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ANALYSIS OF ENERGY AVAILABLE FOR DOMESTIC COOKING IN OWERRI, IMO STATE, NIGERIA

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ABSTRACT

A research was conducted on energy usage in Owerri metropolitan area. Energy consumption survey was done using questionnaires. Classification was made into low, medium and high income earners. Energy consumption was on domestic cooking. To analyse the various sources of energy available for domestic use and know which is more economical, a model equation was used and R^2 value of 0.9246, was obtained, which is an indication of goodness of fit of the model. It also predicts that there was a strong interaction between the source of power and level of income of the populace. It also predict that in domestic cooking, the low income earners spent least by using firewood while the medium income earners spent most by using gas (fossil fuel) .

KEYWORDS: *Domestic, Energy, Usage, Analysis, Metropolitan.*

1. INTRODUCTION

Nigeria, the most populous country in Africa, is a classic example of the country with a high rate of urban growth. While the country's annual population growth rate for the period 1970-1995 was 2.9 percent, the urban population annual growth rate for the same period was 5.7 percent. In 1975, urban population constituted 23.4 percent of the total population but by 2000, it was estimated that 42.35 percent of the total population was classified urban. By the year 2025, it is estimated that 61.6 percent of the total population would be in the urban centres (UNCHS, 1996). This rapid rate of urbanization has been accompanied by complex urban problems in the form of stiff competition for land, inadequate supply of urban infrastructures including housing, portable water and energy.

National economic decline has also affected all sectors of the urban economy including household sector and industries. During the early 1970's Nigeria witnessed a period of economy growth as a result of oil boom. The rapid rise of crude petroleum from 1973 to 1978 brought boom conditions to Nigeria and consequent rapid urbanization, notwithstanding the severe balance of payments pressures elsewhere.

However, when foreign exchange earnings declined sharply in the 1980s due to market drop in the price of crude oil, economic crisis set in, between 1982 and 1985; the economic situation reached disturbing levels, which promoted the Nigeria government to embark on measures to correct the disequilibria in the economy. In April 1982, the civilian federal government promulgated the economic stabilization Act designed to arrest the deterioration of the economy. More stringent exchange control measures and import restrictions supported by appropriate monetary and fiscal policies were put in place (Adelekan and Jerome, 2006).

In January 1986, eighty percent of the petroleum subsidy was removed leading to an increase in the prices of petroleum derived energy sources (Ojo, 1989).

In July 1986, Nigeria adopted a structural Adjustment policy (SAP), which was in response to the World Banks demand for renegotiating its debt repayment schedule. Nigeria's adoption of SAP had detrimental effects. There was negative growth in consumption both at government and private levels and high inflation rates reaching up to 26 percent during the period 1987-1992. The human development index (HDI) for the country also declined from 0.31 recorded in the period 1980 – 85 to 0.20 for the period 1987 – 92 (Federal Office of Statistics, 1992: basic indicators for Nigeria). Among the specific reforms prescribed by the World Bank in renegotiating its debt repayment schedule was the removal of subsides on petroleum and other products. This led to the gradual removal of subsidies that resulted in the pricing of commercial fuels such as kerosine and liquefied petroleum gas (LPG) beyond the reach of majority of the population considering the fact that income was not increased. Aweto (1995) noted that the devaluation of major currencies in West Africa has further increased the price of commercial fuels, making increased consumption of commercial fuel by the low income populace, in the rural and urban areas, a remote possibility.

An outcome of this economic situation is the change in pattern of domestic energy consumption in households, which has had far reaching socio- economic and environmental implications. This is because energy plays a critical role in the inter relationship among environment, development and population. National case studies although essential in examining the impact of polices on patterns of energy use are not readily available. This research attempts to fill this gap by examining the dynamics of household and industrial energy use generally using Owerri an indigenous urban city in sub –Saharan African as study area. Specifically, the study examines which source of energy is more economical across three classes of income earners (low, medium and high).

1.1. Research hypotheses

The general data gathered during the implementation of this study were used to test the validity of the following two hypotheses, namely:

Hypothesis 1: Fossil fuel remains the major sources of energy / power

Hypothesis 2: There exists a relationship between the economic status of the populace and their energy consumption

2. MATERIALS AND METHODS

2.1 Study area.

Household energy consumption survey was carried out in Owerri, Nigeria. Owerri lies within latitudes 5^0 .29'N and 5.485^0N, and longitude 7^0.02'E and 7.035^0E. It is the capital of Imo state in Nigeria, set in the heart of the Igboland. It consists of three local government areas including Owerri municipal, Owerri North and Owerri West. It had an estimated population of about 400,000 as at 2006 census and is approximately 40 square miles ($100km^2$) in area. Owerri is bordered by the Otamiri River to the east and the Nworie River to the south (www.ngex.com).

2.2 Materials

A household energy survey was conducted to elicit information on the pattern of energy consumption for domestic cooking during the period of October 2015 to March 2016. The household questionnaire comprised two main parts: first part consisted of questions addressing the socio-economic characteristics of the respondents and households sampled. This then enabled me to classify them into low income, medium and high income earners, while second part consisted of questions which addressed the pattern of energy used for cooking.

2.3 Method of data collection

I made use of questionnaires to obtain responses from households in the metropolis; the questionnaire is exact, simple and objective, covering issues relating to the subject matter. The questionnaire was administered by hand.

A total of 120 questionnaire forms were administered in a random sampling method with 108 valid responses representing 90% response rate. In classifying the respondents, 31 household fell under low income earners, 58 under medium income while 19 fell under the high income earners, making a total of 108 respondents.

Apart from the above primary source, data were obtained from secondary sources as well; these include the statistical bulletin of Central Bank of Nigeria (CBN), the website of Power Holding Company of Nigeria (PHCN) and relevant literature.

2.4 Method of data analysis

Quantitative data collected in the field were collated and tables showing frequencies of observation were compiled using the statistical package for social science (SPSS) computer program (see tables 3.1 to 3.7).

Fisher's least significant difference (LSD) was used in the analyses:

$$LSD = t_{\alpha/2}\sqrt{MSE\left(\frac{1}{ni} + \frac{1}{nj}\right)} \qquad 2.1$$

Where;

MSE = Mean Squares due to Error

$t_{\alpha/2}$ is based on a t distribution with $n_T - k$ degree of freedom

n_i and n_j are observations.

α - level of significance

Finally, Matlab software package was used to find which of the energy sources is more economical across different classes of income earners. Data were fitted into a model equation (equation 3.2) from Matlab package and used to predict the level of use of the energy sources.

$$Y = a_0 + a_1x_1 + a_2x_2 + a_3x_1x_2 + a_4x_1^2 + a_5x_2^2 \qquad 2.2$$

$a_0 + a_1x_1 + a_2x_2$ = Linear part of the equation.

$a_3x_1x_2$ = the interaction part.

$a_4x_1^2 + a_5x_2^2$ = the quadratic part.

2.4.1 Model Specification

$Y = f(x_1 + x_2 + x_1x_2 + x_1^2 + x_2^2)$ 2.3

Where;

Y = Domestic Energy usage

x_1 = Income level

x_2 = Source of power

x_1x_2 = Interaction of income level and power source.

Matrix form of the equation is

$a_0n + a_1\sum x_1 + a_2\sum x_2 + a_3\sum x_1x_2 + a_4\sum x_1^2 + a_5\sum x_2^2 = \sum y$ 1

$a_0\sum x_1 + a_1\sum x_1^2 + a_2\sum x_1x_2 + a_3\sum x_1^2x^2 + a_4\sum x^3 + a_5\sum x_1x_2^2 = \sum yx_1$ 2

$a_0\sum x_2 + a_1\sum x_1x_2 + a_2\sum x_2^2 + a_3\sum x_1x_2^2 + a_4\sum x_1^2x_2 + a_5\sum x_2^3 = \sum yx_2$ 3

$a_0\sum y + a_1\sum x_1y + a_2\sum x_2y + a_3\sum x_1x_2y + a_4\sum x_1^2y + a_5\sum x_2^2y = \sum y^2$ 4

$a_0\sum x_1^2 + a_1\sum x_1^3 + a_2\sum x_1^2x_2 + a_3\sum x_1^3x_2 + a_4\sum x_1^4 + a_5\sum x_1^2x_2^2 = \sum yx_1^2$ 5

$a_0\sum x_2^2 + a_1\sum x_1x_2^2 + a_2\sum x_2^3 + a_3\sum x_1x_2^3 + a_4\sum x_1^2x_2^2 + a_5\sum x_2^4 = \sum yx_2^2$ 6

$$\begin{pmatrix} n_1 & \sum x_1 & \sum x_2 & \sum x_1x_2 & \sum x_1^2 & \sum x_2^2 \\ \sum x_1 & \sum x_1^2 & \sum x_1x_2 & \sum x_1^2x^2 & \sum x^3 & \sum x_1x_2^2 \\ \sum x_2 & \sum x_1x_2 & \sum x_2^2 & \sum x_1x_2^2 & \sum x_1^2x_2 & \sum x_2^3 \\ \sum y & \sum x_1y & \sum x_2y & \sum x_1x_2y & \sum x_1^2y & \sum x_2^2y \\ \sum x_1^2 & \sum x_1^3 & \sum x_1^2x_2 & \sum x_1^3x_2 & \sum x_1^4 & \sum x_1^2x_2^2 \\ \sum x_2^2 & \sum x_1x_2^2 & \sum x_2^3 & \sum x_1x_2^3 & \sum x_1^2x_2^2 & \sum x_2^4 \end{pmatrix} \begin{pmatrix} a_0 \\ a_1 \\ a_2 \\ a_3 \\ a_4 \\ a_5 \end{pmatrix} = \begin{pmatrix} \sum y \\ \sum yx_1 \\ \sum yx_2 \\ \sum y^2 \\ \sum yx_1^2 \\ \sum yx_2^2 \end{pmatrix}$$

$E \times ai = C \; ai = C/E = CE^{-1}$ 2.3

2.5 Definition of terms used

2.5.1 T- stat

This is a ratio of the departure of an estimated parameter from its notional value and its standard error.

Let $\hat{\beta}$ be an estimator of parameter β in some statistical model. Then a t- stat for this parameter is a quantity of the form.

$$t_\beta = \frac{\hat{\beta} - \beta_o}{s.e\,(\hat{\beta})} \qquad 2.4$$

Where β_0 is a non random known constant.

s.e = The standard error of the estimator $\hat{\beta}$. By default statistical package report t-stat with β_o = o (this t–stat values are used to test the significance of corresponding regressors). However, when t- stat is needed to test the hypothesis of the form Ho: $\beta=\beta_o$, Then a non zero β_o may be used.

2.5.2 P value

This is the probability that an effect at least as extreme as the current observation has occurred by chance.

If P-value is less than or equal to 0.05 it means that there is no more than a 5% probability of observing a result as extreme as that observed solely due to chance and considered statistically significant.

2.5.3 F- statistics

This is a value resulting from a standard statistical test used in ANOVA and regression analysis to determine if the variances between the means of two populations are significantly different. For practical purposes, it is important to know that this value determines the p – value, but the F – statistics number will not actually be used in the interpretation here.

2.5.4 Standard Error (s.e)

Standard error is the deviation of the sampling distribution of a statistics. It is a statistical term that measures the accuracy with which a sample represents a population. In statistics, samples mean deviates from the actual mean of a population; this deviation is the standard error.

The smaller the standard error the more representative the sample will be of the overall population. The s.e is also inversely proportional to the sample size. The larger the sample size, the smaller the s.e because the statistics will approach the actual value.

p- value $\leq$ 0.05 (at 5% confidence).

Rule of thumb: t stat ≥ 2. The coefficient is significant.

2.5.5 Correlation coefficient R squared (R^2)

R^2 - indicates how well data points fit a statistical model - sometimes simply a line or curve. It is a statistic used in the context of statistical models whose main purpose is either the prediction of future outcomes or the testing of hypotheses, on the basis of other related information.

$$R^2 = \frac{1 - SS_{res}}{SS_{tot}} \qquad 2.5$$

Where

SS_{tot} = Total sum of square

SS_{res} = Sum of square of residuals

R^2 is a measure of fit, Adj R^2 is instead a comparative measure of suitability of alternative nested sets of explanators. As such, care must be taken in interpreting and reporting this statistic. Adj R^2 is particularly useful in feature selection stage of model building.

2.5.6 Adjusted R squared (Adj.R^2)

The Adj.R^2 compares the explanatory power of regression models that contain different numbers of predictors. The Adjusted R^2 is a modified version of R^2 that has been adjusted for the number of predictors in the model. The Adj R^2 increases only if the new terms improve the model more than would be expected by chance. The Adj R^2 can be negative, but it's usually not. It is always lower than the $R^{2.}$

2.5.7 Decision Rule

H_o = Null Hypothesis.

Using test statistics: Reject H_o if $F_{CAL} > F_{TAB}$

Where the value of F_{TAB} is based on an F-distribution with k - 1 numerator degrees of freedom and n_T – 1denominator degrees of freedom.

3. Data Presentation/Discussion

The household questionnaire comprised two main parts: first part consisted of questions addressing the socio-economic characteristics of the respondents and households sampled. This then enabled me to classify them into low income, medium and high income earners, while second part consisted of questions which addressed the pattern of energy used for cooking.

A total of 120 questionnaire forms were administered in a random sampling method with 108 valid responses representing 90% response rate. In classifying the respondents, 31 household fell under low income earners, 58 under medium income while 19 fell under the high income earners making a total of 108 respondents

Quantitative data collected in the field were collated and tables showing frequencies of observation were compiled using the statistical package for social science (SPSS) computer program. Matlab software was also used in the analysis.

Apart from the above primary source, data were obtained from secondary source as well; these include the statistical bulletin of Central Bank of Nigeria (CBN), the website of Power Holding Company of Nigeria (PHCN) and relevant literature.

Fisher's least significant difference (LSD) was used in the analyses:

$$LSD = t_{\alpha/2}\sqrt{MSE\left(\frac{1}{ni} + \frac{1}{nj}\right)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.1$$

Finally matlab software package was used to find which of the energy sources is more economical across different classes of income earners. Data were fitted into a model equation (equation 3.2) from matlab package and used to predict the level of use of the energy sources.

$$Y = a_0 + a_1x_1 + a_2x_2 + a_3x_1x_2 + a_4x_1^2 + a_5x_2^2 \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.2$$

3.1 Statistical analysis for domestic cooking (low income earners)

With SPSS software the following tables and figure were generated;

Table 3.1: Amount (₦) spent per household on domestic cooking per month by low income earners.

Sample	Kerosine	Gas	Fire Wood	Electricity (PHCN)
1	2500	1500	550	350
2	2150	1700	570	230
3	2200	1800	600	400
4	2250	1700	580	230
5	2000	2400	500	500
6	2350	1600	530	240
7	2400	1700	600	250
8	2200	1600	540	230
9	2200	2400	550	300
10	2450	2000	560	240
11	2000	1500	500	200
12	2350	2000	580	300
13	2500	2200	600	400
14	2250	1800	560	350
15	2500	1700	600	300
16	2100	2400	530	360
17	2300	1800	500	200
18	2150	2300	600	370
19	2100	2000	500	500
20	2450	2200	600	250
21	2000	1600	500	400
22	2150	1600	550	400
23	2450	1700	550	450
24	2250	1500	500	450
25	2350	1800	600	500
26	2300	2000	600	500
27	2300	2200	500	300
28	2300	2100	550	350
29	2100	2200	550	200
30	2200	2400	550	250
31	2200	2100	600	300
Total	70000	59500	17200	10300
Mean	2258.07^{a}	1919.36^{b}	554.84^{c}	332.26^{d}
SD	±148.94	±300.47	±37.67	±98.00

All values are expressed as means ± SD

Means with uncommon superscript a to d along columns differ significantly at $p < 0.05$ i.e. mean with different superscript are significantly different at 95% level of confidence.

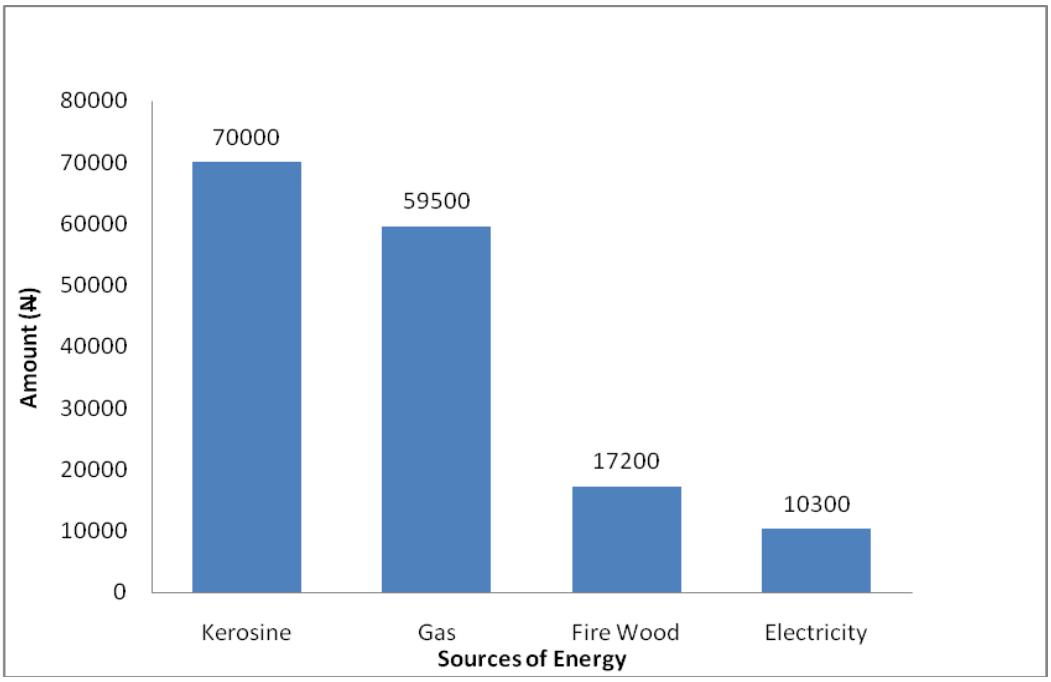

Fig 3.1: Total amount (₦) spent by households on different energy sources for domestic cooking per month (low income).

Table 3.2: One - way ANOVA table on domestic cooking per month (low income).

Source of Variation	SS	Df	MS	F_{CAL}	F_{TAB}
Between Groups	86449355	3	28816452	933.4304	2.680168
Within Groups	3704587	120	30871.56		
Total	90153942	123			

Decision: Using test Statistics: Reject H_o if $F_{CAL} > F_{TAB}$

Since $F_{CAL} > F_{TAB,}$ we reject H_o and conclude that there is difference in the source of energy used by household on domestic cooking per month.

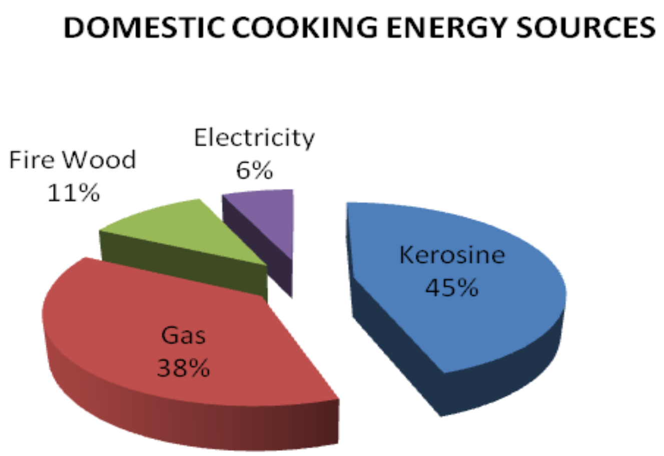

Fig. 3.2: Domestic cooking energy sources in percent (low income).

Table 3.1 shows the average amount (₦) spent per household on domestic cooking per month, which also provided the standard deviation (the most commonly used measure of the spread of a set of observations) for kerosine, gas, fire wood and electricity, as ±148.94, ±300.47, ±37.67 and ±98.00 respectively.

Table 3.2 shows the analysis of energy used by households on domestic cooking per month. From the table, $F_{CAL} > F_{TAB}$ i.e. the variance ratio calculated is greater than the variance ratio tabulated, which showed that the statistical evidence is sufficiently strong to indicate that there was significant difference in the amount of energy used per household on domestic cooking every month.

From fig. 3.2, 45% of domestic cooking energy source was kerosine, followed by gas with 38%, also fire wood has 11% and electricity with 6% of the domestic cooking energy source. The statistical summary in fig. 3.2 has shown that kerosine was the major source of domestic energy for cooking by low income earners.

Table 3.3: Amount (₦) spent per household on domestic cooking per month by medium income earners.

Sample	Kerosine	Gas	Firewood	Electricity (PHCN)
1	2200	3400	500	1800
2	2700	3500	650	2000
3	3000	4000	600	1600
4	3000	3500	300	1500
5	2200	4000	650	1950
6	3000	2600	300	2000
7	1000	4000	550	1850
8	2800	3500	700	2000
9	2500	3200	450	1750
10	1100	2750	550	1850
11	1000	2300	200	1500
12	2200	4000	650	1950
13	2000	2500	500	1600
14	3000	3300	700	2000
15	1000	2300	500	2000
16	1500	2700	300	1600
17	2500	4000	650	2000
18	2000	2450	600	1900
19	1500	3000	700	1500
20	2400	3500	500	1800
21	1400	2850	550	1850
22	2600	3200	700	2000
23	1650	2350	400	1700

24	1500	2800	300	1600
25	2400	4000	600	1950
26	3000	3500	600	2000
27	2100	4000	650	1950
28	1200	2400	250	1550
29	1600	3000	200	1650
30	1450	3000	350	1650
31	2300	3000	600	1900
32	3000	3800	550	1850
33	1600	2900	200	1650
34	1700	3200	450	1750
35	2300	4000	600	1950
36	2000	2450	600	1900
37	1300	2500	300	1550
38	1200	4000	550	1850
39	1300	2300	200	1500
40	2400	3500	500	1800
41	2900	3500	700	2000
42	1650	2350	400	1700
43	1400	2600	300	1600
44	2500	3500	300	2000
45	2500	4000	600	1700
46	1450	2550	350	1700
47	1700	3100	450	1750
48	1500	2400	200	1700
49	1550	2550	350	1700
50	2300	3300	450	1750
51	1400	2400	250	1550
52	2300	2850	600	1900
53	1200	2300	250	1500
54	2700	3600	500	1800
55	1500	2800	300	1600
56	3000	3800	550	1850
57	2000	2500	200	1500
58	1700	3000	400	1750
Total	115850	180350	26850	102800
Mean	1997.41^b	3109.48^a	462.93^d	1772.41^c
SD	±627.47	±587.40	±161.83	±169.15

All values are expressed as means ± SD

Means with uncommon superscript a to d along columns differ significantly at $p < 0.05$ i.e. mean with different superscript are significantly different at 95% level of confidence.

On domestic cooking every month for the sources of energy firewood with superscript d was more economical than other sources of energy.

Table 3.4: One - way ANOVA table on domestic cooking per month.

Source of Variation	SS	df	MS	F_{CAL}	F_{TAB}
Between Groups	205156066.8	3	68385356	344.70	2.64
Within Groups	45233060.34	228	198390.6		
Total	250389127.2	231			

Decision: Using test Statistics: Reject H_o if $F_{CAL} > F_{TAB}$

Since $F_{CAL} > F_{TAB,}$ we reject H_o and conclude that there is difference in the source of energy used by household on domestic cooking per month.

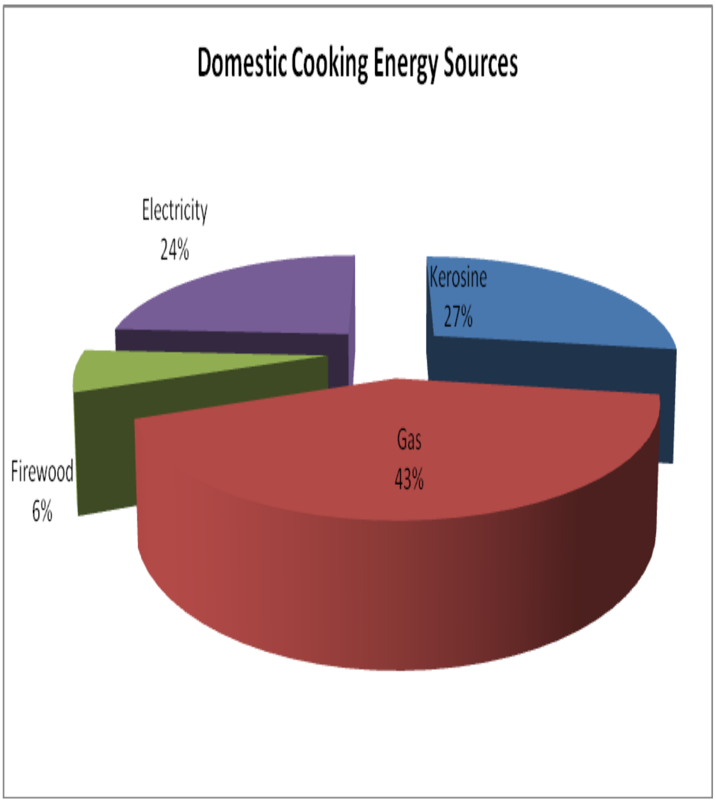

Fig. 3.3: Domestic cooking energy sources (monetary values) in percent (medium income).

Fig. 3.3 shows that 43%, 27%, 24% and 6% of expenditure by medium income earners sampled on domestic cooking were on gas, kerosine, electricity (PHCN) and firewood respectively.

Table 3.5: Amount (₦) spent per household on domestic cooking per month by high income earners.

Sample	Kerosine	Gas	Firewood	Electricity (PHCN)
1	2600	3400	300	1600
2	2000	3000	250	1500
3	1900	2900	250	1600
4	2900	4000	200	1500
5	1100	2500	200	1100
6	2000	3000	300	1400
7	1500	2700	250	1200
8	1800	2800	250	1500
9	1500	2800	200	1300
10	2400	4000	300	1800
11	1200	2600	250	1200
12	1300	2600	200	1200
13	2700	4000	200	1600
14	1400	2700	200	1300
15	1800	2900	250	1400
16	1900	3400	250	1600
17	2900	3900	300	1900
18	2500	3000	300	1500
19	2500	3500	300	1600
Total	37900	59700	4750	27800
Mean	1994.74^b	3142.11^a	250^d	1463.16^c
SD	±578.77	±518.88	±40.82	±211.37

All values are expressed as means ±SD

Means with uncommon superscript a to d along columns differ significantly at $p < 0.05$ i.e. mean with different superscript are significantly different at 95% level of confidence.

On domestic cooking every month for the sources of energy, firewood was the least spent on by high income earners.

Table 3.6: One - way ANOVA table on domestic cooking per month (high income).

Source of Variation	SS	Df	MS	F_{CAL}	F_{TAB}
Between Groups	82165625	3	27388542	168.40	2.73
Within Groups	11710000	72	162638.9		
Total	93875625	75			

Decision: Using test Statistics: Reject H_o if $F_{CAL} > F_{TAB}$

Since $F_{CAL} > F_{TAB,}$ we reject H_o and conclude that there is difference in the source of energy used by household on domestic cooking per month.

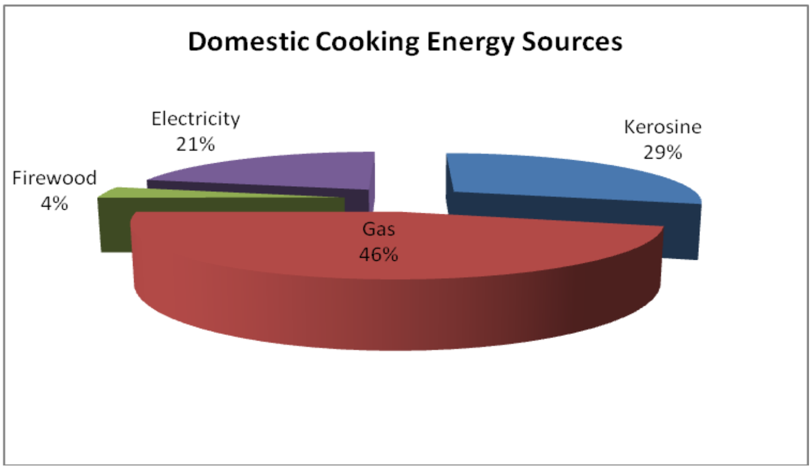

Fig. 3.4: Domestic cooking energy sources (monetary values) in percent (high income).

Fig 3.4 shows that the medium income earners spent 46% on gas, 29% on kerosine, 21% on electricity (PHCN) and 4% on firewood as sources of energy for domestic cooking.

3.2 Analysis with matlab

Code

For domestic cooking; Xc_1 represent income level while Xc_2 represent source of power.

Low Income =1
Middle Income =2
High Income =3

} Xc_1 Income Level

Let low income = $Xc_{11,}$ Medium income = Xc_{12}, High income = Xc_{13}

Sources of power for domestic cooking.

Firewood =1
Kerosine =2
Gas =3
Electricity =4

} Xc_2 Power source

Let firewood = Xc_{21}, kerosine = Xc_{22}, gas = $Xc_{23,}$ electricity = Xc_{24}

Table 3.7 Codes with cost (mean) for domestic cooking.

X_1	1 (xc_{11})	1 (xc_{11})	1 (xc_{11})	1 (xc_{11})	2 (xc_{12})	2 (xc_{12})	2 (xc_{12})	2 (xc_{12})	3 (xc_{13})	3 (xc_{13})	3 (xc_{13})	3 (xc_{13})
X_2	2 (xc_{22})	3 (xc_{23})	1 (xc_{21})	4 (xc_{24})	2 (xc_{22})	3 (xc_{23})	1 (xc_{21})	4 (xc_{24})	2 (xc_{22})	3 (xc_{23})	1 (xc_{21})	4 (xc_{24})
Cost	2258.07	1919.36	554.84	332.26	1997.41	3109.48	462.93	1772.41	1994.74	3142.11	250	1463.16

The costs (mean) are experimental data extracted from table 3.1, 3.4 and 3.6

Using equation 3.2 the following table was generated

Table 3.8: Model analytical values for domestic cooking.

Variables	Coefficients	Se	T stat	P val.	F statistics
a_0	-3.2765x103	1180.5	-2.7755	0.032187	sse=8.576x10^5
a_1	883.9820	982.24	0.89997	0.40281	dfe=6
a_2	3.7087x10	603.72	6.1431	0.000852	dfv=5
a_3	289.6650	119.55	2.4229	0.051661	ssv=1.0511x10^7
a_4	-346.2399	231.52	-1.4955	0.18541	f=14.708
a_5	-798.7976	109.14	-7.3192	0.00033216	P val.=0.0025817

R^2 = 0.9246

Adj. R^2 = 0.8617

MSE =1.4293x10^5

Where R^2 - indicates how well data points fit a statistical model.

While The Adj.R^2 compares the explanatory power of regression models that contain different numbers of predictors. The Adjusted R^2 is a modified version of R^2 that has been adjusted for the number of predictors in the model.

3.3 Model prediction for domestic cooking

The P-value of the interaction factor (X_1 X_2) in table 3.8 and non-linear nature of the contour of the surface plot (Fig.3.5) Shows that there is a strong interaction between source of power and level of income. Thus they do not affect the amount spent on cooking independently, thus level of income affects the source of power and both affect amount spent on cooking.

From the optimization; minimum Xc_{11}=1, Xc_{21}=1 implies that income level is low income while energy source is firewood. This led to the conclusion that low income earners spent the least on cooking by using firewood, the amount spent is N469.81 (predicted by the model, equation 3.2) while N554.84 is the value obtained from table 3.1. The variance was due to limit of model accuracy.

Also from the optimization; maximum X_1=2.4463 (approximately 2), X_2=2.7965 (approximately 3). That is X_1=2 implies that income level is (medium income) and energy source is (gas), which led to the conclusion that the medium income earners spent the most on cooking by using gas, the cost from the model is N2990.40 while N3109.48 is from table 3.3.

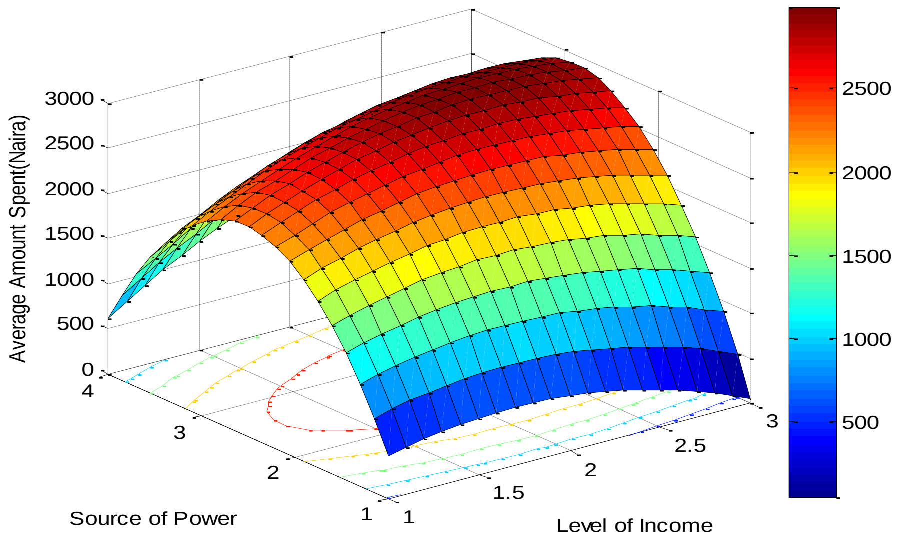

Fig. 3.5: Surface plot for domestic cooking.

3.4 Testing of hypotheses

3.4.1 Fossil fuel remains the major source of energy (Hypothesis1)

Across the classes of households sampled the use of kerosine and gas as energy source in cooking remained predominant. Figures 3.6, 3.7 and 3.8 below shows the total amount spent on kerosine, gas, firewood and electricity (PHCN) by various income earners for domestic cooking. Kerosine is the preferred choice by low income earners, while gas is predominantly used by medium and high income earners. Figures 3.2, 3.3 and 3. 4 show the corresponding percentages.

Therefore, conclusion is hereby drawn that fossil fuel is the major source of energy for cooking by the households surveyed.

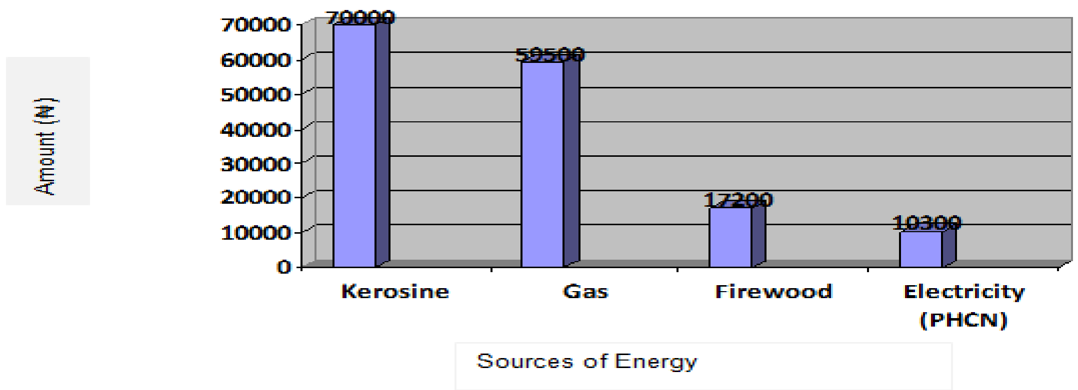

Fig. 3,6: Total amount (₦) spent by households on different energy sources for domestic cooking per month (low income).

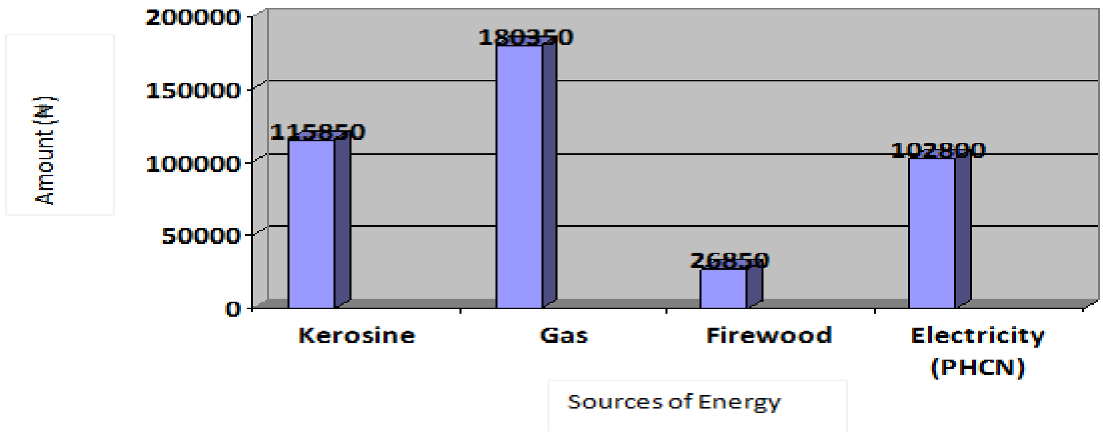

Fig 3.7: Total amount (₦) spent by households on different energy sources for domestic cooking per month (medium income).

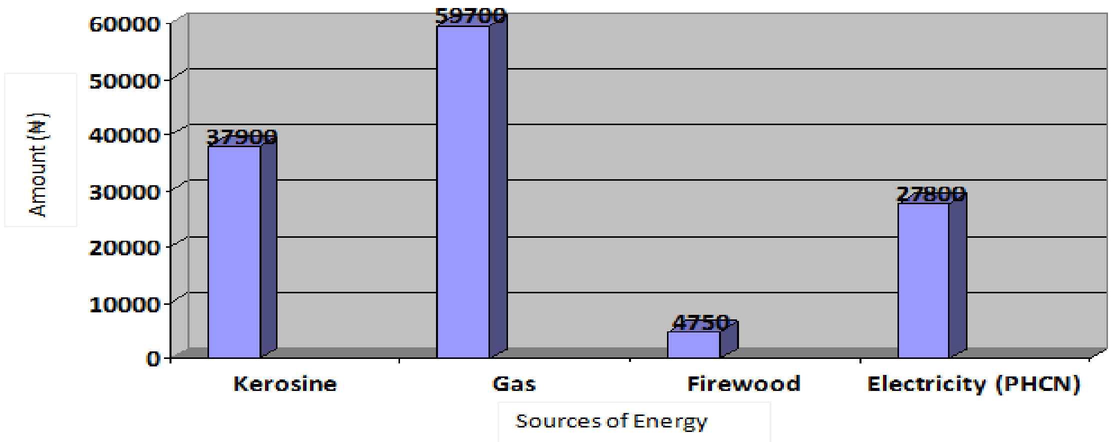

Fig. 3.8: Total amount (₦) spent by households on different energy sources for domestic cooking per month (high income).

3.4.2 There exists a relationship between the economic status of the populace and their energy consumption (Hypothesis 2)

Relating the energy consumption rate to the amount spent by the households, the low income earners spent an average of ₦2258.07, ₦1919.36, ₦554.84 and ₦332.26 on kerosine, gas, firewood and electricity respectively (table 3.1) for domestic cooking while the medium income earners spent an average of ₦1997.41, ₦3109.48, ₦462.93 and ₦1772.41 on kerosine, gas, firewood and electricity respectively (table 3.3) on domestic cooking.

High income earners likewise spent ₦1994.74, ₦3142.11, ₦250 and ₦1463.16 on kerosine, gas, firewood and electricity respectively (table 3.5).

From the above analysis the amount spent on energy sources corresponds with their level of income except firewood which declined drastically due to the fact that there are no facilities such as kitchen for the use of firewood in most urban cities.

Considering the above analysis the amount spent on energy generally increases from the low income to high income earners as clearly illustrated by figure 3.9, (which show a steady rise in amount spent on gas for domestic cooking from low to medium income earners and slightly from medium to high income earners. Electricity increases from low to medium income earners but dropped on high income earners. Kerosine was high on low income earners but dropped a bit low on medium and high income earners which maintain same level. Firewood dropped from low to high income earners).

Hence conclusion is hereby drawn that there is a relationship between the economic status of the populace and their energy consumption (monetary values).

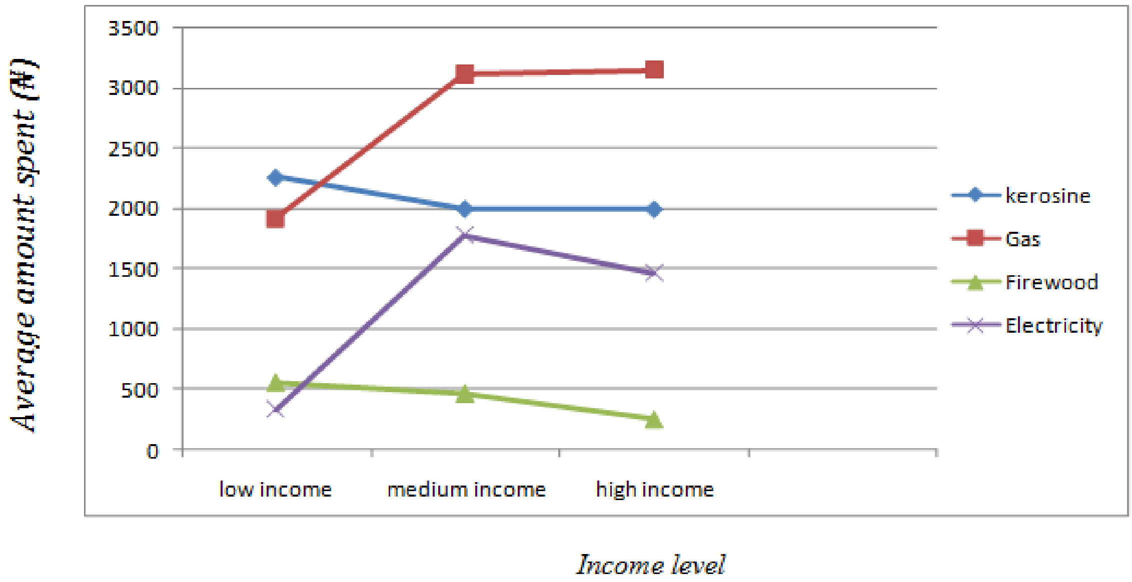

Fig. 3.9: Comparison of amount spent on domestic cooking across the income levels.

4. CONCLUSIONS

The study on household and energy usage in Owerri metropolitan area revealed the following;

1. The major source of energy for the household in the area is from petroleum products (petrol, kerosine, gas and diesel).
2. Electrical and other forms of energy consumption were much lower.
3. Renewable energy technologies have not been effectively utilized.

4. There is a strong interaction between source of energy and level of income which invariably determines energy consumption rate.

5. REFERENCES

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