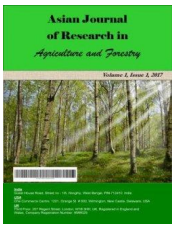

Asian Journal of Research in Agriculture and Forestry

1(4): 1-10, 2018; Article no.AJRAF.43305

Analysis of Cooking Energy Preference among Households in Jos North Local Government Area, Plateau State

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Authors' contributions

This work was carried out in collaboration between all authors. Author SKV designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BG, AAM and MEE managed the analysis of the study. Author OA managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJRAF/2018/43305
Editor(s):
(1) Dr. Reda Ragab Shahin, Professor, Department of Soil Science, Faculty of Agriculture, Cairo University, Giza, Egypt.
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(3) Joseph K. Githiomi, Kenya Forestry Research Institute, Kenya.
Complete Peer review History: http://www.sciencedomain.org/review-history/26091

Original Research Article

Received 25 June 2018
Accepted 31 August 2018
Published 04 September 2018

ABSTRACT

This study assessed cooking energy preference among households in Jos North Local Government Area, Plateau State Nigeria. The multistage sampling procedure was used to select 120 households from six political wards of the Local Government Area for the study. Primary data were collected through the use of questionnaires and interview schedule and were subjected to both descriptive and inferential statistics. Findings from the study revealed that the mean age of the respondents was 40 years with 58.3% of them being male and 80.8% married. The study also showed that 42.5% of the respondents had a tertiary education with an average household size of 6 persons. The results also revealed that 50.8% of the respondents were businessmen/women. The mean monthly income of household heads in the study area stood at N26833. The major energy type used

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by the respondents was kerosene (48.3%) with many (49.1%) of them combining at least two cooking energy types in their households. The majority (50.6%) of household heads indicated a willingness to switch to higher energy types with an increase in income. The multinomial regression result showed that the most significant factors influencing the choice of cooking energy among the households were marital status, educational status, occupation, income, and energy cost.

Keywords: Analysis; households; cooking; energy; preference; Jos North Local Government.

1. INTRODUCTION

Energy is a key ingredient for social, economic and industrial development of every nation. Household energy consumption is a necessity considering its importance on household welfare, public investments, and environment [1]. The pattern of household energy consumption indicates the state of welfare and economic development of an individual and of a particular country. The role of energy in enhancing human life is widely stated. For instance, at macro level, energy is highly regarded as a contributing factor for national socio-economic development [2]. Equally, at micro level, energy is fundamental to sustain household livelihoods: prepare food, accomplish income generating activities and supplement comfortable living environment. For these reasons, energy use is always liable to household consumption expenditure decision making- where households make choices on which type of fuel1 to use and how much amount of energy to consume- to satisfy their daily basic needs such as cooking. However, access to modern, affordable and reliable energy services is an enormous challenge facing the African continent, particularly Nigeria [1].

In developing countries, most of the rural as well as urban communities have less access to modern and clean energy sources and mostly depend on biomass fuels (woods, leaves, twigs, animal dung, charcoal and crop waste) for virtually all their energy needs [3]. While rural households rely more on biomass fuels than those in urban areas, well over half of all urban households in sub-Saharan Africa rely on fuel wood, charcoal, or wood waste to meet their cooking needs [4]. The heavy reliance of urban households in sub-Saharan Africa on biomass fuels contributes to deforestation, forest degradation, and land degradation. This is partly because the use of these fuels is an important source of income for people in both rural and urban areas. This challenge is nowhere more severe than in Nigeria, where for centuries, its people have been experiencing heavy reliance on traditional energy sources with all the negative consequences associated with it. The household cooking sector is the largest consumer of energy in Nigeria, using around 80% of the total, 90% of which is derived from biomass, particularly fuel wood [5]. While rural households rely more on biomass fuels than those in urban areas, a substantial number of urban poor households' in Nigeria rely on fuel wood, charcoal, or wood waste to meet their cooking needs. Although other sources of cooking energy are used in Nigeria, including liquefied petroleum gas (LPG), kerosene, and electricity, they are expensive compared to biomass, which is available at little or no cost. With over 60% of people earning less than $1 per day, biomass stands as the preferred source of household cooking energy in Nigeria [6]. The availability of electricity and other energy sources is also a major challenge, especially in rural areas. For example, only about 40% of the population is connected to the national grid with 90% of rural areas having unreliable or no electricity at all. This virtually eliminates electricity as a source of cooking energy for almost half the population. Urban dwellings, on the other hand, use electricity, as well as kerosene and LPG for cooking, although fuel wood still dominates owing to the high cost of other energy sources [5].

There has been long years of inconsistency in the supply of electricity while kerosene is faced with persistence scarcity and increase in price The cooking gas is also very expensive and out of reach for the poor and low income class [2]. The economic impact on households, therefore, led to either a switch in the choice of energy preferred for domestic use or a situation of energy combination by different income groups. Many of the people in the rural areas, as well as low income class in the urban areas, therefore, preferred to switch to charcoal or firewood which they considered less expensive and available. One set of factors necessary for switching to other fuels particularly in developing countries like Nigeria is better availability of alternative fuels other than biomass fuels. Efforts at encouraging households to make a

substitution that will result in more efficient energy use and less adverse environmental, social, and health impacts are advocated.

In a bid to reduce the world carbon emission levels, the use of renewable energy has been widely encouraged [7]. Many policies have been implemented by public authorities to decrease household wood-energy consumption and to substitute it by alternative conventional fuels. There are three primary renewable energy policies in Nigeria. These include the Nigeria Renewable Energy Master Plan (NREMP), Nigeria Feed-in Tariff for Renewable Energy (RNSE) and the Multi-Year Tariff Order (MYTO) [8]. According to Ohunakin et al. [9] five policies supporting renewable energy are currently in place. These policies are: (1) Reductions in VAT on energy, (2) feed-in tariff/premium payments, (3) public investments, grants or loans, (4) capital grant, subsidies or rebates, and (5) biofuels mandate/obligations.

But despite all the policies, the rate of consumption of wood-energy (and other biomass fuels) and its attendant negative environmental and health impacts are still alarming. The consumption of fuel wood which is a rural practice seems to have now gained acceptance in urban areas in a manner to which its demand is leading to the harvest of both dry and wet wood. It is apparent that excessive utilisation of traditional fuels has negative environmental, social and economic impacts- in cases where frequent use of firewood and charcoal aggravates the rate of deforestation and distorts ecological biodiversity, and increased use of plant residues and animal dung reduces soil nutrients that otherwise would have been used as organic fertilisers for crop and plant cultivation [10]. Moreover, the smoke produced from traditional fuels combustion creates dire health consequences such as respiratory and eye-related infections [11]. The real effect of this problem is that the government understanding of fuel sector and the ability to predict and plan household fuel agenda is woefully inadequate. The World Health Organization(WHO) indicate that as a consequence of indoor air pollution(IAP) generated from using these unclean traditional cooking fuels, more than 3.8 million premature deaths occur every year all over the globe [11].

There exists a knowledge gap regarding how households' characteristics influence fuel choices and use in the fast-growing areas of Jos North Local Government Area of Plateau State, where there is a high demand for household energy considering population increase and urbanisation. This study is, therefore; motivated on the need to encourage households to make fuel substitution that will result in more efficient energy use. This study seeks to analyse cooking energy preference among household in Jos North Local Government Area, Plateau State. Specifically, the study seeks to;

i. Describe the socio-economic characteristics of households in the study area.
ii. Identify the different energy sources used by households.
iii. Determine the energy preferences of households in the study area.
iv. Determine the factors influencing the type of household energy used in the study area.

2. MATERIALS AND METHODS

The study was carried out in Jos North Local Government Area of Plateau State, Nigeria. It is located in the north-west of the State and extends over an area of 219 km^2 with a total population of 429, 300 at 2006 National Population Census and an estimated population of about 850,000 in 2017. The metropolitan nature of the town provides it an added advantage, as there is a tremendous availability of physical infrastructure like good roads, pipe borne water, electricity supply and being the State capital, it is endowed with many socioeconomic and cultural activities which have resulted in high level of socialisation among the inhabitants. The topography of the area is undulating grassland with scattered trees. It is situated on latitude 7° and 11°N and longitude 7° and 25°E and at an average altitude of about 1200 m above sea level. The metropolis falls within the tropical region. It is characterised by cold weather which is markedly influenced by its altitude and position across the seasonal migration of the Inter Continental Discontinuity (ITD). It shares a common boundary with Riyom, Jos South, Barki-Ladi, Jos East and Bassa local government area of Plateau State and Toro local government area of Bauchi State.

Multi-stage sampling technique was employed in this study. In the first stage, Gwom district which is the only district in Jos North Local Government was selected. The second stage involved the selection of six (6) wards out of the fourteen wards in the Local Government Area for the study. They include; Gangare, Tudun Wada,

Jenta Adamu, Apata, Vanderpuye, and Sarkin Arab. In the third stage, a sample frame for each of the sampled wards was drawn. For estimate of the houses in the study area an average of five persons per household standard estimate by World Health Organization (WHO) in its National Programme on Immunization (NPI) field guide, 2001 was adopted. Also according to National Bureau of Statistics (2006), the average number of person per household in Plateau state is 5.0. It is estimated that in every average 5.0 number of persons there is a household. Thus dividing the total population of the any community in Plateau State by 5.0 persons will give the expected number of households in the given community. The data available at Plateau state office of the National Population Commission (NPC) at the time of the researcher's visits gave the number of households in Jos North Local Government as 94417. Statistics for the number of households for the sampled wards were given as follows: Gangare, 2,137 households, Tudunwada/ Kabong, 13,226 households, Jenta Adamu 16,150 households, Apata, 1571 households, Vanderpuye 942 households and Sarkin Arab, 1,257 households.

In the final stage, having gotten the background on the number of residential buildings in the study area, systematic sampling of the houses was done by picking every 10th building in the direction of movement along the major roads and streets within the selected wards. The number of respondents in each ward was based on the proportion of the population of the ward in the Local Government Area. Data for this study was collected using a structured questionnaire designed in line with the objectives of the study. Descriptive statistics such as, percentages, frequency distribution, mean as well as multinomial logit regression Model were used to analyse data for this study.

2.1 Model Specification

2.1.1 Multinomial logistic model

The Multinomial Logistic Model was adopted to estimate the factors believed to influence a household's choice of cooking fuel in the study area. Multinomial logit describes the behaviour of consumers when they are faced with a variety of goods with a common consumption objective. The model assumes that the choice of household's cooking energy is based on the maximisation of the utility derived from this energy. For each of the alternatives j = 0, 1, 2, 3, the utility of individual "i" is expressed in the following form:

$$U_{ij} = U\left(x_{ij}, \varepsilon_{ij}\right) = v(x_{ij}) + \varepsilon_{ij} \quad (1)$$

Where v is a deterministic continuous function, is a random variable. It is assumed that the disturbance / random variable (ε_{ij}) is independent and identically distributed. And x_{ij} define a categorical variable which takes some alternatives according to the choices of individual i. The probability that individual I chooses an alternative can be defined by;

$$P(Y_i = J) = \frac{\exp(\beta_j X_i)}{\sum_{J=0}^{J} \exp(\beta_j X_i)} \quad (2)$$

Where P (Y_i = J) is the probability of choosing charcoal, kerosene, gas or electricity with firewood as the reference cooking fuel category, J is the number of fuels in the choice set, J = 0 is firewood, Xi is a vector of the predictor (exogenous) social factors (variables), βj is a vector of the estimated parameters. When the logit equation above is rearranged using algebra, the regression equation is as follows:

$$Z = \ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \mu \quad (3)$$

Z = log odds of fuel that confers the higher utility with respect to the other alternatives.
From equation (3) the quantity Pi / (1 – Pi) is the odds ratio

Pi = P1, P2, P3,P4,

P_0 = Probability of using firewood. This was used as a reference fuel because we want to know the influence of using a particular cooking energy relative to the reference category and the use of firewood is least expected from the households in this era of energy saving technology.

P_1 = Probability of using kerosene.
P_2 = Probability of using charcoal.
P_3 = Probability of using electricity.
P_4 = Probability of using gas
$1 - P_i$ = the alternative fuel which are kerosene, charcoal, electricity and gas.
P_k = P_1, P_2, P_3, P_4
μ = Error term.
X_1 = Marital status
X_2 = Educational level in years
X_3 = Household size (number)
X_4 = Occupation

X_5 = cost of the energy in naira
X_6 = Household income in naira.
$\beta_1 - \beta_6$ are the coefficients corresponding to independent variables

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of Respondents

Result from Table 1 shows that the respondents had a mean age of 40 years. Age is an important factor in household energy preference because adult people are more likely to engage in energy issues than the dependent age group. There is a particular age bracket that when reached, household heads are more conscious about the disastrous effects associated with incessant consumption of fuel wood. Hence, he/she will use his/her life time savings for consumption of the modern energy sources. The result shows that majority of the household heads were males constituting 58.3% of the respondents while the females constituted 41.7% of the respondents. This male dominance is in line with the religious and cultural ethics in the study area where males function as household's head except in some areas where females function as household's head either as widows or divorcees. The result in Table 1 also shows that 80.8% 0f the respondents are married. It is usual that the demand for cooking energy among married people is higher as a result of their large household sizes. The result of educational level of respondents revealed that 42.5 and 40.8% of the respondents had tertiary and secondary education respectively. This was expected as the study location is an urban area with high literacy rate. The result also showed an average household size of 6 persons in the study area. As household size increases, there is a probability of the household switching or combining energy source to carter for the increasing number. The results in Table 1 further showed that 50.8% of the respondents were businessmen\women, 44.1% were civil servants. The high percentage of businessmen was expected because the area is a business area with a high number of shops and a major market while the fact that the area is an urban area explains the high percentage of civil servants. The result also showed a mean monthly income of N26833 by household heads in the study area. The result indicates that most of the households in the study area are middle or low income earners although majority of them are businessmen and civil servants. The higher the income of the household head, the greater the flexibility of shift to the desired household fuel. This implies that fuel wood is mostly patronised by those who fall below the socio-economic status threshold.

3.2 Household Energy Types in the Study Area

Table 2 revealed that the most common cooking fuel amongst households is kerosene (48.3%) followed by charcoal (41.6%), firewood (30.8%), gas (18.3%) and electricity (9.1%). This shows that a larger proportion of the respondents used kerosene and charcoal for cooking. This could be as a result of availability of kerosene and charcoal at a lower cost. Jos is regarded as an urban city, but it is dominated by the urban poor probably due to the prevailing economic situation of the country. The over dependency on kerosene and charcoal by the respondents are due to high cost, unavailability and inadequate supply of gas and electricity as revealed by the study.

3.3 Average Cost Price of Energy Types in the Study Area

The prices of cooking energy were determined for the cooking energy types considered in this study thus, the mean price of firewood is N175/kg, kerosene N289/litre, charcoal, N2954/ 50 kg bag, electricity, N33.5/kwh and gas, N380/kg. None of the energy types is subsidised, and there is no incentive for consuming any of the energy types.

3.4 Energy Combination of Respondents in the Study Area

As shown in Table 4, one of the most important findings of the survey is that households rarely depend on a single fuel but rather utilise a combination of different fuels. The result shows that only 14.1% of households exclusively use only one type of energy. Majority of the households (49.1%) use two energy types, 31. 6% use three energy types and a few (5%) use more than three energy types. This also reveals how traditional fuels like firewood and charcoal are predominantly used either exclusively or in combination with those modern fuels. The major justification why

Table 1. Socio-economic characteristics of the respondents (n=120)

Variable	Frequency	Percentage	Mean
Age			
21-30	22	18.3	
31-40	50	41.7	
41-50	33	27.5	
51-60	15	12.5	40
Gender			
Female	50	41.7	
Male	70	58.3	
Marital status			
Married	97	80.8	
Single	23	19.2	
Level of education			
Non formal	9	7.5	
Primary	11	9.2	
Secondary	49	40.8	
Tertiary	51	42.5	
Household size			
1-5	71	59.2	
6-10	23	19.2	
11-15	21	17.5	
>15	5	4.2	6
Occupation			
Business	61	50.8	
Civil servant	53	44.1	
Farming	6	5.0	
Income (₦)			
10,000-20,000	42	35.0	
21,000-40,000	62	51.7	
41,000-60,000	12	10.0	
>60,000	4	3.3	26833

Table 2. Distribution of respondents based on type of energy used

Sources of energy	Frequency	Percentage (%)
Firewood	37	30.8
Kerosene	58	48.3
Charcoal	50	41.6
Gas	22	18.3
Electricity	11	9.1

Multiple choice responses

households use multiple fuels is partly related to the fact that some fuels are only convenient for undertaking specific cooking activities. Also, some fuels are not always available and seasonal changes are likely to induce change of fuel.

3.5 Energy Preference on Increased Income

The respondents were asked to indicate the type of energy they would prefer in event of increased income. Result shows that majority (50.8%) of

the respondents said they would prefer gas followed by electricity (48.3%). 43.3 % of the respondents preferred kerosene, 32.5% preferred charcoal while only 9.1% preferred to use firewood.. Indeed, increase in income will increase preferences for modern fuels like gas and electricity among households.

3.6 Reasons for Preference of Energy Source

There are various reasons that influence the choice of energy used by households in the area as shown in Table 7. It was found that 55.0% of respondents preferred gas because it is fast and neat, 50.8% said they prefer kerosene because it is easily available. 35.8% and 28.3% of the households use charcoal and firewood respectively because both of them are cheap. The low number of people that use electricity as a primary source of energy was expected because of the inconsistent power supply and high electricity tariff.

3.7 Factors Influencing Preference of Household Cooking Energy

Table 5 shows the result of multinomial logistic regression showing the factors influencing the choice of cooking energy. The analysis is done by normalising one category which is referred to as the base or reference category. In this study firewood was taken as the base category. The choice options set in the multinomial logistic regression model include kerosene, charcoal, electricity and gas. The socio economic factors are age, marital status, educational level, household size, occupation, cost of the energy in naira and household income in naira.

The results from the multinomial regression indicate that the most significant factors influencing the choice of cooking energy among the households were marital status, educational status, occupation, income, and energy cost.

Table 3. Average cost price of energy types in the study area

Energy type	Average unit price (N) (1kg)
Firewood	175
Kerosene	**Average price (1Ltr)** 289
Charcoal	**Average price (50kg)** 2956
Electricity	**Unit price (1kwh)** 33.5
Gas	**Average price (1kg)** 380

3.7.1 Marital status

The estimated coefficient for marital status of respondents using kerosene had a negative coefficient (-0.710) and was significant at 10% level of probability. This implies that an increase

Table 4. Distribution of respondents based on number of energy types used

Number of energy types	Frequency	Percentage (%)
One energy type	17	14.1
Combination of two	59	49.1
Combination of three	38	31.6
More than three	6	5.0
Total	**120**	**100**

Table 5. Multinomial Logit estimate of factors influencing energy choice by households

Variables	Kerosene		Charcoal		Electricity		Gas	
	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value
Age	-.001	.002	-.028	1.257	-.025	.81	-.003	.008
M/status	-.710***	3.319	-.155	.277	-.361	.941	.123	.156
H/size	-.022	.068	-.075	.785	-.099	.964	-0.023	.053
Edu	-.300	1.987	-387*	3.075	.378	2.594	.534**	4.289
Occup	-.288**	2.768	-.046	.075	-.064	.115	-.268	1.560
Income	.000	.860	.000*	2.952	.000	.024	.000	.812
Cost	.000*	5.404	.000*	2.750	.000	.225	.000*	14110

*Note: Reference category is firewood, levels of statistical significance are denoted as***,** and * for 1%, 5% and 10% respectively*

in marital status of the respondents will lead to a decrease in the likelihood of households choosing kerosene as preferred energy type to firewood. This conforms with the expectation that larger households will prefer to use firewood since it is comparatively cheaper when compared to sources such as electricity which at many times is not available in the study area.

Table 6. Distribution of energy preference of respondents

Preferred energy sources	Responses	Percentage (%)
Firewood	11	9.1
Charcoal	39	32.5
Kerosene	52	43.3
Electricity	58	48.3
Gas	61	50.8

Multiple responses

3.7.2 Educational status

Educational status of respondents using charcoal had a negative coefficient (-0.387) and was statistically significant at 10% level of probability. This means as the educational level of respondents increase, their probability to use charcoal as their energy source relative to firewood decreases. For gas users, educational status had a positive coefficient (0.534) and was significant at 5% level of probability. This means that the probability that the respondents will use gas increases with increase in their level of education. This indicates that, with everything else held constant, the respondents having more education are more likely to switch over to these fuel wood alternatives like gas and electricity. This conforms to the theoretical expectation that as households gain more education, the demand for firewood alternatives will increase. This is because education improves knowledge of fuel attributes, taste, and preference for better fuels.

3.7.3 Occupation

Occupation of the respondents using kerosene had a negative coefficient (-0.288) and significant at 10% level of probability. The negative coefficient indicates that with an increase in occupational status, households will show a reduced likelihood of choosing kerosene over firewood. This is contrary to the theoretical expectation that respondent households that are employed would prefer firewood alternative. A possible explanation is that if a household cooks mainly the food that requires long cooking time, the household is expected to be less likely to use kerosene or cooking gas.

Table 7. Reasons for preference of energy source

Energy type	Reasons	Frequency	Percentage
Firewood	Easily available	21	17.5
	Faster	19	15.8
	Cheap	34	28.3
	Neat	3	2.5
Kerosene	Easily available	61	50.8
	Faster	42	35.0
	Cheap	21	17.5
	Neat	19	15.8
Charcoal	Easily available	36	30.0
	Faster	21	17.5
	Cheap	43	35.8
	Neat	29	24.1
Electricity	Easily available	10	8.33
	Faster	23	19.1
	Cheap	15	12.5
	Neat	21	17.5
Gas	Easily available	17	14.1
	Faster	66	55.0
	Cheap	13	10.8
	Neat	66	55.0

3.7.4 Income

The estimated coefficients of the income of respondents using charcoal is significant and positive (0.000) at 10% level of probability implying that with everything else held constant, the respondent having higher income is more likely to switch over to modern fuel. This concurs with the theoretical expectation that as household income increases; household demand for modern energy sources will increase. The influence of income on the use of charcoal may be attributed to improved socioeconomic status which drives the household upward on the energy ladder.

3.7.5 Energy cost

Energy cost for respondents using charcoal had a positive coefficient, and significant at 10% alpha level. While Energy cost for respondents using gas had a positive coefficient and significant at 1% alpha level. The implication of this is that, as the cost of energy increases, the probability that the respondents will use charcoal and gas increases.

4. CONCLUSION

Based on the findings of the study, it can be concluded that, majority of the respondents were married and within their active ages. The study also showed that majority of the respondents had tertiary education and are middle income earners even though they are business men and civil servants. The most widely used energy type for cooking in the study area is kerosene followed by charcoal. However, majority of household heads indicated willingness to switch to higher energy types like gas and electricity with increase in income. The estimate of multinomial regressions showed that coefficient of marital status, educational status, occupation, income, and energy cost were the most significant factors influencing the choice of cooking energy among the households.

5. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. The study found that the most used fuels were kerosene, charcoal and firewood in that order, it is important for government and energy stakeholders to come up with strategies to reduce overreliance of households on the use of hard fuel such as firewood and charcoal as sources of fuel since their impact on environmental degradation and health is insurmountable. Further, the reliance on use of kerosene also poses health problems and should be discouraged. Alternative and clean energy sources especially the use of liquefied petroleum gas (LPG) should be encouraged.
2. The government should create an enabling environment for development of infrastructures necessary for production of bio fuels for household use. This will ensure the economic utilisation of the biomass resources that abound in the area, rather than the present inefficient use of unprocessed biomass. To this end, government should seek the partnership and expertise of relevant energy research institutes in the country for the production of methanol fuel and biogas fuel to be initially subsidised to users and eventually to be deregulated and taken up by commercial interests
3. The positive effect of income on cleaner fuel like kerosene, electricity and gas in the energy ladder relative to solid fuel such as firewood in the lower energy ladder calls for government and other stakeholders to promote interventions that will enable low income earner to use higher-quality, lower-emission liquid or gaseous fuels. The price of gas needs to be subsidised so that both low and high-income earners in the study area can afford and use it.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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