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RESEARCH ARTICLE

Examining Cost as the Determinant of Household Energy Choices in Bauchi Metropolis, Nigeria

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ABSTRACT

Growing environmental degradation emanating from household micro-decisions requires deep insight. Thus, this study investigates the effect and perceived importance of cost on household energy choices in Bauchi Metropolis, Nigeria, over a decade (2015-2025). A cross-sectional survey of 348 household heads across high-, medium-, and low-density residential areas was conducted. Data were analyzed using Chi-square tests of independence to measure the statistical association between reported energy expenditure and primary fuel choice in 2015 and 2025. Descriptive statistics were used to analyze respondents' perceptions of the most important factor influencing their energy choice and their primary reason for switching fuels over the decade. A statistically significant association between cost and energy choice was found in both 2015 ($\chi^2 = 22.619$, $p = .031$) and 2025 ($\chi^2 = 33.420$, $p < .001$), with the strength of the relationship intensifying over time. The intensifying association over the decade coincides with broader economic forces, such as rising inflation and subsidy removals. When asked directly, 37.93% of respondents identified cost as the single most important factor influencing their current energy choice, surpassing convenience (26.72%) and availability (16.38%). Furthermore, 56.90% cited cost as the primary reason for changing their primary energy source over the past ten years. The findings confirm cost as the central and strengthening driver of household energy decisions in this urban Nigerian context. The study therefore recommends that, to reduce pressure on environmental resources and deforestation, minimize air pollution, and ensure effective energy transition, all policy interventions must prioritize the economic affordability of energy in households.

Keywords: *Fuel Choice; Cost; Energy Transition, Environment; Household*

1. INTRODUCTION

Household energy choices have direct environmental and health consequences. In Nigeria, for instance, over 60 million people who are multidimensionally poor cook with animal dung, fuelwood, or charcoal; this accounts for about 22% of emissions of pollutants into the Earth's atmosphere attributed to household energy usage in the country (Dioha, 2022; National Bureau of Statistics, 2022). The household energy needs of the rural and urban poor population created a growing trade in firewood and charcoal in many parts of Nigeria, thus encouraging deforestation (Tukur, 2015). In addition to deforestation, household air pollution from the incomplete combustion of solid fuels is linked to approximately 2.9 million premature deaths annually worldwide, with women and children, who are most often responsible for cooking, bearing the bulk of this burden (World Health Organization, 2025).

Despite the prevalence of these problems, access to environmentally clean and affordable household energy is still one of the major challenges of sustainable development, yet remains unsolved among developing countries. More than 2 billion people around the world still lack access to clean cooking facilities and rely on solid biomass or coal as their primary cooking fuel, with sub-Saharan Africa accounting for roughly half of this gap and around 960 million people without access in 2023 (International Energy Agency [IEA], 2024).

In order to encourage the transition to cleaner energy, Nigeria as a nation has demonstrated marked policy commitment and efforts to improve household energy access over the years (Animashaun et al., 2025). Public policies in Nigeria such as the Energy Transition Plan (ETP) and the Electricity Act of 2023 set ambitious goals of increasing universal electricity access by 2030 and net-zero emissions by 2060 (Animashaun et al., 2025). How household micro-decisions on energy choices and associated factors stand in relation to the achievement of these national goals requires deeper insight, especially in a secondary city like Bauchi metropolis in north-eastern Nigeria.

The 'energy ladder theory' has stood firmly in the past as a framework for understanding how household energy transitions occur. It posits that as household incomes rise, families linearly substitute traditional, highly polluting solid fuels (e.g., firewood) with transitional options (e.g., kerosene, charcoal) and ultimately transition to modern, clean alternatives (e.g., liquefied petroleum gas [LPG], electricity) (Oyeniran & Isola, 2023). However, existing energy literature has challenged this linear progression, as argued by the 'Fuel Stacking model', where households consume multiple fuels simultaneously to balance price, reliability, and cultural preferences (Manyo et al., 2021). In Nigeria, macroeconomic instability, hyperinflation, and structural adjustments have further distorted these dynamics, calling for further inquiry, especially on household economic proxies (residential class) and temporal basis (Somorin et al., 2017).

The period 2015 to 2025 in Nigeria is marked by unstable prevailing economic conditions and public policies with direct implications on household income and consequently energy dynamics. Among public policies to note are currency devaluation and the removal of fuel subsidies that have led to dramatic fluctuations in the prices of both traditional and modern energy sources (NBS, 2023; Ogbuabor et al., 2021). This macroeconomic reality makes the investigation of household energy cost dynamics an urgent policy imperative. Existing studies on Nigerian household energy have often focused on broad national patterns or specific megacities like Lagos (Akpan et al., 2020; Ozughalu & Ogwumike, 2019). Secondary cities like Bauchi Metropolis, which exhibit distinct socio-spatial stratification and economic profiles, remain underrepresented in the literature (Bala, 2021).

Few studies employ a longitudinal perspective to examine how the relationship between cost and fuel choice has changed amidst a decade of significant economic and policy shifts. Even though the role of cost is frequently cited as paramount in

the literature, the relative weight and evolving influence of cost over time are not fully understood in specific urban contexts among other determinants, such as availability, convenience, cultural preferences, and health awareness (Lewis & Pattanayak, 2012; Puzzolo et al., 2016). Furthermore,

In order to fill these gaps in research, the study seeks to determine the effect of cost on household energy choices in Bauchi metropolis, northeast Nigeria. The study tested the null hypothesis that 'no statistically significant association exists between cost and fuel choice in the study area for the decade of study'. It also focuses on providing answers to two research questions; they include: 'Has the statistical relationship between household energy expenditure and primary fuel choice strengthened over the past decade (2015-2025)?' and 'How do households themselves perceive the importance of cost relative to other factors in their energy decision-making and fuel-switching behaviour?' By providing answers to these questions, the study provides a critical, evidence-based insight for designing effective, targeted, and equitable energy transition policies in Nigeria and similar urban contexts.

2. MATERIALS AND METHODS

The Study Area

The study was conducted in Bauchi Metropolis, the capital of Bauchi State in north-eastern Nigeria. Bauchi Metropolis lies between latitude 9.8050˚N and 10.5502˚N and longitude 9.5940 ˚E – 10.2830 ˚E and covers an estimated landmass of 3,687 km2, as seen in Figure 1, as follows (Bauchi State Government, 2019). Bauchi Metropolis has an estimated population of 723,806 (World Population Review, 2025).

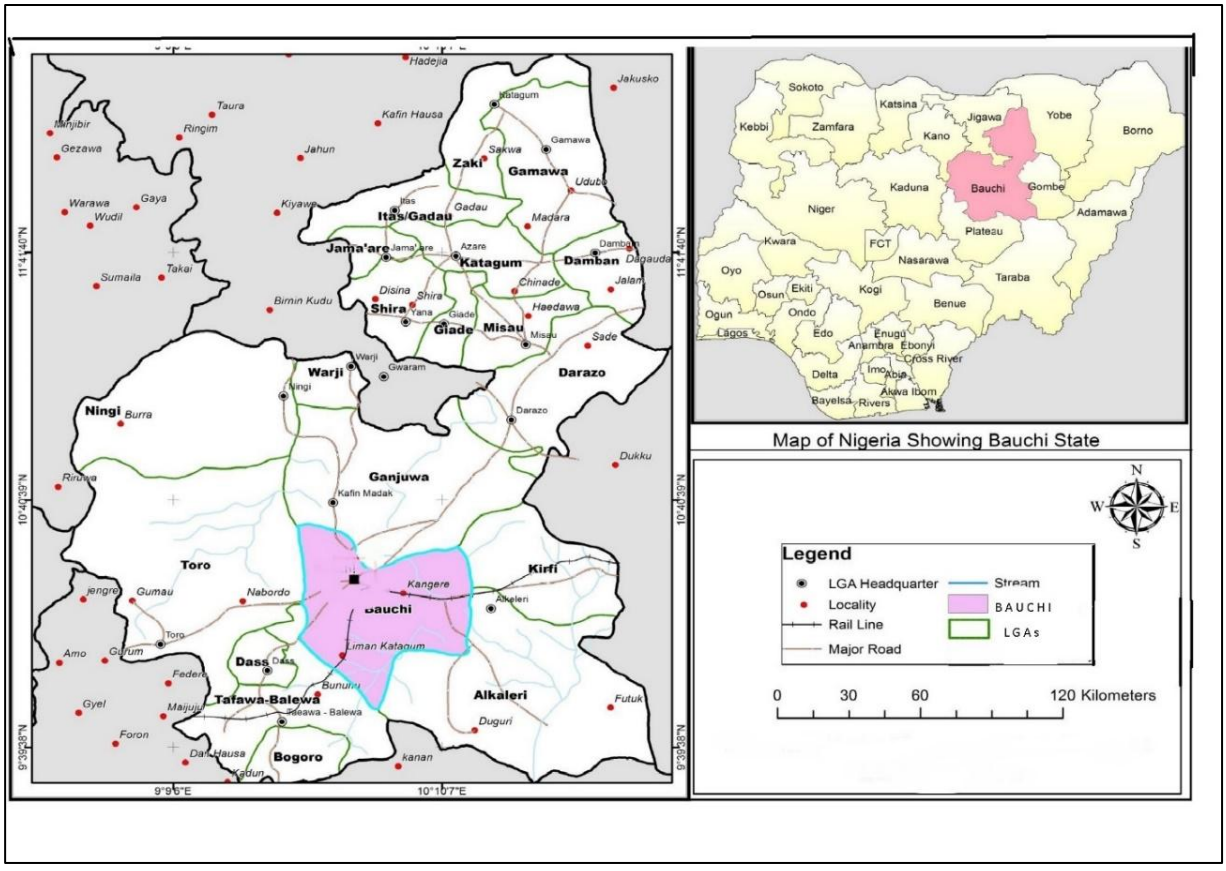

Figure 1. Bauchi Metropolis; the study area (Source: Bauchi State Government, 2019)

The city exhibits clear residential stratification into high, medium, and low-density neighborhoods. The low-density neighborhood includes Fadaman Mada, old and new GRA; the medium-density neighborhood, on the other hand, includes Dan-Iya, Makama, Yelwa, and Ibrahim Bako; while the high-density areas include Dan-Amar, Dan-Kade, and Dawaki, which serve as reliable proxies for socioeconomic status, with low-density areas typically housing more affluent populations (Victor et al., 2019). This spatial diversity makes it an ideal laboratory for studying how cost constraints manifest across different income groups.

Research Design and Sampling

A cross-sectional survey design was employed, utilizing a multi-stage stratified sampling technique. The metropolis was first stratified into the three residential density classes. Using Cochran's (1977) formula with a 95% confidence level and 5% margin of error, a minimum sample size of 384 was calculated from an estimated 172,863 households. Proportional allocation yielded targets of 160, 128, and 96 households for high, medium, and low-density areas, respectively. Trained enumerators administered questionnaires to household heads randomly in each residential class, resulting in 348 valid responses after data cleaning (High: 147, Medium: 115, Low: 86). The shortfall in sample size occurred due to data cleaning, in which invalid and inconsistent responses were discarded; since about a 91% response rate was attained, the researchers adopted 348 valid responses for analysis.

Technique for Data Collection and Analysis

A structured questionnaire was used to collect retrospective and current data on Primary Energy Choice (2015 & 2025), that is, Firewood, Charcoal, Kerosene, Cooking Gas (LPG), and Electricity, while monthly energy expenditure (2015 & 2025) was measured in brackets: <₦2,000; ₦2,000-₦5,000; ₦5,000-₦10,000; >₦10,000. Data on the perceived most important factor for major energy choices, such as Price/Cost, Convenience, Availability, Health & Safety, Environmental Impact, and Culture, were also collected. The primary reason for changing fuel between 2015 and 2025, such as Cost, Availability, Government Policy, Health & Safety Concerns, Environmental Awareness, and Cultural Orientation, was also collected.

The generated data were analyzed using IBM SPSS Statistics 21. Descriptive statistics (frequencies and percentages) were used to analyze the distribution of responses with regard to the chosen household energy option, perceived importance of cost from the respondents' perspective, and the major factor for change in energy option over time. The effect of cost on choice, on the other hand, was assessed inferentially using Pearson's Chi-square test of independence to examine the association between energy expenditure brackets and primary fuel categories for 2015 and 2025 separately. The strength and significance of the association were compared across the two periods to gauge temporal change.

3. RESULTS AND DISCUSSION

To explain the pattern in household energy choice by residential class in the study area over the decade of interest, Table 1 as follows shows the distribution of responses regarding the major household energy source adopted.

Table 1. Major Household Energy Choice by Residential Class and Period

Year	Options	High Density		Low Density		Medium Density		Total	
		F	%	F	%	F	%	F	%
2015	Charcoal	22	38.60	17	29.82	18	31.58	57	16.38
	Cooking Gas	28	35.90	24	30.77	26	33.33	78	22.41
	Electricity	8	53.33	5	33.33	2	13.33	15	4.31
	Firewood	61	42.36	35	24.31	48	33.33	144	41.38
	Kerosene	28	51.85	5	9.26	21	38.89	54	15.52
2025	Charcoal	50	55.56	18	20.00	22	24.44	90	25.86
	Cooking Gas	32	21.33	53	35.33	65	43.33	150	43.10
	Electricity	8	33.33	10	41.67	6	25.00	24	6.90
	Firewood	55	67.90	4	4.94	22	27.16	81	23.28
	Kerosene	2	66.67	1	33.33	0	0.00	3	0.86

The data in Table 1 show a clear shift in household energy use in Bauchi Metropolis between 2015 and 2025. Overall, Table 1 reveals that households moved away from traditional and transitional fuels toward cleaner options. As shown in Table 1, households using firewood dropped from 41.38% in 2015 to 23.28% in 2025, while kerosene use was significantly phased out, falling from 15.52% to just 0.86%. Table 1 further reveals that cooking gas became the dominant fuel, rising from 22.41% to 43.10%. Electricity and charcoal use also increased, from 4.31% to 6.90% and from 16.38% to 25.86%, respectively. Based on Table 1, the transition in fuel use was not uniform across residential classes. In low-density and medium-density areas, the shift to modern fuels was strongest. Low-density households recorded the biggest drop in firewood use, from 24.31% to 4.94%, and the highest uptake of electricity, rising to 41.67% in 2025. Medium-density areas led in cooking gas adoption, increasing from 33.33% to 43.33%. On the contrary, the pattern in high-density areas shows that instead of moving up the energy ladder, many households moved back to cheaper fuels. Firewood use in high-density areas moved from 42.36% to 67.90%, and likewise, charcoal use rose from 38.60% to 55.56%. Table 1 further shows that cooking gas use in high-density areas dropped from 35.90% to 21.33%.

The near stoppage in the use of kerosene, as shown in Table 1, is consistent with real-life situations in many homes and aligns well with the trajectory predicted by the literature once kerosene subsidies erode (Ozoh et al. 2018). In regard to charcoal, the study findings fit more with "fuel stacking"/economic-shock literature: wealthier households appear to be partially reverting to, or supplementing with, charcoal, plausibly because LPG price shocks following the 2023 subsidy removal affected all income groups, not just the poor (Afrobarometer, 2025; ODI, 2024). Because charcoal and firewood use did not decline monotonically across all residential classes, and even rose in absolute terms in the wealthier economic class, deforestation pressure linked to household energy in Bauchi cannot be treated as a poverty-only problem.

To understand patterns in household energy expenditure (cost) in the study area, Table 2 shows the distribution of responses;

Table 2. Household Estimated Monthly Cost of Energy by Residential Class and Period

Year	Options	High Density		Medium Density		Low Density		Total	
		F	%	F	%	F	%	F	%
2015	<N2000	25	17.01	29	25.22	9	10.47	63	18.10
	N2000-N5000	47	31.97	45	39.13	37	43.02	129	37.07
	N5000-10000	37	25.17	28	24.35	34	39.53	99	28.45
	>N10000	38	25.85	13	11.30	6	6.98	57	16.38
	Total	147	100	115	100	86	100	348	100
2025	<N2000	3	2.04	3	2.61	0	0.00	6	1.72
	N2000-N5000	14	9.52	13	11.30	12	13.95	39	11.21
	N5000-10000	41	27.89	34	29.57	15	17.44	90	25.86
	>N10000	89	60.54	65	56.52	59	68.60	213	61.21
	Total	147	100	115	100	86	100	348	100

Table 2 shows that the estimated monthly cost of energy for households in Bauchi Metropolis increased sharply between 2015 and 2025. Overall, the proportion of households spending less than N5,000 per month fell from 55.17% in 2015 to 12.93% in 2025. Furthermore, the share of households spending more than N10,000 rose dramatically from 16.38% to 61.21%. This indicates that energy has become substantially more expensive for the average household over the decade. There is also an observed increase in energy cost between 2015 and 2025 across all residential classes, as shown in Table 2, but the pattern differs. In high-density areas, Table 2 shows that the majority of households moved from the N2,000-N5,000 band in 2015 (31.97%) to the >N10,000 band in 2025 (60.54%). Medium-density households showed a similar shift, with 56.52% now spending above N10,000, up from 11.30% in 2015. Low-density households recorded the highest jump, with 68.60% in the >N10,000 category in 2025, up from just 6.98% in 2015. These findings suggest that the macroeconomic shocks of the past decade, including fuel subsidy removal and currency devaluation, have significantly raised the cost of both traditional and modern energy sources. Secondly, the rising cost burden helps explain the fuel choices observed in Table 1. When Table 2 is observed side-by-side with Table 1, the study reveals that low- and medium-density households absorbed the higher costs by shifting to LPG and electricity, while high-density households, despite reverting to firewood and charcoal, still ended up in higher spending categories. This points to a situation of energy poverty where households pay more but have limited access to cleaner and more efficient fuels. Overall, the data confirm that cost has become a much stronger factor in household energy decisions. As energy expenditure rose, it directly influenced which fuels households could afford and use as their primary source. This suggests that macroeconomic shocks such as subsidy removal can undercut clean-energy transition gains and increase pressure on forest resources as a coping mechanism. Table 3, as follows, is a chi-square analysis describing the association between cost and chosen household energy option between 2015 and 2025 in Bauchi metropolis;

Table 3. Chi-square Tests of Association between Energy Cost and Primary Fuel Choice

Year	Pearson χ^2	Df	p-value	N of Valid Cases
2015	22.619	12	.031	348
2025	33.420	12	.001	348

a = 0.05 level of significance

Since the p-value in both periods is less than the chosen alpha (0.05) for the study, as seen in Table 3, it indicates that there is a statistically significant association between cost (energy expenditure) and the choice of household energy adopted. Table 3 further shows that χ^2 increased from 22.619 ($p = .031$) in 2015 to 33.420 ($p < .001$) in 2025, as both are significant at 12 df. The results reveal that the association between the cost and chosen energy option has strengthened over time. This finding aligns with the broader Nigerian literature, which repeatedly identifies price/cost and income as central, statistically significant correlates of fuel choice (Aminu et al., 2024; Oyediji et al., 2026). By implication, since cost is a statistical driver of fuel choice over time, price-based instruments (targeted subsidies, cylinder-recharge vouchers, VAT relief on clean cookstoves) that reduce energy cost could have increased leverage over environmental outcomes, while rising costs can push households toward more environmentally damaging fuels.

Table 4. Perception of the Most Important Factor Influencing Household Energy Choice

Factor	Frequency	Percentage (%)
Cost	132	37.93
Convenience during use	93	26.72
Availability	57	16.38
Health and safety	45	12.93
Environmental impacts	12	3.45
Culture	9	2.59
Total	348	100.00

According to Table 4, Cost was the single most frequently cited factor (37.93%), ahead of convenience (26.72%), availability (16.38%), health and safety (12.93%), environmental impact (3.45%), and culture (2.59%). Cost is not a majority because roughly 62% of respondents named something other than cost as their single most important factor. This pattern is broadly consistent with other studies, which typically find cost to be a leading but not exclusive driver, alongside convenience, availability, and safety perceptions (Lewis & Pattanayak, 2012; Puzzolo et al., 2016), as agreed with by this study.

Respondents' perception of the primary reasons for changing household energy choices is shown in Table 5 as follows;

Table 5. Primary Reason for Changing Energy Source (2015-2025)

Reason	Frequency	Percentage (%)
Cost	198	56.90
Availability	63	18.10
Health and Safety concerns	42	12.07
Government Policy	27	7.76
Environmental Awareness	15	4.31
Cultural orientation	3	0.86
Total	348	100.00

As seen in Table 5, Cost dominates, with 56.90% of respondents citing cost as their primary reason for switching fuels over the decade, compared to 18.10% for availability, 12.07% for health/safety, 7.76% for government policy, 4.31% for environmental awareness, and 0.86% for cultural reasons.

The finding is also comparable to Nyarko et al. (2021), who reported that a majority of lower-income Nigerian households shifted toward charcoal and firewood specifically in response to rising prices of kerosene, LPG, and electricity. Because switching behaviour is overwhelmingly cost-triggered, environmental-management planning should treat clean-fuel adoption as reversible under economic stress, not as a one-way ratchet. Subsidy design should anticipate and buffer against reversion to biomass fuels during price shocks.

4. CONCLUSION

This study examined the influence of household energy expenditure on fuel choice in Bauchi Metropolis, using data from 2015 and 2025. The findings reveal a significant shift in both energy use and cost over the decade. Between 2015 and 2025, household reliance on traditional fuels such as firewood and kerosene declined, while the use of cooking gas, charcoal, and electricity increased. However, this transition was uneven across residential classes. Low- and medium-density households moved toward cleaner fuels, whereas high-density households reverted to firewood and charcoal, likely due to economic pressure.

The data further show a sharp rise in monthly energy expenditure across all residential classes. By 2025, more than 60% of households spent above N10,000 monthly on energy, compared to 16.38% in 2015. This indicates that cost has become a more critical factor in household energy decisions.

The study concludes that while there is a gradual movement toward cleaner energy sources, affordability constraints continue to limit the energy transition, particularly among low-income households. To achieve the goals of the Nigeria Energy Transition Plan, targeted policy interventions such as subsidies, improved access to LPG, and affordable electricity are necessary to ensure equitable access to clean energy for all household classes in Bauchi Metropolis.

5. COMPETING INTEREST

None to declare.

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