



## A Thematic Review on the Determinants of Household's Energy Choice in Northeast, Nigeria

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### Keywords:

Households  
Energy  
Consumption  
Determinants  
Choices

### JEL Classification:

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### Abstract

*Household energy choices play a crucial role in shaping energy consumption patterns. This review synthesizes existing literature to identify the determinants of household energy choices. A comprehensive search of peer-reviewed articles yielded twenty-six (26) studies, which were analysed using thematic framework. The review revealed that households' energy choices are influenced by factors such as socio-demographic characteristics (Education, household size, housing type, technological advancement, cultural preferences) and not just income. Based on the outcomes of the review, it is recommended that Government should implement targeted subsidies for low-income households to promote the adoption of modern energy use and invest in energy infrastructure development, especially in rural areas.*

## 1. Introduction

It is the predominant goal of every household to achieve an affordable, reliable and sustainable energy for cooking. The choice of energy that will satisfy these goals becomes a critical aspect of modern society, as they have far-reaching implications for both the producers, consumers and the environment. This is because all segments of the economy ranging from manufacturing (producers), residential (consumers), and transport (services) depend largely on various forms of energy to perform their functions effectively and efficiently.

Despite technical improvements to energy in recent times, the scale of global energy poverty is still disturbing. About three billion

people in developing countries remain reliant on traditional cooking fuel and about one billion people lack access to electricity (United Nations Statistics Division, 2018). Most of this clean energy-deprived population seems to reside in rural areas of low-income countries, Nigeria inclusive. Traditional sources of energy such as fuel wood, charcoal and animal residue seem to still be in usage especially in rural areas. Meanwhile, in the rural areas of Nigeria, about 86% of the households depend solely on solid fuels (Fuel wood and Charcoal) as their sources of energy (Maina, 2017b). Notwithstanding, available literature reveals some socioeconomic determinants of households' energy choices. Most used clean energy sources by households in Nigeria are

electricity and Liquefied Petroleum Gas (LPG) (Maina et.al, 2019). Observably, solar energy is gradually becoming another energy choice by some households in Maiduguri Metropolis. The fact remains that dependency on the traditional energy fuel by households can result to environmental degradation, health implications, inefficient cooking and lighting and consequently low productivity.

Attention towards the sustainability of energy sources is becoming increasingly important. Limited leftover fuel resources and concerns about environmental degradation are driving the search for more sustainable alternatives. The United Nations (UN) through its Sustainable Development Goals (SDGs) No. 7 has been encouraging the need for overall access to affordable, clean, and modern energy services by 2030 as a collective global responsibility for all civilized nations. The 'Energy Transition Plan' and the 'Decade of Gas Initiative' of the Federal Government of Nigeria are all policies aimed at providing general access to modern energy services to its population by 2030, thereby reducing the effect of climate change caused by increasing deforestation associated with fuel wood and biomass consumption. Without a clear understanding of households' socio-economic determinants that influence energy choices and consumption pattern, it may be difficult to achieve these goals. There seem to exist some socio-economic factors that determine energy choices; some of these factors include, but may not be limited to the following: age of household heads, monthly income of household heads, household size, educational level of household heads, household type and occupation of household heads. The demand for LPG is found to be low in some parts of urban Nigeria like the north east region because it is usually scarce and where it is available, it is mostly unaffordable (Maina, 2019a). Studies have revealed household's energy usage patterns aiming to promote sustainable energy practices (Maina et al. 2017a & Akeh et al., 2023). Further attention is required regarding household. Additionally, there's a noticeable trend towards the adoption of solar energy

among households. This study aims to thematically review the determinants of household's energy choice in Northeast, Nigeria.

## **2. Literature review**

### **2.1 Conceptual Review**

#### **2.1.1 Energy**

The term energy in the context of this paper refers to the utilization of chemical resources which is aimed at providing a source of power or light for cooking, space heating and cooling, ironing and for other purposes.

#### **2.1.2 Household Energy Choice**

Household energy choice means the total amount of energy purchased and used by households for the various purposes mentioned above. Thus, energy choice is essential for households' welfare, public investments and environmental considerations. The theory of consumer behavior postulates that households as economic agents are rational and try to maximise their utilities. Consequently, as rational consumers, households always choose the most preferred bundle from a set of feasible alternatives (Ado & Darazo, 2016). Therefore, as income increases, households tend to reduce the consumption of traditional fuels, but shift to newer and more improved fuels which are more efficient and user friendly indicating that traditional fuels are inferior goods while the modern fuels are normal economic goods (Ogwumike et al., 2014).

### **2.2 Theoretical Review**

The energy ladder theory suggest that energy demand depend entirely on income.

- i. The first stage is marked as the past centuries era, when all households depend on biomass as their source of residential energy.
- ii. The second stage is called a 'transition phase' involving the use of semi-modern energy sources such as kerosene, coal and charcoal. This is a stage where the income of the household has increased to some level, leading the transition.
- iii. The third stage or rather, the last stage of the model emphasises a situation where the income

of the household increased substantially. According to the model, this is the situation where the household switches to the use of Liquefied Natural Gas (LPG), natural gas and electricity.

However, critics argue that the energy ladder hypothesis is overly simplistic as it implies that a move up the ladder to modern fuels necessarily imply a move away from traditional fuels. But the linear relationship between income and energy demand and preferences; as upheld in the ladder hypothesis, have been criticized because factors other than income could equally explain fuel choices and demand. For example, a pure demand effect, associated with increasing income, will result in substitution because of convenience and changing uses of time. Supply factors can also play a role as scarce or higher production cost fuels have higher prices and will be less available and/or affordable.

The utility theory on the other hand has its roots in the thoughts of early twentieth century economists such as Alfred Marshall and Hicks who saw utility as the satisfaction or pleasure and benefit derived from the consumption or use of a particular commodity or service. According to the theory, given a household budget constraint, the household consumes a commodity that maximizes their utility. Energy as a fundamental utility for households, providing comfort and convenience services. Households demand energy to maximise their utility derived from energy use like cooking. They are assumed to be rational and have preferences that are consistent, invariants, known and ordered. Therefore, households as economic agents can act as utility maximizing consumers. That is, as income increases, they tend to purchase fewer inferior commodities or a times shift completely from the purchase of such commodities (traditional energy) to superior or normal commodities (modern energy). In order to maximise utility.

### 3. Determinants of Households' Energy Choices

#### 3.1 Socio-Economic Determinants

These comprise of social and economic factors that can determine or influence energy demand. This is an argument to energy ladder which states that energy demand is a function of income. Studies have revealed that other factors can influence demand. For example, (Ado and Darazo, 2016). Debebe et al (2023) did a survey of 420 randomly selected households in Northwest Ethiopia to study the determinants of household's energy choice for domestic chores. Using semi structured questionnaire to collect data and employing descriptive and multivariate probit model to analyze data collected. His result revealed that 87% of households in the study area used fuel wood, 32% used charcoal and 17% electricity. Result on the reason for that choice showed that age, gender, household size education, income, access to electricity, distance to forest and housing type were determinants to households' energy choice. Lastly, the result on pattern of utilization skewed towards biomass fuels and price fluctuations were the reason for fuel stacking.

Furthermore, Wassie et al. (2021) analysed the determinants of rural household energy choice for cooking and lighting in Ethiopia. Drawing 660 samples from a cross-sectional sampling technique, the observational study, the Socioeconomic variables considered in the study were distance to wood source, household size, income level and location. While variables to measure energy fuel choices included electricity, solar, kerosene, biogas and fuelwood. chi square test and Multivariate Probit Model (MVP) were used to analyze data. The result revealed that rural households 90.70% depend on fuel wood while only 3.14% used clean fuels for cooking. 50% used kerosene, 29% electricity, 19% solar and 1.98% biogas was used for lighting. The result also revealed that household's cooking fuel choices had a significant relationship with distance to wood source, household's size, income level and location. However, the

outcome of the study cannot be generalized to Nigeria context due to country specific reason.

### 3.2 Household's Level of Income

The income level of households can play a significant role in the type of energy that households will eventually choose. This is because economic thinkers believe that consumption is sensitive to income and that income can help to the consumer to make predictions about future consumption. It implies that rising income of households can lead to a corresponding increase in energy demand. Higher incomes households can increase consumption of energy-intensive goods and services, such as electronic appliances, heating and cooling systems. In Maina et al (2019a) the mean monthly income of households was found to be ₦32,200 and had influence on the expenditure of clean energy at 1% level of significance. Also, Maina et al (2020) averred that households dedicated greater share of their income on dirty fuels. Furthermore, the study conducted by Maina et al (2019b) Identified the patterns of energy sources used by households and analysed their determinants. Using General Household Survey data by NBS. The variables used for the study included household monthly expenditure, household size, age, sex, educational level. Using descriptive statistics (bar chart) and multiple regression and indicted that increase in income, educational level and having a female as a household head were associated with less dirty energy use, while increase in family size and age were associated with high dirty fuel use. However, it may be more appropriate to classify kerosene under transitional fuel rather than dirty fuel.

Debebe, et al. (2023) revealed that the household's income formed part of the reason for energy choice in Northwest Ethiopia. Bisu et al. (2016) revealed that household level of income was found to influence cooking energy choice in Bauchi Metropolis. 53.5% of the households spend about 1-5% of their income on cooking fuels monthly (Ado and Darazo, 2016). Furthermore, the result in Danlami and Islam (2020) indicated that average monthly

income of household was about US \$220, and the average monthly firewood consumption per household was about 35 bundles and 70% of the respondent's used firewood as their main source of cooking and the correlation analysis indicated that income has positive relationship with the quantity of energy consumption and a negative relationship between price of a particular energy source and its consumption.

Choumert et al. (2017) further started that as income of households increase, they tend to move towards modern fuels. Baraya et al. (2023) scrutinized the determinants of households' energy consumption needs in Kebbi State, Nigeria. Household expenditure on electricity, liquefied petroleum gas, kerosene, charcoal and biomass indicated that low-income households' heads accounted for 60% of respondents who rely heavily on traditional methods of biomass to meet their energy needs. Also, household's head income, availability of different energy choices, reliability and affordability were the major determinants of household energy consumption needs. Combining the urban semi urban and rural areas may not give sufficient information on the determinants of energy needs across different income groups. Also, the use of Binary model to analyse qualitative data can lead to data trap.

Maina et al. (2017b) analysed household energy use and the negative externality of CO<sub>2</sub> emission in the North East region of Nigeria. Secondary data was used from National Bureau of Statistics on general household survey (2013) employing CLA and OLS models. The results revealed that petrol was the major carbon dioxide emitted. But charcoal was the dirtiest energy source because it emitted four times more CO<sub>2</sub> than its actual kg that was used. Also, household monthly income, age, family size and rural-urban dichotomy were found to influence negative externalities (CO<sub>2</sub>) positively at 1% level of significance each.

Maina et al. (2017c) analyzed the determinants of household energy demand in the North East Zone of Nigeria obtaining secondary data from NBS on general household survey (2013). To analyse the data,

descriptive statistics and OLS model were employed and the results revealed that about 96% of the respondents were male with the average family size and age of seven (7) people and 49 years respectively. In addition, the result showed that there was an income inequality among the households in the study area with ₦50,200 as the average household monthly income. Also, about 83% of the households interviewed were from rural area. With regards to the socio-economic determinants of energy demand, income, age and household size were found to be positive and significant at 1% level for all the energy sources while the coefficient of area of residence urban was only significant for electricity.

Adetayo et al. (2021) conducted a study on household energy demand in typical Nigerian rural communities. Data were collected from 260 randomly sampled household heads in the study area. Descriptive statistics, ANOVA, and Tobit regression were used for the analysis. Tobit regression results revealed that gender, household size, income, occupation, and per capita expenditure were significant in influencing the use of fuel wood; age, gender, household size, occupation, education, and per capita expenditure were significant in influencing the use of charcoal, while age, marital status, income, education and per capita expenditure were significant determinants in the use of kerosene. Also, income, occupation, and per capita expenditure were the factors influencing the use of electricity among rural households in the study area. The study concluded that apart from income, other household variables were significant in determining energy usage.

Abubakar et al. (2024) investigated the determinants of household energy consumption in Nigeria using a data from the National Population Commission. Measuring modern energy which included electricity, LPG, natural gas, biogas and kerosene and non-modern energy using wood, charcoal/coal/lignite, biomass which included; straw, shrubs, grass. The study made use of descriptive statistics and binary logistic

regression and indicated a significant reliance on traditional energy sources (74%) and the use of modern cooking fuels increased with higher wealth index. Conversely, the use of traditional cooking fuel decreased as wealth index increases. The use of binary model will limit the explanation of energy ladder theory for example, the classification of kerosene under modern fuels and charcoal under traditional energy limits the analyses of the movement along the ladder from traditional to modern. The study by Oyedele (2023) also indicated that household wealth significantly determined the use of cleaner energy sources such as electricity and gas. The cleaner options by households in Ikeja area of Lagos was discovered to be Gas energy being the highest followed by electricity, kerosene, charcoal and firewood respectively in a study conducted by Emagbetere et al. (2016) using Oral interview and administration of structured questionnaire of 250 randomly sampled households in the study area. The Chi - test, linear - by - linear relationship test, likelihood ratio test in the study revealed that level of income and type of employment affects the choice of fuel used for cooking and the type preferred. The limitation of the study is that the data has become stale.

### 3.3 Household's Level of Education

The level of education of households can impact on the choice of energy use. human capital can increase earnings, which lead to increase in purchasing power. Education also increases awareness which in turn affects preferences. Households whose head have higher education tend to prefer clean energy. This is due to the fact that education is regarded as the most important determinant of a person's economic and social success (Riddle, 2006). In Maina, et al. (2019a), about 53% of the respondents had secondary to tertiary level of education and it influenced expenditure on clean energy at 1% level of significance. Debebe, et al (2023) also revealed that the level of education of households was one of the determinants to household's energy choice in North West Ethiopia. The result in Bisu et al. (2016) indicated that households' level of

education influenced cooking energy choice in Bauchi Metropolis.

Furthermore, Ado and Darazo (2016) studied the determinants of fuel stacking behavior among households in Bauchi Metropolis using survey research design to collect data from 420 sampled respondents using questionnaire. Multiple regression was used to analyse data and the result showed that 61% which constituted the majority of the respondent's used energy for cooking and lighting. With regards to the educational attainment or exposure of responding households' respondents 32.7% (majority) of respondents had diploma certificate. On the occupation of respondents, about 51.7% of respondents were public servants. Furthermore, Mperejekumana et al. (2021) examined the determinants of household energy choices for cooking in Northern Sudan a survey that considered Socio economic variables such as gender, location, household size, size of apartment, education, income, credit use, acquaintance with clean cooking and equipment used Multinomial Logic Model (MNL) to analyse data collected from two selected districts. The result posits that Location, household size, size of apartment and educational level are the major determinants of energy choice. The findings also revealed the importance of income, credit use and training about modern cooking and equipment in switching from traditional to modern cooking. Outcome of study cannot be generalized to Nigeria context due to country specific reasons. However, the model adopted is insufficient as it is restricted to only to possible outcome in its likelihood estimation and variance

Maina et al (2019a) analyzed the major energy used by households in Nigeria and their implication on the environment. The study also identified the patterns of energy sources used by households and analysed their determinants using General Household Survey data by NBS. Descriptive statistics (bar chart) and multiple regression analysis was used to analyse the data. Results showed that most of the energy sources used by households in Nigeria for cooking and lighting homes were dirty with the

most common energy used is kerosene 31%, petrol 21%, fuel wood 30% and charcoal. The results further revealed that educational level was associated with less dirty energy used.

Oyedele (2023) examined the determinants of household's cooking energy choice. Nigerian demographic and health survey for 2018 using electricity, LPG (natural and bio), kerosene, coal/charcoal, firewood/other solid fuels number of cooking in household and socio-economic variables. Descriptive statistics and multinomial logit model were employed for the study and found that education significantly determined the use of cleaner energy sources.

Rahut et al. (2020) analysed the sources of energy for cooking fuel and their determinants in Pakistan. Using data from Pakistan's Social and Living Standard Measurement Survey (SLSMS) collected from 2014-2015 and employing ordered probit model. The result showed that educated, (human capital) wealthier, (type of roofing, wall and toilet) and older household head were more likely to adopt gas, while poorer household tend to depend on dung cake, crop residue and fuelwood. The study concluded that financial and human capital are the key drivers of household cooking fuel choices in urban Pakistan. Data gap as the SLSMS data employed is stale, fails to incorporate rural households in the study and country specific reasons are the limitations identified. The result in Ogwumike et al. (2014) also found that educational levels of household heads, per capita expenditure and household size significantly influenced household energy use for cooking and suggested that energy use in Nigeria supported fuel stacking rather than the energy ladder hypothesis. Furthermore, the study conducted by Emagbetere et al. (2016) posits that level of education influenced the choice of fuel used for cooking in Ikeja.

### 3.4 Household Size

Household size is another variable of importance when considering the choice of energy by households. As households grow in size, their consumption patterns tend to change,

as a result of increase in demand for goods and services. The magnitude of cooking can also be an indicator to the level of energy consumption. The result in Maina et al (2019a) revealed that responding households had an average of six persons and was found to have influence on the expenditure of clean energy at 1% level of significance. Debebe et al (2023) revealed that household's size was a determinant to energy choice in North West Ethiopia. Also, in Maina et al. (2019b), the results indicated that increase in family size was associated with high dirty fuel energy use. Furthermore, Bisu et al. (2016) showed that household size was found to influence cooking energy choice in the study area. In Ado and Darazo (2016) the family size of the responding households represented 56% which was 3-6 persons. Meanwhile, Akeh et al. (2023a) Estimated the determinants of household cooking energy choice in public housing estates in Maiduguri, Borno State, using a survey sample of 355 household heads the socioeconomic variables included in the study were gender, age, educational level, occupation of the household head, household size, income, location, kitchen type ownership of dwelling and price of fuelwood. Multinomial Logistic Regression was used for analyses and Higher income, higher educational level, occupation of the household head; location of residence, kitchen type and ownership of dwelling had positive effects on the probability of choosing cleaner sources of energy for cooking. Moreso, lower income households with larger household size had positive correlation with the likelihood of choosing traditional energy sources such as fuelwood and charcoal as the primary cooking energy source among households. Data collected was limited to public housing estates in the study area thereby creating a data gap. Ogwumike et al. (2014) also revealed that household size significantly influenced household energy use for cooking in Nigeria. Mothala et al. (2022) assessed the determinants of household energy fuel choice of cooking and water- heating fuels in household in rural, peri-urban and urban settlement. Using 2017 data

of the demographic variables which include; Gender, age, education, household size, income, and remittances, access to electricity. Traditional fuels (fuelwood, shrubs, crop waste and animal dung) Cleaner fuels (electricity, LPG, penetration paraffin). Multinomial logistic regression was used to assess the determinants of cooking and heating. Education and electricity availability positively influenced the choice of clean energy in higher income settlements. The limitation of this study is that the time data was collected to the time of publication is too wide. This can give and outdated result.

### 3.5 Housing Type

Housing type can influence energy choices among households. Improved housing conditions and infrastructure can enable households to consume more energy for various purposes. For example, Nibretu et al. (2021) conducted a study on the determinants of energy choice for domestic use in informal settlements of Addis Ababa and the result showed that living in a good shelter and large number of rooms has better access to electricity while land title and size owned, electric tariffs and proximity to electric line have no relationships with households' electric-use. The result in Maina et al. (2019a) also revealed that area of residence was associated with increase in clean energy demand. Again Maina et al. (2023b) in a study in Yobe revealed that area of residence was positive and significant at 1%. Debebe et al. (2023) also opined that housing type was a determinant to households' energy choice.

Ezema et al. (2016) found that renewable energy used in the residential units is very low. In contrast, there was high dependence of the occupants on non-renewable direct fuel combustion through the use of fossil fuel-driven privately-owned electricity generators for electricity supply. Furthermore, Akeh et al. (2023a) conducted a study on the determinants of household cooking energy choice in public housing estates in Maiduguri, Borno State, North East Nigeria using survey questionnaire to collect data from a sample of 355 household

heads using systematic sampling technique. Multinomial Logistic Regression was used to analyze the probability of households' choice of different energy types used for cooking purposes. The results revealed that higher income, higher educational level, occupation of the household head; location of residence, kitchen type and ownership of dwelling had positive effects on the probability of choosing cleaner sources of energy for cooking.

Akeh et al. (2023b) analysed the economic and socio-demographic characteristics of households in relation to their energy consumption pattern in public housing estates, Maiduguri, North-east Nigeria systematic sampling technique was used to obtain a sample of 355 Survey household's heads in the 3,192 public housing estates directly under the control and management of the Borno State Housing Corporation (BSHC). The study made use of descriptive statistics to analyse data collected. The results indicated that 72.96% of the residents were males, 66.76% were married and had tertiary education while 50.14% were civil servants. Households with family size of 5 to 8 constituted the majority of the total sampled population. 31.27% had monthly income of N50,000 – N99,999. households that used external kitchen accounted for 67.89%. Further analysis revealed that charcoal and fuel wood were the dominant primary cooking energy source accounting for about 37.18% and 27.61% respectively.

The study also revealed that 69.30% of the respondents lived in their self-owned houses. On the type of dwelling, the results indicated that 38.59% of the respondents lived in detached houses. The results on electricity connection indicated that 91.83% of the households were connected to electricity and while electricity availability in households, accounted for 53.24% indicating that power was available from 1 – 5 hours per day. The results further revealed that 58.9% of households in the study area used pre-paid meters for electricity billing while 41.1% use post-paid billing system. Majority of the housing estates were located within the city center of Maiduguri while 38.31% were

outside the city center. The study also indicated multiple fuel use pattern among households with majority of households combining two or more energy sources for both cooking and lighting consistent with the energy mix model. The use of descriptive statistics to analyse energy consumption will not give complete insights. Multinomial logistic regression will provide more insights.

Adeyemi and Adereleye (2016) studied the determinants of households' choice of cooking energy in Ondo State, Nigeria. Random sampling technique was used to sample 409 households in the study area, using descriptive statistics and multinomial logit to analyse data. Results on descriptive statistics indicated that available energy source for use in the study area was 45% kerosene and 43% firewood, 63.7% of rural populace and 22.9% of people in urban areas utilized fuel wood for cooking in the area. The result on multinomial logit showed the household income, level of education, household size, occupation, nature of dwelling house and ownership of dwelling house are significant factors influencing fuel choice.

Ali et al. (2021) examined the critical determinants of household electricity consumption by evaluating the patterns and flows of consumption and analysing relationships and their effects on electricity usage. Proportionate stratified random sampling based on the type of house was employed to select 620 urban households in Seremban, Malasia using questionnaire instrument, the study classified residential areas based on the types of houses built such as traditional/village, single-store terrace, double store terrace, semi-detached, bungalow and flat units as indicated by the Seremban City Council. Multiple linear regression was used to analyse data, posits that a large portion of electricity was allocated for kitchen/home consumption, followed by cooling and lighting. Multiple linear regressions revealed that married households with a high monthly income and living in spacious houses together with three to five people were important



predictors of electricity consumption in Seremban.

### 3.6 Energy Expenditure

Expenditure can have significant impact on consumer behavior across different products, including energy. Therefore, the cost of energy in many cases can influence consumption pattern and this include not only the initial cost but operational and maintenance cost. For example, the initial cost of solar energy seems to be very costly compared to other energy sources. Also, technological advancement of certain energy type improves efficiency as well as cost. This can make certain energy sources more attractive than others. The constraints for the usage of some energy sources even though preferred are due to cost (Onyekuru et al., 2020).

Sharma et al. (2019) examined the socioeconomic determinants of energy poverty among Indian household. Using a Survey (cross sectional) data collected from 1000 households in Mumbai. The unit of measurement included electricity service expenses, consumption expenditure, dwelling size, educational level and awareness of energy and environment and averred that energy poverty mainly depended on consumption expenditure of household and it varied across four income groups. Increase in dwelling size of low-income group increased expenses on electricity. However, the limitation of the study is based on country specific reasons, outcome from the study cannot be generalized in the context of Nigeria

Also, the result in Ado and Darazo (2016) revealed that expenditure on cooking fuels was about 48.5% of respondents who spent between ₦1,000 and ₦3,000 on cooking fuels per month. Furthermore, Baraya et al. (2023) studied the determinants of households' energy consumption in Kebbi State, Nigeria using descriptive statistics and binary logistic model. Energy consumption indicators included; electricity, liquefied petroleum gas, kerosene, charcoal and biomass and posits that electricity, LPG and kerosene usage were

positively correlated while negatively correlated with biomass usage.

Maina et al. (2020) analysed the impact of fuel expenditure on the environment using secondary data obtained from National Bureau of Statistics (NBS) on general household survey carried out in 2016. The study employed descriptive statistics, Ordinary Least Squares (OLS) and Consumer Lifestyle Approach (CLA) models to analyse data. The results revealed that electricity and Liquefied Petroleum Gas (LPG) were the two clean energy sources and the urban households were found to emit more CO<sub>2</sub> than the rural households. However, it was discovered that households dedicated greater share of their income on dirty fuels. Furthermore, family size, income and educational level revealed positive effect on CO<sub>2</sub> emission, while, younger household heads emit less CO<sub>2</sub>. The Kuznet hypothesis was found to be applicable to Nigerian households (Maina, 2020).

Ogwumike et al. (2014) averred that households' heads, per capita expenditure significantly influenced household energy use for cooking. Also, Hanemann et al (2013) estimated the long run effect of Spanish household's energy demand for cooking and found that relative fuel prices for heating influenced the type of energy source in the long run. While in the short run, demand responded consistently different across rich and poor regions.

Aminu et al. (2024) examined the influence of remittance on cooking fuel choices among other factors in Nigeria. Using Wave 4 (2018/19) of Nigerian General Household Survey (GHS). The study categorised energy into three; traditional (Wood, animal waste, sawdust, and coal briquette) Transitional (kerosene, coal and charcoal) and Modern (LPG gas, piped natural gas, biogas and electricity) descriptive statistic the was used to measure socioeconomic variables and the multinomial logistic regression model was employed the pattern and traditional cooking fuels continued to dominate the cooking fuel landscape. Household that receives remittance were more likely to use modern cooking fuel.

Furthermore, wealthier, more educated household with access to electricity were more likely to influence use of modern and transitional cooking fuels. Cooking fuel prices and quantity of fuels used by household were not captured and it cannot model households' switching between cooking fuels.

Ekholm et al. (2010) analysed the determinants of household fuel consumption choices for heterogeneous household groups in India. average prices of energy (coal, electricity, kerosene, LPG, Biomass), discount rates, inconvenience cost, time consumption and availability of biomass was used to measure energy cost. The study employed linear cost optimization and minimizing approach (to solve energy choice problem) and posited that household expenditure and nature of surrounding in both rural and urban areas were statistically significant, rural household used traditional fuels while urban households opted for modern fuels. The supply of biomass was assumed to be constant thereby making data to become stale to reflect current happenings.

Rasha et al. (2022) identified the determinants of energy consumption in rural households of India using secondary cross-sectional data from Indian household survey data of 2018 and employing Ordinary Least Square (OLS) estimation. Discovered that household size and irrigation pump significantly affected energy consumption expenses in the rural household. However, the study ignored urban households which can shed more light and the variable adopted to represent a rural household is unclear.

Bamiro and Ogunjobi (2015) examined household energy consumption in Ogun state using primary data of 150 respondents selected through stratified random sampling technique. Measurement variables included expenditure on electricity, kerosene, charcoal, wood, petrol, diesel and gas. Descriptive statistics, multinomial logit and Tobit regression models were used for analyses and found that price of wood, kerosene and family size significantly and positively influenced choice of fuels, while the price of wood, kerosene and electricity

determined the monthly expenditure on fuels. Wood was not inferior. However, the combination of kerosene with other modern energy to categories liquid fuels will not clearly explain the energy ladder Hypothesis.

Adepoju et al. (2012) carried out a study on the rural household demand for domestic energy in Odeda Local Government Area, Ogun State, Nigeria. To determine the factors influencing expenditures on energy products by rural households, data were randomly collected from 130 sampled households. Analysis was done using descriptive statistics and Tobit regression. Result indicated that the largest proportion of respondents used kerosene for cooking and lighting. Tobit regression result showed that as household heads grow older, their demand for charcoal and kerosene significantly increased. Households that used fuel wood for cooking were spending less on kerosene and electricity. Also, decision to use each of the energy types for cooking significantly increased the demand.

### 3.7 Behavioral Factors

These are exceptional demand cases where by consumer's choices are not influenced by their level of income or prices of commodities. Rather by relational influence within the environment. Some of the factors include perception of energy use in the neighborhood and cultural preferences) can influence energy consumption pattern.

## 4. Perception of Energy use in the neighborhood

Perception of energy used within a neighborhood can influence energy decision-making by other households. This is because one of the consumption hypotheses (relative income hypothesis), states that individual's consumption pattern is influenced not only by income but also the consumption pattern within his neighborhood. Observing others using a particular energy type can influence consumption behavior (Jhingan, 2010). For example, Onyekuru et al. (2020) averred that the perception of energy fuels in the

neighborhood influenced energy decision-making by households in Enugu state.

#### 4.1 Cultural Preferences

Cultural preferences or upbringing and social beliefs of people can also play a significant role in the choice of energy fuels that will be used by the households. For example, some Cultures prioritize energy conservation as a means of protecting the environment, while others may consider energy use as a symbol of progress and development. According to Lord (2014), the mystery of fire was their earliest energy source. It facilitated not only communal culture of hearth but also made possible control of the flame in a concave stone lamp in which animal oil that burned relatively smoke-free enabled earlier artist to find their way through the darkness of the cave to create the cultural heritage site of the Ice Age. Also, in some cultures, the use of traditional energy (charcoal) for heating and burning traditional incense is a longstanding culture that should be sustained. Onyekuru et al. (2020) looked at the problems associated with the use of each energy source and revealed mean quantities of kerosene in the rural and urban areas to be 26 and 36 liters respectively per month, fuel wood was about 231 and 303kg.

Similarly, Muazu and Ogujiuba (2019) analyzed the dynamics of domestic fuel wood energy consumption in Nigeria with a view to testing the fuel stack hypothesis using micro data of 1,199 households obtained from the National Bureau of Statistics. The results of the study confirmed fuel stacking behavior among households due to family size, price and culture rather than the Energy ladder hypothesis. The study in Jan et al. (2012) also indicated that consumer preferences accounted for household's energy choice and that though households had access to multiple sources of energy, they persistently depended on biomass fuels for domestic energy consumption. This was mostly exhibited by rural households who inter switched fuel according to changes in their socio-economic conditions.

#### 4.2 Technological Advancements

The technological advancement of certain energy type can make certain energy sources more attractive. Advancement in technology can be motivated by increase in economic activities thereby presenting the need to go for more efficient energy options. This can reduce the demand for some energy type consequently, the reliance on specific energy types. Pachauri and Spreng (2004) observed that more efficient energy source is associated with enhanced level of energy use. Also, Onyekuru et al. (2020) opined that LPG was perceived to have the highest level of efficiency and that it cooked faster and cleaner while kerosene had the highest preference because it has lower chances of fire accident than LPG.

Tang and Kogid (2022) examined the asymmetric influence of economic growth, energy prices, technological innovations and financial development on energy consumption in Malaysia over the period between 1970 and 2018 and found that long-run coefficients for GDP was positive indicating the effects of income increases on energy consumption. The data used for the study was not updated. Also, failed to incorporate other energy source like the traditional type of energy. Furthermore, Akinwale (2018) investigated the short run and long run relationships between energy consumption, technology innovation and economic growth in Saudi Arabia using data from World Bank Development Indicator (WDI). The study employed Granger Causality and Autoregressive Distributed Lag (ARDL) model to analyse data and opine that technological innovation had negative effect on energy consumption while economic growth had positive effect on energy consumption. An indirect causality was found between technological innovation and economic growth to energy consumption. However, the variables were co-integrated in the long run.

### 5. Conclusion

There is overwhelming evidence that socioeconomic factors like the household size, level of education, cultural preferences,

housing type and perception of energy use in the neighborhood also determines energy choice by households and not just income. Without the understanding of these socioeconomic determinants of households 'energy choices, it will be difficult to achieve the United Nations' Sustainable Development Goals (SDGs) No. Seven (7). Despite the fact that there has been encouragement for over-all access to affordable clean and modern energy services by 2030 as a collective global responsibility for all civilized nations, most households in Maiduguri Metropolis still depend largely on different forms of energy to perform their functions effectively and efficiently. It is in line with this that Nigeria's Renewable Energy Master Plan (REMP) seeks to increase the use of renewable energy to 30% by the year 2030.

In view of this review, the following recommendations were made:

- i. Government should implement targeted subsidies for low-income households to promote the adoption of modern energy use;
- ii. Invest in energy infrastructure development, especially in rural areas;
- iii. Promote energy efficiency and conservation practices through education and awareness campaigns;
- iv. Encourage renewable energy adoption through incentives and tax relief;
- v. Develop and implement energy pricing reforms to reflect true cost.

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