



## Comparative Study of Residential Household Energy Consumption in Ekiti State-Nigeria

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### Authors' contributions

This work was carried out in collaboration between all authors. Author AOA conceived and designed the study, while authors OTO, OLR and JFE performed the field works and statistical analyses. Author OTO wrote the first draft of the manuscript as part of his M.Eng thesis under the supervision of author AOA. Author AOA reviewed the work for a journal article. All authors read and approved the final manuscript.

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### ABSTRACT

**Aims:** The paper compares the residential household energy consumption pattern between the densely and sparsely populated dwellers on the basis of income level classification with a view to ensuring functional distribution of energy. This study identified, determined and evaluated the various households' energy choices, quantities and costs of domestic energy consumption and provided a database for documentation.

**Place and Duration of Study:** Department of Mechanical Engineering, Federal University of Technology, Akure, Ondo State, Nigeria, between December 2014 and March 2015.

**Methodology:** Primary data were collected through a well structured questionnaires administered on households. Direct and personal observations were used to corroborate same information obtained from the questionnaires used to present more accurate information in the paper. Data obtained were analyzed using both independent and paired t-tests conducted at 5 and 10% levels of significance in the annual energy consumption between the low and high income earners in the visited areas respectively.

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**Results:** The result revealed that, the densely populated area remains the larger consumer of energy content of 827,411.20 MJ (63%) against the sparsely populated areas with 486,267.60 MJ (37%), while on the basis of households' income level; the energy consumed by the low income earners (790,719.30 MJ) is significantly higher than the high income earners (522,959.49 MJ).

**Conclusion:** The study established that, fuel wood was the poor man's energy source (6.5%) as well as charcoal (11.2%) majorly used in sparsely populated areas with high demand. Kerosene consumption (29.6%) was positively and significantly influenced by income and population in both locations while, LPG (44.9%) and electricity (7.8%) were used mainly in the densely populated areas. However, the results implied that, there was a positive link between income and choice of energy consumption by households that showed the low income earners consumed more energy than the high income earners due to their cooking frequency and unit energy purchase index.

*Keywords: Energy choices; residential household; sparsely and densely populated areas; Ekiti State.*

## 1. INTRODUCTION

Energy plays the most vital role in the economic growth, progress, and development, as well as poverty eradication and security of any nation. Hence, the geometrical growing annually at an alarming rate of energy consumption all over the world and need to adopt the energy policy that encourages the efficient usage of limited electricity supply is required. It is on this note that, the standard of living of a given country can be directly related to the per capital energy consumption [1]. The world consumes about 7500 Mtoe of energy every year, while primary energy consumption will grow by almost 50% from 2005-2030. About 30-40% of all the primary energy is used in residential building worldwide [2] which is equivalent to 2500 Mtoe every year. It is an established fact that, the building sector is responsible for a large share of the world's total energy consumption. The pattern of energy usage in Nigeria's economy can be divided into industrial, transport, commercial, Agricultural and household sectors [3]. The household sector accounts for the largest share (about 65%) of energy usage in the country. The major energy-consuming activities in Nigeria's household are cooking, lighting and use of electrical appliances. Cooking accounts for a staggering 91% of household energy consumption, lighting uses up to 6% and the remaining 3% can be attributed to the use of basic electrical appliances such as televisions and pressing irons [2]. Energy consumed by households in developing countries such as Nigeria includes electricity, gas, diesel, kerosene, inverters, candles, lanterns, fuel wood, charcoal, sawdust etc. The energy consumption pattern largely depends on the types of dwelling, occupant numbers, household incomes and climate zones. In most Nigerian homes, it is evident that energy efficiency is not factored in the choice of

household' appliances and electrical fittings. It could therefore be argued that, electrical energy utilization in Nigeria is far from being efficient as in most homes; filament bulbs of wattages ranging 40 watts to 120 watts per hour reported [4]. Households in different parts of the world have different levels of energy consumption based on climate and income [5]. The domestic energy consumption is the amount of energy that is spent on the various appliances used within the house and the amount of energy used per household depending on the standard of living of the country, climate, age and the type of residence. Hence, energy consumption at the household level is a key indicator of standard of living [6]. The domestic energy consumption accounts for about 80% of the total energy consumption in developing countries [7]. In his study of household energy preference for cooking in urban Burkina faso [8], he realized that household cooking energy preference is due to poverty factors while World Bank study in 2004 shows that, there is a high relation between the level of poverty and the energy use for cooking by household. The massive increased in the cost of modern fuel has increased the level of poverty of Nigerians left wood as the fuel of choice for most households in rural areas [9].

World energy consumption refers to the total energy used by all of human civilization. Typically measured per-year, it involves all energy harnessed from energy source as applied towards humanity's endeavours across every industrial and technological sectors across every explorers. The amount of energy used per household varies widely depending on the economic status of people of the country and type of homes among others. Energy resources can be classified on the basis of their renewability as (i) Renewable and (ii) Non-renewable [10]. Renewable energy sources are

sources that can be replenished or produced quickly through natural processes. The rate at which they are used does not affect their availability in future and as such cannot be exhausted. All the regions of the world have reasonable access to one or more forms of renewable energy supply because the resources are generally well distributed all over the world at wide spatial and temporal variation [11]. Despite the fact that, Nigeria is a rich country blessed with a lot of energy resources such as, wind, biomass, crude oil, natural gas and coal, yet an estimated number of 60-70% of Nigerians population does not have access to electricity.

At present, Nigeria energy supply is almost entirely dependent on fossil fuels and firewood which are depleting fast [10]. The 1995 distribution of energy consumption typified the current energy supply mix in the country which shows that the total energy consumption, the share of natural gas was 5-22%, hydroelectricity took 3.05%, fuel wood had a lion share of 50.45% and petroleum product had 41.23% share. This depicts the splitting essentiality between hydroelectricity and traditional fuel wood [12]. The most important energy sector of the Nigerian economy is the household sector presently dominating the highest energy consumption in Nigeria [11]. Hence, the necessity of renewable energy in meeting the future energy need in both rural and urban area [13]. Nigeria receives abundant solar energy that can be usefully harnessed with an annual average daily solar radiation of 5.25 kWh/m<sup>2</sup>/day, falls on the entire land area of Nigeria that is 120,000 times the total annual average electrical energy generated by the Power Holding Company of Nigeria [14]. With a 10% conservative conversion efficiency, the available solar energy resources is about 23 times the energy commission of Nigeria's projection of the total final energy demand for Nigeria in the year 2030 [2]. Research indicated that the identified feedstock substrate for an economically feeble biogas programmed in Nigeria include Water Lettuce, Water Hyacinth, Dung, Cassava Leaves, Urban Refuse, Solid Waste, Agricultural Residues and Sewage, produces about 227500 tonnes of fresh animal wastes daily [12]. Since 7 kg of fresh animal waste produce a about 0.03 m<sup>3</sup> gases, then; Nigeria could produce about 6.8 million m<sup>3</sup> of biogas every day. Economic factor plays an important role in the choice of energy used for cooking. However, this research work has critically examined, quantified and evaluated by analysis the relation between energy

consumption and monthly income levels of the Nigerians.

## 2. DATA COLLECTION AND ANALYSIS TOOLS

The data were collected through a well structured questionnaires administered on households. Direct and personal observations were used to corroborate same information obtained from the questionnaires used to present more accurate information. Data obtained was analysed with the aid of descriptive statistical tool, Independent and Paired t- tests.

### 2.1 The Study Area

Ekiti state is one of the states in south-western Nigeria, created on October 1, 1996. It has land-locked area of between 5,800 and 6,400 square kilometres with 16 local governments and a census population of about 1.6 million (1,647,822 by 2006 census) [15]. Ten local government areas were selected within Ekiti state relative to their population densities, income, available infrastructural facilities and economic growth in the visited locations. The study determined the relation between the residential household energy consumption in Sparsely Populated Area (SPA) and Densely Populated Area (DPA) among Ikole, Ekiti West, Ekiti South West, Ado, Ijero, Emure, Ise-Orun, Irepodun/Ifelodun, Efon and Ilejemeje local government areas.

### 2.2 Sample and Sampling Techniques

Ten local government areas of Ekiti state were considered through their population densities and available facilities via densely and sparsely populated areas as the major determinant of location comparison. The study covered the following local government areas and the randomly selected towns as shown in Table 1 by 2006 population census.

### 2.3 Research Instrument

The questionnaire used in the study consists mainly of questions whose answers are optional, designed to address social-economic characteristics (age, family size and frequency of cooking, safety and convenience, educational qualification, occupation, monthly income, type of dwelling place), types of cooking energy by households according to location (fuel wood, charcoal, kerosene, cooking gas, electricity), quantity of energy consumed, number of hours

**Table 1. List of selected local governments and areas visited in Ekiti State with 2006 population census [16]**

LG	2006 census	Areas visited	2006 populations	Population density	Facilities/ infrastructures /types of dwelling places
Ado	313,690	Ado	256,265	Densely Populated	Universities, Polytechnics, Technical college, Schools, Factories, Filling Stations, Duplex, Detached, Flats, Hospitals, and Teaching Hospital.
Ijero	221,873	Ijero	45,268	Densely Populated	College of Health Sciences, Teaching Hospital, Schools, Wood Processing Factories, Duplex, Flats, Filling Stations, and Clinics.
		Ikoro	31,098		
Ekiti West	179,244	Aramoko	42,191	Densely Populated	Schools, Wood Processing Factories, Duplex, Flats, Filling Stations, and Hospitals.
		Okemesi	35,792		
Ikole	170,414	Ikole	25,601	Densely Populated	University, Technical College, Schools, Wood Processing Factories, Duplex, Flats, Filling Stations, and Hospitals.
		OdoAyedun	16,133		
Ekiti South West	165,087	Ilawe IgbaraOdo	78,961 42,528	Densely Populated	University Study Centre, Technical College, Wood Processing Factories, Flats, Filling Stations and Hospitals.
Irepodun	131,330	Awo Afao	11,069 5,631	Sparsely Populated	Schools, Filling Stations, Flats, and Health Centres.
Ise-orun	113,951	OrunEkiti OgbeseEkiti	6,595 4,057	Sparsely Populated	Schools, Filling Station, Flats, Health Centres ; and Room and Parlour.
Emure	94,264	Eporo Oge	10,212 1,355	Sparsely Populated	Schools, Health Centre; and Room and Parlour..
Efon	87,187	Omoniafe Camp Araromi Camp	1,008 857	Sparsely Populated	Primary School, Single Rooms and Huts.
Ilejemeje	43,459	Ijesamodu	4,509	Sparsely Populated	Schools, Filling Station, Room and Parlours, and Health Centre.
		EdaOniyo	3,904		

used per day, cooking energy satisfied or unsatisfied, and factors influencing choice of energy use and the utmost index of measuring energy consumption via cost implications. Fifty (50) copies of questionnaire were administered to the respondents in each local government areas selected.

**2.4 Estimation of Energy Consumption**

In order to estimate energy consumption of an appliance, there is need to know its wattage and the number of hours that such appliance is in use per day. The wattage can be found on the number of nameplate or manufacturer’s websites and calculated in kilowatt hour for a unit, the energy consumption(www,2014) is estimated thus;

$$D = pt \tag{1} \tag{17}$$

Annual consumption is calculated by multiplying the result from this formula by the number of days that the appliance is in use throughout the year.

$$A = pfr \tag{2} \tag{17}$$

In order to estimate annual cost of running an appliance, multiply the annual kilowatt-hour consumption in kWh by local utility rate of cost per kWh [17].

$$C = re \tag{3} \tag{17}$$

Where; A is the annual consumption, D is the daily consumption, p is the wattage of each appliance, t is the hours used per day, f is the number of days used per year, C is the cost of annual consumption, e is the annual energy consumption and r is the local utility rate.

**Table 2. Determination of energy consumption and cost evaluation in Ekiti State [18]**

Energy	Mass of energy (kg)	Heating value (MJ/kg)	Energy factor (MJ/hr)	Price Unit (₦/kg)	Cost (₦)	Energy (MJ)	Cost Energy (₦/ MJ)
Charcoal	A	28.0	7.8	A	Aa	28A	$\frac{a}{28.0}$
Cooking Gas	B	46.6	6.6	B	Bb	46.6B	$\frac{b}{46.6}$
Electricity	C	3.6	3.6	C	Cc	3.6C	$\frac{c}{3.6}$
Fuel wood	D	16.0	4.4	D	Dd	16D	$\frac{d}{16.0}$
Kerosene	E	43.0	9.8	E	Ee	43E	$\frac{e}{43.0}$

In this paper, five different domestic households' energy choices were considered in this paper namely: fuel wood, charcoal, electricity, kerosene and liquefied petroleum gas. The parameters used for estimating various household's energy choices are shown in above Table 2.

**2.5 Method of Data Analysis**

The data generated were organized and analyzed using simple arithmetic and percentages to access the respondents' view on the research questions. The following statistical tools were used.

- (a) Descriptive statistical analysis was used to analyze socio-economic characteristics of respondents on monthly income level and type of cooking energy, weather influence and locations.
- (b) Independent t- test comparison was used for testing the validity of data collected.
- (c) Paired t- test comparison was employed for confirmatory test of the data obtained.

**3. RESULTS AND DISCUSSION**

Table 3 showed the total energy consumed by various households' energy choices in the ten selected local government in Ekiti State.

Table 4 and Table 5 showed the quantity of energy consumed by the households in both DPA and SPA in the studied areas with their evaluated energy choices' cost respectively. The energy consumed (827,411.20 MJ) and cost (₦3,831,886.29) in DPA is higher than SPA with a total energy of 486,267.60 MJ and cost of ₦1,527,236.66.

**3.1 Results Analysis between Low and High Income Earners**

Tables 4 and 5 showed by analysis the results obtained from households' energy consumption in the ten selected locations.

**3.2 Results Analysis between Low and High Income Earners Using Independent t- test**

Table 8 showed the analysis by application the use of independent t-test to establish the relationship between the energy consumed by the low and high income earners. It was evident from the evaluation that, the low income earners consumed more energy than the high income earners.

From t- table,  $(t_{18}, 1 - \frac{0.05}{2})$  and at 5% level of significant; the low income earners had 47,016.16 MJ and the high income earners consumed 6,535.80MJ. Likewise, from t- table,  $(t_{18}, 1 - \frac{0.05}{2})$  and at 10% level of significant, 43,450.03MJ was consumed by the low income earners while the high income earners consumed 10,101.93 MJ. It is obvious from the above evaluation data in Table 4 that, at 5% level of significant, the true difference between the energy consumption by low income earners and that of high income earners are 47,016.16 MJ to 6,535.80 MJ. But at 10% level of significance the true difference between the energy consumption by households in Ekiti state in both income groups were 43,450.23 MJ in favour of low income earners and 10,101.93 MJ in favour of high income group.

**Table 3. Energy consumption by household cooking energy choices in Ekiti State**

	Ado	Ijero	E W	Ikole	ES W	Irepodun	Ise-Orun	Emure	Efon	Ilejemeje	Total	%
C	12,030.4	11,052.2	10,220.0	10,512.0	15,768.0	17,045.5	22,206.6	17,082.0	15,373.8	16,556.4	147,846.9	11.3
L	129,042.1	104,233.1	103,076.0	77,307.0	69,576.3	23,352.7	20,082.3	20,016.6	26,688.8	16,680.5	590,055.4	44.9
E	20,899.9	13,687.5	15,768.0	10,512.0	9,800.3	13,344.4	5,124.6	3,416.4	5,124.6	4,752.3	102,429.9	7.8
F	3,073.3	5,562.6	5,263.3	5,358.2	3,949.3	13,753.2	10,249.2	13,665.6	11,957.4	11,957.4	84,789.5	6.5
K	36,500.0	40,427.4	38,456.4	41,661.1	33,674.9	59,319.8	35,430.6	38,478.3	31,262.3	33,346.4	388,557.1	29.6
T	201,545.7	174,962.8	172,783.7	145,350.3	132,768.8	126,815.6	93,093.3	92,658.9	90,406.7	83,293.0	1,313,678.8	100

where; C is charcoal, L is liquefied petroleum gas, E is electricity, F is fuel wood, K is kerosene and T is total

**Table 4. Energy consumption and cost evaluation of Domestic Household Cooking Energy choices (DHCE) in densely populated areas**

S/N	LG	Energy consumption of DHCE in densely populated areas (MJ)	Cost (₦)
1	Ado	201,545.70	971,981.62
2	Ijero	174,962.75	814,889.06
3	Ekiti west	172,783.70	809,563.21
4	IkoleWest	145,350.30	651,965.20
5	Ekiti South	132,768.75	583,487.20
	Total	827,411.20 (63%)	3,831,886.29

**Table 5. Energy consumption and cost evaluation of Domestic Household Cooking Energy choices (DHCE) in sparsely populated areas**

S/N	L G	Energy consumption of DHCE in sparsely populated areas (MJ)	Cost(₦)
1	Irepodun/Ifelodun	126,815.60	396,184.23
2	Ise-orun	93,093.25	285,730.05
3	Emure	92,658.90	290,778.00
4	Efon	90,406.85	301,724.27
5	Ilejemeje	83,293.00	252,820.11
	Total	486,267.60 (37%)	1,527,236.66

The values obtained show that, the low income earners had the higher energy consumption compared to high income earners at both level of significant. The test is further confirmed using paired T-test statistical tool as illustrated in Table 9.

### 3.3 Results Analysis between Low and High Income Earners Using Paired t-test

Table 9 shows by analysis the results obtained from households' energy consumption in the ten selected locations.

From t-table, ( $t_9, 0.025$ ) and at 5% level of significant, the low income earners had 34,349.90 MJ while the high income earners consumed 19,202.06 MJ. Similarly, from t-

table, ( $t_9, 0.05$ ) and at 10% level of significant, the low income earners had 32,908.84 MJ while the high income earners consumed 20,643.98 MJ. It is evident from the evaluation above at both 5% and 10% level of significance when paired t-test was used that, there was a substantive significant difference between the energy consumption by the low and high income earners. At 5% level of significant, the energy consumed by low income earners (34,349.90 MJ) against 19,202.06 MJ in favour of high income earners. On further test at 90% confidence interval, the energy consumed by low income earners was 32,908.8 MJ whereas 20,643.98 MJ was in favour of high income earners. It is an established fact at this juncture that, the energy consumed by low income earners was greater than that of the high income earners.

**Table 6. Energy consumption of Domestic Household Cooking Energy (DHCE) by low and high income earners generated in visited areas**

S/N	LG	ECLIE (MJ)	ECHIE (MJ)	TEC by LHIE	PEC by LIE	PEC by HIE	Total (%)
1	Ado	109,934.01	91,611.68	201,545.69	54.6	5.4	100
2	Ijero	108,310.27	66,652.48	174,962.75	61.9	38.1	100
3	EW	90,318.75	82,464.95	172,783.70	52.3	47.7	100
4	Ikole	80,325.17	65,025.13	145,350.30	55.3	44.7	100
5	ESW	77,929.48	54,839.27	132,768.75	58.7	41.3	100
6	Irepodun	77,192.10	49,623.50	126,815.60	60.9	39.1	100
7	Ise-orun	65,588.43	27,504.82	93,093.25	70.5	29.5	100
8	Emure	62,544.76	30,114.14	92,658.90	67.5	32.5	100
9	Efon	60,271.23	30,135.62	90,406.85	66.7	33.3	100
10	Ilejemeje	58,305.10	24,987.90	83,293.00	70.0	30.0	100
	Total	790,719.30	522,959.49	1,313,678.80			

ECLIE= Energy Consumption by Low Income Earners; ECHIE= Energy Consumption by High Income Earners; TEC= Total Energy Consumption; PEC= Percentage Energy Consumption; LIE= Low Income Earners; HIE= High Income Earners

**Table 7. Energy consumption by low and high income earners generated in Ekiti State**

S/N	Local government	Energy consumed by LIE(MJ)	Energy consumed by HIE (MJ)	Total energy consumed by LIE and HIE (MJ)	Percentage of energy consumed by LIE (MJ)	Percentage of energy consumed by HIE (MJ)	Total (%)
1	Ado	109,934.01	91,611.68	201,545.69	54.6	5.4	100
2	Ijero	108,310.27	66,652.48	174,962.75	61.9	38.1	100
3	EW	90,318.75	82,464.95	172,783.70	52.3	47.7	100
4	Ikole	80,325.17	65,025.13	145,350.30	55.3	44.7	100
5	ESW	77,929.48	54,839.27	132,768.75	58.7	41.3	100
6	Irepodun	77,192.10	49,623.50	126,815.60	60.9	39.1	100
7	Ise-orun	65,588.43	27,504.82	93,093.25	70.5	29.5	100
8	Emure	62,544.76	30,114.14	92,658.90	67.5	32.5	100
9	Efon	60,271.23	30,135.62	90,406.85	66.7	33.3	100
10	Ilejemeje	58,305.10	24,987.90	83,293.00	70.0	30.0	100
	Total	790,719.30	522,959.49	1,313,678.80			

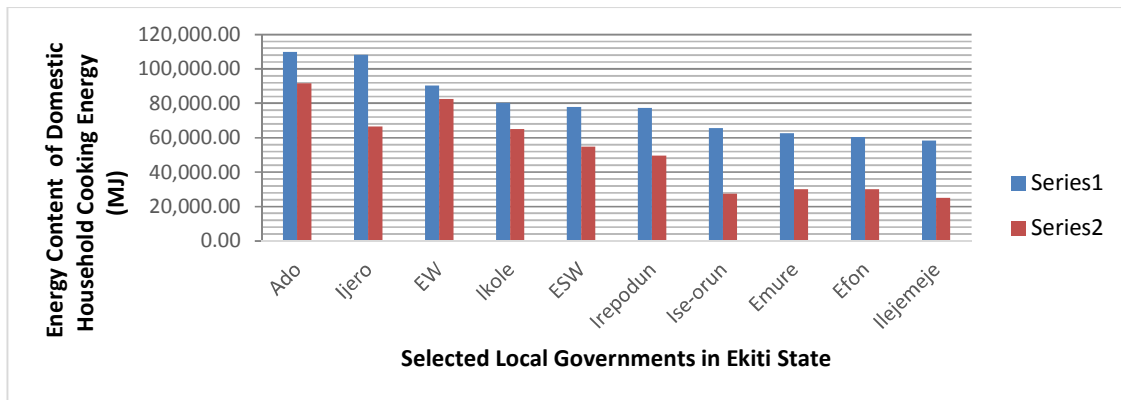
**Table 8. Comparison of energy consumption between the low and high income earners using independent test**

S/N	Local Government	Energy consumed by LIE (MJ) $X_A$	Energy consumed by HIE (MJ) $X_B$	$(X_A - \bar{X}_A)$ (MJ)	$(X_A - \bar{X}_A)^2$ (MJ)	$(X_B - \bar{X}_B)$ (MJ)	$(X_B - \bar{X}_B)^2$ (MJ)
1	Ado	109,934.01	91,611.68	30,862.08	952,467,981.90	39,315.73	1,545,726,625.00
2	Ijero	108,310.27	66,652.48	29,238.34	854,880,526.00	14,356.53	206,109,953.60
3	EW	90,318.75	82,464.95	11,246.82	126,490,960.10	30,169.00	910,168,561.00
4	Ikole	80,325.17	65,025.13	1,253.24	1,570,610.50	12,729.18	162,032,023.50
5	ESW	77,929.48	54,839.27	-1,142.45	1,305,192.00	2,543.32	6,468,476.62
6	Irepodun	77,192.10	49,623.50	-1,879.83	3,533,760.83	-2,672.45	7,141,989.00
7	Ise-orun	65,588.43	27,504.82	-13,483.50	181,80,772.30	-24,791.13	614,600,126.70
8	Emure	62,544.76	30,114.14	-16,527.17	273,147,348.20	-22,181.81	492,032,694.90
9	Efon	60,271.23	30,135.62	-18,800.70	353,466,320.50	-22,160.33	491,080,225.70
10	Ilejemeje	58,305.10	24,987.90	-20,766.83	431,261,228.20	-27,308.05	745,729,594.80
	<b>Total</b>	<b>790,719.30</b>	<b>522,959.49</b>		<b>3,179,928,701.0</b>		<b>5,181,090,271.0</b>

**Table 9. Comparison of energy consumption between the low and high income earners in Ekiti State using paired t-test**

S/N	Local Government	Energy consumed by low income earners (MJ) $X_A$	Energy consumed by high income earners (MJ) $X_B$	$d = (X_A - X_B)$ (MJ)	$(d_i - \bar{d})^2$ (MJ)
1	Ado	109,934.01	91,611.68	18,322.33	71,464,198.32
2	Ijero	108,310.27	66,652.48	41,657.79	221,468,268.90
3	EkitiWest	90,318.75	82,464.95	7,853.80	358,048,896.00
4	Ikole	80,325.17	65,025.13	15,300.04	131,697,198.90
5	ESW	77,929.48	54,839.27	23,090.21	13,584,900.49
6	Irepodun	77,192.10	49,623.50	27,568.60	628,246.46
7	Ise-orun	65,588.43	27,504.82	38,083.61	127,862,496.20
8	Emure	62,544.76	30,114.14	32,430.62	31,974,953.53
9	Efon	60,271.23	30,135.62	30,135.61	11,287,113.74
10	Ilejemeje	58,305.10	24,987.90	33,317.20	42,787,559.09
	<b>Total</b>	<b>790,719.30</b>	<b>522,959.49</b>	<b>267,759.81</b>	<b>1,010,803,832.00</b>





**Fig. 1. Multiple bar charts of energy content of Domestic Household Cooking Energy (DHCE) consumption by the low and high income earners**

*Series 1: LIE: Low Income Earners; Series 2: HIE: High Income Earners*

The multiple bar charts showed in above Fig. 1 revealed the differences between energy consumption by low and high income earners in Ekiti State. It was obvious that, the low income earners have more respondents than high income earners. Hence, the low income earners consumed more energy than the high income earners as illustrated with values and the height of the bars.

#### 4. CONCLUSIONS

The type of energy used by the majority of households reflects the extent of economic development and civilization attained. The major reason why households have shifted from the use of convectional fuel to alternative domestic energy source was as a result of the relative cheap prices of these energy and sources. Biomass is the most preferred fuel in sparsely populated areas due to the epileptic nature of electricity in the State and, scarcity and hike in price of kerosene and LPG. Thus, fuel wood was the alternative energy used by the various households to mitigate the impact of the high cost of other domestic fuels. Generally, the energy consumed by the densely populated group (827,411.20 MJ) was extremely higher than sparsely dwellers (486,267.60 MJ) but, in terms of income level; the low income earners consumed more energy (790,719.30 MJ) than high income earners with 522,959.49 MJ. Among the domestic energy choices consumption via kerosene (388,557.10 MJ), LPG (590,055.35 MJ), charcoal (147,846.90 MJ), fuel wood (84,789.50 MJ) and electricity (102,429.95 MJ), the result showed that, biomass remains the most fuel used for cooking in the sparsely populated areas with fuel wood being the

preferable energy source while gas and electricity were predominately used in the densely populated areas. The study established that, fuel wood was the poor man's energy source (6.5%) as well as charcoal (11.2%) majorly used in sparsely populated areas with high demand. Kerosene consumption (29.6%) was positively and significantly influenced by income, population and common in both locations while, LPG (44.9%) and electricity (7.8%) were used mainly in the densely populated areas. The result therefore showed that, the low income earners consumed more energy than the high income earners as a result of frequency of cooking and smaller unit purchase of their choices of energy. The paper provided a valid and reliable qualitative and quantitative database on the most economically viable domestic fuel of choice, effective energy cost management (for the low income earners to spend less on energy by reducing cooking frequency and to buy in bulk) coupled with poverty reduction in relation to household's income.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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