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ASSESSMENT OF ENERGY POVERTY AMONG RURAL HOUSEHOLDS IN KWARA STATE, NIGERIA

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Abstract
Energy poverty is a widespread phenomenon which is mostly attributed to the poor rural households in developing countries. This study was carried out to assess the energy poverty status and as well analyze the determinants of energy poverty among rural households in Kwara State of Nigeria thus providing information that may lead to improvement in the energy use efficiency of the rural households. A four-staged random sampling technique was used to select 150 rural households from Kwara State and were administered a well-structured questionnaire. The study employed the descriptive statistics, expenditure approach and logit regression model to identify the various energy used for cooking by the rural households, energy poverty status and the determinant of energy poverty in the study area, respectively. The result shows that the household stack the various types of energy with majority of them using the combination of modern and transitional energy types, with 59% using the traditional sources of energy and 49% using the modern sources in the past 7 days. About 39% of the rural households were energy non poor, years of schooling, distance to energy source and household income significantly influence the energy poverty of the households. Although majority of the rural households spend above the energy benchmark for this study, however, majority of them uses the traditional sources of energy. The study therefore recommended necessity to establish regulatory frameworks for the protection of poor consumers to guarantee access to modern energy sources at affordable prices, which may involve the incorporation of subsidies.

Keywords: Energy Access; Energy Indicators, Energy Services; Fuel Stacking; Energy Expenditure; Energy Insecurity

1. INTRODUCTION

Energy' with 'matter' (in solid, liquid and gas) is what the universe is made of and it has the ability to create both physical and chemical changes (Bethel et al., 2018). Energy is the heart of development, it makes investment, innovations and new industries possible and it is a driver for job creation, inclusive economic growth and shared prosperity for the entire economies (World Bank, 2019).

Like many developing countries, energy poverty in Africa is real, severe and widespread (Ishaq, 2018). Energy poverty currently afflicts many regions of the world. However, Africa is apparently most hit by the problem (Ogwumike, and Ozughalu, 2016). According to the IEA, (2016), about two-thirds of the population in Africa, equivalent to nearly 620 million people does not have access to electricity and about 730 million depend on traditional biomass for cooking. In sub-Sahara Africa alone, the household electrification rate is 42%, while population of about 591 million has no electricity. While the rest of the world modernizes its cooking methods, and end the use of biomass, sub-Saharan Africa is the only region to have more people using traditional sources of energy, due to population growth, and it is projected that over 200 million will still be doing so by 2020 (Lambe et al., 2015).

The issue of energy poverty is experienced more in Nigeria by rural dwellers that use the traditional sources of energy which is the affordable energy source for some households (Chidiebere-Mart et al., 2018). According to Nnaji et al., (2012), 86% of the rural households in Nigeria depend on the traditional sources of energy (fuel wood, charcoal) which are channel to domestic and/or commercial use.

The traditional source of energy is characterized with their production of indoor gases which causes health risks (pulmonary, respiratory and carcinogenic) from their regular usage. The burning of traditional biomass in the household (people's home) is estimated to cause 600,000 deaths annually in the sub-Saharan Africa, due to indoor air pollution, exceeding the number of deaths from tuberculosis and AIDs, by 2030 (Morrissey, 2017). The incomplete combustion of biomass generates air pollutant mostly associated with carbon monoxide, particulate matter (PM), Sulphur dioxide, and Nitrogen dioxide, which plays a major role in creating respiratory diseases, and cardiovascular mortality, also spurs climate change by releasing carbon monoxide into the atmosphere (Muller & Yan, 2018), thus subsequently threatening the Nutritional health of human being. Energy service disruption known as energy insecurity, defined as the 'inability to adequately meet household energy needs' leads to arising issues of adverse health effect (Jessel et al., 2019).

2. LITERATURE REVIEW

Energy and poverty are highly related, there is no other way to run modern economies without the use of modern sources of energy (Shahidur, 2011). There is no consensus on the definition and measurement of energy poverty, approaches to measure energy poverty usually refer to a threshold value that is determined by physical or expenditure basis, defining those below this threshold as energy poor (Selçuk et al., 2019).

Determining energy poverty is better done through measurement. According to Herrero (2017), indicators have been a central element of energy poverty literature and have gone through series of development over the years. The different approaches in the measurement of energy focuses on either access to conventional energy sources such as traditional biomass use of firewood and animal waste or modern sources of energy such as LPG, electricity, which is more efficient, reliable and cleaner than traditional energy sources (Sanusi & Owoyele, 2016). Access to these energy sources is dependent on the increasing household prosperity follows the 'energy ladder' idea. An alternative approach to the energy access approach focuses on the amount of energy consumed by household, which is built on the perspective of Human development, and very related to the capability approach of measuring poverty (Day et al., 2016).

In theory, the process of constructing tools and metrics depends on how energy poverty is defined (Mbewe, 2016). Energy poverty metrics and methodologies have been developed over the years, being either uni or multidimensional; single or multiple indicator (Akande et al., 2018). Energy poverty metrics is an indicator that allows for the measuring and monitoring of energy poverty, it portrays the severity of the problem. According to Khandker et al. (2011), it has been difficult to defined energy poverty because basing energy poverty on minimum physical level of heating or cooking which often varies among different geographical locations due to the vast difference in climatic conditions worldwide. Others based on expenditure has been somewhat arbitrary in what defines essential energy services. (Ogwumike and Ozughalu, 2016).

3. CONCEPTUAL FRAMEWORK

Energy poverty is seen as a phenomenon occurring as a result of lack of access to energy (Sadath & Acharya, 2017), and insufficient consumption of energy services, which is the core of many development challenges (Akanda, 2018).

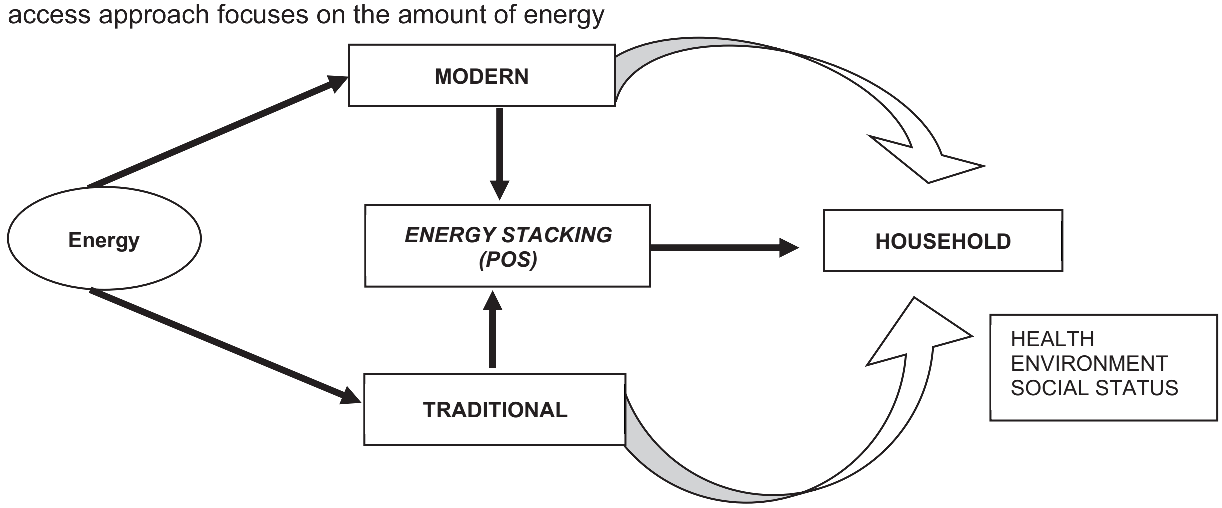

Fig.1 Conceptualizing household energy use and energy poverty.

In many developing countries, the high cost of modern cooking energy (LPG and electricity) and cooking stoves are the major constraints limiting their usage by the households (Kiyawa and Yakubu, 2017). When expressed from non-income dimension, energy poverty can indicate lack of electricity access and reliance on traditional cooking fuels of wood, charcoal and dung (Njiru and Latima, 2018). Figure 1 above shows the concept of various energy used in the Sub-Saharan Africa. However, according to Ismail and Khembo (2015) despite the high electrification rate in South Africa, households earning low income cannot afford sufficient electricity to improve their welfare.

In Nigeria, about 40% of the population has no access to electricity, with over 70% still depending on traditional biomass for cooking (Ehinmowo et al., 2018). According to Emagbetere et al. (2016), price of fuel is a major factor in the choice of fuel use in Nigeria, this makes rural households use the traditional sources of energy due to its affordability and ease of access and use. However, as the idea of energy poverty is multidimensional, so are its consequences (Sadath and Acharya, 2017). The usage of the traditional sources of energy has adverse implications to health, environment, and biodiversity, causing deforestation, loss of biodiversity, land erosion, and other types of harm to human and the environment (Mbewe, 2016).

Biomass collection in the rural households is done by the children and women (Vinet and Zhedanov, 2011). Environmental damage from the use of biomass accounts for about 60% of total global Green House Gas emission (Chidiebere-Mark et al., 2018). The life cycle of energy (from production, through distribution, then to consumption), significantly releases some amount of pollutants, particularly in terms of traditional biomass use (Kohler and Haan, 2010). The time spent for the consumption of traditional fuels such as fire wood depends on factors such as; the time attributed to collecting fire wood; additional time spent in storing wood; splitting to manageable pieces; starting the fire; cleaning and clearing the cooking area, constituting higher frequency and length of cooking event, in addition to productivity losses in cooking with fuel wood (Adamu et al., 2017).

In addition, female children are often withdrawn from school to work at home for helping their mothers in energy related activities such as carrying firewood (Vinet&Zhedanov, 2011). These activities are related to social deprivation which restricts women choices in the rural society.

4. RESEARCH METHODOLOGY

4.1 STUDY LOCATION

The study was carried out in Kwara State of Nigeria. The state was created by the Federal Government in May 1969. It comprises of sixteen (16) Local Government Areas (LGAs) with a population of 2,371,089.

4.2 DATA SOURCE/SAMPLING TECHNIQUE

The population for this study consists of rural household communities in some of the ADP zones in Kwara State. A three-stage random sampling technique was used to sample rural households for the study. In the first stage, three ADP zones, B, C and D were selected from the four ADP zones in the state, and one Local Government Area was selected randomly from each of the zones namely Edu, Asa and Ifelodun LGA. The second stage involved the random selection of five communities from each of the three Local Government Areas from the ADP zones. In the third stage, 15 households were randomly selected from each of the communities using systematic random sampling technique, and a total of one hundred and eighty (180) rural households were captured for the study and administered questionnaire. However, only 121 copies of questionnaire retrieved from the respondents were valid for analysis.

4.3 ANALYTICAL TECHNIQUE

Descriptive statistics was used for the socio-economic characteristics and the various energy choices by the rural households. This involves the mean, frequency and percentage.

4.4 EXPENDITURE APPROACH TO MEASURING ENERGY POVERTU USING FGT

Expenditure approach estimates how much energy is consumed by household to maintain a minimum livelihood, and categorizes household, based on the energy poverty threshold which is created by following some simple steps of standard techniques (Khandker et al., 2011). Using the FGT approach to creating the threshold, we first sum the total expenditure on the various energy use of the household as shown in equation (1).

$$X = \sum_{m=1}^{k} z_{ij} \qquad (1)$$

where X is the sum of the total energy expenditure by the households, z is the total amount of energy expenditure by a household in a month, i is the amount or number of energies consumed, j is the total number of times energy is purchased in a month. In the analysis of energy poverty, it is crucial to establish an energy poverty line. This line is usually based on how much energy consumption is necessary to maintain a bare minimum livelihood for households. This line separates the energy poor from the non-energy poor. However, due to the lack of official poverty line, an attempt to measure poverty uses different lines.

The use of two-third of mean consumption per capital expenditure is used based on the FGT approach, and as also used to establish a benchmark by Sudharshan, Ngwafor and Saji (2002); FOS (1999); Anyanwu (2005, 2010); as cited by Dapel (2018). Here, the energy poverty line is related to consumption expenditure rather than physical requirements.

$$m = \frac{2}{3}\bar{x} \qquad (2)$$

Monthly energy expenditure comes from the cumulative daily energy consumption by all the appliances in use in a household in the month under consideration. Therefore, energy consumption by smart appliances connected within a smart home to a smart meter is optimized to ensure that the household's energy expenditure is not more than the approved national energy expenditure threshold, in the context of the household's income (Longe and Ouahaada, 2018).

4.5 LOGIT REGRESSION ANALYSIS

To estimate the determinants of energy poverty and energy use of the rural household, Logit regression analysis was employed. It works similar to linear regression but with a binomial response in variable (Sandro, 2014). The following model was employed for the study.

$$L_i = \ln\left(\frac{pi}{1-pi}\right) = \alpha_i X_i \qquad (2)$$

The variables are defined as follows:
Li the logit (natural logarithm of the odds ratio); pi =1 if household is in energy poverty and pi = 0 if household is not in extreme energy poverty; (pi/(1-pi)) is simply the odd ratio in favor of being in energy poverty; Where Xi is the vector of independent variables and α is the parameters for the independent variables.

5. RESULTS AND DISCUSSION

Table 1 presents the definition and summary statistics of selected socio-economic characteristics derived from the sampled households, some of which were later used as covariates for econometrics estimation.

Table 1: Socio-economic characteristics of the respondents.

Variables	Categories	Freq	Perc	Mean
Gender	Male	77	63.6	
	Female	44	36.4	
	Total	121	100.0	
Age	≤30	28	23.1	38.0
	31 – 45	63	52.1	
	46 – 60	22	18.2	
	≥61	8	6.6	
	Total	121	100.0	
Household size	<5	70	57.8	6
	6 – 10	46	38.0	
	11 – 15	4	3.3	
	15 – 20	1	0.8	
	Total	121	100.0	
Marital status	Single	11	9.0	
	Married	106	87.6	
	Widowed	2	1.7	
	Separated	2	1.7	
	Total	121	100.0	
Household head education	No formal	16	13.2	
	Quranic	4	3.3	
	Primary	12	9.9	
	Secondary	32	26.5	
	Tertiary	57	47.1	
	Total	121	100.0	
House wife education	No formal	35	31.8	
	Primary	19	17.3	
	Secondary	24	21.8	
	Tertiary	32	29.1	
	Total	121	100.0	
Primary occupation	Farming	44	36.4	
	Civil servant	34	28.1	
	Business	43	35.5	
	Total	121	100.0	
Secondary occupation	None	74	61.3	
	Business	10	8.3	
	Artisan	14	11.5	
	Farming	18	14.9	
	Researcher	1	0.8	
	Others	4	3.2	
	Total	121	100.0	
Average monthly Income	<30,000	40	33.1	85,948.55
	30,000 – 50,000	26	21.5	
	50,000 – 70,000	18	14.8	
	70,000 – 90,000	8	6.6	
	>90,000	29	24.0	
	Total	121	100.0	

Source: field survey, 2020

As presented in the table above, the average age of the respondents was 38 years. About 88% of the respondents were married with an average household size of six persons. 47% of the household head has tertiary education qualification, with farming being their major occupation, earning an average income of about N85, 948 per month. These factors have been specifically highlighted by Ozughalu and Ogwumike, 2016, to have effect on the amount spend on energy by the rural households in the study area.
The description of the various types of energy available to the respondents in displayed in table 2 below.

Majority of the respondents use both the combination of traditional (which includes the firewood) and Transitional energy (which includes the charcoal and kerosene), as shown in table 7. This implies that although household choose to migrate from the traditional energy use to the transitional energy when their income increases but however, they still stack the different energy types which could be because of availability, cost. Few people use a single type of energy; 4% traditional, 12% transitional and 28% modern.

Table 2: Energy use by the rural household in the study area.

Energy type	Frequency	Percentage
Traditional energy	5	4.1
Transitional energy	12	9.9
Modern energy	28	23.1
Traditional and Transitional Energy	58	47.9
Transitional and Modern Energy	9	7.5
Traditional + Transitional + Modern	9	7.5
Total	121	100.0

Source: field survey, 2020

Table 3: Firewood collection by the rural households.

Variables	Categories	Frequency	Percentage
Firewood collection frequency	<1	41	33.9
	1 – 5	77	63.6
	5 – 10	3	2.5
	Total	121	100.0
Person collecting firewood	None	62	51.2
	Children	30	25.6
	Wife	15	12.4
	Husband	10	8.3
	Others	4	3.3
	Total	121	100.0

Source: field survey, 2020

The mean number of times firewood is collected in a week by the respondents who use fireweed is 2. 64% of the respondents go to collect fireweed between 1 – 5 times in a week, as shown in table 8. From the table, 33% of the respondents collect below the mean and 2.5% of the respondent's collect firewood above the mean, on weekly basis. For most of the people who use firewood, the children are responsible for collecting them, 26%. The wife (ves), 12% also constitute the majority of individuals collecting the woods. Others, 3% of the respondents are those who are supplied the woods and do not necessarily go in search of the woods. According to a study carried out by Lenort et al. (2015), the result revealed that as regards to housing, energy poverty has a negative effect on the quality of life, particularly with children and adolescents.

5.1 ENERGY POVERTY STATUS OF THE RURAL HOUSEHOLDS

The result on the energy poverty status of the rural household is presented in the table 4 below. Table 4 shows the result of the energy poverty status of the sampled respondents in the rural household. From the table, the benchmark created for categorizing the households using the FGT approach creates a minimum monthly expenditure of 3,613.008naira for the household's energy use.

Table 4: Energy poverty status on the rural households.

Variables	Frequency	Percentage	Threshold
Energy poverty			3,613.008
Energy poor	47	38.8	
Energy non poor	74	61.2	
Total	121	100.0	

Source: field survey, 2020

According to a study carried about by Curtin and Centre (2016), the results of the analysis show there is little doubt that energy poverty is widespread. Low-income households, already suffering from increased housing costs, are on average spending 12.4% of their income on utility bills and fuel each week, compared with 2.9% for high income households. From the table, about 61% of the households uses the minimum energy expenditure requirement i.e., 61% of the sampled respondents are energy non poor. However, about 39% of the respondents are energy poor.

Table 5: Energy use by the rural household for cooking.

Sources of Energy use	Frequency	Percentage
Energy		
Traditional source of energy	71	58.68
Modern source of energy	50	41.32
Total	121	100.00

The table describes the energy use by the rural household for cooking by the sampled respondents. From the table, about 59% of the sampled respondents use the traditional source of energy (firewood, charcoal, etc.) for cooking with about 41% of them using the modern source of energy (LPG gas, electric stove, etc.) for cooking. This is supported by a study carried out by Amolegbe and Adewumi (2010), in Kwara state. Their finding was that majority of the households use the traditional energy in their various households for cooking.

5.2 FACTORS DETERMINING THE POVERTY STATUS OF THE RURAL HOUSEHOLDS

To identify the factors influencing energy poverty of the rural households, the logit regression model was fitted. The result is shown in Table 6.

Table 6: Determinants of energy poverty in the rural households.

Variables	Coefficients	Std. Error	z value	Pr(>|z|)
Housewife education	-.1906909	.2093907	-0.91	0.362
Household size	.0155722	.0759866	0.20	0.838
Years of schooling	.1356784	.0574707	2.36	**0.018
Age	.0053288	.0210193	0.25	0.800
Distance to energy source	-.0978312	.0475653	-2.06	*0.040
Income	.6870557	.3295866	2.08	*0.037
_constant	-7.953436	3.27555	-2.46	**0.014

Logistic regression
LR chi2(6) = 21.40
Log likelihood = -70.135259
Number of obs = 121
Prob> chi2 = 0.0016
Pseudo R2 = 0.1323

Source: field survey, 2020

Table 6 shows the result of the analysis on the factors that determine the energy poverty of the sampled respondents using the logistic regression.

The result shows that the years of schooling of the household head, the distance to sources of energy, income of the household and the intercept significantly affects the poverty status of the household, while the housewife education, household size and age does not have any significance.

Years of schooling of household head: this is significant at 5% level with a positive coefficient of .1356784. This implies that a unit increase in the years of the household will make the household spend more on their energy use.

Distance to source of energy; this is significant at 5% level with a negative coefficient of -.0978312. This implies that as the distance to the sources of energy by the household increases, reduce their expenditure on energy use, i.e., they will seek alternative means which is to use more of energy closer to them which is the traditional sources.

Household income: this is significant at 5% level with a positive coefficient of .6870557. This implies that as the income of the household increase, the household will increase their expenditure on the energy they use.

5.3 FACTORS DETERMINING THE ENERGY USE OF THE RURAL HOUSEHOLDS

To identify the factors influencing energy poverty of the rural households, the logit regression model was fitted. The result is shown in Table 7.

Table 7: Determinants of energy use by the rural households in Kwara state.

Variables	Coefficient	Std. Err.	z	P>|z|
Household size	-.2142903	.1141274	-1.88	0.060
Housewife education	.0095782	.1782879	0.05	0.957
No of household with education	.3825924	.153646	2.49	0.013

No of rooms	-.2051263	.0961228	-2.13	0.033
No of wives	.1585301	.5010129	0.32	0.752
Expenditure	1.035202	.3248374	3.19	0.001
_constant	-9.713432	3.198327	-3.04	0.002

Logistic regression:
LR chi2(6) = 23.52
Log likelihood = -69.073221
Number of obs = 121
Prob> chi2 = 0.0006
Pseudo R2 = 0.1455

Source: field survey, 2020

Table 7 shows the result of the analysis on the factors that determine the energy use for cooking by the sampled respondents using the logistic regression. The total number of sampled respondents is 121. The Likelihood ratio of the regression model is 23.52 with a probability value of 0.0006, this implies that the model is highly significant at 1% level and as well explains the relationship with about 99% confidence level.

The result shows that the household size, number of households with formal education, number of rooms in the household and totally monthly expenditure was significant.

No of household with formal education; this is significant at 5% level with a positive coefficient of .3825924. This implies that as the number of the members of household with formal education increases, the household increases their use of modern type of energy for cooking. This is because it is more efficient and reduces the time spent on sourcing for large number of woods for cooking. Also, the household will try to be rational by comparing the amount spent on sourcing for traditional energy and modern energy with their efficiency and might likely to choose the modern energy over the traditional energy type.

Number of rooms in the household; this is significant at 5% level with a negative coefficient of -.2051263. This implies that as the number of rooms in the household increase, the household increase their use of traditional type of energy use.

Total household expenditure; this is significant at 1% level with a positive coefficient of 1.035202. This implies that as the total monthly expenditure of the household increase, they tend to use more of the modern type of energy than the traditional type of energy.

6. CONCLUSION

The study revealed that most of the households depend on the traditional type of energy, constituting about 59%, although about 61% of the respondents are energy non poor i.e., they spend the estimated benchmark on the energy they use on monthly basis. It is also revealed that factors such as years of schooling, distance to the source of energy used and the total income of the rural households significantly affect their energy poverty status.

LIMITATIONS

Generally, there are limitations in the various definitions of energy poverty. Using the expenditure as a base to assess energy poverty creates a problem; for example, a large household X who uses traditional energy such as firewood, charcoal or kerosene can spend more on purchasing these energies, and the study might classify them as being energy non poor. However, based on the efficiency of the energy use by household X and the several hazards it can pose to the users, Household X can be classified as energy poor.

Although the study tries to capture the energy poverty status of the household using a more objective approach, it is limited to capturing the quality of the various energy uses by the households. It is also limited to accounting for the demand for the various energy types available to the household in respect to their level of income and the elasticity of the energies with respect to prices. Therefore, further studies might be taken into consideration to analyze for the demand for the various types of energy available in the rural households in Kwara State and the price elasticity as it relates to the energies.

Further studies can as well be carried out to assess the consumptive and productive use of energy among the rural households.

RECOMMENDATION

- A lot need to be done to address the challenges they are facing, to better acknowledge their role and potential, and to further include them in the government policy.
- It is necessary to apply different indicators and not only use a single indicator to measure energy poverty, to reduce the risk of generating a distorted image by ignoring unidentified vulnerable social groups.
- It is necessary to establish regulatory frameworks for the protection of poor consumers to guarantee access to clean, efficient and modern energy sources at affordable prices, which may involve the incorporation of subsidies.

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