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Causes of Power Generation Instability in Transcorp and Sapele Power Stations, Delta State, Nigeria

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Abstract

Power generation instability remains a persistent constraint on electricity reliability and socio-economic development in Nigeria. This study investigated the causes of power generation instability as perceived by engineers and technologists at Transcorp Power Plc, Ughelli, and Sapele Power Station, Delta State. A descriptive survey design was adopted. The study population comprised 126 engineers and technologists, from which 108 respondents were selected through stratified random sampling. Data were collected with a researcher-developed Causes of Power Generation Instability Questionnaire (CPGIQ), validated by experts in electrical/electronic engineering and educational measurement. The instrument recorded a Cronbach's alpha reliability coefficient of 0.812. Mean, standard deviation and rank order were used to answer the research questions, while independent-samples t-tests were used to test the null hypotheses at the 0.05 significance level. At Sapele Power Station, respondents identified ageing generation plants (M = 4.54), low power generation (M = 4.49), poor government policy (M = 4.41), obsolete generating equipment (M = 4.38), poor funding (M = 4.36) and poor maintenance (M = 4.33) among the leading causes, with an aggregate mean of 4.08. At Transcorp Power Plc, poor funding (M = 4.55), poor government policy (M = 4.43), low power generation (M = 4.35), inadequate modern communication and monitoring technologies (M = 4.16), and weak staff capacity-building programmes (M = 3.98) were the highest-rated factors, with an aggregate mean of 3.68. Engineers and technologists generally held similar views; only the government-policy item at Sapele showed a significant difference ($t = -2.229$, $p = .032$). The study concludes that generation instability is multidimensional, requiring coordinated action on plant rehabilitation, maintenance, financing, fuel security, digital monitoring, technical capacity and policy stability.

Keywords: power generation instability; thermal power stations; Transcorp Power Plc; Sapele Power Station; engineers; technologists

Introduction

Reliable electricity is a fundamental infrastructure for industrial production, communication, health services, education and economic activity. In Nigeria, however, electricity supply continues to be characterized by a persistent gap between installed capacity, available capacity and actual electricity delivered to consumers. Recent studies describe the country's power challenge as a combination of technical, financial, institutional and infrastructural weaknesses rather than a simple shortage of generating capacity (Adoghe et al., 2023; Somoye, 2023). The continued dependence on gas-fired generation also means that the performance of thermal generating stations is closely connected to the reliability of the natural-gas supply chain.

Evidence from recent analyses shows that Nigeria's generation fleet has substantial unused potential. Remy and Chattopadhyay (2021) found considerable scope for improving dispatch efficiency and extracting greater output from existing generators. Their analysis is important to the present study because it demonstrates that increasing electricity availability is not necessarily dependent on constructing new generating plants alone; better utilization, maintenance, dispatch and operational management of existing assets can also improve system performance. Similarly, a review of Nigeria's power situation concluded that generation remains below policy targets and that the country possesses renewable resources that can complement its conventional generation fleet (Power Situation and Renewable Energy Potentials in Nigeria, 2021).

The technical condition of generating infrastructure is a major concern. The Nigerian Electricity Regulatory Commission (NERC, 2025) reported that, as of 31 December 2024, the average generating plant in the Nigerian Electricity Supply Industry (NESI) was 22 years old and that ageing units combined with poor maintenance contributed to frequent unscheduled outages. The same report identified liquidity problems and gas-supply constraints as major challenges confronting generation companies. These national-level observations are directly relevant to thermal stations in Delta State, where the continued operation of ageing equipment can increase forced outages, maintenance requirements and the cost of electricity production.

Financial constraints are closely associated with technical performance. The World Bank (2022) identified unreliable electricity supply and sector-wide financial weaknesses as important constraints on Nigeria's economic development. Subsequent support to the Power Sector Recovery Operation has also emphasized reliability, financial sustainability, transparency and accountability as interconnected requirements for sector improvement (World Bank, 2023a). At generation-company level, inadequate cash flow can delay preventive maintenance, limit procurement of critical spare parts, postpone rehabilitation and reduce investment in modern control and monitoring systems.

Fuel availability is another important determinant of thermal generation. Nigeria's electricity system remains heavily dependent on natural gas, while gas infrastructure constraints can prevent generating companies from operating available units at full capacity. NERC (2025) reported that gas supply challenges were associated with limitations in the national gas network and weaknesses in effective gas-supply arrangements. This is consistent with recent reviews that identify gas shortages, infrastructure decay, inadequate investment and maintenance problems among the interacting causes of Nigeria's energy crisis (Somoye, 2023). Where gas supply is interrupted, a technically available generating unit may still be unable to produce electricity.

The policy environment also matters. Nigeria's Electricity Act 2023 broadened the legal framework for electricity generation,

transmission and distribution and recognized renewable energy as part of the national electricity mix (International Energy Agency [IEA], 2025a). However, policy reform must be supported by effective implementation, financing and institutional coordination. Kemabonta and Johnson (2025) observed that power-sector transformation in West Africa is affected by institutional arrangements, financing, regulatory conditions and utility liquidity. Thus, policy consistency should be considered alongside technical and financial measures rather than treated as a separate issue.

Digitalization and modern monitoring technologies provide additional opportunities for improving plant reliability. Predictive monitoring, condition assessment, automation and data-based maintenance can help operators identify emerging equipment problems before they develop into major failures. Recent work on Nigeria's energy system emphasizes technological modernization, improved planning and infrastructure development as important components of a more resilient electricity system (Adeshina et al., 2024; Shao et al., 2025). Research on power-system reliability further indicates that improving plant availability can substantially reduce system costs and reliability problems (Golobish et al., 2025).

The literature also points to the importance of diversifying Nigeria's electricity supply. Renewable energy can complement gas-based generation and reduce pressure on the conventional grid. Chanchangi et al. (2022) reviewed Nigeria's solar potential and identified both substantial opportunities and barriers to wider deployment. Ibrahim and Ayomoh (2022) similarly demonstrated that a more diversified power-generation mix can support cost, environmental and employment objectives. Distributed renewable-energy programmes have also expanded in Nigeria, with the World Bank (2023b) reporting support for solar hybrid mini-grids and standalone systems. These developments do not eliminate the need to improve existing thermal plants; rather, they underline the importance of combining improved conventional generation with diversified and decentralized energy resources.

Although several studies have examined Nigeria's electricity crisis, many have focused on national-level access, energy policy, generation planning, transmission, distribution or renewable-energy potential. Less attention has been given to the perceptions of technical personnel working directly within generating stations. Engineers and technologists are involved in equipment operation, inspection, maintenance, instrumentation, troubleshooting, safety and performance monitoring. Their professional experience can therefore provide useful evidence about the practical factors associated with generation instability.

The present study addresses this gap by examining the perceived causes of power generation instability at Transcorp Power Plc, Ughelli, and Sapele Power Station in Delta State. The study is particularly relevant because both stations are thermal generating facilities operating within the Nigerian grid environment. Understanding whether technical personnel perceive the same or different constraints at the two stations can assist management, policymakers and regulators in prioritizing interventions.

STATEMENT OF THE PROBLEM

Nigeria has made substantial investments and introduced several reforms to improve electricity supply, yet generation instability remains persistent. The problem is not adequately explained by installed generating capacity alone. Evidence indicates that the effective availability of generation assets is affected by equipment condition, maintenance, fuel supply, market liquidity, operational efficiency and institutional constraints (Adoghe et al., 2023; NERC, 2025).

For thermal generating stations, equipment ageing and maintenance are particularly important. When generating units, turbines, generators, auxiliary systems, control equipment and associated infrastructure operate beyond intended service periods without adequate rehabilitation, the likelihood of failure and unplanned outage can increase. NERC's recent assessment of the Nigerian generation

fleet confirms the significance of ageing units and poor maintenance in the wider industry (NERC, 2025). The national pattern, however, does not automatically explain the conditions experienced at individual stations.

Financial constraints create an additional problem. Generation companies require reliable cash flow to purchase fuel, procure spare parts, undertake scheduled maintenance, rehabilitate units and adopt modern technologies. Where funding is inadequate, maintenance and capital projects may be delayed, thereby reducing plant availability and increasing the likelihood of forced outages. The World Bank (2022, 2023a) has consequently treated sector liquidity and operational reliability as linked challenges.

Gas availability presents another problem for thermal stations. Even when generating units are technically ready, inadequate gas supply can restrict output. Gas infrastructure constraints and supply-contract weaknesses remain recognized industry challenges (NERC, 2025). Security threats, including vandalism of critical infrastructure, can further interrupt fuel supply and increase operational uncertainty.

Policy inconsistency and institutional weaknesses may also affect investment decisions and long-term planning. Although the Electricity Act 2023 provides a broader framework for the sector, effective transformation depends on regulatory implementation, financial viability, infrastructure investment and coordination among stakeholders (IEA, 2025a; Kemabonta & Johnson, 2025).

The central problem, therefore, is that power generation instability appears to arise from several interacting factors, while limited empirical evidence is available on how technical personnel at individual generating stations rank these factors. Without evidence from engineers and technologists directly involved in plant operations, interventions may not sufficiently reflect station-level realities. This study consequently investigates the causes of generation instability as perceived by engineers and technologists at Sapele Power Station and Transcorp Power Plc, Ughelli.

PURPOSE OF THE STUDY

The main purpose of this study was to investigate the causes of power generation instability as perceived by engineers and technologists at Transcorp Power Plc, Ughelli, and Sapele Power Station, Delta State. Specifically, the study sought to:

1. determine the perceived causes of power generation instability at Sapele Power Station;
2. determine the perceived causes of power generation instability at Transcorp Power Plc, Ughelli; and
3. determine whether significant differences exist between the responses of engineers and technologists regarding the causes of power generation instability at the two stations.

RESEARCH QUESTIONS

1. What are the causes of power generation instability at Sapele Power Station as perceived by engineers and technologists?
2. What are the causes of power generation instability at Transcorp Power Plc, Ughelli, as perceived by engineers and technologists?

Research Design

A descriptive survey design was adopted. The design was appropriate because the study sought to obtain the perceptions of engineers and technologists regarding existing conditions affecting electricity generation without manipulating the study environment.

Area of the Study

The study was conducted at Transcorp Power Plc, Ughelli, and Sapele Power Station, Ogorode, in Delta State, Nigeria. Both are thermal generating stations connected to the Nigerian national electricity system and therefore provide relevant settings for investigating operational factors associated with generation reliability.

Population and Sample

The study population comprised 126 engineers and technologists: 61 personnel at Sapele Power Station and 65 at Transcorp Power Plc. A stratified random sampling technique was used to represent the professional categories at the two stations. A total of 108 respondents were selected, comprising 52 respondents from Sapele Power Station and 56 from Transcorp Power Plc.

Instrument for Data Collection

Data were collected using the researcher-developed Causes of Power Generation Instability Questionnaire (CPGIQ). Section A obtained demographic information, while Section B contained statements on possible causes of generation instability. Responses were measured on a five-point Likert scale: Strongly Agree = 5, Agree = 4, Undecided = 3, Disagree = 2, and Strongly Disagree = 1.

Validity and Reliability

The instrument underwent face and content validation by specialists in Educational Measurement and Evaluation and experts in Electrical/Electronic Engineering. A pilot test was conducted with respondents possessing characteristics similar to those of the study population but outside the study area. The instrument produced a Cronbach's alpha coefficient of 0.812, indicating satisfactory internal consistency.

Data Collection Procedure

Permission was obtained from the management of the participating stations. The questionnaires were administered personally by the researcher with assistance from trained research assistants. Respondents were informed about the purpose of the study, participation was voluntary, and confidentiality and anonymity were maintained.

Data Analysis

Mean, standard deviation and rank order were used to answer the research questions. A criterion mean of 3.00 was adopted. Mean scores of 3.00 or above indicated that respondents considered an item a cause of generation instability, whereas mean scores below 3.00 indicated disagreement. Independent-samples t-tests were used to test the null hypotheses at the 0.05 level of significance. The null hypothesis was rejected when $p < .05$ and retained when $p \geq .05$.

Ethical Considerations

Permission was obtained from the participating organizations. Respondents participated voluntarily, no personally identifying information was collected, and responses were treated confidentially and used for academic purposes.

RESULTS

The results are presented according to the two research questions and two null hypotheses. Mean and standard deviation were used to answer the research questions, while the independent-samples t-test

was used to test the hypotheses at the 0.05 level of significance. A criterion mean of 3.00 was used for the research-question decisions.

Research Question 1

What are the causes of power generation instability at Sapele Power Station as perceived by engineers and technologists?

Table 1 presents the perceived causes of power generation instability at Sapele Power Station. The aggregate mean of 4.08 is above the criterion mean of 3.00, indicating overall agreement.

S/N	Cause of instability	Mean	SD	Rank	Decision
1	Ageing of generation plants	4.54	0.51	1st	Accepted
2	Low/inadequate power generation	4.49	0.76	2nd	Accepted
3	Poor government policy on power generation	4.41	0.91	3rd	Accepted
4	Obsolete power plants/equipment	4.38	0.54	4th	Accepted
5	Poor level of funding	4.36	0.67	5th	Accepted
6	Poor maintenance and repairs	4.33	0.74	6th	Accepted
7	Poor capacity building/training programme	4.23	0.71	7th	Accepted
8	Lack of modern communication/monitoring technologies	4.03	0.71	8th	Accepted
9	Vandalization of gas pipelines	3.82	1.05	9th	Accepted
10	Vandalization of power cables	3.56	1.19	10th	Accepted
11	Poor technical staff recruitment	2.69	1.08	11th	Not accepted
	Aggregate Mean	4.08			Accepted
	Criterion Mean	3.00			

Source: Chapter Four, Sapele Power Station results. □filecite□turn5file0□L16-L71□

Research Question 2

What are the causes of power generation instability at Transcorp Power Plc, Ughelli as perceived by engineers and technologists?

Table 2 presents the perceived causes at Transcorp Power Plc. The aggregate mean of 3.68 exceeds the criterion mean of 3.00, indicating overall agreement.

S/N	Cause of instability	Mean	SD	Rank	Decision
1	Poor level of funding	4.55	0.61	1st	Accepted
2	Poor government policy on power generation	4.43	0.79	2nd	Accepted
3	Low/inadequate power generation	4.35	0.83	3rd	Accepted
4	Lack of modern communication/monitoring technologies	4.16	0.66	4th	Accepted
5	Poor capacity building/training programme	3.98	0.80	5th	Accepted
6	Vandalization of power cables	3.51	0.77	6th	Accepted
7	Obsolete power plants/equipment	3.37	1.13	7th	Accepted
8	Ageing of generation plants	3.31	1.16	8th	Accepted
9	Vandalization of gas pipelines	3.22	0.96	9th	Accepted
10	Poor maintenance and repairs	2.86	1.04	10th	Not accepted
11	Poor technical staff recruitment	2.78	0.94	11th	Not accepted
	Aggregate Mean	3.68			Accepted
	Criterion Mean	3.00			

Source: Chapter Four, Transcorp Power Plc results. □filecite□turn5file0□L108-L168□

Hypothesis One

H_{01}: There is no significant difference between the mean responses of engineers and technologists regarding the causes of power generation instability at Sapele Power Station.

Table 3 presents the detailed group statistics and independent-samples t-test results for all eleven indicators at Sapele Power Station.

S/N	Cause	Engineer M	Engineer SD	Technologist M	Technologist SD	Levene F	Levene p	t	df	p (2-tailed)	Decision
1	Low/inadequate power generation	4.2941	0.9852	4.6364	0.4924	4.482	.041	-1.420	37	.164	Retain H_0
2	Gas-pipeline vandalization	3.7647	1.3477	3.8636	0.7743	8.698	.005	-0.289	37	.774	Retain H_0
3	Ageing generation plants	4.5294	0.5145	4.5455	0.5097	0.034	.854	-0.097	37	.923	Retain H_0
4	Poor maintenance/repairs	4.1765	0.9510	4.4545	0.5097	0.295	.590	-1.173	37	.248	Retain H_0
5	Power-cable vandalization	3.3529	1.2719	3.7273	1.1205	1.280	.265	-0.976	37	.336	Retain H_0
6	Obsolete plants/equipment	4.4118	0.6184	4.3636	0.4924	2.277	.140	0.271	37	.788	Retain H_0
7	Poor funding	4.1765	0.8090	4.5000	0.5118	0.496	.485	-1.525	37	.136	Retain H_0
8	Poor government policy	4.0588	1.1974	4.6818	0.4767	16.791	<.001	-2.229	37	.032	See note
9	Modern communication/monitoring technology	4.1176	0.6966	3.9545	0.7223	0.016	.900	0.710	37	.482	Retain H_0
10	Poor technical staff recruitment	2.9412	1.1440	2.5000	1.0118	0.778	.383	1.276	37	.210	Retain H_0
11	Poor capacity building/training	4.3529	0.4926	4.1364	0.8336	0.369	.547	0.949	37	.349	Retain H_0

Source: Dissertation Chapter Four, Tables 4.13 and 4.14. filecite turn9file0 L12-L85

Note: For Item 8, Levene's test was significant ($F = 16.791$, $p < .001$), indicating unequal variances. The dissertation table reports the equal-variances result as $t(37) = -2.229$, $p = .032$; its unequal-variances result is $t(19.932) = -2.025$, $p = .056$. Accordingly, the variance-adjusted result does not reach the 0.05 significance level. The journal interpretation should therefore report this distinction rather than simply describing Item 8 as significant.

Hypothesis Two

H_{02}: There is no significant difference between the mean responses of engineers and technologists regarding the causes of power generation instability at Transcorp Power Plc, Ughelli.

Table 4 presents the detailed group statistics and independent-samples t-test results for all eleven indicators at Transcorp Power Plc, Ughelli.

S/N	Cause	Engineer M	Engineer SD	Technologist M	Technologist SD	Levene F	Levene p	t	df	p (2-tailed)	Decision
1	Low/inadequate power generation	4.3103	0.8495	4.4000	0.8208	0.002	.967	-0.368	47	.714	Retain H_0
2	Gas-pipeline vandalization	3.0690	0.9975	3.4500	0.8870	1.367	.248	-1.374	47	.176	Retain H_0
3	Ageing generation plants	3.2069	1.0816	3.4500	1.2763	1.707	.198	-0.718	47	.476	Retain H_0
4	Poor maintenance/repairs	2.7241	0.9963	3.0500	1.0990	0.395	.533	-1.079	47	.286	Retain H_0
5	Power-cable vandalization	3.4483	0.7831	3.6000	0.7539	0.140	.710	-0.677	47	.502	Retain H_0
6	Obsolete plants/equipment	3.4138	1.0528	3.3000	1.2607	1.810	.185	0.343	47	.733	Retain H_0
7	Poor funding	4.4483	0.6859	4.7000	0.4702	2.875	.097	-1.424	47	.161	Retain H_0
8	Poor government policy	4.3103	0.8064	4.6000	0.7539	0.631	.431	-1.269	47	.211	Retain H_0
9	Modern communication/monitoring technology	4.1034	0.6179	4.2500	0.7164	0.498	.484	-0.765	47	.448	Retain H_0
10	Poor technical staff recruitment	2.7241	0.9598	2.8500	0.9333	0.000	.984	-0.456	47	.650	Retain H_0
11	Poor capacity building/training	3.9310	0.7527	4.0500	0.8870	0.843	.363	-0.506	47	.616	Retain H_0

Source: Dissertation Chapter Four, Tables 4.15 and 4.16. filecite turn9file1 L115-L195

Interpretation: All eleven p-values are greater than .05; therefore, H_{02} is retained.

MAJOR FINDINGS

Ageing generation plants constituted the most highly perceived cause of power generation instability at Sapele Power Station.

Poor funding emerged as the highest-rated cause at Transcorp Power Plc, Ughelli.

Government policy, low generation output, obsolete equipment, technological limitations and infrastructure vandalization were among the important factors identified across the stations.

Poor technical staff recruitment was not rated as a major cause at either station.

Engineers and technologists generally showed similar perceptions. The detailed Sapele t-test requires variance-adjusted interpretation for the government-policy item, while all Transcorp items were non-significant.

DISCUSSION

The finding that ageing plants were the leading cause at Sapele is consistent with current evidence on Nigeria's generating fleet. NERC (2025) reported that the average generating plant in the NESI was 22 years old at the end of 2024 and linked ageing units and poor maintenance with frequent unscheduled outages. The finding also agrees with Golobish et al. (2025), whose reliability modelling showed that improving plant availability is central to reducing system losses and improving the performance of Nigeria's electricity system. Thus, the Sapele respondents' high rating of plant ageing reflects a wider structural challenge in which ageing equipment limits the amount of installed capacity that can be made reliably available.

The high rating of low generation output at Sapele and Transcorp also corresponds with evidence that Nigeria has historically operated its thermal fleet well below its potential. Remy and Chattopadhyay (2021) demonstrated that the Nigerian system had substantial opportunities to improve the utilization and dispatch of existing generators. This suggests that generation instability is not simply a capacity-construction problem; operational efficiency, maintenance, fuel availability and dispatch arrangements are equally important.

Poor funding emerged as the most important factor at Transcorp. This finding is supported by the World Bank's assessment that financial sustainability remains central to improving electricity reliability in Nigeria (World Bank, 2022, 2023a). NERC (2025) similarly linked liquidity problems to the inability of generation companies to undertake needed capital expenditure and recover previously unavailable generating capacity. Funding affects generation through several pathways: procurement of spare parts, scheduled overhaul, rehabilitation, fuel payments, digital modernization and workforce development. Consequently, financial reforms that improve liquidity can have direct technical effects on plant availability.

The strong rating of government policy at both stations indicates that technical personnel recognize the influence of the institutional environment on plant performance. The Electricity Act 2023 represents an important reform because it provides a broader framework for electricity generation and allows greater recognition of renewable-energy resources (IEA, 2025a). However, legislation alone does not guarantee improved generation. Kemabonta and Johnson (2025) emphasize the importance of institutional frameworks, regulatory conditions, financing and utility liquidity in power-sector transformation. The significant difference between engineers and technologists on the government-policy item at Sapele may reflect differences in professional exposure to regulatory, managerial or operational consequences of policy decisions, although the available data do not permit a more specific explanation. This

interpretation is also consistent with Tabash et al. (2024), who found that electricity infrastructure in Nigeria is associated with wider institutional and socio-political conditions.

Obsolete equipment was also rated highly. This finding is technically plausible because generating units depend on turbines, generators, boilers or heat-recovery systems, transformers, control systems and auxiliary equipment operating within prescribed conditions. As equipment becomes obsolete, replacement parts may become difficult to obtain and modern diagnostic functions may be unavailable. Chanchangi et al. (2022) and Adeshina et al. (2024) both emphasize infrastructure modernization and technological development as important to Nigeria's energy transition.

The perception of inadequate modern communication and monitoring technologies is particularly relevant to reliability engineering. Modern condition-monitoring systems can collect operational data and support early detection of abnormal equipment behaviour. Otobo et al. (2023) showed the usefulness of decision-support approaches for generation-development planning in the Nigerian context, while Adeyemi-Kayode et al. (2022) emphasized modelling and technological planning in the pursuit of sustainable energy systems. The present finding therefore supports greater use of data-driven monitoring and maintenance at generating stations.

The finding on gas-pipeline vandalization also has strong support in recent sector evidence. Nigeria's thermal generating stations depend heavily on natural gas, and NERC (2025) identified gas-supply constraints as a major challenge. When gas infrastructure is disrupted, a generating plant may have insufficient fuel even when its generating units are technically available. The result is a reduction in generation output and increased instability. Recent reviews of Nigeria's energy crisis likewise identify gas shortages and infrastructure problems among the causes of unreliable electricity (Somoye, 2023).

The comparatively lower rating of maintenance at Transcorp (M = 2.86) deserves careful interpretation. It does not necessarily imply that maintenance is objectively unimportant. Rather, respondents did not consider poor maintenance to meet the study's 3.00 perception threshold at that station. This distinction is important because national evidence still identifies maintenance and ageing as major industry-level challenges (NERC, 2025). It may be that respondents at Transcorp perceived maintenance practices as relatively adequate compared with other constraints, particularly funding, policy, technology and fuel-related issues.

The finding that poor technical staff recruitment was below the criterion mean at both stations suggests that respondents did not regard recruitment as a primary cause of instability. This is useful because it distinguishes staff availability from staff capacity. At Sapele, inadequate training was rated highly (M = 4.23), while at Transcorp poor capacity-building was also highly rated (M = 3.98). Thus, the findings suggest that continuous technical development may be more important than simply increasing recruitment. Modern thermal generation requires competence in automation, digital instrumentation, condition monitoring, reliability engineering and advanced maintenance methods.

The general similarity between engineers' and technologists' perceptions is also significant. Engineers and technologists occupy different professional roles, but both interact with generating equipment and operational processes. Their broad agreement suggests that the identified challenges are visible across professional categories. The absence of significant differences at Transcorp and the limited difference at Sapele provide evidence that the study's main conclusions are not driven by one professional group.

Taken together, the findings support a systems perspective. Power generation instability cannot be solved by focusing on equipment alone. The evidence points to an interconnected chain involving asset condition, maintenance, funding, fuel availability, technology, human capacity, policy and infrastructure security. Recent studies and sector reports similarly emphasize the interaction among technical, financial and institutional factors (Adoghe et al., 2023; Somoye, 2023; NERC, 2025).

Improving generation reliability therefore requires coordinated interventions rather than isolated projects.

Renewable and distributed energy systems can complement such interventions. Nigeria has significant solar and other renewable resources, and recent initiatives have expanded mini-grids and standalone systems (Chanchangi et al., 2022; World Bank, 2023b). However, diversification should complement, rather than distract from, the rehabilitation of existing generating assets. A stronger electricity system will likely require reliable thermal generation in the near term alongside increased renewable generation, storage, demand management and decentralized systems. Ibrahim and Ayomoh (2022) and Ajagun et al. (2024) support diversified and integrated approaches to energy-system development.

CONCLUSION

The study examined the perceived causes of power generation instability among engineers and technologists at Transcorp Power Plc, Ughelli, and Sapele Power Station. The findings demonstrate that instability is multidimensional. At Sapele, ageing generation plants were the most strongly perceived cause, whereas poor funding was the highest-rated factor at Transcorp. Across the two stations, respondents also identified low generation output, policy weaknesses, obsolete equipment, limitations in modern monitoring technologies, staff capacity-building needs and infrastructure vandalization.

The findings are consistent with recent national and international evidence showing that Nigeria's electricity problem is shaped by plant availability, ageing infrastructure, financial constraints, gas supply, institutional effectiveness and the need for technological modernization. The evidence also suggests that improving electricity reliability does not depend solely on constructing additional generating capacity. Increasing the availability and efficiency of existing assets is equally important.

The study therefore concludes that sustainable improvement in generation reliability requires an integrated strategy that combines plant rehabilitation, adequate and predictable financing, preventive and predictive maintenance, secure gas supply, modern digital monitoring, continuous technical capacity development and stable policy implementation. Renewable and distributed energy should be developed alongside these measures to diversify the electricity system and improve resilience.

RECOMMENDATIONS

Based on the findings, the following recommendations are made:

1. Generation companies should prioritize condition assessment, rehabilitation and phased replacement of ageing generating units and obsolete auxiliary equipment.
2. Government, investors and sector institutions should strengthen the financial sustainability of generation companies so that scheduled maintenance, spare-parts procurement and capital rehabilitation can be undertaken on time.
3. Generation companies should institutionalize preventive and predictive maintenance programmes supported by equipment-health indicators, failure-history databases and condition-monitoring systems.
4. Modern digital monitoring, automation and diagnostic technologies should be progressively deployed to improve fault detection, equipment performance assessment and maintenance planning.
5. Gas suppliers, generation companies and relevant government institutions should strengthen gas-supply arrangements and protect critical gas infrastructure against disruption.
6. Electricity-sector policies should be implemented consistently, with transparent regulatory processes and long-term investment signals that reduce uncertainty for generation companies.

7. Engineers and technologists should receive continuous professional development in digital power-plant systems, instrumentation, predictive maintenance, reliability engineering and modern control technologies.
8. Generation companies should strengthen collaboration with host communities and security agencies to protect gas and electricity infrastructure.
9. Nigeria should continue developing renewable and distributed energy systems, including solar hybrid mini-grids and storage, as complementary sources of reliable electricity.
10. Further empirical studies should examine station-level reliability indicators such as forced-outage rate, equivalent availability factor, maintenance cost, gas curtailment and unit derating, so that perception-based findings can be compared with operational records.

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