

# Investigation into House-Hold Energy Consumption in Saki, Southwestern Nigeria

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**Abstract**— Energy is a major means of sustaining life hence its effects on nation's economic development at both micro and macro levels. The dynamics of changes in the energy demand and supply patterns can be properly monitored through appropriate evaluation of consumption rate of available energy for effective planning. The main selection criterion considered in this study for the selection of household energy for cooking and heating, lighting, entertainment, refrigeration, and so on is population density. Energy sources considered in this investigation are electricity, liquefied petroleum gas (LPG), diesel fuel, kerosene, firewood, liquefied natural gas (LNG), charcoal and solar cells. Energy consumption for individual in a family per day per zone to their average level of income per zone were investigated to establish sources, supply, and availability in the prevailing situation of things in the study area. The result of the study indicates that 70.81% of household energy is from biomass which is very disastrous to the environment. Not less than 29.185 % and 0.004766 % of energy were obtained from fossil fuel and electricity respectively. It is evident that residents in the study area depend highly on biomass as source of household energy and much less on electricity. The result of this study have open up the ground for development of predictive model for estimation of daily household energy requirements (DHER) for Saki dwellers and for rural development plan for the area under study.

**Keywords:** Exergy; Biomass; Households; Energy Consumption; Deforestation.

## 1 INTRODUCTION

The major characteristics of African cities have been urbanization from 1950s. UN-Habitat (2008) report showed that in 1980s about 11% of Africans reside in urban area and this rose to about 37.9% in year 2000. This urbanization trend implies that by 2016 over 46.15% of Africans will be living in cities. It was estimated in the same report that in 2007 the world break in term of population globally (50% rural and urban). The National Population Commission (2010) report also indicated that there has been high percentage of urbanization in Africa than any part of the world at about 4% on the averages, while the rate of population increase defers according to region. The Urban and rural growth indicated an average of about 3.2% with the urban area having the higher percentage increase than the rural area in Nigeria [1]. Another growth pattern was observed with respect to the urbanization of Northern and Southern Nigeria with that of the North being significantly higher than that of the South.

The challenge of urbanization is the demands it places on environment with respect to energy sources, generation,

consumption and management. Some identified sources of energy include water, electricity, fuel (bio and fossil) and air all which persistently impact on the environment [2]. Energy consumption has been a driving force of global warming as carbon emission has increased beyond the world ecological limit. Global economic meltdown and its effects on households has adversely influenced energy use pattern as people seek for cheap, affordable and available sources in their locality [4], [5].

Energy is related with poverty index through household income, health, education, gender equality and environmental sustainability [3]. In addition, most economic activities are not possible without massively increasing its use of energy [18]. The trends of technological development require energy to meet up in various capacities. This necessitate the need to obtained energy from various sources to meet the present and future demands in all spheres of human endeavors at home for comfort, entertainment, domestic and industrial usage, and processing and operation of materials and machine

respectively. Productive explorations of available sources are specifically related to economic growth with the impact it made on individuals engaging it as source of income for sustain body and soul and as a viable source of household income.

Transportation of any type depends on mechanical energy obtain from fuels such as petrol, kerosene and liquefied natural gas. Some countries however, based their transportation system on energy obtained from sunshine energy, nuclear and rechargeable electrical battery. The need of energy for daily activities has resulted in the search for more sources of energy. Companies and industries are usually faced with the challenge of getting energy from a source with minimum cost so as to maximize profit. Thus, the demands for provision of stable, more reliable energy source and services, as this directly determines the type of service to expect from other sectors i.e. production, manufacturing and as well as the nation's economy [8], [15] and [16]. The effect of the quest to meet up with modern technological advancement is seen in the gradual wearing away of the green house with the population of trees per square kilometer reducing drastically every day likewise, storm such as tornado has been causing colossal damage to buildings because of deforestation. These were the results from strong quest for energy from biomass; for cooking and other domestic usage. The persistent increased demand for fossil fuel was influenced by incessant increase in the price of liquid fuel in the world-market which places pressure on government to remove subsidy on liquid fuel [3] and [13].

Major consumers of nations' energy supplied are firm and industries while household energy consumption is not appreciable. As small scale enterprises spring up every day, the demand for energy continues to increase [9], [21]. The effects of energy derived from various sources have adverse effects on the income of individual, such that huge amount of money are spent on energy. Likewise, deforestation has caused sudden increase in temperature, gradual desertification, gully erosion and Tornado has caused advert effects on houses etc. It has also led to environmental pollution as a result of releasing too much carbon IV oxide into the atmosphere because the trees in the forest are not sufficient to balance carbon cycle.

At early 19s contrary to the problem of household energy demand was not prominent as Nigerians were farmers and the population was very small. Technological advancement was not well visible and the modern appliances which use exorbitant energy were not

discovered on Nigeria. The Nigeria produce more energy more than the needed one. But in 1956, crude oil was firstly discovered at Oloibiri, which has brought much money and development to Nigeria, some other sources include Afam, Abata, Bomu, Owza, Egben and UgbelliK okori Oleh zone in [22]. The result of our wealth is seen in sudden rise in population of the country, which our administrative capacity cannot cope with. This led to overcrowding in cities as development occurred in cities and decline in agricultural industry, this coupled with explosive offshore environment pollution. Some of the environmental pollutions result from oil spillage, gas flaring and deforestation mangroves which served as source of fuel and habitant animals can no longer survive the oil toxicity which habits us. Afforestation has been difficult as many planted tree seeds cannot survive their early stage in such environment [23]. Prior to 1999, Nigeria was operating mixed economic since 1999 the style has changed to private sector led economic. Since the energy produced by crude oil with the first four years of the 21<sup>st</sup> century contributed an average of about 72% to the federal account 32%, the gross domestic product (GDP) and 97% of the expect earnings. Since 50s, the government research and investment have been majorly on oil sector, while energy produced from other source has declined drastically [8], [13], [14] and [16]. Having discovered the environmental degradation resulting from the consumption of crude oil product in the country, the Nigeria government is now conducting research on renewable energy source [5]. Over the years, there was no proper documentation of the research report, in-ability to have the record of energy consumption and research sources result, difficulty in planning and budgeting on energy consumed and projecting on how to improve those sources available looks impossible, these as well resulted in the exploitations of any available source by consumer for domestic and industrial purposes. It was discovered that people at rural obtained the cooking energy from bio mass and people in city form liquefied petroleum gas (LPG) [11]

In this work household energy consumption in Saki a town in Southwestern Nigeria (also referred to as food basket of Oyo State as a result of massive farming activity taking place in the town) was investigated with the aim of establishing energy consumption pattern as well as identifying the potential risk factors associated with choice of the energy sources. Effort was also made to discover the

optimal and disaster free source which has capacity to meet household energy needs.

## 2 Materials and Method

### 2.1 Study Area

The study was conducted in Saki be the largest town in Oke-Ogun area. Saki is located in Oke-Ogun area, the old Oyo north of Oyo State Nigeria. It located on Latitude 8.67 °N and 3.38°E and 4571-meter elevation about the Saki level (figure 1). It has about 178,677 in habitant according to 2006 population census [17]. It is characterized with rocks namely Ologun, Asabari, Agaran rocks to mention some. The average temperature of Saki is 33.2 °C and it is dominated by some hard woods which are Annogesus, poliveric, deuterium, coiba, votex, burkia, and afzelia (Forestry Report, 2014). Saki is known for farming and commercial center hence called the food basket or our state. It has an area of 2014 km<sup>2</sup> and a population of 278002 at the 2006 census [17].



Figure 1: Map of Study Area [17]

### 2.2 Research Instrument

This investigation makes use of structure questionnaire, record viewing an interview to collect data relating to consumers' demography, behavior, energy sources and usage rate, and availability of each energy sources. Likewise, the consumption rate per day, week and month, the conversion of local measurement to standard measurement, and collection of average wattage for various electrical appliances as well as information on energy volume derivable from various forms of fuel in mega Joule were investigated.

For effective survey ten enumerators were employed and trained on the use of questionnaire and forms for collecting energy data. Two enumerators were deployed to each of the five zone to which Saki township was divided due it's population density in order to capture adequately the information, data and other records obtainable from

consumers and Power Holding Company of Nigeria (PHCN) an organization in charge of electric power generation and distribution in Nigeria. The questionnaire was validated by the field researcher prior to it administration through the conduct of pilot study with the instrument. The township was stratified based on population density, infrastructural distribution and spread of each zone and a total of two hundred and ten (210) copies questionnaire were handed to the enumerators to be administered proportionately.

## 3 RESULT AND DISCURSION

### 3.1 DEMOGRAPHY

The administration of the instrument of research shows a total of 182 valid questionnaires was achieved which indicate a percent success rate of 86.7 %. (Table 1).

Table 1: Questionnaire analysis

Zone	Number Administered	Number Effective	Valid (%)
A	40	33	82.5
B	50	47	94
C	30	24	80
D	30	27	90
E	60	51	85.5
Total	210	182	86.7

The responses to energy sources and uses show that 91.21 percent of houses use charcoal for a number of household chore like cooking, heating to warm room and ironing of cloth (Table 2) It was observed that the popular choice charcoal was also due to it relative low cost compare to other sources of energy, availability and clean nature, Saki is known for abundant source of coal hence it's preference over other available sources of energy. It also serves as means of livelihood to many of the residents of the town. Next to Charcoal is electricity with 76.92 % of the house being connected to national grid for electric supply of power. Further investigation shows that this source is mostly used for lightning, and to power electronic and electrical appliances. It was reported that its supply was not regular and that make people to find it more expensive to install and use than other alternative sources of electric power. A number people whose house have been disconnected form the electric supplied due to non-

payment of electric bill complained of exorbitant bill which does not commensurate with energy used couple with unavailability of power supply. Kerosene as source of energy attracted 76.27 % responses possible due to its accessibility, ease of use for cooking. Lighting and setting of coal to become red hot and speed at which it cooks or produce heat. Petrol was also found to be used by 71.43 % of the houses. It is use in powering of electric generators water pump, and pepper grinding machines. Due to irregular supply of power by PHCN (supply of power at Saki was estimated at 12 days per month), a number of people bought electric generator of various capacity depending on required power rating as alternative source of electric power. However, the disadvantage of sourcing energy from petrol is pollution which results from its spillage leading to death of aquatic animals and the by-product from generator using the fossil fuel. Diesel which is the alternative fossil fuel used to power generator recorded low patronage (15.93 % response) because of the high cost of diesel generators as well as the high cost of a liter of diesel (₦100/L) compare to that of petrol (₦ 100/L).

With the continuous campaign against bush burning and deforestation people have desisted from use of wood as source of fuel. This explain the low response to wood in this study (21.42 %). Likewise, the use of wood fuel exposes people to air pollution result from fume produced from wood burning. Liquefied Natural Gas (LNG) was found to have a low response of 19.78 % because of the low level of education of many of people and fear of it high level of flammability. In urban cities LNG is observed to be used by elites and educated civil servants who understand how to handle the gas fuel safely. It was notice that no individual in the study uses solar source of energy. This could be as a result of the high investment involve in the use of this source which is not within the reach of the people living in the study area. The technology involve is also relatively new and complex for unskilled person to maintain. Saki with the average daily temperature of 31.2°C according to the metrology, is a better area for solar. About 1.65% of power energy were derived from Natural gas may due to it cost (i.e. ₦300.00/kg).

Table 2: Household respondents to various energy sources in Saki.

Zone	No of House	Fuel							
		Electricity	Wood	LNG	Petrol	Diesel	Kerosene	Charcoal	Solar
A	33	26	6	4	18	2	20	33	0
B	47	38	9	21	38	11	36	41	0
C	24	14	11	0	12	0	21	24	0
D	27	20	0	1	20	2	24	23	0
E	51	42	13	10	42	14	38	45	0
Total	182	140	39	36	130	29	139	166	0
(%)	(100)	(76.92)	(21.43)	(19.78)	(71.43)	(15.93)	(76.37)	(91.21)	(0)

The use of charcoal as source of energy for domestic, commercial and industrial differs significantly from zone to zone. Availability was reported to be a major preference factor for choice of household with Zone C having highest rate of energy consumption sourced from charcoal (over  $37.600 \times 10^3 \text{MJ/day}$ ). Zone B had largest energy consumption rate diesel ( $0.850 \times 10^3 \text{MJ/day}$ ), electricity ( $2.980 \times 10^3 \text{MJ/day}$ ) and kerosene ( $15.181 \times 10^3 \text{MJ/day}$ ). This was sequel to the high level of commercial activity which is characteristic of the zone and the centrality of the location (figure 2). Noticeable is the volume of LNG energy source reported for zone D ( $1.177 \times 10^3 \text{MJ/day}$ ), while other zones

put together did not consume as much of LNG. Analysis of electricity shows that 0.0047665% of household energy supply is from electricity and about 76.9% respondent. The energy derived from this source for lighting only is very small; despite large number of the respondent, statistic shows that zone (figure 2) A is the only zone that we enjoy about 62.45% of the electricity supply in Saki, other zones are less benefit due to erratic power supply. In fact, the average power supply at Saki per month is 12days/ month, despite this the bills were distributed across at exorbitant rate. This account for disconnection in various houses in zone C and D. Despite the disconnection, the electricity

monthly bill was not stopped. House-hold respondent who power supply was not disconnected were lamenting of low voltage, despite the use of stabilizer, the supply couldn't carry the load of refrigerator and other appliances. So each household in Saki are now generating the power by them self.

**3.2 Percentage Household Energy Consumed per Day in Saki Town Based on the Compound Classification of their Source.**

The major sources of energy from Saki town are classified into four (4) major sources which are solar, biomass, electricity and fossil fuel. Analysis shows that 70.81% of the house hold energy consumption is from biomass, this is very disastrous for Saki's vegetation, it reflects high rate of deforestation which may lead to desertification, destruction of houses by wind speed and general greenhouse effect. The temperature of the town may likely increase and the monthly and annual average rainfall may reduce. About one-third (29.183 %) of household energy is obtained from fossil fuel such as petrol, diesel, Liquefied Natural gas and kerosene for cooking, lighting, heating and generation of electricity. 0.0476637 of daily energy supplied is obtained

from electricity which is very small. The town and the government need to do something on the improvement of electric power supply in Saki because it affects house source of energy negatively.

**3.3 Percentage Average Household Energy Consumption per House per Source in Saki.**

The analysis shows that a house use average of 22.1427 kilowatt of electricity, which amount of 0.00477% of the total energy used per house per day, 66.733061 MJ of kerosene energy from kerosene (14.365% of household energy used per house). 1.941502 MJ of energy from fuel wood. 327.009419 MJ of energy is from charcoal which is 70.39 of energy used per house. 50.50274725 MJ from which 10.871 % energy used per house, 10.659340.66 MJ of energy from diesel which is 2.294 % of energy used per house, Liquefied Natural Gas accounts for 7.676923 MJ which of energy per house which 1.65% and solar 0% of house hold energy. Analysis shows that the main source of house energy in Saki is from Bio-mass which 70.811%. This comprises of 0.418% of fuel wood and 70.393 of charcoal and about 91.2% respondent to the source.

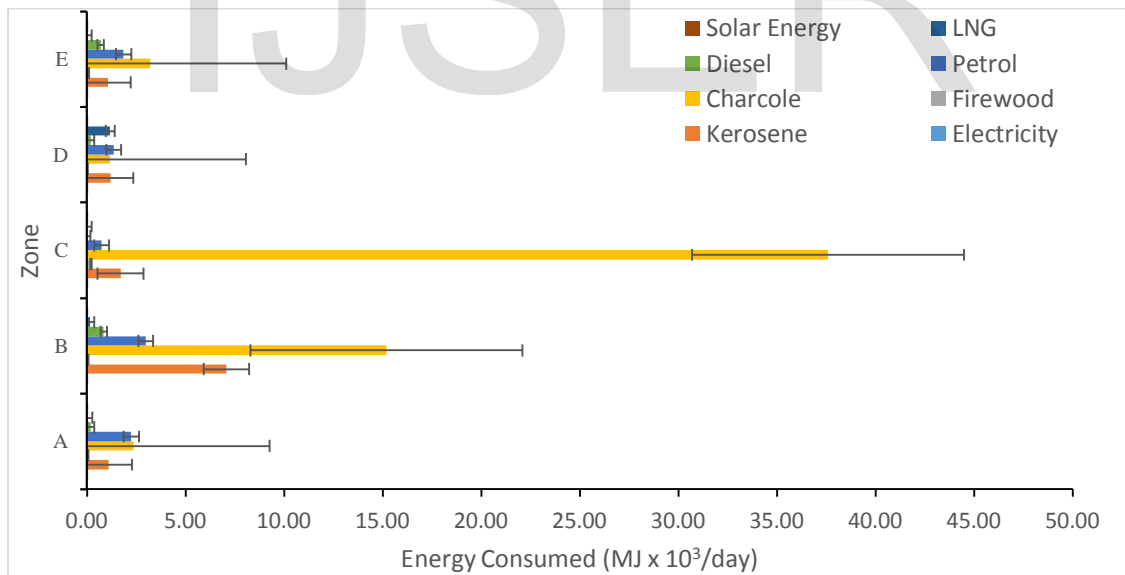


Figure 1: House hold energy consumed in Saki at various Zones

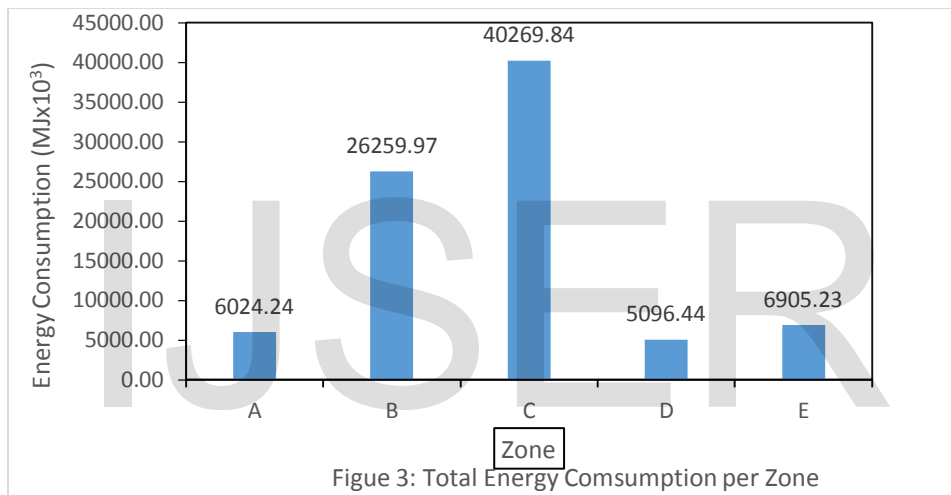
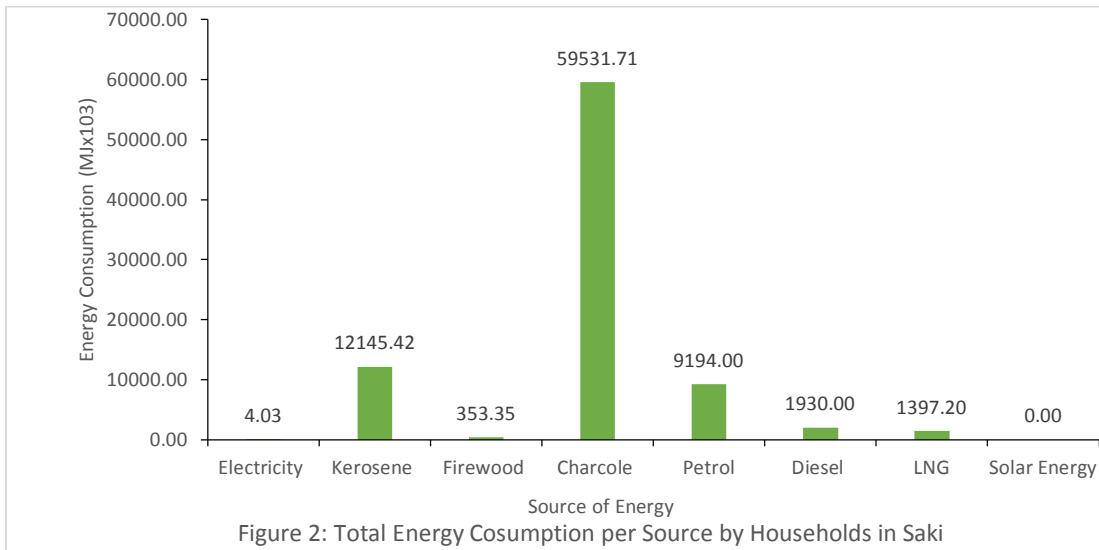


Table 3: Analysis by Percentage of each source in household energy consumption per zone per day

Zone	No of House	Electricity	Kerosene	Firewood	Charcoal	Petrol	Diesel	LNG(Kg)	Solar
A	33	0.0418	18.4267	0.8665	39.4308	37.2983	3.2195	0.7164	0.0000
B	47	0.0025	26.9329	0.0957	57.8140	11.3330	3.2506	0.5712	0.0000
C	24	0.0002	4.2514	0.5326	93.3675	1.8483	0.0000	0.0000	0.0000
D	27	0.0039	23.3491	0.0000	23.0623	26.7218	3.8006	23.0623	0.0000
E	51	0.0084	15.3458	0.8923	46.3061	26.9424	10.1164	0.3887	0.0000

Table 4: Percentage household energy consumption per day based on compound classification of the source

Source	Compound Classification (MJ/day)			
	Fossil	Bio Mass	Electricity	Solar
Total Energy	24674.12	59869.07	4.03	0
Percentage Energy	29.184	70.811	0.005	0

This is very dangerous to the climate of Saki because of the deforestation the result in future can be reflected in: Desertification, Rise in temperature of the region, Increase in wind speed which can cause damage to houses and properties of the people in the town. As a result of reduction in transformation the rainfall of the area will be

reduce. The smoke of the fuel wood causes atmospheric pollution. When the fertilities the land has lost, it leads to food shortage. The analysis shows that the people

preferred to use charcoal because of its availability and its cost compare to the heat it liberate (at Saki 45kg cost N1000.00) charcoal is used for cooking and heating at Saki.

Table 5: Percentage household energy consumed per house per source

Energy Source	Electricity	Kerosene	Firewood	Charcoal	Petrol	Diesel	LNG	Solar
Percentage Energy %	0.0048	14.3652	0.4179	70.3935	10.8714	2.2946	1.6526	0.0000

#### 4 CONCLUSION

From the survey, data and its analysis the major source of house hold energy supply is from biomass (fuel wood and charcoal for cooking and heating). This is aided by others source. The least source of house hold energy supply in Saki is electricity source. This is due to the disappointment received from public electricity made 82% of house to generate fossil fuel for lighting and entertainment. The electricity bill distributed to the house hold in Saki was rated so high by the respondent because of its erratic supply and duration of supply which is the average of 12 day/month and 4hours per day. People are tired of power holding company of Nigeria electricity supply so they show indifferent to their bill. Households using liquefied Natural gas are few due to the low financial capacity and it cost. Finally, huge amount of house hold energy is from charcoal for cooking and heating Saki. Electricity is for entertainment and lighting some energy obtained from kerosene for lighting, heating and cooking, natural gas is for cooking and heating.

#### 5 RECOMMENDATIONS

As the capacity of national supply cannot satisfy the household energy requirement, people in Saki are now generating energy required by themselves from various sources using; solar devices, coal port, charcoal port, dust pot, gas cooker. It is therefore evident that Saki household has lost their trust in National electricity supply. The main supply of household energy is biomass. The following recommendation is made; The power supply per month should be improve and also it duration per day. The voltage of supply should be improved. Prepaid meter should be given to each house so that they can paid as they use. The prize of kerosene which (N130 per liter) and liquefied natural gas (N300 per kg) should be reduced, so that biomass source will be relieved. Natural gas should be made accessible for the house hold consumption in Saki. Law should be made against afforestation and environmental pollution. Solar energy for Saki household

should be encouraged because of it availability and it reliability due to high sun shine in Saki. Other sources should be improved.

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