

Research Article

Impact of Domestic Natural Gas Utilization on the Power Sector in Nigeria

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Abstract

This study investigates the impact of domestic natural gas utilization on Nigeria's power sector performance from 2000 to 2022 using the Autoregressive Distributed Lag (ARDL) model. Natural gas supply and electricity generation served as proxies for natural gas utilization and power sector performance, with Gross Domestic Product (GDP), unemployment rate (UEMP), and inflation (INF) as control variables. The findings reveal that natural gas supply positively and significantly influences electricity generation in the short and long term, with a unit increase in gas supply resulting in a 0.0226-unit rise in electricity generation in the short run and a 0.01447-unit increase in the long run. The Error Correction Term (ECT) demonstrates a strong speed of adjustment to long-run equilibrium. Model fitness and diagnostic tests confirm the reliability of the results, explaining 99.42% of the variation in electricity generation and affirming its predictive robustness. The study aligns with the United Nations Sustainable Development Goal (SDG) 7 by emphasizing natural gas's role in providing affordable, reliable, and sustainable energy. It also contributes to SDG 8 (economic growth) and SDG 13 (climate action) by reducing energy poverty, fostering industrial development, and encouraging a transition to cleaner energy sources. The results underscore the strategic importance of natural gas in addressing Nigeria's energy challenges and achieving energy security. To ensure sustainable development, the study recommends further investments in natural gas infrastructure, renewable energy integration, price stabilization, and policy reforms to address supply constraints. These measures are essential for improving Nigeria's energy reliability, driving socioeconomic progress, and meeting global sustainable development objectives.

Keywords

Natural Gas Utilization, Electricity Generation, Power Sector, Energy Security, Economic Development, Energy Efficiency

1. Introduction

Natural gas, a leading global energy source, is a long-standing and abundant hydrocarbon resource. Recent studies reveal that current reserves can meet global energy demand for the next 200 years [1]. Nigeria, with Africa's largest natural gas reserve and the 9th largest globally, holds approximately 180.5 trillion cubic feet (Tcf) of reserves, producing 4.7 billion cubic feet (Bcf) daily [2]. However,

natural gas accounts for only 12% of Nigeria's energy consumption [3]. Recognizing its untapped potential, Nigeria aims to increase natural gas's contribution to energy production to 70%, presenting opportunities for expanded use in the power, industrial, and transport sectors [4].

From an economic perspective, natural gas drives industrialization, fosters economic growth and reduces energy

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poverty. Based on economic models like the Energy-Led Growth Hypothesis, which posits that high energy consumption drives economic growth [5], and the Solow Growth Model, which suggests that capital accumulation and labour forces economic growth and technological progress [6], efficient natural gas utilization can stimulate productivity and infrastructure development. Furthermore, integrating natural gas into Nigeria's energy mix aligns with Sustainable Development Goal (SDG) 7, which advocates for affordable and clean energy access, and SDG 8, which promotes economic growth and industrialization.

Beyond its economic relevance, natural gas is the cleanest fossil fuel, emitting significantly less carbon dioxide than coal and oil. Its utilization aligns with global efforts to combat climate change and its impacts (SDG 13), making it a viable transitional energy source toward a low-carbon economy [7]. This position is supported by the Substitution Effect (Fuel Switching Theory), which stipulates that the transition from high-carbon to lower-carbon energy reduces emissions [8]. Advanced gas technologies, high energy conversion efficiencies, and adaptability to domestic power demands reinforce its potential in addressing Nigeria's persistent power sector challenges, including frequent blackouts, high dependency on costly diesel generators, and inefficiencies in electricity supply [9, 10].

The Nigerian government has taken significant steps to optimize natural gas utilization through policies such as the Electric Power Sector Reform Act (EPSRA) of 2005, the Nigerian Gas Master Plan (2008), the National Gas Policy (2017), and the Petroleum Industry Act (PIA) of 2021. These measures aim to improve electricity generation, deepen local utilization of natural gas, stimulate industrial productivity, and foster economic growth [11]. However, achieving these objectives requires addressing critical barriers, including inadequate infrastructure, regulatory challenges, and market inefficiencies [12]. Despite this progress, domestic natural gas utilization in Nigeria remains suboptimal, with significant untapped potential in the power, industrial, and transport sectors [13].

Existing literature on natural gas utilization has focused mainly on economic implications, pricing, and reforms. [14] examined the economic impact of gas utilization in Nigeria. The finding indicated that increased gas utilization positively affects Nigeria's GDP and industrial productivity. [15, 16] established a causal relationship between energy consumption (including gas) and economic growth, emphasizing the bidirectional relationship. [17] employed a multivariate cointegration approach, confirming the long-term interdependence between energy consumption and economic development. [18] provided an economic model for gas pricing and distribution and proposed policy interventions for effective gas supply chain management. [19] discussed the potential role of natural gas in shaping Nigeria's energy sector reforms, indicating its importance in diversifying energy sources. [20] provided a scientometric analysis and panel data analysis, confirming the

significant impact of energy consumption on economic growth. [21] analyzed natural gas's potential in Nigeria's energy sector reforms, suggesting its critical role in enhancing economic sustainability. [22] explored the role of domestic energy consumption in enhancing exports, indicating a positive linkage between energy consumption and trade performance in Nigeria. [23] employed a panel analysis to examine the energy-growth nexus in ten Eurasian oil-exporting countries, highlighting the varied impacts across different economies. Identified review gaps included sectoral impacts (power, industry, transportation, etc.), environmental effects, and policy effectiveness.

The work aims to evaluate the impact of natural gas utilization on Nigeria's power sector to assess the implication of natural gas utilization on the power sector performance, economic growth, and environmental impact. Using time series data from 2000 to 2022 and the Autoregressive Distributed Lag (ARDL) Model. The findings indicated that natural gas utilization has a positive and significant relationship with power sector performance in the short and long run. Also, by implication of the Energy-Led Growth Hypothesis and the Fuel Switching Theory, natural utilization positively impacts the economy and reduces CO₂ emissions to the environment. This outcome aligns with long-term implications for achieving sustainable development and meeting global energy goals, particularly SDG 7, which seeks to ensure access to affordable, reliable, sustainable, and modern energy for all. It also contributes to SDG 13 by promoting a cleaner energy transition and SDG 8 by supporting economic growth and industrialization [24]. The study provides empirical evidence on the short- and long-term impacts of natural gas utilization on the power sector in Nigeria, including economic and environmental effects. It recommends further investments in natural gas infrastructure, renewable energy integration, price stabilization, and policy reforms to address supply reliability and constraints.

2. Material and Methods

2.1. Materials

This paper presents the results of an empirical study using secondary time series annual data mined from online sources. Data on Nigeria's domestic natural gas production, supply (export and domestic), electricity generation, and total electricity Consumption were mined from the International Energy Agency. Data on the gross domestic product, inflation, and the unemployment rate were sourced from the World Bank online at the Macrotrend website, while data on electricity installed capacity (from natural gas sources) were sourced from Statista. The data were processed to align related variable units and fitness for EViews-12 software upload. Links for research data used and data sources are provided in the Supplementary Materials Section.

2.2. Time Series Analytical Model

The research utilized the Autoregressive Distributed Lag (ARDL) Model. The ARDL approach to cointegration is particularly useful when the variables are of mixed order of integration (i.e., order zeros (I (0)) and ones (I(1))) [25]. It involves estimating the long and short-run model in equations (1) and (2) and satisfying the assumptions for ARDL model specification, including residual and stability diagnostics. Where co-integration is established, the long-run coefficients are determined using the ARDL model specifications of equation 1.

$$P_t = \alpha_0 + \sum_{i=1}^p \alpha_i P_{t-i} + \sum_{j=0}^q \beta_j G_{t-j} + \sum_{k=0}^r \gamma_k X_{t-k} + \epsilon_t \quad (1)$$

$$\Delta P_t = \lambda_0 + \sum_{i=1}^{p-1} \lambda_i \Delta P_{t-i} + \sum_{j=0}^{q-1} \delta_j \Delta G_{t-j} + \sum_{k=0}^{r-1} \theta_k \Delta X_{t-k} + \phi ECT_{t-1} + \epsilon_t \quad (2)$$

Where ECT_{t-1} is the error correction term derived from the long-run relationship.

The research variables comprise Power Sector Performance (P_t) proxied by Electricity Generation (EG_NGH) in Gigawatt (GW) as the dependent variable, Domestic Natural Gas Utilization (G_t) proxied by Natural Gas Supply (NG_SD) in Trillion standard cubic feet (Tscf) as independent variable and control variable, including relevant variables that might impact the dependent variables, such as economic growth (GDP—US\$ Billion), unemployment rate (UEMP) in percent,

Where:

P_t (Power sector Performance) is the dependent variable.

G_t (Natural Gas Utilization) is the independent variable

X_t Represents control variables (GDP, Unemployment, and Inflation).

P_{t-i}, G_{t-j} & X_{t-k} represents the variables lagged by (i, j & k) Periods.

$(\alpha_i), (\beta_j)$ and (γ_k) are the coefficients of the lagged dependent and independent variables, respectively.

(ϵ_t) is the error term.

Equation 2 gives the Error Correction Model (ECM), estimated to capture the short-run dynamics and speed of adjustment towards long-run equilibrium.

and inflation (INF) in percent. The control variables help to isolate the direct effect of natural gas supply on electricity generation by accounting for external economic influences. GDP captures overall economic activity, preventing omitted variable bias from general economic expansion. UEMP controls labour market fluctuations, ensuring employment shocks do not distort the relationship, while INF adjusts for price instability, ensuring economic distortions do not misrepresent the effect of energy supply. Table 1 describes the variables, their proxies, and their symbols.

Table 1. Variable Description & Proxies.

Variables Description	Variable Symbols	Variable Proxy	Variables Proxy Symbols
Natural Gas Utilization	G(t)	Domestic Natural Gas Supply (Tscf)	NG_SD
Gross Domestic Product	D(t)	Gross Domestic Product (US\$ Billion)	GDP
Unemployment Rate	U(t)	Unemployment Rate (%)	UEMP
Power Sector Performance	P(t)	Electricity Generation (Gigawatt)	EG_NGH
Inflation	F(t)	Inflation (%)	INF

2.3. Methodology

The analysis employed annual time series data from 2000 to 2022 utilizing the ARDL model to explore the short-run and long-run effects of natural gas utilization in the power sector. The ARDL analysis approach requires a chronology of preliminary and leading activities to establish the suitability of the dataset and then perform the ARDL analysis, respectively. Following the definition of aim, scope, objectives, processing, and refining data, it starts with descriptive statistics to provide information on

the normality of the variables, as this is crucial to progressing with the dataset. Next, a time series plot is performed to showcase correlations between variables, stationary consideration (unit root test) is done to check for the stationarity of variables and their order of integration, and lag length selection is carried out to determine optimal lag for each variable. This is followed by analyzing the econometric (ARDL) Model specification and diagnostics test (residuals and stability) to confirm alignment with the necessary ARDL model assumption. The model results is analyzed to evaluate the objective of the study. The research utilizes EViews-12 software to analyze the annual

time series data.

3. Results

This study evaluates the impact of natural gas utilization on the power sector in Nigeria to assess the implication of natural gas utilization on power sector performance, economic growth, and environmental effects. It uses annual time series data from 2000 to 2022 and the Autoregressive Distributed Lag (ARDL) Model with analysis performed using EViews-12 software.

3.1. Descriptive Statistics

Table 2 indicates symmetric distributions for NG_SD, GDP,

EG_NGH, and INF, with UEMP showing slight asymmetry. GDP and NG_SD show significant variability, reflecting economic and natural gas supply fluctuations. UEMP, EG_NGH, and INF have lower standard deviations, indicating stability. UEMP has a positive skew, suggesting a longer right tail with higher unemployment rates. All variables have kurtosis values below 3, except UEMP (2.95), suggesting flat distributions without extreme outliers. The Jarque-Bera test results are above 0.05, suggesting normality at conventional significance levels for most variables. NG_SD and GDP have wide ranges, indicating substantial economic and resource fluctuations, while UEMP, EG_NGH, and INF have narrower ranges, suggesting stable economic and demographic conditions.

Table 2. Descriptive Statistic Result.

Descriptive Statistics	NG_SD (Tscf)	GDP (US\$ billion)	UEMP (%)	EG_NGH (Gigawatt)	INF (%)
Mean	166.8296	333.0534	4.120217	3.103043	12.62557
Median	178.5100	375.7457	3.791000	3.090000	12.53780
Maximum	260.9300	574.1838	5.633000	4.170000	18.87360
Minimum	74.00000	69.17145	3.507000	1.680000	5.388000
Std. Dev.	55.18395	156.9997	0.636784	0.766310	3.809059
Skewness	-0.109850	-0.450042	1.203399	-0.200185	-0.047953
Kurtosis	1.868292	1.895209	2.947989	1.876443	2.158512
Jarque-Bera	1.273654	1.946103	5.553908	1.363398	0.687412
Probability	0.528968	0.377928	0.062228	0.505757	0.709137
Sum	3837.080	7660.228	94.76500	71.37000	290.3882
Sum Sq. Dev.	66995.91	542275.7	8.920860	12.91909	319.1964
Observations	23	23	23	23	23

3.2. Time Series Plot

The time series plot of natural gas utilization, electricity generation, and economic indicators such as GDP, unemployment rate (UEMP), inflation (INF), and economic growth in Nigeria provide critical insights into their trends and relationships over time.

Figure 1 illustrates that Nigeria's economy is heavily influenced by its natural gas sector, with a strong positive cor-

relation between natural gas production and GDP. However, the country's economy is vulnerable to oil and natural gas production fluctuations, as substantial natural gas production is tied to crude production. The Global Financial Crisis (GFC) resulted in a dip in all variables; the global oil surplus occasioned by US shale production and the COVID-19 pandemic has further impacted Nigeria's economy, indicating influence by global events and shocks thereby necessitating diversification and reduced reliance on oil and natural gas.

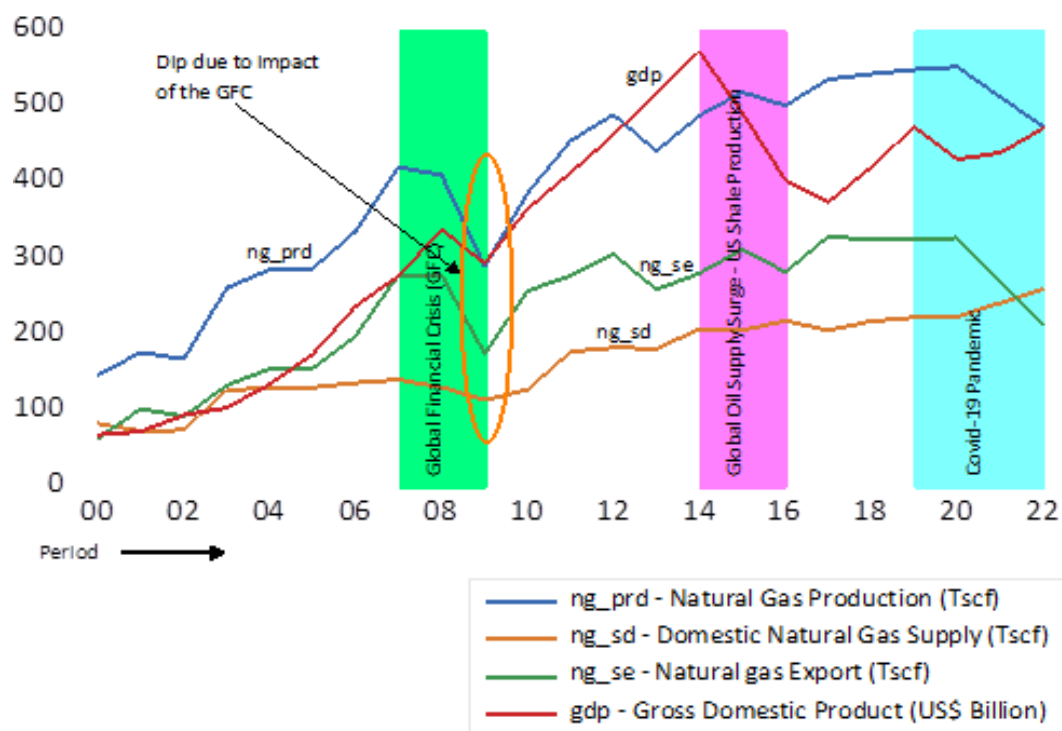


Figure 1. Correlation Between the Natural Gas Sub-Sector and Nigeria's GDP.

The graph of Figure 2 shows a positive correlation between natural gas production and GDP in Nigeria from 2000 to 2022. A stable domestic gas supply supports higher electricity generation, industrial activities, and economic growth. Again, global events like the Global Financial Crisis and COVID-19

have strongly influenced Nigeria's economy, affecting natural gas production, GDP, and electricity generation. Diversification and investment in alternative energy sources could lead to sustainable economic development.

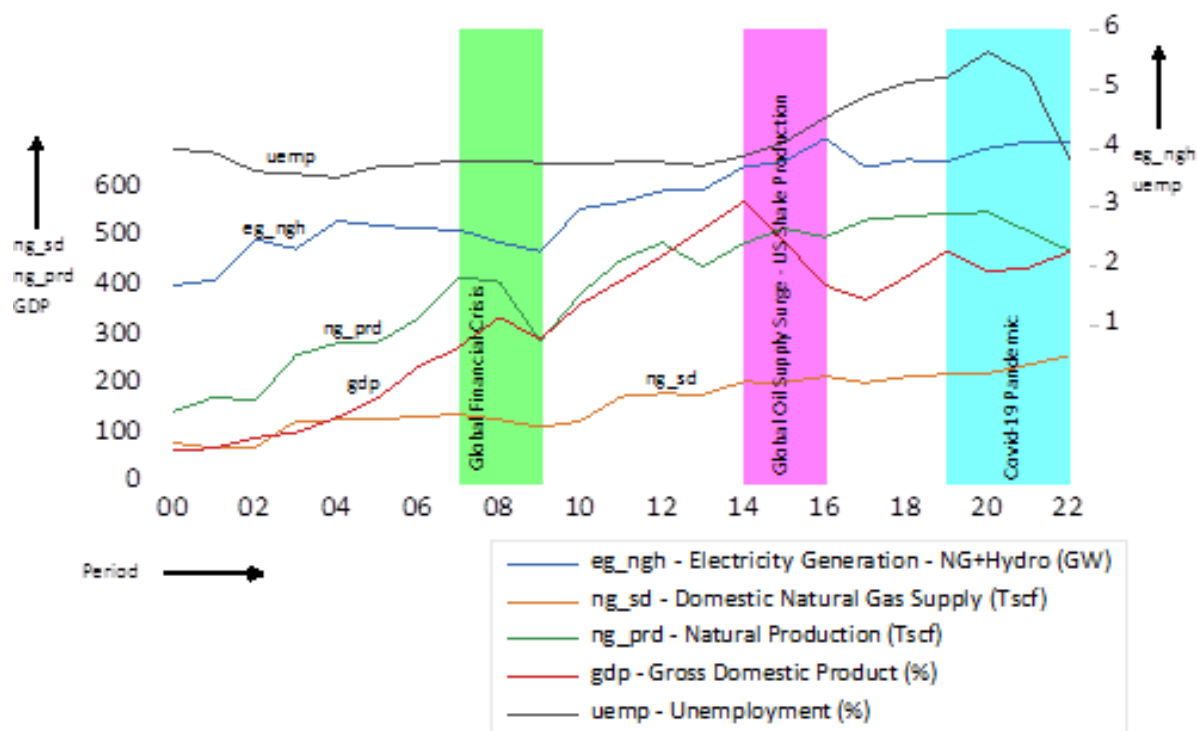


Figure 2. Correlation Between Natural Gas Sub-Sector, EG_NGH, GDP & UEMP.

Figure 3 indicates that from 2000 to 2022, Nigeria's electricity and natural gas sectors experienced a gradual increase in generation and consumption, with a significant rise in installed capacity. The Electricity Power Sector Reform Act (EPSRA) 2005 and the Nigerian Gas Master Plan (NGMP) 2008 aimed to improve efficiency and attract investment.

Post-2008, there was a marked increase in natural gas supply and electricity installed capacity, but this did not translate into a proportional increase in electricity generation. Further reforms and infrastructure development are needed to realize these improvements fully.

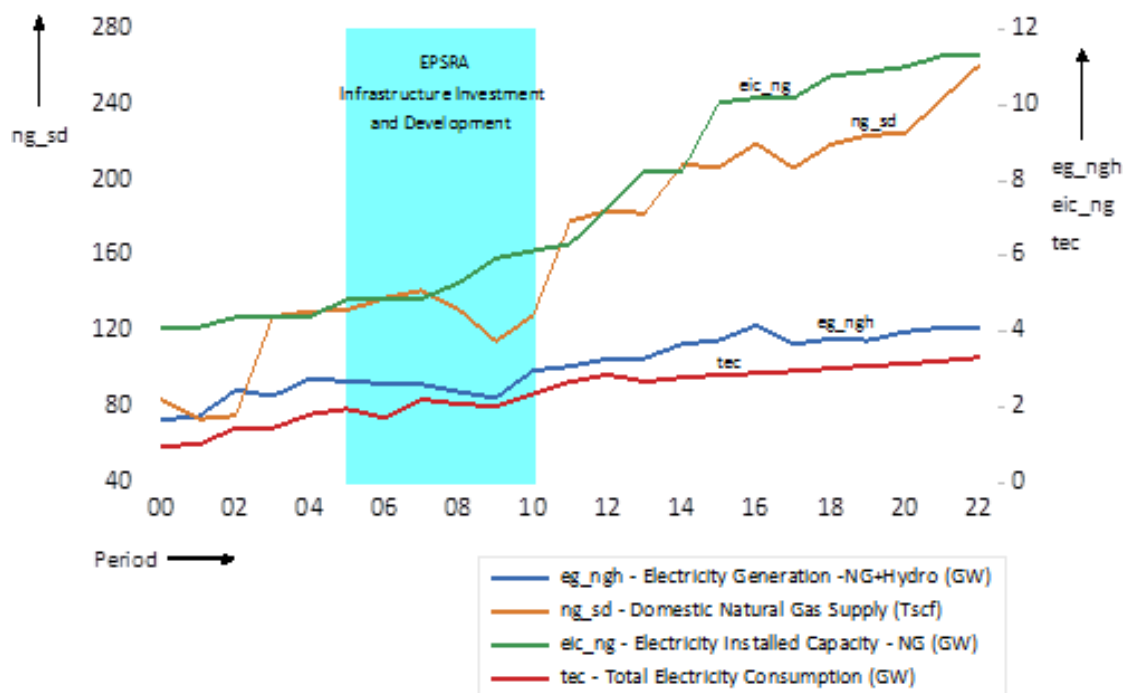


Figure 3. Policy Implication on Natural Gas and Power Sector Performance.

3.3. Stationarity Consideration & Lag Length Selection

The Augmented Dickey-Fuller (ADF) unit root test result

revealed that the variables have mixed integration order of zeros ($I(0)$) and Ones ($I(1)$). In contrast, the Unrestricted Vector Autoregressive (UVAR) Lag Length Selection Criteria results give the optimal lag length of 1 and 2 for the variables as in Table 3.

Table 3. ADF - Unit Root Test and Lag Length Selection Results.

S/N	Variables (units)	ADF Unit Root Test Result	Order of Integration	Optimal Lag Length
1	NG_SD	NG_SD is only stationary at 1st Diff @ C & C&T only	Order of integration is 1, $I(1)$	1
2	GDP	GDP is only stationary at 1st Diff @ C only	Order of integration is 1, $I(1)$	1
3	UEMP	UEMP is only stationary at Level @ C only	Order of integration is 0, $I(0)$	2
4	EG_NGH	EG_NGH is stationary at 1st Diff @ C and C&T only	Order of integration is 1, $I(1)$	1
5	INF	INF is stationary at 1st Diff @ C and C&T only	Order of integration is 1, $I(1)$	1

Note: C – Intercept; C & T - Intercept & Trend

3.4. ARDL Model Specification

The ARDL model examines the short-run and long-run relationships. The model is given by the function in equation (3)

$$EG_NGH(t) = f(NG_SD(t), GDP(t), UEMP(t), INF(t)) \quad (3)$$

From equation 3, the ARDL Model is given by the equation 4

$$EG_NGH_t = \alpha_0 + \sum_{i=1}^p \alpha_i EG_NGH_{t-i} + \sum_{j=0}^{q_1} \beta_{1j} ND_SD_{t-j} + \sum_{j=0}^{q_2} \beta_{2j} GDP_{t-j} + \sum_{j=0}^{q_3} \beta_{3j} UEMP_{t-j} + \sum_{j=0}^{q_4} \beta_{4j} INF_{t-j} + \epsilon_t \quad (4)$$

The bound test results in Table 4 indicated co-integration, implying the presence of long-run relationships since F-Stat. (18.6627) > I(1) (3.49). Equally, R-squared (0.99) and Adj. R-squared (0.98) explains 99% and 98% variability in EG_NGH by the independent variable, indicating an excellent fit. Similarly, from the model parameter fitness results in Table 4, the F-Stat. (72.9166) is significant at a 1% level, meaning the independent variables strongly impact EG_NGH. The Durbin-Watson Stat. (2.2713) value is close to 2, suggesting no significant autocorrelation in the residuals.

From Table 5, in the short run, the intercept (C) of EG_NGH (2.78) is positive and significant at the 1% level. This implies that with all independent variables being zero,

electricity is generated from other means, e.g., hydro sources. The coefficient of NG_SD (0.022) is positive and significant at a 1% level, implying that a unit increase in NG_SD will increase EG_NGH by 0.022 units; the coefficient of GDP is negative and insignificant. UEMP is positive while INF is negative, with both significant at 1% and 5% levels, respectively. In the long run, the intercept (C) is positive (0.86) and weakly significant at 10%. Furthermore, a 1-unit increase in NG-SD will increase EG_NGH by 0.0145 units, which is significant at a 1% level; GDP, UEMP, and INF are insignificant. The Error Correction Term (ECT) = -3.2167, meaning that the speed of adjustment toward a long-run equilibrium is 321.67%, which is very fast.

Table 4. Bound Test and Model Fitness Result.

Bound Test			
Null Hypothesis (H₀): No Co-integration			
F-Stat Value	Signif. Level	Lower Bound I(0)	Upper Bound I(1)
18.6627	10%	2.2	3.09
	5%	2.56	3.49
	2.5%	2.88	3.87
	1%	3.29	4.37
Model Parameter and Fitness Result			
R-Sqd	Adj. R-Sqd	F-Stats	D-W Stat.
0.9942	0.9805	72.9166***	2.2713

Note:

D-W Stat: Durbin-Watson Statistics; F-Stat: F-Statistics.

F-Stat (18.6627) > I(1) (3.49), implies co-integration exists. There is a long-run relationship.

***, ** and * indicate significance at 1%, 5% and 10% level of significance.

Table 5. ARDL Model Analysis Test Result.

Model	Variable	Coefficient	t-Statistic	Prob.*
S. R	EG_NGH(-1)	-1.209508	-5.923706	0.0010
	EG_NGH(-2)	-1.007152	-4.979629	0.0025
	NG_SD	0.022565	7.310685	0.0003
	NG_SD(-1)	0.018382	5.453401	0.0016

Model	Variable	Coefficient	t-Statistic	Prob.*
L. R	NG_SD(-2)	0.005614	2.558587	0.0430
	GDP	-0.001361	-1.935518	0.1011
	GDP(-1)	-0.004508	-3.354790	0.0153
	GDP(-2)	0.004861	5.581701	0.0014
	UEMP	0.443315	4.024897	0.0069
	UEMP(-1)	-0.778954	-2.591026	0.0412
	UEMP(-2)	0.337828	1.333962	0.2306
	INF	-0.039791	-2.898487	0.0274
	INF(-1)	0.037871	4.414472	0.0045
	INF(-2)	-0.012153	-0.844497	0.4308
	C	2.777342	6.781003	0.0005
	NG_SD	0.014475	20.39832	0.0000
	GDP	-0.000313	-1.582563	0.1646
	UEMP	0.000681	0.024538	0.9812
	INF	-0.004375	-0.535780	0.6114
	C	0.863424	10.03302	0.0001

Note: L.R – Long Run; S.R – Short Run; C – Constant (Intercept); (-1) – Coefficient of the lag 1; (-2) – Coefficient of the lag 2; prob* - Probability (p-value)

3.5. Residual Diagnostic Results

The result from Table 6 and the histogram normality plot of Figure 4 gives the Jaeque Bera stat. (0.6673) and p-value (0.7163) > 0.05, indicating that the residuals are normally distributed. Equally, from Table 5, the Breusch-Godfrey Se-

rial Correlation LM test result with Obs*R-squared (1.676666) and p-value (0.1954) > 0.05 indicated no serial correlation in the model residuals. Also, the Breusch-Pagan-Godfrey heteroskedasticity test result with Obs*R-squared (10.59274) with p-value (0.7177) > 0.05 indicated the model residuals are homoscedastic. This result indicates that the residuals satisfy all the necessary conditions.

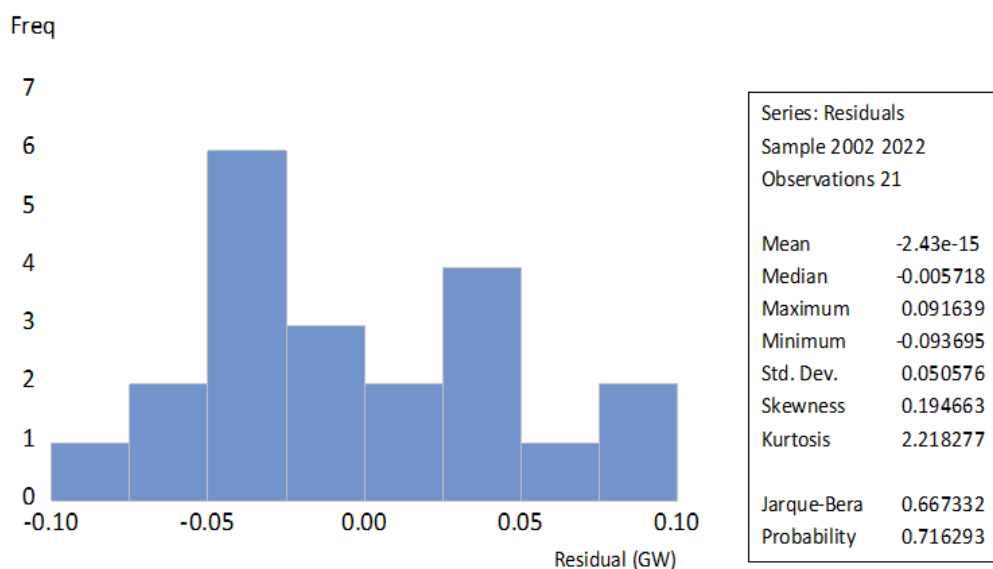


Figure 4. Histogram Normality Plot.

Table 6. Residual Diagnostic Test Results.

	Histogram Normality Test	Breusch-Godfrey Serial Correlation LM Test:	Heteroskedasticity Test
	Jaeque Bera (Prob)	Obs*R-sqd (Prob)	Obs*R-sqd (prob)
Results	0.6673 (0.7163)	1.676666 (0.1954)	10.59274 (0.7177)

Note:

Histogram Normality - Null hypothesis: Residuals are normality distributed

Serial Correlation LM Test – Null hypothesis: No serial correlation

Heteroskedasticity Test - Null hypothesis: Homoskedasticity

Prob = Probability = value in parenthesis = p-value

If the p-value < 0.05, we reject the null hypothesis

If the p-value > 0.05, we cannot reject the null hypothesis

3.6. Stability Diagnostics

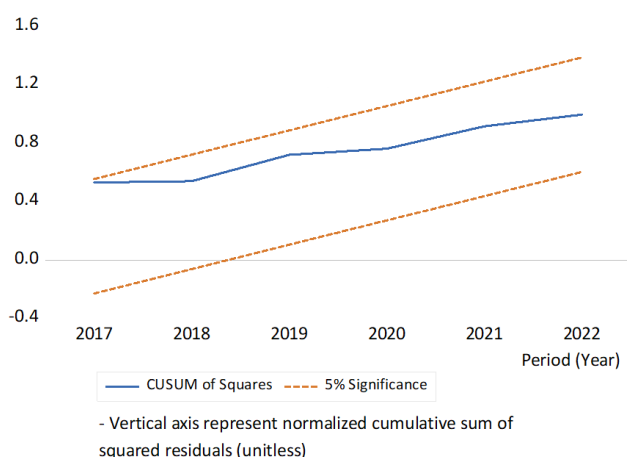
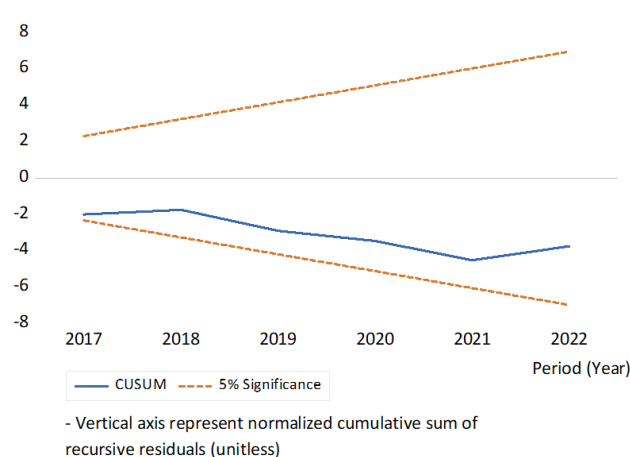
The stability tests include the Cumulative Sum of Square (CUSUMSQ) and the Cumulative Sum (CUSUM) Tests.

From Figure 5, the CUSUMSQ line falls entirely within the 5% significance bounds throughout the sample period (2017 to 2022), implying no evidence of structural breaks or instability in the model parameters during this period. Hence, the CUSUMSQ line plot indicated that the model is stable, and there are no significant structural changes or breaks in the relationship between the variables from 2017 to 2022.

Similarly, from Figure 6, the CUSUM line lies within the 5% significance bounds throughout the period (2017 to 2022). This suggests that the model's coefficients are stable over time, as no significant breaks or deviations exist in the model's structure.

model passes the CUSUM stability test, indicating that the parameters are stable over the sample period with no evidence of structural breaks or instability in the model based on these tests.

Based on the outcome, the research objectives are evaluated to assess the implication of natural gas utilization on power sector performance, economic growth, and environmental effects. The results of the ARDL model analysis indicate that natural gas utilization proxied by natural gas supply (NG_SD) is positive and significant in the short and long run. Similarly, improvements in power sector performance will positively impact economic growth and reduce CO₂ emissions to the environment in line with the Energy-Led Growth Hypothesis and the Fuel Switching Theory. The model parameter, fitness result, residual, and stability diagnostic test satisfy the necessary conditions, affirming the model's validity and reliability for predicting and forecasting.

**Figure 5.** CUSUM of Square Test Plot.**Figure 6.** CUSUM Test Plot.

Although there is a declining trend in the CUSUM line from 2017 to around 2021, followed by a slight increase, it remained within the critical bounds, indicating that the variations in residuals are not sufficient to indicate instability. Hence, the

4. Discussion

The results from the ARDL Model show that the coefficient of NG_SD (0.022) is positive and significant at the 1%

level, meaning that a unit increase in NG_SD will increase EG_NGH by 0.022 units in the short run. Equally, a 1-unit increase in NG-SD will increase EG_NGH by 0.0145 units, which is significant at a 1% level in the long run. This implies that natural gas utilization has a positive and significant relationship with power sector performance in the short and long-run, suggesting that an increase in natural gas utilization leads to an increase in power sector performance. The ECT of 321.67% means that the speed of adjustment toward a long-run equilibrium is very fast. From the model fitness result, R-squared (0.9942) and Adj. R-squared (0.9805) explains $\approx 99\%$ and $\approx 98\%$ variability in EG_NGH by the independent variable, indicating an excellent fit. The F-Statistic (72.9166) significant at 1% level means the independent variables strongly impact EG_NGH. The Durbin-Watson Statistic (2.2713) value is close to 2, suggesting no significant autocorrelation in the residuals. The model's residual diagnostic test indicated that the residuals are normally distributed and homoscedastic, with no evidence of autocorrelation. The stability diagnostics given by the CUSUMSQ and CUSUM line fall entirely within the 5% significance bounds throughout the sample period (2017 to 2022), suggesting that the model parameters and coefficients are stable over time, as no significant breaks or deviations exist in the model's structure during this period. Based on the model analysis and diagnostic test outcome, the model is valid and reliable for predicting and forecasting.

4.1. Effect of Control Variables

The impact of control variables in the short run presents mixed results. GDP exhibits lag-dependent significance, while UEMP has a positive initial effect but a negative lagged effect. Inflation (INF) negatively impacts electricity generation initially but turns positive at lag 1. In the long run, however, NG_SD remains highly significant ($p = 0.0000$), while GDP, UEMP, and INF lose their statistical significance, highlighting the dominance of natural gas in electricity generation. Furthermore, the ECT indicated a high speed of adjustment toward long-run equilibrium, reinforcing the long-term benefits of natural gas utilization for the power sector.

4.2. Comparison with Existing Literature

The findings in this study are consistent with studies highlighting natural gas as a crucial fuel for electricity generation in Nigeria due to its relatively cleaner and more efficient combustion than other fossil fuels like coal and oil. [26] indicated that electricity generation directly impacted Nigeria's gross domestic product. [27] reported that U.S. natural gas consumption reached new highs driven by the electric power sector, with a 4% increase in consumption in 2024 compared to 2023. [28] stated that domestic natural gas demand growth led to a 10% growth in the power sector and a 5% growth in

the industrial sector in Nigeria between 2011 and 2012. [29] cited that natural gas combustion emits less CO₂ than oil and coal, implying emission reduction. [30] demonstrated a marginal 10% increase in electricity generation capacity between 1985 and 2000, mainly from gas-fired power plants. However, this outcome was very low compared to countries like Malaysia, Vietnam, Iran, etc. This also aligns with the conclusions of studies in countries with similar energy portfolios, such as South Africa, where natural gas integration into the energy mix significantly enhances power reliability and capacity [31].

4.3. Impact of Policies and Global Crisis on Result

It is imperative to note that external economic shocks and key energy policies likely influenced these results. The 2008 Global Financial Crisis affected energy investment and consumption patterns, leading to natural gas supply and electricity generation volatility. Equally, the COVID-19 pandemic (2020–2022) further disrupted gas supply chains and reduced industrial demand, impacting the power sector [32–34]. Despite these fluctuations, the Nigerian Gas Master Plan (2008) and the National Gas Policy (2017) provided structural support for gas utilization, promoting investments in domestic gas infrastructure and ensuring supply consistency [35]. The Electric Power Sector Reform Act (EPSRA) 2005 also played a critical role in restructuring the Nigerian electricity market, improving efficiency, and attracting private sector participation [36, 37].

5. Conclusions

This study investigates the impact of natural gas utilization on the power sector in Nigeria to assess the implication of natural gas utilization on power sector performance, economic growth, and the environment. It utilized the ARDL model to analyze annual time series data from 2000 to 2022. The results indicated that domestic natural gas utilization proxied by natural gas supply significantly impacted power sector performance proxied by electricity generation positively, in the short-run and long run. Though the effect of the control variable in accounting for external economic influences was mixed, they were only limited to the short run, emphasizing natural gas dominance in electricity generation. This result also implied that increased natural gas use positively impacted economic growth and CO₂ emission reduction due to the energy switch from high-carbon intensive (coal and oil) to low-carbon intensive (natural gas) sources. The outcome underscores the importance of natural gas as a valuable energy source, highlighting the strategic importance of natural gas in Nigeria's energy planning and its alignment with the global sustainability agenda. To boost and sustain power sector performance, the study recommends that policymakers support expanding natural gas and power infrastructure to ensure a reliable gas supply and

formulate and implement favorable policies to drive natural gas and power infrastructure investments and promote competitive pricing mechanisms. As a contribution, the study provides empirical evidence on the short- and long-term impacts of natural gas utilization on the power sector in Nigeria, giving insights into how natural gas impacts the power sector, the economy, and the environment. The study's use of explicit annual time series data spanning 2000 to 2022 could be a limitation, as this is bound to have omitted some prominent monthly or quarterly variations in natural gas supply that may have impacted the overall outcome. Future studies can adopt monthly or quarterly datasets to analyze the impact of natural gas utilization on power sector performance and compare results. Other studies can also analyze the impact of natural gas on other key sectors such as industry, transportation, residential, etc.

Abbreviations

ADF	Augmented Dickey-Fuller
ARDL	Autoregressive Distributed Lag
Bcf	Billion Cubic Feet
CO ₂	Carbon Dioxide
COVID-19	Corona Virus 2019
CUSUM	Cumulative Sum
CUSUMSQ	Cumulative Sum of Square
ECM	Error Correction Model
ECT	Error Correction Term
EG_NGH	Electricity Generation (in Gigawatt)
EIC_NG	Electricity Install Capacity (Natural Gas Sources)
EPSRA	Electric Power Sector Reform Act
GDP	Gross Domestic Product
GFC	Global Financial Crisis
INF	Inflation
L.R	Long-Run
NG_PRD	Natural Gas Production
NG_SD	Natural Gas Supply (Domestic)
NG_SE	Natural Gas Supply (Export)
NGMP	Nigerian Gas Master Plan
PIA	Petroleum Industry Act
S.R	Short-Run
SGD	Sustainable Development Goal
Tcf	Trillion Cubic Feet
TEC	Total Electricity Consumption
Tscf	Trillion Standard Cubic Feet
UEMP	Unemployment Rate
UVAR	Unrestricted Vector Autoregressives

Supplementary Material

The supplementary material can be accessed at <https://doi.org/10.11648/j.xxxx.2024xxxx.xx>

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Author Contributions

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Toyin Olabisi Odutola: Writing – review and editing, Supervision

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography



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Research Field

Ugbede Mathew Oduka: Microwave/RF power amplifier, low noise amplifier, green wireless systems, natural gas utilization, energy security, electricity generation, gas-to-power, petroleum and energy economics, emission reduction and energy efficiency.

Toyin Olabisi Odutola: Hydrate mitigation, Flow assurance, petroleum economics, renewable energy, oil field chemicals.

Aleruchi Boniface Oriji: Oil and Gas wells Development, Gas production and utilization, Gas storage and transportation, Smart and intelligent well completion and localization of oil and Gas Materials.