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Determinants of Household Energy Utilization and Changing Behaviour in Kenya: Structural Equation Modelling Approach

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ABSTRACT

Knowing the determinants of household utilization and changing behaviour is an important element in understanding the pathways towards clean, sustainable and modern household energy sources. This study, therefore, examines the drivers of household energy usage and choices in Western Kenya using structural equation modelling from 560 sampled households. The research was carried out in Western Kenya (Uasin Gishu and Bungoma counties) from a target household of 663,000. Data was collected using a structured questionnaire and were analyzed to find standard estimate (path coefficients), standard error, critical ratios and the level of significance using AMOS version 23. SEM analysis found that education level, income, residential status, peri urbanization, house size, house composition, age and gender of the household head were the determinants of household energy choices and changing behaviour among households both for cooking. On the other hand, SEM showed that household energy choices for lighting are significantly influenced by income level, family size, location, education level, and residential status. High income and more educated households residing in peri-urban were more likely to use cleaner cooking (LPG, electricity) while lesser households living in rural areas use firewood and agricultural residues for cooking. Rural households mostly adopt solar energy for domestic use because rural areas are isolated and detached from the power grid. Though income and education are the major factors, the research finds that numerous non-income factors similarly play a key role in determining household energy utilization and changing behaviour. This study offers the understanding of improving household energy planning and designing policy and interventions in Kenya and sub-Saharan African countries.

Keywords: Choices, determinants, household, SEM.

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I. INTRODUCTION

Household energy utilization and changing behaviour has been considered by numerous researchers and is now recognized as a vital tragedy for human society owing to its growing prevalence. Yet the understanding of determinants of household energy utilization remains unclear [1], [2]. Worldwide, about 2.5-3 billion people still use biomass as household energy sources and this is associated with 1.2 million premature deaths per year, a figure comparable with the consequences of malaria [3]. In Africa, over 640 million people are predicted to depend on biomass for cooking by 2040 [4]. Furthermore, household indoor air pollution due to traditional fuels is estimated to cause 9.8 million premature deaths by the year 2030. In sub-Saharan Africa, most households still rely on biomass-based fuels for cooking and the number is expected to rise [5]. In Kenya context, over 80% of the total population still use biomass (firewood, charcoal) as the main fuel source for cooking. Also, there is reliance of kerosene as primary energy sources for lighting especially in rural where approximately 80% of Kenya's population lives [6], [7]. It is further estimated that the use of polluting traditional fuels causes about 16 600 premature deaths every year, of which 4900 are children [6]. Therefore, there is need to understand the transition pathways towards clean, sustainable, and modern household energy sources which reduces the health, environmental consequences [8] and improve the energy security.

Previous studies on household energy utilization and changing behaviour reveals different views on how households change towards the use of clean and advanced energies as income rises [9]-[12]. One theory supports the energy ladder thought, i.e., termination of the use of traditional fuels and adoption of cleaner and modern fuels such as electricity and liquefied petroleum gas (LPG); e.g., [11], [13]. The other theory sticks to the energy (or fuel) stacking concept of simultaneous use of diverse kinds of household energies, i.e., continued use (of traditional fuels and gradual adoption of cleaner and modern ones [14]-[17]. However, the drivers of fuel utilization and choices has not been carefully examined in Africa [18], [19] and especially Kenya [20]-[23]. Therefore, there is need to undertake study on determinants of household energy utilization in order to understand the contributing factor that can improve the shift towards clean and modern fuels in the contexts of developing countries and Kenya in particular.

Analyzing the determinants of household energy utilization and changing behaviour with the help of SEM may be useful, as it describes simultaneous examination of the effects which are relevant and allows for the investigation of more varied and complex research [24], [25]. The model approach intends to describe household energy transition pathways for sustainable energy with the aim of identifying the knowledge gaps regarding the factors that drive the energy transition. The structural equation model (SEM) will help to explore future transitions and what might enable or inhibit them; to design and evaluate transition pathways towards modern energy sources and infrastructure for sustainable energy: and modelling assessments to expand our understanding.

II. Materials and Methods

A. Study Areas and Sampling

Submit your manuscript electronically for review. This study was undertaken in two counties i.e., Bungoma and Uasin Gishu. Bungoma consist of nine constituencies, forty-five county ward assemblies and eighty-five locations. The county has a population of 1,670,570 persons as per 2019 census with a density of 552 persons per square kilometer and an average household 4.6 persons. In addition, Bungoma also has 812,146 are males 858,389 females and an area of 2,069 km. Uasin Gishu consists of six constituencies occupies an area of 3,345 Km^2 with a population of 1,163,186 people and 304,943 households. The County's headquarters is Eldoret town that boasts of population taking just over 32% (of the county's population [26].

The study targeted a total number of about 663,000 households in Uasin Gishu and Bungoma counties. The stratified random sampling technique was used to select a sample of 560 rural and peri-urban households in total as also described earlier paper [27]. The suitable sample size was determined according to [28] formula for as follows:

$$S = \frac{NP(1-P)}{(B/C)^2 (N-1) + P(1-P)} \quad (1)$$

where
S = Lowest required sample size (384);
N = the population size (N= 663,000);
P = the population proportion expected to answer in a particular way (the greatest conservative ratio is 0.50);
B = the degree of accuracy expressed as a ratio (0.05); and
C = the Z statistic value based on the confidence level (in this instance, 1.96 is chosen for the 95 per cent confidence level. The calculated least population size was 384. Though, for purpose of this research, 560 samples were used.

B. Data Collection

Data on household energy utilization behavior was collected by means of a household survey, using a structured questionnaire. Similarly, focus group discussions were conducted to offer supplementary background information on household energy utilization. The surveys included the collection of data on household energy usage, household characteristics (such as household size, sex, gender of household head, average monthly income), location (either peri urban or rural), household composition. Table I present the statistics on household characteristics across the study locations, showing the description of explanatory variables used to find the drivers of household energy utilization for cooking and lighting.

C. Data Analysis and Modelling

Data analysis were done using both the statistical program for social sciences (SPSS version 23.0) and structural equation modeling (SEM) technique using AMOS (23.0). Path analysis presently called SEM was used to measure the relationships among various variables. SEM was used to investigate the factors determining the households' energy utilization. The AMOS 23.0 software package was employed to study SEM. Five procedural steps in SEM were used: model specification, identification, parameter estimation, model assessment, and model modification. Model specification defined the hypothesized relationships among the variables in SEM based on the objectives while model identification was used to check if the model was recognized. Model path coefficients were found in the just identified or over-identified model.

Model evaluation was employed to measure the model fitness with measurable indices calculated for the overall goodness of fit. During the whole procedure, modification was done to adjust the model to increase model fit, i.e., the post hoc model modification. The SEM assessment was based on the fit indices for evaluating a single path coefficient (i.e., p value, standard error and critical ratio) and the overall fit model [29]- [31]. The goodness-of-fit index (GFI) [32], [33], the modified goodness-of-fit index (AGFI), parsimony-adjusted normed fit index (PNFI) [34], root mean square error (RMSE) [20], and parsimony-adjusted Comparative fit index (PCFI) are among the model fitness parameters [35]. With critical ratio (CR) values larger than 1.96 or less than -1.96 and a smaller standard error with significance at the $p \leq 0.05$ value, the CR is also extensively recommended basis for evaluating statistical significance of SEM technique.

III. Results and Discussion

A. Determinants of Household Energy for Cooking

The SEM showed that household energy choices are influenced by income, education level, peri urbanization, household size, residential status, gender, and age of the household head. For the overall structural model, the goodness-of fit indices were computed and presented in Table II. As can be seen the values of model fit indices (CMIN/df = 2.53, CFI = 0.994, TLI = 0.938, GFI = 0.991, AGFI = 0.938, RFI = 0.902, NFI = 0.990 and RMSEA = 0.052) exceed the threshold value, indicating that the model fitted the data absolutely fine [36]-[40]. The structural model was validated to test SEM model reliability.

TABLE I: DESCRIPTION OF EXPLANATORY VARIABLES

Explanatory variable	Description	Expected sign for household energy
Location	Location of dwellers; 1 = rural, 2= peri urban	-/+
Age HH	Age of the household head; 1= 0-18, 2= 19-30, = 31-50 and 4 = 51 and above	-/+
Gender HH	Gender of the household head; 1= Male and 2= female	-
Marital status	1= Single and 2 = married	+
Sex	Sex of the respondent; 1= Male and 2= female	-/+
Household size	Number of persons in the households	-
Household composition	Children under 5 years	-
	Youth 6-14 years	+
	Female 15-50 years	+
	Male 15-50 years	+
	Female over 50 years	+
	Male over 50 years	-
Education level	Education level of the household head: 1 = primary level and below; 2= secondary; 3 = tertiary; 4= masters and above	+
Income	Average income of the household head	+
Cars	Number of cars	+
Residential status	II. = owned dwelling, 2 = rentership ownership	+

The computed R2 values which is a measure of the degree of variation in the dependent variable illustrated by independent variables were found to be 0.422 (Charcoal), 0.441 (LPG) and 0.578 (firewood) which all exceeds the threshold assessment of 0.35 as stated by [41] and [42].The results on the determinants of household energy utilization and changing behaviour for cooking found the major drivers that cause gradual change from dependency on dirty fuels to modern and clean energy sources are majorly; household income (for electricity; $\beta = 0.423$, S.E = 0.000, C.R = 10.22) and educational levels (for LPG; $\beta = 0.403$, S.E = 0.046, C.R = 11.457). This result corresponds with research by [15], [43]-[46].

1) Income Level

The results presented in Table II show that income is positively and substantially associated with the use of electricity and charcoal for cooking while it is negatively associated with the use of kerosene at 1% significant level.

Income is also positively but not significant with the use of firewood and agricultural residues. Household income also shows the lowest S.E. value, 0.00 which means it has the strongest ability to predict the use of electricity, LPG, charcoal and kerosene in households. It is further shown that the C.R. value between household income and electricity, LPG and charcoal are out of ± 1.96 ranges and therefore, these three variables are significant to income. The results suggest that higher income encourages a lower probability that households choose low quality fuels as their main cooking fuel rather than other fuel types but a higher probability of choosing LPG and electricity over traditional fuels. This indicates that income level is positively associated with the utilization of modern fuels and further explains why household's choice of LPG is sensitive to household income.

The results support economic theory which states that "households consume more of the same goods and shift towards higher quality goods as household income increases". Higher quality fuels are those that have more economic benefit per joule of energy content by being converted more effectively, being more versatile or easy to use, and by generating fewer emissions [47]. It is expected that lower income households are capable of tolerating the discomfort and emissions generated by the use of lower-quality fuels for energy services production. Therefore, as household income increases, by consuming higher-quality fuels and more total energy, it would be expected households gradually ascend an "energy ladder." The findings concur with results from other researchers [15], [48].

2) Location

The results on location (1= rural and 2 = Peri urban) showed positively and significant relationship between the use of LPG and charcoal and while a negative association with the use of agricultural residues and electricity in peri-urban and vice versa for rural. The use of kerosene showed positive association with peri-urban while firewood reveals positive association with rural areas though not significant.

The findings advocate that there is a change towards LPG and charcoal use in cooking as one transfers from the rural to peri-urban which supports the research done by [10] and [49]. The outcomes are in line with the household energy studies previously done in developing world which confirm an increase in charcoal consumption with rising urbanization levels [50]-[53]. According to [54] living in larger cities or metros also increases the probability of choosing cleaner fuels, as does having more LPG distributors and hence easier accessibility suggesting that there are differences in the choice behavior of households living in different regions of the country. The results are in line with the findings by [47] who found out that peri urban amenities were main drivers for changing household fuel usage [55] while peri urban and rural dwellers choose LPG and conventional fuels (such as firewood), respectively. The outcome suggests that the use of LPG, kerosene and charcoal is significantly higher in peri-urban as compared to rural households while firewood and agricultural waste utilization is lesser in peri-urban compared to rural areas. Moreover, it is observed that rural households collect biomass for cooking mainly from the wild/farms and do not participate in market exchange.

These results concur with findings by [56] who established that peri urban households are dominated by the fossil- based energy sources in terms of energy arrangement, while rural households are dominated by both biomass – fossil based fuels due to a clear difference in energy usage per capita between peri urban and rural. Hence, [56] indicate that rural household emissions are significantly greater than those of peri urban households.

TABLE II: STANDARDIZED REGRESSION WEIGHTS RESULTS FOR HOUSEHOLD ENERGY DRIVERS FOR COOKING

Relationship between variables			Standardized Estimate (β)	S.E.	C.R.	P-Value
Firewood	<---	Household size	0.123	0.012	4.011	***
Electricity	<---	Household size	0.039	0.004	0.942	0.346
Charcoal	<---	Gender HH	0.063	0.095	1.885	0.05**
Firewood	<---	Gender HH	0.046	0.077	1.610	0.107
LPG	<---	Gender HH	0-.031	0.085	-.940	0.347
Electricity	<---	Gender HH	- 0.041	0.024	-1.080	0.280
Charcoal	<---	Age HH	-0.034	0.050	-.966	0.334
Firewood	<---	Age HH	0.144	0.041	4.768	***
LPG	<---	Age HH	0.042	0.045	1.197	0.231
Electricity	<---	Age HH	0.048	0.013	1.204	0.229
Charcoal	<---	Education level	0.272	0.051	7.607	***
Firewood	<---	Education level	-.0091	0.041	-2.966	***
LPG	<---	Education level	0.403	0.046	11.457	***
Electricity	<---	Education level	0.130	0.013	3.187	0.00***
Charcoal	<---	Income	0.090	0.000	2.489	0.01**
Firewood	<---	Income	0.030	0.000	0.952	0.341
LPG	<---	Income	0.330	0.000	9.229	***
Electricity	<---	Income	0.423	0.000	10.221	***
Charcoal	<---	Residence status	0.522	0.086	15.656	***
Firewood	<---	Residence status	-0.684	0.070	-24.032	***
LPG	<---	Residence status	0.234	0.077	7.147	***
Electricity	<---	Residence status	0.022	0.021	0.591	0.555
Agricultural residues	<---	Gender of HH	0.090	0.070	2.353	0.019**
Agricultural residues	<---	Age of HH	-0.043	0.037	-1.083	0.279
Agricultural residues	<---	Education level	-0.510	0.037	-12.551	***
Agricultural residues	<---	Income	0.067	0.000	1.632	0.103
Kerosene	<---	Household size	-0.022	0.013	-0.519	0.604
Kerosene	<---	Gender of HH	-0.042	0.082	-1.066	0.286
Kerosene	<---	Age of HH	0.043	0.044	1.028	0.304
Kerosene	<---	Education level	0.041	0.044	0.968	0.333
Kerosene	<---	Income	-0.133	0.000	-3.121	***
Kerosene	<---	Residence status	0.439	0.075	11.230	***
Charcoal	<---	Peri-urban - rural	0.102	0.080	3.063	0.002***
Firewood	<---	Peri-urban - rural	-0.044	0.065	-1.569	0.117
Agricultural residues	<---	Peri-urban - rural	-0.178	0.059	- 4.726	***
LPG	<---	Peri-urban - rural	0.077	0.072	2.358	0.018**
Electricity	<---	Peri-urban - rural	-0.077	0.020	-2.049	0.04**
Kerosene	<---	Peri-urban - rural	0.036	0.070	0.937	0.349
Agricultural residues	<---	Household size	-0.001	0.011	-0.019	0.985
LPG	<---	Household size	0.023	0.014	0.640	0.522
Charcoal	<---	Household size	0.020	0.015	0.569	0.570
Agricultural residues	<---	Household size	-0.002	0.063	-0.054	0.957

Model summary: Chi-square = 20.241; Degrees of freedom = 8; Probability level = 0.009; CMIN/DF = 3.53; GFI = 0.995; AGFI= 0.938 and RMSEA= 0.05.

3) Residential Status

Residential status (1= Permanent vs. 2 = rental) is one of the factors that often has a direct and significant influence on households' housing choice and changing behaviour. The findings in Table 1 shows positive and significant association between renter ship and the use of charcoal; and LPG while on the other hand negative relationship with the use of firewood at 1% statistical significance level. Electricity showed positive association while agricultural residues publicized negative association with renter ship but no significance. The results support the findings of [57] who studied the effects of the floor material of the house on household energy choices in Bhutan and found that those in rented dwellings tend to use higher fuels (such as kerosene and LPG) because they are compact and will not require large space for storage, since the rented houses usually do not have sufficient space for fuel storage. The results also are in agreement with findings of [58].

4) Household Head Gender

The female-headed households are positively associated with charcoal and agricultural residues at 5% significance level. In addition, female-headed households are positively associated with firewood and negatively associated with kerosene, LPG, and electricity with no significance, indicating that the male household head in the study area tends to give more emphasis to clean energy sources such as electricity and LPG. Most women during interview said they are not able to cook certain traditional dishes such as ugali and githeri with LPG because the food cooked with LPG was less delicious. Others still used primarily LPG because of the smoke reductions and reduction in cooking time. This research evidence is supported by [59]-[61], who observe that the effect of gender of the household's head is insignificant in some contexts. Link, [62] showed that households in Nepal are encouraged by large proportions of female members to use firewood. This is due to women being the primary fuel wood gatherers. Reference [63], on the other hand, found that significant proportions of females in Guatemala do not affect the use of firewood. In addition, [64] found an association of a large female share of the earned income family with a low likelihood of using firewood in urban Bolivia.

5) Education Level

The results on Table II showed that education level is positively and statistically significant with the use of LPG, charcoal, and electricity at 1% significance level while, it is negative and statistically significant with the use of firewood, and agricultural residues for cooking at 1% significance level. The results also showed that education level is positively associated with the use of kerosene though not significant. Growing education level may increase awareness regarding negative externalities of using solid fuel for cooking and therefore higher education can positively influence the LPG transition as explained by [60] and [65]. These results corroborate the findings by [54], whereby it was established that with the household head being uneducated or only having primary education increases the probability of selecting firewood or kerosene as a cooking fuel, whereas those households where the head has a higher level of education are more likely to use LPG. The structural equation model suggests that households with an educated head and spouse tend to choose cleaner energy because of the convenience of use, health benefits and the opportunity cost of their labor. Educated respondents were more likely to pick cleaner fuels, which is consistent with [66] findings. The results are similar to those reported in India by [67], whereby it was found that household head education increases the interest of a household in choosing a clean and efficient energy source such as LPG. The results also agree with [68] findings in rural China, who observed that more educated households are more inclined to choose clean cooking fuels and less inclined to use firewood and agricultural residue.

Furthermore, the results concur with those reported by [69] in India who found that the probability of electricity use is 8.5 % lower if the man in the household is uneducated than if the man has a primary education, whereas a man having a secondary or higher education increases the probability by 7.7 %. The opportunity costs of fuel collection time, seen as increasing with education, may explain some of the observed results. Likewise, more education generally implies a higher income. It may thus be that the estimated education effect is partly an ill-observed income effect, which is consistent with typical rankings of fuels according to necessities and luxuries.

Household Size and Composition: The results in Table I showed that household size is positive and statistically significant with the use of firewood at 1% significance level for cooking while on the other hand it is negatively associated with the use of agricultural residue and kerosene though not significant. The results further show that household size is positively associated with the use of LPG, charcoal and electricity though insignificantly.

In addition, household size showed positive relation between children under 5 years with firewood, agricultural residues and kerosene while negatively associated with charcoal, LPG, and electricity. Moreover, a positive relation between youth5-14 years with firewood and charcoal while negatively associated with electricity, LPG, kerosene and agricultural residues was observed. The negative affiliation between youth and electricity use is a reason of concern as this can affect children under the age of 15 years of education and overall development.

The results further show a positive relation between female aged 15-50 years with firewood, electricity, kerosene, and agricultural residues while negatively associated with LPG and charcoal. On the other hand, positive relation exists between male aged 15-50 years with firewood and electricity while negatively associated with LPG, charcoal, kerosene and agricultural residue. There is also a positive relation between adult female above 50 years with firewood, electricity and kerosene while negatively associated with LPG, charcoal and agricultural residue. On the other hand, positive relation exists between adult male aged 50 years with firewood, charcoal, agricultural residue, and LPG while negatively associated with electricity and kerosene.

Interestingly, all groups of household composition within the family residing in rural areas are positively associated with the choice of firewood by a household, indicating that all rural household members are more likely to choose dirty and traditional fuels such as firewood. Elsewhere, the results of the studies by [55], [61], [67], [70]-[72] indicate that larger households prefer dirty fuels to clean fuels. One possible reason for this could be that the household size is often larger in poorer households that cannot afford modern fuels. Also, households in rural developing countries tend to use children as labor to gather firewood and cow dung; hence, firewood is positively associated with the choice of energy source. In addition, large households are often used to indicate more labour, which might decrease the cost of collecting solid fuels [63]. On the contrary, a large size of a household may not indicate more labour, but rather more income, which increases the use of clean and modern fuels. The findings herein correspond with those by [58] whereby it was established that household size is negatively related to kerosene consumption indicating that when the number of people in a family increase, the quantity of food to be cooked also increase, making kerosene consumption uneconomical.

6) Age of Household Head

The SEM results in Table II showed that age of HH is positive and statistically significant with the use of firewood at 1% significance level for cooking while on the other hand it is negatively associated with the use of charcoal and agricultural residue though not significant. The results further show that age of HH is positively associated with the use of LPG, kerosene and electricity though not significant. In contrast to younger heads of households, older heads of households are likely to be resistant to modern fuel developments and cling to traditional energy sources as a matter of habit. According to [1] the age-energy utilization profiles showed a higher level of energy consumption of firewood in the cold region. Research results are in line with findings from [17], [48], [73] and [74]. This observation is in consistent with previous research, becomes especially clear as age increases there is need for warmed.

B. Determinants of Household Energy for Lighting

Table III presents the results of SEM estimation on the determinants of household choice of energy sources for lighting. According to the SEM model the household energy utilization and changing behaviours are influence by income level, education level, peri urbanization, household size, residential status, gender and age of the household heads as shown in Table III.

1) Education

The SEM results showed that education is positively and statistically significant with the use of electricity at 1%significance level indicating that as the level of education of household heads increases, the percentage of household's dependent on electricity. Conversely, education level is negatively and statistically significant with the use of kerosene at 1% significance level indicating that the proportion of households using kerosene for lighting decreases with the increase in the level of education. Utilization of solid fuels for lighting among the households in rural areas with lower levels of education was noted demonstrating that education plays an important role in a household's choice of energy sources for lighting. The moral of the argument is that education can or is correlated with raising household income, thus increasing household disposable income. The results also show a positive association exists between education level and solar use for lighting though not significant. The result concurs with the research done by [75], who found that the level of education of the household head and household wealth play major roles in the choice of solar energy. According to [10], highly educated people prefer clean and modern energy such as electricity fuels compared with their less-educated counterparts. In our case, education level of the household head is negatively associated with the likelihood of selecting kerosene as compared to electricity. It was further; found that the access to electricity makes the use of all other available sources of energy significantly unlikely. This result supports the research done by [10] and [76]. The results of education confirm that household heads with a higher level of education, wealthy households, and rural households are more likely to use solar energy. The finding proves that with the increase in level of education, purchasing power and awareness level also improves and preference for cleaner and more efficient energy increases.

2) Income

The results presented in Table III show that income is positively associated with the use of electricity and solar for lighting though with no significance while it is negatively and statistically significant with the use of kerosene for lighting at 1% significance level. According to [77], household income is among the principal factor that influences the choice and use of certain forms of energy resource in households. The coefficients of the proxy for household income are negative for kerosene implying that with an increase in income, households are less likely to use kerosene relative to electricity which is the source of better-quality energy given available options. These results are in conformity with the [78] and [79] who found that income level and the availability of electricity have positive impacts on the probability of electricity adoption.

3) Household Size

The results in Table III show that household size is positively associated with the use of kerosene and solar for lighting though not significant while household size is negatively and statistically significant with electricity at 10% significance level. These results suggest that household size have negative effect on electricity use for lighting. As far as the household size is concerned, the probability of using solar and kerosene increases compared to electricity as the size of the household increases. However, households with higher proportions of dependent members are more likely to use kerosene than electricity. Larger households could also exert a heavier burden of dependence on the insufficient family resource to extend that there are hardly any savings available for investment in electricity. Under such circumstances, larger household size would negatively influence the decision to adopt electricity.

4) Age of Household Head

Table III also shows how age of a household head influences the choice of fuel for lighting. As can be seen the age of household head is positively associated with the use of kerosene for lighting while on the other hand age of household head is negatively associated with electricity and solar for lighting with no significance. Age of the household head showed negative relationship with the use of electricity and solar which concur with literature that older heads of households are most resistant to new fuel technologies and cling to traditional fuels as a matter of habit compared to younger heads of households [73], [80]. The findings are in line with [79] who found that age of the household head and the availability of electricity have positive impacts on the probability of electricity adoption.

5) Gender of Household Head

Table III further shows how gender of a household head influences the choice of fuel for lighting. The results show that female household head is positively associated with the use of electricity, solar and kerosene for lighting though no significant. The results contradict the results by [75] who indicated that male-headed households are more likely to adopt solar energy compared to female-headed households.

6) Location

The study results in Table III shows that peri urbanization is positively associated with electricity use and on the other hand it is negatively associated with kerosene use for lighting. This can be due to a lack of access to electricity by rural households forcing them to use solar energy for lighting. The results indicate that rural households are more likely to adopt solar energy for domestic use because rural areas are isolated and disconnected from the power grid. The results concur with [79] who found that urban location and the availability of electricity have positive impacts on the probability of electricity uptake.

TABLE III: DETERMINANTS OF HOUSEHOLD ENERGY FOR LIGHTING

Relations between variables			S. Estimate (*β*)	S.E.	C.R.	P-value
Solar	<---	Household size	0.060	0.019	1.299	0.194
Solar	<---	Gender head	0.050	0.117	1.141	0.254
Electricity	<---	Education level	0.131	0.081	2.865	0.004***
Solar	<---	Education level	0.046	0.062	1.002	0.316
Electricity	<---	Income	0.075	0.000	1.604	0.109
Solar	<---	Residence status	-0.137	0.103	-3.244	0.001***
Kerosene	<---	Gender head	0.027	0.099	.624	0.533
Kerosene	<---	Education level	-0.128	0.053	-2.768	0.006***
Kerosene	<---	Income	-0.104	0.000	-2.224	0.026**
Electricity	<---	Rural – peri urban	-0.010	0.123	-0.235	0.814
Kerosene	<---	Rural – peri urban	0.011	0.083	0.265	0.791
Kerosene	<---	Household size	0.034	0.016	0.745	0.456
Electricity	<---	Household size	-0.079	0.024	-1.739	0.082*
Kerosene	<---	Residence status	-0.001	0.089	-0.024	0.981
Electricity	<---	Gender head	0.021	0.152	0.494	0.621
Solar	<---	Income	0.009	0.000	0.188	0.851
Electricity	<---	Age head	-0.024	0.080	-0.544	0.586
Solar	<---	Age head	-0.066	0.061	-1.460	0.144
Kerosene	<---	Age head	0.042	0.052	0.931	0.352
Electricity	<---	Residence status	0.087	0.136	2.064	0.039**

Model Summary: Chi-square = 17.644; Degrees of freedom = 4; Probability level = 0.001; CMIN/DF = 4.4116; GFI = 0.994; AGFI= 0.915; NFI = 0.970; CFI = 0.975; IFI = 0.977; FMIN = 0.032 and RMSEA= 0.078

7) *Residence Status*

Table III furthermore shows how residence status of a household head influences the choice of fuel for lighting.

The results show that rentership is positively and statistically significant with electricity use for lighting at 5% significance level while on the other hand rentership is negatively and statistically significant with the use of solar for lighting 1% significance level. Further, the results show that rentership is negatively associated with kerosene use though not significant. This could be explained by the fact that rented dwellings tend to use electricity for lighting because it is compact and do not require space for storage. The rented buildings usually do not have sufficient space for fuel storage and more so, the landlords may restrict fuel use to a range of fuels to safeguard their properties. The results agree with the findings by [58] who observes that while those in owned dwellings have more freedom to use cheaper, lower fuels, they have no restrictions by way of rules to install solar structures on rooftops.

IV. CONCLUSION

The study demonstrates majorly that with the increase in household income and level of education, households opt for modern, clean, household cooking energy sources. The SEM technique adopted in this study revealed that it is feasible to obtain an improved understanding of which drivers have influence when trying to untangle the household energy utilization quagmire. The study offers a different view to help design future household energy policies and further attempts to expand knowledge on household energy choices.

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CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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