# Natural Gas and Energy Transition Goals: A Comparative Policy Analysis

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## ABSTRACT

This study assesses natural gas as a transitional fuel in the U.S., Norway, and Nigeria, comparing developed and emerging contexts. Using a policy coding framework, it evaluates regulatory strength, fiscal incentives, institutional effectiveness, and environmental performance. Results reveal governance disparities: the U.S. and Norway exhibit high efficiency and strong environmental controls, while Nigeria's reforms face infrastructural and institutional constraints. Findings highlight that effective energy transition relies on robust regulation, enforcement, and integrated policy.

**Keywords:** energy transition, natural gas, policy analysis, methane reduction, gas flaring, Nigeria, Norway, United States. **JEL Codes:** O57, Q56.

## INTRODUCTION

The accelerating global pursuit of net-zero emissions by mid-century has intensified scrutiny of the roles that fossil fuels should play in national energy systems. Within this debate, natural gas has emerged as both a strategically important and highly contested resource. Often described as a "transition fuel," natural gas emits roughly 50% less $CO_2$ than coal in power generation and provides essential flexibility to complement variable renewable energy sources (IEA, 2023; Edenhofer et al., 2022). These attributes have encouraged governments across developed and emerging economies to integrate gas into their decarbonisation pathways. However, its climate value is conditional: methane leakage, routine flaring, and the lock-in effects of long-lived gas infrastructure can significantly undermine its transitional potential when governance systems are weak or poorly coordinated.

This contrast is evident when comparing the experiences of the United States, Norway, and Nigeria. The United States and Norway—despite differing in market structures and production scales—have embedded natural gas within coherent regulatory and fiscal frameworks that emphasise emissions control, institutional accountability, and transparent market governance. In contrast, Nigeria, though endowed with vast gas reserves, continues to struggle with systemic inefficiencies, persistent flaring, low domestic utilisation, and weak enforcement of environmental and operational standards (World Bank, 2024; NEITI, 2023). These differences indicate that the effectiveness of natural gas in advancing energy transition goals depends less on resource abundance and more on governance quality, institutional capacity, and policy coherence.

Although natural gas is widely promoted as a pragmatic enabler of low-carbon development, evidence shows substantial variation in how countries translate gas potential into sustainable outcomes. Reforms such as Nigeria's Petroleum Industry Act 2021 and the Decade of Gas Initiative have yet to yield measurable reductions in flaring or significant access improvements, while developed economies demonstrate the benefits of strong regulation, transparent fiscal design, and market-based pricing. However, comparative and cross-national analyses linking policy design to environmental performance remain scarce. Without such evidence, emerging economies risk adopting transition policies that are normative rather than diagnostic, potentially locking in high emission pathways.

By examining the United States, Norway, and Nigeria, this study provides a structured comparative analysis of how policy frameworks, institutional effectiveness, and governance quality shape the role of natural gas in contemporary energy transitions. It integrates harmonised quantitative data with structured policy coding. It

introduces a Policy Effectiveness Index (PEI) to deepen understanding of how governance determines whether natural gas serves as a bridge or a barrier to sustainable energy futures.

## LITERATURE REVIEW

Natural gas occupies a central yet debated position in global energy transitions. While it is widely regarded as a cleaner fossil fuel capable of supporting short-term decarbonisation, scholars caution that methane leakage, routine flaring, and infrastructure lock-in can undermine its transitional value (Bridge et al., 2020; Van de Graaf et al., 2022; IEA, 2024). The International Energy Agency emphasises that aligning natural gas with net-zero pathways requires significant reductions in upstream emissions, particularly methane. Across advanced economies, natural gas has been integrated within structured policy frameworks that link gas development with renewable energy growth and stringent environmental regulation. The United States, for example, combines market liberalisation with strong regulatory oversight, while the Inflation Reduction Act enhances methane abatement and technological innovation (EIA, 2024; IEA, 2024). Norway similarly demonstrates institutional coherence, characterised by carbon taxation, fiscal transparency, and strict offshore regulations that contribute to some of the world's lowest flaring intensities (NPD, 2023; Lindholt & Rosendahl, 2023; Fæhn et al., 2022).

In contrast, Nigeria reflects the challenges facing emerging economies, where vast gas endowments coexist with infrastructural deficits, fragmented regulation, and weak enforcement capacity (NEITI, 2023; NUPRC, 2024). However, the Petroleum Industry Act (2021) and the Decade of Gas Initiative signal reform intent, persistent flaring and limited domestic utilisation highlight the gap between policy design and implementation (World Bank, 2024; Ejiogu, 2022). Scholars identify governance quality—not resource abundance—as the decisive factor shaping gas-sector outcomes, noting that insufficient monitoring systems, bureaucratic overlap, and rent seeking undermine transition efforts (Omorogbe & Oniemola, 2021; Asche et al., 2022).

Comparative research, therefore, emphasises that policy coherence, institutional strength, and integrated regulatory frameworks determine whether natural gas functions as a genuine transition fuel or perpetuates high carbon development (Goldthau, 2023; Sovacool & Griffiths, 2023). This study builds on these insights by assessing how governance structures shape gas transition outcomes across the United States, Norway, and Nigeria.

## METHODOLOGY

This study adopts a comparative policy analysis (CPA) framework that combines qualitative institutional assessment and quantitative performance measurement to examine the effectiveness of natural gas governance in supporting energy transition goals. The comparative design allows the evaluation of similarities and differences among three representative cases: the United States (a developed, market-oriented system), Norway (a developed, state-regulated system), and Nigeria (an emerging, reforming system). The mixed-methods approach integrates descriptive analytics, institutional coding, and correlational modelling to link policy structures with environmental and energy outcomes. This design aligns with established methodologies in cross country policy studies (Goldthau & Sovacool, 2022; Stevens, 2023), enabling both diagnostic comparison and prescriptive inference. The research relies exclusively on secondary datasets from internationally verified sources, ensuring cross-national consistency and replicability.

The study relies on several reputable international databases to ensure consistency and accuracy across the three countries examined. Key data on gas production, utilisation, and emissions were obtained from the Energy Institute Statistical Review of World Energy (2025), which provides comprehensive coverage for the United States, Norway, and Nigeria. Global methane emissions data were sourced from the IEA Global Methane Tracker (2025), while information on global flaring patterns was drawn from the World Bank's Global Gas Flaring Tracker (2024). Greenhouse gas emission inventories for the three countries were accessed through the UNFCCC GHG Inventories (2025). Country-specific data were also incorporated, including U.S. natural gas statistics from the EIA Natural Gas Data Portal, Norwegian upstream data from the Norwegian Offshore Directorate's Fact Pages, and Nigeria's petroleum sector information obtained from the NUPRC Annual Report (2024).

Key dependent variables analysed include Methane intensity ($tCO_2e$/bcm), flaring Intensity ($m^3$/boe) and domestic gas utilisation ratio (%). In contrast, the independent variables were derived from the policy and institutional environment and assessed using the Policy Variable Coding Sheet described below.

**Policy Variable Coding Framework**

To capture policy performance in a structured, comparable form, the study develops a Policy Variable Coding Framework (PVCF) comprising eight policy dimensions, as shown in Table 1. Each dimension represents a core area of gas governance and is rated on a 0–2 ordinal scale, with 0 indicating weak or absent implementation, 1 indicating partial or moderate effectiveness, and 2 indicating full integration and enforcement.

Table 1: Policy Variable Coding Framework (PVCF) Overview

| Score | Interpretation | Qualitative Criteria |
|---|---|---|
| 0.0 – 0.5 | Weak | Policy exists on paper but lacks enforcement or measurable outcomes. |
| 1.0 | Moderate | Policy partially implemented; enforcement mechanisms exist but are inconsistently applied. |
| 1.5–2.0 | Strong | Policy fully operational; performance indicators regularly monitored and publicly reported. |

The eight policy dimensions coded include: gas pricing policy, methane regulation, flaring control, fiscal regime, domestic utilisation policy, LNG export policy, transition integration, and institutional effectiveness. For each dimension, three sub-indicators were assessed: Regulatory Strength (R) – clarity and scope of policy frameworks; Implementation Effectiveness (I) – enforcement and monitoring capacity; and Outcome Performance (O) – empirical results such as reduced emissions or improved utilisation.

Scores were computed using the formula:

$$\text{Variable Score} = \frac{(R + I + O)}{3}$$

This coding approach was adapted from comparative institutional analysis literature (North, 1990; Bridge et al., 2020) and validated through triangulation of multiple data sources (IEA, World Bank, NUPRC).

**B. Construction of the Policy Effectiveness Index (PEI)**

To aggregate performance across policy domains, a Policy Effectiveness Index (PEI) was constructed as the arithmetic mean of the eight coded variables:

$$PEI = \frac{\sum_{i=1}^{8} S_i}{8}$$

Where $S_i$denotes the normalised score of each variable for a given country.

The PEI provides a composite quantitative indicator of the coherence, enforcement, and performance of gas governance. Higher PEI values reflect greater alignment between fiscal, regulatory, and environmental objectives.

**C. Analytical Techniques**

Three layers of analysis were conducted: first, a descriptive analysis summarised gas production, utilisation, and emission trends across countries from 2000 to 2024, supported by visualisations such as time-series plots and bar charts derived from Energy Institute and IEA data. Second, a comparative institutional analysis

provided a qualitative assessment of policy instruments, enforcement frameworks, and institutional arrangements in each country, drawing on key legislative documents including the U.S. Inflation Reduction Act (2022), Norway's Climate Action Plan (2021–2030), and Nigeria's Petroleum Industry Act (2021). Third, correlation and statistical validation were undertaken through a Pearson correlation test to determine the relationship between the PEI and performance indicators such as flaring Intensity, methane intensity, and domestic utilisation.

**Reliability, Validity and Limitations**

The study ensures methodological reliability through data triangulation across independent international datasets (IEA, GGFR, NUPRC), peer-reviewed indicator selection aligned with prior comparative studies (Stevens, 2023; Sovacool & Griffiths, 2023), and reproducibility enabled by explicit documentation of all variable definitions and coding procedures. Construct validity is established by aligning coded dimensions with widely recognised policy performance criteria, including fiscal stability, enforcement transparency, and institutional autonomy commonly applied in global energy governance research. While the comparative framework offers significant insights, several limitations are acknowledged: data granularity varies across countries, with emerging economies providing less frequent or disaggregated datasets; ordinal scoring inevitably simplifies complex policy realities, though it remains valuable for cross-national benchmarking; and temporal lag between policy reforms (such as Nigeria's PIA 2021) and measurable outcomes may understate recent progress. Despite these constraints, the triangulated approach ensures analytical robustness and delivers meaningful comparability between developed and emerging contexts.

**Empirical Results**

Comparative data show significant variation in gas production, utilisation, and environmental performance. The United States leads with over 1,000 bcm annual gas production and robust domestic consumption supported by liberalised markets. Norway's smaller but export-oriented sector maintains world-class flaring and methane control. Nigeria, despite significant reserves, records substantial underutilisation and flaring.

Table 2: Policy Variable Coding (0–2 Scale)

| Policy Dimension | United States | Norway | Nigeria |
|---|---|---|---|
| Gas Pricing Policy | 2 | 2 | 0.5 |
| Methane Regulation | 2 | 1.5 | 0.5 |
| Flaring Control | 1.5 | 2 | 0.5 |
| Fiscal Regime | 1.5 | 2 | 1.0 |
| Domestic Utilisation Policy | 1.0 | 0.5 | 2.0 |
| LNG Export Policy | 2.0 | 1.5 | 1.0 |
| Transition Integration | 2.0 | 2.0 | 1.0 |
| Institutional Effectiveness | 2.0 | 2.0 | 1.0 |

Source: Author’s coding from IEA, NUPRC, NPD, EIA, and World Bank datasets (2025)

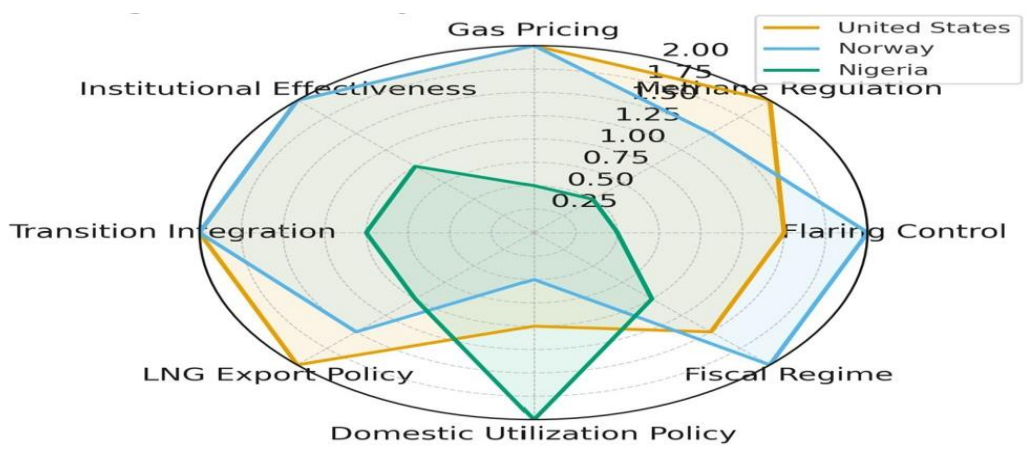

**Figure 1: Policy Variable Radar (0–2 Scale). A visual representation of policy strengths and weaknesses for the three countries.**

Table 3: Correlation between PEI and Performance Indicators

| Country | PEI | Flaring Intensity ($m^3$/boe) | Methane Intensity ($tCO_2e$/bcm) | Domestic Utilisation Ratio (%) |
|---|---|---|---|---|
| United States | 1.75 | 1.5 | 2.0 | 88 |
| Norway | 1.69 | 0.3 | 0.4 | 62 |
| Nigeria | 1.06 | 8.2 | 10.5 | 47 |

Source: Author's computation using IEA, World Bank GGFR, and EI datasets (2025)

## DISCUSSION OF FINDINGS

The results show that the contribution of natural gas to energy transition goals varies significantly across countries, depending mainly on institutional maturity and governance quality. In the United States, a dynamic regulatory environment supports innovation and strong environmental oversight. Policies such as the Inflation Reduction Act and advanced methane detection standards illustrate how fiscal incentives and regulation can stimulate technological progress and reduce emissions. Norway displays the highest level of policy coherence, marked by stringent environmental requirements, effective enforcement, and tight institutional coordination, which together allow the country to maintain substantial gas exports while pursuing net-zero commitments. Nigeria presents a contrasting picture: although reforms such as the Petroleum Industry Act (2021) and the Nigerian Gas Flare Commercialisation Programme signal policy intent, weak enforcement capacity and infrastructure deficits constrain operational results, particularly in flaring reduction and domestic gas utilisation. The Policy Effectiveness Index (PEI) highlights this governance gradient, with the U.S. scoring 1.75, Norway 1.69, and Nigeria just 1.06. Correspondingly, Nigeria records higher flaring and methane intensities than the other cases. A strong inverse correlation between PEI and emissions intensity ($r = –0.82$) indicates that regulatory strength directly improves environmental outcomes. For emerging economies like Nigeria, strengthening institutions, improving transparency, and aligning gas development with renewable planning are critical to transforming natural gas into a genuine transition tool.

## CONCLUSION AND POLICY RECOMMENDATIONS

Natural gas remains a critical component of global energy transitions, offering a cleaner alternative to more carbon-intensive fuels while supporting industrial development and grid stability. However, its capacity to contribute meaningfully to decarbonisation depends on policy coherence, institutional strength, and effective environmental regulation. The experiences of the United States and Norway demonstrate that strong governance—characterised by transparent fiscal systems, rigorous methane and flaring controls, and coordinated regulatory institutions—can align natural gas development with net-zero objectives. Nigeria's ongoing reforms, particularly through the Petroleum Industry Act (PIA, 2021) and the Decade of Gas Initiative, are important foundations but require more vigorous enforcement, robust infrastructure, and improved transparency to translate policy ambition into measurable outcomes. Strengthening institutional coordination under the PIA and NGFCP, supported by inter-agency monitoring, is essential for reducing flaring and improving operational compliance.

Expanding investment in gas-to-power, petrochemicals, and fertiliser industries will enhance domestic utilisation, while targeted incentives and PPP frameworks can attract long-term capital. Nigeria will also benefit from institutionalising digital methane and flaring monitoring through satellite detection and AI-driven analytics, supported by international benchmarking. Aligning fiscal and climate policies—such as carbon pricing, green tax incentives, and performance-linked royalties—can further incentivise cleaner production. Integrating gas planning with renewable energy development will help balance transition needs and prevent long-term carbon lock-in. Strengthened data transparency, human capacity development, and regional

cooperation will reinforce institutional credibility, while public–private research partnerships can accelerate innovation in methane capture, CCUS, and hydrogen technologies. Collectively, these measures can reposition natural gas as a true enabler of Nigeria's sustainable energy transition.

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