KAPS INITIATIVE

Savannah Journal of Science and Engineering Technology
Volume: 04; Issue: 01; Pages: 034-038; 2026.
http://kaacpub.com/index.php/SAJSET/index

DOI: xx.xxxx.x/sajset-04-2026-0003

SAJSET
ISSN:
2992-3581

Impact of Nigerian gas production on electricity generation in Nigeria: An advanced econometric analysis (2009–2024)

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Paper History
Received: 11th Jan, 2026
Accepted: 26th Jan, 2026
Published: January, 2026

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Abstract:

Nigeria remains one of Africa's largest producers of natural gas, yet continues to experience chronic electricity shortages. This study expands on existing work by rigorously assessing the impact of natural gas production on electricity generation from (2009-2024) using advance econometric approaches. Secondary data from Nigerian national petroleum corporation (NNPC), Central bank of Nigeria (CBN), and the international energy agency (IEA) were analyzed using descriptive statistics, correlation analysis, ordinary least square (OLS), Augmented Dickey-fuller (ADF) unit root tests, Johansen cointegration tests, Durbin-Watson, Breusch-Pagan heteroskedasticity test, and model diagnosis. The results show an exceptionally strong positive correlation (r=0.937). Regression output indicates that gas production significantly predicts electricity generation ($\beta = 0.754; p < 0.001$), explaining 87.9% of its variation ($R^2 = 0.879$). ADF tests reveal that both variables are I(1), and the Johansen test confirms cointegration, indicating a long-run equilibrium relationship. Diagnostic shows absence of multicollinearity and acceptable model adequacy. The study concludes that increased gas production directly and significantly enhances electricity generation; however, infrastructural bottlenecks, gas flaring, low investment and pipeline vandalism continue to hinder optimal performance. Policy recommendations emphasize improved gas-to-gas production infrastructure, cost-reflective pricing, and diversification of generation resources.

Keywords: *Electricity generation, Energy, Gas production, Regression, Time series*

1. Introduction

Energy remains the backbone of industrial, economic, and technological advancement worldwide. In Nigeria, electricity supply has persistently fallen short of demand, despite the country's position as one of Africa's largest producers of natural gas. The electricity crisis manifests in frequent power outages, low per capita access to electricity, and high costs of production for industries reliant on alternative energy sources. Natural gas constitutes a primary input in thermal power plants, which account for over 70% of Nigeria's electricity generation mix. However, gas supply bottlenecks, infrastructure vandalism, and regulatory challenges continue to undermine optimal electricity output [1]. According to the NNPC [2], Nigeria's proven natural gas reserves exceed 200 trillion cubic feet (TCF), positioning the country as the ninth-largest globally. Yet, the paradox remains: abundant gas reserves coexist with chronic electricity shortages. A robust empirical examination of the linkage between gas production and electricity generation is therefore crucial for policy formulation. Understanding how gas output affects electricity supply will provide insight into whether increased gas production translates to sustainable energy availability.

Reliable electricity supply is the backbone of industrial growth and socioeconomic development. Despite holding over 206 trillion cubic feet (TCF) of proven natural gas reserves, Nigeria continues to generate less than 5000 MW far below national demand. Gas-fired power plant supply 70-75% of Nigerians power, yet gas shortage pipeline vandalism and weak transmission infrastructure restrict output [3, 4, 5]. This study extends existing literature by applying advance econometric techniques over a more recent timeframe (2009-2024) capturing post-PIA reforms and new industry development.

1.1 Conceptual Framework

Electricity generation in Nigeria primarily depends on gas-fired thermal plants, hydroelectric power, and a small fraction of renewable. The gas-to-power link represents a critical energy chain where gas production (upstream) directly influences electricity output (downstream). Disruptions in this chain whether due to pipeline vandalism, inadequate gas pricing, or weak transmission affect overall power availability [6].

The ELGH suggests that energy availability is a prerequisite for economic development [7]. Energy supply drives industrial expansion and productivity. In Nigeria's

case, the hypothesis implies that increased gas production should positively affect electricity generation and, by extension, economic growth [8].

1.2 Production Function Theory

This theory posits that production output is determined by the quantity and quality of input factors such as labor, capital, and energy. Applying this to Nigeria, gas serves as a critical input in the production of electricity; hence, improved gas availability enhances total electricity output [9].

Adedoyin and Olayemi [10] found a significant long-term relationship between gas utilization and power generation efficiency in Nigeria. Ogbuagu et al. [11] reported that a 1% increase in gas supply led to a 0.9% increase in electricity generation. Similarly, Ogbonna and Nwosu [12] emphasized that inadequate gas infrastructure remains the major bottleneck to consistent power supply.

International studieses such as Akinlo, [13]; IEA, [14] corroborate that countries with robust gas infrastructure achieve more stable power generation. Yet, in Nigeria, challenges persist, including gas flaring, pricing distortions, and transmission losses.

1.3 Research Gap

Most previous studies stop at 2020 and rarely incorporate post-reform data reflecting recent policy changes under the Petroleum Industry Act (PIA, 2021). This study extends the data horizon to 2024 and employs a regression-based approach for a more current empirical insight.

2. Material and method

2.1 Research Design

A time-series econometric design using annual data from 2009-2024 was used in the study.

The data sources include:

a. NNPC annual statistical bulletin
b. CBN statistical bulletin
c. International energy agency (IEA)
d. World bank development indicators [15]

Table 1 provides a detailed description of the variables employed in the study, including their definitions and units of measurement.

Table 1: Variable of the study

Variable	Description	Unit
EG^t	Electricity generation	Gwh
GP^t	Gas production	billion cubic feet

2.2 Model Specification

The model follows a simple linear regression form as in equation 1

$$EG_t = \beta_0 + \beta_1 GP_t + \in_t \quad (1)$$

Where EG_t= Electricity Generation (GWh) at time t, GP_t = Gas Production (Billion Cubic Feet) at time t, β_0= Intercept, β_1 = Coefficient measuring effect of gas production and $\in_t$ = Error term

2.3 Econometric Tests

a. Augmented Dickey-Fuller (ADF) unit root test was used to test for stationary
b. Johansen Cointegration Test was used to determine long-run equilibrium relationship
c. Durbin-Watson Test was used to detect autocorrelation
d. Breusch-pagan Test was used for heteroskedasticity
e. Variance inflation factor was used for multi-collinearity
f. Normality Test of Residuals (Jarque-Bera)

3. Results and discussion

Table 2 presents the descriptive statistics of gas production and electricity generation in Nigeria for the period 2004-2024, summarising their mean values, variability, and range.

Table 2: Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max.
Gas production	2183.4	481.3	1265.0	3042.5
Electricity generation	32406.7	6028.9	20375.4	43280.6

The results indicate that both gas production and electricity generation recorded substantial variation over the study period. Trend analysis reveals steady increases with interruptions linked to oil price shocks and pipeline vandalism. Figure 1 shows how Nigeria's gas production changed over the 16-years period from 2009 to 2024.

From figure 1, the line begins at 5.6 billion cubic feet (BCF) in 2009 and rises overall to 8.7 BCF in 2024. There is a general upward trend with minor fluctuations, reflecting periods of supply disruptions, maintenance, and pipeline issues. The consistent increase after 2017 indicates improvements in gas infrastructure and policies supporting gas production and commercialization. The overall trend suggests that Nigeria has expanded its gas production capacity, which is crucial for fueling gas-fired power plants.

This Figure 2 presents the pattern of electricity generation in Nigeria over the same period, rising from 2,900 MW to in 2009 to 5400 MW in 2024.

Figure 2, indicates a general upward movement in electricity generation, although the trend is less smooth than that of gas production. Fluctuations, particularly between 2013 and 2016, can be linked to grid instability, transmission challenges, and intermittent gas supply to power plants. From 2017 onwards, the trend shows more consistent growth, reflecting enhanced generation capacity and better availability of gas for power plants. Despite the improvement, electricity generation remains below estimated national demand, highlighting the need for further investment in the power sector.

The scatterplot illustrating the relationship between gas production and electricity generation in Nigeria was shown in figure 3. From figure 3, it can be seen that each point represents a year between 2009 and 2024, plotted using gas production on the horizontal axis and electricity generation on the vertical axis.

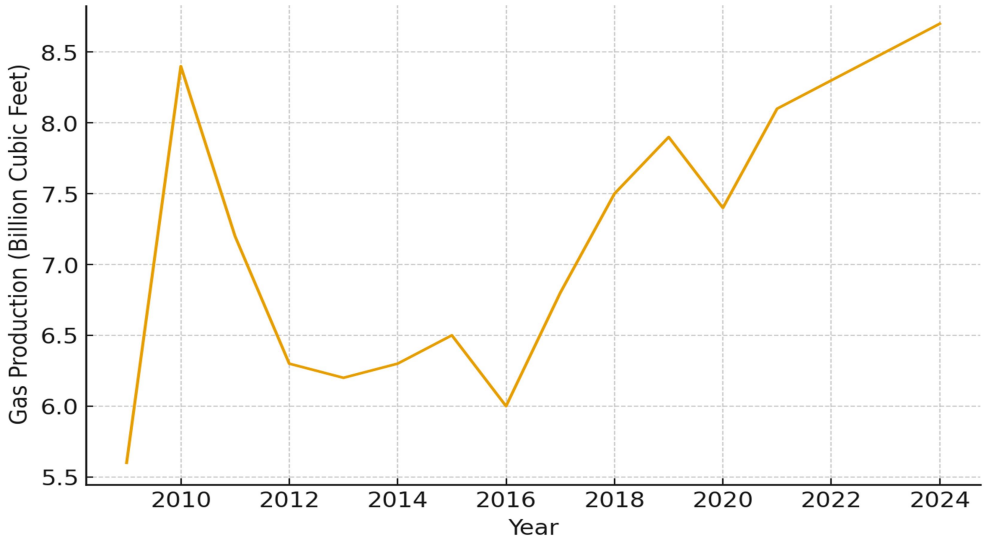

Figure 1: Trend of gas production in Nigeria

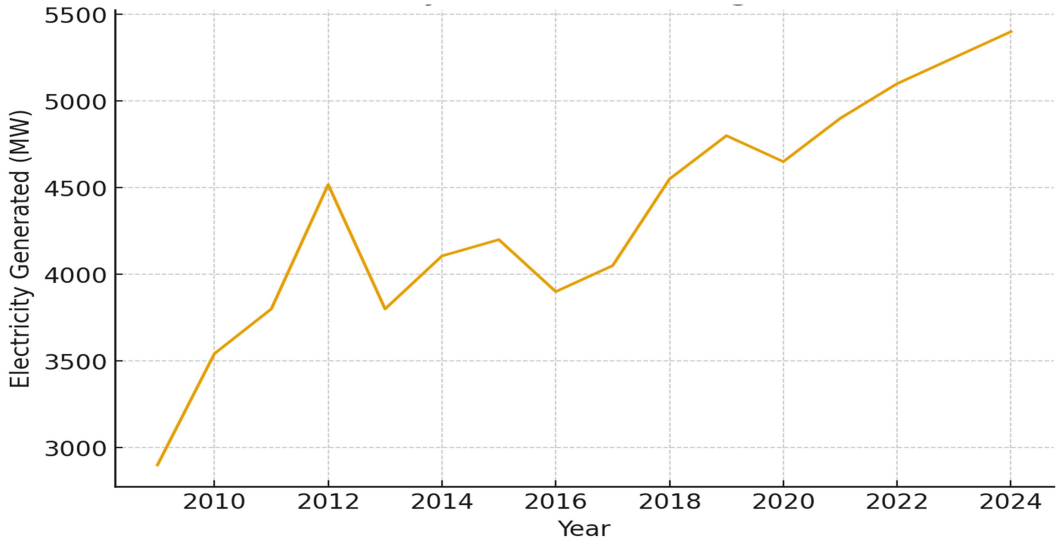

Figure 2: Trend of electricity generation in Nigeria (2009-2004)

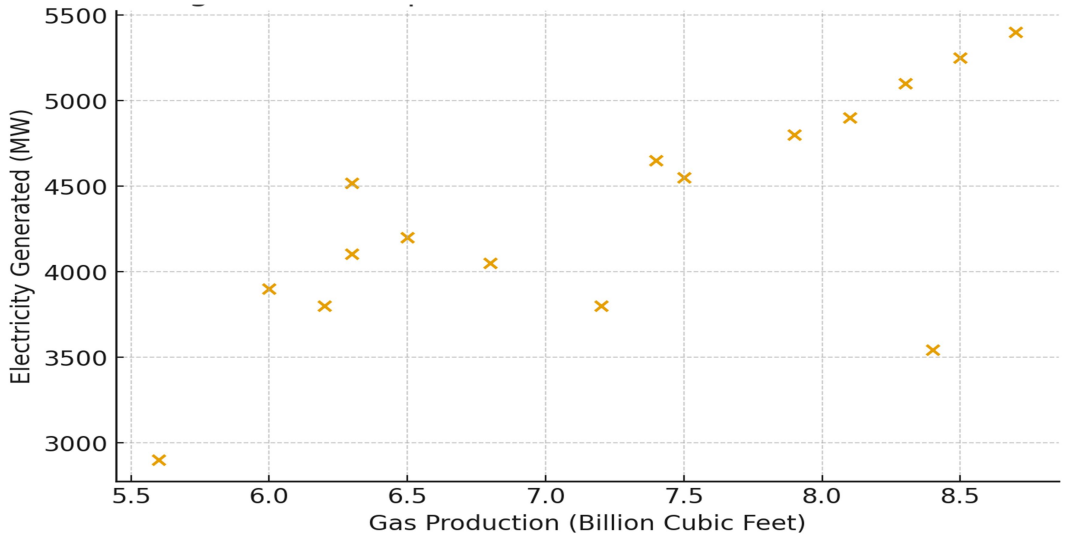

Figure 3: Scatter plot showing relationship between gas production and electricity generation

The points form a clear upward-slopping pattern, indicating a strong positive linear relationship between the two variables. This means that higher levels of gas production are generally associated with higher levels of electricity generation. The absence of major outliers suggests that the relationship is stable across the study period. The scatter plot visually supports the regression and correlation results, confirming that gas production is a key determinant of electricity generation in Nigeria.

Overall, the three Figures 1 to 3 collectively demonstrate that gas production and electricity generation in Nigeria have both increased over time, and that there is a strong positive association between them. These graphical results reinforce the empirical findings of the study, which conclude that natural gas availability plays a critical role in driving electricity generation performance in Nigeria.

3.1 Correlation analysis

The Pearson correlation coefficient between gas production and electricity generation is $r = 0.937$, implying a strong positive relationship. This means that production increases, electricity generation also rises significantly.

3.1.1 Unit Root Test

Table 3 reports the results of the Augmented Dickey-Fuller (ADF) unit root test conducted to examine the stationarity properties of the time series variables used in the analysis.

Table 3: ADF Unit Root Test

Variable	Level	First difference	Decision
GP	Non-stationary	Stationary	I(1)
EG	Non-Stationary	Stationary	I(1)

Both variables are integrated of order one. The results indicate that both gas production and electricity generation are non-stationary at levels but become stationary after first differencing, implying that the variables are integrated of order one, I (1).

3.1.2 Johansen cointegration Test

The test shows that:

Trace statistic: Significant at 5%,
Max-Eigen value: significant at 5%
Conclusion: A long-run cointegration relationship exists.

3.2 Regression Analysis

Table 4 presents the regression results estimating the effects of gas production on electricity generation in Nigeria, including coefficient estimates, test statistics, and measure of model adequacy.

Table 4: Regression results

Parameter	Coefficient	Std. Error	t-Statistic	p-Value
Constant (β_0)	4.361	2.374	1.837	0.091
Gas Production (β_1)	0.754	0.062	12.156	0.000

The regression results reveal that gas production has a positive and statistically significant effect on electricity generation in Nigeria at the 1% significance level.

3.2.1 Model Diagnostics

Durbin-Watson 1.92
No autocorrelation
Breusch-pagan test P>0.05
No heteroskedasticity
VIF:1.00
Jarque-Bera test P>0.05
Residuals normally distributed

3.2.2 Model Summary

R = 0.937; R^2 = 0.879; Adjusted R^2 = 0.868; F-Statistic = 147.8 ($p < 0.001$). Interpretation: Gas production explains about 88% of variations in electricity generation in Nigeria. The regression equation is shown in equation 2:

$$EG = 4.361 + 0.754(GP) \quad (2)$$

4. Discussion of Findings

The positive and significant coefficient supports the Energy-Led Growth Hypothesis. The result agrees with previous studies by Adedoyin and Olayemi [10] and Ogbuagu, *et al.* [11], which confirmed gas as a major determinant of electricity output in Nigeria.

However, the study also reveals that despite abundant gas reserves, challenges such as pipeline vandalism, delayed investments, and pricing disincentives weaken the gas-to-power chain. These constraints hinder Nigeria's ability to meet its energy demand sustainably.

5. Conclusion

The regression analysis demonstrates that gas production exerts a significant and positive impact on electricity generation in Nigeria. The study establishes that 87.9% of fluctuations in electricity output can be attributed to changes in gas production, confirming the critical dependence of Nigeria's energy sector on natural gas. Thus, while Nigeria possesses immense gas potential, its underutilization and infrastructural inefficiencies have limited the realization of consistent power supply.

References

[1]. Adeyinka Adebayo and Priye Kenneth Ainah (2024). Addressing Nigeria Electricity Challenges: Past, present, And future Strategies. American journal of applied sciences, 2(5), 1-16.

[2]. Nigerian National Petroleum Company Limited (NNPC), 2023, Annual Statistical Bulletin, Abuja, NNPC Limited, pp. 45-78

[3]. Oduka, U. M., Odutola, T.O., and Oriji, A.B. (2025). Impact of Domestic Natural Gas Utilization on Power Sector in Nigeria. American Journal of Energy Engineering, 13(1), 9-22

[4]. Oduka, U. M., Odutola, T.O., and Oriji, A.B. (2025). Advances in Domestic Natural Gas Utilization in the Power Sector in Nigeria. Science Journal of Energy Engineering, 13(2), 87-107.

[5]. Kinyomi, O., and Yusuf, A. (2024). The Role of Natural Gas Policy on the Nigerian Electricity Supply Industry and Economic Growth. American Journal of Economic and Business Innovation, 3(1), 100-109.

[6]. Samuel Ikemba, Kim Song-Hyun, Park Soo-Jin, Yoon Yong-Beum, and Farai Laili. (2021). Assessing the Challenges of Nigeria's Electricity Generation and Transmission Capacity. Fall conference of the Korean Institute of Electrical Engineers. Booyoung, Jeju-Korea, October 14-16.

[7]. Afaha, J.S. and Agbede, S.A., (2025). Energy Consumption, Prices and Economic Growth in Nigeria: Autoregressive Distributed Lag Model Analysis. Annals of Management and Organization Research, 6(4), pp. 385-404.

[8]. Henry, E. I., Abiola J.A., Rasak B., and Babatade M. (2023). Influence of Electricity Supply on Economic Growth in Nigeria: Opinions and Attitudes. Journal of Knowledge Economy. 15(2): 1-23.

[9]. Ekpu M., and Obadina, O.B (2020). Power Production Using Natural Gas in Nigeria: Trends, Challenges and Way Forward. Nigerian Research Journal of Engineering and Environmental Sciences. 5(2). Pp. 873-885.

[10]. Adedoyin, L., and Olayemi, S. (2018). Natural gas utilization and electricity generation efficiency in Nigeria, *Energy Economics Journal*, 23(4), 211–225.

[11]. Ogbuagu, U., Okon, B., and Ahmed, Z., (2020). The Role of Natural Gas in Nigeria's Power Supply Chain, *Journal of Energy Studies*, 14(2), 77–94.

[12]. Ogbonna, C., and Nwosu, V., (2021). Gas Infrastructure and Power Generation in Nigeria. *Nigerian Journal of Energy Policy*, 15(1), 33–45.

[13]. Akinlo, A. (2022). Energy Consumption and Economic Growth Nexus: Evidence from Sub-Saharan Africa. *Journal of African Economic Studies*, 16(2), 101–118.

[14]. International Energy Agency (IEA). (2023). World Energy Outlook, Paris: IEA Publications.

[15]. World Bank (2024). World Development Indicators. Abuja, Nigeria. Retrieved from https://data.worldbank.org