Household Energy Utilization Trends in Kenya: Effects of Peri Urbanization

Stephen K. Kimutai and Stephen M. Talai

ABSTRACT

Household energy utilization trends have been argued to be affected by the rate of urbanization. Therefore, due to lack of information there is need to understand the effects of peri urbanization. The main objective of this research was to investigate household energy utilization trends and the effects of peri urbanization on household energy utilization and changing behaviour. The research was carried out in the counties of Bungoma and Uasin-Gishu of Kenya. Random sampling technique was used to select 560 households from a target household of 663,739 and data was collected using a structured questionnaire. The results showed that firewood is still the most common energy resource used for cooking in both rural and peri urban areas as evidenced by responses of 87.5% and 72.4%, respectively. The use of LPG (26 to 42%), charcoal (39.4% to 53.8%) and kerosene (14.3% to 17.3%) for cooking were found to increase as one move from rural to peri-urban and vice versa for agricultural residues (12.3% to 5.3%). Biogas uptake still represents a small fraction (11.4 to 14.6%) of the energy mix at local level. The use of solar for lighting showed reduction as one move from rural to peri urban (44.8% to 39.6%) and vice versa for kerosene (68.4% to 72%) and electricity (55.5% to 58.2%). In conclusion, this study showed that household energy utilization and changing behaviour in Kenya are affected by peri urbanization among others. This study offers understandings in enhancing household energy policy making in Kenya.

Keywords: Household, fuel, peri-urbanization, rural, cooking and lighting.

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I. INTRODUCTION

A growing portion of Africa's population is expected to live in cities and towns by 2030. Whereas urban areas comprise 472 million people at present, it is expected that this number will double over the next 25 years as more people will be pushed out of rural areas [1]. Interestingly, the rate of urbanization is projected to increase from 41% in 2016 to 51% in 2040 [1], [2]. It is likely to be accompanied by a rise in appliance and vehicle use and increased demand for modern household energy use, including energy-intensive products such as Liquefied Petroleum Gas (LPG) and electricity [3]-[5]. However, lack of access to electricity may form a major barrier to urban development and Africa's economic development in general.

Electricity access is the lowest in Sub-Saharan Africa, both in urban and rural areas, with rates at 58% and 12% respectively [5]-[8]. Households in cities and surrounding rural areas differ in energy use and supply needs.

Whereas urban dwellers use relatively less firewood compared to their rural neighbors, they typically employ more charcoal which is usually cheap and readily available. Various energy studies on Sub-Saharan Africa confirm an increase in charcoal consumption with rising urbanization levels [9]-[12].

Literature on the effect of peri urbanization on household energy utilization and changing behaviour is still scarce. Many

scholars have paid special attentions to the relationship between socio economic factors such as income and energy consumption, hence there is need to understand the role and effects of peri urbanization on household energy utilization and changing behaviour. A better understanding of the different factors that affect the household energy utilization will help to design interventions by both Governmental and Non-Governmental organizations working on energy and energy related issues [13]. This study contributes to the limited but growing empirical evidence of household energy factors affecting the utilization of household energy sources.

According to the theoretical explorations, urbanization and industrialization exert impact on energy problems in two main ways: First, the construction and use of abundant infrastructures, buildings, and security during urbanization increase energy consumption and have a negative impact on climate change. Secondly, the economies of scale for energy supply and concentrated use of energy consumption caused by population agglomeration and urbanization, as well as industrial structure optimization, technological innovation, and updating of consumption brought by industrialization, increase energy utilization, thus affecting the energy utilization and changing behaviour [14].

It is believed that housing development in most peri urban is mostly characterized by a high level of informal development, poor quality housing and confronted with a

multi-dimensional environmental and socio-cultural challenges [15]–[17]. Furthermore, grid electricity is usually available in cities, yet, it is not accessible to all particularly the urban poor (i.e., slums) who mostly live at neglected localities deprived of basic infrastructure [18]. In rural areas, homesteads are often dispersed and consequently, not connected to grid electricity because of high transmission and distribution costs associated with grid extension [19]. The latter is particularly evident in Eastern and Southern Africa where the majority of the rural population resides in dispersed homesteads [20]. As a consequence, rural households resort to conventional energy sources, yet at the same time, rural areas are perceived as the ideal place for deployment of new and innovative electrification technologies such as those based on solar energy [20].

Peri urbanization is an important factor that affects the pattern of energy consumed in developing countries especially Kenya [18], [21]. Kenya's current urbanization rate of 27.8 % [1] and it is estimated that nearly half (44%) of the entire population of Kenya will be urban by the year 2050 [22]. It is believed that as a given area becomes urbanized or per urbanized, the level of household energy utilization also changes. This research was carried out in the counties of Bungoma and Uasin Gishu, both located in Kenya's semi-humid region, with the selection of both counties under the guidance of the A Sustainable Approach Livelihood (ASALI) project and experts at the Kenya Forestry Research Institute (KEFRI) [23]. Therefore, the aim of this paper was to untangle the effect of peri urbanization on household energy utilization and changing behaviour in Kenya.

II. RESEARCH AREA AND METHODS

The study was conducted among rural and peri-urban households in two counties with dissimilar levels of peri urbanization and forest coverage, i.e., Bungoma (percent urban population: 22%; forest cover as percent cover of total county area: 21%) and Uasin Gishu (39%; 11%), in Kenya. Selection of both counties as study area was steered by the following: the ASALI project and experts at the Kenya Forestry Research Institute (KEFRI) and researchers who carried out a baseline survey to identify the regions within the country where critical ecosystem services for human well-being are stressed [24], [25]. Moreover, the level of urbanization and availability of forest resources, using forest area as indicator, served as criteria for site selection.

Bungoma County is situated in Western Kenya; its geographical coordinates are 0° 34' 0" North, 34° 34' 0" East. It covers an area of 3,032.2 km². According to the 2019 Kenya Population and Housing Census the population is 1,670,570 and has 358,796 households (KNBS, 2019). On the other, Uasin Gishu County is situated in the former Rift Valley Province. Its geographical coordinates are 0.5528° N, 35.3027° E shares some rather short borders with Bungoma County to the West. It occupies an area of 3,345 Km² with a population of 1,163,186 people and 304,943 households (KNBS, 2019). The County's headquarters is Eldoret town that boasts of population taking just over 32% of the county's population.

The study targeted a total number of 304,943 and 358,796 households in Uasin Gishu and Bungoma counties respectively (KNBS, 2019). The stratified random sampling technique was used to select a sample of 560 rural and peri-urban households in total. Data on household energy utilization behavior was collected by means of a household survey, using a structured questionnaire. Likewise, focus group discussions with local communities in both counties were conducted to provide additional background information on household fuel utilization.

A. Research Hypothesis

The research question revolved around the difference in household fuel utilization between rural and Peri urban hypothesis within the context of Kenya.

III. RESULTS AND DISCUSSION

A. Trend of Household fuel for Cooking

Fig. 1 presents the percentage of households that use specific kind of household energy source for cooking between peri urban and rural areas in the study area. The proportion of households that use fire wood declines from 87.5 % to 72.4 % as one moves from rural to peri-urban, while the use of charcoal increases from 39.4 % to 53.8% in the same case. On the other hand, the use of LPG and kerosene increases from 26% and 39.4% to 42% and 53.8 %, respectively.

Fig. 1. Household Energy for cooking by households.

The results also show the reduced use of modern fuels such as LPG and charcoal among rural households. This was attributed to the heavy dependence of these households on biomass energy for cooking among rural settlements. The findings are in line with the observation that households in rural areas were observed collecting their firewood rather than purchasing, reflective of the occasional use. In addition, the results showed that although biogas technology uptake is still low as it represents a small fraction of the energy mix at local level. Furthermore, households in peri-urban have significantly higher fuel choices than households in the rural areas with firewood and charcoal are the most common combination of multiple fuel use for both peri urban and rural households. These results are in agreement with the findings of previous studies where firewood was found to be a key source of energy for rural dwellers in developing countries Edwards and Langpap [26], [27]–[31] and Duguma, Atela [32].

Among the rural households, firewood remains the main fuel source signifying that majority households still depend on firewood for their cooking needs. Households using liquid fuels (LPG), charcoal, and kerosene are mostly found in peri-urban areas. Notably, there is a shift towards charcoal, LPG and kerosene as one moves from the rural to peri-urban areas and these findings corroborates the research done by Hanif [11], Wang and Dong [12] and Arnold and Persson [9]. Nonetheless, the experimental evidence in the study is in support of the energy stacking model rather than the energy ladder model – of household fuel utilization which suggests that households do shift to superior fuels but do not abandon the inferior fuels altogether [29], [33]. The results of biogas utilization indicates its low consumption on social-economic and environment development among the local communities which concurs with the research done by Katikiro [34], Ouedraogo [27], Sana, Kafando [35].

Appendix II presents the pairwise correlation coefficients which reveal the relationship between the household energy choices made by the households for cooking. They include; firewood, charcoal, kerosene, LPG, biogas and agricultural residues. For rural, the results revealed a positive and significant association between the use of firewood – agricultural residues (0.103*), LPG – charcoal (0.361***), biogas – LPG (0.144***) and charcoal –biogas (0.189***)) while on the other hand negative and significant association between the use of charcoal – firewood (-0.546), LPG-firewood (-0.095*), firewood – kerosene (-0.335***)) and biogas – firewood (-0.073) among the rural households. The results indicate that the households tend to choose dirty, transitional and modern energy sources in bundles.

On the other hand, the results for peri urban show positive and significant association between the use of firewood – agricultural residues (0.111***), LPG - charcoal(0.289***), and charcoal – kerosene (0.230***), while a negative and significant association between the use of firewood – charcoal (-0.454***), LPG – firewood (-0.448***), LPG- kerosene (-0.038***), firewood – kerosene (-0.364***), LPG-agricultural residues (-0.19**), kerosene – agricultural residues (-0.208**) and biogas –kerosene (-0.207***)) is observed. The peri urban result shows a positive correlation among the low-quality energy source, transitional and clean/modern energy sources and also a negative relationship is observed between low quality energy source, transitional and clean/modern. The results further more show a negative and significant pairwise correlation between firewood – charcoal and LPG – firewood signifying the general reduction of fire wood with peri urbanization.

Moreover, the results on household energy for cooking by households support the fuel stacking energy utilization model than energy ladder in study households which can be presented as shown in Fig. 2.

B. Trend of Household fuel use for Lighting

Fig. 2 presents results on the percentage of households that use a specific type of household energy source for lighting. It showed a reduction tendency of solar use as one move towards peri urban (from 44.8% to 39.6%). However, the use of kerosene (68.4% to 72%) and electricity (55.5% to 58.2%) also increases as households move from rural to peri urban areas. The pattern of energy use for lighting shows that there is a

small difference in the use of kerosene and solar between the rural and peri urban households. The results are in agreement with the findings of Maharaj [36] and [18]. The sampled households with access to the electrical network used a variety of backup lighting sources (such as solar, mobile phone light, candles, and kerosene lamp) to enhance energy security. For instance, in rural areas, it revealed that in addition to solar, kerosene fueled lamps is used for enhancing the energy security. Furthermore, it was found that the solar lantern form of light was common due to the fact that it is faster and easier to turn for sudden need than the more complicated task of lighting a kerosene lamp and it can be used in wind or rain. These results are in agreement with the findings of Munro [37] and [38].

Fig. 2. Sources of household fuel for lighting.

TABLE I: CORRELATION COEFFICIENTS OF THE HOUSEHOLD FUEL SOURCE FOR LIGHTING

Area/ Household energy		Solar	Kerosene	Electricity
Rural	Solar	1.000	0.136**	-0.244***
	Kerosene	0.136**	1.000	-0.520***
	Electricity	-0.244***	-0.520***	1.000
Peri urban	Solar	1.000	.095	0.408***
	Kerosene	0.095	1.000	-0.511**
	Electricity	-0.408***	-0.511***	1.000

***, ** and * indicate significance at the 1% and 5% and 10% levels, respectively.

The pairwise correlation coefficients of the household energy sources result for lighting are shown in Table 1. For rural, the results showed a positive and significant association between the use of solar – kerosene (0.136**) while on the other hand negative and significant association between the use of solar – electricity (-0.244***)) and kerosene - electricity (-0.520***)) implying that the majority of rural households use solar and kerosene as a source of energy for lighting. For peri urban, it was found that there is negative association between solar – electricity (-0.408***)) and kerosene – electricity (-0.511***). The findings indicate that the majority of rural households rely on solar and kerosene while peri urban households majorly depend on electricity and solar as back up. The results are in line with Behera and Ali [39] and [40].

IV. CONCLUSION

In conclusion, regardless of the efforts to encourage the use of biogas in Kenya, their adoption level and use is still low with firewood and charcoal as the most common combination of multiple fuel use for both peri urban and rural households.

This research has demonstrated that in addition to income, education and other household characteristics, peri urbanization showed interesting effects on the household energy utilization and changing behaviour. Since the study considered Bungoma and Uasin Gishu counties of Kenya, the data obtained may not be representative of the real situation in other parts of the country. Therefore, a similar study should be carried out in other areas in Kenya to establish if the same results would be obtained. It is thus recommended that since data were collected from different location with different

demographic factors (such as education, income, and consumers' awareness) which may vary from peri urban to rural areas. Future research work be conducted separately rural and peri urban areas of the counties with a larger sample size.

APPENDIX

Appendix I: Fig. 3

Appendix II: Table II

Fig. 3. Household fuel transition model for the study area.

TABLE II: CORRELATION'S COEFFICIENTS OF HOUSEHOLD ENERGY SOURCES FOR COOKING

Area/Fuel	LPG	Firewood	Charcoal	Kerosene	Biogas	Agricultural Residue
Rural	LPG	1	-0.095*	0.361***	-0.049	0.144***
	Firewood	-0.095	1	-0.546***	-0.335***	-0.073
	Charcoal	0.361***	-0.546***	1	0.240***	0.189***
	Kerosene	-0.049	-0.335***	0.240***	1	0.067
	Biogas	0.144***	-0.073	0.189***	0.067	1
Peri urban	Agricultural Residue	-0.195***	0.103	-0.300***	-0.198***	-0.112**
	LPG	1	-0.448***	0.289***	-0.038	-0.024
	Firewood	-0.448***	1	-0.454***	-0.364***	0.036
	Charcoal	0.289***	-0.454***	1	0.230***	0.106
	Kerosene	-0.038	-0.364**	0.230**	1	-0.207**
Agricultural Residue	Biogas	-0.024	0.036	0.106	-0.207***	1
	Agricultural Residue	-0.190***	0.111*	-0.208***	-0.097	0.041

***, ** and * indicate significance at the 1% and 5% and 10% levels, respectively.

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