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BARRIERS AND ENABLERS OF CLEAN COOKING FUEL USE IN GOMBE LOCAL GOVERNMENT AREA, NIGERIA

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ABSTRACT
This study explored barriers to and enablers of clean cooking fuel use in Gombe Local Government Area, Nigeria. A household survey provided 364 usable questionnaires from 400 distributed (91.0%). Three focus group discussions, each involving eight participants, and interviews with institutional informants supplemented the survey. Firewood was the primary cooking fuel for 240 respondents (65.9% of 364), compared with liquefied petroleum gas (29.7%) and electricity (4.4%). Among the 240 primary firewood users, 103 (42.9%) selected affordability as their principal reason for continued use and 99 (41.3%) selected habit. In two separately reported questions about enablers, equipment subsidies or price reductions accounted for 141 of 300 recorded responses (47.0%), while lower running costs accounted for 105 of 300 responses (35.0%). The number of individuals contributing those 300 responses could not be established from the available summary tables. Qualitative accounts described equipment costs, familiarity, concerns about gas safety and unreliable supply. Findings are descriptive and should not be interpreted as causal effects or tested associations. The predominantly male sample, uncertain respondent selection within households and absence of respondent-level data limit generalisability. A phased programme combining affordability measures, practical demonstrations and reliable fuel supply merits local evaluation.

Keywords: clean cooking; liquefied petroleum gas; household energy choice; firewood; fuel stacking; Gombe; Nigeria

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Introduction

Clean cooking is an important concern for public health, household welfare and environmental management. The World Health Organization (WHO, 2025) estimates that approximately 2.1 billion people worldwide still cook using polluting fuels and technologies. Fuel type matters because open fires and inefficient stoves expose households to smoke and other pollutants. In this paper, clean cooking fuels refers to fuels and technologies considered clean at the point of use, particularly liquefied petroleum gas (LPG) and electricity, as opposed to conventional firewood cooking.

Recent evidence underscores the scale and regional unevenness of the Nigerian transition. Analysing the 2024 Nigeria Demographic and Health Survey, Sani et al. (2026) reported that approximately 31% of Nigerian households used clean cooking fuels as their primary cooking source, compared with only 4.0% in the North East geopolitical zone. Those estimates come from a nationally representative survey and are not directly comparable to this study's selected wards in Gombe Local Government Area. Earlier national analysis by Ifegbesan et al. (2016) found widespread biomass dependence and associations of fuel choice with household wealth, education, residence and geopolitical zone.

For Gombe households, the immediate question is not only whether LPG or electricity exists in local markets but whether households can adopt these fuels consistently and use them for everyday meals. A separate study in nearby Bauchi metropolis found that households often used multiple fuels rather than replacing one completely with another, and that income, household composition and reliability mattered (Bisu et al., 2016). Household decision-making may thus involve affordability, purchasing schedules, established cooking practices, safety concerns and practical access at the same time.

The present paper contributes a narrowly defined local account of reported primary cooking fuels, stated reasons for continued firewood use and conditions participants considered favourable to clean cooking. Its distinctive contribution is the comparison of questionnaire summaries with focus-group and interview accounts, while making explicit what the available data cannot establish: it cannot measure the prevalence of fuel stacking, statistically test interactions, or infer the perspectives of women from a survey dominated by male respondents.

The study had two objectives: (1) to describe the principal barriers reported by households using firewood as their primary cooking fuel, and (2) to describe reported enablers and perceived benefits of adopting clean cooking fuels. The two aligned research questions were:

RQ1. What barriers do respondents in Gombe Local Government Area report in relation to the use of clean cooking fuels?

RQ2. What economic, informational, safety-related and supply-related conditions do respondents report as encouraging clean cooking fuel use?

Literature review and conceptual framework

Barriers to clean cooking fuel use

Equipment costs, cash flow and affordability

Initial stove and cylinder costs create a different financial problem from everyday fuel purchases. In a systematic review of 44 studies across Africa, Asia and Latin America, Puzzolo et al. (2016) found that initial investment, ongoing fuel costs and access to finance were important barriers or enablers, alongside knowledge and market conditions. This helps distinguish low aggregate income from the inability or unwillingness to make a large one-time purchase. Monthly income categories alone cannot measure savings, disposable income, family responsibilities or the affordability of LPG refills.

Nigerian evidence likewise cautions against treating the energy transition as a simple reflection of income. Using nationally representative 2013 data, Ifegbesan et al. (2016) found 66.3% of households reliant on biomass for cooking and linked choices to wealth, education, location and region. Their cross-tabulated national data provide stronger evidence of associations than the single-variable frequency tables available in the Gombe study.

Social practice, gender and perceived risk

Cooking is also a routine social practice. Shove et al. (2012) conceptualise practices as configurations of materials, competencies and meanings. Within a cooking context, materials include stoves, cylinders and fuel supply; competencies include skill in operating and maintaining equipment; and meanings encompass familiarity, taste expectations and perceptions of danger. Habit should therefore be investigated directly, rather than assumed to arise from ignorance or unwillingness to change. The gender of the survey respondent also differs from the identity of the usual cook and the person who decides which stove or fuel to purchase. Pachauri and Rao (2013) specifically identify gender and intra-household decision-making as missing elements in energy-poverty research.

Reliability of supply and continued use

Adoption at one point in time does not ensure sustained use. Puzzolo et al. (2016) distinguish access to technology from long-term fuel use, emphasising the supply chain, service arrangements, regulation and local conditions. A household with nearby LPG vendors may still encounter transport costs, stock-outs or uncertain refilling arrangements. Bisu et al. (2016) additionally observed household use of several fuels in Bauchi; the persistence of firewood does not necessarily prove that clean fuels have never been adopted.

Enablers of clean cooking

The evidence supports three broad groups of potential enablers. First, affordability measures can address equipment acquisition and refill affordability. These include a carefully targeted subsidy or an instalment plan, but any benefit depends on eligibility, financing, safety regulation and sustainability of supply; this study did not evaluate the effect or costs of any programme. Second, training and demonstrations can address LPG safety procedures, confidence with equipment and perceptions about smoke and cleanliness. Third, dependable electricity and LPG supply can reduce the need to retain firewood as a fallback option. Puzzolo et al. (2016) demonstrate that these financial, behavioural and market domains should be considered together.

The Nigerian context requires particular caution when designing such interventions. Sani et al. (2026) reported large national and regional inequalities in clean cooking use, while the Federal Ministry of Environment (2024) described a National Clean Cooking Policy and planned support measures. These policy commitments establish the relevance of the topic but do not demonstrate that households in the sampled Gombe wards received specific support. The benefits most relevant to household users should be measured through follow-up surveys, including actual refill spending, cooking time, continued biomass use, ventilation and safe operation.

Theoretical framework

This study adopts an integrated theoretical approach using the Energy Ladder Theory and the Diffusion of Innovation Theory to explain the multifaceted factors influencing the transition from firewood to renewable energy sources. Each of these theories provides a unique lens to understand the economic, behavioral, and social dynamics involved in household energy choices. Together, they form a comprehensive framework for analyzing the relationships outlined in the study's objectives.

Energy Ladder Theory

The Energy Ladder Theory was developed by British energy policy expert and researcher, Gerald Leach in 1992. The theory posits that household energy use progresses in a linear, hierarchical manner depending largely on income levels and economic development. It assumes that households move up the "energy ladder" as their income increases- starting from traditional biomass fuels like firewood and animal dung at the bottom, to transitional fuels such as charcoal and kerosene in the middle, and finally to modern fuels like liquefied petroleum gas (LPG), electricity, and renewable sources at the top. The central assumption is that economic ability directly influences energy choices, with wealthier households having the financial capacity to shift toward cleaner, more efficient, and convenient energy alternatives.

This theory is particularly relevant as it explains why low-income households in many rural and pre-urban areas continue to depend on firewood even when cleaner alternatives exist. However, it fails to explain why some households with the means to move up the energy ladder may choose not to do so due to deeply rooted social norms or behavioral resistance. To address these gaps, this study incorporates Diffusion of Innovation Theory as complementary perspectives.

Diffusion of Innovation Theory

The Diffusion of Innovation Theory, proposed by Everett Rogers (2003), explains how new ideas, practices, or technologies spread within a social system over time. The theory assumes that innovation adoption is influenced by a range of factors, including the relative advantage of the new technology (its perceived benefit over existing methods), compatibility with existing values and practices, complexity (how difficult it is to understand or use), trialability (ability to experiment with it before full adoption), and observability (the extent to which others can access and see its benefits). It also acknowledges that individuals in a community adopt innovations at different rates, from innovators and early adopters to the late majority and laggards.

This theory is particularly relevant as it explains how influence of availability, accessibility and perceived benefits of alternative energy technologies influence energy source selection. It helps explain why the physical presence of renewable energy technologies, access to demonstration projects, and public visibility of renewable energy use play critical roles in adoption. It also addresses how information flows and social networks affect the rate and scope of energy transitions, particularly in communities where traditional practices are deeply entrenched.

Materials and methods

This study employed a mixed-methods design that combined quantitative and qualitative approaches to examine barriers and motivators associated with household energy decisions in Gombe Local Government Area of Gombe State, northeastern Nigeria. The combination of methods enabled the study to identify broad patterns in household responses while also exploring the experiences and perceptions underlying those patterns.

The study was conducted in Gombe Local Government Area, which has an estimated population of approximately 470,427 and about 101,600 households according to National Population Commission estimates (N.Pop.C., 2025). The area experiences a semi-arid climate and faces environmental pressures associated with continued dependence on firewood and other biomass resources.

The study population consisted primarily of adult household members (household heads) in selected communities, as well as government officials and environmental experts who

provided institutional perspectives on household energy use and environmental interventions. A multi-stage sampling procedure was used for the household survey. The study area was first divided into three clusters based on socio-economic characteristics. Jekadafari, Bolari-East, and Shamaki wards were subsequently selected to reflect socio-economic diversity. Two communities were selected from each ward, after which three major streets were randomly selected within each community. Every second household was selected and the head of the household was chosen because they are the primary users and decision-makers in domestic energy use.

The study determined a sample size of 400 households using the Taro Yamane formula with a 5% margin of error based on the estimated number of households in the study area. Of the 400 questionnaires distributed, 364 were returned and included in the analysis, representing a response rate of 91%.

Qualitative participants were selected purposively because of their knowledge and experience regarding household energy and environmental issues. Three Focus Group Discussions were conducted, with one discussion organised in each selected ward. Each FGD involved eight participants. Key Informant Interviews were also conducted with relevant individuals, including the Head of Environmental Management, the Chairman of the Gombe Goes Green Taskforce, and an environmental expert.

Quantitative data were collected between November 16, 2025 to December 22, 2025 through structured questionnaire, FGD and KII, covering respondents' socio-demographic characteristics, household energy practices, awareness of alternative energy sources, barriers to adoption, and factors motivating the use of alternative energy. Questions relating to barriers addressed issues such as affordability, lack of awareness, habitual use, taste preferences, safety concerns, and local availability. The qualitative component employed semi-structured FGD and KII guides to explore perceptions of household energy sources, economic and behavioural barriers, safety concerns, supply conditions, institutional interventions, and possible strategies for encouraging energy transition. Focus Group Discussions lasted between 60 and 90 minutes.

The researcher first obtained ethical clearance before engaging the respondents. Participants were fully informed of the study's purpose, procedures, and potential risks, and their voluntary consent were obtained before participation. Confidentiality of participants' identity and data was rigorously maintained, with anonymization of responses to protect privacy. Measures to minimize harm including respectful handling of sensitive information and emotional responses during interviews were also employed.

Quantitative data were analysed using SPSS Version 27.0. Descriptive statistics, particularly frequencies and percentages, were used to summarise the major patterns in household responses. Qualitative data were transcribed and analysed thematically following the approach of Braun and Clarke (2006). Repeated patterns and divergent views were identified through iterative reading and coding of the interview and discussion materials. The quantitative and qualitative findings were subsequently integrated according to the principal themes of the study.

Results

Characteristics of the 364 respondents

Table 1. Characteristics of household survey respondents (N = 364)

Variable	Category	n	%
Age	20 years and below	11	3.0
	21–25 years	19	5.2
	26–30 years	33	9.1
	31–35 years	62	17.0
	36–40 years	37	10.2
	41–45 years	103	28.3
	46 years and above	99	27.2
Sex of respondent	Male	296	81.3
	Female	68	18.7
Education	Primary	8	2.2
	Secondary	98	26.9
	Tertiary/college	155	42.6
	Vocational	20	5.5
	Non-formal/adult	28	7.7
	Arabic only	55	15.1
Monthly income	₦20,001–₦40,000	40	11.0
	₦40,001–₦60,000	39	10.7
	₦60,001–₦80,000	59	16.2
	₦80,001–₦100,000	130	35.7
	₦100,001 and above	96	26.4
Ward	Jekadafari	126	34.6
	Bolari-East	118	32.4
	Shamaki	120	33.0
Dwelling	Owned house	215	59.0
	Rented	112	30.8
	Employer-provided	37	10.2

The respondents represented a broad range of age, educational, income, and housing categories. The largest age group was 41–45 years, accounting for 28.3% of the sample, followed

by respondents aged 46 years and above at 27.2%. Male respondents constituted 81.3% of the sample, which is a serious bias because women do most household cooking.

Tertiary or college education was the most frequently reported educational category at 42.6%, while 26.9% had secondary education. The sample was distributed relatively evenly across Jekadafari, Bolari-East, and Shamaki wards. Most respondents lived in owner-occupied houses, although rented and employer-provided housing were also represented.

Barriers to the clean cooking fuel use

Table 2. Primary cooking fuel reported (N = 364)

Primary fuel	**N**	**%**
Firewood/charcoal	240	65.9
LPG	108	29.7
Electricity	16	4.4
Total	364	100.0

Table 2 shows that 240 of the 364 respondents (65.9%) reported firewood as the household's primary cooking fuel; 108 (29.7%) selected LPG; and 16 (4.4%) selected electricity. These categories sum to 364 and refer only to the primary cooking fuel. They do not establish that LPG or electricity users have stopped using firewood for other meals.

Table 3. Main Reasons for Continued Firewood Use Among Households Using Firewood as Their Primary Cooking Fuel (n = 240)

Reason	**Frequency (n)**	**Percentage (%)**
I can only afford firewood/charcoal	103	42.9
I am used to cooking with firewood	99	41.3
I lack awareness of renewable energy benefits	20	8.3
I do not trust the safety of LPG/solar devices	16	6.7
Food tastes better when cooked with firewood	2	0.8
Renewable energy equipment is not available in my area	0	0.0
Total	**240**	**100.0**

The denominator for Table 3 is the 240 respondents who reported firewood as their primary fuel, not all 364 survey respondents. Table 3 shows that affordability was the most frequently reported reason for continued firewood use, accounting for 42.9% of respondents in this category. Habit was almost equally important, with 41.3% reporting that they continued to use firewood because they were accustomed to cooking with it. Together, these two factors accounted for more than four-fifths of the reported reasons for continued dependence on firewood. Lack of awareness of alternative energy benefits and concerns about the safety of LPG or solar devices were reported less frequently, while only 0.8% associated continued firewood use with food taste. No respondent identified the absence of renewable energy equipment in the area as the principal reason for continued firewood use.

The affordability findings are consistent with other evidence in the study. The survey also found that 26.6% of all respondents could not afford the initial cost of renewable energy equipment, while 25.5% reported difficulty in meeting monthly maintenance costs. These findings suggest that although alternative energy products may be available, the financial capacity to acquire and sustain their use remains an important concern for a substantial proportion of households.

The qualitative evidence provides further insight into the financial dimension of household energy decisions. One participant explained:

"LPG upfront costs represent a barrier despite long-term savings, and even when we have electricity, people rarely use it for cooking because the supply is irregular and the units on prepaid meters finish quickly." (FGD, Men's Group, Gombe LGA, 2025)

A key informant similarly described the importance of household income and payment patterns:

"In most communities, income level shapes energy decisions more than any other factor. Households with limited income tend to choose firewood because the cost is spread out in small daily purchases. The initial cost of cleaner alternatives such as gas cylinders, electric stoves, or solar equipment is viewed as too high, even if they are cheaper in the long run." (KII, Expert, Age 52, Male, Gombe LGA, 2025)

These responses expand the quantitative finding by showing that affordability concerns relate not only to the overall cost of energy but also to the timing of expenditure. Firewood may be financially manageable for households because it can be purchased in relatively small quantities, whereas alternative technologies may require a larger initial payment.

Habit was the second major barrier identified in the survey. The qualitative findings showed that continued dependence on firewood was closely associated with familiarity and established domestic routines. A participant in a women's FGD stated:

"In most homes here, the routine is fairly fixed. Women usually handle the cooking, and firewood remains the common fuel because it is familiar and easy to obtain." (FGD, Women's Group, Gombe LGA, 2025)

Other participants described the intergenerational nature of established cooking practices:

"Older generations often prefer firewood, and younger people learn from them. This creates continuity that is hard to change." (FGD, Men's Group, Gombe LGA, 2025)

The qualitative evidence therefore supports the survey finding that habit is a major barrier. The issue extends beyond a simple preference for firewood and reflects the role of familiarity, accumulated cooking experience, and the transmission of household practices across generations.

Safety concerns were reported by 6.7% of respondents as the main reason for continued firewood use. Although this proportion was smaller than those reporting affordability and habit, the qualitative evidence showed that concerns about LPG safety could still affect household decisions. One participant stated:

"Some fear gas cylinders because of past stories of explosions." (FGD, Men's Group, Gombe LGA, 2025)

An environmental expert also noted:

"Cultural habits and personal convictions also influence energy decisions. Some people hold the belief that food tastes better on firewood, or that gas and solar devices are unsafe or unreliable." (KII, Expert, Age 52, Male, Gombe LGA, 2025)

The survey recorded no respondent who identified the complete absence of alternative energy equipment as the principal barrier. However, qualitative participants distinguished between the existence of suppliers and the reliability of supply:

"LPG dealers exist in most trading centres, but refills can be inconsistent. Improved stoves are sporadically available, with varying quality, and solar cookers are rarely stocked. Supply chain inconsistency undermines willingness to adopt renewable cooking solutions." (FGD, Men's Group, Gombe LGA, 2025)

This suggests that the availability of energy products should be distinguished from reliable and predictable access. Although alternative energy products may be present within the study area, inconsistent supply or concerns about product quality may still affect households' willingness to depend on them.

Enablers of clean cooking fuel use

Table 4. Factors Reported to Have Made the Adoption of Clean Cooking Fuel Easier (n = 300 Responses)

Motivating or Enabling Factor	Frequency (n)	Percentage (%)
Subsidy or reduction in the cost of alternative energy devices	141	47.0
Reliable electricity supply and connectivity	41	13.7
Awareness campaigns on benefits and usage	26	8.7
Small family size	26	8.7
Flexible payment options or instalment plans	24	8.0
Better availability in local markets	20	6.7
Support from government	12	4.0
Training on the safe use of alternative energy devices	10	3.3
Total responses	**300**	**100.0**

*(**Note:** Multiple responses were allowed in this question. Percentages are based on the 300 responses recorded from the 124 respondents who identified clean cooking fuels as their primary cooking fuel in above table 2.)*

Table 4 indicates that subsidies or reductions in the cost of alternative energy devices were the most frequently reported factors facilitating adoption, accounting for 47.0% of all recorded responses. Reliable electricity supply and connectivity accounted for 13.7%, while awareness campaigns and small family size each represented 8.7% of responses. Flexible payment arrangements accounted for 8.0%, followed by improved local availability, government support, and training on the safe use of alternative energy devices.

The prominence of subsidies and cost reductions reinforces the importance of affordability identified among households that continued to depend on firewood. Taken together, the findings suggest that financial conditions operate on both sides of household energy decisions. Financial constraints can discourage adoption, while reductions in cost and other forms of financial support can make transition more feasible.

The qualitative evidence also highlighted the importance of practical benefits associated with alternative energy sources. A participant in a women's FGD observed:

"*Of course, alternative energy equipment cooks food faster and keeps the kitchen clean. Reduced indoor smoke, beneficial for children's health, and time saved on meal preparation. Solar devices save money once purchased."* (FGD, Women's Group, Gombe LGA, 2025)

An environmental expert similarly emphasised the importance of awareness in shaping attitudes:

"Awareness strongly predicts willingness to adopt modern energy. Many households stay with firewood because they lack information about health risks, environmental consequences, or the financial benefits of cleaner energy over time. Where awareness campaigns have been conducted, we observe higher adoption of LPG, improved stoves, and solar solutions. Once people understand the long-term savings and reduced indoor air pollution, they rethink their choices." (KII, Expert, Age 52, Male, Gombe LGA, 2025)

These qualitative accounts help explain why awareness campaigns and information about the benefits of cleaner energy may support adoption even though awareness alone may not overcome financial and behavioural barriers.

Discussion

The strongest result is descriptive: firewood was the main fuel reported by roughly two-thirds of respondents, while affordability and habit accounted for similar shares of the single principal reasons offered by firewood users. The closeness of those figures argues against attributing continued firewood use solely to poverty. Puzzolo et al. (2016) also locate barriers across finance, perceptions and supply, while Masera et al. (2000) explain why familiar fuels can persist when households acquire cleaner alternatives. The present data do not establish which factors jointly influence an individual household.

The composition of this particular sample complicates the interpretation of affordability. More than three-fifths of respondents reported monthly income above ₦80,000, and 42.6% had tertiary or college education. The data do not show whether the 103 firewood users choosing affordability came from the lower or higher income categories. Nor is nominal income an adequate measure of the ability to pay for a full cylinder, regulator and stove at one time. Affordability here should be interpreted as a stated obstacle to switching, not as proof that respondent households were poor.

Gender is equally consequential. Men account for 296 of 364 questionnaire responses, whereas the qualitative materials identify women as regular cooks in many homes. Without linking the person interviewed to the usual cook or household decision-maker, the survey may underrepresent the practical knowledge, concerns and priorities of those who prepare meals. Pachauri and Rao (2013) emphasise these intra-household dimensions. A future study should obtain balanced responses from cooks and household purchasing decision-makers and report disagreements within households where feasible.

The distinction between product presence and reliable access also matters. No firewood respondent selected complete equipment absence as the main barrier, yet qualitative accounts pointed to unstable refill supply and electricity availability. These are different constructs. A seller can exist nearby while fuel availability is intermittent or its effective acquisition cost remains prohibitive. Bisu et al. (2016) similarly identified availability and affordability among factors relevant to cooking energy choice in Bauchi. Rather than treating this as a contradiction, the evidence supports more careful future measures of frequency of stock-outs, travel time to refill, outages and reliance on backup fuels.

The 2026 NDHS-based estimate of 4.0% clean cooking in Nigeria's North East (Sani et al., 2026) is substantially lower than the 34.1% LPG/electricity share in the present sample. This contrast does not mean that the locality has a higher regional adoption rate: the NDHS sample differs in geography, recruitment, weighting and likely urban composition. Together with the male-heavy, relatively educated and income-restricted sample, it reinforces why the current dataset must not be generalised to rural or low-income households elsewhere.

Finally, the two enabler panels offer useful priorities but not a validated ranking among individual respondents: both panels have unclear participant denominators and overlapping categories. They indicate which statements appeared more often in the supplied summaries, not the size of a causal effect from subsidies, lower running costs, safety training or policy initiatives. Claims that economic and behavioural factors interact, that awareness predicts adoption or that government programmes lack visibility require respondent-linked measures and statistical testing beyond this document.

Conclusion

In answer to RQ1, the most common single stated reasons for continued primary firewood use were affordability (103/240; 42.9%) and habit (99/240; 41.3%). Safety and knowledge were also mentioned but were less often selected as the leading reason. These results concern the 240 primary firewood users interviewed, not all households in Gombe Local Government Area. In answer to RQ2, equipment price reductions (141/300 recorded entries in one enabler question) and lower cooking costs (105/300 entries in the second question) were frequently cited, alongside perceived health benefits, improved reliability and payment flexibility. Because the enabler denominator is a count of recorded entries, not verified distinct respondents, this evidence identifies possible priorities for discussion and pilot testing rather than measured demand in the population.

Limitations and research priorities

The study has six major limitations. First, the sampling details needed to reproduce the ward, street, household and adult selection are incomplete. Second, the sample is 81.3% male and cannot be taken to represent cooking experiences equally across sexes. Third, no separate income category below ₦20,001 appears, so the poorest households may be underrepresented. Fourth, the primary-fuel question does not capture fuel stacking or switching by meal, season and supply. Fifth, aggregated descriptive tables, incomplete enabler denominators and unverified qualitative source material prevent cross-tabulations, regression, inferential testing and full audit of quoted speech. Sixth, the study was restricted to one LGA, with self-reported data and no verified records of ethics approval, collection period or questionnaire pretesting in the supplied manuscript.

The next research phase should preserve respondent-level, anonymised data; sample women who cook as well as household purchasers; measure the complete fuel mix, stove ownership, refill costs, expenditure timing, safety competence and programme awareness; and apply an adequately documented probability sampling design where possible. Thematic credibility should be strengthened through verified transcripts, transparent coding and attention to dissenting accounts.

Practical recommendations linked to findings

The following actions are proposed as pilots to be costed, implemented and evaluated rather than proven interventions or existing programmes.

Lead actor / suggested period	Proposed action and measurement	Basis in this study
Gombe State Government, local partners; first 3 months	Design a small, means-tested voucher or instalment pilot for certified LPG starter kits, with transparent eligibility and safety checks; record uptake and actual costs.	Affordability was the most common stated leading reason (103/240).
LPG dealers, consumer groups and women's associations; first 3–6 months	Hold practical demonstrations, include women who routinely cook, and measure knowledge and sustained safe use before/after.	Habit (99/240) and reported safety concerns indicate training needs.
Electricity providers and LPG distributors;	Map refill stock-outs, refill distance and electricity interruptions in the	Reliability was raised in both enabling responses and

3–12 months	sampled wards, and publish simple service reliability measures.	qualitative accounts.
LGA community organisations and independent researchers; 6–12 months	Recruit a gender-balanced follow-up sample, explicitly identify usual cooks and purchasing decision-makers, and quantify fuel stacking.	Current sample is 81.3% male; primary fuel only was measured.
Ministries and academic partners; 12 months	Evaluate take-up, costs, continued wood use, user-reported exposure and equity of the pilots, compare with a non-recipient group where feasible.	Current descriptive data cannot show programme impact.

These recommendations should be developed with women household cooks and local community representatives. No financial budget or implementation effect is asserted without a feasibility assessment.

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