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Determinant Of Energy Poverty In Rafi Local Government Area Of Niger State, Nigeria

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Abstract: ***Energy access is the bedrock of any meaningful development, be it social or economic. Energy poverty is a phenomenon that is common to both developed and developing countries, especially Nigeria. Energy poverty like poverty comes in different dimension and scale. In Nigeria, energy poverty is more noticeable in the rural area than the urban centres. This study, therefore, examines energy access (EA) and its determinant in Rafi LGA of Niger State. Energy access was measured using a multi-tier approach to energy access measurement developed by Nicolina Angelou for Energy Sector Management Assistant Programme (ESMAP, 2014). Households, enterprise, and community institution forms the three (3) tiers of the community energy access levels, using graduated measurement rather than binary measurement. A total of 447 copies of questionnaires were administered. The data collected are analysed by using descriptive and inferential statistics. Regression analysis was employed as an analytical tool to identify the determinants of energy poverty in the study area. The finding of the study shows that Rafi LGA is energy poor with an energy poverty index of 0.29. Number of years spent in school and average monthly income of household head is a major determinant of energy poverty in Rafi LGA, while age of household head, age of marriage, and household size contribute minimally to energy poverty in Rafi LGA. Improve education and livelihood developments were among the recommendation of the study.***

Keyword: Energy, Energy Access, Energy Access Index, Energy Poverty

I. INTRODUCTION

Despite Africa's endowment in energy resources, it remains the least in terms of energy access amongst all other regions of the world (IEA, 2016). There is a sharp contrast in energy access between the northern Sahara and the Sub-Saharan countries (Moulot, 2005). Electricity access in the northern Sahara is estimated to be 95% as against 23% in the sub-Saharan Africa, which drops considerably to as low as 1% in some countries (United Nation, 2005). United Nation (UN, 2005) asserted that in Sub-Saharan African countries with the exception of South Africa, 80% of the inhabitants depend on traditional biomass for their energy use; hence it is fair to posit that access to modern energy services (electricity and clean cooking fuel) is by far the most pressing challenge facing the continent. Globally, it is estimated that about 3 billion people are currently living in the rural areas, many of who do not have access to clean energy services (Sumiya, 2016). It is also estimated that about one-third of humanity cannot access modern energy forms and services (IEA 2009).

Traditionally, poverty is usually conceptualized using income, however, the social dimension of poverty have been identified and discussed extensively in literatures. The social dimension of poverty involves lack of access to basic human needs (food, water, clothing, shelter, sanitation, healthcare, and education) (Sen, 2004). There is also the energy dimension of poverty; popularly called energy poverty or Fuel poverty. Although several definitions of the term "*energy* *poverty*" have been developed by scholars and international organization (IEA, 2016, ADB, 2013; AGECC, 2010); there is no generally acceptable definition of energy poverty. However, it is evident from most energy poverty definitions that scholars are in agreement over two indicators; access to electricity and access to clean cooking fuel (UN, 2005; IEA, 2010, ADB, 2013). Therefore, the study adopts the Asian Development Bank (ADB, 2013) definition of energy poverty as the working definition of energy poverty for the study. The definition is stated thus "*absence of sufficient choice in accessing adequate, affordable, reliable, high quality, safe and environmentally benign energy services to support economic and human development*."

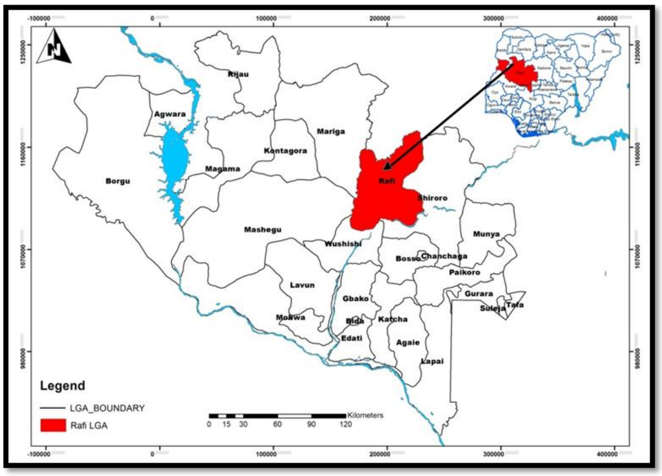
In recent time, studies have been directed toward addressing the issue of energy poverty across the globe with more emphasis on developing countries like Nigeria; (Modi *et al*., 2006; Nussbaumer et al., 2012; Sunday, 2011; Stephen et al., 2011; Edoumiekumo *et al*., 2013; Apere et al., 2014; Sanusi and Owoyele, 2016). The approach to energy poverty measurement by this studies is either deficient in scale or method. Most of the studies on energy poverty dwell more on estimating energy poverty at national, zonal or state level. Studies on energy poverty in Nigeria concentrate on national level estimations, ignoring disaggregated information on energy access at the local level.

Furthermore, there is little or no studies on energy poverty and access that shows the spatial disparities of energy access in the rural areas of the country; In Nigeria, studies on energy poverty have dwelled more on the composite indicator approach using Multidimensional Energy Poverty Index (MEPI), Total Energy Access (TEA), or Energy Development Index (EDI) (Edoumiekumo *et al*., 2013; Apere *et al*., 2014; Ogwumike and Ozughalu, 2015; Sanusi and Owoyele, 2016) which considers indicators on binary metric (Access or No Access) rather than measuring access base on graduated level of its capacity, duration, reliability, quality, affordability, legality and convenience as proposed by the Multi-Tier energy poverty measurement approach.

By these studies, there are two major research gaps. First is the dearth of local level study, especially at the level of rural settlements and secondly, there is a methodological gap in the current approach to measuring energy poverty. This study intends to fill this gap by focusing on rural communities and by employing Multi-Tier energy poverty measurement approach. This was achieved through the following objectives; assess energy access, measure energy poverty using multi-tier approach and identify the determinant of energy poverty in Rafi LGA.

A. STUDY AREA

Rafi is a Local Government Area (LGA) in Niger State, Nigeria. Its headquarters is located in the town of Kagara along Kaduna-Tegina Road. The southern border of the LGA is the Kaduna River. It has an area of 3,680 km² and a population of 181,929 at the 2006 census. Rafi local government has a total of ten (10) political wards. See figure 1.1



Source: Department of Urban and Regional Planning (FUTMINNA)

Figure 1: Rafi LGA in Niger State Context

II. REVIEW OF LITERATURE

A. ENERGY AND HUMAN WELLBEING

Energy is a central aspect of human life as it affects agricultural productivity, environmental sustainability, health care, and job creation. More than a need, energy per se is absolutely essential to deliver adequate living conditions, food, water, health care, education, shelter and employment (Najam *et al*., 2003). Poverty comes in different dimensions; and hence energy is a dimension of poverty. When there is energy poverty; it simply implies that one of the bundles of product needed to maintain a good life is missing (Sanusi *and Owoyele*, 2016). Energy is one of the basic human needs that play a crucial role in improving human well being (Global Network on Energy for Sustainable Development (GNESD), 2013). Human wellbeing, poverty reduction, social inclusion, and economic improvement cannot be advanced without access to electricity and clean cooking fuel (Karkezi *et al*., 2012).

Renewable Energy Policy Network for the 21st century (REN21, 2005) noted that the only available and affordable energy for the world's poor is "traditional biomass" which includes animal waste, fuel wood, and crop residue. Practical Action (2010) cited in Sanusi and Owoyele (2016), highlighted three (3) mechanism that relates energy access to wellbeing, they are; creating new earning opportunity, improving existing earning activities and reducing cost, drudgery and releasing time to enable new earning opportunity. Presently energy is one of the most essential ingredients for poverty alleviation as it is a vital input for people's livelihood. At the most basic level, energy is needed for cooking, heating and cooling (Clancy *et al*., 2003). UNDP (2004) suggested that the deprivations arising from energy poverty on human development are far more significant than energy poverty itself; because it does not only reflect energy poverty but human poverty. There are various deprivations that arise from energy poverty (Ramani, 2004; Modi *et al*., 2006).

Although basic educational services and literacy can be achieved without the use of cleaner energy input, yet, there is a link between access to energy and education services. Access to cleaner energy option can improve the quality and availability of educational services and increases the likelihood that children will attend and complete school (IEA, 2010a; UNDP, 2005; UN, 2005). Mapako (2010) posited that access to cleaner, affordable and modern energy can help to induce a more child friendly environment that encourage school attendance and reduce the significant dropout rate experienced in many low income countries. It can enhance access to clean water, sanitation, lighting, space heating/cooling, and energy for cooking in the case of boarding schools. Access to clean energy can provide quality lighting for both the boys and girls for comfortable night studying (Mapako, 2010); as it also helps to reduce the risk to child's eyesight (Eva and World Health Organization, 2006).

B. CONCEPT OF ENERGY POVERTY

Numerous concepts of energy poverty abound in development literatures, yet there is no universally accepted or adopted concept of energy poverty. Although, popular conceptualizations of energy poverty are usually based on minimum physical levels of basic energy needs, the minimum energy expenditure required and maximum proportion of energy expenditure in relation to total disposable income or expenditure. In the case of poverty itself, researchers have to rely on various indicators to capture the depth of poverty from diverse measurements. However, the realities of energy poverty differ across the globe. Phenomena of energy poverty diverge considerably between developed and developing, between rich and poor countries, as well as between different climatic zones.

Energy poverty and fuel poverty are sometimes used interchangeably by some authors; some sccholars consider energy poverty as a concept highlighting problems in developing countries, while fuel poverty is seen to be prevalent in the Organization for Economic Cooperation and Development (OECD) countries. British definition of fuel poverty from 2000/2001 is expressed as "adequate standard warmth" or not being able "to keep a home warm at reasonable cost" (Schuessler, 2014). Boardman (2009) offered a broader definition according to which a household is energy poor if it cannot attain adequate energy services for less than 10 percent of its net income. In simple term energy poverty refers to poverty in terms of access and consumption of energy. Traditionally poverty is measured in terms of monetary income or expenditure. With the time, the ways of measuring poverty have been changed. In Modern days poverty is directly linked to deprivation. Therefore we can simply identify energy poverty as constraints in energy services for households (Tennakoon, 2008).World Economic Forum (WEF, 2013) conceptualizes energy poverty as: "The lack of access to sustainable modern energy services and products". Energy poverty is defined as a situation where the absence of sufficient choice of accessing adequate, reliable, affordable, safe and environmentally suitable energy services is found (ADB, 2013). In simple words, energy poverty is the lack of access to sustainable and modern energy services and products (kerosene, liquefied petroleum, gas etc).

Energy poverty definitions are based on different indicators, some of which was highlighted by ADB (2013) as follows: Minimum amount of physical energy that meets cooking, lighting, heating, and other basic needs (Barnes *et al.*, 2010); Type and amount of energy used by households at or below the poverty line (Barnes *et al.*, 2010); Household energy spending beyond a certain percentage of the household budget (Barnes *et al.*, 2010); Income level sufficient only to sustain the bare minimum energy needs (below that, energy use or energy expenditure remains the same) (Barnes *et al.*, 2010); Poverty and lack of access to modern forms of energy (Modi *et al*. 2006); or Lack of access to energy services (Pachauri *et al.*, 2004). However, even with the multiplicity of energy poverty definitions, it is evident that most scholars are in agreement over two indicators; access to electricity and access to clean cooking fuel (UN, 2005; IEA, *et al.* 2010, ADB, 2013).

C. CONCEPT OF ENERGY ACCESS

The concept of energy access does not lend itself to an easy definition. In the past, access to energy usually was considered synonymous with household access to electricity. It has been defined variously as, household electricity connection, an electric pole in the village, and an electric bulb in the house. However, these definitions do not take into account the quantity and quality of electricity provided. The global agenda on energy poverty has arose various debate and argument on what constitute energy access by scholars, international organizations and research groups across the globe (IEA, 2009, Energy Sector Management Assistant Programme (ESMAP), 2014). It is important to have a working definition of energy access prior to the development of metrics or indicators for measuring energy access. IEA (2011) conceptualizes energy access in three (3) incremental steps, they are as follows; (i) basic human needs (electricity for lighting, health, education and communication) approximately 50 – 100 Kw per person per year and approximately 50-100 goe of modern cooking fuel or improved biomass cooking stove (ii) Productive uses; electricity and modern cooking fuel for agriculture (pumping of water for irrigation, mechanized tilling), electricity for commercial agricultural processing, cottage industry and other light industries and electricity and modern fuel for transportation e.g. electric train (iii) Modern Society Needs; Modern energy services for many more domestic appliances, increase requirement for cooling and heating (Space and Water) private transportation. Electricity usage is approximately around 2000Kwh per person per year

In 2010, in a report published by the UN Secretary-General's Advisory Group on Climate Change (AGECC, 2010), energy access was conceptualized as "a basic minimum threshold of modern energy services for both consumption and productive uses, that is reliable and affordable, sustainable and where feasible, from low Green House Gas (GHG)]-emitting energy sources." The international development charity Practical Action (2012), in its Poor People's Energy Outlook, uses the term "energy access" to mean the "use of modern energy services by un-served and underserved people." IEA (2012) defines energy access as being without access to electricity and without access to clean cooking facilities. Access to energy is the ability to avail energy that is adequate, available when needed, reliable, of good quality, affordable, legal, convenient, healthy & safe, for all required energy services across household, productive and community uses (ESMAP, 2014). International Institute for Applied System Analysis (IIASA, 2012) define energy access to include access to three forms of energy, each of which provides distinct but essential benefits for economic and social development: less polluting household energy for cooking and heating; electricity for powering appliances and lights in households and public; and mechanical power from either electricity or other energy sources that improve the productivity of labour.

Going by the various definitions of energy access highlighted by international organizations and scholars, it is obvious that there is no single internationally-accepted and internationally-adopted definition of modern energy access. Yet significant commonality exists across definitions, including; Minimum level of electricity access by household; Access to sustainable and safe cooking and heating fuels and stoves; Access to modern energy that enables productive economic activity, (mechanical power for agriculture, textile and other industries); Access to modern energy for public services, e.g. electricity for health facilities, schools and street lighting. All of these elements are crucial to economic and social development, as are a number of related issues that are sometimes referred to collectively as "quality of supply", such as technical availability, adequacy, reliability, convenience, safety and affordability.

D. MULTI-TIER ENERGY POVERTY INDEX

The recent attempt at understanding the subtle difference in energy poverty is that of the Global Tracking Framework (GTF). They combined multi-dimensionality of energy poverty with multi-tiers. This implies that all the facet of the community is captured in terms of the households or community energy access, productive energy access for agricultural processing and enterprises for economic activities. The multi-tier energy poverty measurement approach was developed by Nicolina Angelou who is an Energy economist for Energy Sector Management Assistance Programme (ESMAP) in 2014. This method of energy poverty measures energy poverty based on energy access as a continuum of improvement, based on the performance of the energy supply which includes; Capacity, Duration/Availability, Reliability, Quality, Affordability, Legality, Convenience, and Health & Safety. It is a composite energy poverty approach and it is expressed mathematically as Σ(Pi x K). The multi-tier energy captures all the dimensions of energy poverty from different tiers of the community. Multi-tier framework does not only measure the consumption of energy services, but also measures the quality, reliability, affordability, safety and adequacy of energy access. The method has since been applied and completed by ESMAP in five countries, namely, DRC, Uganda, India, Ethiopia, and Malawi. The multi-dimensionality and the composite measurement approach of the multi-tier energy poverty measurement approach is a good improvement to the existing multidimensional energy poverty measurement approach.

III. RESEARCH METHOD

The study adopted a survey research design approach. The study relies on quantitative data collected primarily from the field; hence, the study is empirical. The unit of analysis for the study is household, enterprise and institutions; the average number of households in Rafi LGA is estimated by projecting the population of Rafi LGA as reported by Nigerian Population Commission, in 2006 to year 2017. The projected population was then divided by national average household size of six to arrive at a population sample of 10885 households. The sample size for the study was determined using Sallant and Dilmann (1997) sample size formular to arrive at 500.

A total of 500 copies of questionnaires was administered using multi stage sampling technique First, Rafi LGA was divided into ten clusters using the ten wards of the LGA, while simple random sampling technique was used to randomly selected rural communities and respondents from each of the wards. The data collected were analysed using descriptive and inferential statistics. Regression analysis was employed as analytical tool to identify the determinants of energy poverty in the study area. In all 38 community enterprises and 29 community institutions were also sampled.

Multi-tier energy poverty measurement approach was adapted to estimate energy poverty in the selected rural areas of Rafi LGA of Niger State. This method of energy poverty measures energy poverty based on energy access as a continuum of improvement, based on the performance of the energy supply which includes; Capacity, Duration/Availability, Reliability, Quality, Affordability, Legality, Convenience, and Health & Safety. It is a composite energy poverty approach and it is expressed mathematically as Σ(Pi x K), where Pi = Proportion of households at the k^{th} tier; K = Tier number {0,1,2,3,4,5}

IV. RESULTS AND DISCUSSION

A. ELECTRICITY CONNECTION AND DURATION OF ACCESS

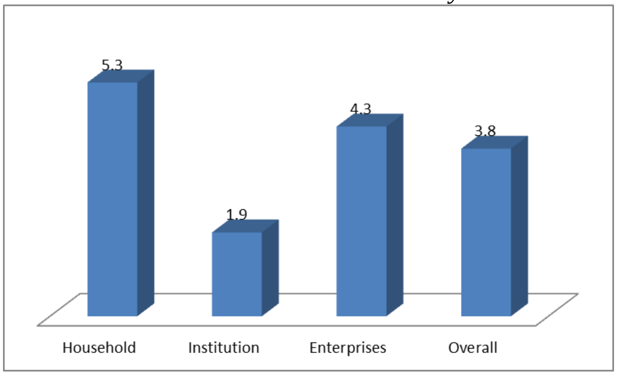
Connection to the public electricity grid was assessed, and the rate of electricity connection in the study area is presented in Table 1. The result shows that electricity connection at household level is 80%, 75% at institutional level, and 49% at the enterprise level. The overall connection rate in the communities is estimated at 68%. The result shows that the entire community tier performed above average, except for institutional tier that records a low connection rate. The result also shows that all the communities are connected to the public electricity grid, except for Sihonna village.

The average daily duration of electricity access in the study area is depicted in Figure 2. The analysis shows that the average electricity duration at household level in Rafi LGA is 5.3 hours, 1.9 hours at institutional level, 4.3 hours at the enterprises level. On the average the communities enjoy 3.8 hours of electricity per day. This shows that although electricity connection rate is high, duration of electricity access is low.

Community Levels	Rafi LGA
Household	80
Institution	49
Enterprises	75
Overall	68

Source: Author's Fieldwork (2017)

Table 1: Connection to Electricity Grid



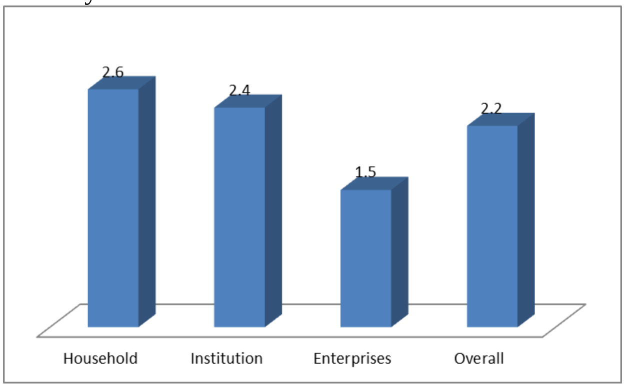
Source: Author's Fieldwork (2017)

Figure 2: Average Daily Duration of Electricity Access

B. RELIABILITY OF ELECTRICITY ACCESS

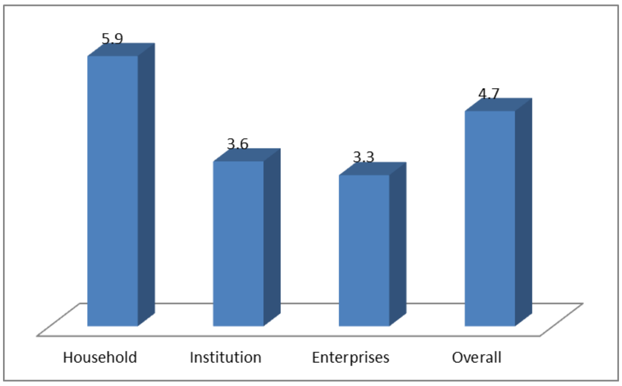
The reliability of electricity access was assessed based on number and duration of electricity outages. The result on average number of daily electricity outages is presented in Figure 3. At household level, an average of 2.6 daily outages is recorded, 2.4 outages for enterprise, and 1.5 daily outages for institutions. The low number of outages recorded at institutional level may be as a result of hours spent at such institutional areas compared to enterprise and household.

The duration of daily outages was also assessed, and the result is depicted in Figure 4. The result shows that daily power outage in Rafi LGA last for an average of 4.7 hours. The highest average duration of outages recorded was at household level (5.9 hours), enterprise 3.6 hours, and institutions 3.3 hours. This is an indication on long hours of outages experienced intermittently at all level of the community.



Source: Author's Fieldwork (2017)

Figure 3: Average Number of Daily Outages



Source: Author's Fieldwork (2017)

Figure 4: Average Duration of Daily Outages

C. QUALITY OF ELECTRICITY ACCESS

The quality of electricity accessed was analysed based on the proportion of respondents from various tiers that experience electricity fluctuation and the duration of fluctuation. The result as presented in Table 2 shows that only 19.6% of the respondents experience power fluctuation. Enterprise recorded the highest proportion of respondents that experience power fluctuation. This may be due to the nature of machines and tools used by enterprises, especially the grinders and welders. Similarly, the communities experience an average of 8.8 minutes of power fluctuation. At household level, the average duration of fluctuation is 9.1 minutes, enterprise 8.6 minutes, and institution 10 minutes (Table 3).

Community Levels	**Rafi LGA**
Household	6.3
Institution	11
Enterprises	45.4
Overall	**19.6**

Source: Author's Fieldwork (2017)

Table 2: Electricity Fluctuation by Communities (Hours)

Community Levels	**Rafi LGA**
Household	9.1
Institution	8.6
Enterprises	10
Overall	**8.8**

Source: Author's Fieldwork (2017)

Table 3: Average Duration of Fluctuation (Hours)

D. HOUSEHOLD ACCESS TO CLEAN COOKING ENERGY

The survey conducted shows that all the households rely on firewood as the primary cooking fuel, hence the study assessed the distance covered by household in search of firewood, rate of distance change per annum, and the time spent in search of firewood. Table 4, shows the distance covered by household in search of firewood. The result shows that the average distance covered by household in search of firewood is 2.5km in the last five years, while presently households cover an average of 4.5km in search of firewood. The maximum distance covered in search of firewood is 5.9km as against 3.5km recorded five years ago..

The rate of distance change within five years is computed and presented in Table 5. The result shows the distance the minimum change in distance recorded between now and the last five years is 1.8km and a maximum of 2.9km. The rate of distance change per annum is between 6.7% to 13.1% per annum. The high rate of distance change in search of firewood is an indication that within the next ten years household may have to travel for about 10km before having access to firewood which may result to energy stress.

Statistics	Last 5years	Presently
	Dist in Km	Dist in Km
Min Dist	1.3	2.1
Max Dist	3.5	5.9
Mean Dist	2.5	4.5

Source: Authors Fieldwork (2017)

Table 4: Distance Covered in Search of Firewood

Statistics	Dist ∆ in Km	Rate of Dist ∆/Annum
Min ∆ Distance ∆	1.8	6.7
Max ∆ Distance	2.9	13.1
Mean ∆ Distance	2.0	9.2

Source: Authors Fieldwork (2017)

Table 5: Distance Covered in Search of Firewood

Furthermore, Table 6, shows the time spent by households in search of firewood. The analysis shows that, on the average, households spend about 3.22 hours in search of firewood in Rafi LGA. Yakila recorded the most hours spent in search of cooking fuel, while the least is recorded in Sihonna. This shows that households spend more than 30 minutes in search of firewood as stated by

Community Levels	**Rafi LGA**
Min	2.0
Max	5.7
Overall	**3.2**

Source: Author's Fieldwork (2017)

Table 6: Electricity Fluctuation by Communities (Hours)

E. ENERGY POVERTY IN RAFI LGA

Energy poverty in Rafi LGA was computed using the Multi-tier energy poverty measurement index. Electricity poverty index across the three levels of the community (Household, Enterprise, and Institutions) and household access to clean cooking energy forms the basis of the energy poverty assessment. Access to electricity and clean cooking energy was also computed across dimensions at various community levels.

a. HOUSEHOLD ACCESS TO ELECTRICITY

Electricity access index in Rafi LGA is depicted in Table 7. The result shows that the Rafi LGA is electricity poor (EP) with an index of 0.36. Household is medial electricity poor (MEP) with an index of 0.53, enterprise and institutions are poor with and index of 0.31 and 0.23 respectively. The community fair better in terms of connectivity (CI) and quality (QI) with an index of 0.65 and 0.59 which implies medial energy poverty. However, affordability (AI), duration (DI), and reliability (RI) remains a major challenge to electricity access with an index of 0.46, 0.13 and 0.02 respectively (Table 8).

Community Levels	Rafi LGA	Remark
Household	**0.53**	MEP
Institution	**0.31**	EP
Enterprises	**0.23**	EP
Overall	**0.36**	EP

Note: H=Household; E=Enterprise; I=Institutions;

Source: Authors Fieldwork (2017)

Table 7: Electricity Access Index by Tier

Dimensions	Index	Remark
C.I	0.65	MEP
D.I	0.13	EP
R.I	0.02	EP
Q.I	0.59	MEP
A.I	0.46	EP

Source: Authors Fieldwork (2017)

Table 8: Electricity Access Index by Dimensions

b. HOUSEHOLD ACCESS TO CLEAN COOKING ENERGY

Household access to clean cooking energy was examined from three dimensions; cleanliness, quality and convenience of access. The household clean energy access index is presented in Table 9. The result shows that all the communities are energy poor having record an index of 0.13. The poor performance of the households in access to clean cooking fuel is occasioned by the combustion of the primary cooking fuel (CI), convenience (CVI) and the quality of the cooking fuel (QI).

c. ENERGY POVERTY IN RAFI LGA

The energy poverty index for the communities was computed based on access to electricity and access to clean modern cooking energy. The result shows that all Rafi LGA is energy poor. That is, they record an energy access index of 0.29. Energy poverty recorded is as low as 0.10 for some communities and the maximum recorded being 0.45. The least is recorded in Sihonna (0.03), which is occasioned by the total absence of electricity connectivity in the community. The spatial distribution pattern of energy poverty in Rafi LGA is presented in Figure 5.

Dimension	**Index**	**Remark**
C.I	0	EP
Q.I	0	EP
CVI	0.39	EP
Overall	**0.13**	**EP**

Source: Authors Fieldwork (2017)

Table 9: Access to Clean Cooking Energy

Dimension	**Index**	**Remark**
Min EPI	0.10	EP
Max EPI	0.45	EP
Aggregate	**0.29**	**EP**

Source: Authors Fieldwork (2017)

Table 10: Energy Poverty Index

F. DETERMINANT OF ENERGY POVERTY

In other to assess and identify the determinant of energy poverty in Rafi LGA, the socio-demographic characteristics of the respondents were assessed. Table 11, shows the socio-demographic characteristics of the respondents. The result shows that the age range of respondents is between 20-67 years, while the average age of respondents is 45 years. The mean household size of the respondents is 8 persons per household, while respondents have acquired an average of 9 years of formal education. The result also shows that the average age of marriage recorded is 17 years, while the mean monthly income of the household head is ₦22735.00.

Statistics	Age	Household Size	Education	Age of Marriage	AVE Monthly Income
Minimum	20	7	6	16	14867
Maximum	67	9	12	34	25804
Mean	45	8	9	17	22735

Source: Authors Fieldwork (2017)

Table 11: Access to Clean Cooking Energy

The socio-demographic characteristic of the respondents was regressed against household energy poverty index. The operational variables for the regression analysis are: energy poverty, age of household head, Age of marriage, household size, years spent in school and monthly income. The dependent variable of the regression analysis is "energy poverty", while the socio-economic variables are the independent variables. The result of the regression analysis is presented in Table 11(a-c). Table 11a shows the regression model summary; the regression analysis recorded an R^2 value of 65.4%. The F-statistics of the regression model is 41.990 and a p-value of (0.00), significant at 95% confidence level. It therefore implies that socio-economic variables account for 65.4% of the energy poverty, while the balance (37.3%) is determined by other variables not considered for the study. The coefficient of the regression model is presented in Table 11c.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.809[a]	.654	.639	.09656

a. Predictors: (Constant), Monthly Income, Years in School

Table 11a: Model Summary

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1.957	5	.391	41.990	.000[b]
Residual	1.035	111	.009		
Total	2.992	116			

Dependent Variable: Energy Poverty

Predictors: (Constant), Monthly Income, Years in School, Age of Marriage, Household Size, Age of Household Head

Table 11b: ANOVA[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-.137	.082		-1.667	.098
Age of Household Head	.004	.002	.240	1.736	.085
Age of Marriage	-.004	.002	-.212	-1.532	.128
Household Size	.005	.005	.063	.969	.335
Years Spent in School	.026	.002	.753	12.587	.000
Average Monthly Income	3.079E-6	.000	.208	3.564	.001

a. Dependent Variable: Energy Poverty

Source: Authors Analysis (2017)

Table 11c: Coefficients

The model for the study as derived from the regression model is stated as follows:

$Y=a +b_i x_i +b_{ii} x_{ii}$……………………..bnxn….Equation (1)

Where Y= energy poverty

a= Intercept

b= slope

X= explanatory variables ($x_{i=\text{age of household head}}$, $x_{ii=\text{age of marriage}}$, $x_{iii=\text{Household Size}}$, $x_{iv=\text{years spent in school}}$, $x_{v=\text{average monthly income}}$)

$Y= -0.137 + 0.004(x_i)-0.004(x_{ii}) +0.005(x_{iii}) + 0.026 (x_{iv}) + 0.000003079(x_v)$....Equation (2)

The model for the determinant of energy poverty as presented in equation (2) shows that all the variables except age of marriage contributes positively to energy poverty, while age of marriage has an inverse relationship with energy poverty. An increase in the age of household head, household size, years spent in school and average monthly income leads to a corresponding increase in the value of energy poverty value, while a decrease in age of marriage by a factor of the -0.04 implies an increase in energy poverty.

V. CONCLUSION AND RECOMMENDATION

Electrification (connection to national grid) in the rural communities of Rafi LGA is quite impressive; which is as a result of government effort towards connecting rural community to public electricity through rural electrification programme across the LGA and the state at large. The quality of electricity enjoyed by the rural communities is also commendable; this may be due to the relatively low population of the communities and absence of heavy machines and equipment which may cause overloading and other electrical problem. However, complete access to electricity is still far from the reach of the rural populace, which stem from the low duration of daily electricity supply especially at nights, and the reliability of the access which is usually subject to unannounced interruption that could last for hours, all these are some of the challenges to electricity access in the rural communities of Rafi LGA..

Access to clean cooking energy in the rural areas is a major challenge and a major contributing factor to energy poverty. It is likely that easy access to trees within and around the environment makes the use of firewood handy and convenient. The availability of fire wood in abundant quantity, and at relatively no cost coupled with the ease of use is among the factor responsible for household choice of cooking energy.

The study therefore, recommends that, access to electricity in the rural areas in terms of connection and quality of access must be matched with reasonable hours of electricity access. Outages and duration of outages must also be reduced.

Until this is achieved, Rafi LGA is still far from achieving electricity access. Concerted effort must be directed towards providing clean cooking energy in Rafi LGA. The use of fuel wood as cooking fuel must be discouraged systematically, through the provision of alternative cooking energy at affordable prices across the LGA. Residence must also be sensitized on the health and environmental implication of fuel wood as primary cooking energy. Electrification in the rural areas must not be restricted to households alone. Other facet of the rural community (enterprise and institution) should also be connected to the electric grid for optimum access. Until the entire community facet is connected to electricity, energy access in the rural areas will remain a mirage.

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