International Journal of Innovative Finance and Economics Research 9(2):52-62, April-June, 2021
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Substitution of Energy Products in Benue State Urban Households

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ABSTRACT
This study investigated substitution possibilities of the energy goods in Benue state urban households. A microeconomic demand model, using a utility maximizing function was estimated. A structured questionnaire was used to collect primary data. The energy sources considered were: electricity, fuel wood, kerosene, liquefied petroleum gas (LPG) and petrol (Premium Motor Spirit). Respondents were selected from the three urban areas of the state. This consisted of 170, 135 and 79 households from Makurdi, Gboko and Otukpo towns respectively. Descriptive statistics and Seemingly Unrelated Regression were used to analyse the data at 0.05 level of significance. Energy prices, total energy expenditure, occupation, level of education, household size, ownership of a dwelling unit and geographical location of household all affected household energy demand in urban areas in Benue State. The income elasticity of demand for electricity (3.65), petrol (7.06), LPG (13.26), fuel wood (-1.42) and kerosene (8.23) indicated that they were normal and luxury goods except fuel wood. Petrol had the largest household's budget share (0.35) while kerosene has lowest share (0.10). The result also showed that electricity and fuel wood, petrol and fuel wood, liquefied petroleum gas and fuel wood are substitutes. Additional energy sources at minimum cost and energy price stability are recommended to the government in partnership with the private sector.
Keywords: Energy Product, Electricity, Energy Choice, Energy Consumers, Urban Household

1.0 INTRODUCTION

Assessment of recent global trends in provision of energy access in relation to living conditions which include energy for cooking, water provision, sanitation, and nutrition indicates that growth rate of all these living conditions are far below those of gross domestic product. But energy is vital in providing essential human services that improve living standards. Some essential aspects of human welfare include long and productive life, enjoying good health, access to knowledge and education opportunities, ability to earn adequate income to provide households with adequate nutrition, shelter and other material, and aesthetic needs. All may be improved when modern energy services are provided. Energy sources also lead to job creation (Scott, 2018, Hussein & Filho, 2012). The use of modern fuels promotes communication and improves environmental sustainability by reducing deforestation and enhancing energy efficiency (Mahmood & Shah, 2017). Thus, inadequate energy such as electricity, Liquefied Petroleum Gas (LPG), petrol, kerosene, fuel wood, among others in a household prevents people from meeting basic daily needs such as cooking, lighting, heating, cooling, and communication all of which are necessary for an acceptable quality of life (Kitchen & Reilly, 2016).

Globally, energy demand is predicted to rise by one-third by 2040, driven higher by growing populations and expanding economies of India, China, Africa, the Middle East and Southeast Asia (IEA, 2015). In

Africa, energy consumption has seen substantial growth on the back of increased economic activity, new infrastructural investment and domestic price subsidies (Ackah, 2014; Eggoh, Bangaké and Rault, 2011). In general, concerns for energy required for the running of homes, industries and the economy generally has been of global concern for some decades (Stern, 2007).

Demand for energy in Nigeria similar to most developing countries exceeds the available supply. A key challenge to Nigeria's energy sector is inadequate access to modern and clean energy services such as Liquefied Petroleum Gas (LPG) and hydro/solar-based electricity. Access to modern energy services in Nigeria has been defined as '…communities /households connected to the grid (that is, electricity access) and the number of households using LPG either as their main fuel for cooking or in combination with other cooking fuels (that is, access to clean cooking fuels)" (Serwaa Mensah *et al*. 2014). Household energy consumption in Nigeria accounts for more than 60% of total final energy consumption (Kayode, Akhavan & Ford, 2018). The major energy carriers in Nigeria are: fuel wood, petrol, kerosene, Liquefied Petroleum Gas (LPG) and electricity. Small amounts of charcoal and coal are also used. The energy consuming activities in the sector are cooking, lighting and operation of electrical appliances. According to Gujba (2015), fuel wood consumed in this sector constitutes about 90 per cent of total residential final energy for cooking in Nigeria, and it is used in rural areas and urban centres.

In Benue State, majority of the population who reside in rural areas use fuel wood because it is freely collected. On the contrary, less of it is used in urban centres because it is a traded good and some housing units are not convenient for its use especially in terms of cooking unlike for other energy sources. The energy requirements of the low income population living in urban settlements or rural areas require some level of substitution possibilities. Unfortunately, there exists a knowledge gap regarding how households' energy substitution. The major objective of current research work is to identify pairs of energy products that can be substituted or complemented in a household.

2.1 Conceptual Framework

A household's energy choice consumption decision can be understood by analyzing its decision in a constrained utility maximization framework where it maximizes energy utility subject to a set of economic and non-economic constraints (Fig. 1). The information that households have on various energy products influences their energy choice and energy substitution decisions. This information is affected by economic and non-economic factors. Economic factors include market price of energy and household income. Non-economic factors may include a set of household characteristics such as educational level of household head, household size, house ownership, nature of occupation and location of residence.

The energy choice and substitution models are applied to various energy products like electricity, kerosene, petrol, LPG and fuel wood. The application of these models will bring an understanding of how various factors influence the energy choice and energy substitution. The outcome of this behavior may be improved economic development.

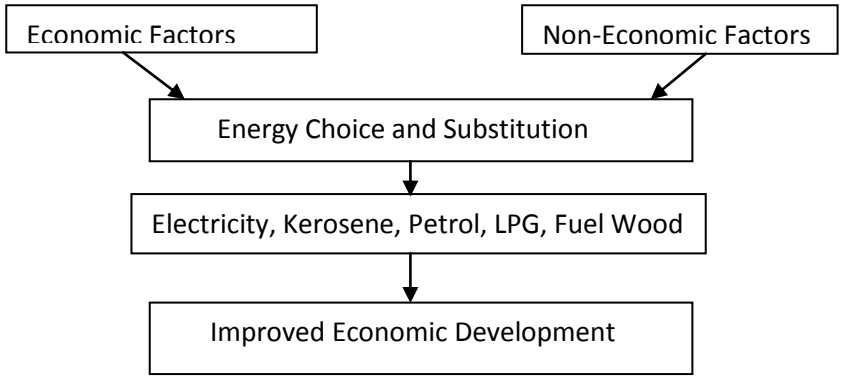


Fig. 1: Conceptual Framework

Source: Authors, 2021

2.2 Theoretical Framework

Theory of energy ladder was introduced in 1990 by Kirk Smith. The theory is one of the most common conceptualizations of energy use dynamics among households. It postulates that low income households generally use traditional stoves and cooking fuels such as animal dung, charcoal and wood, while those households with higher income used modern cooking technology and fuels. As income increases, households transit from traditional fuels and cooking stoves to modern fuels and cooking technology (Leach, 1992). Furthermore, the literature on household energy demand and choice has shown that households in transition (that is, those between low income and high income) consume transition fuels such as charcoal and kerosene. While low income households use biomass fuels, higher income households consume energy that is cleaner and more expensive such as liquefied petroleum gas and electricity (Hosier & Dowd, 1987 and Heltberg, 2005).

The energy ladder hypothesis is predicated on the economic theory of consumer behaviour (Hosier & Kipondya, 1993). However, when income increases, households not only consume more of the same good they also shift to more sophisticated goods with higher quality. Thus the theoretical assumption underlying the energy ladder hypothesis is that low living standards induce greater dependence on firewood and other biomass fuels owing to a combination of income and substitution effects (Baland *et al*., 2007). Furthermore, the energy ladder hypothesis assumes that cleaner fuels are normal economic goods while traditional fuels are inferior goods (Demurger & Fournier, 2011).

Thus, the energy-ladder hypothesis emphasizes the role of income in determining fuel choices. However, it appears to imply that a move up to a new fuel is simultaneously a move away from previously used fuel(s). Mekonnen and Köhlin (2008) suggest the idea of an energy-demand ladder where it is argued that, as incomes rise, households' demand for fuel is guided by the nature of appliances used and that fuel choice and demand depends on the purpose for which energy is required. More recently, it has been argued that households in developing countries do not switch to modern energy sources but instead tend to consume a combination of fuels which may include combining solid fuels with non-solid fuels as sources of energy.

However, this concept holds with regards to both cross sectional and longitudinal variations in income. In addition, household fuel choices are not only based on economic factors such as incomes and prices, but they are also determined by several household variables such as demographic structure, education levels, status and ownership of the dwelling place etc. The contribution of these variables to fuel choice is lacking in the specification of the energy ladder model, neither is it easy to incorporate them to predict discrete fuel choices. Though the energy ladder model has been used to generally understand the energy use dynamics of urban households in the developing world, in its general specification, the model provides a limited view of reality in actual households.

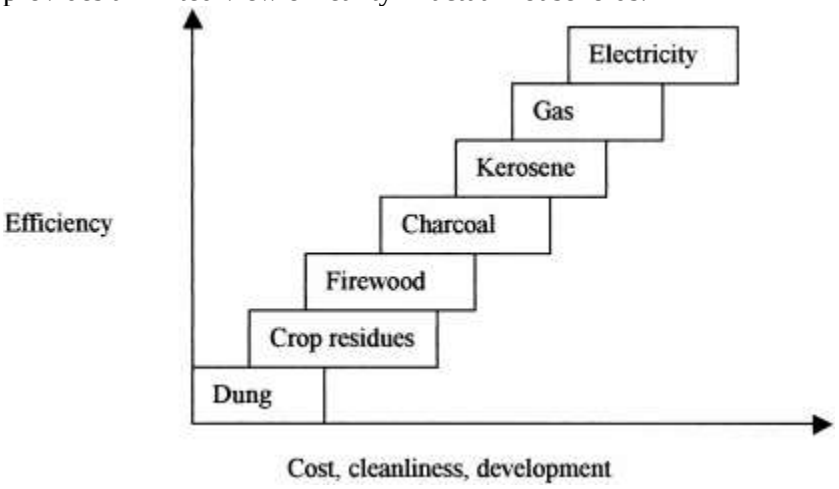
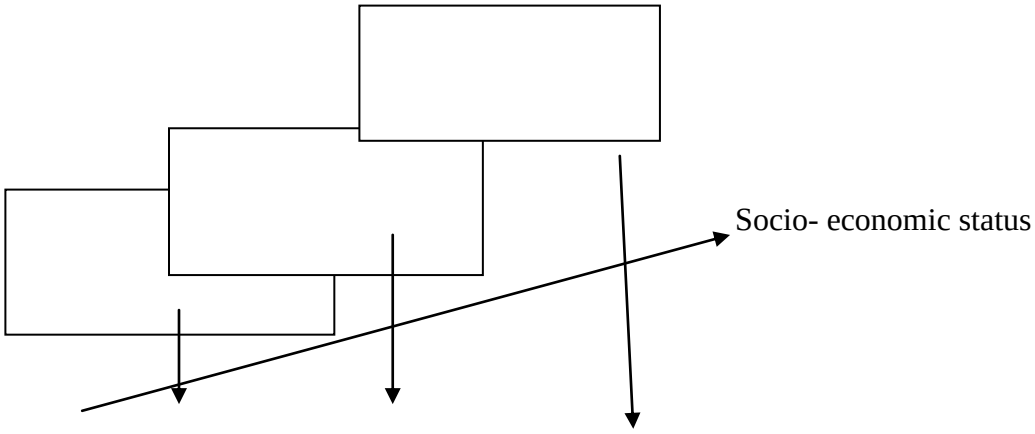


Fig. 2: Energy Ladder

The basic assumption for this model is that, with the improvement of the economic status, the urban households can move up along the ladder to the 'better' energy carriers (Masera et al., 2000). Thus, income is the most important determinant of household energy choice (Leach, 1987).

Another energy theory, the Energy Mix Theory was introduced in 2000 by Masera, Saatkamp and Kammen. According to this theory, energy demand is not only affected by income but also by demographic factors. The theory also posits that people do not completely drop the less efficient energy sources as they climb the energy ladder, rather they combine less efficient and the efficient sources for their consumption.



Primitive fuels	Transition fuels	Advanced fuels
Firewood	charcoal	LPG
Animal waste	kerosene	bio-fuels
Agric waste	coal	electricity

Fig. 3: Energy Mix Theory by Masera.
Source: Masera, Saatkamp and Kammen (2000)

Using data from three Mexican states, they show that households do not switch fuels, but rather follow a general multiple fuel or fuel stacking strategy. The energy mix theory therefore states that households do not simply switch to a new energy product as income increases but would continue using more than one energy product. The specific combination and the relative consumption of each fuel is governed by the characteristics of fuels and end-use devices, fuel availability and local cultural and social contexts. The appeals of the two models (the energy ladder model and the multiple fuel model) provide a basis on which a framework for the analysis of energy demand and substitution in Benue State can be based.

2.3 Empirical Literature

Ogunniyi, Adepoju and Olapade (2012) examined the households' energy consumption pattern using the Almost Ideal Demand System (AIDS) model in Ogbomoso Metropolis, Oyo State, Nigeria. Primary data were collected from 200 heads of household through a multi-stage random sampling technique. The study revealed that kerosene is the most highly consumed energy source and the reason for preferring this energy source is its accessibility in the study area. Cross price relations indicate that kerosene is a substitute for both electricity and charcoal, whereas electricity is a substitute for all the two. Charcoal and kerosene are complements. All the energy sources considered were found to have income elasticity's less than one owing to the fact that energy consumption is a necessity.

Leth-Petersen (2012) estimated household energy demand for a cross-section of Danish households using natural gas and electricity. A conditional demand function to analyze household energy demand and also test for separability between electricity and natural gas was used. The study showed that the demand for

one energy form is separable from the demand for another, for example, the demand for electricity is separable from the demand for natural gas, and this is evidence in favour of single equations modelling of household energy demand. In conclusion the separability result suggested that single equations modelling of household energy demand is reasonable.

One of the few studies of inter-fuel substitution based on disaggregated data is that of Bjorner and Jensen (2012) in an estimated econometric analysis of inter-fuel substitution between different types of energy in Danish industry sector. They estimated two models for inter-fuel substitution between electricity and other fuels using micro panel data set containing information for most Danish industrial companies between 1983 and 1987. Their estimated cross price elasticities of substitution showed that inter-fuel substitution is low within the companies especially between electricity and other fuels.

Broadstock and Chen (2012) applied the AIDS model with The UK annual data set covering the period 1960-2009 to examine the policy options that encourage substitution between gasoline and diesel so as to reduce the emission-based externalities from road transport. They found that own price elasticities for gasoline and diesel are negative and all cross price elasticites are positive, confirming that the fuels are substitutes. Moreover, the own-price and cross-price elasticities for gasoline are much lower than for diesel. This work is similar to others reviewed above. Only one objective is covered for only two energy sources.

Using Probit Models, Akighir and Nomor (2013) investigated the relationship between poverty and firewood consumption in Makurdi metropolis. They collected data from 200 respondents randomly for analysis. The results showed a negative own- price effect in the demand for firewood. Energy consumers were also observed to be consistent with the energy ladder hypothesis. Finally, the result revealed the existence of poverty environment hypothesis i.e a positive relationship between poverty and firewood consumption.

Adeyemi and Adereleye (2016) analysed the factors determining the choice of cooking energy in Ondo state, Nigeria. Random sampling technique was used to sample 409 households in the study area. The data used for the study were obtained with the use of well structured questionnaires. Descriptive statistics and multinomial logit were employed for the analysis. Descriptive analyses show that the energy sources available for the use in the study area are kerosene (45%), firewood (43%) and cooking gas (12%). The analysis shows further that 63.7% of the rural populace and 22.9% of people in urban areas utilize fuel wood for cooking in the study area. The results of the multinomial logit show the household income, level of education, household size, occupation of the respondent, nature of the dwelling house and ownership of the dwelling house are the significant factors influencing fuel choice. In order to encourage households to make fuel substitution that will result in more efficient energy use and less adverse environmental, social, and health impacts, a promotion of higher level of education and a promotion of general economic development could be effective instruments.

The study by Abdul- Hakim and Ibrahim (2017) aimed at determining household's socio-economic factors associated with energy choice in Kano metropolis, Nigeria. A clustered sampling technique was adopted to categorize the study area into different residential zones on the basis socio-economic status. Thereafter, a systematic random sampling technique was used to select households at specific intervals. Chi-square test and Cramer's V statistic were used to test the association between the household's socio-economic factors and choice of energy. Results from the Chi-square test reveal that household socio-economic factors such as geo-political zone of the household head, income, education of the household head and wife were found to be significantly associated with the choice of energy. However, results from Cramer's V reveal that the level of literacy attained by the house wives has the strongest impact. The study concluded that wives with higher educational qualification prefer modern energy because they have a better taste and may be conscious of the negative impact of using biomass energy for cooking. The study recommended that the rates and costs of electricity, gas and kerosene should be carefully monitored to enable all classes of households to use them sustainably. Secondly, the public should be enlightened on the safety use of modern energy sources as well as the implication of using unclean sources energy.

Ghulan, Syeda & Salix (2018) investigated the household energy demand and explored the factors that determine household energy demand for different forms of energy consumption in district Muzaffarabad of the state of Azad Jammu and Kashmir, Pakistan. By using Linear Approximate Almost Ideal Demand System (LA-AIDS), the study estimated Marshallian price and expenditure elasticities of demand for four kinds of energy components including both rural and urban households. Using primary data LA-AIDS estimation indicated that demand for all forms of energy are price inelastic. Cross price relations indicated that electricity is a substitute for LPG, wood and fuel whereas LPG and fuel are complements. Electricity has most inelastic own-price elasticity which shows that households in Muzaffarabad are insensitive to changes in the price of electricity.

Adamu, Adamu, Ade and Ake (2020) reviewed various energy sources for household consumption and examine the implications of their dependence on traditional energy sources as well as the energy ladder model as a concept widely used by scholars in describing the role of income in determining energy use and choices. It further explains the consumption behaviour of households in relation to the major assumptions of the model. The paper posited that the dependence on energy sources at the lowest rung of the energy ladder by most households in Nigeria was accentuated by rising poverty level consistent with the energy ladder hypothesis but disagreed with the notion of complete fuel substitution given that most households tend to have a mix of energy sources for their activities.

The problem associated with the above studies is that their scope is too narrow in terms of energy sources used. Secondly, some authors have merely posited their findings using descriptive statistics in line with energy ladder hypothesis without carrying out an empirical analysis to determine substitution possibilities between the energy products.

3.0 METHODOLOGY

3. 1 Research Design

The type of design utilized for this work is a survey research design. The instrument used in collecting primary data needed for the study is a structured questionnaire. A sample of three hundred and eighty four households was considered enough by the researcher to produce reliable and accurate information on the subject matter. A multi stage sampling technique was used in arriving at the sample size. Primary data collected was mainly on energy prices, households' energy demand, households' energy expenditure, and other households attributes. Methods of data analysis considered for purposes of achieving the objectives of the study were Seemingly Unrelated Regression and the Hicksian Compensated Cross Price Elasticities.

3.2 Sample Size and Sampling procedure

The population of the study therefore consists of all households from, Makurdi, Gboko and Otukpo townships. These local governments' headquarters are selected because of their status as urban centres of the state (Benue State Urban Development Board, 2017). They are also among the high energy consuming local governments of Benue state (Akighir & Nomor, 2013). According to National Bureau of statistics (2018), the average number of persons per household in Benue state is 5.3. The estimated populations of Makurdi, Gboko and Otukpo towns as of 2018 are 600,635, 478,241 and 280,830 respectively (NPC 2018). Therefore, the expected number of households in each of the selected urban centres of Benue state is equal to the total population of the urban centre divide by 5.3 persons, (NBS, 2018).

The Krejcie and Morgan (1970) formula for sample size determination was used

$$S = \frac{X^2 NP(1-P)}{d^2(N-1)+X^2P(1-P)} \quad \text{.....(1)}$$

Where

S= Required Sample Size

X= Z Value (that is 1.96 for 95% confidence level)

N= Population Size

P= Population proportion expressed as decimal (assumed to be 0.5 (50%), since this would provide the maximum sample size.

d= Degree of accuracy expressed as proportion (0.05)

Thus, imputing the values, we have

$$S = \frac{1.96^2 * 271941 * 0.5(1-0.5)}{0.05^2(271941-1)+1.96^2 * 0.5(1-0.5)} = \frac{261172.1364}{680.8104} = 383.6195 \approx 384$$

A three-stage sampling process was used in selecting the respondents. Identification of urban areas of the state was carried out in the first stage. In the second stage, settlement areas or wards in each of the urban areas was identified while random selection of households within the wards was the third stage of the procedure.

3.3 Data Collection and Instrument

Primary data on respondents' background information, energy prices, energy demand, energy expenditure together with other households attributes were collected from respondents through structured questionnaires. The five energy products are fuel wood, kerosene, LPG, electricity, and petrol. Information on them was recorded in different measurement units. Kilowatt hour (kwh) is for electricity, liter (Lit) is for petrol and kerosene, while kilogram (kg) is for LPG and fuel wood. The study considered price, income, household size, occupation of households' heads, geographical location of households, educational level of households' heads and ownership of a house as main determinants of energy demand in a household. In place of income total household expenditure has been used as a proxy.

The questionnaire was validated by experts to ensure that they capture the objective of the study. Cronbach Alpha Coefficient which is a measure of internal consistency of instruments was used in the pilot study. The analysis yielded an alpha coefficient of 0.8941. This indicated the high reliability of the instrument since the coefficient was more than 0.5. Thus the instrument was validated as reliable instrument for data collection and empirical analysis.

3.4 Model Specification

Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer (1980) was specified in this study. According to this model, the budget share of an energy product is a function of energy prices and consumers' income (total energy expenditure). The final specification including socio-demographic variables (level of education, household size, nature of occupation, ownership of a house and geographical location) becomes:

$$w_i = \alpha_i + \sum_{j=1} \gamma_{ij} \ln p_j + \beta_i \ln(X / P) + Demographics + \varepsilon_t \quad \text{.....(2)}$$

Where:

w_i = shares of household expenditure on fuel *i* in total energy expenditure

p_j = price of fuel *j*.

α, β, γ = parameters to be estimated

X= the total expenditure in all categories of energy

In the model:

It is expected that since total energy expenditure and the socio-demographic variables are important factors in energy consumption, they would have a positive and significant effect on the demand for particular types of energy. Expenditure shares in each of the five energy goods were the dependent variables. Total energy expenditure, energy prices and the demographic variables were the independent variables. Since there are five energy sources, the model equation became a system of 5 equations which had to be estimated simultaneously. However, given that the dependent variables (share of goods in total expenditure) are dependent, the error terms (ε) were also expected to be correlated across the equations.

3.5 Method of Data Analysis

The Seemingly Unrelated Regression (SUR) Analysis was used to estimate parameters of the LA-AIDS model. The estimates were then used to compute the Hicksian elasticities. Hicksian cross price elasticities identifies pairs of energy products that are substitutes or complements. SURE technique is a

generalization of a linear regression model that consists of several equations. Each equation is a valid linear regression on its own and can be examined separately. It helps to estimate equation by equation using standard ordinary least squares with a specific form for the variance covariance matrix.

Hicksian own-price elasticity = ε_{ii} =-1 + $\frac{\gamma_{ii}}{w_i}$ + w_i ……..……(3)

Hicksian cross-price elasticity = $\varepsilon_{ij} = \frac{\gamma_{ij}}{\omega_i}$ + w_j ……..……(4)

4.0 ANALYSIS AND RESULTS

4.1 Determinants of Household Energy Demand

The structural parametric coefficients of five equations along with their standard errors (in parenthesis) as well as significant levels are presented in Table 4.1.

Table 1: Factors that influence Household Energy Demand

Variable	Electricity	Kerosene	Petrol	Gas (LPG)	Wood
Price of Electricity	0.7332** (0.0798)	-0.350 (0.2008)	-0.22120 (0.2155)	-1.2800** (0.3538)	0.5922** (0.1797)
Price of Kerosene	-0,1858 (0.1752)	0.8291 (0.4407)	0.0663 (0.4730)	-0.8005 (0.7764)	-0.0820 (0.3945)
Price of Petrol	-0,2581 (0.2724)	-0.1826 (0.6849)	0.2929 (0.7351)	-1.7423 (1.2067)	0.2266 (0.6131)
Price of LPG	-0.1059 (0.2042)	-0.2289 (0.5134)	-0.6104 (0.5511)	1.1159 (0.9047)	0.7296 (0.4597)
Price of Fuel Wood	-0.1515** (0.0160)	-0.1267** (0.0403)	-0.4135** (0.0432)	-0.3042** (0.0709)	1.0610** (0.0360)
Expenditure	0.7151** (0.0130)	0.7230** (0.0331)	2.1193** (0.0355)	1.4717** (0.0582)	-0.4108** (0.0295)
Education	0.0157** (0.0093)	-0.0976** (0.0234)	0.0167 (0.0251)	-0.0361 (0.0412)	-0.0074 (0.0209)
Household Size	0.0100 (0.0060)	0.0908** (0.0152)	-0.0086 (0.0.0163)	-0.0286 (0.0268)	-0.0626** (0.0136)
Occupation	0.0020 (0.0675)	-0.0298 (0.0190)	-0.0206 (0.0204)	0.0006 (0.0335)	0.0215 (0.0170)
House Ownership	-0.0022 (0.0062)	0.0009 (0.0154)	-0.0205 (0.0165)	-0.0219 (0.0271)	0.0358** (0.0137)
Geographical Location	0.0178 (0.0108)	0.0233 (0.0272)	0.0518 (0.0292)	0.0576 (0.0479)	0.0231 (0.0243)
Constant	2.5075 (2.1650)	-0.0835 (5.4433)	-8.9234 (5.8430)	4.5678 (9.5909)	2.5023 (4.8731)
R2	0.9391	0.7285	0.9509	0.7653	0.7472

Source: Own calculations from field survey, 2019; ** are significance levels at 5%; standard errors are in parentheses.

The expenditure elasticities which were directly derived from SUR model are presented in Table 1. Results showed that price of the energy product, prices of other related energy products, income of the consumer (total energy expenditure), occupation of the consumer, level of education, size of household, geographical location of household and owning a personal house all affected urban household energy demand in Benue State.

Demand for electricity was significantly affected by its price, price of fuel wood, total energy expenditure and educational level of consumers; Demand for kerosene was significantly affected by its price, educational level of consumers, total energy expenditure and household size; demand for petrol was significantly affected by price of fuel wood and total energy expenditure; demand for LPG was significantly affected by price of electricity, price of fuel wood and total energy expenditure; and demand for fuel wood was significantly affected by price of electricity, price of fuel wood, total energy expenditure, household size and ownership of a household. The values of R^2 recorded for all the energy products means that the variations in the values of the explanatory variables of the energy products' share equations were responsible for 94%, 72%, 95%, 77% and 75% of the variations of the quantity of electricity, kerosene, petrol, LPG and fuel wood demanded by consumers sampled in the study area, respectively.

4.2 Hicksian Price and Income Elasticities

Since the share of energy product is the dependent variable and the logarithms of the price of the energy product and income of energy consumers are the independent variables in AIDS system, Hicksian compensated elasticities calculated were considered in the identification of pairs of energy products that were substitutes and those that were normal, luxurious or inferior products.

Table 2: Hicksian (Compensated) Price and Income Elasticities (AIDS)

Variable	Price of Electricity	Price of Kerosene	Price of Petrol	Price of LPG	Price of fuel wood	Income Elasticity
Electricity	1.99	-1.20	-0.44	-4.62	2.36	3.63
Kerosene	-1.59	7.40	1.01	-7.88	-0.65	8.23
Petrol	-0.47	-0.42	0.19	-4.86	0.82	7.06
LPG	-0.61	-1.81	-4.74	8.42	6.25	13.26
Fuel wood	-0.62	-0.65	-2.08	-1.67	5.41	-1.42

Source: Authors' computation, 2020.

Table 5 presents full matrices of uncompensated own price and 'cross price elasticities'. Empirical results indicated that all the estimates of own-price elasticities contradict the law of demand having positive signs. This may be as a results of the multiple and important functions they perform. The own-price elasticity for all energy items is above unit (1) except petrol. This result is different from the findings by Ogunniyi *et al.* (2012). From the table, petrol has inelastic own-price elasticity; this indicates that households in urban areas of Benue State are insensitive to changes in the price of petrol. Also, from the cross price elasticities, most of the estimated value had negative sign implying a complementary relationship. Those with positive signs which implies substitution effect are electricity-fuel wood, kerosene-petrol, petrol-fuel wood and LPG-fuel wood.

The Expenditure (Income) elasticities directly derived from SUR depict that expenditure elasticities of all the energy items are more than one. All the energy items are expenditure elastic and LPG having highest expenditure followed by kerosene and petrol while fuel wood has the least expenditure elasticity. All the energy products are normal and luxurious except fuel wood that is normal but inferior.

5.0 CONCLUSION AND RECOMMENDATIONS

Factors that affect households' demand for different types of energy were analyzed in this study. The Linear Approximate Almost Ideal Demand System was used for estimation of Hicksian cross price and spending (income) elasticities of demand for five main types of energy in Benue State urban households. The results of SUR estimates showed that demand for the energy products are affected by both economic and non-economic factors. Cross price relations indicate both substitution and complementary

relationships. Energy substitution exist between electricity and fuel wood; kerosene and petrol; petrol and fuel wood; and LPG and fuel wood.

On the basis of these results, it can be suggested that government should encourage the use of modern and efficient energy sources by embarking on policies that increase the purchasing power of energy consumers. Non-governmental organizations and banks should also partner with the government to provide modern energy sources like solar and wind energy to ensure adequate power supply. Energy consumers also need to be educated on the dangers of using traditional energy sources. This will encourage better energy substitution in the state, especially in the urban areas.

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