Domestic Energy Utilization and Potential Alternative Energy Sources Among Households in Gombi Local Government Area

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Abstract- This study investigates household energy consumption patterns, preferences for alternative energy sources, and awareness of environmental impacts across four selected wards which includes Gombi North, Gombi South, Garkida, and Gaanda in Gombi Local Government Area, Adamawa State, Nigeria. A structured questionnaire was administered to 400 respondents drawn from diverse occupational and socioeconomic backgrounds. Farming (35.9%) and civil service (32.6%) emerged as the dominant occupations, while the majority of respondents earned between ₦21,000 and ₦60,000 monthly, indicating moderate financial capacity. Household sizes varied considerably, with 36.0% of respondents falling within the 5–8 member range, reflecting diverse domestic energy demands across the study area. Findings reveal that wood and charcoal collectively account for 67.7% of primary household energy use, underscoring a heavy dependence on traditional biomass fuels with significant environmental and public health consequences, including air pollution, deforestation, habitat destruction, and soil degradation. Electricity and Liquefied Petroleum Gas (LPG) usage remain limited at 9.0% and 13.2% respectively, constrained by income levels, inadequate infrastructure, and high upfront costs. A Chi-Square analysis confirmed a statistically significant association between income and primary energy source (Pearson Chi-Square = 638.418, p = 0.016), establishing that higher-income households are more likely to adopt cleaner energy alternatives, while lower-income households predominantly rely on biomass fuels. Income level (31.0%) and government policy (26.0%) emerged as the most influential factors affecting energy accessibility across all sources. Solar energy was identified as the most preferred alternative energy source by 55.7% of respondents, followed by biomass (25.8%) and wind energy (18.5%). A substantial 91.5% of respondents expressed interest in adopting alternative energy sources, motivated primarily by environmental benefits (44.8%) and government incentives (25.0%). Regarding environmental awareness, 55.7% of respondent's demonstrated awareness of the environmental impacts of household energy use, with air pollution (84.4%) and deforestation (57.0%) identified as the most recognized consequences. In terms of mitigation measures, the adoption of energy-efficient LED or CFL bulbs (72.4%), energy-efficient appliances (32.3%), and education and awareness campaigns (28.9%) were most widely endorsed. The study concludes that addressing household energy challenges in Gombi requires comprehensive, income-sensitive, and community-specific energy policies that prioritize equitable access to affordable, clean, and sustainable energy solutions across all zones of the local government area

Index Terms- Domestic Energy Utilization, Potential Energy, Sources among Households; Nigeria

I. INTRODUCTION

Access to modern forms of energy is essential in overcoming poverty, promoting economic growth and employment opportunities, provision of social services and sustainability (Fernanda and Ely, 2021). Energy services are required for a variety of purposes such as lighting, heating, cooking and electrical appliances. This usage is commonly referred to as household energy consumption and is defined as the energy consumed in homes to meet the needs of households (Adamu et. al., 2020). Household energy sources include fuel wood, dung, agricultural residues, charcoal, etc. An energy source in its raw state before conversion into mechanical work is said to be primary energy while secondary energy refers to the transformed state of all primary energy. Primary or secondary forms of energy must be subjected to combustion so as to release their stored energy that is referred to as fuels (Hannah, 2022). Adamu et. al., (2020) identified two classes of energy utilized in household as solid fuels and nonsolid fuels.

Available statistics shows that 1.4 billion people around the world lack access to electricity and 1 billion households lack access to clean cooking facilities. Production and consumption of almost any type of energy have environmental impacts as harvesting of fuel wood that contributes to deforestation, soil erosion, and desertification. In Nigeria harvesting of fuel wood contributes to deforestation at a rate of about 400,000 hectares per year and if this trend continues the country's forest resources could be completely depleted by 2050 (Adamu *et. al,* 2020). In addition, use of biomass fuel for cooking causes a lot of health problems due to indoor air pollution. World Health Organization (WHO) estimated about 1.5 million premature deaths per year are directly attributed to indoor air pollution from the use of solids fuels. One set factor necessary for the switching to other fuel is the availability of alternative fuels other than traditional biomass fuels such as Natural Compressed Gas (NCG), electricity, Solar and wind energy but access to such fuels is much more limited in rural areas. The type of energy used in the study area in the recent times, especially in the poor households is attributed to poverty due to the rising of the prices of other more efficient energy like electricity, kerosene, cooking gas or solar energy.

Therefore, the objectives of this study are to: identify the primary domestic sources of energy use in the study area: examine the factors influencing domestic energy consumption among households in in the study area: assess the potentials of alternative domestic energy use in the study area.

II. MATERIALS AND METHODS

This research work will focus on investigating the utilization of domestic energy in the study area which includes fuel wood, charcoal and animal dugs.

Research Design: Quantitative research will be used in this research because of its reliability and easy representation in the form of statistics, graphs, charts and numbers.

The Study Area: The study was conducted in Gombi L.G.A, Adamawa State Nigeria and four (4) wards were randomly selected for the sole purpose of this research namely Gaanda, Garkida, Gombi North and Gombi South. The reason for the selection is due to the high population or most inhabited among the communities (Ishaku *et. al* 2023).

Location and Extent: Gombi is a Local Government in Adamawa State, Nigeria, created in 1976. The local government area is located in the northern part of Adamawa State between latitude 9° 59'-10° 27'N and longitude 12°14-12° 50'E. The local government shares common borders with Borno state to the northwest, Shelleng Local Government to the west, Song Local Government to the south, and Hong Local Government to the east.
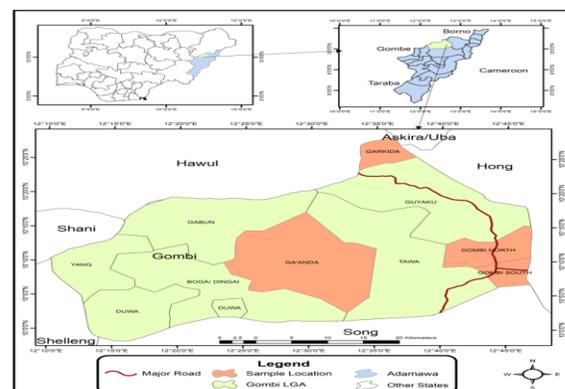

Figure 1: Gombi Local Government Area showing the selected wards
Source: Adamawa GIS, 2025.

Climate: Gombi Local Government Area, located in the Sudan Savanna zone, experiences two distinct seasons: a wet season from May to October, peaking in August, with an average annual rainfall of 972mm recorded over approximately 62 rainy days. The dry season, lasting from December to March, is characterized by dry, dusty, and hazy northeast trade winds blowing from the Sahara Desert. Temperatures in the area range from 27°C to 38°C throughout the year, with December and January being the coldest months (mean 15°C) and April to May being the hottest (mean 34°C). The area's consistently high temperatures present a significant opportunity for solar energy harnessing as an alternative energy source. Additionally, the presence of mountains enhances wind speed in Gombi, making wind energy another viable and exploitable renewable energy resource in the area (Adebayo 1999)

Geology and Landforms: The general topography of the area is mountainous. In terms of its relief profile, Gombi is characterized by a gentle undulating flood plain, rising between 154.2m to 213.4m above the Benue River bed (Opeloye and Dio, 2009). This relief generally portrays a uniform appearance with sandstone hills rising from the North-East running eastward, bordering with the River Benue. The town is located on a rugged terrain and undulating topography with some parts of the settlement on high surfaces and others at lower surfaces.

Soil and Vegetation: Gombi's soils are predominantly sandy loam, with an average composition of 68.44% sand, 18.22% silt, and 13.34% clay, though some areas exhibit loamy sand textures. Soil degradation, including sheet and rill erosion, has been observed particularly in the western parts, driven by declining vegetation cover, climate change, and human activities. The area's vegetation falls within the Sudanian savanna zone, featuring shrubs, scattered trees, and diverse grass species, with common trees including locust bean, baobab, tamarind, moringa, date-palm, and neem. A flora checklist of Gombe State revealed a diverse plant composition dominated by herbs (38.80%), trees (22.07%), shrubs (19.73%), vines (12.4%), and grasses (5.02%). Notably, a new plant species, *Tinnea gombea* (Lamiaceae), has been identified in the region, typically found in grasslands and woodlands of the Sudanian savanna, often on abandoned farmland. (Adebayo and Tukur, 1999).

Population and Economic activities of the study area: According to the 2006 census, Gombi has a total population of 129,855 and the population projections for 2025 put the figure at 222,909 people (National Population Commission, 2006). According to OGP 2025, majority of ethnic groups in and across most wards in Gombi include Fulani, Hausa, Kilba (Huba), Bachama and other minority tribe such as Marghi, Yungur and Higgi who were there for farming activities (OGP 2025). In terms of religion there is a wonderful mixture as some wards have more Muslims than Christians while others had more Christians than Muslims and few numbers of traditionalists amongst the entire wards

Instrument and Procedure for Data Collection: A simple random sampling technique was used to pick respondents from 124,095 people across the four communities. Therefore, a total of 400 respondents were being selected as the sample size from the total population. The distributed questionnaires represent the population of each of the community since population size is not equal. Therefore, more questionnaires were distributed to communities with higher population than those with lower population. Some respondents completed the questions independently, but those who can't read or write the researcher checked off the questions as they were completed. Similar studies such as Ojo *et al.* (2022) and Uzomah *et al.* (2021) also adopt this approach.

Sample and Sampling Technique: A multistage sampling technique was employed in this study, involving the selection of communities from which respondents were drawn and questionnaires administered across Gombi Local Government Area's 48 communities, classified into distinct zones. Purposive sampling was used to select four communities based on their locations, zones, topographic characteristics, and population sizes, ensuring that each selected community represented a different zone. The four selected communities — Garkida (swampy terrain), Gombi North and Gombi South (flat, urban-rural plains), and Gaanda (rocky and hilly terrain) — each possess distinct topographic features and relatively large populations. Together, these four communities represented 67.5% of the total population of Gombi Local Government Area, ensuring a broadly representative sample for the study. The sample size for this study will be obtained using the sampling size formula as represented in Equation 1.

$$N = \frac{Nh \times n}{p}$$

Where *Nh* is the population of the selected study area, *n* is the sample size, and *p* is the total population of the study area.

Table 1: Total number of sampled communities within the study site

Selected Wards	Projected Population (2025)	Percentage (%)	Sample Size
Garkida	25,470	20.5	82
Gombi North	45,909	37.0	148
Gombi South	39,703	32.0	128
Gaanda	13,013	10.5	42
Total	124,095	100	400

Method of Data Analysis and Interpretation: The data that was collected was analyzed using quantitative analysis techniques. Statistical Package for Social Studies (SPSS) was employ to run simple descriptive statistical tools like frequency, mean, and percentages on quantitative data that was collected from various homes and community surveys. Using descriptive analysis, which includes frequency count, simple percentage, and average, it will be possible to determine the socioeconomic characteristics of the respondents concerning their primary source of energy that is use and its consumption rate. In contrast, chi-square was employ to ascertain the reasons behind their selection of that particular energy sources.

III. RESULTS AND DISCUSSION

Table 2: Respondents' Occupation

Occupation	Frequency	Percentage (%)
Civil service	125	32.6
Farming	138	35.9
Artisan	44	11.5
Business	51	13.3
Student	26	6.7
Total	400	100

Table 2 presents a breakdown of the occupational distribution of respondents within the study, reflecting a diverse range of professional backgrounds among the sampled population. Farming emerged as the most predominant occupation, with 138 individuals constituting 35.9% of the total respondents, followed closely by those in civil service with 125 respondents, representing 32.6% of the sample. Business operators accounted for 51 respondents, making up 13.3%, while artisans comprised 44 respondents, representing 11.5% of the total. Students recorded the smallest occupational group, with 26 respondents constituting 6.7% of the total sample. This occupational diversity is particularly relevant to the study, as different occupations are associated with varying patterns of energy consumption and household needs. Farmers, for instance, may have distinct energy requirements closely tied to agricultural activities, while those in civil service and business may exhibit different energy consumption patterns driven by both household and work-related demands. Given the substantial proportion of respondents engaged in farming, there exists a significant opportunity to explore and promote energy solutions that are directly relevant to the agricultural sector, including the adoption of renewable energy sources for irrigation and the introduction of more efficient processing technologies. Such targeted interventions could contribute meaningfully to improving energy efficiency and sustainability within the study area.

Table 3: Monthly Income of the Respondent's

Monthly Income	Frequency	Percentage (%)
5,000-20,000	69	17.3
21,000-40,000	119	29.7
41,000-60,000	160	40.0
Above 60,000	52	13.0
Total	400	100

Table 3 presents the monthly income distribution of respondents, indicating that the majority fall within the ₦21,000–₦40,000 and ₦41,000–₦60,000 brackets, accounting for 29.7% and 40.0% of the total sample respectively, suggesting that a substantial proportion of the population possesses moderate to relatively higher financial capacity. A notable 17.3% of respondents earn between ₦5,000 and ₦20,000, reflecting significant financial constraints that may limit their ability to invest in sustainable energy solutions, while 13.0% earn above ₦60,000, representing a segment with comparatively greater financial capacity and a higher likelihood of adopting advanced energy technologies. This is consistent with findings by Abdullahi et al. (2025), Wang et al. (2025), and Moleskis et al. (2025), who observed that

higher-income households demonstrate a markedly greater likelihood of adopting innovative energy technologies due to their enhanced financial capacity to manage upfront investment costs and broader exposure to renewable energy information. Furthermore, Priesmann and Praktiknjo (2025) identified significant heterogeneity in energy price elasticity's across income groups, noting that higher-income households exhibit lower sensitivity to energy price changes and tend to maintain stable energy consumption regardless of cost fluctuations. The income distribution within the study area therefore underscores the financial dynamics shaping household energy choices, highlighting the urgent need for income-sensitive strategies to promote equitable access to sustainable energy solutions.

Table 4: Distribution of Respondent's according to Household Size

Household	Frequency	Percentage (%)
Less than 5	125	31.3
5 – 8	144	36.0
9 – 14	76	19.0
15 Above	55	13.7
Total	400	100

Table 4 presents the distribution of respondents according to household size in the study. The data reveals a diverse range of household sizes among the sampled population, with 31.3% comprising fewer than 5 members, 36.0% falling within the 5–8 member range, 19.0% comprising 9–14 members, and 13.7% consisting of 15 or more members. Household size is a critical determinant of domestic energy consumption, as smaller households tend to have more manageable energy needs, typically relying on fewer appliances and requiring comparatively less power. In contrast, larger households are generally associated with higher energy demands driven by a greater number of occupants and appliances in simultaneous use. Households with more occupants tend to consume more energy, as more people draw on lighting, electronics, and a wider range of household appliances, directly influencing the demand for cooking, heating, and other energy-related activities. The distribution of household sizes within the study area therefore provides a valuable basis for understanding the varying energy needs and consumption patterns of different households, which is essential for informing the development of appropriate and targeted energy management strategies.

Table 5: Primary Source of Household Energy used

Primary Source of Energy	Gombi North	Gombi South	Garkida	Gaanda	Total (%)
Electricity	16	12	8	0	36 (9.0)
Kerosene	12	13	6	10	41 (10.2)
Liquefied Petroleum Gas	21	18	9	5	53 (13.2)
Charcoal	35	28	31	41	135 (33.3)
Wood	37	25	33	43	138(34.3)
Total	121	96	84	99	400 (100)

Table 5 presents an overview of the primary domestic energy sources in the study area, revealing that wood and charcoal collectively constitute 67.7% of total household energy usage, indicating a substantial reliance on traditional biomass fuels. This overreliance on biomass fuels carries significant negative environmental and public health implications, including deforestation, biodiversity loss, air pollution, soil erosion, and reduced agricultural productivity. The burning of wood and charcoal releases particulate matter and other pollutants, contributing to both indoor and outdoor air pollution and posing adverse health risks to the local population. Electricity is utilized by 9.0% of

households, with Gombi North, Gombi South, and Garkida recording the highest usage at 13.2%, 12.5%, and 9.5% respectively, while Gaanda reports no electricity access, reflecting significant disparities in infrastructure development across the study area. Kerosene accounts for 10.2% of household energy use, with Gombi South recording the highest percentage at 13.5%; however, its combustion emits pollutants such as sulfur dioxide, nitrogen oxides, and particulate matter, contributing to air pollution and respiratory health challenges. Liquefied Petroleum Gas (LPG) usage stands at 17.4%, with most users concentrated in Gombi North, though its relatively low uptake is largely attributable to cost and the income levels of respondents. Compared to biomass fuels, LPG burns more cleanly, emits fewer pollutants, and has the potential to reduce deforestation pressures within the study area.

Spatially, Gombi North, Gombi South, and Garkida are classified as high users of electricity, while Gaanda remains entirely without access. Gombi South and Gombi North are high kerosene users, whereas Gaanda and Gombi North are identified as high users of both charcoal and wood as primary household energy sources. As observed by Murtala et al. (2025), energy poverty and its structural determinants differ markedly between urban and rural populations, with disparities in clean fuel and electricity access shaped by distinct economic and social conditions unique to each setting. This pattern is clearly reflected in the energy consumption distribution across the four communities studied, where geographic location, infrastructure availability, and socioeconomic conditions collectively determine the dominant energy sources used by households. The heavy dependence on biomass fuels underscores an urgent need for targeted energy transition policies and income-sensitive interventions to facilitate the adoption of cleaner and more sustainable energy alternatives. Promoting renewable energy solutions such as solar and LPG in underserved communities like Gaanda could significantly reduce environmental degradation and improve public health outcomes. Overall, the energy consumption patterns observed in the study area highlight the complex interplay between economic capacity, geographic accessibility, and energy choices among households. Addressing these challenges requires comprehensive, community-specific strategies that prioritize equitable access to affordable and sustainable energy solutions across all zones of Gombi Local Government Area.
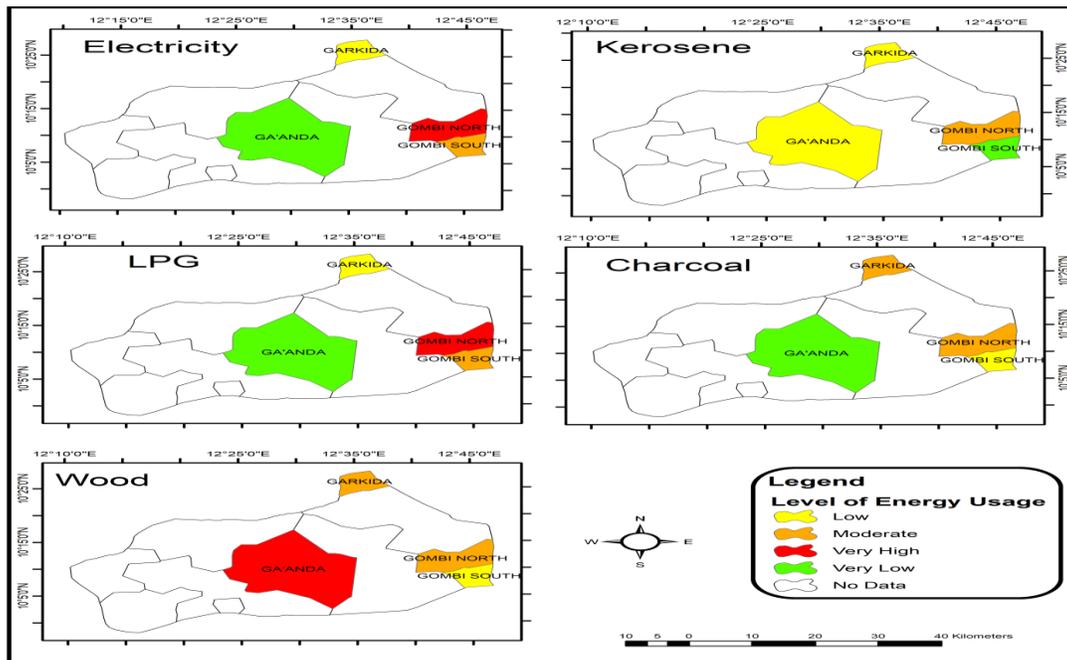

Figure 4.1: Primary Sources of Household Energy in Gombi

Table 6: Availability of Primary Source of Energy

Primary Source of Energy	Electricity	Kerosene	Liquefied Petroleum	Charcoal	Wood	Total (%)
Very Limited	18	11	5	2	3	39 (9.7)
Limited	39	19	2	21	16	97 (24.3)
Moderately Limited	23	21	8	37	44	133 (33.3)
Unlimited	4	16	5	18	19	62 (15.5)
Highly Unlimited	7	6	6	11	39	69 (17.2)
Total	91	73	26	89	121	400 (100)

Table 6 presents the availability of primary energy sources among respondents in the study area, categorized across five availability levels ranging from very limited to highly unlimited. The data reveals that wood is the most widely used primary energy source, with a total of 121 respondents, followed by electricity with 91 respondents, charcoal with 89 respondents, kerosene with 73 respondents, and Liquefied Petroleum Gas (LPG) recording the lowest usage with 26 respondents.

With regard to availability levels, 33.3% of respondents indicated that their primary energy sources are moderately limited, representing the largest proportion of the total sample, while 24.3% described availability as limited. A combined 9.7% of respondents reported their primary energy sources as very limited, reflecting significant supply challenges faced by a portion of the population. In contrast, 17.2% of respondents indicated highly unlimited availability, while 15.5% reported unlimited access to their primary energy sources.

Examining individual energy sources, electricity recorded notably high levels of limited and very limited availability, with 39 and 18 respondents respectively, suggesting persistent challenges with power supply in the study area. Wood, on the other hand, recorded the highest frequency in the moderately limited and highly unlimited categories, with 44 and 39 respondents respectively, indicating its relatively greater accessibility compared to other energy sources. Charcoal and kerosene also showed considerable representation across the limited and moderately limited categories, while LPG consistently recorded the lowest frequencies across all availability levels, reflecting its limited penetration within the study area. These findings underscore the predominance of traditional biomass energy sources such as wood and charcoal in the study area, largely due to their comparatively greater availability relative to modern energy alternatives.

Table 7: Factors influencing the Accessibility of your Primary Energy Sources

Factors	Electricity	Kerosene	Liquefied Petroleum	Charcoal	Wood	Total (%)
Cost	19	10	9	17	16	72 (18.0)
Proximity to Suppliers	4	13	3	12	23	53 (13.0)
Infrastructure Quality	22	10	0	9	5	46 (12.0)
Government Policy, Support or Subsidies	10	17	4	49	24	104 (26.0)

Income Level	33	25	8	8	50	125 (31.0)
Total	88	75	24	95	118	400 (100)

Table 7 examines the factors influencing the accessibility of primary energy sources among households in selected wards of Gombi Local Government Area. With respect to electricity and income level emerged as the most significant factor, cited by 33 respondents representing 37.5% of electricity users, followed by infrastructure quality at 25.0% and cost at 21.6%. Among kerosene users, income level similarly ranked as the most influential factor at 32.5%, followed by government support at 22.7% and proximity to suppliers at 17.3%. For Liquefied Petroleum Gas (LPG), cost was identified as the most dominant factor by 37.5% of LPG users, closely followed by income level at 33.3%. Charcoal users presented a distinct pattern, with over half of respondents (51.6%) attributing accessibility challenges primarily to government policy. This is particularly significant in light of the ban imposed by the Adamawa State Government in late 2023 on the illegal felling of trees and the impoundment of charcoal across several local government areas, including Gombi. This regulatory measure contributed considerably to charcoal scarcity and a consequent rise in its cost, which was reported as an additional limiting factor by 17.9% of charcoal users. Among wood users, 42.4% identified income level as the primary factor influencing accessibility, while proximity to suppliers and government policy were each cited by 20.3% of respondents.

Overall, income level was the most widely reported factor across all energy sources, accounting for 31.0% of total respondents. This finding reinforces the concept of energy poverty, wherein lower-income households encounter significant barriers to accessing cleaner and more efficient energy sources such as electricity, kerosene, and LPG, largely due to the high upfront costs associated with the necessary appliances and infrastructure. Government policy ranked as the second most influential factor, reported by 26.0% of total respondents. Notably, a combined 70.2% of wood and charcoal users acknowledged that government regulations on deforestation significantly affect the availability and accessibility of traditional biomass fuels, with such policies encompassing restrictions on logging and incentives for sustainable forestry management. In contrast, among electricity and LPG users, government subsidies and support were viewed positively, with 37.5% and 33.3% of respective users recognizing their contribution to improved energy accessibility, thereby underscoring the constructive role that well-targeted government interventions can play in advancing the adoption of cleaner and more sustainable energy alternatives.

Cost, reported by 18.0% of respondents, further reflects the economic burden that shapes household energy choices, particularly for those relying on modern energy sources requiring substantial initial investments in wiring, meters, and related equipment. While traditional biomass fuels such as wood and charcoal generally carry lower ongoing costs and therefore remain more financially accessible to low-income households, the recurring expenditure on LPG purchases continues to pose a notable accessibility challenge. Proximity to suppliers and infrastructure quality were the least frequently cited factors, reported by 13.0% and 12.0% of respondents respectively. The relatively low reporting of proximity as a barrier suggests that physical distance to energy suppliers does not constitute a major challenge within the local context, especially for traditional biomass fuels that are typically sourced within the immediate community. However, for modern energy sources such as LPG, where distribution systems tend to be more centralized, and proximity to suppliers may become a more pertinent determinant of accessibility for households in the study area.

Table 8: Test of Association between Income and Primary Source of Household Energy

Chi-Square Tests	Value	Df	Asymptotic Significance (2-sided)
Pearson Chi-Square	638.418[a]	564	.016
Likelihood Ratio	545.623	564	.030
Linear-by-Linear Association	29.243	1	.000
N of Valid Cases	384		

Table 8 shows the result of The Chi-Square test between income and primary source of household energy in Gombi Local Government Area. The result indicates a significant association between income and the primary source of household energy in Gombi Local Government Area. The Pearson Chi-Square test value of 638.418 with 564 degrees of freedom is statistically significant at the 0.016 level. This p-value is less than the significance level of 0.05, indicating that there is a statistically significant association between income levels and the primary source of household energy used by residents. The likelihood ratio test, which is another measure of the association between income and energy source, also shows a statistically significant result with a p-value of 0.030, further confirming the association. The linear-by-linear association test, which assesses the linear relationship between income and energy source, shows a highly significant result (p-value = 0.000). This suggests a strong linear trend between these variables. Households with higher income levels are more likely to afford and adopt cleaner and more efficient energy sources such as electricity and Liquefied Petroleum Gas (LPG). Conversely, lower-income households tend to rely more on traditional biomass fuels like wood and charcoal, which are cheaper but have adverse environmental and health impacts. This further explains why cost is the most reoccurring factor affecting the various energy types used in the study area.

Table 9: Potential Alternative of Energy source use in study area

Alternative Energy Source	Gombi North	Gombi South	Garkida	Gaanda	Total (%)
Solar	58	49	66	50	223 (55.7)
Wind	26	20	17	11	74 (18.5)
Biomass	27	21	30	25	103 (25.8)
Total	111	90	113	86	400 (100)

Table 9 presents an overview of the most preferred alternative sources of household energy across various selected wards in Gombi Local Government Area. Biomass, as the most preferred alternative energy source, is reported by 25.8% of respondents and exhibits a varied distribution across wards, with Garkida having the highest count, closely followed by Gombi North and Gaanda. This suggests that households in Garkida, Gombi North, and Gaanda show a greater preference for solar energy, reflecting an acceptance of solar power as a preferred alternative energy source. Factors such as accessibility to sunlight and awareness of solar technology may influence these preferences.

Wind energy, as an alternative energy source, shows an uneven distribution across wards and is reported by 18.5% of respondents, with Gombi North having the highest representation (26). This suggests that households in Gombi North, followed by Gombi South, exhibit a relatively higher preference for wind energy in those areas. Factors such as wind patterns, geographic location, and awareness of wind energy

technology may contribute to the varying preferences observed across different wards.

Solar is reported by more than half (55.7%) of respondents as the most preferred alternative energy source. It shows a diverse and widespread distribution across all wards, with Garkida having the highest count (66) and Gombi South having the lowest count (49). This indicates that households in Garkida show a notable preference for biomass energy, which includes sources such as wood, crop residues, and animal dung. The overall high count for biomass across all wards highlights its continued significance as a preferred alternative energy source, potentially due to factors such as cultural practices, availability, and affordability

Table 10: Level of Interest for use of alternative source of energy

Alternative Energy Source	Gombi North	Gombi South	Garkida	Gaanda	Total (%)
Very much Not Interested	7	9	13	5	34 (8.5)
Not Interested	8	6	4	6	24 (6.0)
Moderately Interested	19	14	16	14	63 (15.7)
Interested	47	37	58	37	179 (44.8)
Very Much Interested	26	21	31	22	100 (25.0)
Total	107	87	122	84	400 (100)

Table 10 provides an insightful breakdown of the level of interest in using alternative sources of energy across the selected wards in Gombi Local Government Area. It can be seen that 8.5% of respondents are not interested in adopting alternative energy sources. There is a relatively low count across all wards, with Garkida having the highest representation among this group. This suggests that only a minority of respondents in the study area have no interest in using alternative energy sources.

A substantial 91.5% of respondents, on the other hand, expressed interest in trying alternative energy sources. These respondents are well distributed across all the wards, implying that there is widespread interest in alternative energy sources throughout the study area, as indicated in Table 4.2. However, there appears to be a comparatively lower level of interest in Gaanda and Gombi North, which may be attributed to a limited awareness of the potential environmental benefits of alternative energy sources in those wards.

Table 11: Factors influencing choice for alternative source of energy

Factor	Gombi North	Gombi South	Garkida	Gaanda	Total (%)
Lower Cost	7	9	13	5	34 (8.5)
Environmental Benefits	47	37	58	37	179 (44.8)
Availability in Your Area	19	14	16	14	63 (15.7)
Government Incentives or Subsidies	26	21	31	22	100 (25.0)

Energy Independence	8	6	4	6	24 (6.0)
Total	107	87	122	84	400 (100)

Table 11 presents some factors influencing the choice of alternative energy sources across the selected wards in Gombi Local Government Area. Lower Cost, as a factor reported by 8.5% of respondents, exhibits varying counts across the wards. Garkida stands out with the highest count of 13 respondents, while Gombi South has 9 respondents. In contrast, Gaanda has the lowest count of 5, indicating a relatively lower emphasis on cost considerations in this ward.

Environmental Benefits is the most frequently reported factor, accounting for 44.8% of total respondents, and shows diverse counts across wards. Garkida has the highest count of 58, indicating a strong preference for environmental considerations, while Gombi North records a relatively higher count of 47. Gombi South and Gaanda each record a count of 37, suggesting a widespread recognition of the environmental advantages of alternative energy sources. The overall high counts across all wards further underscore the broad acknowledgment of the environmental benefits associated with adopting alternative energy sources.

The Availability factor, reported by 15.7% of the respondents, also exhibits varying counts, with Gombi North recording the highest count of 19, highlighting the significance of local availability in that ward. Garkida records a notable count of 16, while Gombi South and Gaanda each record a count of 14, indicating a relatively lower emphasis on local availability in those wards.

The Government Incentives or Subsidies factor shows diverse counts across the wards, with Garkida and Gombi North recording relatively higher counts of 31 and 26, respectively, indicating a positive response to government initiatives in these wards. Gaanda and Gombi South record counts of 22 and 21, respectively. The distribution across all wards suggests a widespread recognition of the role of government incentives and support in influencing the adoption of alternative energy sources.

Energy Independence is the least reported factor, at 6.0%, suggesting a low desire for energy self-sufficiency among respondents. Achieving energy independence involves minimizing dependence on imported energy resources such as oil, gas, or electricity and promoting the use of domestic or renewable energy sources to meet the demand for power.

Table 12: Awareness of the environmental impacts associated with household energy use

Level of Awareness	Gombi North	Gombi South	Garkida	Gaanda	Total (%)
Not Aware	27	21	30	25	103 (25.8)
Slightly Aware	26	20	17	11	74 (18.5)
Aware	58	49	66	50	223 (55.7)
Total	111	90	113	86	400 (100)

Table 12 presents the level of awareness of the environmental impacts associated with household energy use across the selected wards in Gombi Local Government Area. The table reveals that the majority of respondents, accounting for 55.7%, are aware of the environmental impacts of household energy use.

Among the wards, Garkida records the highest count of 66 aware respondents, followed by Gombi North with 58, Gaanda with 50, and Gombi South with 49, suggesting a relatively broad recognition of the environmental consequences of household energy consumption across the study area.

Respondents who are slightly aware account for 18.5% of the total. Gombi North records the highest count of 26 in this category, followed by Gombi South with 20, Garkida with 17, and Gaanda with the lowest count of 11, indicating a moderate level of partial awareness across the wards.

A notable 25.8% of respondents, however, reported being entirely unaware of the environmental impacts associated with household energy use. Garkida records the highest count of 30 in this category,

followed by Gombi North with 27, Gaanda with 25, and Gombi South with 21. The presence of a significant proportion of unaware respondents across all wards highlights the need for targeted awareness campaigns and educational initiatives aimed at informing households about the environmental implications of their energy consumption practices

Table 13: Environmental impacts of household energy use in Gombi

Environmental Impacts	Frequency	Percentage
Greenhouse gas emissions	116	30.2
Deforestation	219	57.0
Water pollution	58	15.1
Habitat destruction	153	39.8
Air Pollution	324	84.4

Table 13 presents the environmental impacts of household energy use as perceived by respondents in Gombi Local Government Area. Air Pollution emerges as the most widely recognized environmental impact, with 324 respondents accounting for 84.4%, indicating that the majority of

households in the study area associate their energy use with deteriorating air quality. This is likely attributable to the widespread reliance on biomass fuels such as firewood and charcoal, which release significant amounts of smoke and harmful pollutants during combustion.

Deforestation is the second most recognized impact, reported by 219 respondents representing 57.0% of the total. This reflects an awareness of the strong link between household energy consumption and the progressive loss of forest cover, as the continued harvesting of wood for fuel contributes significantly to the depletion of vegetation in the area.

Habitat Destruction follows with 153 respondents, accounting for 39.8%, suggesting that a considerable proportion of respondents recognize the broader ecological consequences of energy-related activities on wildlife and natural ecosystems. Greenhouse Gas Emissions are acknowledged by 116 respondents, representing 30.2%, indicating a moderate level of awareness regarding the contribution of household energy use to climate change.

Water Pollution records the lowest frequency, with only 58 respondents accounting for 15.1%, suggesting that the connection between household energy use and water contamination is the least understood among respondents in the study area. Overall, the findings highlight the diverse range of environmental impacts associated with household energy use in Gombi, and underscore the urgent need for cleaner and more sustainable energy alternatives across the local government area.

Table 14: Measures to mitigate environmental impact arising from energy use in Gombi

Environmental Impacts	Frequency	Percentage
Turning off lights when not in use	95	24.7
Using energy-efficient LED or CFL bulbs	278	72.4
Using energy-efficient appliances (e.g., ENERGY STAR-rated)	124	32.3
Installing solar panels or solar water heaters	11	28.6
Waste-to-Energy Technologies	77	20.1
Afforestation and Reforestation	83	21.6
Education and Awareness	111	28.9
Not over depending on fossil fuel	54	14.1

Table 14 outlines respondents' perspectives on measures to mitigate the environmental impact of energy use in selected areas of Gombi Local Government Area. Approximately 24.7% of respondents recognize the importance of turning off lights when not in use as a measure to reduce environmental impact. This simple yet effective practice contributes to energy conservation and promotes responsible energy consumption habits.

A substantial 72.4% of respondents indicated a willingness to use energy-efficient LED or CFL bulbs. This high percentage suggests a positive inclination toward adopting more energy-efficient lighting technologies, which can significantly reduce electricity consumption and its associated environmental impacts. About 32.3% of respondents expressed a willingness to use energy-efficient appliances, such as those with ENERGY STAR ratings, demonstrating an awareness of the role that energy-efficient devices can play in reducing overall energy consumption and minimizing environmental footprints.

Approximately 28.6% of respondents consider the installation of solar panels or solar water heaters as a viable mitigation measure. This indicates a moderate level of interest in harnessing renewable energy sources and highlights the potential for the adoption of solar technologies within the community. About 20.1% of respondents expressed a willingness to explore waste-to-energy technologies, suggesting an appreciation for the potential of converting waste into energy as a sustainable solution that could contribute to both waste management and energy generation.

A notable 21.6% of respondents acknowledged afforestation and reforestation as essential mitigation measures. This recognition reflects the community's awareness of the relationship between energy consumption, deforestation, and the importance of preserving and restoring natural habitats. Approximately 28.9% of respondents identified education and awareness as a key measure, underscoring the importance of sustained educational initiatives in informing the community about sustainable energy practices and fostering a sense of responsibility and informed decision-making.

Finally, about 14.1% of respondents emphasized the importance of reducing over-dependence on fossil fuels, indicating an awareness of the environmental impacts associated with conventional fossil fuel use and the need to diversify toward cleaner and more sustainable energy sources.

IV. CONCLUSION

There is substantial reliance on traditional biomass fuels such as wood, charcoal, and kerosene in Gombi. These findings highlight the prevalent energy landscape characterized by reliance on readily available but environmentally detrimental sources. The prominence of wood and charcoal, underscores the urgent need for interventions promoting sustainable energy practices to mitigate environmental degradation and public health risks associated with traditional biomass use. Households in Gombi face significant challenges in household energy usage with surging limited access to primary energy sources. Factors such as income levels, infrastructure quality, and government policies emerged as critical determinants influencing accessibility. The disparities in energy availability shows that there is necessity for targeted interventions to address infrastructure challenges and policy frameworks inhibiting universal access to cleaner and more sustainable energy resources. Factors influencing energy consumption among households in Gombi includes socioeconomic and environmental factors shaping consumption patterns. Income levels, cost, government policies, and infrastructure quality emerged as significant influencers. The high reliance on traditional biomass fuels due to affordability and accessibility barriers reveals the concept of energy poverty, highlighting the need for policies promoting access to cleaner and more efficient energy sources. There is growing preference for renewable energy sources such as solar and wind, reflecting a shift towards more sustainable energy practices in Gombi. However, challenges such as limited availability and awareness of alternative energy technologies persist, particularly in rural areas.

V. RECOMMENDATIONS

Based on the findings of the study, these recommendations are made:

i. Given the significant reliance on traditional biomass fuels like wood and charcoal, there is a pressing need to promote sustainable energy practices in Girei LGA. Government at all levels should implement awareness campaigns to educate the community about the environmental and health impacts of traditional biomass use. Additionally, incentivizing the adoption of cleaner and more efficient energy sources such as LPG and solar energy through subsidies and support programs can facilitate the transition towards sustainable energy practices.

ii. Income levels emerged as a significant factor influencing energy consumption patterns. To address this, targeted interventions especially by Government and Non-Governmental Organizations should focus on improving income levels through economic empowerment programs and livelihood initiatives. Additionally, policies should aim to reduce energy poverty by providing financial assistance and subsidies to low-income households for accessing cleaner energy alternatives.

iii. The preference for renewable energy sources such as solar and wind presents an opportunity to diversify the energy mix and reduce reliance on traditional biomass fuels. Gombi residents should embrace energy-efficient technologies, such as energy-saving appliances and renewable energy solutions like solar panels, to reduce energy consumption and environmental impact.

iv. Researchers should continuously study the energy landscape of Gombi LGA to monitor changes over time and identify emerging trends. This includes investigating the effectiveness of implemented interventions and evaluating their impact on energy access, consumption patterns, and environmental sustainability.

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