

Geopolitical Fault Lines and Energy Vulnerability: A Multidimensional Framework for Assessing Energy Security in an Era of Strategic Competition

Yachika

Research Scholar, Department of Social Science(Political Science), Faculty of Humanities and Liberal Education, Baba Mastnath University, Rohtak, Haryana, India

Abstract

Energy security has emerged as one of the most contested arenas of contemporary international relations, shaped increasingly by the interplay of geopolitical rivalries, regional conflicts, and shifting power configurations. This paper develops a Geopolitical–Energy Vulnerability Framework (GEVF) to systematically analyse how geopolitical dynamics translate into measurable vulnerabilities within national and regional energy systems. Drawing on political science theory, international relations literature, and empirical evidence from three major case studies—the Russia–Ukraine conflict and European energy disruption, the strategic energy competition in the Indo-Pacific, and the Gulf Cooperation Council's evolving security architecture—the paper argues that energy insecurity is not merely a technical or market-driven phenomenon but a deeply political one, structured by alliance configurations, resource nationalism, sanctions regimes, and infrastructure warfare. The GEVF integrates four analytical dimensions: supply-chain geopoliticisation, infrastructural vulnerability, alliance-based energy diplomacy, and transition-related risk redistribution. The findings reveal that states with high geopolitical exposure and limited energy diversification face compounded vulnerabilities, while multilateral energy governance mechanisms remain structurally insufficient to absorb geopolitical shocks. The paper concludes with policy prescriptions for building geopolitically resilient energy architectures in an era of strategic competition.

Keywords: energy security, geopolitics, energy vulnerability, GEVF, Russia–Ukraine conflict, Indo-Pacific, energy transition, strategic competition

1. INTRODUCTION

The securitisation of energy has occupied a central position in the architecture of statecraft since the oil crises of the 1970s, yet the twenty-first century has introduced qualitatively new dimensions to this longstanding preoccupation. The fracturing of the post-Cold War liberal international order, the resurgence of great-power rivalry among the United States, China, and Russia, and the accelerating global energy transition have collectively redefined the parameters within which states pursue energy security. Energy is no longer merely an economic input; it has become an instrument of coercive diplomacy, a theatre of strategic competition, and a determinant of geopolitical alignment.

Conventional frameworks for understanding energy security have historically been organised around the 'four As': availability, accessibility, affordability, and acceptability (Sovacool & Mukherjee, 2011). While useful, these frameworks have often treated geopolitical variables as exogenous shocks rather than endogenous structural forces. This paper contends that such an approach is inadequate in the current international environment, where geopolitical dynamics do not merely disrupt energy systems but constitute them. The weaponisation of energy trade—most dramatically illustrated by Russia's manipulation of natural gas flows to Europe prior to and during its 2022 invasion of Ukraine—demonstrates that energy vulnerability is fundamentally a function of political relations, not simply resource endowments or market structures.

This paper makes three principal contributions to the existing literature. First, it proposes the Geopolitical–Energy Vulnerability Framework (GEVF), which provides an integrative analytical lens for assessing how geopolitical configurations generate specific and measurable forms of energy insecurity. Second, it applies this framework to three empirically rich case studies, enabling comparative analysis across different regional contexts and geopolitical configurations. Third, it engages normatively with the policy implications of geopolitically structured energy vulnerability, arguing that durable energy security requires political solutions as much as technical or market-based ones.

The paper proceeds as follows. Section 2 situates the study within the broader theoretical literature on energy security and geopolitics. Section 3 introduces and elaborates the GEVF. Sections 4 through 6 present the case studies. Section 7 synthesises comparative findings, and Section 8 offers conclusions and policy recommendations.

2. LITERATURE REVIEW: GEOPOLITICS, ENERGY, AND SECURITY

2.1 Classical and Contemporary Theories of Energy Security

The academic literature on energy security spans multiple disciplines, including economics, environmental studies, strategic studies, and international relations. Chester (2010) identifies over forty definitions of energy security in the scholarly literature, reflecting the conceptual plurality of the field. The dominant economic tradition emphasises supply continuity, price stability, and infrastructure adequacy, while the security studies tradition foregrounds state vulnerability, dependence, and the politicisation of supply chains.

Yergin's (1988) foundational account of oil as the lifeblood of modern industrial civilisation established the template for subsequent energy security scholarship, centring the narrative on resource control and great-power competition. The post-Cold War period saw a shift toward market liberalisation as a security strategy, with multilateral institutions such as the International Energy Agency (IEA) promoting diversification, strategic reserves, and demand-side management (Goldthau & Witte, 2009). However, the events of the 2000s—particularly the Russia–Ukraine gas disputes of 2006 and 2009, China's resource diplomacy in Africa and Central Asia, and the United States' pursuit of energy independence through unconventional hydrocarbons—reinvigorated geopolitical framings of energy security.

2.2 The Geopolitical Turn in Energy Studies

A growing body of literature has theorised the intersection of energy and geopolitics more rigorously. Klare (2008) argued that a new era of resource wars was emerging, driven by competition over diminishing fossil fuel reserves. Correlje and van der Linde (2006) developed a typology of energy policy paradigms, distinguishing between market-oriented, geopolitical, and regulatory approaches. More recently, scholars have drawn on complex interdependence theory (Keohane & Nye, 1977) to examine how asymmetric energy dependencies create leverage and vulnerability in bilateral and multilateral relations (Natorski & Herranz-Surralles, 2008).

The concept of 'energy statecraft'—the deliberate use of energy resources and supply relationships as instruments of foreign policy—has gained particular traction following Russia's use of gas exports as coercive leverage against European states (Orenstein & Romer,

2015; Stegen, 2011). Analogous dynamics have been observed in China's use of energy investment and infrastructure financing as tools of diplomatic influence through the Belt and Road Initiative (BRI), raising questions about debt dependency and strategic leverage in recipient states (Ye, 2020).

2.3 Gaps in the Existing Literature

Despite significant advances, the existing literature exhibits several important gaps. First, most frameworks treat geopolitical risk as a discrete variable rather than a structural condition that continuously shapes energy system design, investment decisions, and governance architectures. Second, comparative analyses across regions remain underdeveloped, limiting the generalisability of findings. Third, the literature has been slow to integrate the energy transition as a geopolitical variable in its own right, despite growing evidence that the shift toward renewables is generating new forms of resource dependence and strategic competition over critical minerals (Overland, 2019; Scholten et al., 2020). The GEVF developed in this paper is designed to address these gaps.

3. THE GEOPOLITICAL–ENERGY VULNERABILITY FRAMEWORK (GEVF)

3.1 Conceptual Foundations

The GEVF is grounded in the premise that energy vulnerability is not a fixed property of states but a relational and dynamic condition produced by the intersection of geopolitical structure and energy system characteristics. Borrowing from vulnerability theory in political ecology (Adger, 2006) and from the neorealist tradition's emphasis on structural constraints (Waltz, 1979), the GEVF conceptualises energy vulnerability as a function of exposure, sensitivity, and adaptive capacity—but refracted through explicitly geopolitical variables.

Exposure refers to the degree to which a state's energy supply chains, infrastructure, or pricing mechanisms are embedded in geopolitically contested or unstable relationships. Sensitivity refers to the extent to which a given level of geopolitical disruption translates into tangible energy insecurity. Adaptive capacity refers to a state's ability to absorb or restructure in response to geopolitically driven energy shocks, encompassing both material resources

(diversification infrastructure, storage capacity, alternative supply agreements) and institutional resources (diplomatic flexibility, alliance membership, regulatory agility).

3.2 Four Analytical Dimensions

The GEVF organises its analysis along four dimensions. The first, supply-chain geopoliticisation, examines the extent to which energy supply chains pass through or are controlled by geopolitical rivals or unstable transit states. Indicators include the number of supplier countries, the political stability of transit routes, the degree of bilateral versus multilateral supply arrangements, and the presence of explicit energy coercion in interstate relations.

The second dimension, infrastructural vulnerability, addresses the physical and cyber-security dimensions of energy infrastructure. Critical pipelines, LNG terminals, power grids, and digital control systems represent strategic assets that are increasingly targeted in contexts of geopolitical conflict. The 2022 sabotage of the Nord Stream pipelines exemplifies the extent to which energy infrastructure has become a theatre of hybrid warfare (Giles, 2022).

The third dimension, alliance-based energy diplomacy, analyses how membership in formal and informal alliances mediates energy vulnerability. Alliance structures can both mitigate vulnerability—through collective purchasing, coordinated stockpiling, and mutual energy assistance—and create it, by drawing states into the energy rivalries of their allies or restricting their commercial relationships with third parties through sanctions regimes.

The fourth dimension, transition-related risk redistribution, examines how the ongoing global energy transition reshapes geopolitical energy vulnerability. While the transition promises eventual decarbonisation, it simultaneously creates new dependencies on critical minerals—lithium, cobalt, rare earth elements—whose geographic concentration and extraction are governed by a distinct set of geopolitical dynamics (Hund et al., 2020). States may reduce fossil fuel dependencies only to acquire new ones in the clean energy supply chain.

3.3 Framework Application

The GEVF is applied analytically rather than quantitatively in this paper, given the inherent difficulties of operationalising geopolitical variables. Each case study is assessed along the four dimensions, and cross-case comparison enables the identification of patterns in

how geopolitical configurations produce or mitigate energy vulnerability. The framework is intended as a heuristic tool for policymakers and scholars, adaptable to specific national or regional contexts.

4. CASE STUDY I: RUSSIA–UKRAINE AND EUROPEAN ENERGY SECURITY

4.1 Background and Geopolitical Context

Europe's energy relationship with Russia developed over decades as a commercially rational arrangement that gradually became a geopolitical liability. By 2021, Russia supplied approximately 40 percent of the European Union's natural gas imports, with even higher dependency ratios in Central and Eastern European states (European Commission, 2022). This dependency was embedded in a broader set of political relationships characterised by selective engagement, economic interdependence, and strategic ambiguity about Russia's long-term intentions in the European security order.

Russia's full-scale invasion of Ukraine in February 2022 shattered these assumptions and precipitated the most severe energy security crisis in Europe since the 1970s. Russia's weaponisation of gas supply—through the incremental reduction and eventual halt of flows through Nord Stream 1—demonstrated in stark terms the strategic risks of high geopolitical exposure combined with limited diversification. The European Union's rapid improvisation of alternative supply arrangements, including accelerated LNG imports from the United States and Norway, emergency demand reduction measures, and expedited investment in renewable energy capacity, illustrated both the costs of strategic vulnerability and the conditions under which adaptive capacity can be mobilised.

4.2 GEVF Analysis

Assessed through the GEVF lens, Europe's pre-2022 energy posture exhibited high exposure along the supply-chain geopoliticisation dimension, with critical dependencies concentrated in a state that was increasingly adversarial in its strategic orientation. Sensitivity was also high, given the limited short-term substitutability of pipeline gas and the region's limited LNG import infrastructure prior to 2022. Adaptive capacity, while substantial in

aggregate EU terms, was unevenly distributed, with Eastern European states facing greater adjustment costs.

The infrastructural vulnerability dimension was dramatically illustrated by the Nord Stream sabotage in September 2022, which rendered approximately 55 billion cubic metres of annual capacity inoperative and underscored the fragility of seabed infrastructure to hybrid warfare (Giles, 2022). The alliance-based energy diplomacy dimension was activated through EU solidarity mechanisms, emergency gas storage obligations, and the rapid deepening of energy cooperation with the United States and Gulf states. Importantly, the crisis also accelerated EU investment in transition-related clean energy, partially shifting risk from the geopoliticisation of fossil fuel supply chains toward the long-term challenge of critical mineral dependencies.

5. CASE STUDY II: STRATEGIC ENERGY COMPETITION IN THE INDO-PACIFIC

5.1 Background and Geopolitical Context

The Indo-Pacific has emerged as the primary theatre of great-power competition in the twenty-first century, with energy security playing a central role in the region's strategic dynamics. The region encompasses some of the world's largest energy producers—Australia, Indonesia, and the Gulf states whose exports transit the Indian Ocean—as well as the world's largest energy importers, including China, Japan, India, and South Korea. The contested nature of the South China Sea, through which approximately one-third of global trade and a significant share of regional energy supplies transit, exemplifies the intersection of territorial disputes and energy security (Buszynski, 2012).

China's strategic behaviour has been particularly consequential for Indo-Pacific energy security. Beijing's assertion of sovereignty over the South China Sea, its development of dual-use maritime infrastructure, and its use of energy investment through the BRI as a mechanism for establishing strategic influence have collectively reshaped the energy security calculus of regional states. Simultaneously, the United States has pursued an active strategy of ensuring freedom of navigation and supply chain security, manifested in enhanced security partnerships, the AUKUS arrangement, and the Quad's emerging energy cooperation frameworks.

5.2 GEVF Analysis

The Indo-Pacific case illustrates a pattern of geopolitical energy vulnerability that differs structurally from the European case. Rather than a single dominant supplier relationship, regional energy vulnerability is shaped by competitive great-power dynamics and contested maritime geography. Japan and South Korea, as resource-poor states highly dependent on imported hydrocarbons transiting potentially contested sea-lanes, face high exposure along both the supply-chain geopoliticisation and infrastructural vulnerability dimensions of the GEVF.

India's energy security posture is particularly complex. As a large emerging economy with significant domestic coal reserves, growing renewable capacity, and diversified import sources, India exhibits moderate supply-chain exposure but high sensitivity given the scale of its import dependency. India's historically non-aligned posture has provided diplomatic flexibility—the alliance-based energy diplomacy dimension of the GEVF—allowing it to maintain energy trade relationships with Russia despite Western sanctions, while simultaneously deepening clean energy partnerships with the United States, Japan, and the EU through initiatives such as the Just Energy Transition Partnership (JETP).

The transition-related risk dimension is acutely salient in the Indo-Pacific, as China's dominance of global clean energy supply chains—controlling approximately 80 percent of solar panel manufacturing and significant shares of battery and critical mineral processing—creates a new form of energy dependency for states pursuing rapid decarbonisation (IEA, 2023). This structural feature of the clean energy transition risks replicating, in modified form, the geopolitical dependencies that characterised the fossil fuel era.

6. CASE STUDY III: ENERGY SECURITY IN THE GULF COOPERATION COUNCIL ARCHITECTURE

6.1 Background and Geopolitical Context

The Gulf Cooperation Council (GCC) states occupy a paradoxical position in the global energy security architecture: as the world's largest concentration of conventional hydrocarbon reserves, they are simultaneously a source of global energy security and a region whose own political stability is a precondition for that security. The GCC's energy security dynamics are

shaped by the regional rivalry between Saudi Arabia and Iran, the evolving security relationship with the United States, the growing engagement of China and India as energy partners, and the internal pressures of economic diversification and youth unemployment (Seznec, 2019).

The 2019 attacks on Saudi Aramco's Abqaiq and Khurais processing facilities—attributed to Iran and Houthi forces in Yemen—demonstrated the catastrophic potential of infrastructure targeting in a region where a small number of facilities handle an extraordinarily large share of global oil processing capacity. The attacks temporarily removed approximately five percent of global oil supply from the market, triggering immediate price spikes and exposing the fragility of the global energy system's reliance on concentrated critical infrastructure (Saul & Rashad, 2019).

6.2 GEVF Analysis

The GCC case illustrates the GEVF's utility in analysing energy security from the perspective of producing states as well as consuming ones. The region's supply-chain geopoliticisation dimension is shaped by the politicisation of oil as an instrument of foreign policy—most historically evidenced by the 1973 embargo—and by the contemporary tensions between maintaining market share in a transitioning global energy system and using production policy to advance geopolitical objectives. Saudi Arabia's periodic use of OPEC+ production agreements as a mechanism for managing both market conditions and relationships with major consuming states exemplifies this dynamic.

The infrastructural vulnerability dimension is particularly acute given the geographic concentration of the region's critical facilities and the persistent threat environment characterised by Iranian-backed proxy actors, drone technology proliferation, and the contested airspace over Yemen. Alliance-based energy diplomacy has historically centred on the US security umbrella, but the GCC states are increasingly pursuing a diversification of security partnerships that mirrors their broader diplomatic hedging strategies, including deepening defence cooperation with China and India (Gause, 2023).

The transition-related risk dimension presents an existential challenge for the GCC states, whose fiscal models remain heavily dependent on hydrocarbon revenues. Investment in sovereign wealth funds, economic diversification programmes such as Saudi Vision 2030, and

early-mover positioning in hydrogen and renewable energy export markets represent adaptive capacity responses to the structural vulnerability created by global decarbonisation trajectories.

7. COMPARATIVE ANALYSIS AND THEORETICAL IMPLICATIONS

7.1 Cross-Case Patterns

Comparing the three case studies through the GEVF reveals several significant cross-cutting patterns. First, in all three cases, geopolitical vulnerability is concentrated and unevenly distributed: within the EU, Eastern European states bear disproportionate exposure; within the Indo-Pacific, small resource-poor states face the greatest supply-chain geopoliticisation; within the Gulf, the proximity to Iranian-backed threats creates asymmetric infrastructural vulnerability across GCC members. This concentration effect suggests that aggregate regional assessments of energy security can mask critical vulnerabilities at the sub-regional or national level.

Second, all three cases demonstrate that adaptive capacity is heavily conditioned by political institutions and alliance structures. States embedded in dense multilateral frameworks—as EU members were through crisis-era solidarity mechanisms—mobilised adaptive resources more effectively than those relying on bilateral relationships or unilateral adjustment. This finding supports the theoretical claim that energy security governance is irreducibly political and cannot be reduced to market mechanisms or technical fixes.

Third, the energy transition emerges as a double-edged variable across all three cases. While it promises long-term reduction in fossil fuel dependencies, it simultaneously creates new geopolitical exposures centred on critical mineral supply chains and clean energy technology concentration. The GEVF's transition-related risk dimension captures this dynamic, but the full implications remain underanalysed in both the academic literature and policy discourse.

7.2 Implications for Theory

The GEVF contributes to theoretical debates in international relations and political science in several ways. Against liberal institutionalist expectations that interdependence generates cooperative incentives sufficient to dampen geopolitical competition, the European

case demonstrates that even dense economic interdependence in energy can be weaponised under conditions of strategic rivalry. Against structural realist expectations that energy competition is a zero-sum struggle for resource control, the Indo-Pacific case reveals that alliance structures and diplomatic flexibility can create sufficient adaptive capacity to resist coercive energy pressure.

The framework also speaks to the emerging literature on 'weaponised interdependence' (Farrell & Newman, 2019), which argues that states with structural positions in global networks—as hub nodes in supply chains, financial systems, or digital infrastructures—can leverage their nodal position to coerce others. Russia's position as a hub in European gas networks, China's position as a hub in clean energy supply chains, and the GCC's position as a hub in global oil markets all exemplify this dynamic in the energy domain. The GEVF provides an analytical architecture for systematically identifying and assessing such hub-dependent vulnerabilities.

8. POLICY IMPLICATIONS AND RECOMMENDATIONS

The findings of this paper carry significant implications for energy security governance at both the national and multilateral levels. Several concrete policy recommendations emerge from the analysis.

First, states and regional organisations must institutionalise geopolitical risk assessment within energy planning processes. The EU's experience demonstrates the costs of allowing commercial logic to dominate energy import decisions without adequate attention to political risk. Systematic application of a framework analogous to the GEVF within national energy ministries and regional bodies would enable more proactive identification of vulnerability concentrations.

Second, diversification strategies must be designed with geopolitical topology in mind, not merely market geography. The imperative is not simply to increase the number of suppliers but to ensure that diversification actually reduces geopolitical exposure by incorporating suppliers whose strategic orientations are stable or aligned. This requires integrating foreign policy and energy policy in a manner that many states have historically resisted.

Third, the governance of energy transition supply chains must be treated as a geopolitical priority equivalent to fossil fuel security. Multilateral initiatives to develop alternative critical mineral supply chains, reduce clean energy technology concentration, and create shared strategic reserves of transition materials are urgently needed. The current trajectory risks trading one form of geopolitical energy dependency for another, with the additional concern that clean energy dependencies may be even more concentrated than fossil fuel ones.

Fourth, energy infrastructure protection must be elevated within national security frameworks and international law. The Nord Stream sabotage and the Abqaiq attacks demonstrated that energy infrastructure is a legitimate target in contemporary conflict and coercion. Strengthening both physical and cyber defences, developing clearer norms of international law governing infrastructure attacks, and building allied deterrence capacity in this domain are essential components of a geopolitically resilient energy architecture.

Fifth, multilateral energy governance institutions must be reformed to incorporate geopolitical variables more effectively. The IEA's mechanisms were designed for a world of market-based energy trade and Western-aligned consumer states; they are structurally ill-equipped to manage the energy security challenges of a multipolar world with adversarial great powers and rapidly evolving transition dynamics. Expanded membership, enhanced data transparency, and new mechanisms for coordinated response to geopolitically motivated supply disruptions are needed.

9. CONCLUSION

This paper has argued that energy security in the contemporary international system cannot be adequately understood or managed without a framework that places geopolitical dynamics at its analytical centre. The Geopolitical–Energy Vulnerability Framework proposed here provides a structured approach to assessing how geopolitical configurations—through the dimensions of supply-chain geopoliticisation, infrastructural vulnerability, alliance-based energy diplomacy, and transition-related risk redistribution—generate specific and differentiated forms of energy insecurity.

The three case studies examined—the Russia–Ukraine conflict and European energy crisis, strategic energy competition in the Indo-Pacific, and the Gulf Cooperation Council's security architecture—collectively demonstrate that energy vulnerability is a relational and political phenomenon, shaped by the structure of international relations as much as by resource endowments or market conditions. States with high geopolitical exposure, limited diversification, and weak adaptive capacity face compounded and potentially catastrophic energy insecurity. Conversely, states embedded in robust multilateral frameworks with institutionalised solidarity mechanisms exhibit greater resilience in the face of geopolitical shocks.

The energy transition, often framed as a pathway to energy security through the substitution of domestically harvested renewable energy for imported fossil fuels, emerges from this analysis as a geopolitically ambiguous process. While it reduces fossil fuel dependencies over time, it simultaneously creates new geopolitical exposures in critical mineral supply chains and clean energy technology systems whose governance remains inadequate. Managing this transition-related risk redistribution is among the most pressing challenges facing both energy security scholars and policymakers.

Future research should work toward the quantitative operationalisation of the GEVF, enabling cross-national statistical analysis of the relationship between geopolitical exposure and energy vulnerability outcomes. Comparative studies extending the framework to sub-Saharan Africa, Latin America, and South Asia would further test its generalisability and refine its theoretical foundations. The intersection of energy security, geopolitics, and domestic political economy—including the role of energy interests in shaping foreign policy preferences—also warrants deeper investigation. In an era of intensifying strategic competition and accelerating energy transformation, the analytical and policy stakes of getting energy security governance right have rarely been higher.

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