INTERNATIONAL JOURNAL OF CONTEMPORARY EDUCATION AND MANAGEMENT (IJCEM)
E-ISSN 3121-9322 Volume 1, Issue 1, 2026,
Available online at: https://ijcempublications.com/wp-content/uploads/2026/07/article12.pdf

A Cross-Sectional Analysis of Energy Poverty in Kano State, Nigeria: A Multidimensional Approach

Hassan Nuhu Wali

Department of Economics, Sule Lamido University, Kafin Hausa, Nigeria
hnuhuwali@gmail.com

Article Info

Article History:
Received:22, Jul.,2026
Revised: 25, Jul.,2026
Accepted:27, Jul.,2026
Published:28 Jul.,2026

Keywords:
Multidimensional energy
Poverty,
Household,
Demography,
Clean energy,

Jel Code:
Q40, Q56

Abstract

This study examines the extent of multidimensional energy poverty among households in Kano State, Nigeria, using survey data collected from 400 households. The Multidimensional Energy Poverty Index (MEPI) and descriptive statistics were used for data analysis. The findings reveal that energy poverty is prevalent, with 82.29% of households identified as energy-poor and an overall MEPI of 0.523. The most critical areas of deprivation include access to clean cooking energy, affordability of electricity, and reliability of electricity supply. A significant share of households still depend on solid fuels, which raises serious health and environmental concerns. The results also uncover clear differences across demographic groups, with low-income, less-educated, and informally employed households facing greater challenges. Older household heads appear more vulnerable than those in the middle age group. The study underscores the need for targeted and practical policy measures to improve energy access and support a gradual transition to clean energy sources.

How to Cite:
Wali, H. N. (2026). A Cross-Sectional Analysis of Energy Poverty in Kano State, Nigeria: A Multidimensional Approach. *International Journal of Contemporary Education and Management, 1*(1), 135–144,
https://ijcempublications.com/wpcontent/uploads/2026/07/article12.pdf

Introduction

Increasing the number of people with access to clean energy is at the top of the global agenda nowadays (United Nations, 2017). The SDG-7 requires international communities to address the menace by ensuring "universal access to affordable, clean and sustainable energy, a substantial increase in the share of renewable energy in the global energy mix by 2030, and double the global rate of energy efficiency by 2030" (United Nations, 2025). However, access to clean energy remains a point of discussion in developing countries, due to high deprivation of modern cooking facilities and electricity (Schweinfest et al., 2024). Much empirical evidence confirmed a high incidence of energy deprivation in various Sub-Saharan African countries (Adeyonu et al., 2022; Gafa & Egbendewe, 2021; Ogwumike et al., 2014; Ssennono et al., 2021). Findings from Togo and Senegal revealed that in 2021, 80.20 per cent of households in Togo were energy-poor, and 83.10 per cent of the Senegalese were energy-poor (Gafa & Egbendewe 2021).

Despite the availability of energy resources in Nigeria, energy poverty is prevalent in the country. Adeyonu et al. (2022) revealed that in 2019, about 93% of households in Nigeria suffered from multiple dimensions of energy deprivation. Regarding extreme energy derivation Ozughalu & Ogwumike (2019) revealed that 20 per cent of households in the country were extremely energy-deprived in 2010. This implies that people in the country were deprived of all the modern energy services, and their energy deprivation scores in the MEPI reached the highest value of the index. In Nigeria, there is a regional divide in energy access because, in 2010, 97.2 per cent of households in Northern Nigeria were energy-deprived against 87.4 per cent of the Southern region (Adeyonu et al., 2022). The large percentage of energy destitution in the northern part of the country is surprising, considering the potentialities of renewable energies in the region. The region naturally receives more sunshine and wind year-round than the southern region (Wali et al., 2026). Another source of inequality in energy access in Nigeria is the urban-rural divide. Empirical evidence showed that rural areas of the country were left far behind regarding access to clean electricity and modern cooking fuel (Ashagidigbi et al., 2020). Therefore, increasing access to clean fuel can help reduce inequality among various socioeconomic groups in the country. Moreover, increasing energy access is paramount for environmental sustainability and biodiversity conservation. Deprivation of modern cooking facilities leads to deforestation due to the unorganized or massive felling of trees to provide cooking fuel to households. There is a need for tackling deforestation in Nigeria to mitigate desert encroachment and climate change. The northern part of the country is vulnerable to desert encroachment as the region is semi-arid zone.

Access to modern cooking facilities and electricity remains the primary concern in Nigeria as more than half of Nigerians use solid cooking fuel, and many are not electrified (Adeyonu et al., 2022; Ashagidigbi et al., 2020; Sanusi & Owoyele, 2016). Solid fuels are more severe in the country's rural areas (National Energy Commission, 2022). The situation is also prevalent in Kano State as the state was considered the firewood market of northern Nigeria (Cline-Cole & Maconachie, 2016). Solid fuels (firewood and charcoal) are predominant sources of cooking energy in the state despite the medical and environmental implications of using these fuels (Kiyawa & Yakubu, 2017). Thus, continuous solid fuel consumption in Kano State due to energy poverty could endanger desert encroachment since the state is located in extreme northern Nigeria, which is close to the Sahara desert.

Despite the rising trend of energy poverty in Kano State there is a limited understanding on energy poverty among household demographic groups. Therefore, this study supplements the existing literature by providing a demographic analysis of energy deprivation among households using first-hand information. The paper aims to empirically examine energy deprivation among households in Kano State. Therefore, this study was guided by the two specific objectives: First, to identify the incidence and level of energy poverty in Kano State. Second, to examine the heterogeneity of energy poverty across different household demographic groups.

Literature Review

Empirical studies across developing and emerging economies consistently reveal a high prevalence of multidimensional energy poverty, particularly in rural areas, with cooking energy and indoor pollution emerging as dominant drivers. For instance, Sher et al. (2014) reported significant regional disparities in Pakistan, where energy poverty ranged from 47% in Punjab to over 65% in Sindh and Baluchistan, largely driven by deprivation in cooking energy and indoor air quality. Similarly, studies in Sub-Saharan Africa highlight comparable patterns. In Nigeria, Ogwumike and Ozughalu (2016) found that over 75% of households were energy-poor, with heavy reliance on firewood and kerosene, while Ashagidigbi et al. (2020) reported higher rural energy deprivation (over 70%) compared to urban areas.

Across countries such as Ghana and Uganda, the multidimensional nature of energy poverty is further emphasized. Crentsil et al. (2019) documented a decline in Ghana's energy poverty over time, yet identified modern cooking fuel as the most critical deprivation indicator. Likewise, Ssennono et al. (2021) in Uganda showed that about 66% of households were energy-poor, with deficiencies in cooking energy and energy service quality being most severe. Evidence from West Africa by Gafa and Egbendewe (2021) also confirms that cooking energy remains the largest contributor to energy deprivation, with over 80% of households in Togo and Senegal classified as energy-poor.

In Asia, similar trends persist. Sadath and Acharya (2017) demonstrated substantial regional and occupational disparities in India, where informal workers and farmers were more energy-deprived than salaried households. Abbas et al. (2021) further confirmed high energy poverty across South Asia, particularly in Afghanistan and Bangladesh, where over 70% of households were affected. Meanwhile, Jayasinghe et al. (2021) found that in Sri Lanka, although electrification rates were high, lack of clean cooking energy remained a major challenge.Contrastingly, studies in developed and middle-income countries often emphasize affordability rather than access. For example, Selçuk et al. (2019) in Turkey and Castaño-Rosa and Okushima (2021) in Japan applied expenditure-based measures, showing declining energy poverty due to improved incomes and energy efficiency, although such approaches are limited in capturing the multidimensional aspects of deprivation.

Methodologically, most studies adopt either the Multidimensional Energy Poverty Index (MEPI) framework or expenditure-based approaches, each with notable limitations. While MEPI effectively captures multiple dimensions of deprivation, several studies (Ismail & Khembo, 2015; Sadath & Acharya, 2017) fail to incorporate key indicators such as electricity access hours and affordability. On the other hand, expenditure-based measures (Ajetunmobi et al., 2019; Selçuk et al., 2019) often underestimate energy poverty in rural contexts where households rely on freely collected biomass.

Methodology

This study uses cross-sectional survey design. The data of the analysis was generated from household survey conducted in Kano State. A sample of 400 household was surveyed. Structural questionnaires were administered on household heads who stay in Kano state. Six Local Government areas were randomly selected for study. Moreover, the research participants were selected using systematic probability sampling technique. The research instrument was formed based on review of the existing literature, and it was validated by experts. Pilot survey and expert review were conducted to ensure validity of the instrument.

Analytical techniques

This study adapts the Multidimensional Energy Poverty Index (MEPI) framework for calculating the incidence of energy poverty among households in Kano State, Nigeria. The index was adopted from Wali et al. (2025). The threshold for MEPI is 0.33, which means 'if the deprivation score reaches 0.33, the household is multidimensional energy poor'. The incidence of energy poverty is calculated by energy poverty headcount (H). The formula is denoted as:

$$H = 1/N \sum_{i=1}^{q} Ci > K \qquad (1)$$

Where N= Sample size, C_i=population of households that deprivation score greater than or equals cut-off, the K=energy deprivation cutoff

Intensity of energy deprivation is denoted as:

$$A=\sum_{i=1}^{q} Ci\ (k)/ \sum_{i=1}^{q} C_I \qquad (2)$$

Where: '$\sum_{i=1}^{q} C_i$ (k) is the mean deprivation scores of the energy-poor households in the sample'

The overall MEPI =H * A (headcount multiplied by intensity)

Equation 1 refers to the incidence of energy deprivation in the sample. The incidence represents the percentage of energy-poor households in the sample. It is obtained by dividing the number of energy-poor households by the sample size, then multiply by one hundred (100). The energy-poor household is any household in the sample whose total energy deprivation score reaches the threshold (greater than or equal to 0.33). Equation 2 measures the intensity of energy deprivation. In other words, it's a mean deprivation score in the sample. It's obtained by dividing the entire deprivation scores of all the energy-poor in the sample by the total number of energy-poor in the sample. Finally, the overall multidimensional energy poverty index is obtained by multiplying the incidence of energy poverty (H) by the severity of energy poverty (A), its mathematically represented in equation 3.3.

Table 2 *Multidimensional Energy Poverty Index Benchmark*

SN	Indicators	Energy deprivation scores
1	Household is not cooking with clean energy (LPG or electricity)	0.2
2	Household is cooking with dirty energy without chimney	0.2
3	Household doesn't receive a minimum of 6 hours of electricity supply daily	0.15
4	Electricity tariff is not affordable	0.15
5	The household doesn't have a refrigerator or fan	0.1
6	The household doesn't have a television or radio	0.1
7	The household doesn't have cellphones or telephone landlines	0.1
	Total energy deprivation score	**1.0**

Source: Adopted from Wali et al. (2025)

Table 2 explains how the multidimensional energy poverty index is computed. In this work, energy poverty is measured from seven (7) indicators of access to clean energy. Therefore, clean cooking energy and indoor pollution have 0.2 deprivation scores, while electricity supply and affordability indicators have 0.15 deprivation scores each. Finally, household appliances, entertainment, and communication appliances have 0.1 deprivation scores each.

Results and Discussions

Table 3 *Incidence of Energy Poverty in Kano State*

Incidence of EP (H)	Level of EP (A)	Overall MEPI (H*A)
82.29 %	0.6365	0.523

Source: Field survey, 2025

The incidence, severity and overall multidimensional energy poverty in the Kano State are presented in Table 3. The table reveals a high degree of energy deprivation among households in the state. This result shows that the incidence, severity and MEPI are very high in Kano State. The incidence of energy poverty reported by this study was close to the one reported at the national level using nationally representative data from 2018, which showed 93.9 per cent of households in Nigeria were multidimensional energy poor (Adeyonu et al., 2022). The findings also indicate variations in the incidence of energy poverty among the surveyed local government areas of the state. The result of the MEPI depicted in Table 3.3 shows the overall MEPI in Kano State was much higher than the one reported at the national level. (Ashagidigbi et al., 2020) Reported 0.38 MEPI in the country in 2020. (Adeyonu et al., 2022) reported 0.310 MEPI in their analysis using nationally representative data for 2018/19. The findings imply a high level of energy deprivation in the state, which could be a setback to attaining access to clean for all by 2030 as targeted by the SDGs.

Table 4 *Empirical Findings of MEPI Indicators*

	Indicators	**Not deprived (%)**	**Deprived (%)**
1	Clean cooking fuel	18.75	81.25
2	Indoor pollution	58.96	41.04
3	Electricity supply	26.46	73.54
4	Affordability of electricity	10.21	89.79
5	Household appliances	58.12	41.88
6	Entertainment appliances	76.04	23.96
7	Communication	92.5	7.50

Source: Field survey, 2025

Table 4 presents the indicator-by-indicator decomposition of the multidimensional energy poverty index. The cooking dimension emerges as a major source of deprivation, with 81.25% of households lacking access to modern cooking energy. This indicates that a large proportion of households continue to depend on solid fuels, despite the associated health and environmental risks. Earlier studies support this pattern, showing that about 78.94% of households in Kano State rely on fuel wood (Iro, 2019). Evidence further suggests that, over the past decade, the use of solid fuels has increased significantly in the state. This trend is largely attributed to rising petroleum product prices driven by economic reform policies, which have made cleaner alternatives such as LPG and kerosene less affordable for low-income households (Maconachie et al., 2009).

The second indicator of the index reveals that many participants are exposed to indoor air pollution, posing a serious obstacle to achieving the Sustainable Development Goals. Previous research in Kano State reported high concentrations of carbon monoxide resulting from the use of fossil fuels and traditional solid cooking fuels (Ayodele et al., 2010). Indoor air pollution is widely recognized as a leading cause of respiratory illnesses, chronic eye conditions, low birth

weight, and increased neonatal mortality (World Health Organization, 2023). Findings from this study indicate that about 41% of respondents use solid fuels for cooking without proper ventilation, such as chimneys, in their kitchens. During the field survey, many respondents reported experiencing health problems, including breathing difficulties and eye irritation. The World Health Organization (2023) further estimates that household air pollution caused 3.2 million deaths globally in 2020 and contributes to approximately 6.7 million premature deaths each year.

The third indicator of energy poverty relates to electricity supply, and it points to a high level of deprivation driven by unreliable power in the state. Empirical evidence shows that electricity provision in the area is insufficient, largely due to frequent outages that adversely affect households' socioeconomic activities (Ahmad et al., 2023; Dandago, 2002). Despite substantial investments made by successive Nigerian governments to address power shortages, the challenge of inadequate electricity supply remains unresolved (Okwudili et al., 2018)

The affordability indicator points to a significant inability among participants to cope with electricity tariffs. Previous research on electricity billing in Kano State found widespread dissatisfaction among households and firms, with many consumers complaining about estimated billing linked to outdated metering systems. In particular, the Kano Electricity Distribution Company has been criticized for failing to provide prepaid digital meters, especially in rural communities (Abdulwahab, 2010). Tariff levels are also unstable, as electricity prices are frequently adjusted in response to broader economic challenges such as exchange rate fluctuations, persistent inflation, and rising energy costs, including LPG. The origin of these tariff increases can be traced to the 2005 power sector reforms in Nigeria, which introduced deregulation and led to the privatization of state-owned electricity utilities (Oladipo et al., 2018).

With respect to household appliances, the findings indicate considerable variation in ownership across the surveyed local government areas. This disparity is closely linked to inadequate electricity supply, as unreliable power limits the ability of households to acquire and effectively use electrical appliances. In contrast, the indicator for entertainment devices shows relatively low deprivation in the state. Lastly, the communication indicator demonstrates strong performance, with only 7.5% of households lacking access to either a landline or mobile phone. This suggests that access to telecommunication services is nearly universal. Consequently, there is a need for government to strengthen internet security measures to guard against the rising risk of cybercrime.

Table 5 MEPI based on Household's Gender and Marital Status

	Sex		**Marital Status**	
	Male (%)	Female (%)	Married (%)	Not married (%)
Incidence of energy poverty	81.90	93.75	91.46	37.80
Modern cooking fuel	81.03	87.50	91.46	31.71
Indoor pollution	40.52	56.25	46.23	54.55
Electricity supply	73.71	68.75	75.88	72.73
Affordability of electricity	90.09	81.25	88.94	93.90
Household appliances	41.38	56.25	46.23	20.73
Entertainment appliances	23.49	37.50	25.13	18.29
Communication	6.90	25.00	7.79	6.10

Source: Field survey, 2025

Table 5 provides the incidence of energy deprivation based on demographic characteristics of the participants. The family headed by female suffers more from energy deprivation than the one headed by male. The finding implies a gender issue

in access to energy in Kano State. The results also show that female-headed households are more affected in most of the indicators of energy poverty than their male-headed counterparts. However, the proportion of female household heads in the sample was tiny. The survey result shows that out of 400 surveyed households, only 16 were female, which is 3.3 per cent of them. However, the information regarding the participants' marital status shows that households headed by married people are affected by energy deprivation more than those headed by unmarried people. Even though married household heads were 82.92 per cent of the surveyed households. Most of the indicators of MEPI revealed that the families headed by the married were more deprived than the ones headed by a non-married person.

Table 6 MEPI Based on Education Status and age (in percentage)

	Education level				Age group		
	No formal education	Primary	Secondary	Tertiary	15-34 years	35-54 years	55 and above
Incidence of energy poverty	100.00	98.55	97.89	65.25	81.73	77.48	93.86
Modern cooking fuel	100.00	100.00	98.95	62.29	77.88	77.10	93.86
Indoor pollution	61.25	59.42	51.58	24.58	34.62	38.93	51.75
Electricity supply	73.75	79.71	83.16	67.80	84.62	70.23	71.05
Affordability of electricity	92.50	86.96	88.42	90.25	88.46	89.31	92.11
Household appliances	68.75	57.97	53.68	23.31	41.35	36.26	55.26
Entertainment appliances	38.75	27.54	26.32	16.95	25.00	22.14	27.19
Communication	13.75	8.70	7.37	5.08	4.81	8.02	8.77

Source: Field survey, 2025

Table 6 presents the decomposition of energy poverty by households' educational attainment and income levels. The results show that energy deprivation is most prevalent among households with low levels of education. Specifically, households with no formal education exhibit the highest incidence of energy poverty, followed by those with primary and secondary education, while households with tertiary education experience the lowest levels of deprivation. This pattern is expected, as higher levels of education are often associated with greater awareness of the health risks linked to the use of traditional fuels. Consequently, household heads with higher educational attainment tend to be less energy-poor compared to those with limited or no education. This trend is consistent across most indicators of the index.

In terms of age distribution, both the younger and older household groups exhibit higher levels of energy deprivation, whereas the middle-aged group is relatively less affected. Notably, elderly households appear to be more vulnerable to multidimensional energy poverty. The consistency of this pattern across several indicators aligns with the Diffusion of Innovation theory, which suggests that individual characteristics, such as age, influence the adoption of new technologies. Older individuals are generally slower in adopting modern energy solutions. On the other hand, the

relatively high deprivation observed among younger household heads may be linked to limited financial capacity, as their income levels are often lower than those of middle-aged

Table 7 MEPI based Income and Occupation (in percentage)

	Income groups			Occupation	
	Low	**Middle**	**High**	**Salary earners**	**Non-salary earners**
Incidence of energy poverty	94.23	77.71	38.89	64.44	93.00
Modern cooking fuel	91.92	78.31	38.89	62.78	92.33
Indoor pollution	49.23	37.35	12.96	27.22	49.33
Electricity supply	84.23	66.27	44.44	73.89	73.33
Affordability of electricity	88.46	90.36	94.44	89.44	90.00
Household appliances	57.31	28.31	9.26	25.00	52.00
Entertainment appliances	33.08	15.66	5.56	13.89	3.00
Communication	8.46	5.42	9.26	6.67	8.00

Source: Field survey, 2025

Table 7 outlines the incidence of energy poverty across different income groups and occupational categories of the participants. The data on income groups reveal clear differences in levels of energy deprivation, with lower-income households consistently experiencing higher deprivation across nearly all MEPI indicators compared to higher-income groups. This observation is consistent with the energy ladder theory, which suggests that as households improve their socioeconomic status, they gradually transition from using traditional, polluting fuels to cleaner, modern energy sources. Consequently, low-income households tend to rely on solid fuels due to their limited ability to afford cleaner alternatives. This explains why solid fuels are often regarded as inferior goods, while clean energy sources are considered normal goods (Iro, 2019).

Furthermore, the breakdown of energy poverty by occupation shows that 64.44% of salaried workers are energy poor, compared to 93% among non-salaried individuals. This indicates that households with stable, formal employment experience a lower incidence of energy poverty than those engaged in informal sector activities. Similar patterns have been observed in India using nationally representative data, where multidimensional energy poverty varies across occupational groups and social categories. Salaried workers tend to have lower levels of deprivation compared to labourers, farmers, and others in the informal sector, while higher levels of energy poverty were reported among groups such as Dalits, Adivasis, and other backward castes (Sadath & Acharya, 2017).

Conclusion

The findings indicate that both the prevalence and intensity of energy deprivation are considerable among households in Kano State, Nigeria. Many households lack access to modern energy services, rendering them multidimensional energy-poor. The majority of respondents rely on solid fuels for cooking, despite the well-documented environmental and health

risks associated with traditional biomass use. Beyond cooking energy challenges, households also face significant issues related to electricity access and affordability. Specifically, 73.54% of households were identified as deprived in terms of electricity supply, indicating inadequate access, while 89.79% reported being unable to afford prevailing electricity tariffs. The analysis further reveals notable disparities in both the incidence and severity of energy deprivation across the state. Differences are evident among various demographic groups, with low-income and less-educated households experiencing disproportionately higher levels of energy poverty.

In light of the aforementioned conclusions, policies on addressing energy poverty should prioritize low-income households and those working in the informal sector in Kano State. This can be achieved by improving access to reliable and affordable modern energy through initiatives such as subsidized tariffs, flexible payment systems for vulnerable groups, provision of mini-grid electrification, and improvements in electricity infrastructure. There is also a need to encourage the uptake of clean cooking options: LPG and renewable energy technologies by providing financial support, and raising awareness. Similarly, boosting income opportunities, promoting skills acquisition, and improving educational levels among disadvantaged groups will facilitate clean energy transition. Therefore, addressing energy poverty effectively requires a coordinated approach that integrates energy sector policies with efforts from stakeholders.

References

Abdulwahab, L. (2010). An assessment of billing electricity consumers via analogue meters in Kano, Nigeria, by Kano electricity distribution plc. Bayero Journal of Pure and Applied Sciences, 2(1), 27–33. https://doi.org/10.4314/bajopas.v2i1.58451

Adeyonu, A. G., Adams, S. O., Kehinde, M. O., Akerele, D., & Otekunrin, O. A. (2022). Spatial profiles and determinants of multidimensional energy poverty in rural Nigeria. International Journal of Energy Economics and Policy, 12(3), 373–384. https://doi.org/10.32479/ijeep.13163

Ashagidigbi, W. M., Babatunde, B. A., Ogunniyi, A. I., Olagunju, K. O., & Omotayo, A. O. (2020). Estimation and determinants of multidimensional energy poverty among households in Nigeria. Sustainability (Switzerland), 12(18), 1–13. https://doi.org/10.3390/SU12187332

Ayodele, J., Adekiya, A., & Yakubu, I. (2010). Carbon monoxide as indoor pollutant in Kano Metropolis. Journal of Applied Sciences and Environmental Management, 11(3), 1–4. https://doi.org/10.4314/jasem.v11i3.55072

Cline-Cole, R., & Maconachie, R. (2016). Wood energy interventions and development in Kano, Nigeria: A longitudinal, "situated" perspective. Land Use Policy, 52, 163–173. https://doi.org/10.1016/j.landusepol.2015.11.014

Gafa, D. W., & Egbendewe, A. Y. G. (2021). Energy poverty in rural West Africa and its determinants: Evidence from Senegal and Togo. Energy Policy, 156(July), 112476. https://doi.org/10.1016/j.enpol.2021.112476

Iro, H. N. (2019). Descriptive analysis of household energy consumption for cooking in rural and urban areas of Kano State. European academic research, VII(8), 3779–3791.

Kiyawa, A. I., & Yakubu, I. (2017). Socio-economic factors influencing household energy choices in Kano Metropolis, Nigeria. American Journal of Science, 4(3), 10–17.

Maconachie, R., Tanko, A., & Zakariya, M. (2009). Descending the energy ladder? Oil price shocks and domestic fuel choices in Kano, Nigeria. Land Use Policy, 26(4), 1090–1099. https://doi.org/10.1016/j.landusepol.2009.01.008

National Energy Commission. (2022). National energy policy. https://www.databank.energy.gov.ng/energy_laws/Energy_Policy_Document.pdf

Ogwumike, F. O., Ozughalu, U. M., & Abiona, G. A. (2014). Household energy use and determinants: Evidence from Nigeria. International Journal of Energy Economics and Policy, 4(2), 248–262. https://www.econjournals.com/index.php/ijeep/article/view/708

Okwudili, I. V., Ngozi, I. A., & Henson, A. (2018). Impact of deficient electricity supply to small and medium scale enterprises in Kano-Nigeria. Advanced Management, 17(2).

Oladipo, K., Felix, A. A., Bango, O., Chukwuemeka, O., & Olawale, F. (2018). Power sector reform in nigeria: Challenges and solutions. IOP Conference Series: Materials Science and Engineering, 413(1). https://doi.org/10.1088/1757-899X/413/1/012037

Ozughalu, U. M., & Ogwumike, F. O. (2019). Extreme energy poverty incidence and determinants in Nigeria: A multidimensional approach. Social Indicators Research, 142(3), 997–1014. https://doi.org/10.1007/s11205-018-1954-8

Sadath, A. C., & Acharya, R. H. (2017). Assessing the extent and intensity of energy poverty using Multidimensional Energy Poverty Index: Empirical evidence from households in India. Energy Policy, 102(December 2016), 540–550. https://doi.org/10.1016/j.enpol.2016.12.056

Sanusi, Y. A., & Owoyele, G. S. (2016). Energy poverty and its spatial differences in Nigeria: Reversing the trend. Energy Procedia, 93(March), 53–60. https://doi.org/10.1016/j.egypro.2016.07.149

Schweinfest, S., Papathanasiou, D., Neira, M., & Govindarajalu, C. (2024). Access to electricity. In The Energy Progress Report 2022.

Ssennono, V. F., Ntayi, J. M., Buyinza, F., Wasswa, F., Aarakit, S. M., & Mukiza, C. N. (2021). Energy poverty in Uganda: Evidence from a multidimensional approach. Energy Economics, 101(July), 105445. https://doi.org/10.1016/j.eneco.2021.105445

United Nations. (2017). Sustainable Development Goal - 7. UN. http://www.un.org/sustainabledevelopment/education/%0Ahttp://www.un.org/sustainabledevelopment/energy/

United Nations. (2025). Ensure access to affordable, reliable, sustainable and modern energy for all. https://sdgs.un.org/goals/goal7#targets_and_indicators

Wali, H. N., Dutta, T., Sani, B., & Isak, J. M. S. (2025). Impact of energy poverty on human capital: a cross-sectional analysis of the rural households in Kano State, Nigeria. Cogent Economics and Finance, 13(1). https://doi.org/10.1080/23322039.2025.2469785

Wali, H. N., Dutta, T., Umar, M., & Fuad, U. (2026). A critical review of Nigeria ' s energy sector : sources , policies and electricity market. Cogent Economics & Finance, 14(1). https://doi.org/10.1080/23322039.2026.2639684

WHO. (2023). Household air pollution. https://www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health?gclid=CjwKCAiA5L2tBhBTEiwAdSxJX35m7r_HIKd91J7HxcBsRHc29rUns53IMOiUKixWRYKamGoo0iwCxBoCiYYQAvD_BwE