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Fuel energy switching and its socio-economic consequences in rural households in Oye-Ekiti local government area

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Abstract

The access to affordable, clean and modern energy is key to advancing standards of living and environmental health in the economy. This study investigated the socio-economic implications of switching from crude to clean energy for cooking in Oye local government area of Ekiti State. This paper employed a multinomial logit (MNL) model. The result shows that though, cooking is majorly done using fuelwood, the form of fuel usage corroborates the "energy stacking" theory which states that crude energy is used in varying quantities with clean energy in the studied households. The result also shows that increased education and rising income influenced transition from crude to clean energy, as those women with high level of education and increasing income prefer using clean energy to fuelwood for cooking (climbing the energy ladder). It was therefore recommended that women's education be encouraged. Electricity and natural gas should also be made available and affordable in the rural areas. These actions may encourage the switching from fuelwood to clean energy usage.

1. Introduction

Over the years, there has been hard cries world-wide on climate change and its devastating consequences such as ozone layer depletion, rising sea levels, increase in diseases, changes in precipitation, frequency of extreme weather conditions amongst others. These came with the plea to reduce carbon emission and lower global warming below 2°C (see Bello et al., 2021; Baiyegunhi & Hassan, 2014; Eleri et al., 2012; Hyde and Kohlin, 2000; Oyedepo, 2012; Shari et, al., 2022; Veld et al., 2006). Global temperature has risen 1°C above pre-industrial era. Global carbon and greenhouse gases (GHG) emissions keep increasing mainly due to rapid industrialization and other human activities such as fossil fuel usage, natural gas emission, gas flaring, fuelwood utilization, coal usage, bush burning, agricultural activities among others (Selby, 2019).

All these adverse climatic conditions threaten the environment and developing countries are usually the worse hit, as they are more susceptible to health risks globally than the developed countries (Ibitoye, 2017). Several unguided human activities threaten the healthy and peaceful co-existence of humans in the world. In order to meet the sustainable development goal (SDG) number seven which is "to ensure access to affordable and reliable modern energy for all, we should amongst others, reduce carbon dioxide emissions and advocate for energy transition from crude energy to modern clean energy. This would ensure better environment and enhance economic prosperity (Hyde and Kohlin, 2000; Veld et al., 2006).

Though Africa is contributing low GHG emissions globally, but it suffers most from the consequences of climate change. In order to avert the enormous challenges that come with climate change, clean, reliable and sustainable energy is advocated. However, affordability and accessibility of clean energy has been a herculean task and a challenge Africa is facing, including Nigeria due to low income and widespread poverty (Agu &Nyatanga, 2020; Espoir et al, 2022). Energy plays a very vital role in nation's social-economic progress (Eleri et al., 2012; Oyedepo, 2012). Nigeria suffers very serious energy crises despite being endowed with hydro, wind and solar resources and being the leading crude oil and gas producer in Africa (Agu & Nytanga, 2020). Average of 4 out of 10 people in Nigeria are not connected to electricity. The remaining 6 out of 10 people do not have frequent electricity which was blamed on frequent shortages of gas to power the plants, collapse of power grid, vandalization of the national grid and power lines among others (Omokaro, 2008). As at 2021, Nigeria generated about 12,522 MW of electric power from her existing plants. On most days, however, it was able to distribute around 4,000 MW which was insufficient for a population of about 200 million people. Electricity consumption per capita has been below 150 kWh per annum (World Bank, 2021).

In Nigeria, most activities that consume energy are cooking, lighting and usage of appliances. The most used energy are fuelwood, kerosene, natural gas and electricity (Bello et al., 2021). It was estimated that 72 percent of Nigerians use fuelwood for cooking. Despite the challenges posed by unprocessed fuelwood such as health hazards, deforestation, soil degradation and loss of bio-diversity, fuelwood is still the most affordable by rural households and millions of agrarian and poor populations still have high dependence on fuelwood in Nigeria (NBS/CBN/NCC Report, 2011). It seems that more households are descending the energy ladder; moving from cleaner energy sources to crude ones, due to increase in prices of clean energy and increasing poverty rate (Espoir et al.,2022). Though there is energy law such as Renewable Energy Master Plan 2005 among others that should control and regulate energy policies but the government lacks the will and political guts to implement them (Eleri et al., 2012). Inadequate energy law was blamed for increasing energy crisis in Nigeria. The absence and/or non-implementation of energy law has eroded or rather reduced the confidence of the investors in the economy.

Due to the fact that Nigeria is facing energy crisis, the choice for specific energy use should form a policy issue in Nigeria. This is because the policy should address important energy issues like desertification, deforestation, pollution and such issues that relate to climate change. These policies should also address more efficient energy use that will in a long-run, reduce the negative impacts of unrefined fuel usage on health and socio-economic factors on humans and environment. Nigeria as a low-income country lacks the capacity to completely do away with the activities that generate GHG such as agricultural and industrial activities, as it takes huge capital investment to produce GHG-free goods (Espoir et al, 2022). Hence, this study aims at examining the energy transition (diverse cooking fuel alternatives available) in the rural households, in order to ascertain the frequently used energy and its socio-economic implications to the economy.
Existing literature in Africa focused mainly on the effects of energy sources on growth. These studies are either country specific or employed in a panel data setting but overlooked the specific communities that make up the whole country or region, thereby neglecting the differences across countries and regions and communities. The focus on panel dataset proffers a one-size-fit-all policy that may not work for all the communities, as the study of different communities may yield heterogenous results and heterogenous climate policies. Literature on climate change observed that the effects of climate change is usually heterogenous according to regions, climatic regimes and temperature projections (Espoir et al., 2022). This study attempts therefore to add to the existing literature through the study of communities to the climate change.

Subsequent sections of this study are structured thus: section two has relevant literature review. Section three discusses data and methodology. Section four presents result and discussion while section five concludes and proffers some policy recommendations.

2. Literature review

In literature, the concept of fuel energy switching entails the structural movement in energy systems from non-renewable energy source such as wood, coal and other fossil energy sources to renewable energy sources such as electricity, wind and solar with the main concern of reducing over-depletion and environmental impact of fossil fuel sources. This has therefore become a source of concern to various scholars as well as policy makers. The following literature attempts to review different studies conducted in this regard.

Espoir et al., (2022) examined the heterogeneous effects of emissions and temperature on income in some Africa countries between 1995 and 2016. Employing a panel and time-series techniques, the study revealed that increase in temperature have a negative relationship with income. Secondly, increase in CO_2 emissions increases income by 0.23%.

Babayomi et al., (2022) analyzed the affordability of clean energy transition in developing countries: pathway and technologies. The study linked the need for energy transition in the developing countries to attainment of industrialization which is a requirement for economic growth and development. In the study, three attributes of developing countries such as youth demographics, lower rate of urbanization and low grid capacity were identified as factors that can influence energy transition. Consequently, effective low-cost technologies and innovations that can facilitate clean transition in a sustainable socio-economic framework is of great essence.

The global energy and natural resources report 2022 by Bain & company reaffirmed that even though carbon emission reduction is a priority, the drive for profit as well as desire to make progress by the private sector might be a hindering factor unless a targeted policy is applied by the authority. It was therefore opined that investors should be mandated to deploy bold, new and low carbon businesses in order to encourage investment which will in turn facilitate growth and development.

Espoir et al., (2021) analyses the influence of renewable electricity consumption (REC) and unrenewable electricity consumption (UEC) on productivity in 48 African countries spanning 1980 and 2018. Employing panel estimators, slope heterogeneity and cointegration, the study found the variables to be cointegrated. It also found that both REC and UEC have positive and significant relationship with productivity. Finally, the study found evidence for REC and UEC having marginal effects across the countries studied.

Nwozor et al., (2021) carried out a prospective and evaluative analysis of energy transition to green energy and sustainable development in Nigeria. It was observed that energy transition in Nigeria has posed a serious challenge even though the country is endowed with natural resources that would have made energy transition an easy ride but it has been difficult due to domination of the economy by non-renewable energy which is inefficiently tapped and that the country's renewable energy development is saddled with lack of consistency and unavailability of data required in setting targets.

Edomah et al., (2021) empirically analyzed a breakdown of Nigeria's energy transition according to level of technological advancement as well as the primary sources which were being exploited. In the study, it was emphasized that colonialism and trade played major roles in the transition as this facilitated transfer of new techniques and practices which shaped the early aspects of Nigeria's energy transition from wood, coal, electricity, steam engines to the late industrial era which witnessed the extensive use of internal combustion energy with dynamos as well as increased mechanical activities which led to reduced coal usage and crude oil discovery.

Adeyanju et.al (2020) opined that the usage of fossil fuel energy in Nigeria is not unconnected with poverty and lack of access to social amenities such as electricity which drives the populace to stick to the use of wood and charcoal which remains affordable due to their low standard of living. This is in agreement with

Ogwumike et al., (2007) who noted that the continual rise in fuel prices and electricity is a major factor in sticking to these fossil fuel energy sources and this has made energy transition an uphill task. This was in agreement with the study by Efurumibe (2012) which opined though poverty is a factor but not enough to hinder energy transition, he therefore linked the slow transition to lack of regulatory framework and inconsistency of government policy in addressing the issue which is not unconnected with the large expanse of crude oil and gas availability in the country. This was in agreement with Edomah (2021) which states that energy transition has to be driven by policy as forces of demand and supply is not sufficient to reduce carbon and gas emission. The forces will opt for the least-cost option, which is the fossil fuel energy.

Ibitoye et al., (2017) examined the relationship between environmental variables, green growth and carbon emission in Nigeria from 1980 to 2015 by employing the ARDL technique. It was concluded that sustainable environment sustainable environment will be maintained through a gradual movement from fossil fuel energy coupled with an efficient investment in renewable energy and green growth.

Janardhan (2012) reviewed the concept of Energy transition with the context of Indian economy. He opined that hydrocarbon source of fuel energy has been adversely affecting the human and et, al. environmental health but the country could not control due to over-dependence on imported fuel which makes the country vulnerable to supply challenges. He supported the assertion of Edomah (2021) that coordinated and target policy coupled with high share of domestically controlled alternate sources would hasten energy transition.

Going from the reviewed literature, the studies overlooked the influence of time and climatic zones to the contribution of GHG emissions to the devastating effects of climate change to the world. They focused on countries as a whole without considering the different parts that made a whole which this study focus on.

3. Data and methodology

3.1 Theoretical framework

This study is hinged on energy ladder and energy switching theories as were used by Heltberg (2003) and Baiyegunhi & Hassan (2014). These theories argued that the choice for fuel usage depends largely on the level of household income and the relative fuel prices. The theory noted that maximum utility depends on the individual's income. On the other hand, energy ladder model shows a three-stage substituting progressions, relying on the levels of income of the consumers. The theory divided fuel into three namely, the crudest (old biomass), the moderate crude (kerosene, coal and charcoal) and the cleanest fuel (LPG, natural gas and electricity). The theory argued that the consumer switches from the crudest to the cleanest energy as income level increases and vice versa. In other words, the switching progression starts from the crudest fuel usage to the cleanest fuel usage based on the family's income level. However, this theory did not go down well with some studies like Heltberg (2003) and Masera et al., (2000) who argued that no matter the level of consumers' income, they do not completely discard the traditional fuel but rather keep substituting them with the modern fuels at their convenience. Literature also has it that aside from income and wealth, there are other determining factors of fuel choice such as proximity to the fuel source and fuelwood scarcity/availability (see Hyde and Kohlin, 2000; Veld et al., 2006). Other factors are age, educational status of the head of the family, family size, type of house inhabited whether personal or rented apartment, among others (Osiolo, 2009; Pundo and Fraser, 2006).

Based on the foregoing, consumer theory would be used to model the fuel choice of the consumers, as also used by Lancaster (1966); Masera et al., (2000) and Rosen (1974). Consumer theory argues that consumers derive satisfaction not only from a commodity but also from the features that the commodity possesses. Therefore, the information that the household has affects their fuel choice which largely depends on both economic, agro-ecological and social constraints. Such constraining factors may include the proximity of the fuel source, age of the head of the family, the fuel price, income or wealth of the consumers and family size of the consumer. Other factors to be considered may be the type of house the consumer inhabits whether a personal house or a rented apartment, the gender of the consumer amongst others.

This study presumed that a household has the freedom to choose from amongst the available baskets of fuel that can maximize his utility. The household is assumed to have the following utility function:

$$\cup_{ij} + Q(Z_{j,}S_i) + \varepsilon(Z_{j,}S_i) \quad (1)$$

where i denotes household, j represents the level of utility derived from any available fuel choice which is a function of the feature Z of the fuel choice and other constraints mentioned earlier that may influence the household choice of that particular fuel. The utility derived from the chosen fuel alternative (j) is assumed to be higher than the utility embedded in other alternative fuel types. This utility probability is thus represented by the model:

$$P_{ij} = prob\ U_{ij} >; b = 1,2,3 \ldots\ldots j; b \neq j \quad (2)$$

Therefore, if household i chooses fuel type j, it means that Uij is the best alternative choice of fuel that can give the optimal utility among the other alternatives.

3.2 Materials and methods

Study area and data

This study was conducted in Oye-Ekiti Local Government Area of Ekiti State, Nigeria. Oye-Ekiti is one of the 16 Local Government Councils of Ekiti state, southwest geopolitical zone of Nigeria. Oye-Ekiti lies between the latitude 7° 47′–52.55′ N and longitude 5° 19′–42.78° E. The area is characterized by hot season which lasts for about 2.6 months from January 23 to April 9. It has average daily temperature of 88°F with average rain fall of 187.89mm and approximately 15 rainy days in a month. It has its driest month in December. Aside the Federal University and local Government headquarters that are in Oye-Ekiti which have civil and public servants, the majority of the residents in Oye-Ekiti are farmers. The farmers major in crops such as maize, okra, tomatoes, cassava, yam and some live-stocks like Chicken and goats.

On ethical issues, the study sought and obtained an approval on ethical issues from the University of Kwazulu Natal, South Africa with the Protocol reference number: HSS/0541/018D. This is because any research that involves humans and animals supposed to seek and obtain ethical clearance before proceeding to the field for data gathering.

This study employed cross sectional data collected through structured questionnaire and personal (one on one) interviews from women in these communities. Though, Fuel choice may also be taken by the bread winner of a household, who may not be necessarily a woman. However, it is believed that culturally, it is the responsibilities of the women (females) to cook and prepare meals. Hence, the fuel choice should be their responsibility. According to Npopc (2015) Oye-Ekiti has no well-structured and defined villages, communities and towns and therefore the research instrument was not evenly distributed across the villages, towns and communities. Npopc (2015) noted that Oye -Ekiti has a population of 48, 545, comprising of 24,595 males and 23,950 females.

The study employed Yamane (1967) formula to obtain the sample size. The formula is given as:

$$S = \frac{N}{1+N(e)^2}$$

Where: s = Sample size, N = Finite population, e = Margin of error = 5% (0.05), 1 = Constant (Almeda et al., 2010). The sample size is approximately 400. Thus, 430 structured questionnaires were distributed, there is the probability of not retrieving all. 420 were retrieved. After data cleaning, we were able to analyzed 400 questionnaires. The questionnaire was designed in a 5-Point Likert Rating Scale (PLRS) which was graded thus: Strongly Agreed (SA) = 5, Agreed (A) = 4, Neutral (N) = 3, Disagreed (D) = 2 and Strongly Disagreed (SD) = 1.

The principal demand of the instrument was for the respondents to specify their preference for cooking among fuel alternatives and fuelwood. Table 1 presents the dependent and the independent variables used in the multinomial logit model for the study. Multinomial logistic regression was used due to its attendant advantages over other estimating techniques. Amongst whom are: it predicts categorical placement in or the probability of category membership on a dependent variable based on multiple independent variables. Secondly, MNL was used in the study because it is one of the most efficient algorithms when the different outcomes or distinctions represented by the data are linearly separable. Thirdly, MNL has the capacity of handling more than two alternative choices/ independent variables.

Table 1: Dependent and independent variables.

Dependent variable = fuel choice from fuel alternatives.

Socio-economic variables used in the multinomial logit model (MNL)	Description of the variables	a priori Expectation
Independent Variables		
Age	Age of the family head (in years)	−
Educational status	Years of school attendance	−
Household size	Number of persons in the family	+/−
Monthly income	Monthly family income (in Naira)	−
Occupation of the family head	Dummy = 1 if white collar job and zero otherwise	+
Dwelling unit status	Dummy = 1 if personal house and zero otherwise	+
Type of house inhabited	Dummy = 1 if traditional house and zero otherwise	+
duration it takes to cook the food	Dummy = 1 if takes time to cook and zero otherwise	+
Fuelwood price	The cost of fuelwood (in Naira/kg)	−
Proximity to fuel source	Proximity to fuel source (in kilometers)	–

Source: Authors' own computations

3.3 Model specification

This study's model was specified in line with this study of Gujarati and Porter (2009). The household's choice from the four types of fuel, namely; fuelwood, kerosene, natural gas and electricity was examined using the multinomial model (discreet choice). Therefore, it can handle more than two alternative choices thus:

$$Prob\ (Y_i\ = j)\frac{exp\ \beta_j' X_i}{\sum_{k=1}^{4} exp\ \beta_k^{"} X_i}\ with\ j = 1,2,3 \quad (3)$$

Where Yi represents the fuel types and takes the values 1, 2 or 3 if kerosene, gas or electricity was chosen. Fuelwood is used as a reference group. Xi stands for the vector of independent variables. βj stands for vectors of coefficients estimates. The results are interpreted in terms of the odd ratios which are defined thus:

$$ln\left[\frac{P_{ij}}{P_{ik}}\right] = \left(\beta_j - \beta_k\right) = X_i\beta_j\ if\ K = 1 \quad (4)$$

A positive coefficient shows that the probability of selecting other fuel types, that is, kerosene, gas and electricity over fuelwood increases relative to the choice of selecting fuelwood over the other alternatives.

4. Results and discussion

4.1 Respondents' socio-economic factors

The respondents' socio-economic features are shown in Table 2.

Table 2: Socio-economic features of households

Household socio-economic features		Number of respondents	Percentage	Mean
Age (in years)				
25–39		64	13	34
40–59		206	52.6	48
50–69		130	34.4	57
Educational status				
No education (0 years)		120	31.3	–
Primary & adult education (1–6 years)		174	49.3	3.6
Secondary (7–12 years)		47	10.7	8.2
Tertiary (more than 12 years)		38	8.7	9

Family size				
1–5		136	33	3.7
6–10		208	56	6
10–15		46	11	8
Occupation				
Farming		206	40.5	–
Traders		100	26	–
Artisans		34	16	–
Civil servant		50	13.5	–
Unemployed/full-time house wife		10	6	–
Average income per month (N)				
Less than 5000		186	42	1550
5001–10,000		78	20.7	5075
10,001–20,000		52	15	10,500
N20,000		84	24.3	21,050
House status				
Personal house		99	35.7	–
Rented apartment		301	64.3	–
Type of house lived				
Traditional		307	69.3	–
Modern		93	30.7	–

Source: Authors' own computations

All the sampled respondents were married women. From table 2, the average age was 46.3 years, whereas the average years of schooling was 6.93 years. The average family size was 6.23 persons. Occupation wise, while 206 respondents (40.5%) were farmers, 100 respondents (25%) were traders and 34 respondents (16%) were artisans. Civil servants accounts for 52 respondents (13.5%) and 10 respondents (6%) were either unemployed or full housewives. The average monthly income is N10,175 (about $16. 96 [$1 = N600]), this shows that average household is living on less than $1 per day. This qualifies as a poor country (see IMF, 2020). Majority 307 respondents (64.3%) lived in a rented apartment while 99 respondents (35.7%) lived in their personal houses. On the types of houses inhabited, 307 respondents (69.3%) lived in traditional (mud) houses (though many were plastered) while only 30.7% lived in modern houses.

4.2 Choice for cooking energy

Table 3: presents the distribution of choice for cooking energy (fuelwood, kerosene, gas and electricity).

Primary fuel use	Average percentage (%) share of cooking energy				Household (%) fuel used
	Fuelwood	**Kerosene**	**Natural Gas**	**Electricity**	
Fuelwood	74	22	–	24	64.3
Kerosene	7.8	81	3.6	5.2	26
Natural gas	6.2	21	64.9	4.2	5
Electricity	12	14	7.5	38	4.7

Source: Authors' own computations

In Oye local government area, all the respondents use fuelwood for cooking (table 3). It indicates that fuelwood and kerosene are the major energy for cooking. 64.3% of the respondents use fuelwood while 26% use kerosene. 5% of the respondents use natural gas while only 4.7% use electricity. It also shows that the respondents have fuel mix in cooking. The percentage share of fuel mix for those who use fuelwood as their main energy source were [fuelwood 74%, kerosene 7.8%, natural gas 6.2 and electricity 12%]. Other respondents that choose alternative sources as their primary source also have their own mix. For instance, kerosene 81% with their mix, natural gas 64.9% with their mix and electricity 38% with their mix. This finding corroborates the energy stacking theory and the study of Heltberg (2005) which noted that households always use more than one energy type and not just switch from one energy type to another as their income improves or rises. This implies that in the rural setting, traditional fuelwood is combined with the modern fuel for cooking (energy stacking).

4.3 Multinomial logit regression result (MNL)

The Multinomial logit model estimates (MNLE) and the Marginal effects explain the household fuel choic**e.** The parameter estimates and the marginal effects for kerosene, natural gas and electricity (captured with *MNLE and marginal effects* in table 4) are presented in row 1, 2 and 3 respectively. The estimates only show the impact of the independent variables on the dependent variable while the marginal effects show the change in probability of a choice made in a particular energy as a result of a change in independent variable. Comparison was made between the estimations for kerosene, natural gas and electricity with fuelwood which was the study's base reference choice.

The estimation for the age of the family head is statistically significant and negatively related to the probability for the usage of natural gas (Table 4 row 2). The implication is that rise in the age of the family is likely to negatively affect the usage of natural gas in comparison with fuelwood. The marginal effects imply that a year increase in the age of the family head is likely to decrease the choice of natural gas by 43% relative to fuelwood. The economic implication here may not be unconnected to the fact that, the older people grow, the more addicted they are to the old way of life or to the taste of the food cooked with fuelwood instead of opting for a cleaner and more efficient energy. This finding is in line with the study of Heltberg (2005) who observed that families get adhered to fuelwood traditionally due to the taste and the way of life developed over the years.

Table 4: Multinomial and marginal effects of the variable used

Variables	Kerosene		Natural gas		Electricity	
	1		**2**		**3**	
	MNLE	**Marginal effects**	**MNLE**	**Marginal effects**	**MNLE**	**Marginal effects**
Age of the family head	−0.41 (−0.72)	0.21 (0.69)	−1.03 (0.24)***	0.43 (0.47)	0.18 (0.51)	0.19 (0.82)
Educational level	0.22 (0.05)***	−0.20 (−0.52)	0.021 (0.01)**	0.18 (0.02)*	0.02 (0.29)	0.20 (0.29)
Family size	0.02 (0.03)	−0.632 (0.002)**	−0.20 (0.10)**	−0.30 (0.004)**	−0.03 (0.08)	0.321 (0.008)**
Ln household monthly income	0.68 (0.34)**	−0.117 (0.003)**	1.87 (0.35)***	0.334 (0.013)*	1.22 (0.28)*	0.413 (0.017)**
Family head occupation	0.03 (0.05)	0.008 (0.007)	0.01 (0.06)	0.011 (0.006)	0.07 (0.08)	0.016 (0.005)
Personal house	0.71 (0.65)	−0.271 (0.008)**	0.09 (0.52)	0.346 (0.018)**	0.59 (0.43)	−0.145 (1.15)
Type of house	0.02 (0.17)	0.087 (0.84)	−0.30 (0.12)*	0.34 (0.06)***	−3.02 (0.09)*	0.43 (0.14)**
Duration it takes to cook the food	0.95 (1.28)	0.15 (1.02)	−0.30 (0.13)**	0.192 (0.009)**	−0.02 (0.01)**	0.152 (0.006)**
Ln fuelwood cost	0.033 (0.01)***	0.451 (0.81)	0.02 (0.01)	0.113 (0.48)	0.07 (0.05)	0.181 (0.86)
Ln proximity to fuel source	0.72 (0.91)	0.113 (0.05)*	0.68 (1.00)	0.048 (0.99)	0.21 (0.92)	0.007 (1.14)
Constant	−3.74 (1.01)***	-	−5.85 (1.55)***	-	−4.92 (1.25)***	-
No of observation	400					
Pseudo-likelihood	−329.53					
Wald Chi^2	134.67					
Prob N Chi^2	0.0000					
Pseudo R^2 0.68 Fuel choice accuracy (correctly predicted): Fuelwood = 74.6%; kerosene = 16.8%; natural gas = 3.6%; electricity = 5.2%						

MNLE represents multinomial results Note: Standard error in (Par.). ∗∗∗, ∗∗, ∗ are 1%. 5% and 10% significance probability level.

The estimated result shows that educational level is statistically significant and positively related to the family desires to use kerosene and natural gas instead of fuelwood. The implication is that the more educated the family head is, they are likely to prefer kerosene and natural gas to fuelwood for cooking. It shows that a year change in education of the family head induces 20% and 18% transition from the choice for fuelwood to the choice for kerosene and natural gas respectively. The reason for this finding may be because, the increased level of education increases income and knowledge on the usefulness and importance of cleaner energy. It is also a common sense that a highly educated woman may not have all the time to gather fuelwood from the bush. She would rather invest her time in more productive ventures than scouting for fuelwood from the bush or forest. This finding corroborates the studies of Farsi et al., (2007) who noted that highly educated women weigh the opportunity cost of their time between different demanding ventures and invest in the one with higher returns. In this, buying kerosene and natural gas, though more expensive, may offer more utility to them.

The family size has statistically significant and negative relationship with choice from fuelwood to natural gas, implying that as the family size increases, the more likely households transit from natural gas to fuelwood. A unit increase in family size reduces the choice for natural gas over fuelwood by about 30%. Naturally, a big family size would prefer cheap energy for cooking to going for expensive and clean energy, as they can use some of their family members to collect fuelwood easily from the bush. This lowers the cost of the energy for cooking.

The estimation for family monthly income is positively and statistically significant with the probability of transiting from fuelwood to other cleaner energy. The implication here is that, as the family monthly income increases, the more they prefer kerosene, natural gas and electricity to fuelwood. Theoretically, as the income a consumer increases, the better their standard of living and the better they would want to "compete with the jones". A dollar increase in family monthly income will cause 41%, 33% and 11% change in preference for electricity, natural gas and kerosene respectively from fuelwood. This finding is in line with 'energy ladder' theory (Heltberg, 2005) which noted that consumers are most likely to climb the energy ladder as their income increases.

The estimation result for the type of houses inhabited shows a negative and statistically significant sign in relationship to the change from the use of fuelwood to natural gas and electricity. This indicates that families living in old houses (probably without kitchen) prefer fuelwood for cooking to using natural gas and electricity. The marginal effect shows that the likelihood of the families that are living in traditional houses using natural gas and electricity reduces by 34% and 43% respectively in relation to cooking with fuelwood. The simple reason may be unconnected to the fact that, traditional houses most often, have external kitchens (outside the house) that may not make it easy to use clean energy like electricity and natural gas for cooking.

For the variable that discusses the time it takes to cook the food has statistically significant inverse relationship with the probability of using fuelwood to natural gas and electricity as preferred cooking energy. The implication is that if it takes a longer time to cook a certain food, the consumers would prefer to use fuelwood as opposed to using natural gas and electricity. This suggests that the likelihood of the consumer to use natural gas and electricity will reduce by 19% and 15% respectively. A likely cause of this may be because natural gas and electricity consumption per unit of time is more expensive than using fuelwood per same unit of time. Put differently, fuelwood is cheaper than natural gas and electricity for cooking per time.

The result also shows that the probability of using fuelwood is statistically significant and positive to the transition of using kerosene as the primary source of energy. The implication is that when the cost of buying fuelwood rises, it would increase the likelihood of the consumers opting for kerosene as the primary energy use. The marginal effect indicates that the likelihood of transiting to kerosene from fuelwood as a result of increase in price of fuelwood would increase by 45%. The likely reason may be because, as fuelwood is the main energy cooking source in Oye-Ekiti, higher demand of fuelwood increases the price and consumers would go for cleaner energy as their prices are relatively stable and cheaper than the price of fuelwood. This corroborates the law of demand which noted that demand is a decreasing function of price.

Finally, the chi-square result was statistically significant ($p < 0.000$). This submits that the model has high explanatory power. The estimation correctly predicts about 74.6% for using fuelwood, 16.8% for using kerosene, 3.6% for using natural gas and 5.2% for using electricity. The variance inflation factor (VIF) was below 10, showing that there is no problem of multicollinearity in the model.

4.4 Discussions and interviews

Due to the lack of resources to pay for the transport fare, accommodation and entertainment for the women to be interviewed, if they were to be gathered in a place for the interview and discussion, one on one visitation and interview was conducted. Two enumerators, who hear and understand Yoruba language were trained. This is necessary as the majority of the women do not understand English language.

On the discussion and interviews, 15 women were interviewed. The women were asked

"*why do you depend mainly on fuelwood as the major source of cooking energy*?

Majority of the women 12 out of 15 (80%) maintained that fuelwood is cheaper than other fuel sources like kerosene and natural gas. This answer agrees with the responses from the questionnaire. This may be consequent upon the fact that most of them have large family sizes and because the study area is a rural setting where fuelwood can easily be fetched from around the neighborhood's forest. The other 3 (20%) of the women opted for natural gas as their primary source of cooking energy. No one agrees that she uses electricity as the cooking energy.

The enumerators explain the concepts of global warming and its health and economic implications to the invited interviewees and they were asked;

"seeing that global warming and its effects are a reality, why have you not opted for cleaner energy sources like electricity as a source for cooking energy?

They unanimously responded that they rarely have electricity power in the communities. Even when there was electricity, the voltage was most often too low to use electrical appliances. The answers generated from the questions were similar to the responses from the questionnaires. They were further asked

"if clean energy is made available to you and at a moderate cost, would you be willing to use clean energy rather than using crude energy sources"?

In this, 13 (87%) agreed to use clean energy sources. However, the remaining two (13%) of the women cited the type of houses (traditional (mud) houses) they are living as a barrier to using either natural gas or electricity. This also is in line with the results from the estimated multinomial regression.

5. Conclusion and Recommendations

The access to affordable, clean and modern energy is key in advancing standards of living and environmental health in the economy. This study investigated the socio-economic implications of switching from crude to clean energy for cooking in Oye Local government area of Ekiti State, Nigeria. This paper employed a multinomial logit (MNL) model. The result shows that though, cooking is majorly done using fuelwood, the form of fuel usage corroborates the "energy stacking" theory which states that crude energy is used in varying quantities with clean energy in the studied households. Based on the estimated result, the shift from crude energy use such as fuelwood to modern clean energy such as kerosene, natural gas and electricity for cooking is still slow. This is consequent upon the fact that higher proportion of the respondents still use fuelwood as their primary cooking energy. While it is difficult for less educated women to rise on the energy ladder (transiting from the crude to the clean modern energy), highly educated women found it easier to climb the energy ladder. Estimated results also show that increase in age of the head of the family, larger family size, longer cooking period and those living in traditional and rented houses favour the use of crude energy such as fuelwood. This is because all these variables had statistically significant and negatively related with the probability of using fuelwood. On the other hand, increased income, higher education level and living in modern houses favour clean modern energy usage more, their marginal effects show positive and statistically significant result. In summary, the result shows that increased education and rising income influenced transition from crude to clean energy, as those women with high level of education and increasing income prefer using clean energy to fuelwood for cooking (climbing the energy ladder). It was therefore recommended that women's education be encouraged. Government should enhance rural electricity grids and make electricity and natural gas available and affordable in the rural areas. These actions may encourage the switching from fuelwood to clean energy usage. Despite these revelations, our extended analysis based on climate regimes indicates heterogeneous effects across countries. Considering the Paris agreement on climate, this study suggests that policymakers should emphasise country-specific policies than global climatic policies for sustained CO_2 emissions reduction in Africa.

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