Comparative Analysis of Energy Poverty among Rural and Urban Households in Oyo and Ogun States, Nigeria

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Abstract: **Studies on poverty analysis have extended beyond just income and nutritional poverty status determination in recent decades. The understanding of multi-dimensional poverty analysis has widened the scope of research works by considering other forms of poverty that are triggering the living conditions of people in the Nations. As a result, this study seeks to analyse and compare the energy poverty status of rural and urban households in Oyo and Ogun States. Primary data through multistage random sampling technique was used to obtain 378 households and interviewed through structured questionnaires. Descriptive Statistics, energy inconvenience index, energy expenditure approach and a multinomial logit regression model were the tools employed. The study revealed that, socio-economic characteristics had significant effect on energy poverty of the urban more than the rural households. The inclination of the urban (17.7percent) to choose kerosene and gas as their energy mix was stronger than rural (1.06 percent) households. The most prominent energy mix available are kerosene, gas and charcoal (53.44%) and (53.16) for both rural and urban households. Age, household size ($p<0.01$), households' education ($p<0.05$), distance travelled ($p<0.01$), number of trips made ($p<0.01$), transport cost ($p<0.05$), price of kerosene, price of charcoal, total income ($p<0.01$), and marital status are probable and significant factors responsible for the choice of energy used. The Pseudo R^2 was 0.6591 implying that the model explained 65.91% of the deviation of energy choice made in the study area. The most inconvenient indicators of energy poverty are the number of trips, distance travelled and transport cost. The total energy inconvenience index of 0.025, total energy threshold or line of 0.020, energy inconvenience excess -125, energy shortfall of -11.667 and poverty index of -68.33 are indicators that, the rural households experienced energy poverty more than the urban. The pooled data of energy expenditure approach revealed that, the households are energy core-poor because about 53.97% spent a mean amount of ₦4971.18 and ₦5, 000.18 (> 10%) of their average total income on energy sources. Distance travelled, transport cost ($p<0.05$), household education ($p<0.01$), household size ($p<0.01$), amount spent on gas ($p<0.01$), amount spent on kerosene and total expenditure are significant variables subjecting the rural and urban households to energy poverty in the study area. In conclusion, households should have an economical budgetary allocation and be cautious not to spend more than 10 percent of their average monthly income on energy sources.**

Keywords: **Energy, energy poverty, energy poverty line**

I. INTRODUCTION

Energy use may be in its raw form (primary energy) or in its transformed state(secondary energy). When both forms are subjected to combustion to release their stored energy it is called fuel. Energy poverty is a state of insufficient energy sources for basic living Bilal and Adams (2010). It is also a state where households are spending more than 10% of their income on energy use Famhy (2011). Energy poverty can further be defined as an absence of sufficient choice in assessing adequate, affordable, reliable, high quality, safe and environmentally benign energy sources. Energy poverty has also been defined as the state of deprivation where a household or indeed an economic agent is barely able to meet at most the minimum energy requirement for basic needs IEA(2010). Energy poverty line is the minimum quantity of physical energy needed to perform such basic task of cooking and lighting. Energy has a key enabling role in achieving food security and better nutrition. Energy prices influence food prices FAO (2015).The energy sources or primary energy can be split into three broad categories namely: fossil fuels, renewable and nuclear sources. There are many types of fossil fuels of which the most important are coal, petroleum, and natural gas. The main renewable energy sources are solar, wind, hydropower, and geothermal power. The nuclear-powered sources are fission and fusion. They are relatively easy to use to generate energy because they only require a simple direct combustion. However, a problem with fossil fuels is their environmental impact. Indeed their combustion leads to a great deal of greenhouse gas emissions particularly in the case of coal. Renewable energy sources main assets are their environmental cleanliness, low maintenance and running costs compared with fossil fuels and they cannot be exhausted. Major constraints so far are their high investment cost compared with fossil fuels. In the light of increased fossil fuels prices and environmental concerns, renewable energy is becoming more and more attractive UNDP(2017). Renewable energy technologies encompass a diverse array of technologies and the current status of these different technologies varies considerably. Some technologies are readily mature and economically competitive (geothermal and hydropower), other technologies needed additional developmental steps to become competitive without subsidies UNDP (2017). Energy carriers such as electricity and other fuels facilitates job creation, industrial activities, agricultural outputs and micro-enterprises and thus helps alleviating poverty and hunger. Provision of energy services also improve health care facilities and its delivery. Cleaner energy systems contribute to environmental sustainability by addressing adverse impact of energy production, distribution and consumption IEA (2010).It is the fundamental engine that drives industrialization, fosters economic growth, meeting commercial and domestic needs. Energy is not only needed for domestic consumption, its availability creates an enabling environment for small-scale businesses to survive. The hair barber, the hairdresser, fish hawkers by the roadside, sachet water sellers, fishermen, farmers and corn orrice millers. All needs one form of energy or the other to foster their businesses, thus, energy is not only an end but also a means to an end Shahidur *et al.*(2010).The Vision 2020 identified expanded employment opportunities as key to meeting the targets of making Nigeria a top 20 economy. Some of the actions to stimulate job creation include; expansion of investments in critical infrastructure, particularly the energy sector, fostering private sector-led non-oil growth and investing in human capital development. Nigeria would have a large, strong, diversified, sustainable and competitive economy that effectively harnessed the talents and energies of its people and responsibly exploits its natural endowments to guarantee a high standard of living and quality of life to her citizensNBS Report(2011).

From the foregoing, it was noted that energy is indispensable to human growth and development. But households are not conscious of what they spend and how best to use the energy sources available to them which this study seeks to explore. This study therefore compares and analyse the energy poverty among rural and urban households in Oyo and Ogun states, Nigeria. The specific objectives are to profile their socio-economic characteristics, describe the types ofenergy mix used, examine the factors affecting the choice of energy used and determine the energy poverty level of the rural and urban households in the study area.

II. METHODOLOGY

The study was carried out in Oyoand Ogun States, South Western Nigeria. South Western Nigeria is made up of Lagos, Ogun, Oyo, Osun, Ondo and Ekiti States. It is also known as the South West geographical zone of Nigeria. The area lies between longitude 2^0 31^1 and 6^0 00^1 East and Latitude 6^0 21^1 and 8^0 37^1N of equator with a total land area of 77,818 km^2 and a projected population of 28, 767, 752 NPC(2006). The area is bounded in the east by Edo and Delta States, in the north by Kwara and Kogi States, in the west by the Republic of Benin and in the south by the Gulf of Guinea. Oyo State is made up of four Agricultural Zones which are Ibadan/Ibarapa, Oyo, Ogbomoso, and Shaki with three Senatorial Districts namely Oyo central, Oyo South and Oyo North respectively MRP (2008). Ogun, the Gateway State, was created in 1976 and is in South Western Nigeria. The state is named after the Ogun River which runs right across it from north to south. Ogun State is strategically located; bordered to the east by Ondo State and to the north by Oyo and Osun States. Its border with the Republic of Benin, to the west, makes it an access route to the expansive market of the Economic Community of West African States (ECOWAS), to the South by Lagos, the former Capital of Nigeria and still remains the commercial nerve centre of the country and indeed that of West Africa Sub-region and also by the Atlantic Ocean. Ogun State has a land area of 16,409.26 square kilometers.

Multistage sampling technique was used to select the households' in the study area. The first stage was the purposive selection of Oyo and Ogun States out of the six States that make up the South Western part of Nigeria. Nigeria as a country is richly endowed with crude oil, coal, fuel wood, solar energy and a large capacity to develop hydropower Ajani (2000). Therefore, Oyo and Ogun States represents a wide spectrum of energy sources which are vital for national economic development. The second stage was a random selection of one Agricultural Development Programme (ADPs)zone from each of the States earlier chosen. Oyo State is divided into four (4) Zones, namely, Saki, Ogbomoso, Oyo and Ibadan/Ibarapa zones and Ogun State ADP (OGADEP) was also divided into four namely Ilaro, Ikenne, Abeokuta and Ijebu Ode. The third stage was random selection of Local Government Areas (LGAs) from each ADP zone that included both the rural and urban households using simple random techniques making a total of seven LGAs in Oyo and Ogun States, that is four LGAs in Oyo and three LGAs in Ogun states respectively. The fourth stage involved the random selection of villages each, from each of the selected local government areas which was obtained from the information unit of each of these local government areas. The final stage was the random and proportional selection of the households' using proportionality factor from each village. This was informed by the high number of deprivation and inability of the inhabitants to meet the minimum energy requirement for basic needs and also the zones are faced with the problems of unaffordability of kerosene, expensive charcoal with small size bags and of poor quality, hardship in collecting fuel wood, erratic and exorbitant bills from electricity among others. Thus, a total of three hundred and seventy-eight (378) households'was sampled using proportionality and representative sampling methods.Both descriptive statistics (mean, frequencies and percentage es) and Multinomial Logit Model was used. Multinomial logistic regression was used to predict a nominal dependent variables given one or more independent variables. It is sometimes considered an extension of binomial logistic regression to allow for a dependent variable with more than two categories. The response variable poverty category was treated as categorical under the assumption that the levels of poverty status do not have natural ordering and the stata analytical package was allowed to choose the referent group as used by Adepoju (2019).

The general form of the multinomial Logit model was:

$$Pr(y_i = j) = \frac{exp(X_i\beta_j)}{1+\sum_{j=1}^{J} exp(X_i\beta_j)} \text{ …. (1)}$$

To ensure identification,

$$Pr(y_i = 0) = \frac{1}{1+\sum_{j=1}^{J} exp(X_i\beta_j)} \text{ …. (2)}$$

$$P_{ij} = \frac{exp(\gamma_j X_i)}{1+\sum_{j=1}^{3} exp(\gamma_i X_i)} \text{for j = 1, 2, 3. …. (3)}$$

P_{ij} will be the probability of being in each of the groups 1 and 2

$$P_{i0} = \frac{1}{1+\sum_{j=1}^{3} exp(\gamma_i X_i)} \text{for j = 0 …… (4)}$$

P_{i0} is the probability of being in the reference group or group 0

In practice, when estimating the model, the coefficients of the reference group was normalized to zero Rahji and Fakayode(2009). This was based on the fact that, the probabilities for all the choices must sum up to unity Greene (1993). Hence, for 3 choices only (3-1) distinct sets of parameters was identified and estimated. The natural logarithms of the odd ratio of equations (1) and (2) gave the estimated equation Greene (1993) as:

$$\ln = \frac{P_{ij}}{P_{i0}} \gamma_j X_i \text{ ……… (5)}$$

This denoted the relative probability of each of the groups 1 and 2 to the probability of the reference group. The estimated coefficients for each choice therefore reflected the effects of Xi's on the likelihood of the households choosing the alternative relative to the reference group. However, following Hill (1983) and Rahji and Fakayode(2009), the coefficients of the reference group might be recovered by using the formula

$$\gamma_3 = -(\gamma_1 + \gamma_2) \text{ ………. (6)}$$

The Multinomial Logit Regression Model, energy options variables was categorized into 3 levels; that is,

- ❖ Poverty status (based on average energy expenditure of the households'in ₦)
  - Non-poor (spending >₦4,971) = 2
  - Moderately poor (spending exactly = ₦4.971) = 1
  - Core poor (spending <₦ 4,971) = 0 and
- ❖ Poverty status (based on ten percent (10%) of average total income in ₦)
  - Non- poor (spending >₦5,000) = 2
  - Moderately poor (spending exactly = ₦5,000) = 1
  - Core poor (spending <₦5,000) = 0

Where = 1, 2, -----------------*n* variables

K = 0, 1, --------------------------- j energy options

β = vector of parameters that relates to the probability of being in energy options. The linear equation for multinomial logit regression was represented below;

- ❖ **That is, factors influencing the energy poverty status of the households' based on their average energy expenditure and ten percent (10%) average total income.**
- ➢ **Factors influencing the energy poverty status of the households' based on their average energy expenditure that is (₦4,971)**

Y=Poverty status {Average energy expenditure of the households'(2, 1, and 0)

- Non-poor (spending >₦4,971) = 2
- Moderately poor (spending exactly = ₦4.971) = 1
- Core poor (spending <₦4,971) = 0

$Y_1 = \alpha_1 + \alpha_1X_1 + \alpha_2X_2 + \alpha_3X_3 + \alpha_4X_4 + \alpha_5X_5 + \alpha_6X_6 + \alpha_7X_7 + \alpha_8X_8 + \alpha_9X_9 + \alpha_{10}X_{10} + \alpha_{11}X_{11} + \alpha_{12}X_{12} + \alpha_{13}X_{13} + \mu$

X_1= Age of the household head in years

X_2 = Marital status

X_3 = Household size

X_4 = Household education in years

X_5= Distance travelled to the place of purchasing energy types used in (km)

X_6 = Number of trips made per month in buying energy needs

X_7 = Amount spent on transportation to the place of purchasing energy type in (₦)

X_8 = How expensive the energy used are

X_9 = Price of kerosene in (₦)

X_{10} = Price of charcoal in (₦)

X_{11} = Price of gas in (₦)

X_{12}= Total income of household head in (₦)

X_{13} = Total expenditure on energy type used in (₦)

α_0= Intercept coefficient

α= Slope coefficient (δy/ δx)

μ= Stochastic error terms.

- ➢ **Factors influencing the energy poverty status of the households' based on ten percent (10%) average total income that is (₦5,000)**
  - Non-poor (spending >₦5,000) = 2
  - Moderately poor (spending exactly = ₦5,000) = 1

- Core poor (spending <₦ 5,000) = 0

Y=Poverty status {average energy expenditure of the households'(2, 1, and 0)

$Y_1= \alpha_1+ \alpha_1X_1+ \alpha_2X_2+ \alpha_3X_3+ \alpha_4X_4+ \alpha_5X_5+ \alpha_6X_6+ \alpha_7X_7+ \alpha_8X_8+ \alpha_9X_9+\alpha_{10}X_{10}+\mu$

X_1= Distance travelled to the place of purchasing energy types used in (km)

X_2= Number of trips made per month in buying energy needs

X_3 = Amount spent on transportation to the place of purchasing energy type in (₦)

X_4 = Household education in years

X_5= Household size

X_6 = amount spent on gas in (₦)

X_7 = amount spent on charcoal in (₦)

X_8= Amount spent on kerosene in (₦)

X_9 = Energy expenditure (actual purchase cost plus transport cost) in (₦)

X_{10} = Total expenditure on energy type used in (₦)

α_0= Intercept coefficient

α= Slope coefficient ($\delta y/ \delta x$)

μ= Stochastic error terms.

III. RESULT AND DISCUSSION

Table 1 presents the socioeconomic characteristics of the households. The table revealed that, there are more aged people in the urban than the rural households. This could result from many years spent in school. There are more female and married in the urban areas than the rural households. This accounts for a large family size. The reason could be as a result of migration to the urban area and that households would be in need of energy sources either for cooking and or lighting purposes. More of the rural households had no formal education while some educated persons still reside in the rural areas claiming that they come to the village by weekends. This could result to high tenancy rate in the urban. The major occupation of the households is farming and civil service for both rural and urban respectively. Some urban households still visit to the rural areas for farming activities. More urban households earned between 40,000-80,000 per month while the rural earned less than 40,000 per month. The mean amount earnings showed that the urban households earned more than the rural households. This could result to the fact that the urban households have stable salaries than the rural households.

Table 1: Descriptive Statistics of Socio-economic variables of the households

Age	**Rural**	**Urban**
< = 25	0.53	1.58
26 -50	55.32	57.37
51 – 57	42.55	40.00
> 75	1.60	1.05
Mean	49.44	48.83
Sex		
Male	33.51	28.95
Female	66.49	71.05
Single	6.38	5.26
Married	93.62	94.74
Household size		
1-3	31.91	20.00
4-6	55.85	61.05
7-9	11.70	18.42
>9	0.54	0.53
Mean	4.85	4.92
Education Status		
(No-formal)	26.60	15.79
Primary	13.30	20.00
Secondary	21.28	27.89
Tertiary	38.82	36.32
Primary occupation		
Farming	57.45	30.53
Civil service	31.91	62.11
Others	10.64	7.36
Distance travelled (mean)	3.56	3.95
Number of trips made (mean)	3.44	3.15
Transport cost (mean)	291.01	285.58
Total Income		
< 40,000	43.62	38.42
40,001-80,000	38.83	42.63
80,001-120,000	10.11	11.58
120,001-160,000	4.79	4.21
>160,000	2.65	3.16
Mean	56,429.52	57,803.95

Energy Mix Available to the Households' in the Study Area

Table 2 revealed the energy mix used by the households in the study area. The rural households used more of kerosene and charcoal while the urban households mixed kerosene, charcoal and fuel wood. This could mean that, the urban used any form of energy sources available to them. The urban households used a mix of kerosene and gas more than the rural households. The reason could be that, the rural are not aware of gas or that they are afraid of the risk involved. Non-of the urban households included crop residue in their energy mix except the rural households who used kerosene, crop residue and fuel wood. Likewise, the rural households' does not kerosene and electricity mix as urban households except some areas where government erected solar panels. Fidelis and Uche (2016) in their own study showed that most households in Nigeria use fuel wood for cooking (69.98 per cent) while most households in the country use kerosene and mains electricity for lighting; 49.66 per cent use kerosene while 45.39 per cent use mains electricity. Omokaro(2008), reported that, the energy consumption mix in Nigeria is dominated by fuel wood (50.45%), petroleum products (41.28%) and hydro-electricity (8%) while biomass, solar, wind geothermal, coal and nuclear sources are largely ignored. The absolute poverty rate of Nigeria was 61.9% by 2011 Yemi(2012)implying that the major domestic energy consumption is predominantly fuel wood because it is cheap and easily available. In accordance to the study carried out by Elijah, (2012) indicated that charcoal, wood biomass accounts for 31% and 50% of cooking energy sources for urban and rural areas in Nigeria thus making it to be dominant cooking fuel source. Their study also showed that 42% and 33% of urban and rural dwellers respectively use kerosene while only 10% of the urban dwellers use liquefied petroleum gas (LPG) for cooking, and a further 4% of the rural dwellers use LPG as cooking fuels. Hence, the study revealed that, the rural and urban households in the study area experienced energy poverty because their dominant energy mix was kerosene and charcoal rather than kerosene and liquefied natural gas which was the base outcome used.

Table 2: Distribution of the households' based on energy mix available to the households' in the study area

Energy mixes	**Rural**	**Urban**
Kerosene and charcoal	53.72	53.16
Kerosene, charcoal and fuel wood	21.81	25.26
Kerosene and gas	1.06	17.7
Kerosene, petrol, engine oil and firewood	2.13	2.63
Kerosene, crop residue and firewood	19.68	-
Kerosene and electricity	-	0.53
Kerosene, charcoal and petrol	0.53	0.53
Kerosene, gas and electricity	1.06	0.53

Factors affecting the choice of energy used by the households in the study area

The result in Table 3 revealed the factors that explained the rural and urban households' disposition to the number of different energy mix used in the study area such as fuel wood, charcoal, sawdust, residues, kerosene, gas, petrol, electricity and solar based on multinomial logit estimates results. The variables that are significant include; age, marital status, household size, household education, number of kilometers to the place of purchase, number of trips to the place of purchase, how expensive, prices of kerosene, charcoal, gas, total income and total expenditure on energy use. Household head income was significant at 1% ($p<0.006$) and had negative coefficient (-0.0000689). This implied that as rural and urban households' income tends to reduce, there is greater likelihood for households to augment his or her sources of energy mix used to meet their domestic energy purposes. The implication is that household that are poor tend to be disposed to the use of kerosene, charcoal and fuel wood while those that were better-off tend to augment with liquefied natural gas. The variable age tend to influence households' disposition to the use of various energy sources. The variable age has positive coefficient ($p<0.016$) and significant at 1% level. The implication of this is that, the higher the age of household head, the higher the types of different energy mix used by the households. This effect plus that of income will make such household to move from a particular energy option or sources to another.

The result was in accordance to the study carried out by Fakayode *et al.*, (2013) on the determination of biomass augmented with non-forest resources, variables that were significant include; income, age, and prices of forest energy option. Monthly income of household head was significant at 1% and had negative coefficient. This implied that as rural income tends to reduce, there is greater likelihood for household to augment forest and non-forest energy resources together to meet domestic energy purposes. The implication is that household that are poor tend to be disposed to the use of forest resources (charcoal or fuel wood) while those that were better-off tend to augment with non-forest alternative fuels. The marginal effect for the household was revealed to be -1.20006 and relative risk ratio of 0.9999734. These results can be interpreted as follows; a low income increases the probability of choosing different energy mixes such as kerosene and charcoal, as their main energy option than not using kerosene, liquefied natural gas and electricity at all. More precisely, an average income that is (₦50,120.00) lower increases this probability by one point. This result agrees with that of Stephane *et al* (2006) but the only difference was that Stephane *et al.* (2006) carried out their research using urban households. Since poorer households tend to be disposed to the use of fuel wood, then this resource appeared to be an inferior goods. But when it is augmented or used as back-up with non-forest resources, it has the characteristic of a normal good. This result was also justified by that of Stephane *et al* (2006) which have the estimate of income to be negative and significant. Prices of kerosene, charcoal and liquefied natural gas energy options seemed to have positive effect on the probability of choosing kerosene and charcoal as their main source of energy. This implied that as the prices of the various energy sources increases, there is low demand for such products. This conforms to the theory of demand, considering these products to be a normal good. Prices of different energy sources significantly affect the choice of either kerosene, charcoal, gas and fuel wood. This variable showed negative coefficient (-0.6255836) and significant at 10% (0.085) for the households sources of energy choices. The significance of this truly reflect energy consumption pattern in the developing world. So, as the energy become expensive, the disposition of the respondents to the use of the various energy sources decreases. This result was in contrast to Kolawole and Sekumade (2017)**,** who showed that the prices of forest energy option significantly affect the choice of both biomass and non-forest energy option. This variable exhibited positive coefficient and significant at 1% and 10% for forest (charcoal or fuel wood) augmented with non-forest resources and non-forest resources (liquefied natural gas) alone respectively. The significance of the prices of fuel wood or charcoal does not truly reflect its consumption pattern in the developing world today. The estimates showed that as their prices increases, so also is the disposition to the use of biomass and non-forest resources (liquefied natural gas).

Table 3 Summary table of factors affecting the choice of energy used by the households in the study area

No of different energy mixes	Coefficient	p>/z/	Marginal effect	RRR
Age	-0.0608916	0.016*	-.0027366	.9409252
Marital status	3.630544	0.003*	-.0034704	2.52521
Household size	-0.2527279	0.014**	-.0026297	.7766792
Household education	0.3743103	0.039**	-.0250554	.7405254
Distance travelled (km)	0.4379185	0.001*	.0277734	1.549479
Number of Trips	0.3280303	0.018*	.0082156	1.388231
Cost of Transport	-0.003185	0.039**	-.0001249	.99682
Expensive	-0.5438616	0.085***	-.0248375	.5805022
Price of kerosene	0.007441	0.079***	-.000437	1.002912
Price of charcoal	-0.0012672	0.012*	-.0000554	.9987336
Price of gas	-0.0000689	-0.06	.0000458	.9999311
Total income	-0.0000139	0.011**	-1.23	.9999734
Total expenditure	7.12	0.041**	-2.13	1.0000
Total Cost of Energy used	0.0001626	0.049**	-5.24	0.9999815
Log Likelihood	-558.2278			
Pseudo R^2	0.6591			
Chi^2	0.0000*			
LR Chi^2	(98) 267.88			

*, **, *** represents 1%, 5% and 10% respectively

Energy Expenditure Approach

Expenditure on energy was calculated by summing together all money metric costs incurred on the energy facilities or energy types used. These are;

1) Transport cost to and from the place of purchase of the energy types and
2) The actual purchase cost of the various energy types.

It was given by;

$$EEX_{ij} = ETPT_{ij} + APC_{ij}$$

where;

EEX_{ij} = total expenditure on all energy use i by household j in naira per month

$ETPT_{ij}$ = transport expenses incurred on energy use i by household j in naira per month

APC_{ij}ij = actual purchase cost of the energy use i by household j in naira per month

Famhy (2011) and Department for International Development (DFID) (2009) declared that energy poverty is a state where a household is spending more than 10% of his or her income on energy facilities. Based on this fact, the following results were obtained from the study.

The result in Table 4 presented a summary of energy poverty statistics using the income or economic approach. The table showed 117 representing 30.95% households who spent less than 10% of their average total income on energy used types are energy non-poor. Those households' that are moderately poor are 15.08%, that is, those who spent exactly 10% of their average total income. While households' that spent greater than 10% and core poor are 53.97%. The average total income expenses on energy types used by both the rural and urban households' in the study was ₦5000.18.

This implied that, households in the study area should spend below 10% of their average income on energy types including transport cost in other to be energy non-poor. In contrast to Bilal and Adams(2010) their study showed that 62 households representing 19 percent of the sample were energy non-poor while 257 households representing 81 percent of the sample were energy poor. Department for International Development DFID(2009) and Famhy(2011) stated that households that spent more than 10% of his or her income on energy use are energy poor. Therefore, 10% of the respondents average income was ₦5,000.18 So, 0 implied energy core-poor spending <10% of the respondent's average income. 1 implied energy moderately poor that is those who spent exactly 10% of their average income and 2 implied non-poor for respondents who spent more than 10% average total income. This implied that, the households in the study area were not enjoying energy sources adequately but had free access to non-green energy sources like fuel-wood which they collect free of charge. The above result was in between Samuel *et al* (2013) and Betchani *et al* (2013) works. Samuel reported 83.2% while Betchani *et al* (2013) revealed that over 90% respectively of the households sampled were energy poor.

Table 4 Energy poverty status based on 10% average total income spent on energy used by households'

Energy poverty status		Frequency	Percentage
Non-poor (spending < 10%)	2	117	30.95
Moderately poor (= 10%)	1	57	15.08
Core poor (> 10%)	0	204	53.97
Average total expenditure = ₦5,000.18			

Energy poverty status based on average total expenditure on energy used by households'

A measure of energy poverty borrowed from income poverty literature to compute a relative energy poverty line using descriptive statistic methods. A relative measure of energy poverty was performed where the mean of the cost of energy was computed. The result in Table 5 showed that, 173 households representing 45.77 percent are energy non-poor. These households are spending less than ₦4971.18 of their average income on energy commodities or types including transportation. Also, 204 households are found to be energy poor represent 53.97%. That is, those spending greater than ₦4971.18 of their average income on energy types including transportation. Only one household representing 0.26% of the households that was moderately poor because they spent exactly ₦4971.18 of their average income on energy commodities or types including transportation. In the study carried out by Betchani *et al* (2013). He found out that, those whose cost was found to be below the average were referred to as energy poor and those above the mean were energy well-off. The study therefore revealed that, 53.97 percent of the households' in the study area are energy poor because they spent above their mean income. The two results are almost the same. That is, the method used by Famhy (2011) and Betchani *et al* (2013) as adopted in this study. This implied that, 54 percent of the households in South Western Nigeria are experiencing energy poverty. In accordance with Bilal and Adams(2010) study which concluded that at least 60 percent of the households in south Lunzu Township could be classified as in energy poverty.

Table 5 Energy poverty status based on average total expenditure on energy used by households'

Energy poverty status		Frequency	Percentage
Non-poor (spending <₦4971)	2	103	27.25
Moderately poor (= ₦4971)	1	71	18.78
Core poor (>₦4971)	0	204	53.97
Average total expenditure = ₦4971.18			

Factors that influence the energy poverty status of the rural and urban households in the study area

The result in Table 6 showed factors that explain rural and urban households' disposition to energy use such as fuel wood, charcoal, sawdust, farm residues, kerosene, gas, petrol, electricity and solar based on multinomial logit estimates results. Variables that were significant include; transport cost, household education, household size, amount spent on gas, amount spent on kerosene and total expenditure on energy type used. All these had influenced on the energy poverty status of the rural and urban households in the study area if they are to be energy non-poor in relation to the base outcome. The multinomial logit result indicated that a one unit increase in the variable distance travelled is associated with a -0.28169 in the relative log odds of the households' energy poverty status. Distance travelled by the households was significant at 1 percent (0.008). This implied that, as the households' distance travelled increased by one kilometre, their energy poverty status would also increase. A one unit increase in the variable number of trips made is associated with a -0.03939 in the relative log odds of the households' energy poverty status. The number of trips made by the households was not significant at any level. This implied that, as the households' number of trips made increases, their energy poverty status would also increase. A one unit increase in the variable transport cost is associated with a -0.002418 in the relative log odds of the households' energy poverty status. Transport cost by the households was significant at 5 percent (0.043). This implied that, as the households' transport cost increases by one naira, their energy poverty status would also increase. A one unit increase in the variable household education is associated with a 0.76621 in the relative log odds of the households' energy poverty status. Households' education by the households was significant at 1 percent (0.000). This implied that, as the households' household education increases by one year, their energy poverty status would also increase.

A one unit increase in the variable household size is associated with a 0.21072 in the relative log odds of the households' energy poverty status. The households' size was significant at 1 percent (0.007). This implied that, as the households' size increases by one person, their energy poverty status would also increase. A one unit increase in the variable amount spent on gas is associated with a 0.00058 in the relative log odds of the households' energy poverty status. The amount spent on gas by households' was significant at 10 percent (0.0075). This implied that, as the amount spent on gas by households' increases by one naira, their energy poverty status would also increase. A one unit increase in the variable amount spent on charcoal is associated with a 0.00022 in the relative log odds of the households' energy poverty status. The amount spent on charcoal by households' was not significant at any level. This implied that, as the amount spent on charcoal by households' increases by one naira, their energy poverty status would also increase. A one unit increase in the variable amount spent on kerosene is associated with a 0.00085 in the relative log odds of the households' energy poverty status. The amount spent on kerosene by households' was significant at 1 percent (0.007). This implied that, as the amount spent on kerosene by households' increases by one naira, their energy poverty status would also increase. A one unit increase in the variable total cost of energy used is associated with a 0.00073 in the relative log odds of the households' energy poverty status. The total cost of energy used by households' was significant at 1 percent (0.019). This implied that, as the total cost of energy used by households' increases by one naira, their energy poverty status would also increase.

A one unit increase in the variable total expenditure is associated with a 0.00002 in the relative log odds of the households' energy poverty status. The total cost of energy used by households' was significant at 1 percent (0.000). This implied that, as the total expenditure incurred by households' increases by one naira, their energy poverty status would also increase. The pseudo R2 was (0.5503). This implied that, the explanatory variables explained 55 percent of the factors influencing energy poverty status of the households in the study area. It also implied that households' that are poor tend to be disposed to energy poverty while those that were better-off tend to augment with non-forest (liquefied natural gas) alternative fuels Fakayode *et al.* (2013).

The amount spent on gas was significant at 10% while the amount spent on kerosene was significant at 1%. This implied that as the amount spent on energy sources increases, there will be low demand for energy used types. This conforms to the theory of demand, considering the energy sources to be a normal good. The households' education (0.000) and household size (0.007) were both significant at 1%. The number of trips made to the place of purchase was not significant at any level but had negative coefficient (-0.0393916) and negative marginal effect (-0.0059656). The implication of this is that, the more the households visit the place of purchase the more the level of their poverty status. This was in accordance to the study carried out by Fidelis and Uche (2016) which showed that the determinants of energy poverty in Nigeria included household size, educational level, gender and age of household head, general poverty, region of residence and proportion of working members in the household.The Log-Likelihood Ratio test and the Chi-Square value testing the overall performance of the model was -315.1159 and 111.50 respectively was significant at 1%. This implied that, the predictor in the multinomial logit regression model are collectively important in explaining the behaviour of energy poverty of the households' in the study area.

Table 6 Summary Table of Factors that influence the energy poverty status of therural and urban households in the study area

Energy poverty status	**Coefficient**	**t-values**	**p>/z/**	**Marginal effect**	**RRR**
Distance travelled	-.2816991	-2.64	0.008*		.0804125
Number of Trips made	-.0393916	-0.56	0.578	-.0059656	.9613742
Transport cost	.0024176	2.02	0.043**	.000446	1.00242
Household education	.7662046	5.26	0.000*	.154284	2.151585
Household size	.2107162	2.71	0.007*	.0399736	1.234562
Amount spent on gas	.0005803	1.78	0.075***	.0001301	1.00058
Amount spent on charcoal	.0002221	1.20	0.230	.000035	1.000222
Amount spent on kerosene	.0008473	2.72	0.007*	.0001802	1.000848
Total cost of energy used	-.0007259	-2.34	0.019*	-.0001625	.9992744
Total expenditure	.0000159	3.84	0.000*	2.86e-06	1.000016
_cons	-3.783803	-4.53	0.000*		.0227361
Log likelihood	-315.1156				
Lr chi2(20)	111.50				
Prob>chi^2	0.0000*				
Pseudo R^2	0.5503				
Observation	378				

*, **, *** represents 1%, 5% and 10% respectively

IV. CONCLUSION

In conclusion the study has found out salient facts which will be relevant and of great importance to the Nigerian Developmental Policies on energy supply to Oyo and Ogun States in South Western Nigeria. Knowing fully that energy sources either for cooking, lighting or business is indispensable. The study revealed that, energy utility maximisation was at different points for various households at different income levels and various prices. There is a need for households' in the study area to have an economically budgetary allocation for their energy needs per month. The major energy mix in the study area are kerosene, liquefied natural gas and charcoal. Therefore, rural households' in the study areacould move to a more attractive energy sources (kerosene and liquefied natural gas) while the urban households' move to a most attractive energy sources (liquefied natural gas and solar) to meet their domestic energy needs. Households should not spend more than their mean or above 10% of their average monthly income on energy used types because of the resultant effect of changes in the prices of their different energy mix used. Household heads are encouraged to purchase all their energy types needed at once in other to reduce their transport cost and number of trips to the places of purchase of their energy sources with respect to the available income at their disposal. Finally, increase in household size would lead to more expenditure on energy sources. Therefore, households in the study area are encouraged to intensify more efforts on other sources of income in other to have more to satisfy their energy needs and making prudent use of their income.

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