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SUSTAINABLE COOKING ENERGY USE AMONG LOW-INCOME URBAN HOUSEHOLDS OF ABEOKUTA METROPOLIS, OGUN STATE NIGERIA

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Abstract

The study examined the types and factors influencing the choice of cooking energy consumed by low-income urban households in the Abeokuta metropolis, Ogun State. The objective is to provide information on the urban poor and the primary factors influencing household energy choice in the study area. A sample frame of 123,657 regular households was obtained from the National Population Commission (2006) for the 36 political wards across five local government areas obtained from the Independent National Electoral Commission. Cochran's (1977) standard formula for sample size determination was used to select 1166 selected households aa s sample on which a structured questionnaire was administered. Responses were analysed using percentage distribution, chi-square and Principal Component Analysis. Results showed that 43.7% of the respondents were in low-income urban areas. Dominant energy types consumed in the study area was electricity (88.5%), gas (5.9%), Kerosene (4.3%), Firewood (0.9%), Charcoal and Coal (0.1%) each. The result also indicated that residents of low-income areas mixed firewood and coal with electricity (43.4%). The dominant factors influencing the choice of energy consumed by households in the area were availability (Factor Score = 0.79), increase in the unit price (Factor Score = 0.65), and types and quantity of meals cooked (Factor Score = 0.65). It concluded that the distribution of household energy consumption in the study area was significantly and positively influenced by economic factors of household budget (r = 0.805), income (r = 0.645) and increase in the unit price of energy type (r = 0.609). Consequently, the study recommended a planned appliance incentive such as the distribution of affordable gas and kerosene stoves, provision of highly subsidised gas cylinders and target awareness campaigns, especially in low-income urban areas, on the use of environmentally clean energy types as a panacea for sustainable energy for all.

Keywords: Low-income urban areas, Dominant energy, Energy mix, Primary factors.

Introduction

Generally, the household sector accounts for 15-25% of primary energy used in developed countries, while this percentage is higher in developing countries. The massive gap in household energy use between developed and developing countries is created, according to (Oleg and Ralph, 2009), by increased energy-based living standards, more efficient energy use by developed countries and contradictory government policies, especially in developing countries which have brought about mixed results.

In most countries of the world, the percentage of energy used by households, according to (Eurostat, 2010), "is about one-third of the total in developed nations". However, this varies from country to country. In the 27 European Union (EU) countries generally, 36% is used by industries, households 31%, the commercial sector 30% and transport 3%. The second largest household sector is used mainly for cooking, water heating, refrigeration, gadgets and appliances, for example, washing machines, cooling food preservation, and even leisure and entertainment. Ekweozoh (2016) observed that Nigeria's electricity consumption per capita is 12Watt/person, which is very low compared to many countries in the World, for example. Brazil 268watts/person, Spain 645 watts/person, and South Korea 1038 watts/person in 2014.

It is estimated by (Bamiro and Ogunjobi, 2015) that approximately 2.5 billion people in developing countries rely on biomass energy to meet cooking needs, while (Mordi, Mcmade, Lallement and Saghir, 2005) noted that around 1.6 billion of this figure have no access to electricity. If new policies are not adopted in many developing countries, this figure may increase to 2.5 billion in 2015 and 2.7 billion by 2030 (about one-third of the world population due to population growth (Bamiro and Ogunjobi, 2015).

International Energy Agency (IEA, 2006) reported that "about half of the urban households in sub-Saharan Africa rely on fuelwood, charcoal and wood waste, i.e. biomass to meet their cooking needs. The problem with this fuel type is the problem of indoor air pollution; hence (IEA, 2006) noted that "because of the availability of alternative energy (which are environmentally-friendly and pollution-free, for example, solar and liquefied petroleum gas), about 1.3 billion people have switched over to other energy types which can easily be purchased in urban centres.

"Access of households, especially to modern, affordable and reliable clean energy services, is a great challenge" (Bowman, Balch and Artaxo, 2009) noted, for instance, that electricity in Nigeria is characterised by frequent power outages, supply of high or low voltages most times are conditions which often have wrecked havocs such as colossal human and material losses in many households.

(Bowman et al., 2009) "Nigeria's national electricity access and per capita consumption is only 48% and 149KWh/person, respectively. This is lower than those of some African countries like Senegal at 56% and 187KWh/person, Cote D'Ivoire at 59.5% and 212KWh/person, Ghana at 72% and 344KWh/person and Morocco at 98.96% and 826KWh/person. Yet all these countries have fewer units of energy resources than Nigeria.

National Bureau of Statistics (2009) estimated that Nigeria's population was 148 million people that year, of which 46.72% of households had access to public electricity. However, this figure excludes homes designated as having access but do not have electricity most of the time due to incessant power outages and hence must rely on alternative sources such as generators. (Bamiro and Ogunjobi, 2015) noted that presently in Nigeria, "public power supply is almost a standby source in many urban areas while consumers have sought more expensive power alternatives, for example, generators and solar inverters." (George, 2016) remarked, "Energy deficit between increasing energy demand and the limited supply is growing". The federal government has failed to significantly improve power generation to meet up with the demand of the increasing population. He further noted that 'the electricity generation and distribution companies (GENCOS and DISCOS) in Nigeria are more interested in profits, rather than bridging the nation's energy supply gap, Nigerian households thus seek alternative sources and ultimately making Nigeria a dumping ground for all sorts of substandard alternative energy sources and appliances from the developed world.

The Energy Ladder Model

This model also called the energy switching or energy transition model, is a central concept valid for a household energy transition which assumes households mimic the behaviour of the utility. Its dominant approach emphasises household income and energy type's cost price. It is the starting point for understanding energy consumption by households; this it does by showing how households will move to more sophisticated and cleaner fuel energy as their economic status improves. It sees the primary constraint to transition to cleaner fuel energy as poor access to modern fuels and the high cost of appliances for using them.

Essentially it involves three steps:

i. Universal reliance on solid fuels, i.e. animal dung, agricultural residue, biomass in wood, saw-dust and charcoal (remnant of burnt wood). These come at little or no economic costs as they can be obtained freely from the environment and used mainly with tripod stones for cooking and heating with high indoor air pollution.

ii. Higher incomes make households graduate to the use of commercial transition fuels, which can be liquid or solid form, i.e. kerosene and coal, whose pollution rates are far less than those of the first category and are available in urban areas and used mainly for cooking, heating, baking, non-electrical ironing (especially coal) etc.

iii. Adoption of cleaner, modern and sophisticated fuel energy, for example. LPG, biofuels, electricity (HEP, solar or thermal), e.t.c, which are used for cooking, heating, cooling, lighting e.t.c while using sophisticated and more expensive equipment. Indoor and outdoor pollution is almost non-existent or very low (Figure 1).

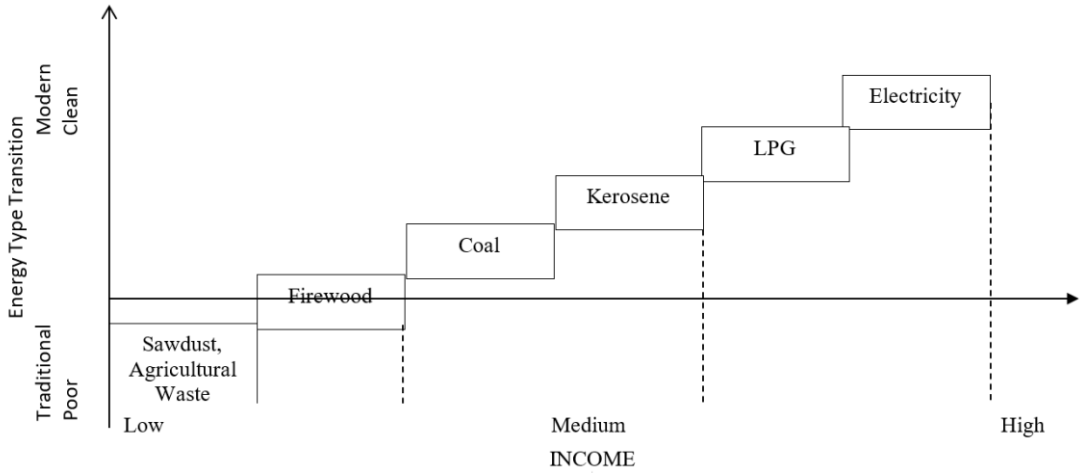

Figure 1.0: Energy Ladder Model
Source: (Rajmohan and Weerahewa, 2005)

Methodology

Secondary data were obtained from statutory and government agencies. Population figures, their projection till the year 2020, territorial and sizes and population density figures, maps of selected Enumeration Areas (EA) as well as the number of households for Abeokuta Metropolis were obtained from the priority tables of the National Population Commission (NPC), as well as from the National Bureau of Statistics. Information on the names and geographical extent of the 36 political wards making up the study area were obtained from the Independent National Electoral Commission (INEC) state office.

Primary data were obtained through a structured household questionnaire, direct observation and two sets of Key Informant Interview (KII) schedules. All heads of households in the 36 wards in Abeokuta Metropolis constituted the sampling frame. The 36 wards comprise six wards in Abeokuta North LGA, 15 wards in Abeokuta South LGA, one ward each in Ewekoro and Obafemi–Owode LGA, and three adjoining wards from Odeda LGA.

The actual sample frame, i.e. the total number of regular households for Abeokuta Metropolis, was 123,657. The sample size was proportionally determined from the sample frame of 123,657 normal households in the Abeokuta metropolis using Cochran's (1977) standard formula for sample size determination. It is statistically expressed as equation 1:

$$n_0 = t^2 \times \frac{S^2}{(d)^2} \quad \ldots\ldots\ldots 1$$

Where n_0 = sample size

t = table value for the acceptable margin of error.

S^2= estimate of variance

d = acceptable margin of error to take

t = value for the above equation = 1.684

d = acceptable margin of error to take = 0.05 at 95% confidence interval

S^2= The estimated variance for a total population of 123,657 regular households in Abeokuta metropolis = 1.029

Applying the sample size formula, 1166 households were obtained as sample size.

This figure represents 0.944% of the total regular households in the study area. This agrees with the assertion of (Neuman, 1994) that "a larger population permits smaller sampling ratios for equally good samples". He further argued that, as population size grows, the returns in accuracy for sample size shrinks". Hence, for a larger population of over 120,000, small sampling ratios (1.0%) are possible. Furthermore, the sample size for this study is supported by the assertion of Singleton and Bruce (1988) that '0.5% is a good proportion for a sample survey of a larger population.

Results and Discussion

Average Cash Income of Household heads per Month

Abeokuta is a civil service-dominated area where respondents' wages or monthly cash incomes are categorised into three broad groups premised on Nigeria's current N30,000 monthly minimum wage. These three broad groups are the low-income group (N30,000 or less), middle-income group (N30,001–N55,000) and high-income group (above N55,000)

per month. General analysis of the average cash income of heads of households revealed that (43.7%) of respondent households are in the low-income category, a further (42.7%) are middle-income earners, while the minority of (13.6%) are in the high-income group, as shown in Table 1. This grouping of monthly incomes of the heads of households energy types and quality consumed by households as established by the Energy Ladder Model and buttressed by Adenikinju (2017), who noted that 'energy quality increases with income over time.

Table 1: Average Cash income of Household heads per Month

Income Group	Frequency	Percent
Low-income	509	43.7
Middle-income	498	42.7
High-income	159	13.6
Total	1166	100.0

Source: Authors Analysis, 2020.

Table 2: Average Cash Income of Household heads per month

Ward	Average Cash income of household heads per month (₦)						Total
	5000-15000 (%)	15001-25000 (%)	25001-35000 (%)	35001-45000 (%)	45001-55000 (%)	Above 55000 (%)	
Elega	0.0	0.0	1.2	2.2	6.9	19.5	3.9
Ibara I	0.0	0.5	2.0	10.3	15.5	15.7	5.5
Ibara II	0.0	0.0	4.9	10.3	6.0	11.9	4.5
Sodeke/Isale-Ijeun I	1.9	2.7	2.8	0.1	0.0	1.3	2.0
Ijaiye/Idiaba	0.0	0.5	1.2	1.5	9.5	2.5	1.9
Obada-Oko	0.0	1.7	2.8	5.9	0.9	1.3	2.1
Adigbe	2.9	0.2	1.2	0.0	2.6	2.5	1.2
Alabata	1.0	1.7	0.8	0.0	2.6	4.4	2.0
Obantoko	2.5	1.0	2.8	2.9	5.2	6.9	3.0
Osiele	4.9	4.7	1.2	1.7	2.6	1.3	1.8
Imala/Idi-Emi	1.0	3.7	1.2	0.7	0.0	0.0	1.7
Erunbe/Oke-Ijeun	0.0	0.5	3.7	5.1	1.7	0.6	1.8
Ake I	23.3	7.4	4.9	5.1	3.4	6.3	7.5
Ake II	1.0	2.5	1.2	0.7	1.7	4.4	2.1
Ake III	5.8	0.5	0.0	2.9	2.6	3.8	1.8
Igbore/Itori/Ago-Oba	10.7	3.5	6.1	4.4	9.5	2.5	5.2
Isaga/Ilewo	0.0	2.7	0.8	0.0	0.0	0.0	1.1
Ikereku	1.9	1.7	0.8	1.5	0.0	0.0	1.1
Ikija	3.9	4.4	2.8	2.2	0.0	0.0	2.7
Isaga/Orile	1.9	2.0	0.8	0.0	0.0	0.0	1.0
Olorunda/Idi-Emi	5.8	3.0	0.0	0.0	0.0	0.0	1.5
Keesi/Emere	0.0	4.9	2.0	4.4	0.9	0.0	2.7
Sodeke/Isale-Ijeun II	0.0	3.7	2.4	4.4	0.9	0.0	2.4
Ijemo	0.0	2.0	6.9	0.0	0.0	0.0	2.1
Ago-Egun/Ago-Ijesa	0.0	8.9	4.5	0.0	0.0	0.0	4.0
Agura	4.9	3.7	3.3	0.7	0.0	0.0	2.5
Ilugun/Iberekodo	5.8	2.5	3.3	1.5	0.0	0.0	2.2
Sabo	0.0	5.4	0.8	3.7	2.6	1.9	3.0
Ago-Oko	0.0	7.2	4.9	0.0	0.0	0.0	3.5
Ago-Ika	6.8	2.5	1.6	0.0	0.0	0.0	1.8
Lafenwa	0.0	2.2	8.9	0.0	2.6	3.8	3.4
Totoro/Sokori	3.9	3.7	2.8	5.1	5.2	3.1	3.8
Ita-Oshin/Olomore	0.0	0.0	2.0	2.9	7.8	3.8	2.1
Oke Ago-Owu	6.8	6.9	3.7	3.7	0.0	0.0	4.2
Imo/Isabo	2.9	2.2	7.7	11.0	9.5	2.5	5.2
Itoko	0.0	3.2	1.6	0.0	0.0	0.0	1.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors Analysis, 2020

Further analysis of spatial variation in the monthly income of heads of household within wards revealed that the majority of low-income wards such as Olorunda/Idi-Emi (100%) complete low-income households, Isaga/Orile (83.3%), Isaga/Ilewo (84.6%), Imala/Idi-emi (80%), Agura (69%), Ikereku (69%), are all in Abeokuta North LGA. However, the Elega ward, with (67.4%) of households in the high-income category and Ikija ward, with a combination of (31.2%) of middle and (68.8%) of low-income earners, are exceptions in Abeokuta North. In Abeokuta south, most of the wards have middle- and high-income group earners, such as Ibara I with (57.8%) middle and (39.1%) high-income households, while Ibara II had (63.5%) middle and (36.5%) high-income households with none in the low-income group.

Wards in the traditional core areas have significant proportions of all income groups, such as Ake I (62.1%) low, (26.4%) middle and (11.5%) high-income households; Ake II had (45.8%) low-, (25%) middle-, and (29.2%) high-income households; Ake III had (38.1%) low, (33.3%) middle and (28.6%) high-income households as shown in Table 2.

On a Local Government Area (LGA) basis, a similar pattern was observed, dominated with highest percentages in 4 LGAs with Abeokuta south (48.3%), Ewekoro (64%), Odeda (45.6%) and Obafemi Owode (42.8%) with the only exception being Abeokuta North where the low-income group dominated with (54.8%) as revealed in figure 2.

Of all the LGAs without exception, the high-income category was the least such as Abeokuta North (11%), Abeokuta south (14.0%), Ewekoro (8.0%), Obafemi – Owode (28.6%) and Odeda (25.3%) as shown in Table 2.

This observation revealed no preclusion of any household in any of the wards or LGAs based on income category; however, in Ibara I, Ibara II, Elega and Ita-Oshin/Olomore where government housing estates-initiated development processes, low-income households are virtually not present.

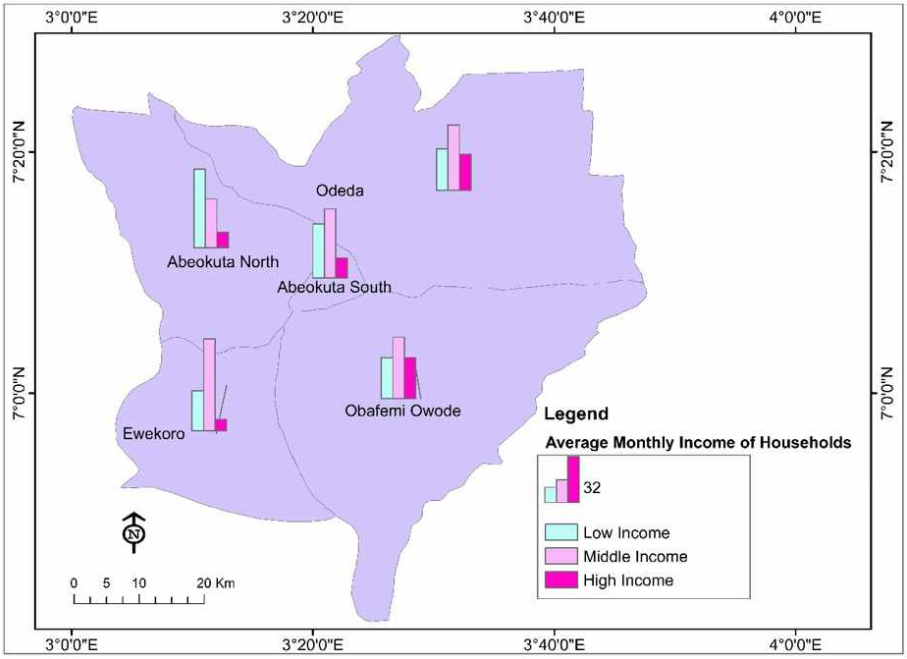

Figure 2: Average Monthly Cash Income of Households

Table 3: Average Monthly Cash Income Group of Household heads by LGA

Monthly Income Group	Local Government Area											
	Abeokuta North		Abeokuta South		Ewekoro		Obafemi Owode		Odeda		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Low-income	254	54.9	221	37.8	6	28.0	4	28.6	23	29.1	509	43.7
Middle-income	158	34.1	282	48.2	16	64.0	6	42.9	36	45.6	498	42.7
High-income	51	11.0	82	14.0	3	8.0	4	28.6	20	25.3	159	13.6
Total	463	100	585	100	25	100	14	100	79	100	1166	100

$X2$ (1166) = 52.005; df = 8; pvalue (0.000<0.05)

Source: Authors Analysis, 2020.

Analysis of variance (ANOVA) was performed with an F value = 15.274 and the significance value of .000. This result is significant at p<0.001. This implies that there are no significant differences in average monthly cash income between the LGAs as well showed that income has a significant direct impact on energy consumption which agreed with the assertion of (Reddy, 2004) that 'energy consumption varies due to increasing of dishes now prepared and the use of various appliances which have resulted from an increase in income'. In conclusion, it can be said that with increasing status and incomes, prices and quantity of fuel energy for household consumption become less of a constraint.

The number of other household members, for example, spouses and mature young adults earning in the family, also contributes to the total household income and thus affects the energy type used in such households. The bulk of other income earners apart from household head showed one person with an overall average of 62%, which in most cases is the spouse if not the head, followed by two persons (24.8%), three persons (6.9%), none earning income (2.6%) which in most cases are infants or teenagers of school age, above four persons (2.5%) and finally four persons exactly (1.2%) as shown in Table 4. A majority (86.8%) have between 1 to 2 persons earning additional incomes in households in the study area.

Table 4: Number of Other Household Members Earning Income

Other household members	Frequency	Percent
0	30	2.6
1	723	62.0
2	289	24.8
3	81	6.9
4	14	1.2
Above 4	29	2.5
Total	**1166**	**100.0**

Source: Authors Analysis, 2020

Based on wards and LGAs, households with a prevalence of one other person earning income in the household are coincidentally the high-income and educationally superior wards of Ibara I (87.5%) and Ibara II (73.1%) in Abeokuta south LGA as well as Ita-oshin/ Olomore (83.3%) and Elega (54.4%) and these are mainly the educated spouses. Other identified wards are the middle-income wards where heads of households were engaged in the public/civil service, private sector or private employment, such as Imo/Isabo (90.2%), Ijemo (100%), Ake II (62.5%) in Abeokuta South LGA; Ilugun/Iberekodo (84.6%), Ago-oko (95.1%), Ago-Ika (85.7%), Agura (79.3%) in Abeokuta North LGA, Alabata (73.9%) and Obantoko (76%) in Odeda LGA. Wards dominated by low-income farmers and traders in the Northwestern part of Abeokuta north have very high percentages as wives, wards and grown-up children assist and engage in agro-allied businesses such as Isaga/Orile (100%), Olorunda/Idi-emi (100%), Imala/Idi-emi (85%) while Ago-Egun/Ago-Ijesa in Abeokuta South LGA also recorded 100% as shown in Table 5.

Finally, the chi-square analysis performed with X^2 value for 1166 respondents = 82.488 at 20 degrees of freedom with the asymptotic significance of (.000<0.05) indicates spatial variation in several other household members earning income is significant at 0.05 selected level of significance. Hence guaranteed income from the household heads and at least one other member per household thus increases total household income, less pressure on the household heads and hence more household income, part of which is expended on household energy consumption. This is corroborated by the findings of (Shittu, Idowu and Ismail, 2004) that "additional income has a positive effect on all fuel energy types because they are income elastic except for firewood which is income inelastic". While switching and stacking household energy for middle and high-income groups, the low-income groups still stick to free firewood collected from open fields and nearby farms to reduce household energy costs while using low-quality traditional energy types.

Relationship between Socio-Economic Characteristics and Types of Energy Used by Households

Public electricity supplied by the Ibadan Electricity Distribution Company (IBEDC) proved to be the most popular energy type used by households for cooking (36.6%), followed respectively by gas (30.2%), kerosene (30.1%), firewood (21.1%) and coal (1.0%) as shown in Table 6.

The use of firewood for cooking is prevalent in the low-income wards of Imala/Idi-emi (65%), Olorunda Idi-emi (77.8%), Isaga/Orile (66.7%), Erunbe/Oke-Ijeun (76.2%) as shown in Table 7.

Estimates of correlation coefficients resulting from correlation analysis using SPSS were used to establish the relationship between the socio-economic attributes of households and the types of energy used. A correlation was used to show us the direction and significance of variables of interest.

Table 5: Number of other Household Members Earning Income

Ward	Number of other household Members earning income						Total
	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	Above 4 (%)	(%)
Elega	13.3	3.5	4.2	1.2	28.6	0.0	3.9
Ibara I	6.7	7.7	0.7	0.0	0.0	13.8	5.5
Ibara II	26.7	5.3	0.7	2.5	0.0	6.9	4.5
Sodeke/Isale-Ijeun I	0.0	2.2	1.4	1.2	7.1	3.4	2.0
Ijaiye/Idiaba	0.0	1.1	3.5	3.7	0.0	3.4	1.9
Obada-Oko	0.0	2.6	0.7	4.9	0.0	0.0	2.1
Adigbe	6.7	1.0	1.4	1.2	0.0	0.0	1.2
Alabata	3.3	2.4	0.7	1.2	0.0	6.9	2.0
Obantoko	0.0	2.4	4.5	3.7	0.0	6.9	3.0
Osiele	0.0	0.7	3.5	4.9	14.3	0.0	1.8
Imala/Idi-Emi	0.0	2.4	0.3	1.2	7.1	0.0	1.7
Erunbe/Oke-Ijeun	0.0	1.8	1.4	0.0	0.0	13.8	1.8
Ake I	0.0	4.0	12.5	16.0	28.6	17.2	7.5
Ake II	0.0	2.1	1.7	3.7	0.0	3.4	2.1
Ake III	0.0	0.3	2.1	9.9	14.3	10.3	1.8
Igbore/Itori/Ago-Oba	6.7	2.8	12.8	2.5	0.0	0.0	5.2
Isaga/Ilewo	0.0	0.8	1.0	4.9	0.0	0.0	1.1
Ikereku	0.0	0.6	2.1	3.7	0.0	0.0	1.1
Ikija	6.7	3.6	1.4	0.0	0.0	0.0	2.7
Isaga/Orile	0.0	1.7	0.0	0.0	0.0	0.0	1.0
Olorunda/Idi-Emi	0.0	2.5	0.0	0.0	0.0	0.0	1.5
Keesi/Emere	0.0	3.5	1.0	1.2	0.0	10.3	2.7
Sodeke/Isale-Ijeun II	0.0	2.4	3.5	1.2	0.0	0.0	2.4
Ijemo	0.0	3.5	0.0	0.0	0.0	0.0	2.1
Ago-Egun/Ago Ijesa	0.0	2.1	11.1	0.0	0.0	0.0	4.0
Agura	10.0	3.2	1.0	0.0	0.0	0.0	2.5
Ilugun/Iberekodo	6.7	3.0	0.7	0.0	0.0	0.0	2.2
Sabo	0.0	3.7	1.7	3.7	0.0	0.0	3.0
Ago-Oko	0.0	5.4	0.7	0.0	0.0	0.0	3.5
Ago-Ika	0.0	2.5	1.0	0.0	0.0	0.0	1.8
Lafenwa	6.7	2.9	2.4	12.3	0.0	0.0	3.4
Totoro/Sokori	0.0	3.6	4.8	4.9	0.0	0.0	3.8
Ita-Oshin/Olomore	0.0	2.8	1.4	0.0	0.0	0.0	2.1
Oke Ago-Owo	6.7	4.7	3.5	3.7	0.0	0.0	4.2
Imo/Isabo	0.0	5.1	6.2	6.2	0.0	3.4	5.2
Itoko	0.0	0.6	4.5	0.0	0.0	0.0	1.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Authors Analysis, 2020

Table 6: Energy Type Used for Household Cooking

Energy Type	Frequency	Percent
Electric	427	36.6
Gas	352	30.2
Kerosene	351	30.1
Coal	12	1.0
Firewood	24	2.1
Total	1166	100.0

Source: Author's Analysis, 2020

The first dependent variable was the energy type used for cooking by households. The five energy types used for cooking by households in this study area were electricity, gas, kerosene, coal and firewood. The correlation coefficients obtained in Table 6 revealed that the gender of the household heads is positively and significantly related to the use of electricity as a type of energy used for household cooking in the study area with an r value = 0.078 and significance level of 0.008. It is also positively related to coal and firewood but inversely associated with the use of gas (r = -0.113) and Kerosene (r = -0.021).

The male household heads and the majority of those in the low and middle-income group, as the ones who bear the burden of household energy provision, may be interested in the choice of electricity (a clean energy source) and the use of cheap and readily available backup and hence the preference for firewood and coal as against gas and kerosene.

However, female household members that play essential roles in household cooking support the male household heads' decision on the choice of electricity but were not comfortable with the choice of firewood as supplementary because of cost-cutting considerations only, as noted by (Father, 1998) and (Israel, 2002) that 'female members cook, collect and carry firewood. Hence their support for clean energy (electricity) and reservation for firewood.

Economically, the inhabitants of the study area are mainly in the low-income category (43.7%), middle (42.7%) and high-income group (13.6%), though there are variations in these proportions within wards and between Local Government Areas. Further ANOVA test on income groups showed that income had a significant direct impact on household energy consumption, and hence highest incomes and status make unit prices and energy quantity required by households less of a constraint. On the other hand, low-income households spend proportionately more of their incomes on energy and are hence more affected by an increase in unit prices than the middle and high-income groups.

The most dominant energy type households use in the study area is electricity. Its usage cuts across all household activities such as lighting, cooking, cooling/warming, food preservation, powering of electrical, electronic and pumping machines, and clothes smoothening. Its erratic and epileptic supply by the IBEDC made many households seek alternative energy types, which was the starting point of the energy mix.

Table 7: Energy Type and Appliance Used for Household Cooking by Wards

Ward	Energy type and appliance used for household cooking 1					Total %
	Electric %	Gas %	Kerosene %	Coal %	Firewood %	
Elega	6.3	8.0	0.6	0.0	0.0	3.9
Ibara I	13.6	1.9	0.6	0.0	0.0	5.5
Ibara II	9.4	4.7	0.6	0.0	0.0	4.5
Sodeke/Isale-Ijeun I	1.6	1.4	3.4	8.3	0.0	2.0
Ijaiye/Idi-aba	1.6	5.2	1.1	0.0	0.0	1.9
Obada-oko	5.9	0.0	0.0	000	0.0	2.1
Adigbe	2.1	1.9	0.3	0.0	0.0	1.2
Alabata	4.2	1.9	0.3	0.0	0.0	2.0
Obantoko	2.3	10.0	0.6	8.3	0.0	3.0
Osiele	1.2	2.8	2.6	8.3	0.0	1.8
Imala/Idi-Emi	0.5	0.0	1.1	8.3	7.9	1.7
Erunbe/Oke-ijenu	1.2	0.0	0.00	0.0	9.7	1.8
Ake I	4.7	20.3	6.8	0.0	0.0	7.5
Ake II	4.4	1.4	0.6	0.0	0.0	2.1
Ake III	0.7	6.6	1.1	0.0	0.0	1.8
Igbore/Itori/Ago-oba	2.6	0.0	0.6	0.0	29.3	5.2
Isaga/Ilewo	0.9	0.0	2.6	0.0	0.0	1.1
Ikereku	0.0	0.0	2.6	0.0	2.4	1.1
Ikija	1.9	0.0	3.7	8.3	6.1	2.7
Isaga/Orile	0.0	0.0	1.0	00.0	4.8	1.0
Olorunda/Idi-Emi	0.0	0.0	1.1	0.0	8.5	1.5
Keesi/Emere	2.8	0.0	4.6	0.0	2.4	2.7
Sodeke/Isale-Ijeun II	2.8	0.0	3.7	0.0	1.8	2.4
Ijemo	4.9	0.0	1.1	0.0	0.0	2.1
Ago-Egun/Ago-Ijesha	0.0	0.0	10.3	0.0	6.7	4.0
Agura	0.9	1.4	6.0	8.3	0.0	2.5
Ilugun/Iberekodo	0.9	1.9	4.6	16.7	0.0	2.2
Sabo	3.3	0.0	5.1	0.0	1.8	3.0
Ago-Oko	1.4	2.8	7.7	0.0	1.2	3.5
Ago-Ika	0.5	1.9	3.7	0.0	1.2	1.8
Lafenwa	1.9	2.8	5.7	25.0	1.8	2.4
Totoro/Sokori	4.9	2.8	4.8	0.0	0.0	3.8
Ita-Oshin/Olomore	4.4	2.4	0.0	0.0	0.0	2.1
Oke-Ago-Owu	1.9	0.0	6.6	8.3	10.4	4.2
Imo/Isabo	4.2	17.5	1.4	0.0	0.6	5.2
Itoko	0.0	0.0	3.4	0.0	3.0	1.5
Total	100	100	100	100	100	100

Table 8: Relationship between Socio-economic Characteristics of Household Heads and the Type of energy used for cooking

Variables		Electricity	Gas	Kerosene	- Coal	Firewood
Gender Recode	Correlation Coefficient	0.078**	-.113**	-.021	.038	0.033
	Sig. (2-tailed)	0.008	0.000	0.478	0.194	0.257
	N	1166	1166	1166	1166	1166
Age of respondents in Year	Correlation Coefficient	-0.050	-.083**	0.188**	-0.007	-0.085**
	Sig. (2-tailed)	0.091	0.004	0.000	0.821	0.004
	N	1166	1166	1166	1166	1166
Level of Education in Years of HH Recode	Correlation Coefficient	0.486**	0.188**	-0.531**	-0.080**	-0.158**
	Sig. (2-tailed)	0.000	0.000	0.000	0.006	0.000
	N	1166	1166	1166	1166	1166
Level of Education in Years of Spouse Recode	Correlation Coefficient	0.338**	0.134**	-0.340**	-0.027	-0.160**
	Sig. (2-tailed)	0.000	0.000	0.000	0.365	0.000
	N	1166	1166	1166	1166	1166
Number of people presently in the household	Correlation Coefficient	-0.227**	0.049	0.099**	0.109**	0.099**
	Sig. (2-tailed)	0.000	0.095	0.001	0.000	0.001
	N	1166	1166	1166	1166	1166
Average Income Recode	Correlation Coefficient	0.392**	0.166**	-0.417**	-0.023	-0.169**
	Sig. (2-tailed)	0.000	0.000	0.000	0.427	0.000
	N	1166	1166	1166	1166	1166

The proliferation of gas plants and retail outlets has popularised and increased the percentage of households using this clean energy type; however, for middle and low-income families, the fear of explosion is the most significant concern in most wards (59.0%). Apart from income and status, a significant factor influencing choice decisions of household energy type is the dwelling unit type structure of the building and the home environment where the household is domiciled. Duplex and owner-occupied households with medium and high-income group owners used more high-cost energy appliances that suit the use of higher-cost energy types, while the reverse is the case with low-income households. High-income households budget for and consume more energy with an increase in household income.

High-income households limited themselves to alternative energy types, which are also clean, such as solar and gas, the middle and low-income groups were observed to use unlimited alternative energy types but often combined with electricity. It was also observed that all energy types had discomforts attested to by respondents. (71.7%) of respondents complained of irregular and erratic supply of electricity, (66.1%) complained of the fear of gas explosions, users of kerosene complained of a smoke problem from the old stove (67.7%), while users of firewood had the greatest variety of complaints such as dirtiness of pots (64.6%) as well as respiratory diseases associated with inhaling of smoke. Finally, using the generator as an alternative energy source has limited noise and greenhouse gas pollution in high-income areas as against the cacophony of noise and high emission of gases from the low-income wards where multiple households share the same buildings.

Test of Hypotheses

This section examined four hypotheses relating to the different energy types used among wards in the Abeokuta metropolis.

Relationship between Monthly Income Group and Uses of Electricity

Hypothesis: There are no significant differences between the use of electricity for cooking by household among the different income groups in the study area.

The results of χ^2 test (Table 7) showed that χ^2 = 171.260, df = 2, asymptotic significance = 0.000 and selected level of significance value of 0.05. This implied an acceptance of the alternative relationship hypothesis and concluded that there are significant differences in the types of energy used for cooking by Wards and LGAs in the different income groups of the study area.

Furthermore, a crosstab of electric energy used and income level, as shown in Table 9, showed that the use of electricity to cook increases from low-income (16.1%) to middle-income (49.6%). Thus, it can be said that income level determines the proportional use of electricity for cooking.

Relationship between Income Group and the use of Gas

Hypothesis: There are no significant differences in the use of gas for cooking by households among the different income groups in the study area.

The result of $\chi 2$ test indicated that $\chi 2$ =29.502, df = 2, Asymptotic Sig.=0.000, Selected level of Sig.=0.05. Hence, we accept the alternative hypothesis and conclude that there were significant variations in the use of gas among the different income groups and across wards of the study area. An examination of a crosstab table also revealed a pattern similar to electricity. Thus, we conclude that there is an increased use of clean energy with higher income and status, which is in line with the assertion of the Energy Ladder Model, as shown in Table 10.

Relationship between Income Group and the use of Kerosene

Hypothesis: There are no significant differences between the use of Kerosene for cooking by

Table 9: Monthly Income Group *Energy for Cooking – Electricity

Monthly Income Group		Energy for Cooking - Electricity		Total
		No	Yes	
Low-income	Count	427	82	509
	% Within Monthly Income Group	83.9	16.1	100
Middle-income	Count	251	247	498
	% Within Monthly Income Group	50.4	49.6	100
High-income	Count	61	98	159
	% Within Monthly Income Group	38.4	61.6	100
Total	Count	739	427	1166
	% Within Monthly Income Group	63.4	36.6	100

$\chi 2$ =171.260, df = 2, Asymptotic Sig.=0.000, Selected level of Sig.=0.05.
Source: Author's Analysis, 2020

Table 10: Monthly Income Group*Energy for Cooking – Gas

Monthly Income Group		Energy for Cooking – Gas		Total
		No	Yes	
Low-income	Count	447	62	509
	% Within Monthly Income Group	87.8	12.2	100
Middle-income	Count	396	102	498
	% Within Monthly Income Group	79.5	20.5	100
High-income	Count	111	48	159
	% Within Monthly Income Group	69.8	30.2	100
Total	Count	954	212	1166
	% Within Monthly Income Group	81.8	18.2	100

$\chi 2$ =29.502, df = 2, Asymptotic Sig.=0.000, Selected level of Sig.=0.05.
Source: Author's Analysis, 2020.

household among the different income groups in the study area.

The results of the χ^2 test, as revealed in Table 9, showed significant differences between income level and use of kerosene in the study area with a value of $\chi^2 = 213.654$, df = 2, asymptotic significance = 0.000 and selected level of significance value of 0.05. P value is (0.000 <0.05); hence we accept H_1 that there are significant differences between the use of Kerosene for cooking by households among the different income groups in the study area. A close look at the crosstab of kerosene use revealed that kerosene which is an intermediate energy type is now used more by the low-income group (52.3%), middle-income group (14.7%) and the high-income group (7.5%). With an increasing percentage of middle-income groups imbibing the use of gas because of its proliferation and availability at retail shops in areas very close to their residences, the use of kerosene had significantly reduced in its use as fuel energy type in areas where it hitherto held sway.

Conclusion and Recommendations

An exposition of the weakness of the household energy transition model was revealed. Results showed that household energy consumers do not simply have better energy options with increasing income and status but rather mix multiple energy sources in complex ways. While all households, irrespective of income groups, attest to the popularity of electricity as the most preferred energy type that can be used to perform the majority of household activities, its erratic and epileptic nature was identified as a significant factor influencing the use of alternative energy types. Modern energy types are used to supplement firewood in urban areas by the low-income group rather than it's been abandoned. It is not surprising to see huge stacks of firewood in urban areas because of its availability and cheap cost. The low and middle-income groups have the largest energy mix options of up to 4 in some cases, while the high-income group limits itself to mostly two electricity and gas/solar.

The most important theoretical contribution of the study, however, is its illumination of the fact that energy choices are not based on our theoretical calls embedded in our vastly unread journals, on enlightenments because they do not get to the right persons but rather are the product of active decisions made by individual households according to their perspectives, preferences means of survival and sustaining the household lifestyles. Energy ladder and mix models may not effectively resolve the problems associated with urban firewood consumption; hence, this study calls for the recognition of the flexibility, diversity and dynamism of household energy consumers' choices to be factored into theoretical models of energy consumption.

Targeted awareness campaigns, especially among the uneducated, low-income earners and vulnerable households, on the use of environmentally friendly clean energy types to reduce personally perceived negative and environmental impacts and fear against the use of gas must be deliberately and practically addressed.

Planned appliance incentives for low-income households, such as the distribution of gas and petrol stoves, and highly subsidised gas cylinders, must be put in place to drive the desire of the low-income

Table 11: Monthly Income Group*Energy for Cooking – Kerosene

Monthly Income Group		Energy for Cooking – Kerosene		Total
		No	Yes	
Low-income	Count	243	266	509
	% Within Monthly Income Group	47.7	52.3	100
Middle-income	Count	425	73	498
	% Within Monthly Income Group	85.3	14.7	100
High-income	Count	147	12	159
	% Within Monthly Income Group	92.5	7.5	100
Total	Count	815	351	1166
	% Within Monthly Income Group	69.9	30.1	100

$\chi 2$ =213.654, df = 2, Asymptotic Sig. =0.000, Selected level of Sig. =0.05.

Source: Author's Analysis, 2020.

households to catch up with better energy types used by the middle-income group. The government should strengthen the energy sector, especially electricity, whose use cuts across all household activities irrespective of income group, so that it can generate transmission through improved energy infrastructure and effectively supply sustained steady electricity to households, hence reducing the emission of greenhouse gases from other energy sources. Developing new and renewable energy sources is seriously advocated to move away from rhetoric to a seriously viable policy option implementation.

Finally, the policy implication of this study is more crucial from a future energy demand perspective if tackling the current challenges of climate change through the reduction of greenhouse gases and improvement of personal health, especially of women and children in households, is to be effectively addressed.

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