

## **HOUSEHOLD ENERGY CONSUMPTION PATTERN IN PUBLIC HOUSING ESTATES IN MAIDUGURI, NORTH-EAST NIGERIA: AN ECONOMIC AND SOCIO-DEMOGRAPHIC ANALYSIS**

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### **ABSTRACT**

*This study analyzed the economic and socio-demographic characteristics of households in relation to their energy consumption pattern in public housing estates, Maiduguri, North-east Nigeria. A survey questionnaire was administered on a sample of 355 respondents using systematic sampling technique. The data collected were analyzed descriptively. The results obtained indicated that 72.96% of the residents were males while 27.04% were females. Similarly, 66.76% were married, 44.23% had tertiary education while 50.14% were civil servants. Households with family size of 5 to 8 constituted the majority accounting for about 50.42% of the total sampled population. Majority (31.27%) had monthly income of N50,000 – N99,999. Additionally, the results show that 67.89% of households use external kitchen facilities for the preparation of meals. Electricity supply was found to be low with about 53.24% having supply for between 1 -5 hours per day. Further analysis revealed that charcoal and fuelwood were the dominant primary cooking energy source accounting for about 37.18% and 27.61% respectively. The findings indicated multiple fuel use pattern among households with majority of households combining two or more energy sources for both cooking and lighting end uses consistent with the energy mix model. Although all households are connected to electricity from the national grid, its use for household cooking and lighting is limited due to constant outages. It is recommended that policy makers and stakeholders should take into consideration the economic and socio-demographic characteristics of its population in any policy or strategy geared towards providing clean, efficient and affordable energy sources if maximum success is to be achieved so as to engender sustainable energy use and environmental sustainability.*

**Keywords: Household, traditional fuels, modern fuels, energy transition, consumption**

### **INTRODUCTION**

The role of energy in human lives cannot be overemphasized. Energy remains the mainstay of many economies of the world and a major driver of economic development. According to Mukwaya (2016), the level of development of a society is measured not only in terms of goods and services but also from energy consumed. Akinola, Oginni, Rominiyi and Eiche (2017) posited that the standard of living of any given country is directly related to the per capita energy consumption of its population. Globally, the pattern of household energy consumption is seen as a reflection of the state of welfare and economic development in any country (Kadiri & Alabi, 2014).

It is estimated that about 30 - 40% of all primary energy is used in residential buildings worldwide (International Energy Agency, IEA, 2002), thereby making the built environment responsible for a large share of the world's total energy consumption. In Nigeria, the household sector accounts for the largest share of about 65% of energy usage (Oyedepo, 2012). According

to Akinola *et al.* (2017), the major energy consuming activities in Nigeria's households are cooking, lighting and use of electrical appliances accounting for 91%, 6% and 3% respectively. However, energy for cooking and lighting activities have been described as the fundamental energy needs of households in Nigeria (Ogwumike, Ozughalu and Abiona, 2014).

While the developed world is said to have near universal access to modern energy, households in developing countries are confronted with the challenge of clean, efficient, reliable and affordable energy to meet their domestic requirements. Many households thus have restricted access to various energy types and as a result, are faced with a daily challenge of having to make appropriate energy choices to meet their energy requirements. Energy sources from traditional biomass have their own implications with regards to human health and environmental degradation arising from forest resource depletion and Green House Gas (GHG) emissions. The World Health Organization (WHO, 2018) estimates that over 3.2 million people die prematurely every year as a result of illnesses attributable to indoor air pollution caused by incomplete combustion of solid fuels used for household cooking. In fact, indoor air pollution has been described as the world's largest single environmental health risk by the World Health Organization.

Available estimates show that Nigeria consumes over 50 million metric tons of fuelwood annually, a rate which exceeds the regenerative ability of forests to meet future needs creating concerns that the country's 15 million hectares of forest and woodland resources could be depleted within the next fifty years (Energy Commission of Nigeria, ECN, 2003). Similarly, over 90,000 people, mainly women and children, die annually from smoke and other complications from traditional fuels, making smoke the third largest killer after malaria and HIV/AIDS in Nigeria (Nnodim, 2022).

Recognizing that access to modern energy sources is a key to any development initiative, the United Nations (UN) through its Sustainable Development Goals (SDGs) No. 7 has been promoting the need for universal access to affordable, clean and modern energy services by 2030 as a collective global responsibility for all civilized nations. The 'Energy Transition Plan' and the 'Decade of Gas initiative' of the Federal Government of Nigeria are all policies geared towards providing universal access to modern energy services to its population by 2030 thus reducing the impact of climate change occasioned by increasing deforestation associated with fuelwood and biomass consumption as well as the health effects of indoor air pollution.

There is the need to encourage households to shift from the use of less efficient energy sources to the adoption of more efficient ones. Accordingly, Lee (2013) asserted that moving towards the use of cleaner fuels is an important step to improving the standard of living for countries that rely heavily on traditional energy sources. Improving access to modern energy sources such as electricity for light and appliances and clean cooking technologies is therefore an important development goal and considered critical in enhancing the quality of life of many people particularly in developing countries.

Without a clear understanding of those households' economic and socio-demographic characteristics that influence energy preferences and consumption, policies and strategies designed for the adoption of clean and modern energy sources may never be realized. It is against the above backdrop that this study is undertaken to analyze the economic and socio-demographic characteristics of households in relation to their energy consumption pattern in public housing estates in Maiduguri, North-east Nigeria. The findings of the study has implication for policy and environmental sustainability.

## **LITERATURE REVIEW**

The Energy Ladder hypothesis is one of the most common conceptualizations of energy use dynamics among households in developing countries. The concept depicts how improvement in energy use correlates with an increase in household income (Kayode, 2016). The Energy Ladder Model constructs a linear model of household energy use and depicts a hierarchical relationship of

fuel types that a household follows with rising economic status, switching from one energy source to another along the energy ladder.

Simply put, the energy ladder presupposes that economic growth shifts households towards better fuels. Hosier and Dowd's (1987) paper is credited as one of the first academic papers to discuss this relationship (Arthur, Zahran & Bucini, 2010). The energy ladder model in its simplest form is its ability to capture the strong income dependence of fuel choices (Heltberg, 2005). A synopsis of the energy ladder indicates that there is a positive relationship between socio-economic level and modern fuel uptake and fuel preferences are ordered by physical characteristics and fuel costs and that there is an assumption of complete substitution of one energy source for another.

The basic notion of the Energy Ladder Model is that as income rises, households tend to climb upwards along an invisible energy ladder and while climbing upwards, they move away from polluting and low quality traditional fuels (e.g. fuelwood, charcoal) placed on the lowest rung of the ladder (Kowsari & Zerriffi, 2011; van der Kroon, Brouwer and van Beukering, 2013). Low income households generally use traditional stoves and cooking fuels such as animal dung, charcoal and wood, while those households with higher income used modern cooking technology and fuels. As income increases, households transit from traditional fuels and cooking stoves to modern fuels and cooking technology.

Furthermore, the energy ladder hypothesis assumes that cleaner fuels are normal economic goods while traditional fuels are inferior goods (Demurger & Fournier, 2011). Thus, the energy-ladder hypothesis emphasizes the role of income in determining fuel choices. However, it appears to imply that a move up to a new fuel is simultaneously a move away from previously used fuel(s). Mekonnen and Köhlin (2009) suggest the idea of an energy-demand ladder where it is argued that, as incomes rise, households' demand for fuel is guided by the nature of appliances used and that fuel choice and demand depends on the purpose for which energy is required.

Empirical evidence based on energy demand have confirmed the energy ladder hypothesis. For instance, Rajmohan and Weerahewa (2007) investigated household energy consumption patterns of urban, rural and estate sectors in Sri Lanka. The results show that the energy ladder hypothesis holds for Sri Lanka and the country as a whole is moving towards modern fuels such as LPG and electricity. A study by Nansaior, Rambo and Simaraks (2011) found that there was a decline in the use of biomass as household income improved in an urban community within the study area of northern Thailand. Similarly, Buba, Abdu, Adamu and Usman (2017) investigated the socio-economic determinants of households' fuel consumption using the 2013 demographic and health survey data sets for Nigeria. The findings of the study confirmed the propositions of the Energy ladder hypothesis. Their study also showed that demographic characteristics, economic status, public awareness and social variables were strong determinants of household energy choice in the country. Khundi-Mkomba (2020) also observed that cooking fuel use patterns were consistent with the Energy ladder hypothesis among Rwandan households.

More recently, it has been argued that households in developing countries do not switch to modern energy sources but instead tend to consume a combination of fuels which may include combining solid fuels with non-solid fuels. Hence, instead of moving up the ladder step by step as income rises, households choose different fuels as from a menu (Mekonnen & Köhlin, 2009). They may choose a combination of high-cost and low-cost fuels, depending on their budgets, preferences and needs (World Bank, 2005).

Scholars have therefore developed a new concept known as the 'energy mix theory' or fuel stacking as opposed to fuel switching or an energy ladder (Masera, Saatkamp and Kammen, 2000). Proponents of energy mix theory argue that the energy ladder theory does not adequately describe the dynamics of households' fuel use. Instead, they noted that fuel stacking was common in both urban and rural areas of developing countries. Like the Energy ladder hypothesis, the Energy mix theory also constructs a hierarchical relationship of fuel types, but differ from the former to the extent that households do not immediately ascend to improved fuels and simultaneously abandon

inferior ones but rather rely on multiple types of fuel, consuming a higher proportion of superior fuels with rising income.

A number of empirical evidence based on energy demand have confirmed the energy mix theory. For instance, Ogwumike, *et al.* (2014) study on household energy use and determinants in Nigeria based the 2004 Living Standard Survey data involving 19,158 rural and urban households obtained from the National Bureau of Statistics supported fuel stacking rather than the Energy ladder hypothesis. They found that educational levels of household heads, per capita expenditure and household size significantly influenced household energy use for cooking.

Similarly, Muazu and Ogujiuba (2019) analyzed the dynamics of domestic fuelwood energy consumption in Nigeria with a view to testing the fuel stack hypothesis using micro data of 1,199 households obtained from the National Bureau of Statistics. The results of the study confirmed fuel stacking behaviour among households due to family size, price and culture rather than the Energy ladder hypothesis.

A recent detailed review by Adamu, Adamu, Ade and Akeh (2020) on the applicability of the Energy ladder hypothesis on household energy consumption in Nigeria showed that the dependence on energy sources at the lowest rung of the Energy ladder by most households was induced by rising poverty level consistent with the Energy ladder hypothesis. They however asserted that the notion of complete fuel substitution as postulated by the energy ladder hypothesis was not practicable given that most households tend to have a mix of energy sources for their domestic activities.

## **MATERIALS AND METHODS**

The target population of the study consisted of all household heads in the 3,192 public housing estates directly under the control and management of the Borno State Housing Corporation (BSHC). Households' heads were chosen since they were essentially the ones responsible for making decisions on energy use in their respective households. The sample size was determined using Yamane's (1967) formula for sample size determination as follows:

$$n = \frac{N}{1 + N(e)^2}$$

Where: n = sample size, N= population size, e= level of precision.

At 95% level of significance

$n = 3192 / \{1 + 3192(0.05)^2\}$  Therefore, n = 355 Households

Having calculated the sample size of 355 households, the figure was then divided proportionately among the seven public housing estates as to determine the actual number of questionnaires to be distributed in each estate. This was achieved by multiplying the total housing units in each housing estate by the sample size of 355 and dividing the product with the total number of housing units (3,192) in the entire estates.

Systematic random sampling technique was adopted in selecting the actual respondents for the study. The width interval for each estate was first determined by dividing the total population of housing units in a given estate by the sample frame as stated by Kumar (2011). According to Kothari (2004), an element of randomness is introduced when using systematic sampling technique. Thus, the first house was randomly selected and subsequently, every ninth house was chosen as the width interval/sampling digit for all the housing units with the exception of CBN Quarters where every tenth housing unit was chosen as the width interval/sampling digit. Informed consent was sought and obtained by the researcher before administering the research instrument on each of the household head selected for the study. Descriptive analysis involving frequencies and percentages were used to analyze the data.

## **RESULTS AND DISCUSSION**

### ***Economic and socio-demographic characteristics of households***

Table 1 presents the economic and socio-demographic characteristics of respondents of public housing estates in Maiduguri. The results shows that 4.51% of the respondents were

between 20 to 29 years old, 9.01% were between 30 to 39 years old, 38.03% were between 40 to 49 years old, 34.08% were between 50 to 59 years old while 14.37% of the respondents were above 60 years old. This implies that majority of the respondents were between the ages of 40 to 49 years old, which suggests that most of the household heads in the study area are within the active population group.

It was found that majority of the respondents representing 72.96% were males while 27.04% were females. The greater gender variation is in line with the norms, tradition and cultural beliefs in the study area where males are considered as household heads except in rare cases where the female gender functions as a household head either as a widow or divorcee. About 25.63% of the respondents were single, 66.76% were married, 4.51% were widowed and 1.97% were separated while 1.13% were divorced. This implies that majority of the household heads in the study area are married underscoring the need for one form of energy source or the other for their daily domestic needs such as cooking and lighting in the household. With regards to education level, the results indicated that 12.68% of the respondents had no formal education, 17.46% had received primary education and 25.63% had secondary education while 44.23% had tertiary level education. This result suggests that majority of the household heads have tertiary education background. This can influence the choice of energy that a household makes since an educated person is better informed on the effects of different energy sources available.

The table further indicated that 50.14% of the respondents were civil servants, 25.92% worked in the private sector while 21.41% of the respondents were self-employed. About 2.54% of the respondents do not have a standard job. This result implies that majority of the respondents in public housing estates in Maiduguri are civil servants. This is important given that the choice made of a given energy source by a household head is to some extent influenced by his occupation, which translates to income.

In terms of household size, the results showed that 7.61% of the respondents had family size ranging from 1 to 4 people, 50.42% had between 5 and 8 people, 26.20% had between 9 and 12 people while 15.77% had more than 13 people. This implies that majority of the respondents had between 5 to 8 household size. The size of a household can be a significant factor in terms of the choice and rate of consumption of different energy types by the respective households.

Based on monthly income by household, the results revealed that 3.94% of the respondents earned below 18,000, 16.62% earned between 18,001 and 29,999 and 25.63% earned between 30,000 and 49,999. About 31.27% of the respondents earned between 50,000 and 99,999, 14.65% respondents earned between 100,000 and 149,999 while 7.89% of the respondents were earning a monthly income of above 150,000. This implies that majority of the respondents' monthly income falls between 50,000 to 99,999 Naira. Income is a strong determinant of energy choice among households. Generally, higher income household heads tend to have a propensity to use fuels in the upper rung of the Energy ladder that are clean, efficient and safe (Heltberg, 2005).

**Table 1: Economic and socio-demographic characteristics of respondents (N=355)**

Variable	Frequency	Percentage
<i>Age</i>		
20-29	16	4.51
30-39	32	9.01
40-49	135	38.03
50-59	121	34.08
>60	51	14.37
<i>Gender</i>		
Male	229	72.96
Female	96	27.04
<i>Marital status</i>		

Single	91	25.63
Married	237	66.76
Widowed	7	1.97
Separated	4	1.13
Divorced	16	4.51
<i>Education</i>		
Non-formal	45	12.68
Primary level	62	17.46
Secondary level	91	25.63
Tertiary level	157	44.23
<i>Occupation</i>		
Civil servant	178	50.14
Private sector	92	25.92
Self-employed	76	21.41
Others	24	2.54
<i>Household size</i>		
1-4	27	7.61
5-8	179	50.42
9-12	93	26.20
>13	56	15.77
<i>Monthly income (in Naira)</i>		
<18,000	14	3.94
18,000-29,999	59	16.62
30,000-49,999	91	25.63
50,000-99,999	111	31.27
100,000-149,999	52	14.65
>150,000	28	7.89

**Source: Field survey, 2022**

The characteristics of housing units in which households live also play a significant role in determining energy choices and consumption behaviours among households. Table 2 presents households' dwelling characteristics. The results showed that 69.30% of the respondents lived in their self-owned houses while 30.70% lived in rented houses. There are conflicting findings on the effect of ownership dwelling on the use of energy. For instance, while Arthur, Zahran and Bucini, (2010), Lay, Ondraczek and Stover (2013), Baiyegunhi and Hassan (2014) found that house owners were more likely to shift towards cleaner fuels as compared to tenants, Ouedraogo (2006), Pundo and Fraser (2006) however reported contrary results.

On the type of dwelling, the results indicated that 38.59% of the respondents lived in detached houses, 32.11% lived in semi-detached houses and 25.63% lived in storey-buildings while 3.66% of the respondents lived in duplexes. Majority of houses representing 35.21% are two bedrooms followed by one bedroom (27.04%). Meanwhile, 22.25% and 12.11% of the houses are three bedrooms and four bedrooms respectively. Only a negligible 3.38% are five bedroom apartments. Heltberg (2005) found association of number of rooms with a switch away from wood towards LPG exclusively in Guatemala. Similarly, Arthur *et al.* (2010) observed in Mozambique that house size measured by the number of rooms was associated with adoption of electricity.

The results also revealed that majority of the respondents representing 67.89% use internal kitchens in the preparation of their meals while 32.11% use external kitchen facilities. The place where a household cooks its food could have a major influence on the choice of energy type as well as its consumption. DeFries & Pandey (2009), Taylor, Moran-Taylor, Castellanos (2011) found that the level of outdoor air pollution a household emits in the form of black carbon, carbon dioxide, and sulphur dioxide is related to energy type. The results in table 4.3 further shows that electricity connection is available to 91.83% of the households. Only 7.32% of households indicated that electricity connection was not available to their homes. On electricity availability in

households, majority of the respondents representing 53.24% indicated 1 – 5 hours per day. Another 30.14% indicated 6 to 10 hours per day and 11.55% indicated 11 – 15 hours per day. Only 5.07% of the respondents get electricity supply of more than 15 hours per day. This result suggests that most of the respondents only have electricity supply for 1 to 5 hours per day. The use of electricity as a source of household energy is determined by the existence of electric connections already in place and this is more likely in modern-type housing as in the case of the study area. The results further revealed that 58.9% of households in the study area use pre-paid metres for electricity billing while 41.1% use post-paid billing system. This result suggests that majority of households in the study area are increasing becoming aware of the disadvantages of arbitrary billing of electricity associated with post-paid method of electricity billing.

Majority of the housing estates representing 61.69% are located within the city centre of Maiduguri while 38.31% are outside the city centre. Locational setting affects available resources and accessible fuels. Living in urban areas could undermine a household's ability to collect fuelwood and therefore leads the household to purchase the fuelwood they consume (Hiemstra-van der Horst & Hovorka, 2008). Nansaior *et al.* (2011) as well as DeFries and Pandey (2009) found that urban households consume a smaller share of fuelwood relative to other types and less fuelwood per capita as compared to rural households.

**Table 2: Households' dwelling characteristics in public housing estates in Maiduguri (N=355)**

Characteristics	Frequency	Percentage
<b><i>Ownership status of dwelling</i></b>		
Self-owned	109	30.70
Rented	249	69.30
<b><i>Type of dwelling</i></b>		
Detached building	137	38.59
Semi-Detached building	114	32.11
Storey building	91	25.63
Duplex	13	3.66
<b><i>Number of Rooms</i></b>		
One	96	27.04
Two	125	35.21
Three	79	22.25
Four	43	12.11
Five	12	3.38
<b><i>Kitchen type for cooking</i></b>		
External kitchen	114	32.11
Internal kitchen	241	67.89
<b><i>Electricity connection to building</i></b>		
Available	329	91.83
Not available	26	7.32
<b><i>Supply of electricity to household</i></b>		
1-5 hours/day	189	53.24
6-10 hours/day	107	30.14
11-15 hours/day	41	11.55
>15 hours/day	18	5.07
<b><i>Electricity billing system</i></b>		
Pre-paid	209	58.9
Post paid	146	41.1
<b><i>Location of household</i></b>		
Within City centre	219	61.69
Outside city centre	136	38.31

**Source: Field survey, 2022**

### **Household energy consumption pattern in public housing estates**

Results of household energy consumption pattern in Table 3 reveals that 27.61% of the respondents use fuelwood as their primary source of energy for cooking, 37.18% use charcoal. Another 12.39% of the respondents use kerosene as their main source of cooking energy while 19.44% and 3.38% of the respondents use LPG and electricity respectively as their primary source of cooking energy. The implication of the results is that majority of households in public housing estates in the study area use charcoal as their primary source of energy for cooking followed by fuelwood. This outcome is consistent with earlier findings by Ogwuche and Asobo (2013), Kadiri and Alabi (2014), which found that charcoal was a major source of energy for cooking among households in Makurdi and Offa City in Nigeria respectively. The result also confirms Masera *et al.* (2000) which found that traditional fuels such as fuelwood and charcoal were consumed not only in rural areas but by a large proportion of urban residents. It however contrasts with Emagbetere, Odia and Oreko (2016) and Adamu *et al.* (2017), who found that kerosene was the major energy source used by households for daily cooking in Ikeja and Bauchi metropolis respectively. Similarly, Ezemonye and Emeribe (2016) found that cooking gas was widely used by households in Benin City followed by electricity contrary to the results of this study. Given that majority of households in the housing estates use internal kitchens for cooking activities, which are more adaptable to charcoal use, may have been responsible for the current energy consumption pattern. In addition, the prevailing worsening economic situation in Nigeria, which has seen the prices of cooking gas and kerosene gone up coupled with supply distribution challenges in some locations may have also been responsible for the predominant use of charcoal as a cooking energy source in the study area.

Although most of the respondents use charcoal as their primary energy source for cooking, the results also indicated multiple fuel use among respondents for cooking end uses. The results in Table 4 shows that for cooking end use, 25.92% of the respondents combine fuelwood and charcoal, 16.34% combine fuelwood and kerosene, 17.75% combine charcoal and kerosene, 20.85% combine charcoal and LPG. Furthermore, 4.32% of the respondents combine kerosene and LPG, 9.30% combine fuelwood, charcoal and LPG, 3.10% combine fuelwood, kerosene and LPG while 2.54% combine kerosene, charcoal and LPG. The finding suggest that majority of respondents use fuelwood and charcoal as their energy mix for cooking end uses followed by charcoal and LPG. This result which confirms the energy stacking model by Masera *et al.* (2000), is consistent with previous findings by Ngui, Mutua, Osiolo and Aligula (2011), Alem, Beyene, Kohlin and Mekonnen (2015) which found multiple fuel use by households in Kenya and urban Ethiopia respectively.

For lighting end uses, the results revealed that 62.82% of the respondents use electricity as their primary source of lighting energy, 25.63% use generators, 6.20% use solar energy, 1.13% use kerosene, 2.54% use rechargeable lamps while 1.69% use dry cell battery torch lights. This result implies that electricity from the national grid is the primary source of lighting energy for majority of households as virtually all the housing estates in the study area are connected to the grid.

The results also revealed multiple fuel use pattern for lighting end use among households with many combining two or more energy sources. It shows that 40.28% of the respondents combine electricity and generators, 22.25% combine electricity and rechargeable lamps, 7.61% combine electricity and solar energy, 3.94% combine electricity and kerosene, 8.17% combine electricity and Dry cell battery torch lights. In the same vein, 5.07% combine electricity, generator and solar, 9.58% combine electricity, generator and rechargeable lanterns while 3.10% of the respondents combine electricity, kerosene and dry cell battery torch lights. This result seem to suggest that despite households' connection to the grid, they still combine a number of fuels to meet their daily domestic needs for lighting. This mix use pattern of energy sources for lighting purposes reflects the epileptic nature of electricity supply in most urban centres of the country and

in particular, Maiduguri. A study by Babagana and Ali (2017), for instance, found that household access to municipal electricity supply services in Maiduguri was characterized by low supply and high tariffs that was mostly considered unaffordable.

The results show that the use of solar energy for households' lighting end use is minimal. The low usage of solar energy may imply that most households are either not aware of it as a modern energy source or are not financially buoyant to bear the initial cost of infrastructure required for its installation. A study by Lay *et al.* (2013) provided evidence that access to renewable energy technology such as solar energy fosters a greater acceptance of modern fuels by households.

**Table 3: Households' energy consumption pattern in public housing estates in Maiduguri**

S/No	Energy end use	User category	F	%		
A	Cooking purposes (Main cooking energy source)	Fuelwood	98	27.61		
		Charcoal	132	37.18		
		Kerosene	44	12.39		
		LPG (Cooking Gas)	69	19.44		
		Electricity	12	3.38		
		<i>Multiple fuel users</i>	Fuelwood + Charcoal	92	25.92	
			Fuelwood + kerosene	58	16.34	
			Charcoal + kerosene	63	17.75	
			Charcoal + LPG	74	20.85	
			Kerosene + LPG	15	4.25	
			Fuelwood + Charcoal + LPG	33	9.30	
			Fuelwood + Kerosene + LPG	11	3.10	
			Kerosene + Charcoal + LPG	9	2.54	
		B	Lighting purposes (Main cooking energy source)	Electricity	223	62.82
				Generators	91	25.63
Solar	22			6.20		
Kerosene	4			1.13		
Rechargeable lanterns	9			2.54		
Dry cell battery torch lights	6			1.69		
<i>Multiple fuel users</i>	Electricity + Generator			143	40.28	
	Electricity + Rechargeable lantern			79	22.25	
	Electricity + Solar			27	7.61	
	Electricity + Kerosene			14	3.94	
	Electricity + Dry cell battery torch lights			29	8.17	
	Electricity + Generator + Solar			18	5.07	
	Electricity + Generator + Rechargeable lantern			34	9.58	
Electricity + Kerosene + Battery torch lights	11	3.10				

**Source: Field survey, 2022**

## CONCLUSION AND RECOMMENDATIONS

The study analyzed the economic and socio-demographic characteristics of households in public housing estates in Maiduguri, North-east Nigeria in relation to household energy consumption pattern. The analysis revealed that charcoal remains the dominant primary energy source for cooking by majority of households. The findings indicated multiple fuel use pattern among households with majority of households combining two or more energy sources for both cooking and lighting end uses consistent with the energy mix model. Although all households are connected to electricity from the national grid, its use for household cooking and lighting is limited due to constant outages and epileptic supply. It is important that any policy or strategy geared towards providing modern energy services take into consideration the economic and socio-demographic characteristics of its population so as to achieve maximum success and engender sustainable energy use and environmental sustainability.

The following recommendations have therefore been made based on the findings of the study:

- i. Stakeholders in the energy sector should develop and promote renewable, clean technologies to reduce the pressure on forest resource exploitation as well as indoor air pollution with a view to meeting the demand of energy in urban areas.
- ii. Programmes targeted at promoting energy access to households should be integrated with the component of sensitization of households on the utilization of clean energy technologies as well as the dangers of traditional, low efficient and dirty fuels.
- iii. Government should initiate policies that will promote the production of improved and more efficient charcoal stoves that emit significantly less smoke thereby reducing the problem of indoor air pollution known for causing many avoidable deaths in the country.
- iv. Government intervention is necessary to encourage LPG consumption especially among the urban poor by reducing the upfront cost of acquisition of LPG cylinders and other accessories.
- v. Given the strong influence of income on energy consumption and preferences, which is suggestive of the role of poverty in mitigating sustainable energy consumption, government should provide incentives for households and businesses through ready availability of subsidies and credit facilities to help them acquire technologies for clean energy utilization.

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