions. The region covers an area of 20,054 $km^2$(7,743 sq mi). According to national census of 2022, the region had population of 2,977,608. Geita region is among of top 5 regions with high growth rate. The region is home of Tanzanians largest gold mining industries. The reason for choosing Geita as study area is, it is a second region from bottom which uses clean sources of energy in Tanzania, so large number of households depends on non-clean energy sources for lighting (Geita strategic plan report, 2023).

### 2.2 Research Design

The study adopted quantitative data analysis where by type of clean energy utilized is dependent variable while household budget share for lighting, income, household size, location of household, employment status of head of household, education level are independent variables. The cross-sectional data from household budget survey (HBS 2017/18) was collected from Tanzania National Bureau of Statistics.

### 2.3 Data Source

The study used cross sectional data from household budget survey 2017/18 that was conducted by Tanzania National Bureau of Statistics.

### 2.4 Variables and Their Measurement Scales

Table 1 presents variables and their measurement scales

**Table 1: Variables and their measurement scale**

| VARIABLE | DESCRIPTION | MEASUREMENT OF SCALE |
|---|---|---|
| Type of energy utilized for lighting | 0= Clean energy<br>1=Non-clean energy | Nominal |
| Total expenditure | Tanzanian shillings | Ratio |
| Location of household | 0= Urban<br>1= Rural | Nominal |
| Employment status of household head | 0= Not employed<br>1= Employed | Nominal |
| Education level | 1= Primary education<br>2= Secondary education<br>3= Above secondary higher education. | Ordinal |
| Gender of household head | 0=Female<br>1=Male | Nominal |
| Age | Years | Ratio |

**Source**: Authors' construction (2024).

### 2.5 Data Analysis

#### 2.5.1 Descriptive statistics

The study used descriptive analysis for statistical analysis, whereby descriptive analysis present measures of central tendency and dispersion of the data. For household energy utilized descriptive statistics such as mean, maximum, minimum, median and standard deviation are used in analysis.

### 2.5.2 The two sample independent test.

Two sample independent tests are the test which examines whether there is statistical significant difference between the means in two unrelated groups. The null hypothesis for the independent test is that the population means from two unrelated groups are equal. In two sample independent tests variables is approximately normally distribution between the groups. When two samples are drawn from different populations, we will look whether the difference between the proportion of successes is significant or not. In other words, we take the null hypothesis as $H_0$: p1 = p2and for testing the significance of difference, we work out the test statistic as under:

Hypothesis testing $H_0$: p1 = p2

Test statistics $$z = \frac{P_1 - P_2}{\sqrt{\frac{P1\ q1}{n1} + \frac{P2\ q2}{n2}}}$$

Where $p1$ = proportion of success in sample one, $p2$ = proportion of success in sample two, $q_1 = 1 - P_1$, $q_2 = 1 - P_2$, $n1$ = size of sample one, $n2$ = size of sample two

And $\sqrt{\frac{P_1\ q_1}{n_1} + \frac{P_2\ q_2}{n_2}}$ = the standard error of difference between two sample proportions (Kothari, 2004). This test will be used to analyze the significance difference between households utilizing clean and non-clean source of energy.

### 2.5.3 Chi-square test for independence

To examine the significant relationship between the dependent variable (type of energy source being clean or non-clean) and independent categorical variables mainly education level, gender of household head, location of households, and employment status of household head, the chi-square test of independence was conducted before the binary logistic regression analysis to check the association between these independent categorical variables to the dependent variable. The Chi-square test is expressed as follows:

$$X^2 = \sum_{j=1}^{n} \frac{(O_j - E_j)^2}{E_J\ (1 - {}^{E_j}/_{n_j}}$$

Where:

$X^2$= Chi- squared.

$n_j$ = Number of observations in the $j^{th}$ group.

$O_j$ = Number of observed cases in the $j^{th}$group.

$E_j$ = Number of expected cases in the $j^{th}$ group

### 2.5.4 Binary logistic regression model

Binary logistic regression is a regression analysis where the dependent variable is a dichotomy with two response “success” and failure, success is coded 1 and failure is coded 0. It contains data with only two outcomes coded as (Y=1 or Y=0). The aim of binary logistic regression is to fit the model, which describes the relationship between dependent variable and independent variables (Kothari, 2004).This method will be employed to test the effects of household budget share for lighting, household size, location of household, employment status of household head, gender of household head and education level on the type of energy utilized by household for lighting. Equation model

Logit (y) = $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon i$

Where: $\beta_0, \beta_1, \ldots, \beta_k$ Are regression coefficients; $X_1, X_2, \ldots, X_k$ are predictor variables

The odds of an event are the ratio of the probability of an event occurring to the probability of the event not occurring. The odd ratio gives the relative amount by which the odds of the outcome increase (odds ratio greater than 1) or decrease (odds ratio less than1) when the value of the predictor is increased by a unit or when comparing a level of categorical predictor variable to its reference level (Maddala, 2001).

$$\text{logit}(\pi) = \log\left(\frac{\pi}{1-\pi}\right) = \text{Odds}\left(\frac{\pi}{1-\pi}\right) = \frac{\text{Probability of an event occurring}}{\text{Probability of an event not occurring}}$$

This test will be used to analyze the factors influencing choice of clean and non-clean energy among households in Geita region.

### 2.5.5 Marginal effects of binary logistic regression model

In a binary regression model, the marginal effects represent the change in the probability of the dependent variable taking a particular value due to one unit change in one of the dependent variables, while holding other variables constant. Marginal effect of binary variables measure discrete change while for continuous variables will be measuring the instantaneous rate change. For a logistic regression model with a multiple independent variables calculation will involve partial derivatives, the marginal effect (ME) is calculated as; $ME_i = P\left(Y = 1\right) . \left(1 - P\left(Y = 1\right)\right) . \frac{\partial P(Y = 1)}{\partial X_i}$

Where $P\left(Y = 1\right)$ is the predicted probability of the dependent variable being 1.
$\left(1 - P\left(Y = 1\right)\right)$ is the probability of the dependent variable being 0.
$ME_i$ is the marginal effect for the $i$ -th independent variable. This test will be used to analyze the marginal efffects of factors influencing choice of energy among households.

## 2.6 Diagnostics for the Logistic Regression

Hosmer-Lemeshow test will be used to assess the accuracy of the Binary logistic regression model.

## 2.7 Goodness of Fit

The study used Hosmer-Lemeshow goodness-of-fit test to assess if the model has effectively described the outcome variable. Hosmer-Lemeshow goodness-of-fit test in its form divides subjects into deciles based on predicted probabilities and computes a chi-square from observed and expected frequencies under the null hypothesis that the fitted logistic regression model is the correct model. The large p-value signifies that there is no significant difference between the observed and the predicted values of the outcome.

# 3.0 Results and Discussion

## 3.1 Descriptive Statistics of the Studied Variables

Result in Table 2 shows that about 64.59 percent of households utilize non clean type of energy for lighting while about 35.41 percent of household utilize clean source of energy for lighting.

These findings where in contrary to Ahmar et al., (2022) who examined rural household's energy choices for cooking and lighting in Pakistan that 37.96 percent of households utilized non clean source of energy for lighting while 62.04 percent of households utilized clean source of energy for lighting.

**Table 2: Summary of descriptive statistics for the variables used in the analysis.**

| Variable | Frequency | Percent |
|---|---|---|
| **Type of energy** | | |
| Clean | 142 | 35.41 |
| Non clean | 259 | 64.59 |
| **Total** | **401** | **100** |
| **Location** | | |
| Urban | 70 | 17.46 |
| Rural | 331 | 82.54 |
| **Total** | **401** | **100** |
| **Employment status** | | |
| Employed | 289 | 72.07 |
| Unemployed | 112 | 27.93 |
| **Total** | **401** | **100** |
| **Gender** | | |
| Male | 306 | 76.31 |
| Female | 95 | 23.69 |
| **Total** | **401** | **100** |
| **Education level** | | |
| Primary | 265 | 66.08 |
| Secondary | 31 | 7.73 |
| Higher education | 105 | 26.18 |
| **Total** | **401** | **100** |
| **Variable** | **Mean** | **Std. dev** |

| | | |
|---|---|---|
| Household expenditure | 368062.2 | 405661 |
| Age | 47.341 | 15.085 |
| Household size | 7.312 | 5.271 |

**Source:** Authors’ compilation (2024).

About household location, Table 2 shows that households in Geita region located in rural areas are of about 82.54 percent and 17.46 percent located in urban areas. This means that majority of households were located in rural areas compared to urban areas. The result are similar to Onyekuru *et al*. (2020) examined determinants of cooking energy use and preferences among households in Enugu State, Nigeria, the study showed that 85 percent of households lives in rural areas and 15 percent located in urban area.

About employment status Table 2 shows that households in Geita region are headed by employed person of about 72.07 percent while 27.93 percent are headed by unemployed persons, so majority of households are headed by employed persons compared to unemployed. Similar to Ahmar *et al.* (2022) who examined rural household’s energy choices for cooking and lighting in Pakistan, the result showed that majority of households were headed by employed persons.

About education level, Table 2 shows that the majority of household head in Geita region have acquired only primary education which is about 66.08 percent followed by those who reached higher education which is about 26.18 percent and 7.73 percent is for those who only end in secondary education. The result were contrary to Baraya *et al.* (2023) who examined determinants of households energy consumption needs in Kebbi state, Nigeria that majority of households were having secondary education of about 51.04 percent followed by post- secondary and informal education.

About gender of household head, Table 2 showed that majority of households in Geita region are headed by male which is 76.31percent and the remaining which is 23.69 percent of households are headed by female. Similar to Baraya *et al.* (2023) who examined determinants of households’ energy consumption needs in Kebbi state, Nigeria, the result showed that about 76.19 percent of households are headed by male while 23.06 percent are headed by female.

About age of households, Table 2 showed that the average age of household head was 41.341years with standard deviation of 15.08 means that the variation of age was about 15 years around mean age. Similar to Debebe *et al.* (2023) who examined the determinants of household’s energy choice for domestic chores in Northwest Ethiopia, the result showed that the average age of household was 45.2 years with standard deviation of 11.4 mean the variation of age was 11 years around the mean.

About household’s size, Table 2 showed that average household’s size is 7.3 people with standard deviation of 5.3 people means that there is variation of 5 people around the mean. Similar to Wassie *et al.* (2020) examined the determinants of household energy choice for cooking and lighting in southern Ethiopia. The result showed that average household size was 6.24 people with standard deviation of 2.38 mean that there is variation of 2 people around the mean.

### 3.2 Comparing Proportion of Households Utilizing Clean and Non-clean Energy Sources for Lighting

The two sample t test was used to determine the significance difference between proportions of households utilize clean and non-clean type of energy. Results presented by Table 3 show that there is a significant difference between proportions of households utilizing clean and non-clean energy sources for lighting, and this is significant (p=0.000). This provides sufficient evidence that sufficient households utilizing clean and non-clean energy sources differ significantly, and hence they can be considered as distinct categories in the analysis.

**Table 3: The test for significance difference between types of energy utilized**

| observation | Degree of freedom | t | p-value |
|---|---|---|---|
| 401 | 399 | 4.563 | 0.000 |

**Source:** Authors' compilation (2024).

### 3.3 Testing Association between Dependent and Independent variables

Table 4 presents results for chi-square test of independence between type of energy utilized and education levels, gender of household head, location of households, employment of household head, household expenditure, and age and households' size. Results presented in Table 4 showed that chi-square value was 19.89 and significant (p=0.000). Hence, it can be concluded that there is association between type of energy utilized and location of households.

**Table 4: Results for chi-square test.**

| Variable | Response | Clean energy | Non-clean energy | $\times^2$ | p-value |
|---|---|---|---|---|---|
| **Household location** | Urban | 41 | 29 | 19.89 | 0.000 |
| | Rural | 101 | 230 | | |
| **Education level** | Primary | 92 | 173 | 13.69 | 0.001 |
| | Secondary | 20 | 11 | | |
| | Higher education | 30 | 75 | | |
| **Gender** | Male | 117 | 189 | 4.50 | 0.034 |
| | Female | 23 | 89 | | |
| **Employment status** | Employed | 119 | 170 | 15.03 | 0.000 |
| | Unemployed | 23 | 89 | | |

**Source:** Authors' compilation (2024).

Furthermore, results presented in Table 4 showed that chi-square value was 13.69 and significant (p=0.001). Hence, it can be concluded that there is association between type of energy utilized and education level of households. Similar to the result reported by Baraya et al., (2023) who examined determinants of households energy consumption needs in Kebbi state, Nigeria who found a significant relationship between education level and the type of energy utilized by households.

Also, result presented in Table 4 showed that chi-square value was 4.50 and significant (p=0.034). Hence, it can be concluded that there is association between the type of energy utilized and gender of households. This is contrary to Ahmar *et al.* (2022) who examined rural household’s energy choices for cooking and lighting in Pakistan, the study findings showed that gender has insignificant effects on determining the energy choices for lighting among households. This shows that gender has no influence on the type of energy utilized among households.

Lastly, results presented in Table 4 showed that chi-square value was 15.03 with significant (p=0.000). Hence, it can be concluded that there is association between the type of energy utilized and employment status of households. Similar to Ahmar *et al.* (2022) who examined rural household’s energy choices for cooking and lighting in Pakistan, the study findings showed that employment status has significant effects on determining the energy choices for lighting among households.

### 3.4 Analysis of Factors Influencing Choice of Clean and Non-clean Energy Sources for Lighting.

Binary logistic regression was used to analyze the effect of independent variables (gender, employment status, location, age, household expenditure, household size and education level) on dependent variable (type of energy utilized being clean or non-clean energy). Table 5 present results for binary logistic regression.

The Table 5 showed that the value of likelihood ratio (LR) chi-square test is 41.80 its degree of freedom is 5. The overall model p-value is 0.000 this means that the predictor variables have highly significance effects on the type of energy utilized. The binary logistic results are presented by odds ratio. The logistic regression analysis showed that employment status and location of households are statistically significant at 5% level of significant while education level and gender was not statistically significant at 5% level.

**Table 5: Results for binary logistic regressions**

| Type of energy | Odds ratio | S.E | p-value | Lower limit | Upper limit |
|---|---|---|---|---|---|
| **Education level** | | | | | |
| Primary (reference) | | | | | |
| secondary | 2.734 | 1.133 | 0.016 | 1.076 | 6.094 |
| Higher education | 0.912 | 0.274 | 0.734 | 0.544 | 1.673 |
| **Location** | | | | | |
| Urban(reference) | | | | | |
| Rural | 0.388 | 0.126 | 0.001 | 0.228 | 0.753 |

| | | | | | |
|---|---|---|---|---|---|
| **Employment status** | | | | | |
| Employed(reference) | | | | | |
| Unemployed | 0.420 | 0.140 | 0.002 | 0.273 | 0.854 |
| **Gender** | | | | | |
| Female(reference) | | | | | |
| Male | 1.651 | 0.412 | 0.082 | 0.755 | 2.468 |
| **Expenditure** | 1.000 | 0.000 | 0.000 | 1.000 | 1.000 |
| **Age** | 0.998 | 0.008 | 0.807 | 0.982 | 1.014 |
| **Household size** | 0.974 | 0.026 | 0.313 | 0.924 | 1.026 |
| **Constant** | 0.929 | 0.312 | 0.829 | 0.208 | 1.662 |
| LR chi2(8) = 72.42 | | | | | |
| Prob > chi2 = 0.0000 | | | | | |
| Pseudo R2 = 0.1389 | | | | | |

**Source:** Authors' compilation (2024).

Results presented in Table 5 showed that, head of household with secondary education are 2.734 times more likely to have clean sources of energy for lighting rather than non- clean source of energy for lighting compared to household with primary education, this is significance at (p=0.016). This finding is simiar to Debebe *et al.* (2023) who found that the household head years of schooling showed positive effects on the choice of energy utilized. Both research and comparative studies reveal that higher levels of education correlate with greater adoption of clean energy solutions this consistency can be attributed to the role of education in raising awareness about the environments and economic benefits of clean energy.

Results presented in Table 5 showed that the households located in rural areas are 0.391 times less likely to use clean type of energy other than non-clean type of energy for lighting compared to households located in urban areas, and this is significance at (p= 0.001). This finding is in support with the Energy Ladder theory and results are similar to Ahmar *et al.* (2022) who found that the location of households has positive effects on the choices of energy for lighting among households. This means that as the society experience economic growth it tends to shift from non-clean source of energy to clean in continuum so that the people in urban area who experience economic growth use more lean energy than rural areas.

Results presented in Table 5 showed that households which are unemployed are 0.466 times less likely to use clean type of energy other than non-clean type of energy for lighting compared to households with employment, and it is significant at (p= 0.002). This finding are similar to Ahmar *et al.* (2022) who found that employment status has positive effects on determining the energy choices for lighting among households. Also it is similar to Debebe *et al.* (2023) who found that employment status has significant effects on determining the choice of household energy for lighting. This means that employment status impacts households' ability to adopt and utilize clean energy sources as its provide incomes, better access to information and awareness to environment issues.

Results presented in Table 5 showed that a unit increase in expenditure of households result to increase in choice of clean energy sources by 1.000 compared to non-clean energy sources for lighting among households, this is significant with (p=0.000). The findings are similar to Baraya *et al.* (2023) who found that household expenditure has positive effects on the choice of energy utilized. This is means that households with higher monthly expenditure have greater financial flexibility to invest in clean energy solutions and driving preference for clean energy sources.

### 3.5 The Marginal Effects of Independent Variables on Dependent Variable

The marginal effects were carried out to analyze the probability of independent variables (gender, location, employment status and education level) to cause effects on dependent variable (type of energy utilized for lighting being clean or non-clean energy source)

**Table 6 Marginal effects of independent variables on dependent variable**

| Type of energy | $dy/dx$ | Z | p-value |
|---|---|---|---|
| **Education level** | | | |
| Secondary | 0.2254122 | 2.40 | 0.017 |
| Higher education | -0.0189603 | -0.34 | 0.733 |
| **Location** | | | |
| Rural | -0.2124577 | -3.22 | 0.001 |
| Urban(reference) | | | |
| **Employment status** | | | |
| Unemployed | -0.170955 | -3.46 | 0.001 |
| Employed(reference) | | | |
| **Expenditure** | 4.12e-7 | 5.16 | 0.000 |
| **Age** | -0.000 | -0.24 | 0.807 |
| **Household size** | -0.005 | -1.01 | 0.311 |

**Source:** Authors' compilation (2024).

Results presented by Table 6 show that the marginal effect for secondary education to utilize clean energy is 0.225. This means that the probability of households utilizing clean energy is 22.5% points higher in households with secondary education compared with primary education, this effect is statistically significant at 5% level (p-value 0.017).

For location of households, Table 6 show that the marginal effect is 0.212. This means that the probability of utilizing clean energy is 21.2% points lower in households located in rural areas compared to households located in urban areas. This effect is significant at 5% level of significant (p-value 0.001).

For employment status of household, Table 6 show that the marginal effect is 0.171. This means that the probability of utilizing clean energy is 17.1% points lower in unemployed households compared to employed households. This effect is significant at 5% level of significant (p-value 0.001).

Table 6 show that household monthly expenditure the marginal effects is 4.12e-7 with p-value 0.000. this means that there is very small but statistically significance positive relationship between expenditure and the type of energy utilized.

### 3.6 The model goodness of fit

Table 7 presents results for testing goodness of the model. This involves analyzing if the model fit well the variables and data as well; Hosmer-lemeshow method was used to analyze the fitness of the model between dependent and independent variables. Model interpreted according to p-value if p-value < 0.05 model does not fit if p-value> 0.05 model fit the data.

**Table 7: Fitness of the model**

| Observations | Groups | $\times^2$ | p-value |
|---|---|---|---|
| 401 | 20 | 18.31 | 0.768 |

**Source:** Authors' compilation (2024).

The analysis showed that the model fit well the data since p-value > 0.05 (p-value o.768) at 5% level of significance.

## 4.0 Conclusions and Policy Implications

This study examined determinants of energy sources utilized for lighting in Geita Region Tanzania by using secondary data from 2017/2018 Tanzania Household Budget Survey. The study employed two sample t-test, chi-square test and binary logistic regression for analysis. Based on analytical results, the study conclude that location of a household, education level of the household head, gender of the household head, employment status of the household head, and household's expenditure as significant factors which choice of clean energy sources for lighting by households. The study recommends to the government the need to enhance the infrastructure and distribution network to make clean energy options more accessible especially in remote and under-privileged areas, enhance education programs to raise awareness about the benefits of clean energy and how to access and use it in both school curriculums and community outreach initiatives to ensure broad-based understanding, foster collaborations between government entities, private sectors and nongovernmental organizations to create comprehensive strategies for clean energy promotion and offer financial assist to low-income households and reduce the cost of energy to make the low-income households afford the cost of clean energy technologies so as to bridge the gap between usage of clean and non-clean energy for household lighting. The study recommends to the government the need formulate mechanisms for monitoring and evaluating sustainable utilization of clean energy sources by households so as to detect and manage potential factors which ought to hinder utilization of clean energy sources.

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