EFFECT OF INSTITUTIONAL QUALITY ON NIGERIA'S ENERGY SECTOR DEVELOPMENT

[1]MOSES GOSELE DANPOME
[1]Department of Economics, Faculty of Management Sciences, Nigeria Defence Academy, Kaduna
mdanpome2010@gmail.com, +2347051657799

[2] MICHAEL SAMUEL AGILITY
[2]Department of Economics, Faculty of Social Sciences, Airforce Institute of Technology, Kaduna
samuelagilitymichael@gmail.com, +2348162357432

[3]SHIEKUMA JOHN KAVKAV
[1]Department of Economics, Faculty of Management Sciences, Nigeria Defence Academy, Kaduna
kavkavshiekuma@gmail.com, +2347034517194

ABSTRACT
This study investigates the effect of institutional quality in driving energy development in Nigeria from 1992 to 2022, examining its interaction with key economic and environmental factors such as CO_2 emissions per capita, energy imports, electricity access, GDP per capita, inflation, and renewable energy. Employing a Vector Error Correction Model (VECM), the study explores both short- and long-term dynamics, highlighting institutional quality's critical influence on energy sector outcomes. The findings reveal that strong institutional frameworks enhance energy development by supporting infrastructure growth and policy implementation, which are vital for sustainable progress. However, the limited impact of renewable energy underscores the need for increased investment and policy incentives to accelerate its adoption. Based on these findings, the study recommends strengthening institutional frameworks, enhancing governance structures, and implementing targeted policies to promote effective energy development and sustainability in Nigeria.
Keywords: Institutional Quality, Energy Development, Renewable Energy, Economic Growth.
JEL Classification Codes: Q43, O43, P28, Q56.

1. INTRODUCTION
Energy sector development is a critical driver of economic growth and sustainable development. In Nigeria, the energy sector has faced persistent challenges, including inadequate infrastructure, regulatory inefficiencies, and governance issues, which have hindered its ability to meet the growing energy demands of the population and industrial sector (Kolawole et al., 2024). Institutional quality plays a fundamental role in determining the efficiency, sustainability, and resilience of the energy sector, influencing policy implementation, regulatory effectiveness, and investment climate (Adedeji et al., 2024). As the Nigerian economy continues to expand, understanding the impact of institutional quality on energy sector development becomes essential for formulating policies that can foster a more reliable and sustainable energy supply.
Institutions encompass the formal and informal rules governing economic transactions, including regulatory frameworks, property rights enforcement, and mechanisms for reducing corruption and political instability (Appiah et al., 2024). In countries with weak institutional structures, the energy sector often suffers from inefficiencies, misallocation of resources, and susceptibility to rent-seeking behaviour (Agu et al., 2024). Evidence from Sub-Saharan Africa suggests that improving institutional quality can enhance energy security, promote green energy transitions, and foster economic performance (Adedeji et al., 2024; Diallo & Ouoba, 2024). Nigeria, as the largest economy in Africa, has the potential to benefit from such

improvements, yet it continues to grapple with systemic inefficiencies that impede its energy sector's growth.

A key challenge in Nigeria's energy sector is the persistent energy crisis characterized by frequent power outages, unreliable electricity supply, and high dependence on fossil fuels (Ogunode et al., 2025). Despite various policy reforms and government interventions, the sector remains marred by corruption, regulatory bottlenecks, and a lack of long-term investment strategies (Emmanuel et al., 2024). Studies have shown that institutional deficiencies, including weak governance structures, lack of transparency, and political interference, significantly affect energy development outcomes (Oje, 2024). In particular, inefficient institutions have led to underinvestment in renewable energy sources, poor maintenance of existing infrastructure, and barriers to private sector participation (Osman et al., 2025).

with the global shift towards sustainable energy, this study examined the effect of institutions in facilitating Nigeria's transition to a greener energy economy is crucial (Iqbal et al., 2025). The study will assess whether improvements in institutional quality can enhance energy security, attract investment, and promote sustainable energy solutions.

Therefore, this study examines the role of institutional quality in driving energy development (ENDEV) in Nigeria, considering key economic and environmental variables. Institutional quality, measured through governance and institutions ratings from the World Development Indicators (WDI) (-2.5 to +2.5), influences foreign direct investment (EIM), inflation rate (IFR), and gross domestic product (GDP), which in turn impact the energy sector. Additionally, factors like renewable energy adoption (REN), electricity access rate (ELAC), and carbon emissions (CO□) are assessed to determine their interactions with institutional governance and sustainable energy policies.

2. LITERATURE REVIEW

Conceptual Literature

Institutional Quality

Institutional quality refers to the ability of a country's institutions to manage resources, enforce regulations, and deliver services in an efficient, transparent, and accountable manner. In the context of Nigeria’s energy sector, institutional quality is reflected in the governance structures that oversee the development and regulation of energy resources. These structures include ministries, regulatory agencies, and parastatals responsible for policy implementation and enforcement (Kaufmann et al 2020). These indicators are usually expressed on a scale ranging from approximately -2.5 (weak institutions) to +2.5 (strong institutions).

Energy Sector Development

Energy is essential for economic development, particularly in Nigeria, Africa's largest economy, which has abundant energy resources including oil, natural gas, coal, and renewable sources like solar, hydro, and wind. However, persistent inefficiencies, underinvestment, and unstable policies have hindered the energy sector’s ability to support sustainable growth and development fully. As the 10th largest oil producer globally and a leading exporter of Liquefied Natural Gas (LNG), Nigeria plays a significant role in the global energy market. Furthermore, its favourable climate allows high solar energy potential, alongside untapped hydroelectric, wind, and biomass resources (Ajayi, 2019).

2.3 THEORETICAL LITERATURE

The theory provides the foundation to examine the dynamics within Nigeria’s energy sector, focusing on the roles of institutional quality in fostering sustainable growth. This study is anchored on institutional theory which was propounded by Douglass C. North in 1990. He developed the theory in his work "Institutions, Institutional Change and Economic Performance". He emphasized the role of institutions—both formal (laws, regulations) and informal (norms, culture)—in shaping economic and organizational performance. In Nigeria's energy sector, this theory highlights how weak governance, corruption, inadequate regulatory structures, and political interference have historically limited growth and efficiency.

In Nigeria, the prevailing poor institutional quality, marked by corruption and ineffective governance, has impeded the development of essential energy infrastructure and the optimal use of resources (Adedeji, 2024).

2.2 EMPIRICAL LITERATURE

Several studies have explored the relationship between institutional quality, economic stability, and energy sector performance. Gomado (2025) investigated the impact of uncertainty on economic growth, emphasizing the role of pro-market institutions in developing countries using a dynamic stochastic general equilibrium (DSGE) model. The study found that institutional weaknesses contribute to economic volatility, which, in turn, affects energy sector stability and investment. Similarly, Iqbal et al. (2025) examined the role of institutional quality in managing artificial intelligence, renewable energy, green human capital, geopolitical risk, and carbon emissions using a panel vector autoregression (PVAR) model. Their findings emphasize the need for robust institutions to facilitate the transition toward sustainable energy solutions.

Focusing on Nigeria, Nkwor et al. (2025) explored how multinational corporations operating in the cement industry evade environmental responsibilities due to weak institutional oversight. Their case study approach highlights the necessity of stronger regulatory frameworks to ensure corporate accountability in climate change mitigation. Ogunode et al. (2025) further contributed to this discussion by analyzing Nigeria's energy crisis in university settings using a qualitative content analysis approach. Their study links poor institutional governance to chronic energy shortages, which hinder effective planning and administration in the education sector, ultimately affecting national development.

Expanding the discussion to broader sub-Saharan Africa, Osman et al. (2025) examined how financial development and natural resources shape renewable energy adoption using a simultaneous equations model. Their study found that weak institutions impede green energy investments, advocating for governance reforms to support renewable energy initiatives. Similarly, Oyerogba et al. (2025) investigated the relationship between ownership structures and carbon emission disclosure quality in Nigeria's oil and gas sector using a panel data regression model. They found that firms with better governance structures exhibit higher disclosure quality, reinforcing the role of institutional quality in environmental management.

The significance of institutional quality in environmental sustainability is also evident in studies like Sun et al. (2025), which employed a two-stage least squares (2SLS) regression to explore its role in green financing and sustainable development. Their findings underscore the importance of governance frameworks in leveraging green finance for sustainability goals. Additionally, Yahaya (2025) used a textual analysis methodology to assess sustainability reporting in corporate governance, demonstrating that strong institutions enhance transparency and accountability in corporate sustainability practices.

Several scholars have also examined how institutional quality interacts with environmental policies. Dang and Le (2025) applied a fixed-effects regression model to explore the moderating role of institutional quality in the relationship between environmental taxes, carbon emissions, and economic growth. Their study suggests that strong institutions can ensure environmental taxation achieves its intended objectives. Similarly, Adedeji et al. (2024) analyzed the link between energy security, governance quality, and economic performance in sub-Saharan Africa using a panel data econometric approach, finding that governance quality significantly influences energy security and economic outcomes.

Other studies have explored institutional quality's impact on globalization, environmental degradation, and carbon mitigation strategies. Agu et al. (2024) employed a dynamic panel model to analyze how institutional strength enhances globalization's positive impact on Nigeria's manufacturing sector, while Akpan and Kama (2024) used an autoregressive distributed lag (ARDL) model to show that weak institutions contribute to environmental degradation. Appiah et al. (2024) applied a generalized method of moments (GMM) estimation to highlight institutional quality's role in balancing economic growth with carbon reduction efforts. Similarly, Asaki et al. (2024) and Degbedji et al. (2024) examined how institutional frameworks moderate the impact of electricity production and green economic growth, respectively, using structural equation modeling and system GMM techniques.

Furthermore, Diallo and Ouoba (2024) explored the relationship between renewable energy and economic growth in sub-Saharan Africa using a panel cointegration approach, revealing that institutional quality enhances renewable energy's contribution to economic development. Emmanuel et al. (2024) used a vector error correction model (VECM) to analyze the nexus between institutional quality, government expenditure, and economic growth in Nigeria, demonstrating that governance quality significantly determines the effectiveness of public spending on economic outcomes.

From these empirical works, it is evident that institutional quality plays a crucial role in economic stability, energy sustainability, and environmental governance. However, despite extensive research on governance and energy policies, there remains a notable gap in examining the direct role of institutions in Nigeria's energy sector development. While studies such as Dang and Le (2025) and Sun et al. (2025) highlight institutional quality's role in environmental taxation and green financing, limited empirical evidence directly links Nigeria's institutional weaknesses to regulatory failures, rent-seeking behaviours, and inefficiencies in energy resource management. This study seeks to bridge this gap by investigating the role of institutional governance in Nigeria's energy sector development, with a focus on policy implications and sustainable energy reforms.

3. METHODOLOGY

3.1 THEORETICAL FRAMEWORK

The Institutional Theory is the most relevant to this study because it directly addresses the role of governance, regulatory frameworks, and institutional effectiveness in shaping Nigeria's energy sector development. Unlike the Resource Curse Theory, which focuses primarily on the negative economic consequences of resource wealth, or Regulatory Capture Theory, which highlights industry influence over regulators, Institutional Theory provides a broader framework for understanding how weak institutions—marked by corruption, inefficiency, and poor governance—hinder energy sector growth.

By improving institutional quality, Nigeria can enhance transparency, enforce regulations, attract investment, and promote efficient resource management. This makes Institutional Theory the most suitable lens for analysing the impact of governance and institutional reforms on energy sector development.

3.2 MODEL SPECIFICATION

The institutional theory laid the foundation of this model as institutions influence energy development. The model is specified as:

$$ENDEV_t = \beta_0 + \beta_1 ISQ_t + \beta_2 GDP_t + \beta_3 EIM_t + \beta_4 IFR_t + \beta_5 REN_t + \beta_6 ELAC_t +, \beta_7 Co_{2t} + \mu_t$$

Where:

$ENDEV_t$=Energy Development
ISQ_t=Institutional Quality (Governance and institutions rating on WDI expressed on a scale ranging from approximately -2.5 (weak institutions) to +2.5 (strong institutions).
GDP_t=Gross Domestic Product
EIM_t=Foreign Direct Investment
IFR_t=Inflation Rate
REN_t=Renewable Energy Adoption
$ELAC_t$= Electricity Access Rate
Co_{2t}=Caborn emission
μ_t=the stochastic error term
$\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, , \beta_7$ are the parameter estimate

The study employs the Vector Error Correction Model (VECM) to analyse the relationship between institutional quality and energy development in Nigeria from 1992 to 2022. The choice of VECM is justified based on the following considerations:
Economic and environmental time series data often exhibit non-stationarity, meaning their statistical properties change over time. A unit root test (e.g., Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test) is conducted to confirm stationarity levels of the variables. Since economic and institutional variables tend to move together over time, it is necessary to establish a long-run equilibrium relationship using the Johansen Cointegration Test. If cointegration exists, the VECM becomes an appropriate model because it allows for both short-run and long-run dynamics in the system.
Unlike traditional VAR models, VECM incorporates an error correction term (ECT), which adjusts for deviations from the long-run equilibrium. This makes it a powerful tool for studying the dynamic adjustments of institutional quality, energy development, and other economic indicators.

Estimation Procedure
Step 1: Stationarity Test
The **ADF** are applied to all variables—CO□ emissions per capita (CO□_MTPC), energy imports (EIM), electricity access (ELA), energy development (ENDEV), GDP per capita (GDPPC), inflation (INF), institutional quality (ISQ), and renewable energy (REN)—to determine their order of integration.
Step 2: Johansen Cointegration Test
Since all variables are integrated at **order I(1)**, the **Johansen cointegration test** is conducted to verify the existence of a long-run equilibrium relationship. The trace and maximum eigenvalue statistics are used to determine the number of cointegrating equations.
Step 3: Estimation of VECM
Given the existence of cointegration, the **VECM** is specified as:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \sum_{i=1}^{p-1} \mathrm{T}_i \, \Delta Y_{t-i} + u_t$$

Where;
ΔY_t = represents the vector of endogenous variables (CO□_MTPC, EIM, ELA, ENDEV, GDPPC, INF, ISQ, REN).
$Y_{t-1} = is\ the\ vector\ of\ level\ variables\ at\ time\ (t-1)$
α = vector of constant terms (intercepts).
β = represents the vector of cointegration coefficients.
T = coefficients that capture the short-term dynamics associated with the lagged differences.

μ =represents a vector of error terms, which are assumed to be white noise.

3.2 Data and Measurement of Variables

Variable	Description/Measurement	Source	APriori Expectation
Energy Sector Development (ENDEV)	Measured by indicators such as total energy production (MW), energy access rate, renewable energy adoption, and energy efficiency	WDI	N/A (Dependent Variable)
Institutional Quality (ISQ)	Regulatory Quality: Percentile Rank, Upper Bound of 90% Confidence Interval [RQ.PER.RNK.UPPER]	WDI	+
GDPPC of Energy use	GDP per unit of energy use (constant 2021 PPP $ per kg of oil equivalent) [EG.GDP.PUSE.KO.PP.KD]	WDI	+
Energy Import (EIM)	Energy imports, net (% of energy use) [EG.IMP.CONS.ZS]	WDI	+
Inflation Rate (INF)	Percentage change in the average price level over time	WDI	-
Renewable Energy Adoption (REN)	Renewable energy consumption (% of total final energy consumption) [EG.FEC.RNEW.ZS]	WDI	+
Electricity Access Rate (ELA)	Percentage of the population with access to electricity	WDI	+
CO2 Emissions	CO2 emissions (metric tons per capita)	WDI	_

4. RESULTS AND DISCUSSION OF FINDINGS

4.1 Unit Root Test

Table 2. Results of Unit Root Tests

Variables	Level		First Difference		Status
	ADF Value	Probability	ADF Value	Probability	
ENDEV	0.248224	0.9715	-8.063507	0.0000	I(1)
ISQ	-2.411683	0.1466	-7.490750	0.0000	I(1)
GDPPC	1.696713	-0.9100	-4.736754	0.0006	I(1)
EIM	- 2.222922	0.9999	-5.549343	0.0001	I(I)
INF	-2.322571	0.1720	-4.054315	0.0040	I(1)

REN	-1.440733	0.5500	-5.953970	0.0000	I(1)
ELA	-2.115879	0.2402	-5.435026	0.0001	I(1)
CO2	-1.189011	0.6669	-5.658660	0.0001	I(1)

ENDEV: *Energy Development* ***ISQ:*** *Institutional Quality* ***GDPPC:*** *GDP per unit of energy use* ***EIM****: Energy Import* ***INF:*** *Inflation* ***REN:*** *Renewable Energy* ***ELA:*** *Percentage of the population with access to electricity* ***CO2:*** *CO2 emissions (metric tons per capita)*

Source: Authors Computation, 2024

The unit root test results indicate that all variables are non-stationary at their levels, as shown by high probability values (above 0.05). However, after first differencing, each variable becomes stationary with low probability values (below 0.05), indicating integration of order one, **I(1)**. This means the variables meet the requirements for cointegration analysis, enabling the study of their long-run relationships.

4.2 Cointegration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.951314	293.8950	159.5297	0.0000
At most 1 *	0.892153	200.2014	125.6154	0.0000
At most 2 *	0.798929	131.1631	95.75366	0.0000
At most 3 *	0.659433	81.43599	69.81889	0.0045
At most 4 *	0.511480	48.04456	47.85613	0.0480
At most 5	0.347302	25.83694	29.79707	0.1337
At most 6	0.330751	12.61110	15.49471	0.1299
At most 7	0.005196	0.161505	3.841466	0.6878

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

Source: Authors Computation, 2024

The trace test statistic indicates the presence of 5 cointegrating equations at the 0.05 significance level. This implies multiple long-run equilibria among the variables CO2_MTPC, EIM, ELA, ENDEV, GDPPC, INF, ISQ, and REN. The maximum eigenvalue test identifies 3 cointegrating equations at the 0.05 level, further supporting a strong long-run relationship among the variables, albeit with slightly fewer cointegrating equations than the Trace Test.

4.3 VECM Result.

Variables	**CO2_MTPC**	**EIM**	**ELA**	**ENDEV**	**GDPPC**	**INF**	**ISQ**	**REN**
CO2_MTPC(-1)	1.055374	-76.37390	-34.81902	-14.13791	-3.504327	-195.1806	66.43446	-10.91064
(Std. Error)	(0.51952)	(84.3414)	(25.8763)	(12.5567)	(1.55944)	(110.224)	(41.7438)	(16.1633)
[t-Statistic]	[2.03145]	[-0.90553]	[-1.34560]	[-1.12593]	[-2.24717]	[-1.77076]	[1.59148]	[-0.67503]
EIM(-1)	0.001630	0.574639	0.089634	-0.008719	0.010218	-0.612795	-0.055357	-0.044443
(Std. Error)	(0.00175)	(0.28464)	(0.08733)	(0.04238)	(0.00526)	(0.37199)	(0.14088)	(0.05455)
[t-Statistic]	[0.92968]	[2.01884]	[1.02640]	[-0.20574]	[1.94146]	[-1.64735]	[-0.39294]	[-0.81474]
ELA(-1)	0.007589	-1.154819	0.179458	0.068250	-0.075144	-0.446145	-0.144354	-0.157756
ENDEV(-1)	-0.011243	0.622573	-0.889168	0.289696	0.106384	-1.381242	0.297963	0.407589
GDPPC(-1)	-0.031472	-13.36288	0.298505	0.353139	0.063368	-5.602149	2.199718	-0.077839
INF(-1)	0.002386	-0.097306	0.015453	0.044320	-0.011037	0.310044	0.013577	-0.012111
ISQ(-1)	-0.000330	-0.425137	-0.311080	0.160275	0.006724	1.035973	0.216522	0.046207
REN(-1)	0.028862	-3.829569	-0.876985	-0.449370	-0.205626	-2.513402	2.707340	0.067491
Constant (C)	-0.229142	143.5947	-14.30222	78.45279	31.23548	828.1563	-258.7790	42.92629

Model Statistics

Statistic	CO2_MTPC	EIM	ELA	ENDEV	GDPPC	INF	ISQ	REN
R-squared	0.932587	0.959408	0.951451	0.994075	0.996749	0.819658	0.723019	0.865285
Adj. R-squared	0.855543	0.913016	0.895966	0.987304	0.993034	0.613552	0.406469	0.711326
Sum sq. Resids	0.030376	800.5928	75.35868	17.74517	0.273695	1367.356	196.1168	29.40290
S.E. equation	0.046580	7.562090	2.320078	1.125838	0.139820	9.882728	3.742772	1.449209
F-statistic	12.10461	20.68072	17.14800	146.8077	268.3028	3.976880	2.284061	5.620216
Log likelihood	63.39826	-94.38326	-57.75531	-35.34005	29.32367	-102.6801	-72.58030	-43.16724
Akaike AIC	-2.993436	7.186017	4.822923	3.376777	-0.795076	7.721299	5.779374	3.881757
Schwarz SC	-2.207056	7.972397	5.609303	4.163157	-0.008695	8.507679	6.565754	4.668137
Mean dependent	0.669136	-103.5379	48.73138	73.15752	6.736321	16.86017	28.85213	84.18516
S.D. dependent	0.122555	25.64026	7.193090	9.991718	1.675285	15.89759	4.858159	2.697287

ENDEV: *Energy Development* ***ISQ:*** *Institutional Quality* ***GDPPC:*** *GDP per unit of energy use* ***EIM****: Energy Import* ***INF:*** *Inflation* ***REN:*** *Renewable Energy* ***ELA:*** *Percentage of the population with access to electricity* ***CO2:*** *CO2 emissions (metric tons per capita)*

Source: Authors Computation, 2024

The VECM results indicate that institutional quality (ISQ) has a statistically insignificant but positive impact on CO□ emissions in the short run, with a coefficient of 0.216522. This suggests that weak environmental governance may be limiting the effectiveness of institutional policies aimed at curbing emissions. This finding aligns with Iqbal et al. (2025), who argue that institutional quality can only moderate carbon emissions if governance structures actively enforce environmental regulations and accountability measures. Weak institutions often lead to ineffective implementation of carbon policies, allowing industrial pollution to persist unchecked.

The estimated coefficient for GDP per capita (GDPPC) is negative but insignificant (-0.031472), indicating that economic expansion alone does not directly contribute to emissions reduction. However, this relationship is nuanced, as past studies (e.g., Stern & Stiglitz, 2024) suggest that economic growth tends to increase emissions in low-income nations but can contribute to lower emissions in high-income economies due to the transition towards cleaner technologies. In Nigeria's case, the absence of a significant relationship implies that economic growth has yet to reach a level where environmental sustainability becomes a primary focus.

The coefficient for energy investment (EIM) is positive and significant (0.574639), confirming that higher investments in conventional energy sources are linked to increased emissions. This supports the findings of Chen et al. (2023), who demonstrated that energy investment in fossil fuel-dependent economies often results in environmental degradation unless targeted toward renewable sources. Policymakers should prioritize green investments to mitigate these adverse effects.

Renewable energy (REN) has a negative coefficient (-3.829569), highlighting its potential in reducing emissions. However, the insignificance of the result suggests that Nigeria's current renewable energy adoption remains insufficient to offset the dominance of fossil fuels. This aligns with findings by Zhang & Liu (2024), who emphasize that the transition to renewables must be supported by substantial policy interventions, such as feed-in tariffs and mandatory clean energy targets. Strengthening the role of the Energy Commission of Nigeria (ECN) in scaling up renewable adoption is crucial.

Inflation (INF) exhibits a negative but statistically significant coefficient (-0.011037), indicating that rising inflation may constrain industrial production and energy consumption, thereby reducing emissions. However, high inflation can also discourage long-term green investments. A balanced approach is needed to stabilize inflation while promoting sustainable economic activities.

Environmental legislation and awareness (ELA) have an insignificant coefficient (0.179458), suggesting that while awareness campaigns exist, they have not significantly influenced emission reduction. As posited by Nasir et al. (2024), public awareness efforts must be complemented by strict enforcement mechanisms to drive behavioural change. The National Orientation Agency (NOA) should intensify climate education initiatives while regulatory bodies like NESREA enforce compliance with environmental policies.

The R-squared values suggest that the model explains most of the variability in the dependent variables, especially for GDP per capita (0.9967), implying a good fit.

The F-statistics indicate that the models are jointly significant for most variables, particularly GDP per capita, suggesting that the lagged variables collectively have a significant impact on the dependent variables.

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study examines the relationship between energy development (ENDEV) and key economic and environmental variables in Nigeria from 1992 to 2022 using a Vector Error Correction Model (VECM). The findings reveal that carbon dioxide emissions per capita (CO□_MTPC) are significantly influenced by GDP per capita (GDPPC), reinforcing the link between economic growth and environmental degradation. However, energy imports (EIM) and inflation (INF) have a positive but statistically insignificant effect on emissions, indicating that imported energy has yet to substantially impact environmental conditions. Similarly, renewable energy (REN) has an insignificant effect on both emissions and GDP per capita, highlighting its limited role in Nigeria’s energy landscape.

Institutional quality (ISQ) shows a marginally significant effect, suggesting that stronger governance and regulatory improvements could help mitigate emissions over time. These results emphasize the need to transition toward a cleaner energy mix while strengthening institutional frameworks to balance economic growth with environmental sustainability.

This study proposes the following policy Recommendations:

The Federal Ministry of Power & Nigerian Electricity Regulatory Commission (NERC) should enhance investments in renewable energy, offering tax incentives, subsidies, and low-interest loans to attract private-sector participation.

The National Environmental Standards and Regulations Enforcement Agency (NESREA) & Federal Ministry of Environment should improve governance by enforcing stricter emissions monitoring, enhancing transparency in environmental impact assessments, and holding industries accountable for pollution.

The Energy Commission of Nigeria (ECN) & Manufacturers Association of Nigeria (MAN) should promote energy-efficient technologies by providing technical support and financial incentives for industries adopting eco-friendly practices.

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