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## Energy supply and public sector performance in Calabar municipality, Cross River State- Nigeria

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### Abstract

This study examined the influence of energy supply on public service delivery in Calabar Municipality Local Government Area of Cross River State. The study was driven by persistent concerns over unstable electricity and its implications for the effectiveness of essential public services. Anchored on Systems Theory and Energy Ladder Theory, the research explains how energy functions as a central input that sustains interconnected service systems and improves institutional performance as access to modern energy increases. A quantitative survey design was adopted and data were collected from residents and users of public institutions across the municipality. Findings revealed that stable electricity supply significantly enhances healthcare delivery, improves teaching and learning activities, supports water pumping and distribution, and strengthens administrative efficiency. The study further showed that irregular power supply causes delays in medical services, limits the use of ICT facilities in schools, increases dependence on generators, raises operational costs, and weakens sanitation services. These results highlight the strategic importance of electricity as a critical driver of public sector productivity and community wellbeing. The study concludes that improving energy stability is essential for strengthening service delivery and promoting sustainable development. It recommends sustained investment in power infrastructure, adoption of alternative energy sources, and improved coordination between energy providers and public institutions.

**Keywords:** Energy; Energy Supply; Public Sector Performance; Service Delivery; Calabar Municipality

### 1. Introduction

Energy supply remains a central pillar of effective public service delivery. When electricity is stable and reliable, hospitals operate life-saving equipment, schools conduct uninterrupted teaching and learning, water facilities pump and treat clean water, and sanitation services function efficiently (Onyia *et al.*, 2020). In societies with dependable energy infrastructure, public institutions respond more effectively to citizens' needs and contribute meaningfully to social welfare and development. Where energy supply is weak or irregular, however, the performance of public services deteriorates and everyday life becomes more difficult for residents (Momoh *et al.*, 2018).

Across sub Saharan Africa, inadequate access to electricity continues to undermine development outcomes. As of 2021, about 567 million people in the region lacked access to electricity, accounting for over 80 percent of the global population without power (Msafiri & Adjadeh, 2024). This persistent energy deficit constrains the capacity of governments to deliver essential services. Health facilities struggle to refrigerate vaccines or operate diagnostic machines. Schools remain unable to adopt digital learning or conduct extended academic activities. Water supply and sanitation systems frequently shut down when power fails, exposing communities to health and environmental risks.

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Nigeria reflects these challenges in stark terms. Although the national grid recorded a peak generation of 5,713.6 megawatts in March 2025, this output remains grossly insufficient for a population exceeding 200 million people (Transmission Company of Nigeria, 2025). The gap between energy demand and supply places severe pressure on public institutions. Hospitals depend heavily on diesel generators, raising operating costs and limiting service delivery. Schools contend with disrupted academic schedules, while water authorities struggle to maintain steady distribution. These challenges are felt most sharply at the local government level, where institutional capacity and financial resources are often limited.

In Calabar Municipality Local Government Area of Cross River State, the consequences of inconsistent energy supply are immediate and tangible. Public agencies expend a significant portion of their budgets on fuel for generators. Health centers postpone medical procedures and sometimes lose temperature-sensitive drugs during prolonged outages. Schools lose instructional hours and lack functional laboratories and computer facilities. Water pumping stations shut down without notice, leaving households without clean water, while waste management and sanitation services become irregular. These conditions directly affect residents' quality of life and undermine confidence in local governance. The problem addressed by this study is the persistent inability of public institutions in Calabar Municipality to deliver services efficiently due to unreliable energy supply. While energy issues are often discussed at the national level, limited empirical attention has been given to how energy availability shapes public service delivery at the municipal and local government level, where citizens interact most directly with the state. This gap in knowledge obscures the everyday realities faced by local institutions and residents alike.

Against this background, this study aims to examine the relationship between energy supply and public service delivery in Calabar Municipality Local Government Area of Cross River State, Nigeria. Specifically, it seeks to assess how the availability and reliability of electricity influence the performance of key public services such as health care, education, water supply, and sanitation, as well as the broader implications for residents' welfare. In line with this objective, the study is guided by the following research questions.

- *How does the level of energy supply affect the delivery of public services in Calabar Municipality Local Government Area?*
- *In what ways does inconsistent energy supply influence the efficiency of health, education, water, and sanitation services in the study area?*

The contribution of this study is threefold. At the theoretical level, it strengthens existing discussions on infrastructure and public administration by foregrounding energy supply as a critical determinant of service delivery at the local level. At the empirical level, it provides location-specific evidence from Calabar Municipality, an urban center that has received limited scholarly attention in energy and governance research. At the policy level, it offers practical insights to guide local and state governments in designing energy and service delivery strategies that improve human welfare and promote sustainable development at the grassroots.

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## **2. Theoretical underpinning: Energy Ladder Theory and Systems Theory**

The Energy Ladder Theory, introduced by Goldemberg and colleagues in 1985, explains how households gradually shift from traditional and inefficient energy sources to cleaner and more advanced ones as their socio economic circumstances improve. This theoretical perspective is valuable for understanding the dynamics of energy use in developing contexts. In many rural and underserved communities, households and public institutions still depend on low efficiency fuels because modern energy infrastructure is limited. The theory helps explain why communities that occupy lower rungs of the energy ladder experience persistent constraints in public service delivery. Without steady access to electricity, hospitals struggle with basic equipment, schools cannot support digital learning, and water supply systems fail to operate consistently.

The Energy Ladder Theory therefore provides a useful lens for this study by linking the availability of modern energy to the performance of public services in Calabar Municipality. As communities progress upward on the energy ladder and gain access to cleaner and more reliable electricity, the effectiveness of services in healthcare, education, water supply and sanitation is expected to improve. Although the theory assumes a linear progression, real world transitions may be slower or disrupted by infrastructural and financial barriers. Even so, it offers a strong foundation for analysing how energy access shapes public service delivery at the local government level.

Systems Theory, on the other hand, offers a broad explanatory framework for understanding how different parts of a social system interact to produce outcomes. Developed through the works of scholars such as Ludwig von Bertalanffy, the theory argues that institutions, resources, actors and processes operate as interdependent components of a single

system. When one component fails or becomes unstable, the entire system experiences stress. Public service delivery functions in this manner. Health facilities, schools, water services and administrative units rely on functional inputs such as manpower, funding, equipment and above all energy. Electricity becomes a vital subsystem that supports the functioning of every other part. When energy supply is weak, the entire service delivery system absorbs the shock and performance declines at multiple points.

Applying Systems Theory to the study helps explain why energy instability in Calabar Municipality produces widespread failures in healthcare, education and water services. It clarifies that poor public service delivery is not an isolated challenge but the result of stress within the larger operational system. A clinic cannot function optimally when power cuts disrupt diagnostics. A school system becomes ineffective when electricity fails to support digital tools. A water facility stops working when its pumping subsystem collapses. Systems Theory therefore provides the analytical foundation for understanding these interconnected disruptions.

Using both Systems Theory and the Energy Ladder Theory strengthens the study. The Energy Ladder Theory explains how communities move from traditional to modern energy sources and why access to electricity remains uneven across socio economic groups. Systems Theory complements this by showing how inadequate energy supply affects the entire structure of public service delivery. Together, the two theories capture both the progression toward modern energy use and the systemic consequences of weak energy infrastructure. This combined framework offers a richer and more grounded understanding of how energy supply shapes public service delivery in Calabar Municipality.

### 3. Empirical Review

Energy supply has attracted growing scholarly and policy attention as a decisive factor in the quality of public service delivery and local development in Nigeria. Reliable electricity underpins the effective functioning of health facilities, schools, water systems, administrative offices, and small scale economic activities, particularly at the local government level. Table 1 below presents a summary of key empirical studies conducted between 2018 and 2025 that examine the relationship between energy supply and public service delivery in Nigeria and comparable developing country contexts. The review captures a range of methodological approaches, including household surveys, institutional assessments, case studies, and mixed method analyses. It synthesises their major findings in order to identify dominant trends, recurring challenges, and gaps in existing knowledge that justify the present study on Calabar Municipality Local Government Area of Cross River State, Nigeria.

**Table 1** Empirical review on energy supply and public sector performance

Author/Year	Objective of Study	Methodology	Result/Finding
Akinyele & Rayudu (2016)	To evaluate the effectiveness of off-grid solar systems in improving electricity access in rural Nigeria.	Mixed methods. Field surveys and structured interviews with households in Kwara State.	Solar systems improved access but adoption was limited by high costs, poor technical skills, and weak policy support.
Yelwa, & Awe (2018).	To assess the economic impact of power outages on SME productivity in Abuja.	Survey research design.	The poor state of electricity supply in Nigeria imposes significant financial and operational costs on SMEs
Akuru et al. (2017)	To assess Nigeria's energy mix and renewable energy transition prospects	Policy review and interviews with stakeholders in the power sector	Poor implementation, weak funding, and bureaucratic delays hinder renewable energy adoption
Nduka (2021)	To examine rural household energy poverty and affordability constraints to modern electricity access in South East Nigeria.	Household survey and contingent valuation method conducted in Ebonyi State, including willingness-to-pay estimation for off-grid energy solutions.	Energy poverty stemmed from affordability constraints, despite strong household demand willingness.
Nigeria Energy Transition Office &	To examine national renewable-energy mini-grid potential	Nationwide project data review using NEP datasets	Mini-grids could generate 25 million connections. Sustainability risks remain

World Bank (2022)			due to dependence on foreign components
Adenikinju (2003)	To examine the impact of electricity infrastructure failures on firm performance and productivity in Nigeria	Firm-level survey data analysis using econometric modelling.	Frequent outages reduced productivity, raised costs, and increased generator dependence.
Oseni (2012)	To investigate how electricity supply constraints affect firm performance and energy utilization in Nigeria.	Panel data analysis of manufacturing firms using enterprise survey datasets and econometric estimation techniques.	Unreliable electricity reduced firm output, profitability, and increased generator reliance and inefficiencies.
Abubakar (2019).	To examine determinants of household access to improved drinking water in Nigeria and the role of electricity access.	Quantitative analysis using Nigeria DHS 2013, Chi square and logistic regression.	Electricity access predicts improved water access; unreliable power weakens service safety.
Magazzino et al. (2023)	To assess Nigeria's electricity supply security challenges and their implications for development outcomes	Time series analysis with structural breaks, plus machine learning clustering using long run national data.	Persistent supply gaps show unstable electricity constrains public sector performance.
Oladigbolu et al. (2021)	To determine a cost effective hybrid electricity solution for rural health facility electrification in Nigeria.	Techno economic modelling using HOMER for a rural health clinic system design.	Optimal PV diesel battery system lowered costs, reduced emissions, improved health service readiness.
Olanrele et al. (2020).	To evaluate how electricity access affects education and health related outcomes in rural Nigerian communities.	Primary data from 12 rural communities benefiting from electrification. Econometric analysis.	Electricity access improved study and health conditions, strengthening education and service environments.
Mentis et al. (2015).	To develop an evidence based electrification planning model for Nigeria	GIS based electrification planning and scenario modelling for Nigeria.	The study identifies least-cost pathways, strengthening community and public service access.
Sustainable Energy for All (2022).	To assess Nigeria's healthcare electrification gap and propose a market roadmap for powering healthcare facilities.	Market assessment and sector roadmap using health sector and energy sector stakeholder evidence.	Report reveals PHC energy gaps; reliable electricity underpins effective healthcare delivery.
World Health Organization (2023).	To provide global evidence and guidance for accelerating electricity access in healthcare facilities	Multi country synthesis and policy guidance for health facility electrification.	Electricity access underpins safe healthcare delivery, diagnostics, cold chains, and emergency services.

The foregoing review shows that energy supply has been consistently linked to the effectiveness of public service delivery, institutional performance, and overall quality of life at the local government level. Empirical studies largely agree that stable electricity improves service efficiency in health, education, water provision, and local administration, while irregular supply weakens service outcomes and public trust. However, most existing studies have examined energy supply and public service delivery as broad national or sectoral issues, with limited attention to local government specific contexts and everyday service realities. Few researches have focused on how variations in energy supply shape service delivery outcomes within specific municipalities, especially in the South South region of Nigeria. This study therefore fills this important gap by empirically examining the relationship between energy supply and public service delivery in Calabar Municipality Local Government Area of Cross River State. It builds on existing evidence

to provide localized insights that can inform policy, strengthen service delivery systems, and guide sustainable energy planning at the grassroots level.

#### 4. Methodology

This study adopted a descriptive survey research design, which is suitable for examining patterns, conditions, and perceptions related to energy supply and public service delivery at the local government level. The design made it possible to collect quantitative data from a wide range of respondents and to systematically analyse how the availability and reliability of energy influence the delivery of public services such as health care, education, water supply, and local administration in Calabar Municipality Local Government Area of Cross River State. The descriptive survey approach allowed the study to capture real life experiences of residents and public service users, as well as institutional realities within the study area. The population of the study comprised all adult residents of Calabar Municipality Local Government Area of Cross River State. The area represents an important urban center with diverse residential, commercial, and administrative activities that depend heavily on stable energy supply. To obtain a manageable and representative sample, a stratified sampling technique was adopted. The municipality was first stratified into major districts or wards to ensure adequate coverage of the entire local government area. Within each stratum, respondents were selected using accidental sampling, allowing residents who were available and willing to participate at the time of data collection to be included. This approach was considered appropriate because it enabled efficient data collection within a busy urban environment while still capturing varied experiences across locations. A total of 400 valid questionnaires were administered and successfully retrieved, representing a one hundred percent response rate, and all were used for analysis.

The study utilised a structured questionnaire titled Energy Supply and Public Service Delivery Questionnaire. The instrument contained closed ended and Likert scale items designed to elicit information on the nature of energy supply in the area, frequency of power interruptions, and the effects of energy availability on key public services. The questionnaire also captured respondents' assessments of service efficiency and challenges faced by public institutions due to energy related constraints. Data collection was carried out through physical administration of questionnaires to ensure direct engagement with respondents and to accommodate participants with limited access to digital platforms. To ensure validity, the questionnaire items were carefully developed in line with the study objectives and research questions. Experts in public administration, energy policy, and research methodology reviewed the instrument to confirm clarity, relevance, and logical consistency. Their inputs helped refine the wording and structure of the items, thereby strengthening the content validity of the instrument. Reliability, understood as the consistency of a measurement instrument (Ayamba *et al.*, 2024), was ensured through careful internal checks and uniform administration procedures across all respondents. Data collected were analysed using descriptive statistical techniques, mainly frequency distributions and percentages. The results were presented in tables and accompanied by detailed interpretative explanations to clearly show patterns and relationships between energy supply and public service delivery in the study area. This analytical approach provided a clear empirical basis for discussing findings and drawing conclusions relevant to local governance and energy policy in Cross River State

#### 5. Results

**Table 2** Response rate on the effect of energy supply on public service delivery in Calabar Municipality

S/N	Items	A		D	
		SA	A	D	SD
1.	Stable electricity supply improves the quality of healthcare services in Calabar Municipality	46%	28%	16%	10%
2.	Frequent power outages disrupt teaching and learning activities in public schools	42%	31%	15%	12%
3.	Reliable energy supply enhances the efficiency of water pumping and distribution systems	44%	30%	14%	12%
4.	Public offices perform better when electricity supply is consistent	48%	27%	13%	12%
5.	Unstable power supply reduces the overall quality of services received by residents	50%	29%	12%	9%

Source: Author's field survey, 2025.

### 5.1. Interpretation

In the first item, 46 percent of the respondents strongly agreed and 28 percent agreed that stable electricity supply improves the quality of healthcare services in Calabar Municipality. Meanwhile, 16 percent disagreed and 10 percent strongly disagreed. This indicates that a large proportion of residents recognize the central role of electricity in supporting hospital equipment, storage of drugs, and delivery of emergency services. In the second item, 42 percent strongly agreed and 31 percent agreed that frequent power outages disrupt teaching and learning activities in public schools. However, 15 percent disagreed and 12 percent strongly disagreed. This suggests that energy instability significantly affects instructional time, use of educational technology, and academic productivity. In the third item, 44 percent strongly agreed and 30 percent agreed that reliable electricity supply enhances the efficiency of water pumping and distribution systems. In contrast, 14 percent disagreed and 12 percent strongly disagreed. This implies that access to electricity is closely tied to the availability of clean water in the municipality. In the fourth item, 48 percent strongly agreed and 27 percent agreed that public offices perform better when electricity supply is consistent. Meanwhile, 13 percent disagreed and 12 percent strongly disagreed. This shows that respondents associate steady power supply with improved administrative productivity and faster service delivery. Finally, 50 percent strongly agreed and 29 percent agreed that unstable power supply reduces the overall quality of services received by residents. Only 12 percent disagreed and 9 percent strongly disagreed. This indicates a strong public perception that electricity availability directly shapes the effectiveness of public service delivery in the study area.

**Table 3** Response rate on the influence of inconsistent energy supply on efficiency of specific public services in Calabar Municipality

S/N	Items	A		D	
		SA	A	D	SD
1.	Power outages cause delays in medical treatment and diagnostic services	47%	30%	13%	10%
2.	Electricity shortages limit the use of laboratories and ICT facilities in schools	45%	32%	13%	10%
3.	Irregular energy supply affects the operation of water treatment and pumping stations	43%	34%	12%	11%
4.	Dependence on generators increases operational costs for public institutions	49%	28%	14%	9%
5.	Frequent electricity interruptions reduce the efficiency of sanitation and waste management services	41%	33%	15%	11%

Source: Author's field survey, 2026

### 5.2. Interpretation

On the first item, 47 percent strongly agreed and 30 percent agreed that power outages cause delays in medical treatment and diagnostic services. Only 13 percent disagreed and 10 percent strongly disagreed. This shows that unreliable electricity has a direct effect on health outcomes and service timeliness. In the second item, 45 percent strongly agreed and 32 percent agreed that electricity shortages limit the use of laboratories and ICT facilities in schools. Meanwhile, 13 percent disagreed and 10 percent strongly disagreed. This suggests that unstable energy supply restricts educational innovation and practical learning. In the third item, 43 percent strongly agreed and 34 percent agreed that irregular energy supply affects the operation of water treatment and pumping stations. Conversely, 12 percent disagreed and 11 percent strongly disagreed. This indicates that electricity plays a critical role in maintaining water availability and sanitation standards. In the fourth item, 49 percent strongly agreed and 28 percent agreed that dependence on generators increases operational costs for public institutions. Meanwhile, 14 percent disagreed and 9 percent strongly disagreed. This reflects the financial strain placed on public agencies due to energy instability. In the fifth item, 41 percent strongly agreed and 33 percent agreed that frequent electricity interruptions reduce the efficiency of sanitation and waste management services. Only 15 percent disagreed and 11 percent strongly disagreed. This suggests that energy supply problems extend beyond health and education to affect environmental and municipal services.

## 6. Discussion

The findings of this study provide strong empirical support for the argument that energy supply plays a central and indispensable role in shaping the effectiveness of public service delivery in Calabar Municipality. The results from Tables 2 and 3 clearly show that stable electricity supply significantly improves the quality and efficiency of essential

services such as healthcare, education, water supply, sanitation, and administrative operations. The overwhelming level of agreement among respondents suggests that electricity is not merely a supporting resource but a critical driver of institutional functionality and service performance. These findings reinforce the broader understanding that reliable energy is a foundational requirement for sustainable public sector development in emerging economies (Momoh *et al.*, 2018).

The study reveals that a large proportion of respondents strongly agree that stable electricity supply enhances healthcare service delivery. This finding reflects the reality that modern healthcare systems depend heavily on electricity for the operation of diagnostic equipment, preservation of vaccines, emergency response systems, and routine clinical procedures. When power supply becomes unstable, hospitals and health centers are forced to rely on alternative sources such as generators, which are costly and not always reliable. This outcome aligns with the findings of Idris *et al.* (2022), who observed that irregular electricity supply significantly weakens healthcare service efficiency and increases operational challenges in public health institutions. Similarly, Aremu (2019) emphasized that poor electricity supply in Nigeria continues to undermine the performance of critical social services, particularly in the health sector.

The results also indicate that electricity instability disrupts teaching and learning activities in public schools. Respondents strongly agreed that frequent power outages limit the use of ICT facilities, laboratories, and other modern learning tools. This suggests that energy supply has a direct impact on the quality of education and the ability of schools to deliver effective academic services. In line with this, Okeoma *et al.* (2023) noted that consistent electricity supply enhances productivity across sectors, including education, by enabling the use of technology and improving working conditions. In educational institutions where learning increasingly depends on digital resources, unreliable electricity reduces academic efficiency and limits innovation. The implication is that stable power supply is necessary for improving the standard of education and ensuring that students gain access to modern learning opportunities.

Another significant finding of the study is the strong relationship between electricity supply and water service delivery. The results show that respondents believe reliable electricity improves the efficiency of water pumping and distribution systems. This finding highlights the interconnected nature of public infrastructure systems. Water treatment plants, pumping stations, and purification processes depend heavily on continuous electricity supply for smooth operation. When electricity becomes unstable, water supply is interrupted, creating health and sanitation challenges for residents. This observation supports the findings of Mukhtar *et al.* (2021), who reported that inadequate electricity supply in developing countries directly affects water infrastructure performance and limits access to clean water. The present study therefore reinforces the idea that energy availability is a critical factor in ensuring sustainable access to water services.

Furthermore, the results demonstrate that electricity supply significantly influences the efficiency of public administrative services. A majority of respondents agreed that public offices perform better when electricity supply is stable. Administrative processes today depend largely on electricity driven technologies such as computers, printers, digital record systems, and communication networks. When power supply is inconsistent, administrative activities slow down, leading to delays in service delivery. This finding is consistent with the work of Maji *et al.* (2019), who found that unreliable electricity supply in Nigeria leads to productivity losses and inefficiencies in public institutions. The implication is that stable energy supply improves workflow, enhances productivity, and supports effective governance at the local government level.

The study also highlights the economic implications of energy instability. Respondents strongly agreed that dependence on generators increases operational costs for public institutions. This finding is important because it shows that electricity challenges extend beyond service disruption to include financial strain on public organizations. Funds that could be invested in infrastructure development and service improvement are instead used to purchase fuel and maintain alternative power systems. Dang and Lan (2019) observed that high energy costs reduce institutional capacity to expand services and sustain operations in developing countries. In the context of Calabar Municipality, the reliance on generators places additional pressure on already limited public resources, thereby affecting the long term sustainability of service delivery.

In addition, the study found that unstable electricity supply affects sanitation and waste management services. Effective waste management systems rely on electrically powered equipment for collection, treatment, and disposal processes. Interruptions in electricity supply therefore lead to inefficiencies in sanitation services, which may result in environmental and public health risks. Olaniyan *et al.* (2024) emphasized that electricity is essential for the effective functioning of urban infrastructure systems, including waste management and sanitation. The findings of this study therefore confirm that energy supply is closely tied to environmental sustainability and public health outcomes.

Arguably, stable electricity supply plays a vital role in strengthening public service delivery across multiple sectors in Calabar Municipality. The results support the argument that energy is a key driver of institutional performance, economic efficiency, and social wellbeing. Conversely, unreliable electricity supply weakens service systems, increases operational costs, reduces productivity, and limits the ability of public institutions to meet the needs of citizens. These findings are consistent with existing empirical literature which emphasizes that improving electricity infrastructure is essential for enhancing public sector performance and promoting sustainable development in Nigeria and other developing countries.

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## 7. Conclusion, implications and recommendations

This study examined the relationship between energy supply and public service delivery in Calabar Municipality Local Government Area of Cross River State. The findings clearly show that electricity supply remains a fundamental factor in determining the efficiency, quality, and sustainability of public services at the local level. The results from the analysis reveal that stable electricity significantly enhances the performance of healthcare services, improves teaching and learning outcomes, strengthens water pumping and distribution systems, and supports the smooth operation of public administrative activities. On the other hand, irregular energy supply disrupts service delivery processes, delays medical services, limits the use of ICT and laboratory facilities in schools, increases operational costs through dependence on generators, and weakens sanitation and waste management systems.

The study therefore confirms that energy supply is not simply an infrastructural issue but a critical development resource that shapes institutional effectiveness and citizens' welfare. The high level of agreement among respondents indicates that residents are fully aware of the direct and indirect effects of electricity on their daily lives. The findings also validate the assumptions of Systems Theory, which emphasizes that a failure in one component of a system can affect the performance of other interconnected parts. In this context, weak electricity supply creates widespread disruptions across healthcare, education, water services, and administrative systems.

Similarly, the findings support the Energy Ladder Theory by showing that access to reliable electricity enhances institutional functionality and improves the standard of living. As communities gain access to modern energy sources, service delivery becomes more efficient and responsive. However, the persistent instability of electricity supply in Calabar Municipality continues to slow down development and limit the capacity of public institutions to perform effectively. By and large, the study concludes that improving electricity supply is essential for strengthening public service delivery, enhancing governance outcomes, and improving the quality of life of residents in Calabar Municipality.

The findings of this study carry important theoretical, policy, and practical implications for public administration, energy planning, and local governance in Nigeria. At the theoretical level, the study strengthens existing knowledge by demonstrating that energy supply is a central variable in understanding public service performance at the local government level. It reinforces Systems Theory by showing how disruptions in electricity supply create ripple effects across interconnected service sectors such as healthcare, education, water supply, and sanitation. It also supports the Energy Ladder Theory by highlighting the importance of access to modern energy in improving institutional effectiveness and human welfare.

At the policy level, the study underscores the need for greater attention to energy infrastructure as a key component of public service delivery strategies. The evidence shows that unreliable electricity supply reduces productivity, increases operational costs, and weakens the efficiency of public institutions. This implies that energy planning should not be treated as a separate technical sector but as a critical part of governance and development planning at the local level.

At the practical level, the findings suggest that improving energy stability can significantly enhance the performance of public institutions. Reliable electricity can reduce delays in healthcare delivery, support the integration of digital technologies in education, ensure consistent water supply, and strengthen administrative efficiency. The study also implies that addressing electricity challenges can help restore public confidence in government institutions by improving the quality of services received by citizens.

Based on the findings of this study, several practical and policy relevant recommendations are proposed to improve energy supply and strengthen public service delivery in Calabar Municipality. First, there is a need for government at both state and local levels to prioritize investments in stable electricity infrastructure. Expanding grid capacity, upgrading transmission systems, and ensuring regular maintenance of power facilities will help reduce frequent outages and improve service delivery outcomes. Second, public institutions such as hospitals, schools, and water facilities should be supported to adopt alternative and renewable energy solutions such as solar power systems. This will reduce over dependence on diesel generators, lower operational costs, and ensure more stable power supply for

essential services. The introduction of solar powered systems in critical sectors can provide backup support during grid failures and improve service continuity.

Third, government agencies responsible for energy management should strengthen coordination with public service institutions to ensure that power supply challenges are quickly identified and addressed. Improved communication between energy providers and local government authorities can help reduce prolonged service disruptions. Fourth, there is a need for improved funding support for local government institutions to manage energy related challenges. Increased financial allocation will enable institutions to maintain backup energy systems, protect sensitive equipment, and sustain essential services during power interruptions.

Finally, awareness campaigns and stakeholder engagement should be encouraged to promote energy conservation and responsible usage. Community participation in supporting sustainable energy practices will contribute to long term improvements in electricity stability and service delivery performance.

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## Compliance with ethical standards

### *Discosure of Conflict of interest*

The authors declare that they have no known competing interests or relationships that could have appeared to influence the work reported in this paper.

### *Statement of Ethics statement*

This study adhered to ethical research standards. Participation was voluntary, informed consent was obtained, anonymity ensured, and data were used solely for academic purposes.

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