Energy Utilisation and Household Consumption in Rivers State

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ABSTRACT

In this study, the link between energy utilisation and household consumption was examined. The energy utilization comprised both solid and non-solid fuels such as electricity, liquified petroleum gas (LPG), premium motor spirit (PMS), kerosene and charcoal. A well-structured questionnaire was used to obtain the required primary data from a sample of 384 households across the three senatorial zones in Rivers State. The data analyses integrate both descriptive and inferential statistics with a focus on frequency counts, simple percentages, mean ratings and ordered logit regression analysis. The distribution of the households based on their consumption level showed that 132 (34.38%), 124 (32.29%) and 128 (33.33%) of the respondents in the survey reported fair, good and excellent consumption respectively, indicating that the majority of them experience fair consumption. The marginal effects results of ordered logit regression showed that electricity use significantly increases the probability of reporting better consumption (from fair, good to excellent) by 0.582%. Similarly, the results showed that LPG utilization increases the probability of reporting better consumption by 1.97%. This finding highlights the importance of access to clean energy on household consumption. In addition, the results showed that the use of charcoal significantly increases the probability of reporting better consumption by 0.125% while PMS utilization significantly decreases the probability of reporting better consumption (from fair, good to excellent) by 0.164%. Given the findings, this study recommends that government should prioritise a stable electricity supply by investing in infrastructure upgrades and build synergy with the private sector to improve LPG supply to enhance availability and affordability of energy for better household consumption.

Keywords: Energy use, household consumption, electricity, liquified petroleum gas, kerosene and charcoal

INTRODUCTION

The use of traditional biomass to meet energy needs has been identified in extant literature to affect household economic well-being while generating adverse implications on environmental sustainability. According to estimates from the World Health Organisation (WHO, 2018), approximately 3.2 million people die prematurely each year from illnesses linked to indoor air pollution caused by improperly burned solid fuels used in domestic cooking. This highlights the dampening implications of traditional biomass on the long and healthy of households. Ma, Vatsa and Zheng (2022) opine that the use of non-clean fuels for cooking is detrimental to human health and, the environment and worsens climate change. There are also increasing incidences of environmental-related issues in Nigeria such as indoor and outdoor air pollution, urban air pollution, environmental degradation and climate change, among others associated with the utilization of solid fuels, especially biomass and fossil fuels (Adetayo *et al.*, 2021). The use of traditional biomass is identified as a major cause of forest depletion and Green House Gas (GHG) emissions (Toole, 2015; Muller and Yan, 2018). This tends to pose a threat to the well-being of households by adversely affecting their livelihoods and health conditions.

In recent times, there has been increasing awareness of the transition to environmentally friendly non-solid and clean modern energy to meet household energy needs. Electricity, liquid and gaseous fuels like liquefied petroleum gas, biogas, and natural gas in general are all examples of modern energy carriers (Nnaji *et al.*, 2021). Notably, Schunder and Bagchi-Sen (2019), and Akter and Pratap, (2022) highlight the benefits of the transition to modern clean cooking fuels which include improvement in individuals' health and well-being, reduction of

household air pollution and control of greenhouse gas emissions for sustainable future. In addition, Morrissey (2017) contends that modern energy utilization by households helps to improve their well-being. As outlined in the 7th Sustainable Development Goal (SDG7), access to affordable, reliable, sustainable and modern energy for all is an integral aspect of sustainable development. This requires effective energy planning to foster adequate energy supply at the lowest possible economic, social, and environmental costs. Accessibility, cost, burner type, and several non-technical elements like awareness of energy conservation and protection of human health all have an impact on energy transition (Cherp *et al.,* 2018; Tao *et al.,* 2021).

With the increasing awareness of the importance of access to modern energy sources, the Federal Government of Nigeria introduced the 'Energy Transition Plan' and the 'Decade of Gas Initiative' to provide a sustainable roadmap for universal access of households to modern energy services by 2030 in accordance with the 7th SDG. This is also intended to mitigate the adverse implications of climate change triggered by increasing deforestation associated with fuelwood and biomass consumption as well as the health effects of indoor air pollution by households (Akeh *et al.,* 2023). Therefore, increasing access to modern energy sources, such as electricity for lighting and appliances and clean cooking technology, is a significant development goal and is thought to be essential to improving the well-being of households. Nigeria's experience in terms of access to modern energy sources, especially electricity has largely been described as unimpressive. The IEA (2021) report shows that rural access to electricity between 2005 and 2020 is below 50%. This highlights the increased level of energy poverty in the country as less than half of the rural population does not have access to electricity.

Despite the increasing awareness of the transition to clean energy, households have a mix of energy sources for their domestic activities. Essentially, households have continued to combine to switch between conventional solid and non-solid modern energy sources to meet their cooking, heating, and lighting needs, among others. The choice of the energy mix varies depending on accessibility, affordability, demographic characteristics, public awareness and other socioeconomic conditions. The World Bank (2018) report shows that households tend to choose a combination of high-cost and low-cost fuels, depending on their budgets, preferences and needs. It is argued in extant literature that households with high income tend to move towards a modern energy mix by combining liquified petroleum gas (LPG) and electricity to meet their domestic activities. On the other, low-income households often tend to resort to combining traditional biomass with some form of non-solid fuels, especially kerosene for cooking, heating, and lighting. Given the dynamics of the energy mix amidst the increasing energy costs, this study seeks to examine the effect of energy utilisation on household consumption in Rivers State.

LITERATURE REVIEW

Theoretical Literature

Masera and Navia (1997) proposed the household fuel-stacking theory also known as the multiple fuel use model. The theory was popularised by Masera, Saatkamp, and Kammen (2000) as a critic of the energy ladder. The core tenets or assumption of this theory is that most households in developing countries do not apply the single-fuel substitution and linear transition as proposed by the energy ladder model but tend to employ an energy mix approach in meeting energy needs. Again, the fuel-stacking model provided a more precise explanation for how a variety of factors affected family energy decisions. Preference for and familiarity with conventional fuels, together with a propensity to create a sense of energy security, were among the determinants of household fuel-stacking behaviour (Alem *et al.,* 2016).

According to the fuel-stacking model, households employ an energy mix or menu instead of completely switching to other fuel types when their income increases. Numerous factors, including constant shortages of modern fuels and fluctuations in the energy market price, contribute to multiple energy use. Thus, the intricacy of the energy-switching process suggests that a variety of factors, beyond wealth, may affect energy usage. Additionally, Erdmann and Haigh (2013) assert that economic growth cannot be regarded as the primary cause of households' decisions to alter their energy-use habits on its own because other significant factors also play a role in shaping these decisions, including living standards, environmental pressure, technological advancement, resource availability, and people's own decisions.

Muller and Yan (2018) assert that the fuel stacking model has garnered recognition in the explanation of the empirically observed household energy choices in developing countries. The underlying argument of this model is that an income level increase may not lead to household energy switching upward the energy ladder as they will still keep lower-level fuels and use them simultaneously or as a supplement (Masera et al., 2000). According to Ruiz-Mercado and Masera (2015), energy mix has remained an integral aspect of household energy consumption behaviour because traditional fuels were associated with specific cultural and traditional components of household lifestyle, thus modern fuels were considered inadequate substitutes for them.

Empirical Literature

Ren, Liu, Li and Zang (2022) empirically analysed the effect of clean household energy consumption on the well-being of households in China. Primary data was used for this study and the data came from the China Health and Retirement Longitudinal Survey (CHARLS), collected from middle-aged and elderly people aged 45 and above. The sample used for their study was 19,683 households. In the study, well-being was categorized into five categories not at all satisfied, not very satisfied, somewhat satisfied, very satisfied and completely satisfied. In the study, the cooking fuel considered as clean were marsh gas, natural gas, liquefied petroleum gas and electricity. Other control variables were considered and they include gender, marriage, education, work, debt, expenditure, regions, and medical insurance. Two mediating variables of health condition and depression were factored in, the moderating variable of social contact was used and the electric bicycle was used as an instrumental variable. The model specified in the study to explain how clean household energy consumption affects residents' well-being was estimated using an ordered probit mode, conditional mixed process method, mechanism analysis model and the instrumental variables method. The regression result shows a positive and significant impact of clean household energy consumption on residents' well-being, as the probability of households completely satisfied is expected to increase by 0.007 when the consumption of clean household energy increases by 1 unit. They report a positive correlation between gender and well-being as an increase in the proportion of women can enhance well-being. Further, they showed that those married are happier than those unmarried and increasing family expenditure improves well-being.

Ezeh, Nwogwugwu and Ezindu (2020) extended the neoclassical growth theory in examining the effect of household electricity consumption on the standard of living. The study of the relationship was carried out using Nigerian data and the period covered extended from 1981 to 2017. In their work, standard of living was decomposed into poverty rate, income level, education level, and health care, with each proxy made to depend on electricity consumption, capital (measured using capital formation), labour (to which labour force was used as proxy), inflation rate, economic growth (index with real gross domestic product), population rate, and unemployment rate. The estimation of these relationship was conducted using the autoregressive distributed lag (ARDL) method and cointegration was based on the bounds test. They were able to show using bounds test that, an equilibrium condition that holds the interest variables (the regressors of electricity consumption, capital formation, labour force, inflation rate, real gross domestic product, population rate, and unemployment rate, and the explained variables of poverty rate, income level, education level, and health care) together in the long run exist. Their ARDL estimates show positive and significant relationship between electricity consumption and income of households; increased utilization of electricity significantly improves health of households; and electricity consumption had significant positive effect on poverty. Also, they report that increased consumption of electricity significantly enhanced the education level of households.

Wu (2021) recognizing that women in developing countries are major undertakers of cooking and may be vulnerable to household air pollution resulting from the combustion of solid fuel, investigated the effect of household fuel switching on the health status of women in China. To achieve this objective, longitudinal data from China Family Panel Studies in 2014 and 2018 was employed and the data was trimmed from 16,000 households to 5,180 samples from 25 provinces in China. In the study, three health indicators were used and include self-ratings of health status, IADL and interviewer's assessment of respondents' health. In the panel model, other variables that may influence the health of the respondents were considered and these include household income, marriage status, age, whether the respondent smokes, have insurance, and the number of family members. The panel model which they specified was estimated using the fixed-effect method. It was revealed from analysis of respondents' data that the reliance of households on solid fuels dropped from 50.40% to 37.20% and the share of households using non-solid fuels such as LPG/LNG and electricity rose from 48.67%

to 62.10%. The estimates from the fixed-effect model shows household switching cooking fuel from solid fuel to clean fuel experience significantly improvement in women self-rated health and others-rated health. The result implies that, the health risks women are exposed to when cooking with solid fuels are reduced when such solid fuel is substituted for cleaner fuel. It was noticed from the estimation that, switching cooking fuel does not influence the ability of women to cope with daily activities significantly. The result of this study was consistent with the energy ladder hypothesis as household income had significant positive effect on women's health status. Consistent with theory, women's age was found to be negatively related with the health status of women.

Sade, Mathew, Esther and George (2020) examined the interactive effect of energy consumption and poverty on life expectancy in Nigeria. They expressed life expectancy to depend on poverty, energy consumption, petroleum products consumption, exchange rate, health expenditure, oil revenue and inflationary rate. The investigation conducted covered the period from 1980 to 2017 and this was estimated using the autoregressive distributed lag (ARDL) method. They found using the bound test method that the variables used for the study have long run relationship among them. The long run result shows that there is energy poverty in Nigeria as the interactive effect of poverty and energy consumption on life expectancy was negative and significant. Other long run determinants of life expectancy identified in their study were oil revenue and real effective exchange rate. The study found poverty, health expenditure, petroleum products consumption, dependency ratio, energy consumption, inflation rate and corruption to be short run determinants of life expectancy.

George and Oseni (2012) examined the influence of electricity power outputs, supply and consumption in addressing the high rate of unemployment in Nigeria. The study which covers the period of 1970 to 2005 discovers that the power supply to the industrial sector was lower than the supply for residential consumption. The study also establishes that the major cause of unemployment in Nigeria can be traced to inadequate and unstable power supply to the industrial sector. The study recommended that the government and the policymakers to invest more in electricity power generation and ensure that the industrial sector is given a higher priority in the supply of electricity if the high unemployment rate is to be abated.

METHODOLOGY

Area of Study

This study was restricted to Rivers State, Nigeria. Rivers State is geographically located in the south-south geopolitical zone. The state is bounded by Imo state in the northeast, Akwa Ibom on the east and Bayelsa on the west. It equally shares boundaries with Imo States. The state has a total of 23 local government areas. According to data from the 2006 National Census, Rivers has an estimated population of 7,303,900 people. Oil and gas resources, with a predominant role played by International Oil Companies (IOCs), dominate the state's economic activity.

Population of the Study

The population of the study comprised all the households in Rivers states. The population of households in Rivers State local government areas (LGAs) were used for this study. As such, the results of the study was generalized to the whole of Rivers State.

Sampling Technique and Sample Size

The sampling technique employed in this study is a multistage sampling procedure. The first stage involved three senatorial zones in Rivers State – Rivers East senatorial district, Rivers South East senatorial district and Rivers West senatorial district. The second will involve selecting 4 LGAs (Emohua, Ikwerre, Obio-Akpor and Port Harcourt) from Rivers East senatorial district, 3 LGAs (Eleme, Oyigbo and Tai) from Rivers South East senatorial district and 4 LGAs (Degema, Ahoada West, Abua–Odual and Akuku-Toru) from Rivers West senatorial district.

The Cochran's *(1977)* method was applied to determine the sample size based on the population. The formula

is provided as follows:

$n = [Nz^2pq] / [E^2(N-1) + z^2pq]$ (3.1)

Where: n = sample size, N = population of study, Z = Standard score equivalent to 95% confidence level (1.96), p and q = population proportions which is taken as 50 percent (0.5) and E = error margin of 5% (0.05) 0.9604 0.0025

Thus, the computation of the sample size is provided as follows:

$n = [(3,982,400) (1.96)^2(0.5) (0.5)] / [(0.05)^2(3,982,400-1) + (1.96)^2 (0.5) (0.5)]$

$n = 3,824,696.96 / 9,956.96$

$n = 384.15 \cong 384$

Thus, the sample size for this study are 384 respondents

Method of Data Analysis

This study employed descriptive statistics, specifically frequency counts, simple percentages, and cumulative percentages, to analyse the socioeconomic attributes of the households in the survey. The mean rating was employed to analyse the households' opinions on the implications of energy use for their economic well-being. With a four-point Likert scale, the decision rule requires that each of the statements is accepted if the computed mean score is greater than the critical mean value of 2.5. Similarly, this study relied on the mean ratings to analyse the underlying barriers to energy use among the households in the study area. More importantly, this study employed an ordered logit regression model (OLM) to estimate the odd ratio and marginal effects of energy use on the economic well-being of the household. Thus, the odd ratio and marginal effects (slope parameters) provide the basis for estimating how each of the independent variables (energy use indicators) increases/decreases the probability of economic well-being under the OLM. The rational for the choice of OLM followed the assumptions that economic well-being which are measured as discrete outcomes can be ordered to elicit more robust and representative information. Thus, the dependent variable under the OLM is classified as polychotomous responses (more than two outcomes).

RESULTS AND DISCUSSION

Socio-demographic Characteristics of the Respondents

Table 1: Gender distribution of the respondents

Gender	Freq.	Percent	Cum.
Male	185	48.18	48.18
Female	199	51.82	100.00
Total	384	100.00	

Source: STATA output

The distribution of the respondents based on gender showed that 48.18% of them are males while the remaining 51.82% are females. This finding indicates that the majority of the respondents in the survey are females. This also explains the increasing population of females in the state.

Table 2: Age distribution of the respondents

Age group	Freq.	Percent	Cum.
18-30	97	25.26	25.26
31-45	97	25.26	50.52
46-60	104	27.08	72.92
≥ 61	86	22.40	100.00
Total	384	100.00	

Source: STATA output

The results showed that about 25.26% of the respondents are between 18 and 30 years old and 31 to 45 years old. The results further showed that 27.08% of the respondents are between 46 and 60 years old while 22.40% of the respondents are greater than or equal to 61 years. This finding indicates that the majority of the respondents are adults who are in their economically active ages.

Table 3: Distribution of the respondents based on their marital status

Marital status	Freq.	Percent	Cum.
Single	99	25.78	25.78
Married	108	28.13	50.00
Widow/widower	84	21.88	71.88
Divorced	93	24.22	100.00
Total	384	100.00	

Source: STATA output

It is evident from the results that 25.78% of the respondents are single whereas 28.13% of them are married. The results further showed that 21.88% of the respondents are widow/widowers while 24.22% of them are divorced. In sum, it followed from the results that majority of the respondents are married.

Table 4: Distribution of the respondents based on their educational attainment

Education	Freq.	Percent	Cum.
No formal education	104	27.08	27.08
Primary	93	24.22	51.30
Secondary	93	24.22	75.52
Tertiary	94	24.48	100.00
Total	384	100.00	

Source: STATA output

The results showed that the majority of the respondents which account for 27.08% of the total number of respondents in the survey have no formal education. This suggests that most of the respondents tend to be artisans and traders, among others. The results also showed that 24.22% of the respondents have access to primary and secondary education whereas 24.48% of the respondents are graduates.

Table 5: Distribution of the respondents based on their household size

Household	Freq.	Percent	Cum.
≤ 1	83	21.61	21.61
2-4	90	23.44	45.05
5-7	103	26.82	71.88
≥ 8	108	28.13	100.00
Total	384	100.00	

Source: STATA output

The distribution of the respondents based on their household size showed that 21.61% of them have a household size of less than or equal to 1 person while 23.44% of them have a household size of 2 to 4 persons. The results further showed that 26.82% and 28.13% of the respondents have a household size of 5 to 6 persons and greater or equal to 8 persons. In sum, the results showed that the majority of the respondents have a household size of 8 persons and above. This finding attests to the increasing number of household size in the study area.

Summary Statistics on Household Consumption

Table 6: Summary of the respondents' opinion on their consumption

Consumption	Freq.	Percent	Cum.
Fair	132	34.38	34.38
Good	124	32.29	66.67
Excellent	128	33.33	100.00
Total	384	100.00	

Source: STATA 17 output

The results showed that about 132 (34.38%), 124 (32.29%) and 128 (33.33%) of the respondents in the survey reported fair, good and excellent consumption respectively. Thus, it followed from the results that the majority of the respondents experience fair consumption. This could be attributed to the growing level of food inflation and energy prices that reduced household purchasing power.

Model Estimation

Table 8: Ordered logit results

Variable	Odds ratio	Std. err.	z	P>|z|	[95% conf. interval]
ELC	.9999107***	.2457349	4.07	0.000	.9887335 1.011214

LPG	.9924564***	.0271929	7.80	0.000	.9405652 1.04721
PMS	-1.002869**	.4034888	-2.48	0.030	-.9960544 1.70973
HHK	.96631	.6204466	1.54	0.105	.927055 1.007227
CHC	1.005586**	.3187872	3.16	0.026	.9694298 1.043091
/cut1	-.8775456	.6249165			-2.102359 .3472681
/cut2	.4726662	.6236439			-.7496533 1.694986
Pseudo R^2	0.3043	Prob > chi2	0.0027		

Source: STATA 17 output

Note: *** p<0.01, ** p<0.05, * p<0.1 denote significant at 1%, 5% and l0% level respectively

The results showed that electricity use increases the possibility of reporting better personal consumption (from fair, good to excellent). This finding is impressive as it reveals that electricity utilization plays an important role in promoting household consumption while holding other variables constant. Similarly, the results showed that the tendency to report better personal consumption (from fair, good to excellent) increases with a unit increase in LPG use while controlling for other variables. This finding could be linked to the efficiency associated with the use of LPG which makes cooking faster while reducing the pollution of the environment. In addition, it was found that the use of PMS decreases the possibility of reporting better consumption (from fair, good to excellent) while holding other variables constant. This finding could be attributed to the fact the PMS is hardly used by households to meet their cooking needs. However, it was found that kerosene usage is not significant at the 5% level in increasing the possibility of reporting better consumption (from fair, good to excellent). This could be explained by the increasing availability of energy alternatives for households. The use of charcoal as an energy source was found to significantly increase the possibility of reporting better (from fair, good to excellent) at the 5% significance level. This finding could be attributed the relatively cheap price of charcoal and the perfection that it gives food a nature taste it deserves. The pseudo R-squared of 0.3043 indicates that 30.43% of the total variations in household consumption are jointly explained changes in the energy use indicators. Additionally, the probability value (0.0027) of the chi-square statistic is less than 0.05, indicating that the variables are jointly significant in explaining changes in household consumption.

Table 9: Marginal effects results

Variable	dy/dx	Std. err.	Z	P>|z|	[95% C.I.]	X
ELC	.0058201***	.00129	4.51	0.000	-.002511 .009551	46.9948
LPG	.019705***	.00617	3.19	0.000	-.010388 .113798	9.35417
PMS	-.0016451**	.00078	-2.11	0.044	-.00218 .006889	65.5781
HHK	.0077165	.00477	1.62	0.105	-.001623 .017056	12.5703
CHC	.0012543***	.00021	5.97	0.000	-.0095 .006991	16.6927

Source: STATA 17 output

Note: *** p<0.01, ** p<0.05, * p<0.1 denote significant at 1%, 5% and l0% level respectively

The marginal effects results show the probability of reporting better consumption given a change in each energy

use indicator. As observed from the results, electricity use significantly increases the probability of reporting better consumption (from fair, good to excellent) by 0.582%. This finding is impressive given that a unit increase in electricity use enhances household consumption in the study area. Similarly, the results showed the probability of reporting better consumption (from fair, good to excellent) by 1.97% given a unit increase in LPG utilization. This finding highlights that continuous LPG usage improves the level of consumption. In addition, the results showed that the use of charcoal significantly increases the probability of reporting better consumption (from fair, good to excellent) by 0.125%. This finding could be attributed to the increasing level of energy poverty which has led to an overwhelming reliance on traditional energy sources including charcoal for cooking. However, the results showed that household kerosene does not significantly increase the probability of reporting better consumption (from fair, good to excellent) at the 5% significance level. On the other hand, the results showed that PMS significantly decreases the probability of reporting better consumption (from fair, good to excellent) by 0.164%. This finding explains the fact that PMS is rarely used for cooking to meet the consumption needs of households as it is used primarily in light and medium-duty motor vehicles, which are rarely owned by the poor. It can also be attributed to the highly inflammable nature of PMS which makes to be avoided by most households.

CONCLUSION

This study explores how the use of solid and non-solid energy resources such as electricity, LPG, kerosene, PMS and charcoal affected household consumption in Rivers State. This followed the recognition that changes in energy prices, increasing levels of the energy mix and gradual transition to modern and clean energy affect household consumption decision in many ways. The findings showed that electricity and LPG utilisation significantly improved household consumption. This suggests that moving up the energy ladder by transitioning to cleaner energy sources such as electricity and LPG as the main fuel source benefits the consumption of households. The results further showed that PMS utilization adversely affected household consumption. This finding suggests that the continuous increase in the price of PMS following subsidy removal undermines household consumption in the study area. Given the findings, this study concludes that the transition to modern and clean energy, especially electricity and LPG offers more opportunities for better household consumption. Thus, this study recommends that government should prioritise a stable electricity supply by investing in infrastructure upgrades and build synergy with the private sector to improve LPG supply to enhance availability and affordability of energy for better household consumption.

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