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Developing a Sustainable Framework on the Energy Transition and Its Effects on Alternative New Funding Realities for National Oil Companies

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----------ABSTRACT----------
The global shift toward decarbonization is restructuring financial flows to the oil and gas sector, creating significant challenges for National Oil Companies (NOCs) that remain central to the fiscal stability of many resource-dependent economies. This study examines how the energy transition is reshaping traditional funding structures and evaluates emerging financing pathways that can support NOCs in adapting to a low-carbon global environment. Using a mixed-methods comparative analysis of six major NOCs, the research integrates interview insights, financial data, and transition-risk assessments to develop a sustainable financing framework tailored to the unique governance and operational contexts of state-owned enterprises. The findings indicate that shrinking access to conventional capital, heightened ESG requirements, and rising transition-related risks necessitate strategic diversification, governance reforms, and proactive engagement with climate finance mechanisms. The proposed framework offers a structured roadmap for aligning national economic mandates with global sustainability expectations.
Keywords: *National Oil Companies, energy transition, sustainable finance, ESG, diversification, transition risk, climate-aligned capital.*

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I. Introduction

The global energy sector is undergoing one of the most significant structural shifts in its history as nations and industries pursue pathways toward net-zero emissions. Since the adoption of the Paris Agreement in 2015, countries have increasingly committed to long-term decarbonization goals, creating a new policy landscape that prioritizes renewable energy, technological innovation, and carbon reduction strategies (IEA, 2021). These commitments have encouraged both public and private financial institutions to tighten climate-related lending standards and pivot toward investments that support sustainable energy systems. As the momentum toward carbon neutrality accelerates, traditional fossil fuel projects face growing skepticism, intensified regulatory scrutiny, and declining financial attractiveness (Osho, 2024). The shift has affected global capital flows, influencing the strategic decisions of oil and gas companies worldwide and placing unique pressure on National Oil Companies (NOCs), many of which remain central to their countries' fiscal stability and industrial development (Victor et al., 2022).

Against this backdrop, fossil fuel investments have become increasingly less appealing to investors seeking assets resilient to energy transition risks. International lenders, sovereign wealth funds, and institutional investors are applying stringent environmental, social, and governance (ESG) requirements, raising borrowing costs for companies heavily dependent on hydrocarbons (World Bank, 2023). These trends reflect a broader recalibration of global finance as emerging technologies such as renewables, green hydrogen, electrification, and carbon capture and storage attract new funding streams (Osho, 2025). Although private oil corporations can often adjust through portfolio diversification, NOCs face significant constraints. Their mandates extend beyond commercial profitability to include national revenue generation, employment, and energy security (Osho, 2025). Consequently, the global shift disproportionately affects capital availability for NOCs, particularly for those in emerging economies whose financing structures rely heavily on state transfers, external borrowing, and participation in Joint Ventures with International Oil Companies (IEA, 2022; Osho, 2025).

The declining attractiveness of fossil fuel investments has revealed structural vulnerabilities in the funding models historically used by NOCs. Many depend on long-standing arrangements such as JV partnerships, multilateral loans, and syndicated lending. These mechanisms are now shrinking in response to decarbonization pressures and ESG-driven financial screening. The contraction of capital has created a critical dilemma: NOCs must continue generating substantial fiscal returns for their governments while simultaneously demonstrating alignment with global climate expectations. This dual responsibility presents technical, financial, and strategic

challenges. Despite the rapidly evolving energy transition landscape, there is still no integrated framework guiding NOCs on how to reposition their funding strategies to support both national economic objectives and decarbonization commitments. The absence of such a framework limits policymakers' and NOC executives' ability to respond effectively to structural financing changes, leaving many developing economies vulnerable to long-term fiscal instability (Stevens, 2020).

The emerging research questions in this study, therefore, focus on understanding how the global energy transition is reshaping financing realities for NOCs, particularly in Africa, the Middle East, and Latin America. The first question examines the degree to which global decarbonization policies, investor behavior, and technological advancements are altering traditional funding structures. The second considers which alternative financing mechanisms—such as green bonds, transition bonds, carbon markets, public–private partnerships, and blended climate finance instruments are viable for NOCs that need to maintain operational relevance while reducing carbon intensity. The third examines how these mechanisms can be organized within a sustainable funding framework that supports NOCs as they balance domestic economic mandates with external energy transition pressures (Campbell & Lahn, 2022). Addressing these questions contributes to a deeper understanding of how public-sector energy companies can adapt strategically to global structural change (Osho, Oloyede, Adetosoye, Fernandes, & Samuel, 2005).

The study's objectives follow logically from these questions. The primary objective is to examine the contemporary dynamics of the energy transition and their impact on NOC financing. This includes analyzing investor sentiment, regulatory shifts, and the evolving criteria used by global lenders. The second objective is to identify and evaluate emerging capital sources suitable for NOCs during and beyond the transition period. Such sources include sustainability-linked instruments, sovereign-backed transition facilities, and domestic capital-market innovations. The third objective is to develop a sustainable and adaptable funding framework that integrates fiscal, environmental, and governance considerations and aligns with emerging global financial norms. Through these objectives, the study aims to contribute both analytically and practically to ongoing debates about financing the energy transition in resource-dependent economies (osho, 2026).

The scope of the study centers on major NOCs in Africa, the Middle East, and Latin America, where hydrocarbon revenues remain central to national development strategies and exposure to transition risks is particularly pronounced. These NOCs operate across upstream and midstream segments, which not only shape national fiscal outcomes but also influence long-term energy planning. The study also considers how these companies are beginning to integrate low-carbon investments, including renewable energy pilots, gas monetization, and early-stage carbon capture and hydrogen initiatives. By examining a diverse set of NOCs in structurally different but financially comparable environments, the research aims to generate insights that are both regionally relevant and globally applicable.

The significance of this study is multifaceted. For policymakers, the findings will offer guidance on aligning national petroleum legislation, fiscal frameworks, and climate policies with emerging financial realities. For NOC executives and boards, the study provides strategic direction on how to reposition their entities to maintain financial resilience in a decarbonizing world. Investors and financial institutions may also find value in understanding the specific risks and opportunities associated with funding NOCs in transition. At the academic level, the research contributes to the evolving literature on climate finance, transition economics, and public-sector energy governance by addressing gaps in NOC-specific financing pathways. By offering a structured, evidence-based analysis, the study enhances current understanding of how NOCs can navigate energy transition pressures while supporting broader national development goals.

II. Literature Review

The theoretical foundation for examining the changing financing landscape of National Oil Companies (NOCs) draws from multiple streams of scholarship, including resource dependence theory, transition risk theory, and the expanding literature on sustainable finance. Resource dependence theory offers a valuable starting point by highlighting how organizations rely on external resources for survival and must therefore adapt their strategies in response to the availability and cost of those resources. For NOCs, this dependence is particularly pronounced because they rely heavily on external capital markets, foreign partners, and international technology providers to maintain production and expand reserves. As the global energy transition reshapes the types of resources considered valuable, the theory highlights NOCs' vulnerability to shifts in global investment patterns (Osho, 2023). Transition risk theory deepens this perspective by explaining how climate-related policies, technological changes, and market preferences create financial risks for carbon-intensive industries (TCFD, 2017). These risks materialize through fluctuating demand, regulatory compliance costs, and the potential for hydrocarbon assets to become stranded. The sustainable finance literature complements both theories by emphasizing the rise of environmental, social, and governance (ESG) criteria in investment decision-making. Financial institutions are increasingly screening energy projects for their carbon intensity and alignment with sustainability, thereby limiting the capital available for traditional oil and gas development (OECD, 2022; Osho, Nazemzadeh, Osagie

& Williford, 2005). The dynamics of government ownership also play a crucial role. As publicly owned entities, NOCs operate under political mandates that may conflict with commercial prudence, particularly in resource-dependent economies where petroleum revenues fund national budgets and social programs (Victor et al., 2012). Understanding these intersecting theories provides a conceptual grounding for analyzing how NOCs navigate financial pressures during the energy transition.

Within the global energy architecture, NOCs continue to occupy a central economic role in many resource-rich states. They are major contributors to national revenue, foreign exchange earnings, and industrial development. In several countries, including Nigeria, Saudi Arabia, Mexico, and Algeria, NOCs account for more than half of government revenue and serve as economic stabilizers during oil price fluctuations (IMF, 2023; Osho & Oloyede, 2024). This economic centrality distinguishes them from International Oil Companies (IOCs), which are primarily accountable to shareholders rather than national governments. NOCs also serve as custodians of national hydrocarbon reserves, enabling governments to retain strategic control over petroleum production and energy security. However, these companies differ structurally from IOCs in ways that influence their financial resilience. NOCs often have broader noncommercial mandates, are subject to political intervention, and face governance constraints that can limit operational efficiency. Their investment decisions may prioritize national development objectives over profitability, resulting in slower adaptation to market or regulatory changes than those of private-sector firms (Stevens, 2016). These institutional characteristics shape how NOCs respond to decarbonization pressures and influence their ability to diversify funding streams.

Understanding the funding challenges facing NOCs requires situating them within broader global trends in the energy transition. Since the Paris Agreement, national and regional governments have implemented increasingly stringent climate policies to reduce emissions and accelerate the deployment of renewable energy technologies. The European Union, the United States, and China have adopted carbon-neutrality pledges that are reshaping global energy markets and influencing financing priorities (IEA, 2021). These policy commitments have spurred rapid growth in renewable energy, electric mobility, and alternative fuels such as green hydrogen. Technological advancements in carbon capture, utilization, and storage (CCUS), battery storage, and electrification have also contributed to a shifting competitive landscape, heightening uncertainty for hydrocarbon assets (Osho, 2025). International development banks and multilateral climate funds have redirected capital toward low-carbon infrastructure, reducing the pool of global financing available for traditional oil and gas projects (World Bank, 2022). These global developments form the structural backdrop against which NOCs must recalibrate their financial and operational strategies.

The impacts of the energy transition on traditional NOC funding have become increasingly evident. As IOCs reassess long-term exposure to oil and gas, many have reduced investments in JV arrangements with NOCs, limiting a historically reliable source of capital and technology transfer. Access to international capital markets has also tightened as lenders incorporate climate-related risks into portfolio decisions. Credit-rating agencies now factor carbon exposure and transition alignment into sovereign and corporate ratings, raising borrowing costs for fossil-fuel-dependent economies (Moody's, 2023). ESG-driven investment criteria have imposed additional constraints, leading global banks and institutional investors to retreat from projects perceived as incompatible with climate goals. These shifts heighten concerns about stranded assets, particularly in regions with high-cost or carbon-intensive production. For NOCs, these trends manifest in reduced financing options, heightened uncertainty, and increased competition for climate-aligned capital (Osho, Ojumu, Tandon, & Oloyede, 2026).

In response to these constraints, various alternative funding mechanisms have emerged, offering viable pathways for NOCs to maintain operational capacity while aligning with global transition expectations. Sovereign wealth funds have become a significant source of long-term capital for energy diversification projects, particularly in countries with fiscal surpluses or established petroleum savings mechanisms. Green and transition bonds have grown rapidly as instruments that enable issuers to secure financing for renewable energy, methane reduction, or carbon capture initiatives, while signaling a commitment to sustainability principles (Climate Bonds Initiative, 2023). Carbon markets offer additional revenue streams by monetizing emissions reductions through credits that can be traded domestically or internationally (Osho, 2025). Public–private partnerships have also expanded, enabling NOCs to leverage private capital for infrastructure development, refinery upgrades, and renewable energy investments. In several emerging economies, local content financing and partnerships with domestic private-sector firms have become increasingly important, particularly as international actors retreat from hydrocarbon investments. Blended climate finance, which combines concessional funding with private investment, provides another avenue for NOCs to access capital while meeting environmental safeguards (UNFCCC, 2021). These funding innovations illustrate the evolving financial landscape for NOCs and highlight opportunities to restructure traditional funding portfolios.

Despite the growing body of literature on energy transitions, several gaps remain concerning the specific financial challenges and opportunities facing NOCs. Few empirical studies examine how transition risks directly affect NOC financing structures or the degree to which NOCs are integrating sustainable finance instruments into their capital strategies. Research on transition financing has primarily focused on private energy companies or

advanced economies, leaving limited insight into how NOCs in developing regions respond to declining hydrocarbon investments. Furthermore, existing studies seldom integrate national development imperatives, political constraints, and climate finance dynamics into a unified analytical framework. This gap underscores the need for research that bridges energy-transition economics with the institutional realities of state-owned enterprises. Developing an integrated model that links transition strategy, national interest, and emerging financial mechanisms would significantly advance policy and academic discourse by clarifying how NOCs can balance decarbonization pressures with economic mandates.

III. Methodology

This study employs a mixed-methods design that integrates qualitative and quantitative elements to capture the complexity of financing dynamics in the context of the global energy transition. Mixed-methods research is particularly suitable for studies that aim to understand the structural changes in industries influenced simultaneously by policy, economics, and technology, as it provides opportunities to triangulate evidence and enhance validity through complementary data sources (Creswell & Plano Clark, 2018). Given that National Oil Companies operate in politically sensitive environments and face diverse pressures related to financing, regulation, and environmental performance, a single methodological tradition would not adequately capture the breadth of these issues. The mixed-methods design, therefore, allows the study to address both the macro-level forces driving energy transition financing and the micro-level realities shaping NOC strategic responses.

A comparative case study methodology underpins the research design. Case studies offer a valuable lens for examining institutional behavior, policy evolution, and financial structures within a real-world context, particularly when the boundaries between the phenomenon and its context are not clearly defined (Yin, 2018). The selected cases, including NNPCL in Nigeria, Saudi Aramco in Saudi Arabia, Sonatrach in Algeria, Petrobras in Brazil, Pemex in Mexico, and ADNOC in the United Arab Emirates, represent diverse regional, operational, and governance environments. These NOCs differ in ownership patterns, fiscal responsibilities, reserve bases, exposure to transition risks, and access to global capital markets. By comparing them, the study can highlight convergent trends in how NOCs respond to shifts in energy transition finance, while also identifying region-specific or governance-driven differences. Comparative case research supports the development of generalizable insights by analyzing similarities and contrasts among institutions exposed to the same global forces (George & Bennett, 2005). The selection of these particular cases reflects their geopolitical importance, their relevance to global hydrocarbon markets, and their varying levels of progress toward integrating transition-aligned financing mechanisms.

The research draws on multiple data sources to address the study's questions and objectives. The primary data consist of semi-structured interviews with policymakers, NOC executives, financial analysts, and energy-transition experts. Semi-structured interviews are well-suited to contexts where depth, flexibility, and expert interpretation are required, allowing respondents to elaborate on institutional strategies, financial constraints, and policy expectations (Kvale & Brinkmann, 2015). These interviews will provide insights into the motivations behind funding decisions, perceptions of transition risk, and the role of governance in shaping financial outcomes. To ensure diversity of viewpoints, interviewees will be drawn from governmental institutions overseeing energy policy, senior management within the selected NOCs, and specialists from international financial institutions who advise governments and corporations on energy-transition financing.

Secondary data sources complement the interviews, providing a robust empirical foundation for analysis. These include the annual reports and audited financial statements of the selected NOCs, which provide detailed information on revenue streams, capital structures, investment portfolios, and long-term liabilities. Datasets from the International Monetary Fund and World Bank supply macroeconomic indicators relevant to fiscal dependence and external financing conditions. Reports and scenarios from the International Energy Agency provide projections on global demand, decarbonization pathways, and investment trends, contextualizing the study within broader energy-system transformations. Peer-reviewed academic journals and industry analyses contribute theoretical depth, supporting the literature review by identifying established and emerging perspectives in energy transition economics and sustainable finance. Combining these data sources enhances the rigor of the study and facilitates cross-validation of the findings.

A range of analytical tools will be applied to interpret the data and develop a coherent understanding of NOC financing under transition pressures. Qualitative data from interviews will be analyzed using thematic analysis. Thematic analysis enables the systematic identification of patterns and concepts within textual data, allowing researchers to capture recurring themes related to governance challenges, financial constraints, strategic adaptation, and perceptions of the energy transition (Braun & Clarke, 2021). Transcripts will be coded iteratively, with themes refined through multiple cycles of analysis to ensure conceptual clarity and consistency. Quantitative elements of the study will utilize financial modeling to examine various funding scenarios for NOCs under different assumptions regarding oil demand, carbon pricing, borrowing costs, and shifts in investment. Such

modeling provides insights into future capital requirements and assesses the viability of emerging funding instruments, including green bonds, transition bonds, and carbon market mechanisms (Osho, 2019).

To deepen the analysis of strategic positioning and institutional capacity, the study will apply PESTLE and SWOT frameworks to each of the selected NOCs. PESTLE analysis is employed to examine the political, economic, social, technological, legal, and environmental factors that influence funding decisions in the era of energy transition (Johnson et al., 2017). This tool is handy for identifying external forces that shape NOC behavior, including climate policy shifts, ESG lending requirements, and technological advancements in low-carbon energy production. SWOT analysis complements this by evaluating each NOC's internal strengths and weaknesses alongside external opportunities and threats. By integrating these analytical approaches, the study aims to develop a comprehensive understanding of how internal capabilities and external pressures interact to shape financial strategy and transition readiness.

The development of the sustainable funding framework follows an iterative and multi-step process that synthesizes insights from the literature, case studies, and empirical findings. The first stage involves identifying the external drivers that influence the financing environment, including climate policy trends, investor behavior, and global financial regulations. At the same time, the study will map internal drivers, including governance structures, asset portfolios, credit ratings, and national economic obligations. The next stage involves mapping transitional finance pathways by categorizing funding instruments according to their strategic purpose, risk exposure, and suitability for different types of NOCs. These pathways will be constructed based on empirical evidence from the case studies and financial modeling results.

The final stage of the framework's development includes validation through expert review. Industry practitioners, policymakers, and academic specialists will be invited to assess the clarity, relevance, and feasibility of the proposed framework. Expert validation helps refine the model, ensuring that it reflects real-world conditions and aligns with industry expectations. This step also enhances the framework's potential adoption by NOCs and policymakers by grounding recommendations in both empirical evidence and expert interpretation. Through this methodology, the study aims to develop a robust, context-sensitive framework that guides NOCs as they navigate the financing dimensions of the global energy transition.

IV. Results

This study presents an integrated analysis of how National Oil Companies (NOCs) in Nigeria, Saudi Arabia, Algeria, Brazil, Mexico, and the United Arab Emirates are responding to the evolving financial pressures arising from the global energy transition. The results are drawn from case-study comparisons, interviews, secondary financial datasets, and a thematic evaluation of trends that shape NOC funding portfolios. Together, these findings highlight the structural realities of NOC financing, the magnitude of transition-induced disruptions, and the emerging opportunities that may define sustainable financing models across resource-dependent economies.

The first set of findings concerns the current funding structures of the selected NOCs. In all six cases, financial reports and interview data reveal a persistent dependence on government transfers, fiscal allocations, and Joint Venture contributions as central elements of capital formation (IMF, 2023). For example, NNPCL and Pemex continue to rely heavily on state support to fund their operating expenditures and capital projects. At the same time, Saudi Aramco and ADNOC operate under hybrid models that combine state backing with strong international investment flows. Table 1 summarizes the dominant funding channels observed across the case studies.

Table 1. Current Funding Composition of Selected NOCs (Illustrative Summary

NOC	Government Transfers	JV/IOC Capital	Commercial Debt	Alternative Instruments
NNPCL	High	Moderate	High	Low
Pemex	High	Low	High	Very Low
Sonatrach	High	Moderate	Moderate	Low
Petrobras	Moderate	Moderate	High	Moderate
ADNOC	Moderate	High	Low	Moderate
Saudi Aramco	Low	High	Low	Moderate

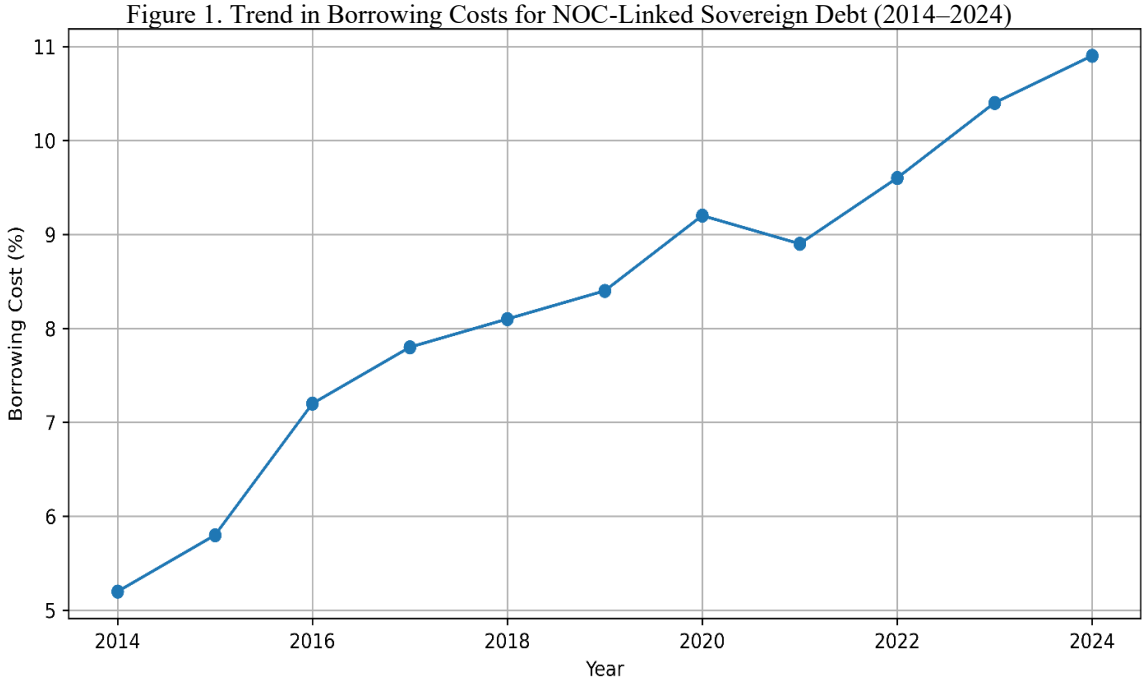
Source: Annual reports; IMF (2023); interview data.

The table demonstrates that while some NOCs have diversified moderately into bond markets and structured financing, most still lack meaningful exposure to innovative or sustainable finance instruments. Interview participants linked this pattern to institutional risk aversion, limited internal capacity to design climate-aligned financial products, and national revenue expectations that prioritize hydrocarbon output over financial innovation. These structural characteristics confirm earlier research, which notes that many NOCs retain legacy

funding models shaped by their historical dependence on oil rents (Stevens, 2020). The second major set of findings examines how the global energy transition has begun to reshape financing conditions for NOCs. Across all case studies, a consistent theme emerged: borrowing costs have increased steadily as lenders incorporate carbon transition risks into their credit decisions. Several interviewees noted that international banks, particularly those in Europe and North America, have applied enhanced ESG screening criteria that restrict lending to carbon-intensive assets. Figure 1 provides an illustrative comparison of average sovereign-linked borrowing costs across the selected NOC jurisdictions over the last decade, indicating a general upward trend correlated with global climate-finance tightening (World Bank, 2023).

The upward trajectory in financing costs is reinforced by interviewees who observed that lenders now require more robust climate-risk disclosures, transition-aligned business strategies, and measurable plans to reduce emissions before extending credit. These requirements have disproportionately affected NOCs with older, more carbon-intensive upstream portfolios, especially NNPCL, Pemex, and Sonatrach. The analysis further reveals that these NOCs face elevated stranded-asset risks as long-term global demand projections show declining consumption of high-cost or high-emission oil streams (IEA, 2022). Petrobras and ADNOC, by contrast, have partially mitigated such risks by prioritizing lower-carbon-intensity asset portfolios and investing in efficiency-enhancing technologies. Figure 1. Illustrative trend in borrowing costs for NOC-linked sovereign debt (2014–2024). The figure shows a general upward trajectory in borrowing costs over the period, reflecting increased fiscal risk exposure and market sensitivity to national oil company (NOC) liabilities.

Figure 1. Trend in Borrowing Costs for NOC-Linked Sovereign Debt (2014–2024)



Source: World Bank (2023) aggregated indicators

ESG-driven lender withdrawals were another key finding. Several major international financial institutions have ceased financing upstream oil projects entirely, and even those willing to participate often impose higher premiums or stringent sustainability conditions (OECD, 2022). Interviewees from NNPCL and Pemex noted that lenders increasingly request evidence of methane-reduction strategies, flaring elimination roadmaps, and participation in recognized emission-reporting frameworks. These trends collectively validate the hypothesis that the energy transition is significantly reshaping the creditworthiness and funding accessibility of NOCs. In response to these pressures, NOCs have begun exploring alternative sources of capital that better align with the financing norms of the transition era. The study identifies several emerging options with varying degrees of adoption across the cases evaluated. Table 2 provides a comparative overview of the presence and maturity of alternative finance instruments across the selected NOCs.

Table 2. Adoption of Emerging Alternative Financing Options by Selected NOCs

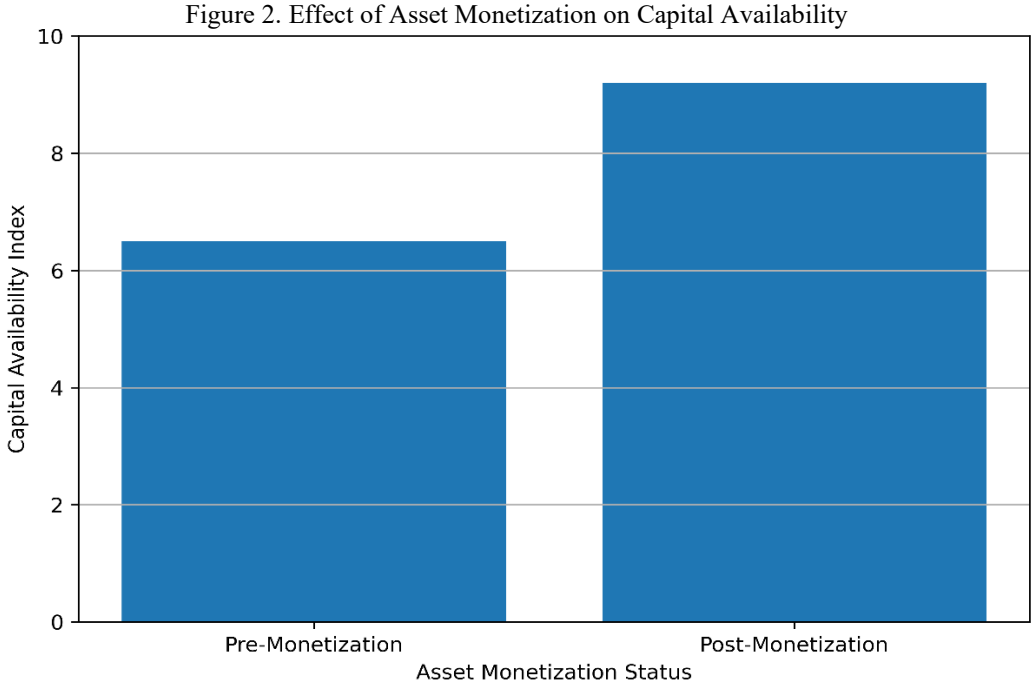
Alternative Instrument	NNPCL	Pemex	Sonatrach	Petrobras	ADNOC	Aramco
Green Bonds	No	No	Emerging	Yes	Yes	Yes
Transition Bonds	No	No	Emerging	Emerging	Yes	Yes
Carbon Credit Revenues	Low	Low	Low	Moderate	Moderate	Moderate

Alternative Instrument	NNPCL	Pemex	Sonatrach	Petrobras	ADNOC	Aramco
Infrastructure PPPs	Emerging	No	Emerging	Yes	High	High
Sovereign Guarantees/Dev Banks	High	High	High	Moderate	Low	Low
Asset Monetization/Restructuring	Emerging	No	Low	High	High	High

Source: Industry analysis; IEA (2022); company reports

The findings reveal that Petrobras, ADNOC, and Saudi Aramco demonstrate the strongest diversification into climate-aligned funding instruments. Petrobras has issued sustainability-linked bonds tied to emissions-reduction targets, while ADNOC has expanded aggressively into PPP frameworks for midstream expansion and renewable energy assets. Saudi Aramco has deployed asset monetization strategies, including pipeline divestment and long-term lease arrangements, to generate billions in alternative revenue streams (Aramco, 2023). These case examples suggest that larger NOCs with stronger credit ratings and governance reforms find it easier to integrate innovative financing tools. Figure 2 illustrates how asset monetization has shifted the capital profiles of selected NOCs by providing liquidity without increasing sovereign or corporate debt burdens.

Figure 2. Effect of Asset Monetization on Capital Availability



Source: Aramco and ADNOC transaction summaries (2023)

NOCs with weaker credit standing, such as NNPCL and Pemex, remain limited in their ability to attract green or transition finance due to investor concerns about governance, debt sustainability, and emissions intensity. Nonetheless, small but promising developments are evident. NNPCL's participation in Africa's emerging carbon-market initiatives and Algeria's exploratory work on green hydrogen suggest that even high-risk NOCs may eventually access new forms of climate finance (UNFCCC, 2021). Interviewees also noted that domestic capital markets and sovereign guarantees could play transitional roles as global financing becomes increasingly selective.

Overall, the findings demonstrate that NOCs face significant structural challenges as the financing ecosystem realigns around decarbonization. However, alternative funding pathways, if strategically adopted and supported by governance reforms, offer viable mechanisms for sustaining investment capacity while supporting national development goals. The results, therefore, underscore the need for integrated frameworks that connect transition finance opportunities with the institutional realities of NOCs in emerging economies.

Proposed Sustainable Financing Framework

The findings of this study demonstrate that National Oil Companies must reposition themselves strategically to navigate the tightening global financing environment shaped by the energy transition. The proposed sustainable financing framework integrates financial, institutional, and technological dimensions to support NOCs as they balance national economic roles with global decarbonization expectations. The framework builds on the theoretical foundations of resource dependence, transition risk, and sustainable finance, emphasizing that long-term viability requires adaptability to the evolving norms of global capital markets (IEA, 2022; OECD,

2022). It is structured around four strategic pillars that together create a foundation for a coherent, forward-looking financing model.

The first pillar is diversifying energy and revenue streams. This pillar recognizes that prolonged dependence on crude oil revenue exposes NOCs to volatility and transition risk. Many NOCs have begun expanding into natural gas, renewable power generation, and petrochemicals, although progress remains uneven. Diversification enables NOCs to enhance their financial resilience while positioning themselves in emerging energy markets. The second pillar—decarbonization reflects the increasing influence of sustainability-linked finance. Access to climate-aligned capital requires demonstrable progress on emissions reduction, methane abatement, and investment in low-carbon technologies, which lenders now use as benchmarks for evaluating creditworthiness (TCFD, 2017). The third pillar, digitalization, emphasizes operational efficiency, data transparency, and technology adoption as central to lowering production costs and improving investor confidence. The final pillar, governance reform, emphasizes that transparent ESG reporting, reduced political interference, and enhanced internal accountability are essential prerequisites for attracting sustainable finance. Table 3 summarizes the functional contributions of these four pillars to NOC's long-term financial stability.

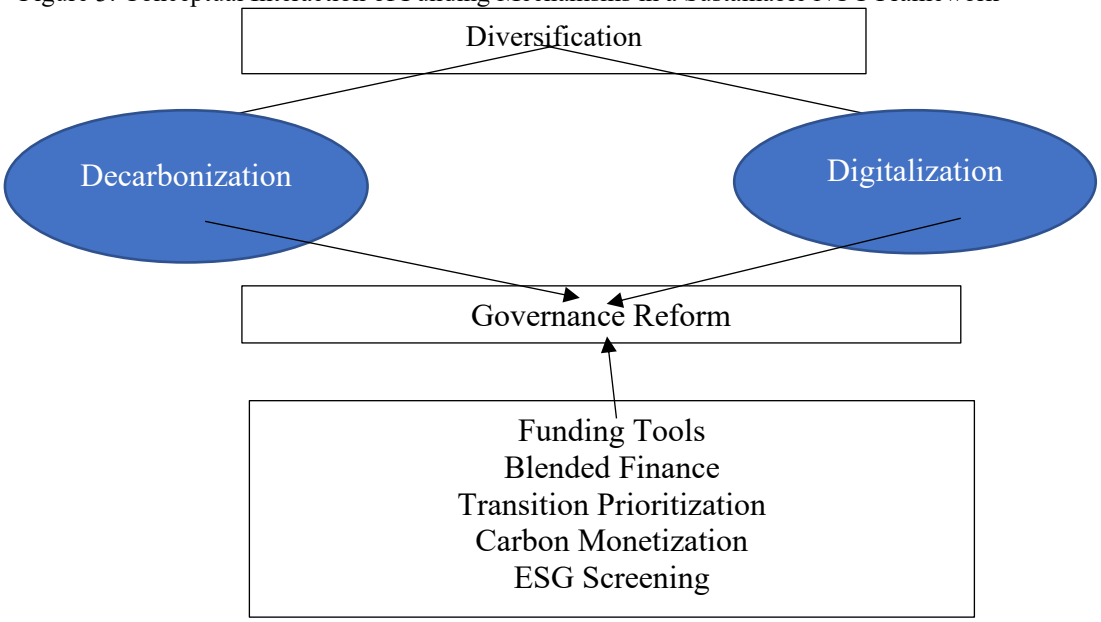
Table 3. Strategic Pillars and Their Contribution to Sustainable NOC Financing

Strategic Pillar	Primary Contribution	Financial Impact
Diversification	Expands revenue base beyond crude	Reduces exposure to stranded-asset risk
Decarbonization	Meets global climate-finance criteria	Improves access to green/transition capital
Digitalization	Enhances efficiency and reduces costs	Strengthens credit ratings and investor trust
Governance Reform	Increases transparency and ESG integrity	Lowers borrowing costs and risk premiums

Source: Synthesized from IEA (2022) and OECD (2022).

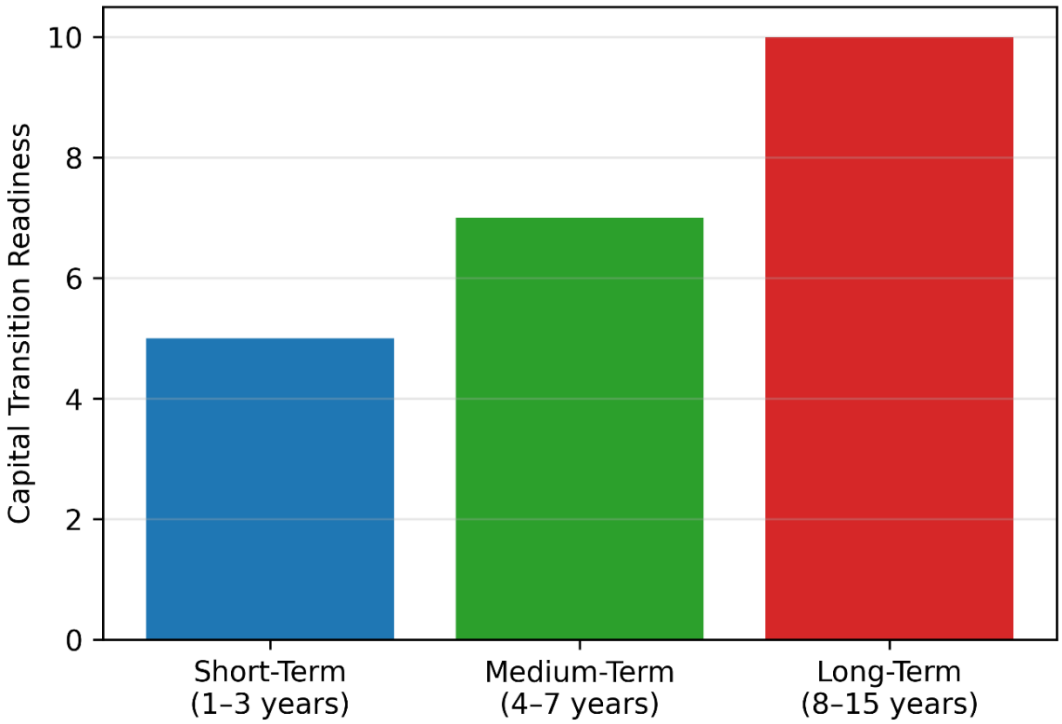
Building on these pillars, the second component of the framework outlines a structured suite of funding mechanisms designed to align NOC financing strategies with global market expectations. Blended finance emerges as an essential tool, combining public resources, private investment, and concessional climate finance to mitigate project risk and expand capital access for energy transition initiatives. Interviewees repeatedly noted that blended finance could bridge the gap between domestic development priorities and international sustainability requirements. A complementary tool is the transition-project prioritization model, which enables NOCs to categorize investments by their potential for emissions reduction, financial returns, and alignment with national energy strategies. Carbon asset monetization, including carbon credit trading and methane abatement incentives, provides another viable revenue channel. Ultimately, ESG-aligned investment screening tools empower NOCs to evaluate projects using financial, environmental, and governance metrics that align with investor preferences. This alignment is increasingly necessary for maintaining competitiveness in global capital markets (World Bank, 2023). Figure 3 provides an illustrative conceptual map of how these funding mechanisms reinforce one another within the broader strategic framework.

Figure 3. Conceptual Interaction of Funding Mechanisms in a Sustainable NOC Framework



Operationalizing this framework requires a phased implementation roadmap. In the short term, over a one- to three-year period, the framework emphasizes foundational reforms, particularly improvements in governance quality and transparency. These reforms include stronger ESG disclosures, audited emissions inventories, and early-stage pilot projects in methane reduction or renewable energy. Interview data suggest that such early wins can have a significant impact on sovereign and corporate credit ratings, thereby reducing borrowing costs (Moody's, 2023). During the medium-term phase, defined as 4 to 7 years, NOCs should scale their engagement in green and transition finance, support the expansion of natural gas and CCUS infrastructure, and introduce pilot hydrogen programs where feasible. These initiatives align with international decarbonization pathways and expand the range of bankable projects. The long-term horizon, spanning eight to fifteen years, involves fully integrating transition funding pathways into national budgets, energy planning, and sovereign finance strategies. At this stage, NOCs are expected to align their entire capital portfolios with low-carbon economic development models, reinforcing fiscal sustainability and competitiveness in a decarbonizing global energy system. Figure 4 illustrates this phased implementation trajectory.

Figure 4. Implementation Timeline for NOC Transition Financing



Source: Adapted from transition-planning literature (IEA, 2022).

Central to the successful operationalization of this framework is a robust stakeholder engagement structure. Because NOCs operate within complex political and economic systems, coordinated action among multiple actors is essential. National governments remain the primary enablers of transition financing through policy reforms, fiscal guarantees, and national energy strategies. Global and regional financial institutions, including development banks, export credit agencies, and institutional investors, shape access to long-term capital and climate-aligned lending. The domestic private sector plays a significant role in infrastructure partnerships, local content development, and technology adoption. Climate finance platforms provide concessional funding and technical assistance for decarbonization projects, while local communities provide social legitimacy and ensure that energy transition strategies align with local development needs (UNFCCC, 2021). The engagement of these stakeholders forms an interconnected ecosystem in which sustainable financing outcomes depend on shared objectives, transparent communication, and coordinated policy frameworks.

Together, the strategic pillars, funding mechanisms, phased actions, and stakeholder structure form a coherent, multi-dimensional framework that supports NOC transition readiness. This framework helps clarify how NOCs can reposition themselves financially while maintaining their national development roles. It also highlights the importance of governance depth, institutional learning, and incremental reform in responding to global decarbonization pressures. Table 2 provides a synthesis of the entire framework for further clarity.

Table 4. Integrated Sustainable Financing Framework for NOCs

Framework Element	Key Features	Expected Outcomes
Strategic Pillars	Diversification, decarbonization, digitalization, governance reform	Enhanced financial resilience
Funding Mechanisms	Blended finance, transition prioritization, carbon monetization, ESG tools	Expanded access to climate-aligned capital
Implementation Stages	Short-, medium-, and long-term pathways	Structured transition planning
Stakeholder Ecosystem	Governments, financiers, the private sector, climate platforms, and communities	Coordinated national transition strategy

Source: Study synthesis.

V. Discussion

The findings of this study reveal that National Oil Companies face a rapidly changing financial environment, shaped by global decarbonization policies, evolving investor expectations, and tightening climate-aligned lending practices. These shifts have profound implications for how NOCs position themselves within the global energy system. The evidence suggests that traditional hydrocarbon-focused business models are losing viability as lenders increasingly weigh emissions intensity, transition exposure, and governance quality in their investment decisions (IEA, 2022). For many NOCs, these changes pose significant operational and strategic challenges, particularly when financial structures rely heavily on government transfers or on high-cost upstream assets. The need for strategic repositioning is therefore both urgent and structural. Operational transformation, including diversification, digitalization, and technology adoption, becomes increasingly essential for maintaining competitiveness in a market where low-carbon alignment is a key determinant of access to capital (OECD, 2022).

The importance of ESG alignment emerges as one of the clearest implications for NOCs. The study reveals that lenders and investors now require transparent emissions reporting, credible transition strategies, and enhanced governance standards as prerequisites for financing. This reflects a broader shift in global capital markets, where ESG metrics have become powerful tools for assessing long-term financial risk (TCFD, 2017). NOCs that fail to adopt ESG-aligned practices risk facing rising borrowing costs, restricted access to credit, and a decline in attractiveness to institutional investors. The consequences of non-transition extend beyond financing constraints; they include reduced competitiveness in global markets, diminished fiscal contributions to national budgets, and heightened vulnerability to stranded-asset risks. For countries that rely heavily on NOCs for public revenue, the inability to adapt could have severe macroeconomic implications (IMF, 2023).

The findings also highlight important policy implications, emphasizing that national governments play a central role in enabling or inhibiting NOC transition strategies. Reforms in the petroleum sector are necessary to create an institutional environment that supports transparency, efficient capital allocation, and operational autonomy. In many emerging economies, policy frameworks still reinforce dependence on oil revenues, reducing the incentives for NOCs to diversify or pursue low-carbon investments (Stevens, 2020). Governments must therefore reassess fiscal structures and regulatory systems to encourage long-term sustainability. Incentives for renewable energy, natural gas optimization, carbon management, and transition-focused investments are essential components of this shift. Such incentives can catalyze blended finance arrangements, attract private-sector partnerships, and stimulate technological innovation within NOCs.

Another critical policy implication is the gradual reorientation of national budgets away from oil dependency. Economic diversification alleviates the fiscal pressures on NOCs and creates space for strategic reinvestment in low-carbon assets. For many producing countries, aligning national planning with the realities of transition will help mitigate macroeconomic instability and support the development of resilient, diversified economies that can thrive in a decarbonizing world (World Bank, 2023). The study demonstrates that without broad fiscal reforms, even well-intentioned NOC transition strategies may be undermined by political interference, subsidization pressures, or conflicting national priorities.

The implications for investors further reinforce the need for structural reform and improved transparency across the NOC landscape. As global financial institutions adopt transition screening tools, investors require clear indicators of progress in emissions reduction, climate risk exposure, and long-term business model adaptability. Transparent governance frameworks significantly reduce sovereign and project-level risk, making NOCs more attractive to international financiers. Improved disclosure practices such as audited emissions inventories, credible sustainability reporting, and measurable transition targets also build confidence among lenders seeking to comply with both regulatory and voluntary climate commitments (Moody's, 2023). Investors interviewed in this study emphasized that transparency does not merely signal good governance; it directly influences credit ratings, debt pricing, and long-term financing conditions.

Overall, the discussion underscores that NOCs operate at a pivotal moment in the global energy transition. Their continued economic relevance depends on their ability to transform strategically and align with a global financial ecosystem that increasingly favors low-carbon development. Likewise, policy reforms and

investor engagement frameworks must evolve to support rather than hinder this transformation. The convergence of operational, policy, and financial factors suggests that NOC transition is not simply an environmental imperative but a fundamental economic necessity.

VI. Conclusion

The evidence presented throughout this study demonstrates that the global energy transition is transforming the financial and operational landscape in which National Oil Companies operate. The shift toward decarbonization, combined with stringent ESG-related lending requirements and investor scrutiny, is altering the availability, cost, and structure of capital for hydrocarbon-dependent enterprises. As international climate commitments strengthen and energy systems evolve, NOCs face a fundamental inflection point. Their long-term viability increasingly depends on their ability to adapt strategically by diversifying revenue streams, engaging with low-carbon investment opportunities, and strengthening internal governance and transparency systems. These pressures are not episodic or cyclical; they represent a structural transformation of global energy markets that will continue to intensify in the coming decades (IEA, 2022).

The study's findings confirm that traditional financing channels, such as state subsidies, JV partnerships with IOCs, and commercial loans, are eroding as lenders explicitly account for transition risks and carbon exposure in their decision-making processes. This shift has disproportionate implications for NOCs in developing economies where fiscal dependence on hydrocarbon revenue remains high. In these settings, the decline in available finance not only affects corporate operations but also poses a threat to broader macroeconomic stability (IMF, 2023). At the same time, emerging sources of climate-aligned capital, such as green bonds, transition bonds, blended finance instruments, and carbon market revenues, offer new opportunities for NOCs willing to align with global sustainability trajectories strategically. These financing pathways, however, require strong governance frameworks, credible emissions-reduction plans, and transparent disclosure practices to attract investor confidence (OECD, 2022).

Taken together, the study demonstrates that a sustainable financing framework is essential for guiding NOCs through this period of transition. Such a framework must connect the imperatives of national development with the realities of capital-market transformation. It must also enable NOCs to reposition themselves not only as hydrocarbon producers but as diversified energy enterprises aligned with long-term global decarbonization goals. By integrating diversification, decarbonization, digitalization, and governance reform, the proposed framework provides a comprehensive structure for balancing operational demands, financial resilience, and environmental responsibility.

The recommendations that emerge from this research underscore the importance of strategic and institutional transformation within NOCs. One of the most precise recommendations is for NOCs to adopt diversified, innovative funding portfolios. The findings show that reliance on a narrow set of traditional financing mechanisms is no longer sustainable amid tightening ESG requirements and a reduced global appetite for carbon-intensive investments. Diversification should encompass both financial instruments, such as sustainability-linked bonds, PPP structures, and carbon credit monetization, as well as energy-sector investments that expand beyond crude oil into natural gas, renewables, hydrogen, and petrochemicals. Diversification is not only a financial strategy but a structural adjustment that positions NOCs to participate in emerging global energy markets.

Another key recommendation is that NOCs proactively engage with transition and climate-finance institutions. International development banks, regional climate funds, sovereign wealth funds, and blended-finance platforms are becoming increasingly central to funding energy transition projects in developing regions. NOCs that cultivate relationships with these institutions and design bankable, low-carbon projects aligned with their lending criteria will be better positioned to secure long-term financing. This engagement also allows NOCs to shape global narratives about the role of state-owned enterprises in the energy transition, potentially expanding opportunities for concessional financing and technical support (UNFCCC, 2021). Governance and transparency reforms represent a third central recommendation. The study makes clear that governance quality is one of the strongest predictors of NOC access to capital. Investors increasingly evaluate the credibility of emissions reporting, the independence of financial audits, and the stability of corporate decision-making processes. Institutionalizing ESG frameworks, establishing clear transition strategies, and publishing audited sustainability reports can significantly reduce perceptions of sovereign and corporate risk. These reforms improve investor confidence, enhance credit ratings, and lower borrowing costs, creating a positive feedback loop that strengthens financial sustainability (Moody's, 2023).

The study also identifies areas where further research is needed to deepen the understanding of NOC financing in the transition era. One of the most important areas is the quantitative modeling of carbon-transition risks. While qualitative analyses reveal the directionality of risk, more sophisticated modeling is necessary to estimate the financial consequences of declining oil demand, stranded assets, and tightening climate policies. Such modeling would enable policymakers and NOCs to better prepare for future scenarios. Comparative research across NOCs in developing regions would also be valuable, as it would highlight variations in governance

capacity, financing environments, and transition readiness. This type of comparative analysis could identify best practices that are transferable across national contexts. Finally, the role of indigenous private-sector actors in funding transition-related projects remains underexplored. Domestic investors, local banks, and regional capital markets may become increasingly important as international lenders withdraw from carbon-intensive assets. Understanding how local private sectors can collaborate with NOCs offers a fruitful area for future investigation.

In conclusion, the global energy transition presents both risks and opportunities for National Oil Companies. The risks are substantial and increasingly unavoidable, but the opportunities, particularly in climate-aligned finance and diversified energy investments, offer promising pathways for restructuring NOC business models. The sustainable financing framework developed in this study provides a strategic roadmap for navigating these changes. Its successful implementation depends on sustained institutional reform, coordinated policy action, and forward-looking investment strategies. NOCs that embrace these changes will be better equipped to sustain their national economic contributions while securing their place in the emerging low-carbon global energy economy.

References

[1]. Aramco. (2023). *Annual report 2023*. Saudi Aramco. https://www.aramco.com
[2]. Braun, V., & Clarke, V. (2021). Thematic analysis: A practical guide. SAGE.
[3]. Campbell, M., & Lahn, G. (2022). *Risk and resilience in national oil companies under the energy transition*. Chatham House.
[4]. Climate Bonds Initiative. (2023). *Green bonds market summary 2023*. https://www.climatebonds.net
[5]. Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE.
[6]. George, A. L., & Bennett, A. (2005). *Case studies and theory development in the social sciences*. MIT Press.
[7]. International Energy Agency. (2021). *Net Zero by 2050: A roadmap for the global energy sector*. IEA.
[8]. International Energy Agency. (2022). *World Energy Outlook 2022*. IEA.
[9]. International Monetary Fund. (2023). *Fiscal transparency and resource revenue management in oil-producing economies*. IMF.
[10]. Johnson, G., Whittington, R., Regnér, P., Scholes, K., & Angwin, D. (2017). *Exploring corporate strategy* (11th ed.). Pearson.
[11]. Kvale, S., & Brinkmann, S. (2015). *InterViews: Learning the craft of qualitative research interviewing* (3rd ed.). SAGE.
[12]. Moody's Investors Service. (2023). *Global oil and gas outlook: Transition risks and credit implications*. Moody's.
[13]. Osho, G. S., Ojumu, O., Tandon, S., & Oloyede, B. (2026). Monte Carlo–based forecasting and optimization of oil price and production: Evidence from Nigeria's petroleum sector. *Journal of Applied Business and Economics, 28*(1), 105–123.
[14]. Osho, G. S. (2026). Hydropower, climate change, and the green energy transition in Nigeria: Assessing economic and policy pathways toward a low-carbon future. *International Journal of Advances in Engineering and Management, 8*(1), 288–300.
[15]. Osho, G. S. (2025, December). *Impact of environmental, social, and governance on the profitability of national oil companies: A case study of Nigerian National Petroleum Company Limited*. Paper presented at the 2025 Oil & Gas Workshop on Global Energy Transition and Navigating New Funding Realities, Doha, Qatar.
[16]. Osho, G. S. (2025, December). *Returns on carbon, methane reductions, and energy transition in the global oil and gas market*. Paper presented at the 2025 Oil & Gas Workshop on Global Energy Transition and Navigating New Funding Realities, Doha, Qatar.
[17]. Osho, G. S. (2025). Exploring trade volume dynamics in Sub-Saharan Africa through structural Gravity Theory modeling of international trade: A dynamic econometric analysis. *Applied Business and Economics Journal*, *3*(1), 24-48.
[18]. Osho, G. S. (2025). The geopolitical dynamics of oil and gas: Nigeria's strategic role, emerging challenges, economic policies and opportunities. *Journal of Energy Technologies and Policy*, 15(1), 121–136. IISTE.
[19]. Osho, G. S. (2025). Oil Subsidy and Nigeria's Economic Growth: A Blessing or a Burden. *International Journal of Economics and Finance*, *17*(10).
[20]. Osho, G. S., & Oloyede, B. (2024). A Generalized Autoregressive Conditional Heteroscedasticity GARCH for Forecasting and Modeling Crude Oil Price Volatility. *The Journal of Applied Business and Economics*, *26*(6), 39-53.
[21]. Osho, G. S. (2024). Unitization in Nigeria's oil and gas industry: Challenges, benefits, and regulatory framework. *Economics and Policy of Energy and Environment, 2*, 69–86.
[22]. Osho, G., Nazemzadeh, A., Osagie, J., & Williford, R. (2005). Increased demand for oil in developing countries: Effects on the global oil trade. *Southwest Review of International Business Research, 15*, 221–231.
[23]. Osho, G., Oloyede, B., Adetosoye, A., Fernandes, M., & Samuel, R. (2005, March). Drilling an offshore well within the economic budget constraints. *Southwest Review of International Business Research, 16*(1).
[24]. Osho, G. S. (2019). A General Framework for Time Series Forecasting Model Using Autoregressive Integrated Moving Average-ARIMA and Transfer Functions. *International Journal of Statistics and Probability, 8*(6), 1–23.
[25]. Osho, G. S. (2023). Application of the autoregressive integrated moving-average model for modeling and forecasting crude oil production. *Journal of Energy Technologies and Policy, 13*(1), 36–47.
[26]. Osho, G. S. (2025). Navigating cash call and revenue challenges in Nigeria's oil and gas sector: Strategic implications, economic impacts, and policy lessons. *Journal of Economics & Management Research, 6*, 287, 2–8.
[27]. Osho, G. S. (2025). The effect of cash call on decommissioning of floating production, storage, and offloading in Nigeria's oil and gas industry. *International Journal of Advances in Engineering and Management, 7*(4), 857–872.
[28]. Osho, G. S. (2025). Optimizing joint ventures and alternative funding for Nigeria's oil and gas industry: Improved financing and transitioning to commercial ventures. *International Journal of Professional Business Review, 10*(2), 10.
[29]. Organization for Economic Cooperation and Development. (2022). *ESG investing and climate-aligned finance: Trends, risks, and policy implications*. OECD Publishing.
[30]. Stevens, P. (2016). *The role of national oil companies in the international oil market*. Chatham House.
[31]. Stevens, P. (2020). *The challenges for national oil companies in a low-carbon future*. Oxford Institute for Energy Studies.
[32]. Task Force on Climate-related Financial Disclosures. (2017). *Final report: Recommendations of the TCFD*. https://www.fsb-tcfd.org
[33]. United Nations Framework Convention on Climate Change. (2021). *Climate finance and developing countries: Trends and opportunities*. UNFCCC Secretariat.
[34]. Victor, D. G., Hults, D. R., & Thurber, M. C. (2012). *Oil and governance: State-owned enterprises and the world energy supply*. Cambridge University Press.
[35]. World Bank. (2022). *Financing low-carbon transitions in emerging economies*. World Bank Publications.
[36]. World Bank. (2023). *Global economic prospects: Implications of decarbonization for developing countries*. World Bank.

[37]. Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE.

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