

Cooking Fuel Cost Comparison and Preferences among Electricity Consumers In Nigeria

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Abstract This work investigates the electricity consumers' fuel preferences for cooking through online sharing of questionnaire. It also compared the cost of using three fuels for cooking through experimentation and created equations to serve as templates for cost comparison. These templates were used to compare cost of cooking fuels for selected States in Nigeria. The fuels considered are liquefied petroleum gas (LPG), kerosene and electricity. The results obtained from the analysis of the responses show that higher percentage of respondents prefers to use LPG for cooking because they feel it is cheap and readily available. Many of the respondents don't like to use electricity because it is considered to be expensive and not readily available. However, contrary to the believe by many respondents, the results of the experiments showed that electricity is the cheapest of all the three fuels considered and LPG is the most expensive for the location and time of study. The results comparing the pre and post economic reforms costs of the cooking fuels for selected States of the country are also presented.

Keywords: Cooking fuel; Respondents; Cost comparison; Questionnaire; Nigeria

I. Introduction

Cooking is an essential part of human existence and it has been in practice for ages. It is the art of using heat energy to prepare food for human or animal consumption. Sometimes, cooking makes food edible for eating and also enhances the taste. Heat energy comes from various sources such as biomass (firewood, crop waste and dung), kerosene, charcoal, biogas, liquefied petroleum gas (LPG), electricity and so on. Biomass and charcoal are mostly used in villages while a blend of other fuels are found in households in urban centers. Each of these

sources has various contributions to air pollution in the home which may have adverse effect on human health. However, some are cleaner than others. Biomass and charcoal are the dirtiest as they were reported to be associated with the deterioration of human health due to excessive exposure to indoor pollution [1],[2]. The carbon emission from the use of kerosene is higher than that of LPG, but the use of electricity for cooking comes with no carbon emission at the point of use [2]. Most of the health challenges from the emissions usually affect organs associated with respiration [3]. It was also reported that the use of cooking fuels with excessive emission causes eye diseases like cataract, blindness and conjunctivitis [1]. Despite the reported environmental friendliness (as a result of zero emission) associated with the use of electricity for cooking, in Nigeria, electricity consumers generally believe that it is more

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expensive to use it for cooking [4],[5]. As a result of this, many of them avoid its usage and opt for LPG or kerosene. It won't be a surprise to even find out that, those who use it for cooking are using it for free by bypassing their energy meter or they are on estimated billing system [4]. The question that now arises from this development is that, is electricity the most expensive, despite being a very clean source of cooking? It is a known fact that availability of electricity in the country is epileptic and this, among other factors can influence consumers' choice.

Several works have studied cooking fuel preferences and/or cost comparison of cooking fuels used in different countries in the past. [6] and [7] worked on rural Indian households, [8] worked on rural and urban settlements in Burundi, [5] worked on rural and urban Tanzania, [9] worked on Nyeri County, Kenya, [10] worked on households in Ghana. [11],[12] [1],[2],[13],[14] respectively, reported for households in Abuja, Ondo, Lagos, Zaria, Ekiti and Enugu, Nigeria. In majority of the works available in open literature for the subject matter in Nigeria, residents' cooking preferences (based on various factors) were investigated using questionnaires. One of the reported factors that contribute to individual preference is the cost of cooking fuel. Studies only reported the believes of the respondents without necessarily confirming if the claims are right or not. For example, the authors in the work of [1] reported that Over 90% of non-LPG users were willing to switch to LPG but cited safety issues and high cost as potential barriers to switching. The authors also reported that, among those who switched from LPG to kerosene, cost of LPG was the reason most of them gave for switching while some of those who switched to kerosene from electricity cited cost of electricity as their reason for switching.

The objectives of this work are to investigate electricity consumers' fuel preference for cooking based on availability, hazard it poses and cost; compare the cost of using the fuels for cooking through experimentation to know if consumers' notions on cost are correct or not, create equations to serve as template for cost comparison and apply such template to compare cost of cooking fuels for selected States of the country. The fuels under investigation are LPG, kerosene and electricity.

To investigate consumers' preference, a structured questionnaire was developed. The questions are mainly targeted at knowing reasons behind consumers choice of cooking fuel and specifically knowing why electricity is not been used by those who don't use it. The prices of the fuels used for this study were gotten from the data released by National Bureau of Statistics (NBS) and Nigerian Electricity Regulatory Commission (NERC). Prices of cooking fuels (electricity inclusive) have recently been on the rise due to high level of inflation in Nigeria.

II. Materials and Method

The materials used for this study include kerosene, liquefied petroleum gas (LPG), and electricity as cooking fuels, along with a Newcastle gas stove, a Wheel brand kerosene stove, and a Master Chef Crown Star electric hot plate (MC-HP2001). Additional equipment includes a cooking pot, 4 liters of water, a digital weighing scale, an infrared laser thermometer, and a stopwatch. The selected cooking appliances represent commonly used models available in local markets, ensuring relevance to real-world consumer choices.

To assess consumer fuel preferences, a structured questionnaire was developed and administered via Google Forms. The

questionnaire comprised nine targeted questions aimed at understanding factors influencing cooking fuel selection, particularly focusing on reluctance to use electricity. The survey was distributed among staff members of Osun State University, Osogbo, Nigeria, through social media platforms. This demographic was selected due to their potential exposure to multiple cooking fuel options.

Quantitative analysis of survey responses was conducted using MATLAB 2018a, chosen for its efficiency in handling matrix-based operations. Responses were numerically encoded, arranged into structured arrays, and processed using MATLAB scripts. Each participant's responses were mapped to corresponding columns, with answer choices assigned numerical values (e.g., 1, 2, 3, 4) to facilitate computation. Sample responses and their coded representations are presented in Tables 1 and 2. The dataset was then used as input for statistical analysis.

Given the significant role of cost in cooking fuel selection, controlled experiments were conducted to measure the consumption rates of LPG, kerosene, and electricity during cooking. The cost of using each fuel was determined, and mathematical models were developed for cost comparisons across different locations in Nigeria. Fuel prices fluctuate over time, and for this study, the average retail prices at the time of survey administration were: LPG at ₦318.82/kg (₦3,985.15 per 12.5 kg), electricity at ₦26.22/kWh (including 5% VAT), and kerosene at ₦1,085.22 per gallon (₦241.16 per liter). These values were sourced from the National Bureau of Statistics (NBS) and the Nigerian Electricity Regulatory Commission (NERC) [15], [16], [17]. It is important to note that the gallon used in this study is equivalent to 4.5 liters [16].

The experimental procedure involved heating a fixed quantity of water (4 liters) using each cooking fuel type, with measurements taken to determine fuel consumption and efficiency. The initial and final weights of the fuels were recorded using a digital weighing scale, while an infrared laser thermometer monitored temperature changes. A stopwatch was used to measure cooking duration. The appliances were tested under similar environmental conditions to minimize external variability. The results obtained provided insights into the cost-effectiveness and efficiency of each fuel type.

A. Evaluating LPG Usage

The steps taken for the evaluation of LPG usage are shown in Figure 1.

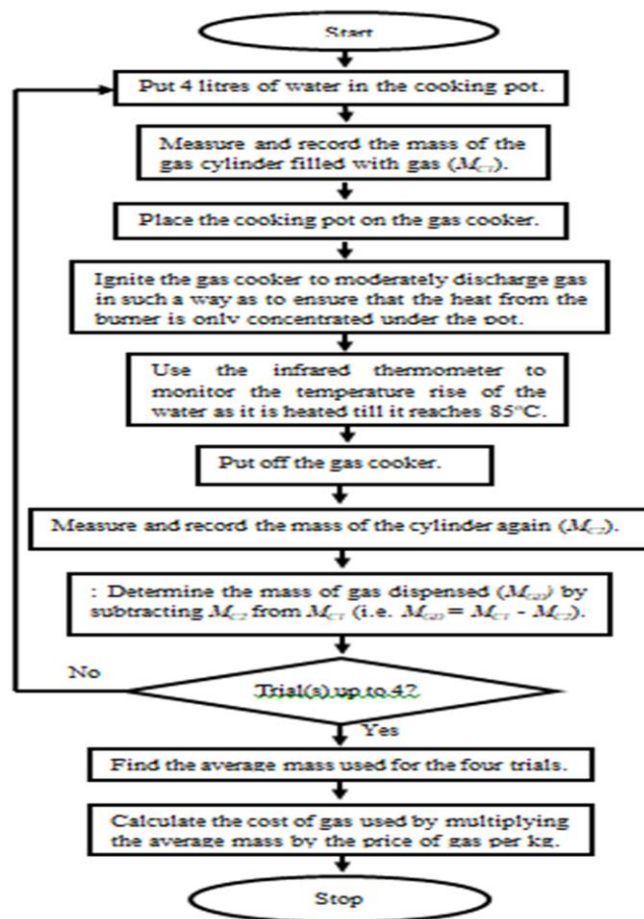


Figure 1: Procedure for Evaluating LPG Usage

Table 1: Sample Responses as Downloaded From Google Form

Questions	Which distribution company supplies you with electricity?	Do you have energy meter?	What type of meter do you use?	If on postpaid meter, what type of bill do you get?	How often do you have electricity supply daily?	What is/are your major cooking fuel?	What is your most commonly used cooking fuel?	Main reasons for your choice?	If you DON'T use electricity for cooking, why?
Respondent 1	Ibadan Electricity Distribution Company	Yes	Digital prepaid	N/A I am on prepaid	12-18 hours	Gas and Electricity	Gas	It is readily available It is the cheapest, least hazardous and readily available	It is not always available
Respondent 2	Ibadan Electricity Distribution Company	Yes	Analogue postpaid	Metered bill	0-6 hours	Gas only	Gas	It is the cheapest and readily available	It is not always available
Respondent 3	Ibadan Electricity Distribution Company	Yes	Digital prepaid	N/A I am on prepaid	0-6 hours	Gas only	Gas	It is the cheapest and readily available	It is expensive
Respondent 4	Ibadan Electricity Distribution Company	Yes	Digital postpaid	Metered bill	6-12 hours	Gas only	Gas	It is readily available	It is not always available
Respondent 5	Ibadan Electricity Distribution Company	Yes	Digital prepaid	N/A I am on prepaid	6-12 hours	Gas and Electricity	Gas	It is readily available	It is not always available

Table 2: Sample Coded Responses for Analysis

Questions	Which distribution company supplies you with electricity?	Do you have energy meter?	What type of meter do you use?	If on postpaid meter, what type of bill do you get?	How often do you have electricity supply daily?	What is/are your major cooking fuel?	What is your most commonly used cooking fuel?	Main reasons for your choice?	If you DON'T use electricity for cooking, why?
Respondent 1	1	1	3	4	3	4	2	3	4
Respondent 2	1	1	1	1	1	2	2	7	4
Respondent 3	1	1	3	4	1	2	2	5	1
Respondent 4	1	1	2	1	2	2	2	3	4
Respondent 5	1	1	3	4	2	4	2	3	4

B. Evaluating Kerosene Usage

The steps taken for the evaluation of kerosene usage are as highlighted in Figure 2. Equation (1) was used to convert mass of kerosene to volume in liters. The density of kerosene was determined using a density bottle.

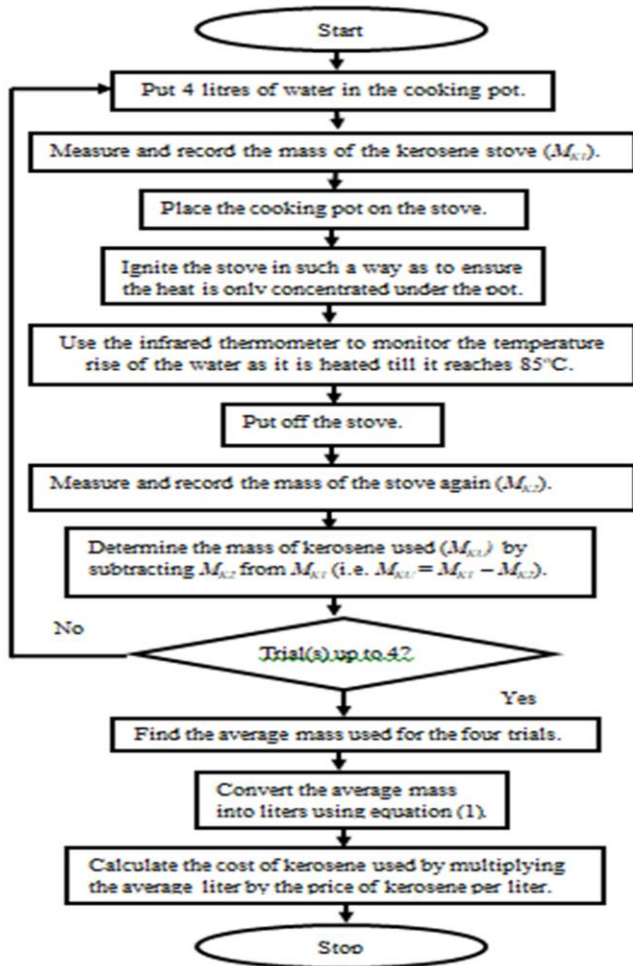


Figure 2: Procedure for Evaluating Kerosene Usage

$$\text{Volume of kerosine} = \left(\frac{\text{mass of krosine}}{\text{density of kerosine}} \right) \times 1000 \quad (1)$$

C. Evaluating Electricity Usage

The steps taken for the evaluation of electricity are as stated in Figure 3.

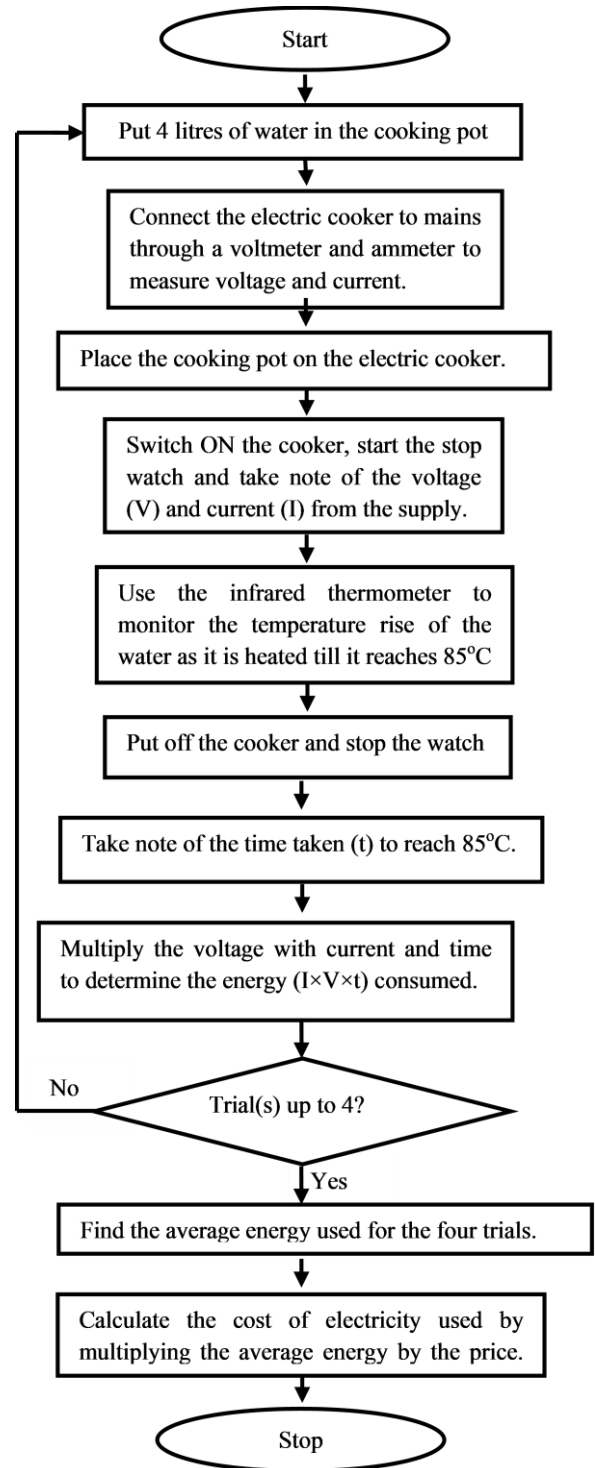


Figure 3: Procedure for Evaluating Electricity Usage

III. Results and Discussion

This section presents the results from the analysis of the responses to the questionnaire

and experiments conducted to determine the consumption of various fuels for cooking.

A. Results from Analysis of Questionnaire

As stated earlier, the questionnaire in Google form format was administered through online means. Responses were harnessed through Google generated excel file and analyzed with MATLAB 2018a program codes. 79 responses were available for analysis despite sharing the forms on various platforms. . It is important to note that response rate to online survey in this part of the world is low, hence the few responses recorded [18] [19] [20]. Out of these respondents, 78 customers are supplied by Ibadan Electricity Distribution Company (IBEDC) while the remaining one is supplied by Benin Electricity Distribution Company (BEDC). Respondents' distribution company (DISCO) is needed to know their energy cost. Out of all respondents, 69 (87.34%) has meter while 10 (12.66%) don't have. Out of the 69 respondents with meter, 7, 8 and 54 respondents, respectively, have analog post paid (APP), digital postpaid (DPP) and digital prepaid (DPRP) type of meters. These, respectively, represent 9%, 10% and 68% of the respondents as shown in Figure 4

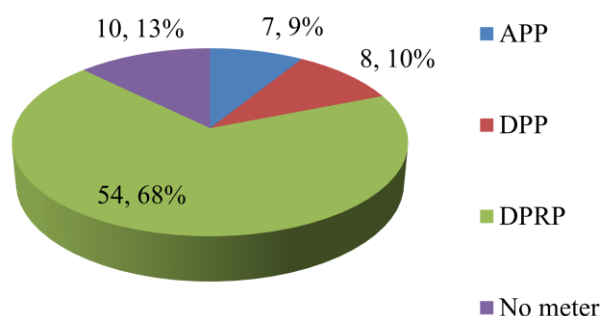


Figure 4: Frequency of Type of Meter Used by Respondents

In Nigeria, having an APP or DPP doesn't guarantee being given a metered bill. The only sets of customers that are sure of paying for the energy they use (if energy is not stolen) are those with DPRP meter and they are not given bill as they pay for electricity before usage. Figure 5 shows the number of respondents that are on postpaid billing system. These respondents are either issued metered bill (MB) or estimated bill (EB) and since customers on DPRP meter are not issued bill, they constitute respondents with

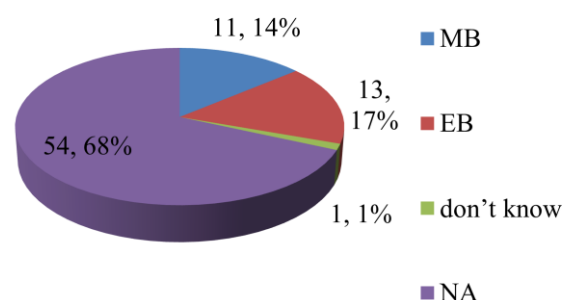


Figure 5: Frequency of Respondents' Postpaid Billing System

not applicable (NA) responses. EB is the type of energy bill given to electricity consumers based on the utility's estimation and not consumer's actual energy usage. This type of bill is supposed to be given to those without meter only but in Figure 4, there are 10 respondents without meter, but 13 people are on estimated billing system (see Figure 5). So, three respondents are wrongly given EB. The knowledge about respondents' billing system is necessary to know if they pay for actual electricity usage or not. A consumer that is not metered or metered, but on EB can afford to use electricity recklessly when compared to a metered consumer. In other to know the availability of electricity to the respondents, their hours of electricity supply

were inquired. Figure 6 shows the respondents' hours of electricity supply. Majority of the respondents are supplied for 6 to 12 hours while few are supplied for 18 to 24 hours. This is expected as electricity supply in Nigeria is epileptic.

There are three basic types of fuel popular with the average class living in urban areas in Nigeria. These are electricity, gas and kerosene. Figure 7 shows the distribution of the type of fuels being

used by the respondents while Figure 8 shows the fuel they commonly use. It is obvious from Figure 7 that 35, 30, 1 and 6 respondents, respectively, use gas only, gas and electricity, kerosene and electricity, gas and kerosene. Seven respondents use all the types of fuel. Nobody uses electricity or kerosene only. From Figure 8, 11% and 89% of respondents, respectively, commonly use electricity and gas for cooking. Table 3 shows the reasons for respondents' choices for the commonly used fuel. It can be

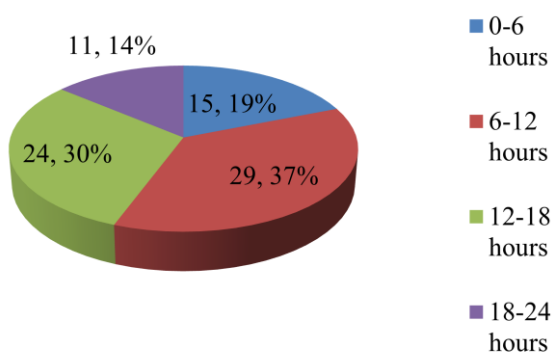


Figure 6: Frequency of Respondents' Period of Electricity Supply

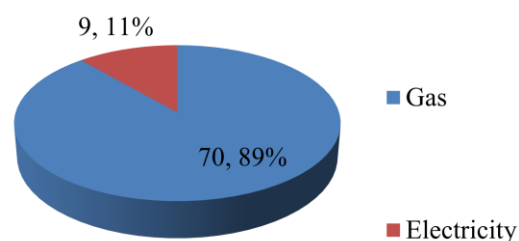


Figure 8: Frequency of Respondents Commonly Used Cooking Fuel

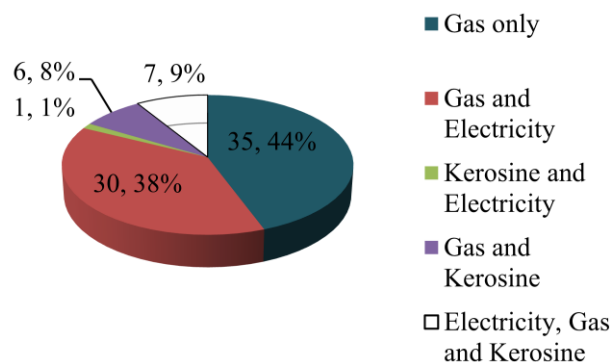


Figure 7: Frequency of respondents cooking fuel choices

Table 3: Frequency of Respondents' Reason for Adopting their Common Cooking Gas

S/No	Reason	Frequency	
		LPG	Electricity
1	Cheapness	6	1
2	Least hazardous	0	0
3	Readily available	27	1
4	Cheap and least hazardous	1	2
5	Cheap and readily available	25	2
6	Least hazardous and readily available	1	1
7	Cheap, least hazardous and readily available	10	2
Total		70	9

inferred that cost and availability are the main reasons for the selection of LPG by most respondents. It is generally believed that LPG is the cheapest and the most readily available. It is a known fact that LPG is readily available when compared to electricity, but is gas cheaper than electricity for cooking? This question will be answered with the outcome of the second phase of this research.

Availability of electricity is part of the factors that determine if an electricity consumer will use electricity for cooking. Table 4 shows the number of electricity consumers that consider the usage of electricity for cooking based on their hours of supply. Out of 15, 29, 24 and 11 respondents (presented in Figure 6) that are, respectively, on 0-6, 6-12, 12-18 and 18-24 hours of supply, 1, 17, 15 and 4 of them, respectively, consider electricity for cooking. Though, it is expected that those with 12 hours and above supply should use electricity, however, those that do not use it may consider it to be expensive.

Table 4: Frequency of Respondents' Electricity Usage for Cooking Based on Daily Hour of Supply

Hours of supply	No of respondent	Number of users	Percentage %
0-6	15	1	7
6-12	29	17	59
12-18	24	15	63
18-24	11	4	36

Type of bill given to consumers is also a factor that determines if an electricity consumer will use electricity for cooking or not. Customers on EB can use electricity without caution. Table 5 shows the number of electricity consumers that consider the usage of electricity for cooking based on the type of billing. Out of 11, 13 and 54 respondents that are respectively on metered,

estimated and prepaid billing systems, 5, 9 and 23 of them, respectively, consider electricity for cooking. As expected, higher percentage of those on EB system uses electricity for cooking, since their billing doesn't depend on usage [4]. However, the few who do not consider electricity are likely not to be supplied electricity regularly. It is also clear that most consumers on

Table 5: Frequency of Respondents' Electricity Usage for Cooking Based on Type of Meter

Billing system	No of respondent	Number of users	Percentage %
MB	11	5	45
EB	13	9	69
DK	1	1	100
PP	54	23	43

MB and prepaid (PP) system don't see electricity usage as an option as they may see it as expensive. It may even be possible that some of those who use it for cooking bypassed the meter to steal energy.

The reason why respondents refuse to use electricity was asked and frequencies of responses are given in Figure 9. As expected the unavailability of power supply was a major reason for not using electricity as 41 respondents mentioned unavailability as one or more reasons for not using the fuel while 41 respondents also said its expensiveness is one or more reasons that have prevented them from its usage. Nine respondents claim that its hazardous nature is one or more reasons for not using it

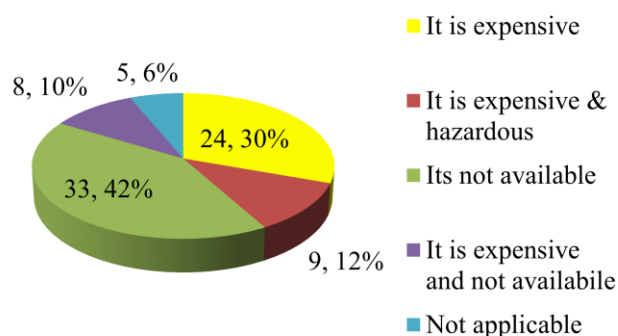


Figure 9: Frequency for Reasons for not Adopting Electricity for Cooking

B. Experimental Analysis of Different Fuel Consumption

The mass of the cylinder with LPG was measured as 7.90 kg. After heating the 4 liters of water to 85°C for the first experiment, the mass of the cylinder reduced to 7.85 kg signaling a decrease of 0.05 kg. The results for the four trials are given in Table 6. The results from the table are an indication that the average mass used for the four trials was 0.05 kg. Since the price of gas was ₦318.81/kg, the cost of gas used was ₦15.94.

Table 6: Mass of Gas Used for Different Trials

Experiment trial	Mass of cylinder and gas kg	Difference kg
0	7.90	-
1	7.85	0.05
2	7.80	0.05
3	7.75	0.05
4	7.70	0.05

For the kerosene usage, the mass of the stove used for this test was measured as 2.15 kg. After kerosene was poured into it, the mass of both was recorded as 3.45 kg. After the first experiment trial, the mass of the stove with kerosene dropped by 0.05 kg to 3.40 kg. Results

of subsequent trials are shown in Table 7. From the table, the average mass used was 0.045 kg. The density of the kerosene used was calculated to be 820.1 kg/m³. Using Equation (1), the average volume of kerosene used was 0.0549 liter. Recall that the price of kerosene was ₦241.16/liter, hence, the cost of kerosene used was ₦13.24.

The ammeter and voltmeter confirmed the rating of the electric stove used to be approximately 1000 W. The first experiment trial took 29.28 mins for the 4 liter of water to be

Table 7: Mass of Kerosene Used for Different Trials

Experiment trial	Mass of stove and kerosene kg	Difference kg
0	3.45	-
1	3.40	0.05
2	3.36	0.04
3	3.32	0.04
4	3.27	0.05

heated to 85°C. Time taken for the remaining trials is shown in Table 8. The table also contains the energy consumed by the electric stove for the four trials. The average energy consumed was 0.497 kWh. Using an electricity price of ₦26.22/kWh, the cost of electric energy used was ₦13.03.

Table 8: Energy Consumed by Electric Stove for Different Trials

Experiment trial	Heating time min	Energy kWh
1	29.28	0.49
2	30.25	0.5
3	28.35	0.47
4	31.5	0.53

Unlike most responses that chose LPG as the cheapest, from the cost of the three fuels determined from the experiments carried out, it is obvious that electricity was the cheapest followed by kerosene and LPG was the most expensive. However, many respondents chose LPG ahead of kerosene (despite both being readily available), possibly due to environmental friendly nature of it. LPG is clearly cleaner than kerosene.

To project cooking fuel cost comparison for any location, Equations (2 to 4) can be used. These equations were inferred from the results of the experimental analysis carried out.

$$C_{LPG} = 0.05 \times C_{pkg} \quad (2)$$

$$C_{KERO} = 0.0549 \times C_{plt} \quad (3)$$

$$C_{ELECT} = 0.497 \times EP \quad (4)$$

where C_{LPG} , C_{KERO} and C_{ELECT} are, respectively, the cost of LPG, kerosene and electricity to heat water to 85°C.

C_{pkg} , C_{plt} and EP are, respectively, the cost per kg of LPG, cost per liter of kerosene and cost per kWh of electricity to heat water to 85°C.

C. Cost of Cooking Fuels in Some Selected States Pre and Post 2023 Economic Reforms

In 2023, the Federal Government carried out some economic reforms that affected the prices of LPG, kerosene and electricity (for some consumers). The reforms are the removal of electricity tariff subsidy for some consumers and floating of the naira against foreign currencies. The prices of LPG, kerosene and electricity moved respectively, from a National average price of ₦811.17 per kg, ₦780.50 per litre and ₦63.87 per kWh in November, 2022 to ₦1378.04 per kg, ₦1495.31 per litre and ₦225.21 per kWh in November, 2024. These account for 69.88%, 91.58% and 252.60%

increase in the prices of LPG, kerosene and electricity, respectively, for the period under consideration. The prices for LPG and kerosene are based on cost for 12.5 kg and gallon (4.5 liters), respectively [21],[22],[23],[24]. The prices for electricity are based on the multi-year tariff order (MYTO) released for years 2022 and 2024 [25] [26].

Using the developed equations (2 to 4) as template, comparisons of the costs of LPG, kerosene and electricity for cooking in some selected states before and after the reforms were carried out. The periods under study are November, 2022 and 2024. The states were selected on the basis that, each of the selected states must be supplied by one of the 11 DISCOS in the country. Table 9 shows the selected states and the DISCOS that supply them. Lagos is being supplied by two DISCOS: Ikeja Electricity Distribution Company (IKEDC) and Eko Electricity Distribution Company (EKEDC). Lagos-I and Lagos-E, respectively, represent Lagos State residents supplied by IKEDC and EKEDC. It is important to note that, band A tariff class was used for electricity usage as it was the only tariff class that was greatly affected by the reform. All other tariff classes are still averagely not too higher than the band A charges used for the 2022 analysis. For example, In November, 2024, the highest charges for band B customers in Osun and Yola were ₦75.69 and ₦74.06 per kWh, respectively while highest charges for band A customers in both States as at November, 2022 were ₦69.21 and ₦74.64 per kWh, respectively.

The comparisons of the costs of using the three cooking fuels pre and post 2023 economic reforms are shown in Figures 10 and 11. From Figure 10, it is clear that electricity is the

cheapest cooking fuel for all states selected in 2022. However, the cost of LPG is cheaper than kerosene in some states while it is otherwise in some other states. Unlike pre-reform prices in Figure 10, Figure 11 shows that electricity is the most expensive after the reform, while LPG is the cheapest in most States except Lagos where kerosene is slightly cheaper than LPG. However, for customers still using other tariff classes, electricity remains the cheapest means of cooking.

IV. Conclusion

This study investigated cooking fuel preferences among electricity consumers and compared the cost of three different fuels through experimentation. The fuels considered for the study are LPG, kerosene and electricity. Structured questionnaire was developed to investigate electricity consumers cooking fuel

Table 9: Selected States and their DISCOS

State	DISCOS
Osun	Ibadan Electricity Distribution Company (IBEDC)
Lagos-E	Eko Electricity Distribution PLC (EKEDC)
Lagos-I	Ikeja Electricity Distribution Company (IKEDC)
Delta	Benin Electricity Distribution Company (BEDC)
Enugu	Enugu Electricity Distribution Company (EEDC)
Kaduna	Kaduna Electricity Distribution Company (KAEDC)
Kano	Kano Electricity Distribution Company (KEDC)
Rivers	Port Harcourt Electricity Distribution Company (PHEDC)
Adamawa	Yola Electricity Distribution Company (YEDC)
Plateau	Jos Electricity Distribution Company (JEDC)
Abuja	Abuja Electricity Distribution Company (AEDC)

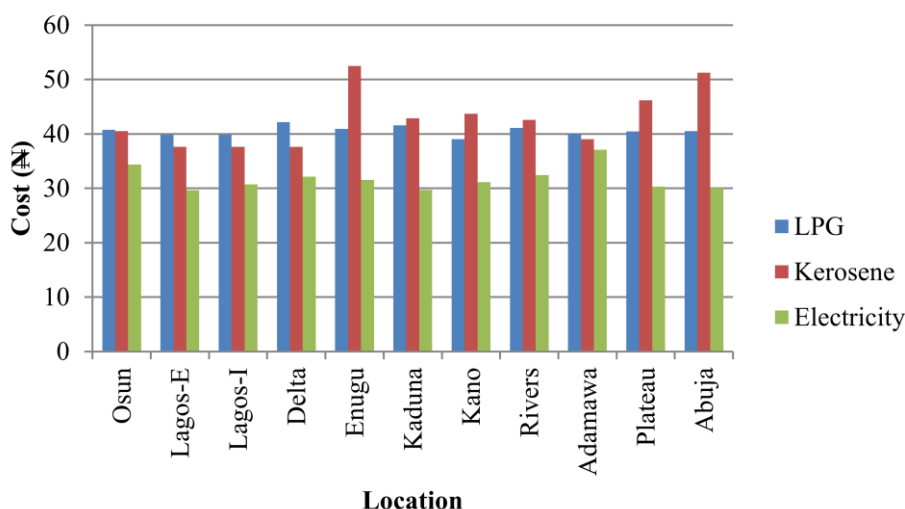


Figure 10: Pre-Economic Reform Cost Comparison for Three Cooking Fuels

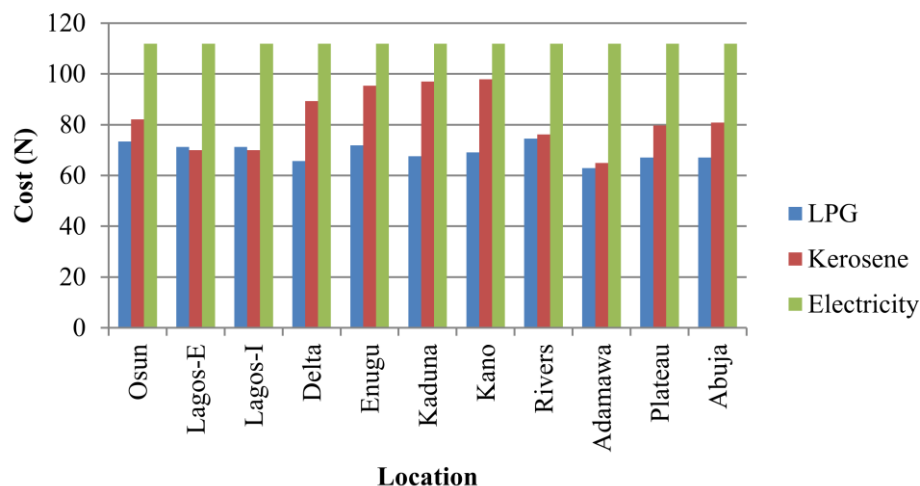


Figure 11: Post-Economic Reform Cost Comparison for Three Cooking Fuels

preferences vis-à-vis availability, hazard it poses and cost. Experiments were conducted to determine the quantity of fuel consumed to heat specific amount of water to 85°C. The determined amounts of fuels were used to calculate the costs of fuel consumption and these costs were compared. Three equations that served as templates for cost comparison were used to compare cooking fuels across selected States in Nigeria for November, 2022 and 2024. From the results obtained, it can be concluded that;

- i. Most electricity consumers use LPG, citing availability and cheap cost as reasons for their choice.
- ii. Many consumers abstain from using electricity because they believe it is expensive for cooking, despite being the cleanest of all fuels.
- iii. The experiments showed that, contrary to the believe of many respondents as at the time the questionnaires were administered, electricity is the cheapest, followed by kerosene and LPG is the most expensive in the location of study (Osun State).

- iv. In November, 2022 (i.e. pre-reform period), the developed templates showed that electricity was the cheapest across the selected States of the Federation. Kerosene is cheaper than LPG in some locations while reverse is the case in some other locations.
- v. In November, 2024 (i.e. post-reform period), the developed templates showed that electricity has become the most expensive for those in band A tariff class, but still cheapest for other tariff classes. For the band A customers, LPG is the cheapest across most States of the Federation.
- vi. It is worthy of note that equations (2 to 4) can be used to have a clue about the differences in cost of using the three fuels at any specific location and time.

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