



Households' Clean Energy Demand in Nigeria and Its Implication on the Environment

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ABSTRACT

Understanding the demand for clean energy in Nigeria may have an important influence on the policy of achieving a sustainable environment. Hence, the extent of clean energy use has a direct positive impact on the environment with regard to global warming inducement. This study therefore looks at the pattern and determinants of clean energy demand among households in Nigeria using GHS 2016. The data of the study was analyzed using descriptive statistics and multiple regression analysis. The results show that the demand for clean energy is low except for electricity by urban households which recorded over 50% use. Also, majority (78%) of the households were male headed with a mean age of 53 years and an average of six persons per household with a mean monthly income of ₦32, 200. About 53% of the respondents had secondary to tertiary level of education. All the variables considered in the study were found to have influence on the expenditure of clean energy at 1% level of significance. Among these variables, area of residence, household income and educational level were associated with increase in clean energy demand while age of household head and family size had negative influence on demand for clean energy. As a result of these findings, it was recommended that electricity supply should be improved by investing in solar and wind energy sources. Also, LPG use should be improved because it will play a great role in reducing the use of dirty fuels especially for cooking.

Keywords: Clean Energy Household Demand Environment.

INTRODUCTION

Clean energy are those fuel sources that create less negative externality (pollution) by emitting less amount of Green House Gases [GHG] such as Carbon-dioxide CO₂ to the atmosphere. These energy sources include wind, solar, Hydro and Geothermal sources of energy (Quaschnig, 2016). In another development, clean energy is viewed more as renewable energy/technologies that have much lower contribution to global warming, and harm the environment minimally in comparison to others, is constantly replenished and will never run out (Europa, 2015). Clean energy types are very important when measured on a total fuel cycle because burning them emit lower GHG than biomass (Fuel wood and Charcoal) and fossil fuels (kerosene, petrol and diesel) used by households for cooking and lighting (Maina, 2018). Although, Liquefied Petroleum Gas [LPG] originates mainly from natural gas production; however, it is non-toxic and does not contaminate soil or aquifers in the event of a leak. In addition, it is cost-effective, since a high proportion of its energy content is converted into heat. Therefore, it can be up to five times more efficient than

traditional fuels, resulting in less energy wastage and better use of our planet's resources (Nett technology, 2017). Clean energy sources are more environment friendly, emit the least amount of negative externality of CO₂ into the atmosphere and contribute less to indoor air pollution and health implications among women and children (Quaschnig, 2016).

The most used clean energy source by households in Nigeria are electricity and LPG (Maina, Kyari & Jimme, 2019). Although solar energy power is also used by some households, due to its high cost of installation, low awareness on its advantages among its limitations when compared to electricity, its demand still remains insignificant in the country (Maina & Kyari, 2019). On the other hand, most other energy sources in Nigeria such as Fuel-wood, charcoal, petroleum, diesel and Kerosene emit a substantial amount of negative externality of CO₂ into the atmosphere resulting in more negative impact on the environment (Maina, Dantama & Kyari, 2017).

The demand for clean energy (electricity and LPG) in Nigeria is influenced by various factors such as affordability, availability, accessibility and in the case of LPG low awareness about its importance on environmental sustainability through less air pollution (Source). Furthermore, in the urban centres, demand for electricity is often limited by the epileptic nature of supply of electricity due to supply and demand imbalance (Olaleye & Akinbode, 2012; Okunede, 2011 & Olufemi *et. al.*, 2012). The demand for LPG is low in some parts of urban Nigeria like the north east region, because it is usually scarce and where it is available, it is mostly unaffordable (Maina, 2018). Meanwhile, in the rural areas of Nigeria, about 86% of the households depend solely on solid fuels (Fuelwood and Charcoal) as their source of energy. This is because most of the households are not connected to the National Electricity Grid and have little access to LPG due to absence of good road networks (Maina, 2018) as well as its relative high cost. Thus, it makes them to depend highly on alternative source of fuels that are environmentally dirty.

Household socio-economic characteristics have been observed to tend to exert influence on the demand pattern of and the expenditure on clean energy. Factors such as monthly income, family size, age of household head and rural urban dichotomy (area of residence) are found to be positively related to expenditure on energy sources (Bello, 2011; Busola & Olaniyi, 2012, Olaleye & Akinbode, 2012 and not listed). Hence, there is the need to understand the demand for clean energy and its determinants in order to inform household energy decision and their implication on the environment.

There are a lot of studies that were conducted on household energy demand or consumption in Nigeria. Among them are the study by Olaleye and Akinbode (2012) on demand for Alternative fuels in Lagos state Nigeria; Bello (2011) assessed the impact of wealth distribution on energy consumption in Gombe state. Another study (Maina *et al.*, 2017) looked at determinants of energy demand in the north east zone of Nigeria. Each of these studies dwelt on energy demand for all the sources available to households without given emphasis to whether they are clean or otherwise. Therefore, this paper bridges the gap by assessing the demand for clean energy (Electricity and LPG) and its implications on the environment. This study considers two objectives: the pattern of clean energy demand and the socio-economic characteristics of household heads and the determinants of expenditure on clean energy sources (LPG and Electricity) demanded by households in Nigeria.

METHODOLOGY

Study Area

The study was conducted in Nigeria. It lies between latitudes 4° 12' 40.37" N to 13°51' 36.50" N of the equator and longitudes 2° 45' 47.735" E to 14°42' 55.123" E of the Greenwich meridian. Located at the extreme inner corner of the Gulf of Guinea on the west coast of Africa, Nigeria occupies an area of 923,768 sq. km (356,669 sq mi), extending 1,127 km (700 mi) East to West and 1,046 km (650 mi) North to South. The country has 36 states and a projected population of 214, 312, 387 at the end of 2018 (National Population Commission [NPC], 2006). The study area suffers from acute shortage of electricity supply. Its energy demand far outstrips the supply (Ogunleye & Ayeni, 2012).

Secondary data set was used for the study, obtained from the database of the National Bureau of Statistics (NBS) on General Household Survey, Panel 2015-2016. A total of 5000 households were interviewed across the country. The relevant information collected in the survey include household socio-economic characteristics, information on farm, non-farm enterprise, income generating activities, food consumption expenditure, and other non-food expenditure. This paper considered only two energy sources (LPG and electricity) and six independent variables (Household income, age, sex, area of residence, household size and educational level of the household head).

Model Specification and Method of Estimation

Multiple regression analysis

In this study, multiple regression analysis was used for households that record 100% expenditure share to the use of any of the clean energy source and linear regression was chosen as the lead equation based on the coefficient of determination (R^2), the magnitude of the t-values and the significant difference. The model is specified as:

$$Y = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + U_i \dots\dots\dots (i)$$

Where:

- Y_i = Household monthly expenditure on clean energy source (₦)
- X_i = Household income (₦)
- X_2 = Age of household head (Numbers)
- X_3 = Sex of respondent (Male 1, Female 0)
- X_4 = rural/urban dichotomy (Urban 1, Rural 0)
- X_5 = Household size (Numbers)
- X_6 = Educational level (Years)
- U = Error term

A priori expectation

The coefficients of household Income, Educational level, area of residence rural and urban residence areas as classified by the GHS data and age would have positive effect while the sex of household head and family size would have a negative effect on clean energy.

RESULTS AND DISCUSSION

Pattern of Clean Energy Demand

The demand for clean energy is estimated in this study in terms of the expenditure share of the two clean energy sources among both rural and urban households. The demand for household clean energy demand is presented in Table 1 and figure 1.

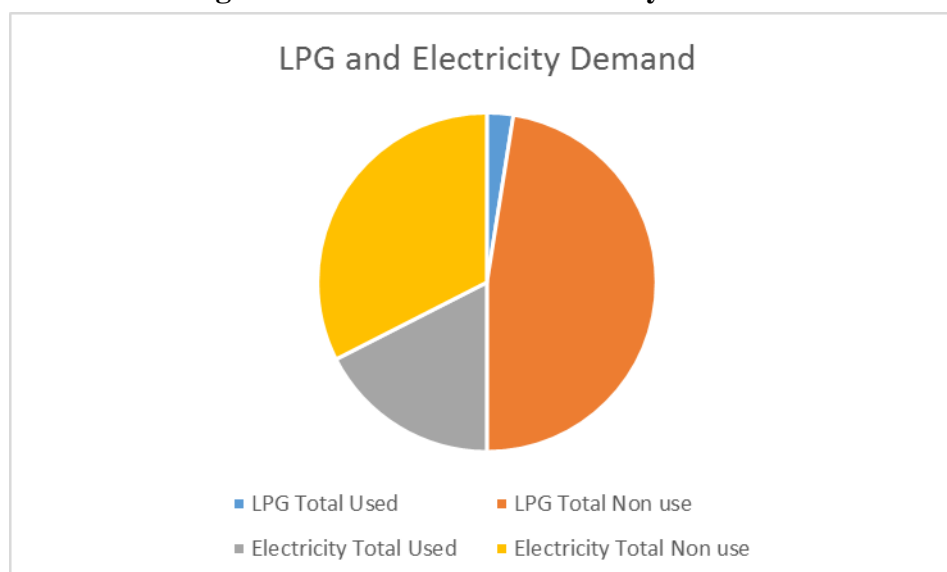
Table 1: Demand for Clean Energy Demand in Nigeria

Energy	Frequency in %
LPG Rural (Non Use)	98
LPG Urban (Non Use)	91
LPG Rural (Used)	2
LPG Urban (Used)	9
Electricity Rural (Non Use)	76
Electricity Urban (Non Use)	47
Electricity Rural (Used)	24
Electricity Urban (Used)	53

Source: Generated by Meltab from GHG 2016 data

From Table 1 it can be seen that both electricity and LPG demand were very low in rural and urban households. Among the rural households only 2% and 24% of them used the LPG and electricity respectively. Similarly, in the urban areas only 9% used LPG. The result in Table 1 also reveals that demand for electricity was more than demand for LPG in the urban areas because most of the households (53%) used electricity while 47% did not even though almost all households are connected to the national electricity grid. They use it for lighting homes and cooking. This could be justified by the fact that most households were forced to resort to the use of alternative (dirty) energy sources due to the epileptic nature of power supply in the country as opined by (Olaleye & Ainbode, 2012). Figure 1 presents a pie chart representation of the demand for clean energy in Nigeria.

Figure 1: LPG and Electricity Demand



Source: Generated by Meltab from GHG 2016 data

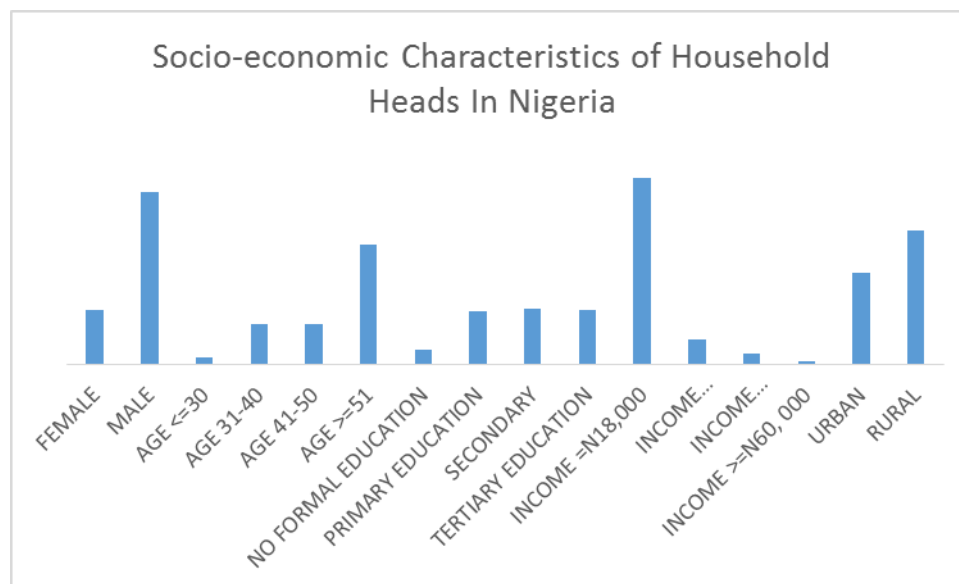
Figure 1 is the virtual presentation of clean energy demand vis a vis electricity and LPG demand in Nigeria. It can be observed that the two wide areas represent the percentages of those who did not use the energy sources with LPG having the widest of 98% and 91% for rural and urban areas respectively. These represent the percentages of the households that did not allocate any budget share to it. The two smallest areas represent the households that demanded for the two clean fuels.

These show that the demand for clean energy is very low in Nigeria which proves that the households are using other inefficient energy sources to sustain their livelihood. Thus, the implication on the environment would be detrimental and consequently affect the globe and the climate in the long run. This agrees with the findings of Kavi & Brinda (2007).

Socio-economic Characteristics of the Respondents

Previous works have shown that household socio-economic characteristics differ significantly and could influence household energy demand pattern. Figure 2 presents the socio-economic characteristics of the household heads in Nigeria.

Figure 2: Socio-economic Characteristics of Household Heads in Nigeria



Source: Generated by Meltab from GHG 2016 data

Sex of Household Head: Figure 2 shows that about 78% of the respondents were male. This implies that there is dominance of the male as household head in Nigeria. A similar classification was reported for north east region of Nigeria in the study of north east region of Nigeria by (Maina, Kaura & Kyari, 2017). The household head is often responsible for decisions on household expenditure including decision about household expenditure on energy. Furthermore, given the relative high cost of clean energy compared to cost of dirty energy, the household head would prefer to dedicate his income on inexpensive cooking fuels even if they are not clean. Thus, he would choose affordability over comfortability of the energy type even if it will have a negative implication on the environment.

Age of Household Head: The result showed that the mean age of the respondents was 53 years. Most (%) of the respondents were in the age range of 50 years and below. This falls within the range of active age identified by Food and Agricultural Organization [FAO],

(1992). This implies that the household heads could support the demand for energy either for cooking or lighting their respective homes because mostly at this age they are already married as shown by the (GHS, 2015). However, the demand for clean energy sources could be influenced by factors such as income. Thus, the type of energy used by household over the years whether clean or dirty type could have the most influenced either positive or negative on the environment.

Rural/Urban Dichotomy: The demand for clean energy could be low in both rural than urban areas. This is justified by the fact that in terms of electricity most of the rural households are not yet connected to the National Electricity Grid as opined by (Maina, Kyari & Jimme, 2019) which is also justified by figure I. While the urban centres on the other hand have low expenditure on clean energy due to demand and supply imbalance. With regards to LPG, lack of awareness on its efficiency in terms of environmental sustainability and low risk/less health implication, availability, affordability and accessibility could be the reason for its low demand (Adepoju., *et al.*, 2012).

Household Size: The result revealed that the household size with the highest frequency was between one to six persons constituting a total of 66% with an average of six persons per household. A similar range was reported by Maina, Kaura & Kyari, (2017) this could mean that the higher the household size the more the use of energy by the household in form of cooking, ironing clothes, and other appliances. However, *Ceteris Paribus* the higher the household size the more the use of cheaper fuels even if they are dirty because the more the financial burden on a household head the more he opts for cheaper energy sources that have negative implications on the environment.

Household Income: The finding in figure 2 reveals that majority (%) of the households in the study earned ₦18, 000 and below. The mean monthly income of respondents was ₦32, 200. This shows that majority of the household in Nigeria are low income earners. The result reflects the poverty status and wealth inequality situation in Nigeria. A similar report was presented by Bello (2011). Moreover, income is one of the determinants of effective demand and it is expected that the higher the income the more the demand for clean energy sources as postulated by the energy ladder model (Maina, 2018). However, the prevalence of low income among respondents implies less demand for clean energy especially LPG and therefore, more negative implication on the environment due to high demand for alternative energy sources that are dirty.

Educational level of household head: The result reveals that most of the respondents (53%) have secondary to tertiary level of education. High level of education is perceived to be generally linked with high levels of awareness. Thus, it is assumed that the more educated a household head is, the more well informed he is about the current environmental trends and the more logical he would be about his fuel choices towards achieving a sustainable environment. Education is also related to income such that people with high levels of education are likely to have higher incomes than people with low or no education.

Determinants of Clean Energy Demand

Multiple regression analysis was employed to determine the socio-economic factors influencing clean energy demand in the Nigeria. The coefficients and the significant levels are presented in the Table 2.

Table 2: Socio-economic Determinants of Clean Energy Expenditure

Variable	Coefficient	Standard error	T value	p>[t]	R ²
Constant	4.780335	.3371886	14.18	0.000*	0.774
Rural-urban dichotomy	.4627846	.0906047	5.26	0.000*	
Monthly Income	.4144782	.018944	21.88	0.000*	
Household size	-.3039194	.0401087	-7.58	0.000*	
Sex	-.4763712	.0906047	-5.26	0.000*	
Educational level	.2507012	.0222897	11.25	0.000*	
Age	-.6507781	.0142047	-20.87	0.000*	

Source: Generated by Meltab from GHG 2016 data

Household Monthly Income was a significant determinant of clean energy demand with regard to LPG and Electricity use at 1% level. This corresponds with the findings of (Olaleye and Akinbode, 2012). Moreover, the result is in line with the *a priori* expectation which assumes that the coefficient of income would be positive. *Ceteris paribus*, income is one of the major determinants of budget share allocation among households. Also, the coefficient of income was the highest among all the others. This indicates that the higher the income of the household heads in Nigeria the more they will spend on clean energy sources. Hence, the higher the income level, the more the demand and the lesser the use of dirty fuels by households if clean fuels are available and accessible. Invariably, this finding implies that the higher household monthly incomes are, the more sustainable the environment would be.

Age of Household Head: The coefficient of age of household head was found to be a negative influencing factor of the level of expenditure on clean energy sources significant at 1%. This is contrary to the findings of Busola & Olaniyi, 2012 who found that age of household head was positively related to expenditure on clean energy sources. Moreover, the finding is contrary to the *a priori* expectation which assumed that the coefficient of age would have positive effect on expenditure for clean fuels. This result suggests that *Ceteris paribus* the older the household head, the less the use of clean energy sources (electricity and LPG). The demand for electricity declines as household head gets older this could be because for so many years now the supply of electricity in the country has being epileptic, thus the more the years of being a household head the more the adoption of other alternative reliable energy sources. Similarly, LPG demand decreases as household head gets older. This could be justified by the fact that the older the head gets in a married household it is expected that the more the family size increases due to child birth. Hence, for convenience and less risk, household with more children would prefer other energy sources especially for cooking over LPG which is perceived to be complicated to use and requires more caution. This is in line with the findings of Olufemi, *et al.* (2012).

Sex of Household Head: was negatively related to expenditure of clean energy sources but significant at 1% level. This agrees with the *a priori* expectation which assumed that the coefficient of male household head would be negative for cleaner fuels. This is however, in contrast with the finding of Busola & Olaniyi, (2012), who found that the coefficient of expenditure for clean energy in relation to male household head was positive. The result implies that the more the household head is a male the lower the demand for clean energy. In

most households', women and children are the ones responsible for household chores including cooking and ironing clothes. However, there is the dominance of male gender as the household head in the study area as shown by figure 2. Also due to the culture and the religions of the study area as opined by Akinleye (2009), the household head is responsible for going out to purchase material needs of the family, including energy sources. Hence, he would prefer to support an energy type that is affordable not really minding whether it is a clean fuel or otherwise.

Rural-Urban Dichotomy: The result shows that rural urban dichotomy was a factor that influences clean energy expenditure in Nigeria. This is in consonance with the *a priori* expectation which assumed that the coefficient of urban area would have positive effect on the expenditure for clean energy sources. This implies that *Ceteris paribus*, households in the urban areas use more clean fuels than ones in the rural areas. This finding is contrary to that of Olufemi *et al.* (2012), who found that the coefficient of urban area has a positive effect on the expenditure for clean energy sources. The result could be justified based on Table 1, where it shows that about 53% and 9% of the urban households use electricity and LPG respectively. The reason for the low electricity demand of only (24%) by rural households could be owing to the fact that most households are not connected to the National Electricity Grid compared to the proportion of the households in the urban areas. The low demand for LPG on the other hand could be due to poor road networks to link the rural and urban centres thereby causing shortage in supply and consequently high price and low demand. This agrees with the finding of Adepoju, Oyekale & Aromolaran, (2012).

Household Size: The coefficient of household size appeared to be negative and significantly related to expenditure for clean energy. This is also contrary to the finding of Bello (2011) and to the *a priori* expectation which assumed that the coefficient of family size would have positive effect on clean energy sources. This finding suggests that all things being equal, an increase in household size would result in decrease in the expenditure for clean energy sources. The higher the household size the lower the expenditure on clean energy sources because an increase in family size would increase the need to iron more clothes, heat more water for bathing during Harmattan season and cool rooms with air conditioning appliances during hot season. Therefore, if these increases are not accompanied by increase in incomes it would result to additional financial burden. Thus, a rational consumer would switch to other affordable and convenient energy sources.

The coefficient of Educational level of the household head was significant at 1% and positively related to the expenditure for clean energy. This finding agrees with the *a priori* expectation which assumed that the coefficient of educational level of household head would have positive effect on clean energy sources. This suggests that *Ceteris paribus*, increase in the educational level of household head would increase his expenditure for clean energy sources. This could be because the more educated a household head is the more his level of awareness on the importance of the use of clean energy sources. In addition, the more the education of household heads, the greater the likelihood of higher paying jobs which could make clean energy more affordable compared to people with lower education.

CONCLUSION

This study analysed the demand for clean energy sources (LPG and Electricity) by various households in Nigeria. The results show that the demand for clean energy sources are generally low in both rural and urban households although demand for both LPG and electricity as sources of household domestic energy in the rural areas were higher than those

for urban areas. In general, the demand is low and this could place a considerable burden on the environment as demand for clean energy is replaced with the use of dirty fuels. The household heads in the study are in the most, male headed, low income literate and rural. The demand for clean energy was significantly determined by the level of education, age, household size income, sex, and either rurality or urbanism of household heads.

RECOMMENDATIONS

Based on the findings of the study, the following policies are recommended to government/policy makers.

- Firstly, Nigerian government needs to by all means improve electricity supply. This can be achieved if the ongoing hydroelectric dams are completed. Also, there should be investment on solar and wind energy sources in the various zones where such resources are abundant in the country.
- Secondly, there is the need to improve the income level of the consumer because increase in income induces the demand for clean energy. Hence, the the welfare of the populace should be improved. Policies similar to the trader mony and N power packages that are in existence now should be considered and be sustained beyond short term targets.
- Finally, the use of LPG as a source of clean energy should be improved. This can be achieved if the governement adopts a proper policy either by given some incentives, quota or subsidizing the cost of installation or making some of the equipment reasonably affordable for households to switch to in order to encourage the use of LPG as their major source of energy for cooking.

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