INTERNATIONAL JOURNAL OF SOCIAL SCIENCE, MANAGEMENT, PEACE AND CONFLICT RESEARCH (IJSMPCR)
Journal homepage: https://ijsmpcr.com/

# Impact of electricity supply deficits on health and infrastructure security in Nigeria

**By**
**[1]VINCI Fadeyi Oyetunji & [2]ZAMANI Andrew E. Prof.**
**[1&2]Institute for Governance and Development Studies, Nasarawa State University Keffi, Nigeria**
**[1]Phone +2348037193714, Email: vincy.joyce@yahoo.com**

***International Journal of Social Science, Management, Peace and Conflict Research, 11(01), 156-172***
***Publication history: Received on November 18; Revised November 22; Accepted November 29, 2025***

**Abstract**

*With incessant collapse of national power grids, there is no denying that the uncertain state of electricity supply phenomenon endangered critical national assets security and delivery capabilities, impact economic security, and disrupt health security particularly in emergency response capabilities. It is against this background that this study engaged the dependency theory to interrogate electricity supply deficit on health and infrastructure security in Nigeria. This study employed a survey research design and Krejcie and Morgan (1970) scientific sampling technique on a purposive study population of major organizations driving power generation, distribution and transmission of electricity supply in Abuja and Lagos to elicit data. The findings reveal a significant negative relationship between electricity supply and critical infrastructure security in Nigeria. Paucity of electricity supply contributes to increase production costs, reduced scale efficiency, and poor industrial performance, particularly in small and medium-scale enterprises. The study further establishes that electricity deficits severely undermine health security by reducing the operational capacity of primary healthcare centers. This is evident in inadequate service delivery, poor functionality of medical equipment, limited health information access, ineffective vaccine storage, and insufficient energy for lighting, refrigeration, and diagnostic services. The study recommends that all layers of government should engage robust public-private partnership framework for the development of micro and mini power grids to reduce reliance on the overburdened and fragile national grid. Additionally, policymakers across all levels of government are urged to design specific energy policies prioritizing healthcare facilities, particularly in rural areas. The mandatory deployment of renewable energy solutions in healthcare centers is emphasized as a sustainable approach to mitigate the adverse effects of electricity supply deficits on health security.*

**Keywords:** Critical Infrastructure Security, Dependency Theory, Electricity Supply Deficit, Health Security

## Introduction

The importance of electricity is well captured under the sustainable development goals 7 (SDG) which seeks to ensure access to affordable, reliable, sustainable and modern energy. SDG 7 is about ensuring access to clean and affordable energy, which is key to the development of agriculture, business, communications, education, healthcare and transportation (United Nation Organisation, 2023). It is a global phenomenon that a secure electricity supply has direct impact on social welfare, human development, a precondition of modern life and economic development. The interruption of electricity supply negatively impact daily activities, cost of dependence on alternate power source for electricity this inadvertently affect cost of production. The electricity access deficit is overwhelmingly concentrated with Sub-Saharan Africa having 62.5 percent deficit and Nigeria trailing behind India as top 20 access deficit countries with 85 million mostly without access to electricity supply (The World Bank, 2021).

* Corresponding author: **VINCI Fadeyi Oyetunji**
Department of Security and Strategic Studies, Nasarawa State University, Keffi, Nigeria.

Nigeria's electricity supply sector has been characterized by chronic and systemic challenges. Frequent power outages, voltage fluctuations, and unreliable service have been persistent issues that affect all sectors of the economy, society, and governance. The greater the per capital consumption of electric power in a country, the higher the standard of living of its people, while Iceland electricity consumption per capital stands at 53924 Nigeria's electricity consumption per capita stands 147 kilowatts (Statista, 2023), thus threatening her national security from multidimensional angles.

Interestingly, year 2023 witnessed the birth of a decentralized power system in Nigeria after 44 years of discounting similar provision of 1979 constitution. With the amendment of articles 13 and 14 of the 1999 constitution to allow State Governments to license, regulate, generate, transmit, and distribute electricity in areas already covered by the national grid. The implication of this translates that the States can accelerate their development at their own pace. The amended Electricity Act 2023 repeals the erstwhile Electric Power Sector Reform Act (EPSRA) 2005 birthed by the 1999 constitution as amended (Oyebanjo, 2023).

Over the years, demand for electricity has continued to grow while supply has consistently declined. The shortages of electricity supply formed the major background for energy crisis in Nigeria namely sourced from hydropower and gas (Bassey et al., 2022). Government efforts at confronting paucity of electricity supply is situated in a $20 billion investment plan hinges on new power plants, grid stability, and transmission lines towards 20,000 megawatts by year 2023, 30,000MW by 2030, and 60,000MW by 2060 (Akintayo, 2023). The 2024 Electricity Act also empower all Local Government Areas (LGAs) in Nigeria to generate 10MW with or without license as this will help to further unbundle the national Electricity grid whose incessant collapse is seen as a national embarrassment

Electricity supply is closely tied to the security of critical infrastructure. These infrastructure sectors, including transportation, water supply, telecommunication, banking, communication, and energy, are vital to the functioning of society and the government. Electricity as the lifeblood of critical infrastructure, provide power to essential services and facilities. The erratic state of electricity supply poses vulnerabilities to the resilience of these sectors, affecting the security and stability of the nation. Nigeria’s over-dependence on one source of energy has proved to be inadequate, the absence of private and public collaborations and investments forecloses possibility of self-generation of electricity for individuals (Awuku et al., 2021), amidst an 8 million metering gap

The nexus electricity supply and health security could be seen in how paramount the health security and well-being of a nation's citizens is. Adequate healthcare and reliable emergency response systems depend on consistent electricity supply. Healthcare facilities require electricity to operate essential medical equipment,

refrigerate vaccines, laboratory tests, and medicines, and provide life-saving procedures. The erratic state of electricity supply disrupts patient care, diagnosis, and treatment, posing risks to public health, health security and outright disruptions of nation's productivity index (Musa, 2023). This study explored the complex relationship between electricity supply and health security, and critical infrastructure security in Nigeria.

**Statement of the Problem**

In Nigeria, the healthcare sector faces chronic electricity supply challenges, including frequent power outages, voltage fluctuations, and insufficient energy infrastructure. This largely endangers operation of medical equipment, refrigeration of vaccines and medicines, and the provision of life-saving procedures. Frequent power outages disrupt patient care, diagnosis, and treatment, posing risks to public health.

Importance of electricity to critical infrastructure resilience is fundamental to the functioning of transportation, water supply, industries, finances, communication, and telecommunication. Disruptions in electricity supply can lead to vulnerabilities in these sectors, affecting the resilience of the national security.

**Objectives of the Study**

The main objective of this study investigated impact of electricity supply on national security in Nigeria. The specific objectives:

i. Interrogate relationship between electricity supply and critical assets security in Nigeria.
ii. Analyse the effect of electricity supply on health security in Nigeria.

**Statement of the Hypotheses**

The following null hypotheses was tested to attain the objectives of this study;

**$H_{01}$:** Electricity supply has no significant effect on critical infrastructure security in Nigeria.

**$H_{02}$:** Electricity supply has no significant effect on health security in Nigeria?

**Literature Review**

**Conceptual Framework**

**Concept of Electricity Supply**

Electricity Supply means that consumers are able to procure the desired quantity of electricity at all times at the necessary level of quality and at reasonable tariffs (Swiss Federal Office of Energy, 2023). Power supply was described as a prerequisite to a nation's development which cannot be avoided, even as development is grossly limited in any nation whose power supply is characterized by poor power outages (Onuchie et al., 2015). Best and Burke (2018) situated that the availability of electricity is a factor for speedy economic

growth. To enhance electricity supply and electrification benefits, the adoption of the mini-grid option is inevitable, particularly for fledging economies that desire the active participation of private investors outside the monopolistic grip of the state.

The mini grid option requires government commitment for sustainability and adequate frameworks. The off-grid solution, which is usually renewable solution, with strong supporting legislation is equally required for rural electrification strategy. The efficiency of any reliable electricity system could also entails the implementation of gas master plan, which is crucial in paving way for increasing supply reliability, coverage, and then higher social benefits. The 2023 Electricity Act (EA) empowered states to generate, transmit and distribute electricity, about eight states sought and secured regulatory autonomy from Nigerian Electricity Regulatory Commission (NERC). This has led to a major milestone in the Nigerian Electricity Supply Industry (NESI) in 2024 with autonomy granted to Enugu, Ekiti, Oyo, Ondo, Kogi, Edo, Imo, and Lagos States for regulatory oversight. This mandated the existing distribution companies to within 60 days incorporate new sub-companies for the interstate energy supply (Ofikhenua, 2024).

This study defines electricity supply as the accessibility, affordability and ability to make choices from different sources of energy mixes by the citizenry of a nation.

**Electricity Generating Companies**

Generation companies (GenCos) include Afam Power, Sapele Power, Egbin Power, Ughelli Power, Kainji Power, Jebba Power and Shiroro Power, while the Independent Power Plants (IPPs) include Shell, Agip, AES, and Geometric Power. Electricity generated by these companies are sold to TCN via the Nigerian Bulk Electricity Trading (NBET) company. The Federal Ministry of Power (formerly Ministry of Power, Works and Housing) is in charge of the energy sector. The Federal Ministry of Environment enforces regulations pertaining to pollution and waste management, climate change and environmental standards. These include environmental compliance requirements such as environmental impact assessments.

**Electricity Transmission Companies**

The Transmission Company of Nigeria (TCN), the sole electricity transmission company, is fully government-owned and also a licensed operator. The challenges in the transmission segment lies in the lack of modern transmission lines and equipment, gross mismanagement, poor maintenance of available infrastructure and inefficient grid design. Distribution companies face the problem of huge Aggregate Technical, Commercial, and Collection (ATC&C) losses (Centre for the study of the economies of Africa, 2023). The Transmission Company of Nigeria (TCN) operates the transmission grids of Nigeria. The average

capacity evacuated to distribution companies (DISCOs) during Q4 2019 was 2,868 MW. Transmission losses (from generation to DISCOs) amounted to 22%.

**Electricity Distribution Companies**

The Nigeria Electricity Distribution Companies (DISCOs) operate regional distribution grids in Nigeria. DISCOs operate distribution grids in different states as per a licensing regime. While they have a mandate to extend their grids, extension over long distances is proving to be challenging for numerous reasons. They also authorise private mini grids. There are 11 DISCOs in Nigeria which include; Abuja Electricity Distribution Company, Benin Electricity Distribution Company, Eko Electricity Distribution Company, Enugu Electricity Distribution Company, Ibadan Electricity Distribution Company, Ikeja Electricity Distribution Company, Jos Electricity Distribution Company, Kano Electricity Distribution Company, Kaduna Electricity Distribution Company, Port Harcourt Electricity Distribution Company and Yola Electricity Distribution Company.

The Power Holding Company of Nigeria (PHCN) is the holding company of the 11 regional distribution companies and the 6 generation companies. Improving access and reliability of power is key to reduce poverty and unlocking economic growth. The operations of the DISCOS are expected to improve the financial viability of the DISCOs and increase revenues for the whole Nigerian power sector, which is critical to save scarce fiscal resources and create jobs by increasing the productivity of private and public enterprises (Chaudhuri, 2021).

**Critical Infrastructure Security**

Critical infrastructure refers to assets and systems essential to a nation's security, economy, public health, and safety, such as energy systems, transportation networks, communication facilities, water supply systems, and emergency services (Department of Homeland Security, 2019). The availability and reliability of electricity are foundational to the effective functioning and security of these infrastructures. The paucity of electricity fundamentally compromises critical infrastructure security by disrupting operations, increasing vulnerabilities, and impairing emergency response systems. Addressing electricity shortages is, therefore, vital for enhancing the resilience of critical infrastructure. Investments in alternative power sources, robust grid infrastructure, and backup systems are essential to mitigating these risks.

Literature shows that there is a significant effect of electricity supply on the performance of small and medium-scale enterprises in Calabar South and Calabar Municipality. The study shows that there are enormous difficulties being experienced by businesses in Cross River State and other parts of Nigeria due to inadequate and unreliable electric power supply (Bassey & Imoh, 2021). This study conceptualise critical

infrastructure as any system be it public or private whose functional operations facilitate delivery of services or commerce t the populace.

**Health Security and Electricity Supply**

The World Health Organization (2014) stresses that electricity is a "critical enabler" of universal access to health care and that without electricity, "many life-saving interventions simply cannot be undertaken". Literature also abound that expanding access to electricity accompanied with reliability, measured using hours of supply and voltage stability, can have much larger welfare effects including impacts on health (Aklin et al., 2016). Other energy sources used in healthcare facilities may include kerosene or gas to power vaccine refrigerators (The World Bank, 2017). World Health Organisation (2023) submit that close to 1 billion people in low- and lower-middle-income countries are estimated to be served by health-care facilities without reliable electricity supply or with no electricity access at all.

Electricity is crucial for the availability and reliability of essential health services, as well as for bettering health, with outcomes such as safe childbirth, vaccination, diagnostic capacity and emergency response. Owa-Onibiyo et al. (2023) submitted that absence of storage facilities for COVID-19 vaccination in Kogi state of Nigeria resulted in gross loss and expiration of most federal allocated COVID-19 vaccines. Power shortages can compromise the ability of emergency services such as fire departments, police, and disaster management agencies to respond promptly to crises (Panteli & Mancarella, 2015). Reliable basic infrastructure, particularly electricity, is a critical enabling factor in improving health systems and consequently achieving the health sustainable development goals (SDGs). Reliable electricity can be an effective tool in improving core components of health systems. In addition to targeting direct factors within the health systems such as health workforce and health financing, investments in supporting infrastructure are warranted to achieve the health SDGs (Chen et al., 2019).

**Empirical Review**

**Electricity Supply and Critical Infrastructure Security**

Bassey and Imoh (2021) comparatively study of the effect of electricity supply on the performance of small and medium-scale enterprises in Calabar South and Calabar Municipality. The study employed survey research design of structured questionnaire on a randomly selected sample size of 248 small and medium scale business owners and power holding staff. The results that emanated from the study revealed that insufficient electricity supply significantly affect the performance of small and medium-scale enterprises in Calabar South and Calabar Municipality. The study concludes that inadequate and unreliable supply of electricity imposes costs and therefore constrained firms' operational performance as firms suffer high overhead cost due to the deficient electricity supply from the national grid. The study submits that the issue

of power supply reliability should be facilitated by both private and public investment in electricity infrastructure.

Bassey et al. (2022) interrogated the influence of electricity consumption and its implications on industrial performance in Nigeria. The study engaged time series data sourced from the Central Bank of Nigeria Annual Report, Statistical Bulletin, Publications of the International Monetary Fund and the National Bureau of Statistics which spanned from 1981 to 2019. The study employed Fully Modified Ordinary Least Squares Method and Descriptive Statistics to carry out the empirical analysis. The findings revealed that a unit rise in industrial electricity consumption contribute to industrial performance by 9.4%. The study submitted that irregular electricity supply has weakened industrial performance in Nigeria despite various energy resources available.

Chinedum and Nnadi (2016) examined the influence of electricity supply and the output of the Nigerian manufacturing sector. Time series data spanning the period between 1981 and 2013 were analyzed using Johansen Cointegration and Vector Autoregression tests. The results revealed that there exists a long run relationship between electricity and manufacturing output in Nigeria such that electricity supply has an insignificant relationship with the manufacturing sector in Nigeria.

In the South Asia, Abeberese (2017) engaged data on Indian firms to analyze the relationship between electricity costs and the performance of manufacturing firms in India. The study in a bid to address the potential endogeneity of electricity prices in India made use of two features of the electricity sector in India. First, the source as mostly from thermal plants that use coal as the source of fuel and secondly, as each states in India, is responsible for the provision and pricing of electricity for its residents. The study therefore, constructs an instrument for the electricity price faced by firms in a state as the interaction between the price of coal paid by power utilities and the share of thermal generation in a state's total electricity generation capacity. Result from the study showed that higher intensities in electricity use have important implications for productivity growth, underlining the importance of making electricity affordable and available for manufacturing firms in India.

**Electricity Supply and Health Security**

Olanrele et al. (2020) empirically analysed the nexus between health sectors and access to electricity in rural communities of Oyo State, southwest, Nigeria. The study adopted primary data from twelve rural communities that have benefited from rural electrification. Results from study showed that electrification decreases the rate of indoor air pollution by 1.1 percent. Household electricity expenditure increases with

reduction in indoor air pollution; it decreases the rate of air pollution by 1.6 percent. Better illumination due from access to modern electricity reduces indoor pollution by 1.2 percent.

Undie et al. (2022) engaged content analysis to examine effects of electricity generation from fossil-fueled engines on health, published during the period from 1985 to 2021 are reviewed. The review is categorized into sections based on the aforementioned categories of articles. The findings from the study signified that a co-integration relationship exists between electricity supply and national growth. Also, the study revealed that the noise level emission and pollutant concentration from fossil fuel generators were greater than the recommended values by the WHO, and the carbon emitted during the combustion of these engines is the leading cause of global air pollution and as well, global warming.

Fakih et al. (2020) interrogated the nexus between performance of manufacturing firms and power outages on the in the MENA region. The study employed firm-level dataset derived from the World Bank's Enterprise Surveys (WBES) database, by representing firm performance by sales, employment, and productivity growth rates while extents of power outages are depicted by objective measures characterizing durations and frequencies of power outages, and by perception-based measures reflecting firms' perceived severity of power outages. Findings from the study underscored the adverse consequences of power outages for the performance of manufacturing firms in the MENA region. The study suggests that different patterns of power outages have varying implications for firm performance, and that the effects of power outages exhibit variations with firm size. Study only focused on manufacturing sector while this study will consider health sectors amongst other critical national assets and electricity supply in Nigeria.

Chen et al. (2019) interrogated the relationship between health facilities, health information and child, maternal health services utilization and reliable electricity in rural Gujarat, India. The study examine the effect of a rural electrification program providing 24-h electricity to rural non-agricultural users in Gujarat, India, on core components of health systems including health facilities, health information, and health services utilization. The study engaged the District Level Household and Facility Surveys and administrative data from electricity distribution companies on rural electrification program implementation, Findings from the study showed that rural electrification program implementation significantly improved the operational capacity of primary health centers by increasing the availability and functionality of a wide range of essential devices and equipment. The electrification program significantly increased access to health information through television.

World Health Organisation (2014) in a review of status significance challenges and measurement investigated access to modern energy services for health facilities in resource-constrained settings. The study focused on

the energy needs of health facilities which have very limited access to energy in many facilities of low-income countries or emerging economies, but also present in resource-constrained settings of middle-income countries. Available evidence regarding patterns of energy access and its impacts on health services is considered, along with trends in the use of new energy technologies. The findings from the study submitted that electricity is most relevant to clinics and health centers at the primary and secondary tiers of health systems, often struggling to access sufficient energy to power lighting, refrigeration and basic medical devices of diagnostic services. The study was a crosscountry studies hence the need to conduct a state specific study in Nigeria.

**Theoretical Framework**

**The Dependency Theory**

The Dependency Theory as propounded by Raúl Prebisch and Andre Gunder Frank in the 1950s and 1960s can be applied to analyze Nigeria's dependency on electricity for economic activities and how this dependency influences national security. It could provide insights into power dynamics and vulnerabilities arising from dependence on a critical resource. Dependency Theory provides a critical lens through which to examine the implications of electricity supply on national security in Nigeria. This theory asserts that developing countries like Nigeria are structurally dependent on more developed nations and international financial institutions, which shapes their economic and social policies. In the context of electricity supply, Nigeria's dependency on external resources and technology for power generation and distribution has significant ramifications for its national security across various dimensions.

Concerningly, the state of electricity supply directly impacts national security in Nigeria by exacerbating social inequalities and political instability. Persistent power outages contribute to dissatisfaction among citizens, leading to protests and unrest (Omolade, 2017). Dependency Theory highlights how Nigeria's reliance on foreign expertise and investment in its electricity sector has perpetuated this vulnerability, undermining efforts to achieve stable governance and social cohesion. Furthermore, the effect of electricity supply on economic security is profound, as industries crucially depend on reliable power to operate efficiently. Nigeria's economy suffers from frequent blackouts, hindering industrial productivity and foreign investment (Ajibade, 2018). Dependency Theory would argue that this reliance on external technology and financing for electricity infrastructure perpetuates economic vulnerability, reinforcing Nigeria's subordinate position in the global economic hierarchy.

Lastly, the effect of electricity supply on health security is significant, with unreliable power contributing to challenges in delivering healthcare services. Hospitals and medical facilities struggle with power outages, impacting patient care and public health outcomes (Ibeneme & Nnoli, 2020). Dependency Theory argues that

Nigeria's reliance on external resources and technologies in its electricity sector perpetuates inequalities in access to healthcare and exacerbates health security risks.

## Research Methodology

This study adopted survey research design and was carried out majorly in agencies that are purposively chosen to form the sampled size population of this study, because of their influence on electricity generation, supply and distributions. Visitations to corporate headquarters of agencies central to electricity generation, supply, and distributions was explored to elicit data.

Such institutions include but not limited to purposively selected staff of Electricity Generating Companies (GENCOS), Electricity Distribution Companies (DISCOS) and Electricity Transmission Companies, Association of Licensed Electrical Contractors in Nigeria, Nigeria Medical Society, National Health Insurance Scheme, selected operators of critical national assets and Small and Medium Entrepreneur Development Agencies in Nigeria (SMEDAN). Nigerian Electricity Regulatory Commission (NERC), General Hospital Gwagwalada, Federal Medical Centre Suleja, The Energy Commission of Nigeria (ECN), Rural Electrification Agency (REA), Nigerian Electricity Management Services Agency (NEMSA), The Nigerian Investment Promotion Commission (NIPC), Federal Competition & Consumer Protection Commission (FCCPC), The Presidential Task Force on Power (PTFP).

These purposively selected agencies constituted the population of this study. This population which is large and as the entire population was not studied. This study employed scientific sampling technique determination of Krejcie and Morgan (1970) that recommends a sample size of 384 for a population of 1 million. This study engaged survey research design with the administration of structured questionnaires instruments to elicit information, while data analysis and presentation of findings carried out using statistical software which includes SPSS.

### Reliability and Validity Test

Reliability of the primary data is checked through Cronbach's alpha. Reliability of the survey instrument is evaluated through Cronbach Alpha. The study computes separate and combine reliability estimates, which are similar to the normally used coefficient alpha statistics. Cronbach value beyond ($\alpha$ = .7) signifies acceptable reliability.

**Table A: Cronbach's Alpha Test Results Summary**

| Variable | Cronbach Alpha | Number of Items |
|---|---|---|
| State of Electricity Supply (SOES) | 0.834 | 7 |
| Critical Infrastructure Security (CRIS) | 0.739 | 7 |
| Health Security and Electricity Supply (HESC) | 0.876 | 7 |
| Total Questions | 0.921 | 21 |

**Source: Extracted from SPSS Output, 2024**

The measurement scales' computed Cronbach's Alpha (α) results in Table A on State of Electricity Supply (SOES) revealed Cronbach's Alpha (α) of 0.834, while questions on Critical Infrastructure Security (CRIS) showed Cronbach's Alpha value of 0.739, and Health Security and Electricity Supply (HESC) revealed Cronbach's Alpha (α) of 0.876. The overall questions translated to a Cronbach Alpha (α) of 0.921. The measurement scales were reliable as all the Cronbach's value are well above 0.6 threshold which is the recommended coefficient for a given research instrument.

**Data Analysis and Results**

**Table B: Responses Frequency on Electricity Supply and Critical Infrastructure in Nigeria**

| SA= Strongly Agree (5); A= Agree (4); NA= Neutral (3); SD= Strongly Disagree (2); D= Disagree (1) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **SA** | **A** | **N** | **D** | **SD** | **StdDev** | **Mean** | **Total** |
| 1 | Inadequate electricity supply significantly affects the functionality of critical infrastructure in Nigeria. | 137 | 144 | 2 | 45 | 56 | 0.7065 | 3.5469 | 384 |
| | | 0.357 | 0.375 | 0.005 | 0.117 | 0.146 | | | 1 |
| 2 | Frequent power outages increase the vulnerability of critical infrastructure to failures and disruptions. | 150 | 120 | 3 | 49 | 62 | 0.7402 | 3.7458 | 384 |
| | | 0.391 | 0.313 | 0.008 | 0.128 | 0.161 | | | 1 |
| 3 | The current state of electricity supply has limited the capacity of critical assets to support national development. | 198 | 117 | 2 | 26 | 41 | 0.6677 | 3.8842 | 384 |
| | | 0.516 | 0.305 | 0.005 | 0.068 | 0.107 | | | 1 |
| 4 | Reliable electricity supply is essential for the efficient operation of critical infrastructure | 148 | 119 | 5 | 65 | 47 | 0.4851 | 3.3099 | 384 |
| | | 0.385 | 0.31 | 0.013 | 0.169 | 0.122 | | | 1 |
| 5 | Inadequate power supply has discouraged foreign investment and economic stability. | 151 | 126 | 6 | 52 | 49 | 0.8353 | 3.7177 | 384 |
| | | 0.393 | 0.328 | 0.016 | 0.135 | 0.128 | | | 1 |
| 6 | Unreliable electricity makes critical infrastructure more susceptible to physical and cyber threats. | 170 | 109 | 3 | 57 | 45 | 0.7906 | 3.8123 | 384 |
| | | 0.443 | 0.284 | 0.008 | 0.148 | 0.117 | | | 1 |
| 7 | Renewable energy solutions can improve electricity supply and enhance Reliability of critical infrastructure in Nigeria. | 190 | 122 | 2 | 38 | 32 | 0.7065 | 3.5469 | 384 |
| | | 0.495 | 0.318 | 0.005 | 0.099 | 0.083 | | | 1 |

**Source:** Field Survey, 2024

Opinions that inadequate electricity supply significantly affects the functionality of critical infrastructure in Nigeria, emerging data shows that 73.2% of respondents agreed, while 26.8% were neutral, or strongly disagreed. This could be attributed to the dependency of infrastructure systems like transport, water supply, and telecommunication on stable electricity, which ensures operational efficiency and reliability. The mean value of 3.5469 and a standard deviation of 0.7065 indicate a strong perception that inadequate electricity adversely impacts infrastructure.

On the assertion that frequent power outages increase the vulnerability of critical infrastructure to failures and disruptions, respondents position reveal that about 70.4% of respondents agreed, while 29.6% expressed neutral or dissenting views. With a mean value of 3.7458 and a standard deviation of 0.7402, there is a substantial agreement on the risk posed by power outages. Frequent outages may lead to equipment

malfunctions and service downtimes, which compromise infrastructure resilience and increase vulnerability to both natural and human-induced disruptions.

The submission that the current state of electricity supply has limited the capacity of critical assets to support national development. This could be seen from the overwhelming majority of 82% that were in agreement while only 17.9% expressing disagreement. This finding reflects how inadequate electricity constrains the performance of critical infrastructure, undermining economic growth, industrial output, and service delivery, which are essential for national development. The high mean of 3.8842 and a relatively low standard deviation of 0.6677 underscore a consensus on this issue.

Reliable electricity supply is essential for the efficient operation of critical infrastructure, result from the field showed that approximately 69.5% of respondents agreed, while 30.5% were neutral or disagreed. The mean value of 3.3099 and a moderate standard deviation of 0.4851 indicate a recognition of electricity's critical role in infrastructure efficiency. This relationship highlights how consistent electricity supply underpins the seamless operation of transport systems, healthcare facilities, and energy grids, ensuring that they meet their intended purposes.

The perception that inadequate power supply has discouraged foreign investment and economic stability, responses to this assertion reveal that 72.1% strongly agreed, while 27.9% disagreed or were neutral. With a mean value of 3.7177 and a relatively high standard deviation of 0.8353, there is a general agreement on the impact of electricity on foreign investments. Investors require reliable infrastructure, and the lack of stable power hinders business operations, increasing operational costs and reducing the attractiveness of the Nigerian economy for foreign investors.

Unreliable electricity makes critical infrastructure more susceptible to physical and cyber threats, majority of respondents 72% agreed, while 27.3% expressed dissenting views. The mean value of 3.8123 and a standard deviation of 0.7906 indicate a strong consensus. Inconsistent electricity weakens the physical security of infrastructure by disrupting surveillance and alarm systems while increasing the vulnerability of digital infrastructure to cyberattacks due to intermittent connectivity and system downtimes.

Renewable energy solutions can improve electricity supply and enhance the reliability of critical infrastructure in Nigeria. A strong agreement 81% was recorded among respondents, with only 18.7% expressing neutral or negative views. The mean value of 3.5469 and a standard deviation of 0.7065 suggest that renewable energy is widely seen as a viable solution. This aligns with global trends in adopting solar, wind, and hydropower to ensure consistent and sustainable electricity supply, which is vital for maintaining infrastructure reliability.

The study highlights the pervasive impact of inadequate electricity supply on the functionality, security, and development potential of critical infrastructure in Nigeria. The findings underscore the urgent need for reliable electricity to enhance infrastructure resilience, attract foreign investments, and support national development. Renewable energy solutions emerge as a viable alternative to addressing electricity shortages, reducing infrastructure vulnerabilities, and ensuring economic stability. Effective policies targeting infrastructure investment and energy diversification are essential to mitigate these challenges and foster sustainable development in Nigeria.

**Table C: Responses Frequency on Electricity Supply and Health Security in Nigeria**

| **A= Strongly Agree (5); A= Agree (4); NA= Neutral (3); SD= Strongly Disagree (2); D= Disagree (1)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Inadequate electricity supply negatively affects the quality of healthcare services in Nigeria | **SA** | **A** | **N** | **D** | **SD** | **StdDev** | **Mean** | **Total** |
| | 189 | 143 | 2 | 30 | 20 | 0.3456 | 2.0346 | 384 |
| | 0.492 | 0.372 | 0.005 | 0.078 | 0.052 | | | 1 |
| Frequent power outages disrupt the operation of essential medical equipment in healthcare facilities. | 182 | 122 | 3 | 45 | 32 | 0.4125 | 2.2143 | 384 |
| | 0.474 | 0.318 | 0.008 | 0.117 | 0.083 | | | 1 |
| Poor electricity supply contributes to poor health outcomes in Nigeria, especially in rural areas. | 198 | 181 | 1 | 2 | 2 | 0.6677 | 3.4543 | 384 |
| | 0.516 | 0.471 | 0.003 | 0.005 | 0.005 | | | 1 |
| Reliable electricity is critical for the effective storage and distribution of vaccines and other medical supplies. | 148 | 119 | 5 | 65 | 47 | 0.7851 | 3.4223 | 384 |
| | 0.385 | 0.31 | 0.013 | 0.169 | 0.122 | | | 1 |
| Inconsistent electricity supply hampers emergency healthcare services, putting lives at risk. | 146 | 154 | 2 | 43 | 39 | 0.8353 | 3.5144 | 384 |
| | 0.38 | 0.401 | 0.005 | 0.112 | 0.102 | | | 1 |
| Health facilities without reliable electricity supply are less capable of handling life-threatening cases. | 170 | 154 | 1 | 21 | 38 | 0.7832 | 3.3456 | 384 |
| | 0.443 | 0.401 | 0.003 | 0.055 | 0.099 | | | 1 |
| Government policies on electricity supply are inadequate to meet the energy needs of the healthcare sector | 199 | 135 | 2 | 11 | 37 | 0.7065 | 3.5469 | 384 |
| | 0.518 | 0.352 | 0.005 | 0.029 | 0.096 | | | 1 |

**Source:** Field Survey, 2024

On the assertion that inadequate electricity supply negatively affects the quality of healthcare services in Nigeria. The findings reveal that 86.4% of respondents agreed that inadequate electricity supply negatively affects healthcare quality, while 13.6% were neutral or disagreed. The mean value of 2.0346, combined with a low standard deviation (0.3456), suggests a strong consensus on the negative impact. This could be attributed to the reliance of healthcare services on electricity for basic operations such as lighting, diagnostics, consulting, record retrieval and referral, and patient care, within same medical domain and beyond.

On frequent power outages disruption of operations of essential medical equipment in healthcare facilities. About 79.2% of respondents agreed to this assertion, while 20.8% were neutral or disagreed. The mean value of 2.2143 and a standard deviation of 0.4125 indicate a significant recognition of this issue. Power outages

can cause equipment failures, affecting diagnostics and treatment. This disruption is critical, as life-saving devices often require uninterrupted electricity.

On the opinion that poor electricity supply contributes to poor health outcomes in Nigeria, especially in rural areas. A majority of respondents 98.7% agreed while only 1.3% were neutral or disagreed. The high mean value of 3.4543 and standard deviation of 0.6677 demonstrate a strong consensus. This highlights the disproportionate burden of inadequate electricity on rural areas, where health facilities often operate without alternative energy sources, leading to delayed or inadequate care delivery.

The position that reliable electricity is critical for the effective storage and distribution of vaccines and other medical supplies. Showed submission that while 69.5% of respondents agreed, a notable 30.5% were neutral or disagreed. The mean value of 3.4223 and a higher standard deviation of 0.7851 suggest varying perceptions. Electricity is crucial for maintaining cold chain systems required for vaccine storage and delivery, making disruptions a significant barrier to healthcare quality, particularly during public health crises.

That inconsistent electricity supply hampers emergency healthcare services, putting lives at risk, emerging data shows that 78.1% of respondents agreed while 21.9% were neutral or disagreed. A high mean of 3.5144 and a standard deviation of 0.8353 underscore the critical link between electricity and emergency care. Power interruptions can delay life-saving interventions, reflecting the urgent need for reliable electricity in emergency rooms and trauma centers. Health facilities without reliable electricity supply are less capable of handling life-threatening cases. The findings indicate that 84.4% of respondents agreed while only 15.6% disagreed. The mean of 3.3456 and a standard deviation of 0.7832 reflect agreement on this point. Reliable electricity is vital for advanced medical care such as surgeries and intensive care, and its absence significantly compromises health outcomes in life-threatening situations.

Respondents line of thought on Government policies on electricity supply as inadequate to meet the energy needs of the healthcare sector, shows that majority of 87.0% of respondents agreed, with only 13.0% neutral or disagreeing. The highest mean value of 3.5469 and a standard deviation of 0.7065 highlight widespread dissatisfaction with government policies. This emphasizes the urgent need for comprehensive energy policies tailored to the healthcare sector to ensure consistent power supply for critical services.

The above finding s underscores the significant impact of electricity supply on health security in Nigeria. The consistently high mean values across responses indicate that inadequate electricity supply as negatively aggravating healthcare quality, disrupts medical operations, endanger health information retrieval and

comparative capabilities of health official on patient, and compromises health outcomes, especially beyond rural areas to the metropolis.

**Discussion of Findings**

Quantitative expression gotten from this study translate that electricity supply has a negative relationship with critical infrastructure security in Nigeria. This could be seen at the existence of paucity of electricity supply which significantly affect critical infrastructure security; such as production costs, scale efficiency of firms, and industrial performance of critical infrastructure as seen of small and medium-scale enterprises in Nigeria. This finding is in line with prior works of Bassey and Imoh (2021); Bassey et al. (2022); Chinedum and Nnadi (2016); Cissokho and Seck (2013); Abeberese (2017).

The result that emanated from the survey study establish the fact that the prevalence of paucity of electricity supply negatively aggravate health security in Nigeria. This is largely accounted as electricity unavailability reduce operational capacity of primary health centers in service delivery and equipment usage, poor health information access and retrieval, poor vaccination storage due to paucity of electricity supply, paucity of energy for lighting, refrigeration and basic medical devices of diagnostic services. This study aligns with similar findings of Olanrele et al. (2020); Fakih et al. (2020); Chen et al. (2019); World Health Organisation (2014)

**Recommendations**

It was against this background that the study advanced the following recommendations

i. That all the Federal Government, Regional Development Commissions, States Government and Local Government in Nigeria should extensively seek Public Private Partnership engagement in power generation independence through preponderances of micro and mini power grids as against the overburdened National power grid which is vulnerable to incessant collapse.

ii. That tiers of government policy makers should design and project specific energy policies tailored to the needs of the healthcare sector, while ensuring that healthcare facilities are prioritized in electricity distribution. Mandatory deployment of renewable energy solutions in healthcare facilities can no longer be ignored particularly in rural areas.

**References**

Abeberese, A. B. (2017). Electricity cost and firm performance: Evidence from India. *The Review of Economics and Statistics, 99*(5), 839–852 https://doi.org/10.1162/REST_a_00641.

Ajibade, I. (2018). Electricity supply and economic development in Nigeria: A critical appraisal. *Nigerian Economic Review, 22*(1), 56-72.

Akintayo, O. (2023, October 11). Reviving Nigeria's power sector through tech, partnership *Punch Newspaper*. Retrieved from https://punchng.com/reviving-nigerias-power-sector-through-tech-partnership/#:~:text=%E2. Accessed November 12, 2024.

Aklin, M., Cheng, C.Y., Urpelainen, J., Ganesan, K., Jain, A. (2016). Factors affecting household satisfaction with electricity supply in rural India. *Natural Energy, 1,* 1–6.

Awuku, S. A., Bennadji, A., Muhammad-Sukki, F., & Sellami, N. (2021). Promoting the solar industry in Ghana through effective public-private partnership (PPP): Some lessons from South Africa and Morocco. *Energies*, *15*(1), 17.

Bassey, C. E., & Imoh, I. K. (2021). The effect of electricity supply on the performance of small and medium-scale enterprises in Nigeria: A case study of Calabar south and Calabar municipality of Cross River State. https://ssrn.com/abstract=3906458 or http://dx.doi.org/10.2139/ssrn.3906458

Bassey, C. E., Oduneka, A. E., & Ikpe, I. I. (2022). Electricity consumption and industrial performance in Nigeria. *Journal of Economics and Public Finance, 8*(2). DOI: 10.22158/jepf.v8n2p1

Best, R., & Burke, P. J. (2018). Electricity availability: A precondition for faster economic growth?. *Energy Economics, 74*, 321–329.

Chaudhuri, S. (2021, February 5). Nigeria to Improve Electricity Access and Services to Citizens. *World Bank.Org.* Retrieved from https://www.worldbank.org/en/news/press-release/2021/02/05/nigeria-to-improve-electricity-access-and-services-to-citizens. Accessed September 2, 2024.

Chen, Y. J., Chindarkar, N., & Xiao, Y. (2019). Effect of reliable electricity on health facilities, health information, and child and maternal health services utilization: Evidence from rural Gujarat, India. *Journal of Health, Population and Nutrition, 38*(7) https://doi.org/10.1186/s41043-019-0164-6

Chinedum, E. M., & Nnadi, K. U. (2016). Electricity supply and output in Nigerian manufacturing sector. *Journal of Economics and Sustainable Development, 7*(6), 154-163.

Cissokho, L., & Seck, A. (2013). Electric power outages and the productivity of small and medium enterprises in Senegal. Investment Climate and Business Environment Research Fund Report No. 77/13. Ottawa, ON: International Development Research Centre (IDRC).

Department of Homeland Security (DHS). (2019). Critical infrastructure security and resilience. www.dhs.gov.

Fakih, A., Ghazalian, P., & Ghazzawi, N. (2020). The effects of power outages on the performance of manufacturing firms in the MENA region. *Journal Review of Middle East Economics and Finance*. https://doi.org/10.1515/rmeef-2020-0011

GET. Invest (2024). Nigeria. Energy Sector. Retrieved from https://www.get-invest.eu/market-information/nigeria/energy-sector/#:~:text=The%20Power%20Holding%20Company%2 0of, and%20the%206%20generation%20companies. Accessed January 1, 2025.

Ibeneme, C. O., & Nnoli, N. O. (2020). Power outage and health outcomes in Nigeria. *Journal of Public Health and Epidemiology, 12*(3), 112-125.

Musa, W. (2023, July 14). NERC to collaborate with stakeholders on power supply. The Guardian. Retrieved from https://guardian.ng/business-services/nerc-to-collaborate-with-stakeholders-on-power-supply/. Accessed October 16, 2024.

Ofikhenua, J. (2024, December 30). Macroeconomic Review 2024… Power. *The Nations.* Retrieved from https://thenationonlineng.net/macroeconomic-review-2024-power/ Accessed January 6, 2025.

Olanrele, I. A., Lawal, A. I., Dahunsi, S. O., Babajide, A. A., & Iseolorunkanmi O. J. (2020). The impact of access to electricity on education and health sectors in Nigeria's rural communities. *Journal of Entrepreneurship and Sustainability Issues, 7*(4), 3016-3035. DOI: 10.9770/jesi.2020.7.4(30).

Omolade, A. O. (2017). Dependency theory and political instability in Nigeria. *Journal of African Studies, 21*(4), 210-225.

Onochie, U. P., Egware, H. O., & Eyakwanor, T. O. (2015). The Nigeria electric power sector (opportunities and challenges). *Journal of Multidisciplinary Engineering Science and Technology, 2*, 494– 502.

Owa-Onibiyo, F. T., Ifah, S.S., & Ukawuilulu, J. O. (2023). Impact of covid-19 sensitization and awareness programmes on the practice of vaccination by aged persons in Kogi State, Nigeria. *World Journal of Advanced Research and Reviews, 19*(01), 1533–1544. DOI: 10.30574/wjarr.2023.19.1.1485

Oyebanjo, I. (2023, December 25). The Nigerian Power System. 2023 – The Year of Restructuring and Devolution of Power to States. Retrieved from https://nigerianpowersystem.wordpress.com/2023/12/25/2023-the-year-of-restructuring-and-devolution-of-power-to-states/ Accessed January 1, 2025

Panteli, M., & Mancarella, P. (2015). Influence of extreme weather and climate change on the resilience of power systems: Impacts and possible mitigation strategies. *Electric Power Systems Research, 127*, 259–270.

Statista. (2023, July). Electricity consumption per capita worldwide in 2022, by selected country (in kilowatt-hours). *Energy & Environment*. Retrieved from https://www.statista.com /statistics/383633/worldwide-consumption-of-electricity-by-country/#:~:text=Iceland% 20is %20by%20far%20the,intensive%20industries%20in%20the%20country. Accessed October 2, 2024.

Swiss Federal Office of Energy. (2023). Electricity supply security. Retrieved from https://www.bfe.admin.ch/bfe/en/home/supply/electricity-supply/electricity-supply-security.html Accessed October 23, 2024.

The World Bank. (2017). Modern Energy Access and Health. Retrieved from https://documents1.worldbank.org/curated/en/756131494939083421/pdf/BRI-P148200-PUBLIC-FINALSEARSFHealthweb.pdf Accessed December 18, 2024.

The World Bank. (2021, February 5). Nigeria to Improve Electricity Access and Services to Citizens. *The World Bank*. Retrieved from https://www.worldbank.org/en/news/press-release/2021/02/05/nigeria-to-improve-electricity-access-and-services-to-citizens. Accessed October 2, 2024.

Undie, E. U., Bala, J. A., Aibinu, A. M., Olatunji, D. E., Folorunso, T. A. (2022). Effects of electricity generation and supply on national growth and human Health: A case study of Nigeria. Retrieved from http://repository.futminna.edu.ng:8080/jspui/bitstream /123456789/18807/1/electricity%20and%20national%20growth%20%281%29.pdf

United Nation Organisation. (2023). The Sustainable Development Goals Report 2023. Retrieved from https://www.un.org/sustainabledevelopment/energy /#:~:text=Ensure% 20access%2 0to%20affordable%2C%20 Accessed October 4, 2024.

World Health Organisation. (2023, August 31). Electricity in health-care facilities. Retrieved from https://www.who.int/news-room/fact-sheets/detail/electricity-in-health-care-facilitie s. Accessed December 12, 2024.