



An Examination of Energy Security in Norway, Canada, Angola and Lessons For Nigeria

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ABSTRACT: Energy security remains a global priority, with countries adopting strategies shaped by resource endowments, governance, and climate commitments. This paper examines legal regimes in Norway, Canada and Angola, drawing lessons for Nigeria. Norway shows how strong institutions, transparent revenue management, and renewable diversification can mitigate the resource curse and ensure stability. Canada offers insights into balancing fossil fuel production with sustainability through federal-provincial cooperation and clean energy innovation. Findings in the work indicate that Nigeria faces a paradox of abundant hydrocarbons and persistent energy poverty. Angola, like Nigeria, struggles with oil dependence, weak institutions, and price volatility, exposing governance risks. Furthermore, the energy security challenges experience in Nigeria erode investor confidence, destabilise production and impedes the availability, affordability, sustainability, energy governance and deepen inequality. The paper concludes that resource wealth alone does not guarantee energy security; governance quality, resilience, and sustainability commitments are decisive. Nigeria can adapt best practices from the three countries and enhance its energy security prospects by strengthening institutions, diversifying sources, embedding transparency, and aligning with global climate policies. The work recommends governance accountability, coherent policies, technological innovation, community inclusion, renewable energy transition and sustainability as drivers of a secure energy future.

I. INTRODUCTION

In an increasingly interconnected and energy-dependent world, the concept of energy security has emerged as a cornerstone of national policy and global cooperation. While the term broadly refers to the reliable, affordable, and sustainable supply of energy, its interpretation and implementation vary widely across jurisdictions. From fossil fuel-rich nations pursuing “all-of-the-

above” strategies to resource-constrained countries investing heavily in renewables and energy efficiency, the pathways to energy security are shaped by geography, politics, technology, and economic priorities.

Developed countries often emphasize resilience through distributed energy systems, strategic reserves, and advanced control technologies. In contrast, developing nations prioritize diversification and self-sufficiency to mitigate vulnerabilities linked to socio-economic instability and geopolitical pressures. Regional approaches also differ: Europe leans into decentralized energy resources, Africa embraces emerging technologies, and the Americas invest in long-term energy planning. [1]

This global mosaic of strategies underscores the complexity of achieving energy security in a world facing climate change, pollution, pipeline vandalisation, cyber threats, and shifting resource dynamics. Exploring how different jurisdictions tackle these challenges not only reveals innovative practices but also highlights the need for international collaboration and adaptive policy-making.

Energy security remains a cornerstone of national development, economic stability, and geopolitical influence. This comparative study examines the energy security frameworks of Nigeria, Canada, Norway, and Angola - four nations with distinct energy profiles, governance structures, and resource endowments. The analysis evaluates key dimensions including energy availability, affordability, efficiency, sustainability, and governance.

Nigeria and Angola, as resource-rich developing nations, face challenges such as infrastructural deficits, over-reliance on fossil fuels, limited diversification, and vulnerability to global oil price fluctuations. In contrast, Norway and Canada exhibit advanced energy governance, diversified energy mixes, and robust legal and institutional mechanisms that support energy transition and climate commitments. Norway's



success in balancing oil exports with renewable energy development and Canada's emphasis on indigenous energy rights and environmental stewardship offer valuable lessons for Nigeria.

This study underscores the need for Nigeria to strengthen its legal framework, invest in renewable energy infrastructure, and adopt adaptive policies that promote energy equity and sustainability. By drawing insights from global best practices, the research advocates for a multidimensional approach to energy security that aligns with national development goals and global climate imperatives.

II. ENERGY SECURITY IN NIGERIA: A MULTI-DIMENSIONAL ANALYSIS

Energy security is a cornerstone of sustainable development, encompassing the reliable supply of energy at affordable prices while safeguarding environmental and social interests. For Nigeria, Africa's largest economy and oil producer, energy insecurity remains paradoxical given its vast resource endowment[2].

Nigeria's energy availability is constrained despite abundant reserves. The country holds over 37 billion barrels of crude oil and 209 trillion cubic feet of natural gas, yet electricity generation averages below 5,000 MW against a demand exceeding 20,000 MW.[3] Transmission bottlenecks, vandalism of pipelines, and underinvestment in renewable energy exacerbate shortages. For instance, rural electrification rates remain below 40%, leaving millions reliant on biomass and kerosene.[4] This mismatch between resource endowment and energy access underscores structural inefficiencies in Nigeria's energy system.

Energy affordability is undermined by high tariffs and the removal of subsidies. The 2023 removal of petrol subsidies increased fuel prices by over 200%, disproportionately affecting low-income households.[5] Electricity tariffs, though regulated, remain unaffordable for many, leading to widespread reliance on diesel generators. Studies show that Nigerian households spend up to 30% of income on energy, far above global affordability benchmarks [6]. Without targeted subsidies or social protection, energy poverty will deepen, limiting access to reliable power for vulnerable populations.

Energy efficiency is the sum of measures and actions in all areas of life with the ultimate goal of minimizing energy consumption, provided that the level of work and life remains the same or improves. Almost all the governments of the world

face climate change and energy security dilemmas (in correlation with public support), especially in times of economic hardship. In those countries that rapidly advance technologically and generate the highest income per unit of energy consumed, thus becoming more and more energy efficient, production and consumption per capita increase. According to the International Energy Agency (IEA), in the period from 2005 to 2025, primary energy consumption is expected to increase by 40%. Therefore, it is necessary that the development of energy is strategically planned and thoroughly analyzed from all aspects, such as those of technologically, economically, as well as socially and ecologically. Energy efficiency enables the most economically efficient use of energy to perform a certain task (such as light, or heat) by minimizing the units of resources per unit of output. Energy efficiency can include substituting resource inputs or fuels, changing habits and preferences, or altering the mix of goods and services to demand less energy. A key part of improving the efficiency of energy technologies and services relates to innovation, research development and end user's optimization of available energy. Another part of efficiency includes consumer demand for energy services and consumer behavior, ensuring that energy fuels and carriers are matched in scale and quality to end uses and that consumers use only as much energy as they truly need.

Nigeria's energy system suffers from inefficiency across production, transmission, and consumption. Technical losses in electricity transmission and distribution exceed 30%. [7]. Inefficient appliances and industrial processes increase demand pressures. The lack of energy-efficient building codes and weak enforcement of appliance standards further exacerbate inefficiency. Improving efficiency could reduce costs and emissions, but requires investment in smart grids, modern technologies, and stronger regulatory framework[2].

Environmental stewardship is a crucial dimension of energy security, encompassing the protection of natural environments, communities, and future generations. It involves ensuring that energy production and consumption do not harm the environment, thereby contributing to long-term sustainability and resilience. In its traditional definition, the idea includes the striking of a balance between the needs of future generations and usage of resources today. For instance, fulfilling "the needs of the present without compromising the ability of future generations to



meet their own needs” is how sustainable development was defined in the seminal 1987 Brundtland report on when it comes to energy policy, sustainability has typically meant pursuing three guidelines at once: Making sure that waste emissions do not surpass pertinent assimilative rates: and making sure that the rates at which renewable resources are harvested don't exceed rates at which they are renewed.

Entities like the International Energy Agency have acknowledged that measures to mitigate and adapt to climate change are integral to any strategy aimed at achieving energy security. The acceleration of climate change and associated issues with waste, water, agriculture, and deforestation pose serious threat to global energy security. The various oil spills and oil and gas pollution in the Niger Delta negatively affects communities whose main sources of income were fishing, wetlands, and tourism, serves as a stark reminder of the connection between environmental determination and socioeconomic well-being.

Nigeria's energy sector contributes significantly to environmental degradation. Gas flaring, though reduced, still accounts for millions of tonnes of CO₂ emissions annually.[3] Oil spills in the Niger Delta devastate ecosystems and livelihoods[8].Section 20 of the 1999 Nigerian Constitution of the Federal Republic of Nigeria (CFRN), underscores the importance of environmental sustainability in the quest for energy security in Nigeria by stating that "The state shall protect and improve the environment and safeguard the water, air, land, forest, and wildlife of Nigeria."Section 20 of the 1999 CFRN sets environmental objectives, but because it is placed under Chapter II, whose provisions are non-justiciable and beyond judicial enforcement, these goals remain aspirational rather than binding, leaving them ineffective in practice [9]. Furthermore, renewable energy sources such as solar, wind, and hydropower, remain underutilized despite Nigeria's vast potential. Transitioning to a low-carbon energy system is essential for meeting Nigeria's climate commitments under the Paris Agreement. However, financing constraints and policy inertia hinder progress.

Governance structures significantly influence energy security outcomes in developing countries. Effective governance in the energy sector involves establishing clear regulations, institutions, policies and processes that promote stability, transparency, and accountability. Strong governance quality enhances economic performance and facilitates clean energy supplies.

Clear rules and regulations are essential for promoting investment, efficiency, and competition in the energy sector.Strong institutions are necessary for effective governance. In Nigeria, the regulatory regime governing the oil and gas industry plays a pivotal role in achieving energy security. This regime includes a complex framework of laws, regulations, and policies designed to manage the exploration, production, distribution of petroleum resources and environment. Key legislative instruments, such as the Petroleum Industry Act and the 1999 Constitution, provide the legal foundation for the industry's operations.

Nigeria's energy sector is plagued by inadequate institutional capacity, which hinders the implementation of policies and regulations. Transparency in energy decision-making and accountability of policymakers are critical for ensuring that energy resources are managed efficiently and effectively.Governance failures remain the most critical barrier to energy security. Policy inconsistency, corruption, and weak regulatory institutions undermine progress. The 2013 power sector reform, which unbundled the Nigerian Electricity Supply Industry (NESI), created opportunities for private participation but failed to deliver due to poor enforcement of contracts and inadequate oversight [6]. Comparative studies suggest that Nigeria could benefit from decentralized governance models and strategic reserves, similar to those in the Canada. Strengthening governance requires transparent regulation, accountability, and long-term policy coherence.

Nigeria's energy security challenges are multidimensional, spanning availability, affordability, efficiency, sustainability, and governance. A comparative analysis of energy security in other jurisdictions provides policy lessons, governance insights, and benchmarks for reform, helping Nigeria move from resource abundance to genuine energy security.

III. ENERGY SECURITY IN SELECTED JURISDICTIONS

NORWAY: Norway is both a major oil and gas exporter and a global leader in renewable energy. Its abundant hydropower resources have enabled near-zero emissions in electricity generation, while petroleum continues to underpin economic strength. This dual identity shapes Norway's energy transition, affordability, efficiency, and governance challenges.



Norway is a major oil and gas producer and exporter and has set ambitious targets for reducing Green-House Gas (GHG) emissions and establishing a low emissions society by 2050[10]. As an energy-rich country, Norway is in a unique starting position with respect to the energy transition. Norway exports 87% of its energy production, supplying 3% of global gas consumption and 2.3% of global oil production in 2020. Hydropower accounts for 92% of electricity generation, creating a renewables-based power sector [11]. As a reputable and reliable producer, Norway has played a stabilizing role in the world's oil and gas supply, particularly in meeting European demand. Also, Norway and its Nordic neighbours are world leaders in employing renewable energy, clean technology, and alternative fuels.

Nonetheless, to meet its ambitious target of being a low-emission society by 2050, Norway has considerable work ahead, especially since electricity generation is already zero emission and the country already has substantial electrification of the buildings sector and almost half of industry, thereby also achieving low emissions in these sectors. As a result, many of the easy wins for reducing emissions have already been achieved and the remaining emissions reductions will be more complex, challenging and costly, notably in transport and industry.

Overall, Norway's many natural advantages help it achieve a successful energy and climate transition. In particular, it can be well-positioned to lead the world on new technologies for decarbonising hard-to-abate sectors, such as Electric Vehicles (EVs), Carbon Capture and Storage (CCS), and hydrogen, if the right policies and incentives are put in place. Leveraging its renewables-based electricity system, Norway can further support its goals by developing detailed, long-term sectoral transition road-maps, underpinned by specific policy measures, to lay out a well-defined pathway for sectoral change.

Affordability is central to energy security. Declining solar photovoltaic (SPV) module prices and falling renewable energy costs after 2010 illustrate sector maturity. However, interconnectors, while lowering system costs overall, can raise domestic electricity prices, sparking debates about whether surplus renewable power should be exported or reserved for domestic industry. Legal and policy frameworks must balance conventional and renewable costs to ensure equity [12][15].

Norway targets a 30% reduction in energy intensity by 2030 compared to 2015, though progress has been modest [16]. Enova, the national agency, supports efficiency and emission-reduction projects, with transport policies driving electric vehicle (EV) adoption. By 2021, 64.5% of car sales were zero-emission, reflecting strong incentives. Despite affordable energy, efficiency improvements remain vital, especially amid rising electricity prices. A national efficiency strategy with sectoral targets would strengthen resilience.

Norway's governance framework integrates petroleum, electricity, and emergency preparedness under robust laws and institutions. The Energy Act liberalizes electricity markets while safeguarding consumers, and the Petroleum Act enforces strict safety and environmental standards. Institutions such as the Ministry of Petroleum and Energy, NVE, and Statnett coordinate policy and grid operations. Hydropower reservoirs, gas exports, and interconnectors enhance resilience, though affordability debates persist.

Norway balances renewable leadership with continued petroleum exports, investing heavily in CCS projects such as Longship. Governance challenges include aligning energy, climate, and security policies under a unified vision, particularly in light of geopolitical risks. Transparent decision-making on interconnectors and industrial policy will be crucial for sustaining affordability, resilience, and sustainability [13] [14].

Norway's energy system is defined by hydropower dominance, strong governance, and global leadership in EV adoption. Yet, future progress depends on addressing hard-to-abate sectors, balancing affordability with export commitments, and integrating climate and security strategies into a coherent long-term framework [17]. Its ability to adapt governance will determine whether Norway remains a model of secure, sustainable energy transition.

CANADA: Canada's energy security is underpinned by abundant natural resources, diversified energy sources, and a robust legal and institutional framework. This framework balances availability, affordability, efficiency, and sustainability, while embedding resilience against global market volatility and geopolitical risks. Canada's dual reliance on fossil fuels and renewables shapes its energy transition and governance challenges.



Canada benefits from a diversified energy mix including hydroelectricity, nuclear, oil, gas, and renewables. Provinces such as Quebec and British Columbia rely heavily on hydro, while northern communities remain dependent on diesel [18]. The Canadian Energy Regulator Act 2019 empowers the Canada Energy Regulator (CER) to oversee interprovincial and international flows, ensuring reliability despite infrastructural and jurisdictional fragmentation [19].

Affordability is central to Canada's energy security. While renewable energy costs have declined, fossil fuel dependence exposes households to global price volatility. The International Institute for Sustainable Development notes that renewables are often cheaper than coal or gas-fired electricity, underscoring the need for supportive legal framework [20]. Equity concerns persist, as hydro-rich provinces enjoy lower rates compared to fossil fuel-dependent regions. Legal instruments such as subsidies and rate design policies are vital to safeguard affordability and fairness [21].

Energy efficiency complements availability and affordability. The Energy Efficiency Act 1992 sets national standards for appliances and industrial processes, while building codes and incentive programmes promote conservation. Efficiency reduces demand pressures, mitigates exposure to volatile markets, and enhances resilience. However, fragmented jurisdiction between federal and provincial governments complicates harmonisation. Legal disputes over carbon pricing further highlight governance challenges [22].

Canada's governance framework integrates constitutional, statutory, and institutional mechanisms. The Constitution Act 1867 divides jurisdiction between provinces and the federal government, ensuring localized control while maintaining national oversight [23]. The Impact Assessment Act 2019 mandates environmental and social reviews for major projects, embedding sustainability into energy planning. Institutions such as CER, Natural Resources Canada, and provincial regulators enforce compliance, manage infrastructure, and promote innovation [24]. Judicial oversight, particularly through Indigenous rights cases such as *Haida Nation v British Columbia (Minister of Forests)* and *Tsilhqot'in Nation v British Columbia* embeds constitutional protections into energy governance [25] [26].

It is pertinent to note that Canada integrates sustainability into energy planning through environmental assessments and efficiency

standards. Investment in renewables and Environmental, Social and Governance{ESG} frameworks has redirected capital away from fossil fuels, increasing regulatory burdens on traditional energy sectors. Strong governance and legal predictability foster investor confidence, ensuring continued innovation and international partnerships.

Canada's energy security framework demonstrates resilience through diversification, regulatory stability, and sustainability integration. Legal instruments and institutions balance availability, affordability, and efficiency, while constitutional protections ensure equity and justice. Challenges remain in harmonising federal and provincial jurisdictions and addressing affordability disparities. Nonetheless, Canada's framework positions it as a reliable global energy partner while advancing towards a just and sustainable energy future.

2.3 ANGOLA

Angola, one of Africa's largest oil producers, stands at a critical juncture in its energy transition. While endowed with vast hydrocarbon reserves, the country faces uneven electricity access, systemic inefficiencies, and governance challenges. Its energy security framework is shaped by oil and gas legislation, electricity laws, and national strategies, overseen by institutions such as the National Agency for Petroleum, Gas and Biofuels (ANPG), the Ministry of Energy and Water (MINEA), and the Regulatory Institute for Electricity (IRSE).

Hydrocarbons account for over 90% of Angola's export revenues, positioning the country as a major global supplier. Yet domestic electricity access remains uneven, with rural electrification below 40% [27]. The Energy Strategy 2025 prioritises diversification into hydropower and solar to reduce reliance on oil exports and mitigate exposure to global price volatility [28]. Legal reforms aim to strengthen generation and distribution, though weak institutions hinder implementation [29].

Historically, subsidies kept fuel and electricity prices low, but fiscal pressures have led to gradual removal, disproportionately affecting low-income households. The *Lei de Electricidade* 1996 mandates tariff regulation, yet enforcement remains inconsistent. Comparative lessons from Nigeria show that subsidy reforms without social safety nets exacerbate inequality. Angola must balance utility cost recovery with equitable access, embedding affordability into law and policy [29].



Energy efficiency remains underdeveloped. The Lei de Electricidade 1996, Articles 20–23, and reforms under Law No 6/25 (2025) [30] outline obligations for efficient energy use, but enforcement is weak. Unlike Canada's Energy Efficiency Act 1992 or Norway's Energy Act 1990, Angola lacks strong regulatory oversight and institutional capacity. Efficiency measures remain aspirational, hindered by limited technical expertise and weak judicial enforcement.

Angola's reliance on fossil fuels has significant environmental consequences, including pollution and carbon intensity. Policies promoting renewables and emissions control have been introduced, with commitments to expand solar and hydropower. Law No 6/25 (2025) incorporates environmental safeguards, but enforcement remains limited, raising concerns about long-term sustainability [30].

Governance is the linchpin of Angola's energy security. Corruption, weak institutions, and limited transparency undermine progress. While reforms under Law No 6/25 (2025) strengthen regulatory oversight, accountability remains weak. Effective governance requires judicial enforcement and civil society participation. Without robust institutions, Angola's energy insecurity persists despite legal reforms [29] [30].

Angola's energy framework demonstrates both potential and fragility. Abundant oil reserves guarantee availability, but affordability, efficiency, sustainability, and governance remain underdeveloped. Legal reforms mark progress, yet enforcement gaps and institutional weaknesses hinder resilience. Angola's future energy security depends on embedding affordability, efficiency, and sustainability into enforceable governance structures, ensuring equitable access and long-term stability.

IV. COMPARATIVE ANALYSIS OF ENERGY SECURITY FRAMEWORKS OF NORWAY, CANADA, ANGOLA WITH NIGERIA

Examining Nigeria, Norway, Angola, and Canada reveals how legal and institutional frameworks shape resilience and vulnerability in different national contexts. The analysis is based on the dimensions of energy security, such as, availability, affordability, energy efficiency, environmental sustainability and energy governance.

Availability

Canada and Norway exemplify strong availability through diversified energy mixes and robust infrastructure. Canada's reliance on hydroelectricity, nuclear, oil, gas, and renewables is overseen by the Canadian Energy Regulator Act 2019, Part 2, ss 31–34, which regulates interprovincial and international energy flows. Judicial oversight has reinforced regulator independence, as seen in *TransCanada Pipelines Ltd v National Energy Board* [31], where the Federal Court upheld the Board's discretion in pipeline approvals. Comparatively, Norway and Nigeria present contrasting cases: Norway is a high-income country with surplus renewable energy and strong institutions, while Nigeria is a developing economy facing chronic electricity shortages and heavy reliance on fossil fuels. Studies emphasize the robustness of Norway's legal framework, including the Energy Act, Water Resources Act, and Petroleum Act, which balance energy production with environmental and consumer protections. Kivimaa & Szulecki note the need for greater policy coherence between energy and security domains [32]. Research highlights Nigeria's fragmented legal framework, dominated by petroleum laws and weak electricity regulation [33]. Nwokike stresses the role of the Nigerian National Petroleum Company Limited and private actors in energy security. Uche et al. argue that institutional mechanisms remain inadequate for promoting sustainable energy security [34].

Norway's Energy Act 1990, Chapter 3, provides a licensing framework for hydropower and grid management, while the Supreme Court in *Greenpeace Nordic and Nature & Youth v Energy Ministry (The North Sea Fields Case, 2023)* scrutinised petroleum licensing against constitutional environmental rights [35]. The Electric Power Sector Reform Act 2005 established the Nigerian Electricity Regulatory Commission (NERC) to oversee electricity generation and distribution.

Nigeria and Angola, despite vast oil and gas reserves, face chronic electricity shortages due to infrastructural deficits and weak governance. Nigeria's Electricity Act 2023, Part II, ss 63–70, introduced competitive electricity markets, but implementation remains uneven, as highlighted in *Folorunsho S. Bamidele & Ors v Attorney General of the Federation* [36]. Despite abundant resources, Nigeria struggles with inadequate infrastructure and frequent blackouts, highlighting a gap between legal frameworks and practical availability.



Angola's Lei de Electricidade 1996, Articles 12–15, has been criticised for weak tariff regulation, though reforms under Law No 6/25 (2025) seek to attract private investment. Canada maintains diversified sources, but remains vulnerable to import shocks, particularly in the wake of geopolitical crises. Nigeria, by contrast, remains heavily dependent on oil and gas, with the Petroleum Industry Act 2021 restructuring the Nigerian National Petroleum Corporation (NNPC) into a commercial entity and creating new regulatory bodies. However, electricity availability remains constrained by inadequate infrastructure and generation capacity, despite reforms under the Electric Power Sector Reform Act 2005. Frequent blackouts and reliance on diesel generators highlight the fragility of Nigeria's energy availability.

Affordability

Affordability remains a pressing challenge in Nigeria and Angola. Nigeria, struggles with affordability due to high reliance on imported refined petroleum products and inefficiencies in the electricity sector. Tariff structures overseen by the Nigerian Electricity Regulatory Commission (NERC) often fail to balance cost recovery with consumer protection, leading to widespread energy poverty. Many households spend a disproportionate share of income on energy, and businesses face high costs due to reliance on private generators. Angola faces similar distortions, with electricity costs disproportionately high outside urban centres, reflecting weak tariff regulation under Lei de Electricidade 1996[29]. Canada, by contrast, benefits from declining renewable costs and policies under the Federal Sustainable Development Strategy 2019–2022, Theme II, pp 45–52, reinforced by judicial emphasis on environmental priorities in *Chippewas of the Thames First Nation v Enbridge Pipelines Inc*[37].

Norway's affordability framework is influenced by EU law, with the constitutional compliance in adopting EU energy market rules. These interventions highlight the tension between market liberalisation and social equity, as governments are compelled to intervene to stabilise household bills. Nigeria, however, struggles with affordability due to subsidy mismanagement, tariff hikes, and inefficiencies in distribution. The Nigeria's Petroleum Industry Act 2021 attempted to restructure subsidies, but affordability remains a challenge for households.

Energy Efficiency

Canada and Norway lead globally in energy efficiency. Canada's Energy Efficiency Act 1992, Part I, ss 4–7, establishes regulatory standards, reinforced in *Pembina Institute v Canada (Attorney General)*[38], which highlighted the government's duty to enforce efficiency standards. Norway's Energy Act 1990, Chapter 5, affirms grid efficiency obligations under EU law. Furthermore, Norway embeds efficiency into its Net Zero targets through the Climate Change Act 2017.

Nigeria's National Energy Efficiency Policy 2017, s 3.2, sets retrofit targets for buildings but enforcement remains weak, with minimal judicial intervention. Angola's Lei de Electricidade 1996, Articles 20–23, and reforms under Law No 6/25 (2025) aim to strengthen compliance. The comparative picture demonstrates that efficiency is not merely technical but a governance issue, requiring strong institutions and judicial oversight.

Environmental Sustainability

Nigeria's reliance on fossil fuels has significant environmental consequences, including pollution and carbon intensity. Expanding utility-scale solar, wind, and distributed systems, as seen in Norway and Canada, can reduce volatility and emissions. Norway's trajectory in carbon capture and storage (CCS) and methane abatement provides lessons for balancing availability with sustainability. Even countries with abundant low-carbon electricity, such as Norway, must plan for rapid demand growth (industrial and transport electrification) to avoid deficits. Similar foresight is necessary for Canada.

Canada's commitments under the Paris Agreement reinforce domestic legislation, with courts recognising climate obligations in *La Rose v Canada*[39]. For Nigeria, adopting renewable energy frameworks and integrating sustainability into governance structures is essential to ensure long-term energy security. Norway's role as a European supplier ties its domestic energy law to EU directives, while judicial review in the *North Sea Fields Case*[40] reflects tensions between climate commitments and fossil fuel expansion.

Nigeria and Angola highlight the importance of institutional strength: despite ambitious legislation, weak enforcement and infrastructural deficits undermine sustainability. Nigeria's regulatory fragmentation between federal and state agencies complicates implementation, while Angola's reliance on state-owned enterprises limits competition.



Energy Governance

Governance capacity is the decisive factor in aligning energy security with sustainability. Canada and Norway demonstrate how strong institutions and judicial oversight can integrate environmental imperatives into energy law. Norway's model isn't without challenges, but it's a compelling example of how a country can leverage fossil fuel wealth to fund and accelerate its green transition. The adoption of Electric Vehicles, through aggressive subsidies and infrastructure investment, helps reduce domestic transport emissions even as oil exports continue. Norway's legal and institutional framework ensures energy security through strong laws, capable institutions, and integration with European markets. Nigeria's framework, by contrast, struggles with availability, affordability, and governance due to petroleum dependence and weak institutions.

Judicial review increasingly serves as a critical mechanism for accountability, ensuring that governments adhere to statutory and constitutional obligations. In Canada, courts have reinforced regulator independence and environmental obligations.[40] In Nigeria, courts are beginning to play a role in tariff disputes and regulatory compliance [41]. Angola, however, remains constrained by weak judicial capacity, limiting the role of courts in energy governance.

V. KEY LESSONS AND POLICY IMPLICATIONS FOR NIGERIA

Nigeria's energy sector faces persistent challenges of poor governance, weak institutions, pipeline vandalism, and environmental degradation. Comparative analysis with countries such as Norway, Canada, and Angola offer valuable lessons for reforming Nigeria's energy security framework.

Nigeria's dependence on imports and underperforming refineries undermines stability. To address this, Nigeria must prioritize refinery turnaround and encourage modular and private refineries to stabilize domestic production. Norway's emphasis on system adequacy and grid expansion further illustrates the importance of infrastructure planning.

Strengthening infrastructure resilience is equally vital. Norway and Canada adopt strategic planning and cross-agency coordination to secure pipelines and generation assets against shocks. Nigeria can adapt these models to protect its energy infrastructure from vandalism and insecurity. Norway and Canada demonstrate how robust

institutions, transparent frameworks and predictable policy attract investment and support resilience. Strengthening regulatory capacity and transparency is a high-leverage intervention for Nigeria and Angola.

Affordability remains a pressing issue in Nigeria, particularly following subsidy removal. Canada's expansion of renewables demonstrates how diversification can dampen global fuel price swings and stabilize household bills during crises. Transparent pricing and targeted support, guided by independent oversight, are essential to protect vulnerable populations. Affordability and public acceptance are critical; targeted social protections and phased subsidy reforms are necessary to avoid social backlash while encouraging efficient use.

Energy efficiency is a neglected dimension in Nigeria's energy security. Canada's federal programmes scale building retrofits, industrial efficiency, and grid loss reduction, offering a blueprint for Nigeria. Data and digitalization, through metering, monitoring, and performance baselines are critical to reducing technical and commercial losses. Canada's measurement frameworks highlight the importance of evidence-based efficiency policies [42].

Nigeria's reliance on fossil fuels has significant environmental consequences. Expanding utility-scale solar, wind, and distributed systems, as seen in Norway and Canada, can reduce carbon intensity and price volatility. Norway's trajectory in carbon capture and storage (CCS) and methane abatement provides further lessons for Nigeria in balancing availability with sustainability. Norway shows that even countries with abundant low-carbon electricity must plan for rapid demand growth (electrification of industry and transport) to avoid future deficits. Similar foresight is necessary for Canada.

Norway and Canada demonstrate how robust institutions, transparent frameworks and predictable policy attract investment and support resilience. Governance underpins all dimensions of energy security. Norway's recommendations for institutional coherence and the Canada's dedicated energy security governance demonstrate the importance of coordination across energy, environment, finance, and security. Nigeria must establish similar structures to ensure accountability.

Regulatory capacity and local content enforcement are also crucial. Angola's reform experience shows how regulatory strengthening can improve outcomes, while Nigeria's own legal analyses highlight the need to translate statutes into effective practice.



Nigeria's energy security challenges require a holistic response. Lessons from Norway, Canada, and Angola demonstrate that availability, affordability, efficiency, sustainability, and governance are interdependent. By diversifying supply, stabilizing affordability, investing in efficiency, accelerating renewables, and strengthening governance, Nigeria can transform its energy sector from a source of vulnerability into a driver of resilience and prosperity.

VI. CONCLUSION

Energy security outcomes are determined by the interplay of natural endowments, institutional quality, infrastructure, and strategic choices. The comparative analysis reveals that energy security frameworks are deeply intertwined with environmental sustainability and governance capacity. Canada and Norway demonstrate resilience through diversified energy mixes, efficiency standards, and strong institutions. Norway and Canada illustrate how governance and forward planning can convert resources and technology into high levels of security and transition readiness. By contrast, Nigeria and Angola show that resource wealth alone cannot substitute for robust institutions, investment in infrastructure, and measures to prevent resource losses. For resource-rich developing countries, a pragmatic portfolio of governance reforms, targeted infrastructure investments, and international partnerships offer the fastest path toward improved energy security while managing the energy transition. Nigeria's energy security challenges require a holistic approach. By diversifying energy sources, reforming subsidies, enforcing efficiency standards, investing in renewables, and strengthening governance, Nigeria can emulate best practices from Norway, Canada and Angola while tailoring them to its unique context.

Furthermore, energy security in Nigeria is at a crossroad, shaped by a legacy of systemic challenges and the promise of new opportunities. The persistence of poor governance, price instability, weak institutions, pipeline vandalisation, disputes over oil ownership, environmental degradation, inadequate compensation mechanisms, subsidy removal, climate change pressures, insecurity, and entrenched corruption has created a fragile energy landscape. These issues have not only undermined the reliability of energy supply but also eroded public trust and discouraged investment. Without deliberate reforms, Nigeria risks perpetuating

cycles of instability that compromise both economic growth and social welfare.

In conclusion, Nigeria's energy security will depend on its ability to replicate long-term structural reforms applicable in Norway, Canada and Angola. By combining diversification of energy mix, governance accountability, technological innovation, community inclusion, and sustainability, Nigeria can transform its energy sector from a source of vulnerability into a driver of resilience and prosperity. The challenge is formidable, but with coherent policies and political will, the prospects for a secure and sustainable energy future remain within reach.

VII. RECOMMENDATIONS

To achieve sustainable energy security, Nigeria must adopt a multi-pronged policy approach such as:

1. Strengthen Legal and Institutional Frameworks: Needs harmonization of overlapping laws (Petroleum Act, Petroleum Industry Act and other energy governance statutes) and stronger enforcement to reduce corruption and inefficiency. Nigeria should consolidate and modernize its energy laws, drawing on Norway's integrated legal model and Canada's sustainability-linked frameworks.

2. Diversify Energy Sources and Reduce Fossil Dependence: Over-reliance on oil and gas, vulnerable to militancy and price shocks. Nigeria should accelerate renewable adoption (solar, wind, biofuels), learning from Norway's hydropower dominance and Canada's renewables push.

3. Enhance Energy Efficiency and Demand Management: To address high transmission losses, inefficient grid, weak demand-side policies, Nigeria should adopt efficiency schemes like Norway's Enova and Canada's affordability programs to reduce waste and improve access.

4. Improve Energy Security through Diversification of Supply Chains: Oil theft, pipeline sabotage, and import dependence for refined products undermine security. Nigeria should diversify supply chains, invest in refining capacity, and adopt Norway-style resilience planning. It should also improve monitoring of pipelines and assets by leveraging drones, sensors, and Artificial intelligence (AI) for real-time surveillance of energy infrastructure.

5. Invest in Technology and Innovation: Innovation drives breakthroughs in science, technology, and industry. Nigeria has limited research and development policy. Engineers and technicians should be trained in energy-efficient



technologies to improve implementation. It should engage in systematic investigation to discover new knowledge, ideas, or technologies and apply the knowledge to create new products, processes, or services, or to improve existing ones. Nigeria should prioritize research and development in clean energy technologies, leveraging Canada's innovation pathways and Norway's CCS expertise.

6. Address Socio-Political Risks and Governance

Challenges: Militancy in Niger Delta, corruption, and insecurity undermine energy security. Hence, Nigeria should address root causes of insecurity and enhance collaboration between security agencies and host communities. Nigeria must strengthen transparency (NEITI audits), address militancy, and adopt Norway's transparent governance model to stabilize its energy sector.

7. Regional and International Cooperation:

Nigeria needs stronger regional cooperation (Economic Community of West African States, African Union) and alignment with global climate goals. Nigeria should deepen regional energy integration (West African Power Pool) and align with international climate frameworks, learning from Norway's EU solidarity and Canada's global renewable leadership.

Nigeria's energy security requires a multi-pronged, long-term strategy that balances governance reforms, infrastructure resilience, community inclusion, diversification, and sustainability. By implementing these recommendations, Nigeria can transform its energy sector from a source of vulnerability into a foundation for national stability, economic growth, and global competitiveness.

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