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NAVIGATING ENERGY SECURITY AMID AN EVOLVING RISK LANDSCAPE

A Discussion Paper

Prepared as part of the Thai-German Energy Dialogue (TGED) on behalf of the German Federal Ministry for Economic Affairs and Energy (BMWE)

Agora Energiewende

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Imprint
The discussion paper, *Navigating Energy Security Amid an Evolving Risk Landscape*, presents a structured foundation to help stakeholders navigate today's complex energy security landscape and guide them towards practical, context-specific strategies for managing interconnected risks and advancing more resilient, forward-looking energy systems. It is published by GIZ under the framework of the Thai-German Energy Dialogue (TGED) on behalf of the Federal Ministry for Economic Affairs and Energy (BMWE) and the Ministry of Energy of Thailand (MoEN). The TGED promotes collaboration across a range of energy-related fields to help accelerate the energy transition in both countries.

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1 Introduction

Energy security has once again emerged as a central concern for governments, markets and societies worldwide. The ongoing United States-Israel-Iran war has triggered one of the most severe disruptions in modern energy market history. The de facto closure of the Strait of Hormuz has placed a significant share of global oil and LNG flows at risk, effectively stranding large volumes of Gulf exports. In addition, damage inflicted on critical energy infrastructure across the region has turned what might have been a temporary disruption into a deeper structural supply shock. For many countries, particularly fossil fuel importers, the crisis has reverberated across multiple dimensions, disrupting physical supply chains, driving price volatility, straining fiscal positions, and amplifying social and political pressures. Against a backdrop of heightened geopolitical risks, these developments are prompting countries to re-evaluate the foundations of their energy security strategies.

At the same time, the global energy system is undergoing profound transformation. As clean electricity becomes the central pillar of the modern energy system, the transition towards low-carbon energy, increasing electrification, and the growing integration of digital technologies are reshaping how energy is produced, delivered, and consumed. While these changes create new opportunities to enhance system flexibility and reduce exposure to traditional risks, they are also introducing new dependencies and sources of vulnerability that are not fully captured by conventional approaches to energy security. As a result, energy security is increasingly being shaped by a broader set of interrelated forces that extend beyond fuel supply alone. Understanding how these forces interact—and how they influence the resilience and performance of energy systems—has become central to navigating both immediate disruptions and longer-term structural change.

Given this context, this discussion paper seeks to offer a structured framework to deepen stakeholders' understanding of today's complex energy security landscape and guide their efforts in navigating interconnected risks, exploring strategic interventions, and fostering coordinated, forward-looking dialogue. Specifically, the purpose of this discussion paper is twofold:

- To raise awareness among stakeholders of how energy security is being reshaped in light of shifting global dynamics, and to help frame thinking around interconnected risks and the strategies required to mitigate and adapt to them in an integrated manner; and
- To provide a forward-looking foundation to support more informed dialogue, planning, and decision-making, enabling stakeholders to identify priorities and develop context-specific strategies to strengthen energy security in a proactive manner.

The sections that follow build on this rationale. Section II examines the limitations of conventional energy security paradigms and motivates the need for a broader perspective. Section III introduces a structured view of the evolving energy security risk landscape. Section IV explores how risk profiles differ across countries and evolve over time, particularly in the context of the energy transition. Sections V and VI focus on how these insights can inform practical approaches to strengthening energy security, including the identification and prioritisation of key actions. Section VII concludes with key reflections for policymakers and stakeholders.

2 The Need to Rethink Energy Security

Energy security has long been viewed through a fossil fuel-centric lens that prioritises affordable, uninterrupted access to and control over oil, gas, and coal resources. This framing reflects a reality in which supply disruptions, price volatility, and geopolitical rivalries over hydrocarbons continue to pose significant and immediate risks, particularly for fossil fuel import-dependent economies. The current upheaval in global energy markets stemming from the US-Israel-Iran conflict underscores the profound economic and social consequences that such disruptions can impose, especially on countries with limited capacity to absorb price shocks or secure alternative supplies. At the same time, however, this perspective captures only part of a broader and increasingly complex energy security landscape, as these immediate pressures are unfolding alongside deeper structural changes in how energy systems operate and where vulnerabilities arise.

At the heart of this shift is a transformation in how energy systems are configured and operated. Increasing electrification, the expansion of renewable energy, and the deepening interconnection between energy, digital, and economic systems have introduced new layers of risk alongside traditional concerns about fuel supply. Energy security is now increasingly shaped not only by whether fossil fuels can be affordably procured, but also by how effectively entire systems function—from how generation assets and networks operate to how end-use systems and the supporting digital infrastructure perform.

For example, as digitalisation and artificial intelligence permeate the energy sector, they unlock efficiency and flexibility gains but simultaneously expand exposure to cyber threats and systemic failures. In parallel, the rise of energy-intensive AI-driven data centres is driving a sharp increase in electricity demand, placing significant strain on power grids. Furthermore, climate-related disruptions—from extreme heatwaves and wildfires to flooding—are exerting unprecedented pressure on physical infrastructure, exposing structural gaps in the adaptive capacity of energy networks globally.

These developments show that energy systems are increasingly vulnerable to multiple overlapping stressors. Geopolitical tensions, technological change, economic constraints, and environmental pressures now converge within energy systems in ways that produce compounding and cascading system-wide effects. For instance, a prolonged heatwave may coincide with a period of elevated LNG prices, creating simultaneous pressures that strain ageing grids and tighten budgets. In such conditions, utilities may be forced to prioritise short-term reliability over longer-term investment in renewable assets, inadvertently reinforcing dependence on existing systems, including imported LNG. These interlinkages mean that system-wide vulnerabilities often emerge less from any single pressure than from the ways in which multiple pressures converge and compound, sometimes even reinforcing the very dependencies that helped create the stresses in the first place.

Importantly, recognising the limitations of a fuel-centric perspective does not diminish the urgency of addressing current supply disruptions or their impacts. Rather, it highlights the need to situate these challenges within a broader framework—one that addresses immediate vulnerabilities while also considering how energy systems can be designed to reduce exposure to external shocks over time.

These considerations point to the need for a more comprehensive understanding of energy security that recognises the multidimensional nature of risks and the evolving structure of energy systems. Rather than focusing solely on securing access to fuels, this broader perspective emphasises how energy systems perform under stress, how they respond to disruptions, and how they adapt to long-term structural change. The following section builds on this premise by outlining a structured view of the evolving energy security risk landscape, providing a foundation for more integrated and forward-looking analysis.

3 The Evolving Risk Landscape

To translate this broader perspective into a workable analytical foundation, it is helpful to begin with a clear mapping of today's risk landscape. Systematically distinguishing between categories of risk provides stakeholders with visibility into the underlying contours of energy security, helping to break down complexity into identifiable dimensions. While these categories are not watertight and often overlap, viewing them in structured form offers a foundation for understanding where vulnerabilities lie, how they interact, and where mitigation and adaptation efforts may be most effectively targeted. Gaining a clear understanding of these foundational risk elements is essential for stakeholders to engage effectively in developing integrated, forward-looking solutions. To provide a clear framework for analysis, this section organises these vulnerabilities into seven key risk categories, offering a structured lens through which stakeholders can explore and discuss emerging challenges.

Figure 1: Energy Security Risk Categories

A. Geopolitical and Global Macroeconomic Risks

Energy systems today are highly exposed to geopolitical turbulence, with critical infrastructure and assets not only vulnerable to collateral damage from intensifying military conflicts but also to targeted attacks from agents that seek to disrupt supply, undermine economic stability, or exert strategic leverage. For instance, strikes on major energy assets across the Gulf have become a defining feature of the current US-Israel-Iran conflict, serving as an increasingly potent instrument of geopolitical pressure with implications that could reshape global oil and gas trade flows for years to come. Similarly, Russia's war tactics in Ukraine include efforts to cripple the latter's power stations and grids, rail hubs, and fuel depots, weakening Ukraine's ability to sustain its defence and economy (Atlantic Council, 2025).

Furthermore, energy system assets are increasingly becoming a focal point of hybrid operations that blur the boundary between overt military action and covert, deniable forms of disruption. The 2022 sabotage of the Nord Stream gas pipelines, which is widely understood to have been a deliberate act but not definitively attributed to any state actor, exemplifies this trend, illustrating how strategic energy infrastructure can be

targeted to sow uncertainty and exert pressure without open military engagement (CSIS, 2022). It is also worth noting that disruptions in one region can trigger far-reaching consequences across interconnected markets. For example, interruptions to European pipeline gas flows following the outbreak of the Russia-Ukraine war prompted a European scramble for LNG that priced out several developing economies, especially those in South Asia (Bloomberg, 2022).

Strategic risks linked to dual-use materials and technologies add another dimension to energy security. Materials such as rare earth elements and lithium-ion batteries, which are essential to both clean energy systems and defence capabilities, are vulnerable to deliberate restrictions or control by states seeking strategic advantage (IEA, 2025a). In conflict or crisis situations, governments may prioritise these resources for defence, build strategic stockpiles, restrict access to foreign entities, or even deliberately politicise supply chains to gain geopolitical advantage or extract concessions. These measures can directly constrain civilian and commercial deployment of critical technologies, slowing the energy transition and limiting energy security.

In parallel, economic statecraft and industrial policy measures are increasingly being wielded to steer global energy and raw material markets in politically advantageous directions (Bordoff & O'Sullivan, 2025). Tariffs, export restrictions, sanctions, and local production quotas can constrain supply and reshape trade flows, while subsidies and environmental regulations can redirect investment and production towards politically advantageous objectives. These interventions not only affect the availability and pricing of energy commodities and inputs but also introduce uncertainty that can slow investment and complicate long-term energy planning.

In addition to uncertainties created by government actions and the strategic competition between states, energy and commodity markets are also inherently volatile, with prices and availability shaped by global supply-demand imbalances and short-term shocks. These fluctuations can cascade through energy-importing economies, driving up costs for consumers and industry, reducing competitiveness, straining public finances, and amplifying broader economic pressures, particularly in countries with limited buffers to absorb sudden price shocks. The inherently cyclical nature of these markets adds another layer of unpredictability, often leading to boom-bust investment cycles that disrupt long-term planning, delay infrastructure development, and create systemic fragility in supply chains. These cycles are closely intertwined with broader macroeconomic conditions: recessions, inflationary surges, and broad-based fiscal tightening can both result from and feed back into energy market instability, amplifying price swings, constraining government and corporate investment, and increasing exposure to energy supply disruptions.

B. Resource and Supply Chain System Risks

Energy security is increasingly shaped by systemic vulnerabilities embedded across resource bases and complex, globally integrated supply chains.[1] Modern energy systems rely on tightly coupled networks spanning extraction, processing, manufacturing, and transport, where disruptions at critical nodes—whether physical corridors or industrial hubs—can cascade rapidly across markets.

Logistical constraints and transport route vulnerabilities represent one of the most immediate and visible forms of systemic risk. The de facto closure of the Strait of Hormuz amid the US-Israel-Iran conflict has taken

[1] While closely related, Categories A and B capture distinct but complementary dimensions of energy security risk. Category A focuses on externally driven disruptions, arising from geopolitical dynamics, state actions, and macroeconomic developments that can trigger shocks to energy systems. Category B, by contrast, captures structural vulnerabilities embedded within resource bases and supply chains, which also determine the extent to which energy systems are exposed to and affected by such disruptions. In practice, these risks often interact (for example, geopolitical events may activate or amplify underlying supply chain vulnerabilities) but distinguishing between them helps clarify both the sources of risk and the levers available to manage them.

roughly 20% of globally traded oil and LNG off the market, setting off cascading effects across economies worldwide (Reuters, 2026). This disruption illustrates how dependence on narrow maritime corridors with limited alternative routing capacity can rapidly constrain global supply and amplify price volatility. Similar vulnerabilities exist across other transport networks (e.g., gas pipelines that run through conflict zones) and critical shipping lanes (e.g., Red Sea, Panama Canal), where limited redundancy increases the likelihood that localised disruptions escalate into system-wide shocks.

Supply chain concentration and industrial bottlenecks represent a more structural but equally significant form of vulnerability, driven by the growing clustering of critical nodes in global energy and clean technology supply chains (Rystad Energy, 2025). Across multiple stages of the value chain—from the refining and processing of key materials such as lithium, cobalt, nickel, rare earth elements, and polysilicon to the manufacturing of clean energy technologies including photovoltaic cells, batteries, and wind turbines—capacity is heavily concentrated, with China playing a dominant role. These industrial concentrations are further strained by logistical and transport dependencies, as energy commodities, critical raw materials, and clean technology components move through constrained networks with limited redundancy. Delays, technical failures, or disruptions at any of these nodes can cascade through international supply networks, stalling clean energy project deployment, inflating costs, and limiting the ability of systems to scale in line with demand. Where such structural vulnerabilities intersect with external pressures such as geopolitical competition or policy interventions, the risks and potential impacts are amplified, as illustrated by measures such as Beijing's shutdown of illegal rare earth mines in Jiangxi and Inner Mongolia—a move that, while addressing safety and environmental concerns, also tightens global supply and reinforces China's market dominance (Reuters, 2025).

Domestic resource limitations and import dependence reflect another structural dimension of supply chain risk. Countries with limited indigenous energy resources or capacity to deploy them must rely on external sources for fuels, critical materials, and key components. This reliance is not only a matter of exposure to foreign suppliers, but also of constrained domestic capability to store, substitute, or process inputs when disruptions occur. Limited reserves, inadequate storage infrastructure, and insufficient downstream capacity can reduce the ability of energy systems to absorb shocks, making supply disruptions more persistent and recovery more costly.

Unsustainable resource practices present another key challenge. Current patterns of sourcing, developing, and consuming fuels, bioenergy feedstocks, and critical raw materials often generate significant emissions, environmental degradation, and social impacts that undermine long-term security (WRI, 2025). Resource depletion, ecosystem damage, water stress, and land-use conflicts can progressively constrain future availability, increase production costs, and heighten the likelihood of disruption over time. Mining, bioenergy, and infrastructure projects that fail to account for these factors may proceed more quickly in the short term but often face elevated risks of disruption over time due to regulatory reversals, community opposition, environmental degradation, or resource depletion.

C. Infrastructure, Operational, and System Planning Risks

The reliability of energy systems depends heavily on the condition and performance of underlying infrastructure, with electricity grids representing a core focus due to their centrality in supply, flexibility, and integration of VRE. Ageing and inadequate power grid systems create capacity constraints and reliability risks, while gaps in modernisation leave many networks ill-prepared to meet rising demand or integrate new sources of supply, particularly variable renewable energy (Agora Energiewende, 2025). In some contexts, even basic transmission and distribution reliability remains uncertain, exposing economies to recurrent blackouts and high efficiency losses (IEA, 2023a).

The rapid expansion of energy-intensive digital infrastructure, particularly AI data centres, is emerging as a new source of system stress (IEA, 2025b). These facilities draw large, continuous power loads, which can compound local grid congestion and increase the need for grid upgrades and flexible generation. While data centres typically operate with steady baseline consumption, certain events (e.g., simultaneous server boot-ups, sudden surges in computational workloads) may trigger transient but significant spikes in power demand. If not properly anticipated in grid planning, these fluctuations can pose significant risks to local grid stability, particularly in regions with ageing infrastructure or limited grid flexibility.

Furthermore, as the share of variable renewable energy (VRE) grows, the need for adequate system flexibility, storage capacity, and grid stability measures becomes increasingly critical. Higher penetration of inverter-based VRE generation alters grid stability dynamics (e.g., frequency control and voltage management), which, if not properly managed, can increase the likelihood of disturbances and cascading outages, as seen in the 2025 Iberian blackout (Agora Energiewende, 2025). Power systems that lack sufficient balancing resources such as grid-scale storage, demand response mechanisms, and flexible generation face heightened risks of instability and inefficiency. Without these capabilities, power networks would struggle to accommodate fluctuations in supply, leading to supply-demand mismatches, curtailment of renewable output, and increased reliance on backup fossil generation.

Operational inefficiencies compound these risks. Weaknesses in system dispatch and load management, inadequate maintenance practices, slow responses to imbalances, and suboptimal fuel inventory management can all erode the resilience of energy supply. In many cases, these are systemic challenges that accumulate over time, making disruptions more likely and recovery slower. Furthermore, energy infrastructure remains vulnerable to accidents and failures. Equipment malfunctions, electrical faults, industrial accidents, and human errors can cause sudden interruptions in supply and lasting damage to facilities. In highly integrated networks, such failures are likely to trigger wide cascading effects, with significant implications across regions and industries.

Electricity grids currently face the most immediate infrastructure and operational pressures, but comparable vulnerabilities and emerging challenges are also appearing across other energy transport and delivery networks, including those tied to new carriers like hydrogen. A major factor driving these vulnerabilities across systems is fragmented planning and insufficient coordination across different energy vectors. As energy systems shift towards deeper electrification and the introduction of carriers such as hydrogen, infrastructure planning will become increasingly complex and interdependent. When electricity, gas, and hydrogen networks are developed in isolation based on their own demand forecasts and policy assumptions, significant inefficiencies can arise. In some cases, this can lead to redundant parallel networks that end up underused; in others, it can create critical shortfalls when anticipated synergies between systems do not materialise. Such coordination gaps can lock in suboptimal investment choices, raise system costs, and weaken overall resilience.

D. Technological and Cybersecurity Risks

As energy systems become more digitalised and interconnected, their dependence on advanced technologies introduces new vulnerabilities. Control and communication systems (e.g., SCADA) and power electronics (e.g., inverters) are increasingly exposed to cyberattacks and technical failures (IEA, 2023b). A successful breach can disrupt operations, compromise sensitive data, or even disable critical infrastructure, with impacts extending well beyond the energy sector.

Heavy reliance on foreign technology vendors magnifies these risks. Dependence on a limited set of external suppliers for critical components—from grid controllers to advanced inverters—creates exposure not only to

supply disruptions but also to embedded security weaknesses or shifting geopolitical dynamics. This dependence can limit countries' ability to safeguard their own systems against attacks and constrain options for timely upgrades or repairs.

Another key challenge lies in interoperability gaps across diverse technologies and devices. Fragmentation between energy system components can hinder seamless operations, create inefficiencies, and increase the likelihood of malfunction. These gaps become particularly critical when integrating new technologies from multiple vendors, as inconsistent standards or interfaces can amplify the vulnerabilities already present in core systems.

As energy systems decentralise and become more diffuse, the cybersecurity practices of small and medium-sized enterprises (SMEs) will play an increasingly critical role in overall system integrity. Many SMEs operate essential distributed energy resources, yet often they lack the resources or expertise to implement robust cyber protections (Tetteh, 2024). Weaknesses at these nodes can propagate across the network, creating vulnerabilities that affect the broader energy system.

Emerging technologies also bring their own uncertainties. The integration of artificial intelligence and automation into grid management and energy markets promises efficiency, but it also creates risks of algorithmic failures, misaligned decision-making, or overreliance on systems that may not perform reliably under stress.

E. Governance, Political, and Social Risks

Energy security depends not only on resources and infrastructure, but also on the quality of governance and the political and social conditions under which decisions are made. Weak governance, fragmented policymaking, entrenched interests, and limited institutional capacity can collectively undermine a country's ability to design and implement enabling energy policies that unlock and de-risk investments in renewable energy and other critical energy infrastructure.

Fragmented policymaking and insufficient alignment among institutions responsible for energy planning, regulation, and implementation can leave countries ill-prepared to address interconnected risks or to implement long-term strategies. Coordination challenges may occur across ministries, between regulators and system operators, or across agencies responsible for investment oversight and project delivery. In certain countries, these challenges are amplified by political instability and leadership turnover, which further weaken policy credibility and continuity of energy strategies and make it difficult to mobilise coherent, system-wide responses to energy security challenges. Beyond these systemic governance weaknesses, entrenched interests and policy capture (e.g., lobbying from fossil fuel incumbents) can also slow decarbonisation efforts and, in effect, lock systems into legacy pathways that may no longer serve long-term security.

Institutional and workforce capacity gaps represent another governance-linked challenge. Limited technical expertise in energy planning and regulation and inadequate training programmes constrain the ability of energy systems to scale and manage modern technologies. These human capital gaps are particularly acute in remote regions where much of the new investment in critical raw materials and metals for the energy transition is taking place, making it difficult to attract and retain qualified personnel (OECD, 2025). More broadly, at the national level, insufficient numbers of trained professionals across the rare earth supply chain outside of China are creating strategic vulnerabilities (Discovery Alert, 2025). These human capital gaps are also social risks by nature. If workers and communities feel excluded from the opportunities created by the energy transition, resistance to change is more likely. Public pushback, whether driven by concerns over

affordability, fairness, or job security, can delay or derail projects that are otherwise essential for enhancing energy security.

These governance weaknesses ultimately manifest as regulatory, policy, and implementation bottlenecks that slow project delivery and complicate investment decisions. Delayed permitting approvals, PPA terms that limit bankability, unclear tender timelines, and inconsistently applied procurement criteria for renewable energy projects show how these weaknesses become concrete barriers to the energy transition. Taken together, these bottlenecks increase uncertainty, deter investment, and erode market confidence, even where high-level policy commitments exist.

Importantly, governance, political, and social risks are highly cross-cutting. They shape and intensify nearly every other dimension of the energy security landscape, from infrastructure investment to climate adaptation. Without durable political will, transparent institutions, and broad-based societal support, even the most well-designed technical or financial solutions will struggle to take root and deliver results.

F. Climate and Environmental Risks

Climate change and environmental pressures present mounting risks to energy security, not as distant threats but as immediate stressors already reshaping systems worldwide. Extreme weather events such as storms, floods, heatwaves, and droughts have disrupted electricity grids, damaged pipelines, and constrained generation capacity (IEA, 2022). For coastal facilities (e.g., oil ports and LNG terminals), sea level rise and storm surges create persistent exposure to flooding and erosion, raising the cost of maintenance and protection. Furthermore, climate change and extreme weather increase repair times for major components of energy infrastructure, particularly undersea pipelines and subsea cables. Some of these challenges are mitigated by advances in sensing technologies and robotic repair systems such as pipeline inspection gauges (PIGS), but bottlenecks remain due to limited availability of specialised repair vessels, a sector constrained by historical underinvestment and rising demand (Briaud & McLean, 2025).

Water scarcity further complicates the picture. Hydropower output is directly affected by shifting rainfall patterns and sedimentation, while thermal power plants face cooling constraints during droughts (Cronin, Anandarajah, & Dessens, 2018). These water-energy tensions often exacerbate competition across sectors, particularly in regions already experiencing scarcity or cross-border water disputes. Land-use pressures add another layer of complexity as renewable projects, transmission corridors, and bioenergy production must increasingly contend with competing agricultural, urban, and conservation needs.

In addition, ecosystem degradation and longer-term shifts in climate patterns add systemic risks. For example, air pollution reduces the efficiency of solar panels, deforestation alters wind flows, and degraded soils reduce biomass productivity (Li, Mauzerall, & Bergin, 2020; Wohland, et al., 2024). These environmental stresses compound uncertainty in renewable energy output and complicate long-term system planning.

Crucially, these climate and environmental risks directly intersect with governance, financial, and infrastructure challenges: a government's ability to enforce land-use policies, a utility's capacity to finance climate-proofing measures, or a grid operator's readiness to adapt to volatile generation patterns all determine how acute the impacts will be. In this sense, climate and environmental risks act as a risk multiplier which can amplify vulnerabilities across the entire energy security landscape.

G. Financial and Investment Risks

Energy security increasingly depends on the availability and stability of financing across the entire energy system. However, financial and investment risks are expanding, shaping the ability of governments, firms, and consumers to sustain critical infrastructure and advance a secure energy transition.

At the macro-financial and sovereign level, volatility in interest rates, inflation, and exchange rates complicates long-term planning and raises borrowing costs. High public debt burdens and tightening fiscal conditions further constrain government capacity to buffer energy systems from shocks or fund infrastructure upgrades. This can also limit the ability of governments to provide de-risking instruments such as guarantees, which are often critical to mobilising private investment. For many emerging economies, elevated sovereign risk premiums and persistent currency depreciation amplify exposure to global financial cycles and increase the cost of imported fuels, equipment, and technologies.

Risks also stem from domestic capital markets and the broader investment ecosystem. Shallow financial markets, dependence on a narrow pool of investors, limited access to long-term or low-cost capital, and weak risk-mitigation frameworks increase perceived investment risk and constrain financing conditions. Shifts in global investor sentiment add further uncertainty, raising required returns and discouraging investment. As a result, fewer projects meet investment thresholds, contributing to persistent investment gaps. These dynamics raise the cost of capital for clean energy investments, as higher perceived risk directly translates into a higher weighted average cost of capital (WACC). Even moderate increases in WACC can materially raise the levelised cost of electricity (LCOE), particularly for capital-intensive variable renewable energy (VRE) technologies, where upfront costs dominate total lifetime costs (Wilson, Shrimali, & Caldecott, 2025).

Balance-sheet pressures among utilities and energy companies intersect increasingly with climate-related insurance challenges. Utilities burdened by debt, declining revenues, or potential asset impairments—such as from fossil fuel stranding—may struggle to maintain infrastructure, honour contractual commitments, or invest in modernisation and clean technologies. At the same time, rising physical climate risks are driving up insurance premiums or reducing coverage for energy assets (KPMG, n.d.). Underinsurance can prolong recovery after disruptions and heighten financial strain, further weakening sector stability.

Lastly, financial vulnerability at the household and SME level presents a significant barrier to a secure energy transition. Credit constraints and the high initial costs of cleaner technologies limit uptake of efficiency measures and decentralised solutions. Without addressing these financing gaps, the transition risks becoming uneven, with large segments of society unable to access or contribute to emerging opportunities that could enhance long-term energy security.

A) Geopolitical and global macroeconomic risks

External political, military, and economic dynamics that pose physical security threats to energy systems and/or adversely affect market stability, energy trade, and investment flows

→ **Intensifying hostilities, armed conflict, and hybrid warfare** [that threaten the physical security and reliability of energy infrastructure, assets, and value chains]
→ **Strategic risks linked to control of dual-use materials and technologies** (e.g., rare earth elements, lithium-ion batteries)
→ **Economic statecraft and industrial policy risks** (e.g., tariffs, export restrictions, sanctions, market-shaping industrial policy shifts in key countries)
→ **Volatility of global energy and commodity markets and macroeconomic conditions** (e.g., fiscal tightening, inflationary surges)

B) Resource and supply chain system risks

Systemic vulnerabilities across resource bases and supply chains that undermine reliable, sustainable, and affordable access to energy resources and technologies

→ **Logistical constraints and transport route vulnerabilities** (e.g., dependency on narrow shipping corridors, limited alternative routes)
→ **Supply chain concentration and bottlenecks** (e.g., chokepoints for the sourcing, refining, and processing of raw materials and manufacturing of clean technologies)
→ **Domestic resource limitations and import dependence** (e.g., oil, gas/LNG, critical raw materials, rare earths, biofuel feedstocks)
→ **Unsustainable practices in sourcing, developing, and consuming resources** (e.g., in bioenergy production, mining of critical raw materials)

C) Infrastructure, operational, and system planning risks

Risks arising from the physical condition, capacity, operational performance, and planning of energy systems

→ **Ageing and inadequate grid infrastructure** (e.g., insufficient grid capacity and reliability risks, grid modernisation gaps)
→ **Insufficient system flexibility and storage capacity** [to accommodate VRE intermittency]
→ **Operational performance and efficiency gaps in the energy system** (e.g., inefficient system dispatch/load management, inadequate maintenance practices, slow responses to imbalances, suboptimal fuel inventory management)
→ **Vulnerability to operational accidents and system failures** [that interrupt supply and/or result in damaged facilities/infrastructure] (e.g., equipment failure, electrical faults, industrial accidents, human errors)
→ **Infrastructure planning and coordination risks across energy vectors** (e.g., siloed planning that leads to overbuilding, underutilisation, or critical gaps in system capacity)

D) Technological and cybersecurity risks

Vulnerabilities, dependencies, and integration challenges in energy system technologies and digital systems

→ **Security risks in control and communication systems and power electronics** (e.g., SCADA, EMS, smart grid technologies, inverters, controllers)
→ **Dependence on foreign technology vendors** [resulting in increased vulnerabilities to attacks and constrained options for timely upgrade and repairs]
→ **Interoperability gaps and system fragmentation risks** [between devices and energy system technologies]
→ **SME cybersecurity risks in distributed energy systems**
→ **AI-related risks and automation failures** [in grid management and energy markets]

E) Governance, political, and social risks

Challenges related to political will, governance quality, vested interests, and societal alignment that affect energy security

→ **Governance challenges and political instability** (e.g., fragmented policymaking, insufficient inter-agency coordination, political turnover affecting policy continuity)
→ **Entrenched interests and policy capture** (e.g., fossil fuel economic entrenchment, lobbying)
→ **Institutional and workforce capacity gaps** (i.e., limited technical expertise in energy planning and regulation, outdated education/training programmes, insufficient skilled workforce)
→ **Regulatory, policy, and implementation bottlenecks** (e.g., delayed permitting approvals, PPA terms that limit bankability, unclear timelines and inconsistent criteria for RE procurement)
→ **Public and stakeholder resistance** (e.g., due to inequities/perceived inequities associated with the energy transition, NIMBY attitudes)

F) Climate and environmental risks

Risks from climate change, environmental pressures, and natural hazards that threaten energy systems

→ **Extreme weather events and natural disasters** (e.g., cyclones, storm surges, heatwaves, wildfires)
→ **Sea level rise and coastal impacts** (e.g., flooding of coastal power plants; disruption of oil ports and LNG terminals)
→ **Land-use competition** [affecting siting of energy infrastructure and renewable projects]
→ **Water conflict and water scarcity** [affecting power generation] (e.g., reduced hydropower generation, cooling constraints for thermal plants)
→ **Ecosystem degradation and systemic shifts in climate patterns** [that affect renewable energy output and energy consumption]

G) Financial and investment risks

Risks related to the availability, cost, stability, and structure of capital and financial conditions that affect the financing of energy systems and the affordability of energy for consumers

→ **Macro-financial and sovereign-level risks** (e.g., interest rate volatility, currency risks, debt sustainability, fiscal constraints)
→ **Capital market and investment ecosystem risks** (e.g., underdeveloped domestic capital markets, reliance on limited foreign capital, limited green finance instruments, and insufficient de-risking measures)
→ **Asset and balance-sheet risks** (e.g., stranded assets, impaired utility balance sheets, rising credit risk)
→ **Climate-related insurance and protection gaps** (e.g., underinsurance of assets, rising insurance premiums for energy infrastructure)
→ **Household and SME-level financial vulnerability** (e.g., barriers to financing distributed energy, limited microfinance or SME credit access)

Figure 2: Energy Security Risk Taxonomy

4 The Contextual Nature of Energy Security

It is worth noting that the relative importance of different risks outlined in the previous section and the capacity to manage them vary significantly across countries. Energy security is inherently context-specific, shaped by differences in resource endowments, domestic capabilities, energy system configurations, institutional capacity, and geopolitical positioning. As such, there is no single pathway to achieving energy security; rather, it is essential for countries to interpret and prioritise risks through the lens of their own circumstances and development trajectories.

The Diversity of Risk Profiles Across Countries

Countries with different energy mixes and structural characteristics face fundamentally distinct energy security challenges. Fossil fuel import-dependent economies, for example, remain highly exposed to external supply disruptions, price volatility, and geopolitical risks, as demonstrated by the current oil and gas supply shock arising from the unfolding crisis in the Middle East. In contrast, countries with abundant domestic resources, including hydro-rich systems, fossil-fuel exporters, and nuclear-reliant power sectors, may face a different set of risks. These range from climate-driven hydrological stress and nuclear reactor accidents to stranded asset risks and the volatility that accompanies dependence on fossil fuel import revenue streams.

Even among countries that are undergoing similar transitions, risk perceptions and priorities can differ markedly. Dependencies on specific supply chains, technologies, or external partners may be viewed as critical vulnerabilities in some contexts, while being considered acceptable in others. For example, while European policymakers increasingly consider reliance on Chinese clean-energy technologies as a strategic vulnerability tied to long-term industrial competitiveness, many Southeast Asian governments are more concerned with attracting investments in local value-added manufacturing, rather than positioning themselves to compete with China in high-end innovation. These differences reflect not only economic and technical factors, but also geopolitical alignments, industrial strategies, and broader development objectives.

This heterogeneity underscores a key principle: energy security narratives and strategies cannot be directly transferred across countries. Policies and solutions that are effective in one context may be misaligned or infeasible in another. Consequently, it is important for countries to define their own energy security priorities, grounded in a clear understanding of their unique risk profiles and capabilities rather than external narratives or globally dominant policy trends.

The Dynamism of Countries' Risk Profiles

In addition, energy security risks are not static; they evolve alongside changes in energy systems, technologies, and external conditions. As countries expand electricity access, diversify their energy mix, or integrate new technologies, the nature of their exposure to risk shifts accordingly. Measures that successfully mitigate one set of risks may, over time, give rise to new vulnerabilities, particularly as systems become more complex and interconnected.

For example, efforts to enhance system reliability through increased electrification and digitalisation can introduce new dependencies on cyber infrastructure and data systems. Similarly, strategies aimed at strengthening resilience, such as localisation of supply chains or the development of strategic reserves, may entail fiscal costs or long-term efficiency trade-offs. These dynamics highlight the importance of adopting a forward-looking and adaptive approach, where energy security planning is continuously updated to reflect evolving system conditions and emerging risks.

The Evolution of Energy Security Amid the Energy Transition

The ongoing energy transition represents a fundamental shift in the nature of energy security risks. Rather than eliminating risk, the transition reconfigures risk profiles, reducing exposure to some vulnerabilities while introducing new ones. On one hand, reducing reliance on imported fossil fuels can significantly mitigate exposure to external supply disruptions and geopolitical shocks, which are risks that are often beyond the direct control of individual countries. On the other hand, the increasing deployment of renewable energy technologies introduces new dependencies, particularly in upstream supply chains for critical materials and in the manufacturing of technologies such as solar photovoltaic systems and batteries.

However, an important distinction lies in the nature and manageability of these risks. Many of the risks associated with renewable-based systems are more domestic and operational in character. Challenges such as variability in generation, grid integration, and curtailment can be addressed through investments in grid infrastructure, energy storage, forecasting systems, and more flexible system operations. While supply chain dependencies for technologies remain a concern, disruptions in these areas typically affect the pace of future deployment rather than the functioning of existing installed capacity. This contrasts with fossil fuel-related risks, where supply disruptions can have immediate and widespread impacts on energy availability and prices, with limited scope for short-term mitigation, particularly for import-dependent economies.

Importantly, this does not imply that fossil fuels will cease to play a role in energy systems or in energy security considerations. Even in systems with high shares of renewable energy, some degree of fossil fuel consumption is likely to persist, and associated risks will need to be actively managed through measures such as diversification of supply, improved contractual arrangements, and strengthened procurement and inventory management practices.

Taken together, these dynamics suggest that the energy transition, if managed effectively, can lead to more balanced and manageable risk profiles, while also creating new economic and development opportunities. However, realising these benefits requires deliberate and context-specific strategies that account for both the opportunities and the trade-offs inherent in the transition process.

5 From Risk to Response: Strategic Interventions and the 3R Framework

Understanding the evolving and context-specific nature of energy security risks is only the first step. The more critical challenge for policymakers and stakeholders lies in translating this understanding into coherent, forward-looking strategies that strengthen the overall security and adaptability of energy systems. In an increasingly complex and uncertain environment, energy security is not achieved through isolated measures, but through coordinated interventions across multiple domains, supported by clear prioritisation and strategic alignment.

Strategic responses to energy security risks span a wide range of technical, institutional, and market-based measures. These include, but are not limited to, investments in infrastructure, diversification of energy sources and supply chains, enhancement of system flexibility, strengthening of regulatory and governance frameworks, and the development of financial and risk management capabilities. Key strategic interventions commonly associated with each risk category are highlighted in the table below. Intended as a conversation starter rather than an exhaustive set of recommendations, this risk-intervention domain catalogue can help guide stakeholders in exploring solutions and mitigation strategies while leveraging local insights and expertise to identify context-specific priorities.

Risk Category	Key Strategic Interventions
A. Geopolitical & Macroeconomic	*Diplomacy, enhanced international cooperation, infrastructure protection, scaling of renewable energy and domestic alternatives (incl. DERs), demand-side management*
B. Resource & Supply Chain	*Supply chain localisation, technology transfers, circular economy solutions, energy and resource efficiency, diversification strategies, R&D and industrial support*
C. Infrastructure & Operational	*Grid development and modernisation, flexibility-driven system and market design, energy storage, cross-border interconnections, digitalisation and data solutions*
D. Technological & Cybersecurity	*Cybersecurity and oversight frameworks, supplier compliance requirements, common standards and protocols, technology partnerships, network segmentation*
E. Governance, Political & Social	*Long-term policy commitments, cross-sectoral coordination and planning, just transition measures, workforce reskilling/upskilling, educational reforms, public consultations*
F. Climate & Environmental	*Climate and environmental mainstreaming, climate adaptation (e.g., microgrids), integrated spatial and water-energy planning, disaster preparedness*
G. Financial & Investment	*Public-private partnerships, innovative and diversified financing mechanisms, risk allocation measures, fit-for-purpose investments, fossil asset retirement planning*

Table 1: Energy Security Risk-Intervention Domains

Importantly, these interventions are often interdependent: actions taken in one domain can reinforce outcomes in another. For instance, diplomatic efforts can help ease trade barriers, safeguard key infrastructure and shipping routes, secure access to critical raw materials, and improve access to foreign capital, while enhanced international cooperation can drive technology transfer, support workforce reskilling, strengthen global energy technology standards, and facilitate knowledge sharing in areas such as power system operations and climate adaptation planning. Another example of a cross-cutting intervention is distributed energy resources (DERs), which can alleviate grid investment pressures, enhance power system flexibility, and cushion the impacts of widespread system failures. By enabling more localised generation and flexible operations, DERs also strengthen the ability of power systems to withstand climate-related shocks and extreme weather events. Beyond these technical benefits, DERs can also improve energy access in remote or underserved communities, create local employment opportunities, and support workforce development

initiatives that align with just transition strategies. Approaching each risk-intervention domain from a purely siloed perspective risks overlooking such opportunities for strategies to intersect, generate synergies, and extend their benefits across multiple dimensions of energy security.

As such, a fragmented or reactive approach to risk management would fall short of what is required to navigate the complex, interdependent risks facing modern energy systems. This underscores the value of a structured framework that can serve as a conceptual anchor for proactive and integrated energy security planning, where strategic interventions can be aligned and coordinated under common energy security objectives. One way to approach this is through the 3R Energy Security Framework (Figure 3), which offers a practical lens through which diverse interventions can be organised around three complementary energy security objectives: Reliability, Responsiveness, and Resilience (3Rs). Interventions can be mapped within each pillar or at intersections where they simultaneously advance multiple objectives, highlighting opportunities for synergy and mutually reinforcing benefits. Beyond this exercise, the framework also prompts a re-examination of how reliability, responsiveness, and resilience should be defined within today's intricate, interdependent energy landscape.

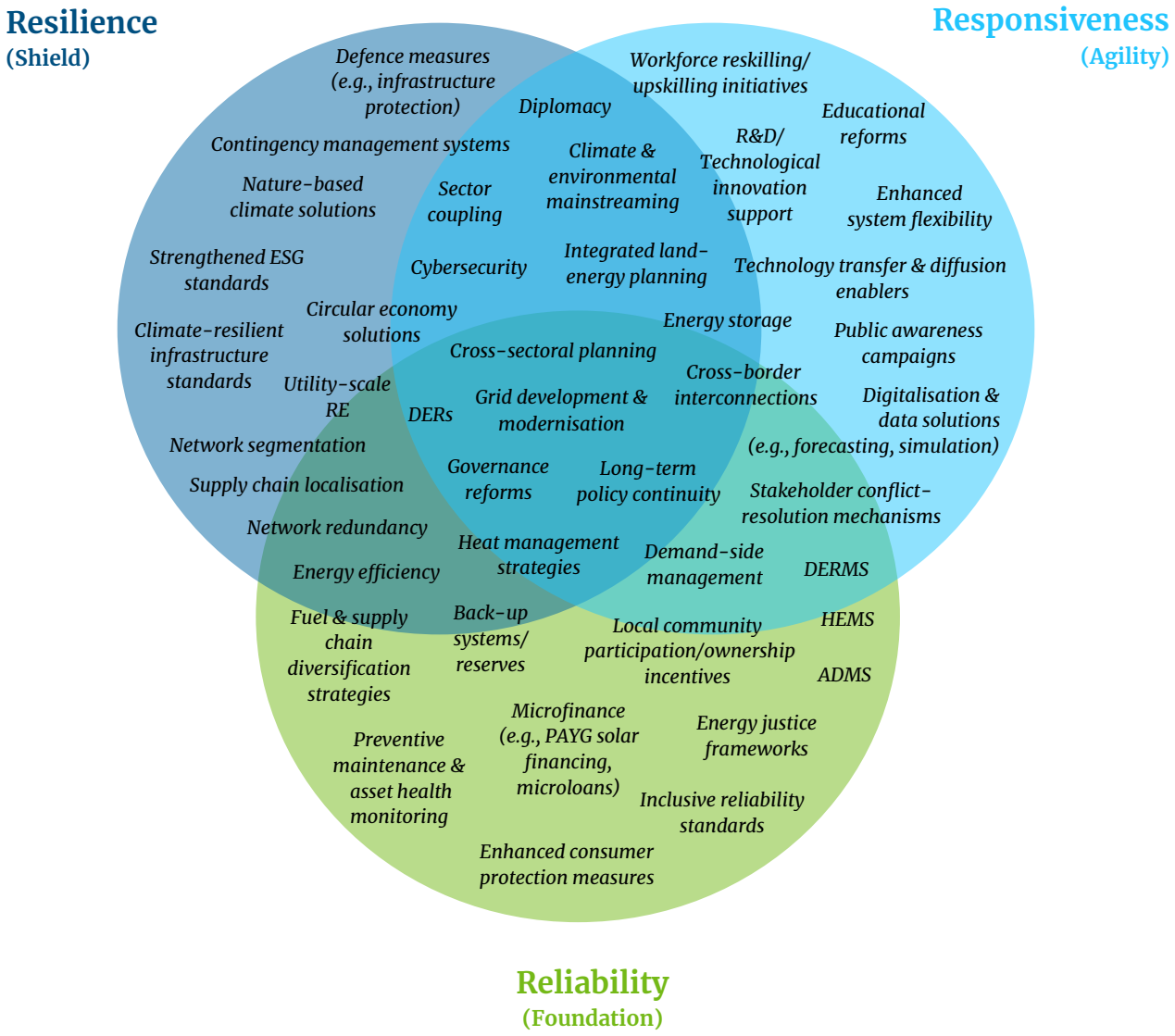

Figure 3: 3R Energy Security Framework[2]

[2] The interventions mapped onto the 3R Energy Security Framework are not exhaustive.

Pillar I. Reliability

Reliability has traditionally been primarily regarded as the ability of energy systems to ensure continuous, stable energy supply. While important, this narrow, supply-centric view rooted in traditional notions of security of supply does not adequately capture the full scope of reliability requirements in today's rapidly evolving landscape. As distributed energy resources increasingly come into play, reliability in the context of energy security can no longer solely be about stable supply-side delivery. Consumers are expected to play an increasingly active role in energy systems. As such, enablers that support consumers in effectively managing and contributing to energy flows, such as smarter meters and Home Energy Management Systems (HEMS), need to be recognised as integral components of modern reliability frameworks.

Reliability must also be regarded from social perspectives. A technically stable system alone is insufficient if households and businesses cannot afford energy. When fuel and electricity prices soar, consumers may be forced to ration usage, resort to inefficient alternatives (e.g., biomass for cooking), or curtail daily routines and business operations, diminishing the relevance of uninterrupted availability of energy as a goal while undermining economic stability. Moreover, a reliable energy system must be one that serves all members of society, not just those with financial resources and favourable circumstances. Without equitable access and inclusive participation, reliability would become a selective benefit for privileged groups as opposed to a foundational element of energy security for society as a whole. In light of these reflections, this framework defines reliability as **the ability of energy systems and supporting institutions to ensure that all consumers can equitably access uninterrupted, affordable energy,** including opportunities from decentralised and distributed energy resources.

Pillar II. Responsiveness

Responsiveness is often described in operational terms, focusing on the ability of power systems to adjust output, dispatch reserves, or smooth demand peaks in real time. This function has only grown in strategic significance as fluctuations in supply and demand grow sharper, driven by surges in electric vehicle charging, increasing variability of renewable generation, rapid adoption of rooftop solar, and weather-related shifts in energy consumption. In this context, flexibility becomes indispensable, whether through fast ramping capabilities, load-shifting mechanisms, or the integration of energy storage. Yet, while this technical dimension remains vital, an understanding of responsiveness confined to system operations is no longer sufficient.

To meet the challenges of today's energy landscape, perspectives on responsiveness must broaden. Energy systems are increasingly shaped by forces that extend beyond the grid itself. For example, disruptive weather events, volatility in fossil fuel markets, global supply chain instability, and larger societal shifts such as rapid urbanisation are intensifying pressures on the ability of energy systems and institutions to respond effectively. At the same time, technological developments also demand new forms of adaptability. This would involve, among other things, integrating safeguards to protect against cybersecurity vulnerabilities, retraining workers to adopt and integrate emerging technologies, enabling households and businesses to embrace energy-efficient and digitally integrated practices, and fostering public support for cleaner energy alternatives. In this expanded sense, responsiveness is not merely a technical reflex but a systemic one, anchored in institutional agility and social adaptability as much as grid flexibility. Taken together, these factors highlight that responsiveness encompasses more than operational reflexes. Therefore, this framework defines responsiveness more comprehensively as **the capacity and capabilities of energy systems and stakeholders to respond with flexibility and agility to changing operational, technological, environmental, social, and economic conditions.**

Pillar III. Resilience

Resilience is often equated with the ability of energy systems to endure shocks and quickly restore operations, emphasising physical robustness and quick recovery. This limited view overlooks the broader spectrum of long-term and compounding stresses that today's energy systems must navigate. Today, resilience must be understood as **the capacity of energy systems and supporting institutions to sustainably withstand, absorb, manage, and recover from not only sudden crises but also long-term stresses,** such as resource depletion, economic recessions, military conflicts, and climate change. Unlike short-term shocks, these stresses often unfold over years or even decades, gradually undermining the stability of energy systems. Resource depletion can quietly erode supply chains and reduce strategic flexibility, while economic recessions often trigger cascading failures in investment, innovation, and infrastructure maintenance. Similarly, climate change alters demand patterns and compromises the viability of existing assets, just as prolonged military conflicts can disrupt critical trade routes and fracture global energy alliances. Crucially, the ability to manage such stresses effectively depends on the sustainability of the system itself. Without sustainable resource use, investment practices, and institutional arrangements, resilience cannot be maintained over the long term.

In this context, resilience can no longer be just about bouncing back after disruption. Instead, it increasingly demands the ability to sustain core system functions over time and under stress, ensuring the capacity to shield essential services while recognising that long-term resilience is inseparable from sustainability. This broadened conception recognises that energy security depends on interconnected physical, institutional, and societal capacities to ensure that essential energy services can continue to function effectively even amid prolonged or multiple crises.

6 Applying the Framework in Practice

Moving from the conceptual framing of energy security risks and the 3R Energy Security Framework to real-world application involves navigating the complex environments in which energy decisions are made. Energy systems operate within complex institutional, political, and economic environments, where decision-making is shaped not only by technical considerations but also by competing priorities, resource constraints, and stakeholder interests. As such, applying the framework requires a practical, iterative, and context-sensitive approach that translates high-level concepts into actionable strategies. The high-level steps outlined below provide a structured pathway for doing so, guiding stakeholders from initial risk assessment through intervention design, implementation, and the embedding of these practices into routine decision-making.

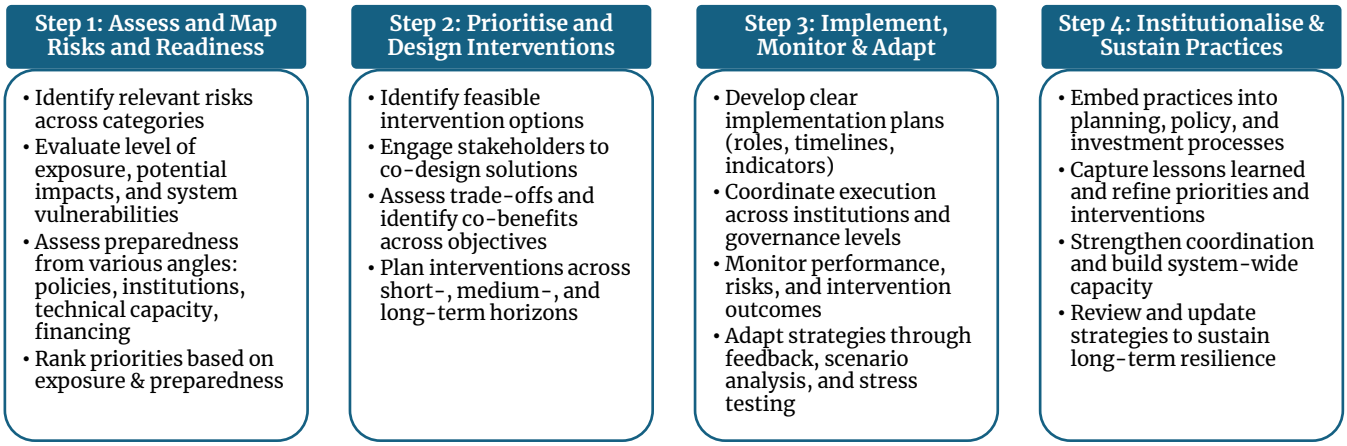

Figure 4: A Structured Process for Delivering Energy Security

Step 1: Assess and Map Risks and Readiness

The starting point for application is a clear understanding of the country-specific risk landscape. Drawing on the risk categories outlined in Section III, stakeholders assess which risks are most relevant to their energy system, taking into account factors such as energy mix, infrastructure condition, import dependence, exposure to climate variability, and institutional capacity. This assessment benefits from integrating domain-specific expertise alongside a system-wide perspective, enabling stakeholders to capture both detailed risk characteristics and the interdependencies through which disruptions may propagate across the energy system.

To translate discussions into concrete priorities, a structured method for weighing the relative significance and readiness to address various risks is critical. Tools such as a Priority Action Matrix (Figure 5) can support this assessment by helping stakeholders categorise risks based on their relevance—defined by the potential scale of risk exposure and impact to energy security in the local context—and the current level of preparedness to address it. Preparedness in this context may reflect factors such as existing policy frameworks, institutional capacity, availability of technical solutions, access to financing, and the maturity of implementation mechanisms.

This allows policymakers to distinguish between critical priorities that demand immediate attention, items that should be monitored and maintained, watch-list issues that may grow in importance over time, and lower-priority risks requiring limited focus. By applying this lens, dialogues can move beyond abstract deliberation towards a shared, evidence-based view of what matters most, while still keeping sight of emerging or less urgent risks that may require attention in the future. In doing so, the process establishes a clear and actionable foundation for prioritisation and subsequent intervention design.

Relevance (*vertical axis*): magnitude of exposure & potential impact on energy security objectives in the local context
Preparedness (*horizontal axis*): readiness/capacity to address the risk in the local context

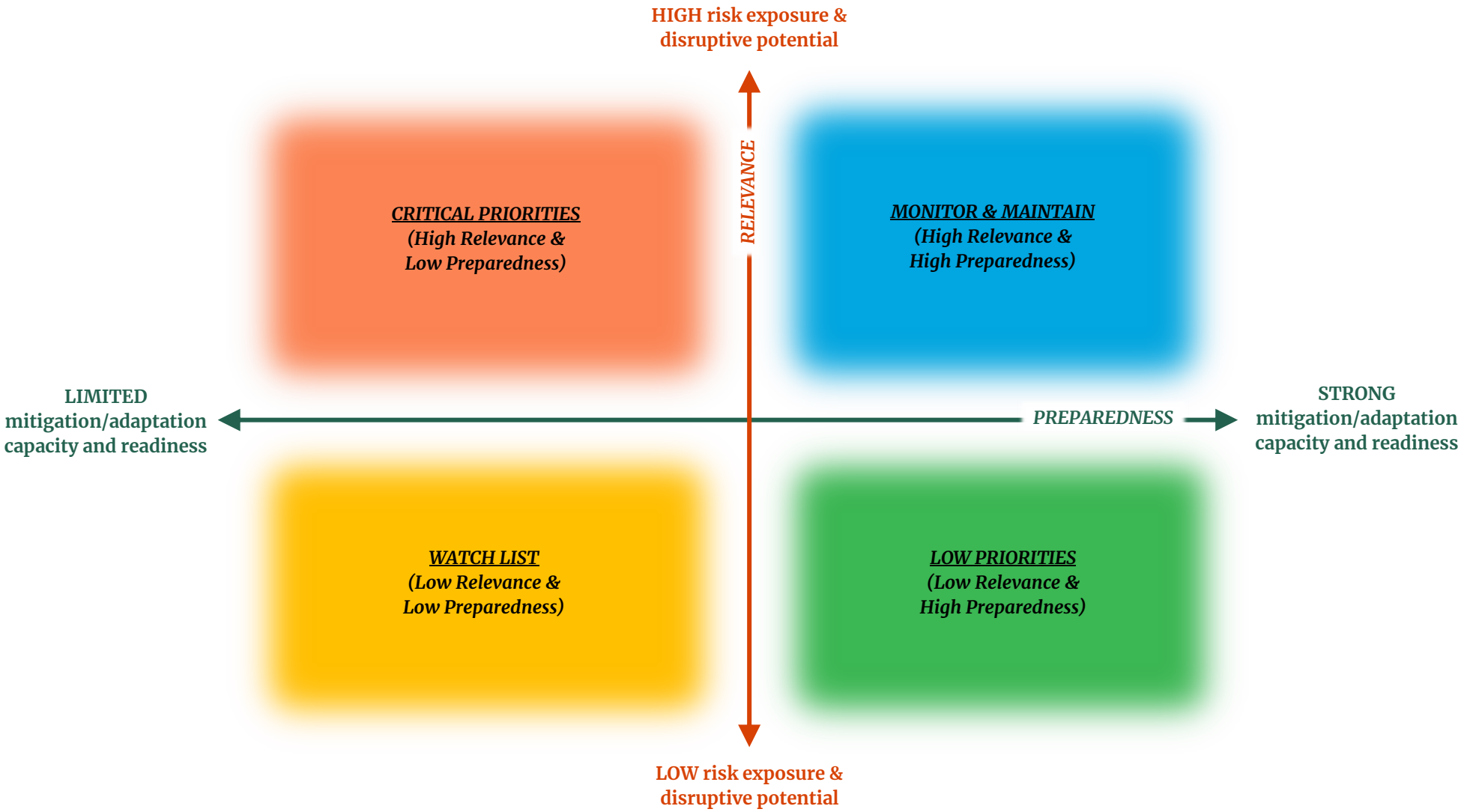

Figure 5: Priority Action Matrix

Step 2: Prioritise and Design Interventions

With risks assessed and readiness evaluated, the next step is to translate these insights into prioritised interventions, developed in collaboration with relevant stakeholders across sectors. Bringing together energy planners, regulators, private sector actors, and other sectoral representatives creates space to identify a range of possible responses, compare their relative impacts, and co-develop solutions. This collaborative process supports more grounded decision-making, helping ensure that interventions are technically feasible, aligned with broader energy system objectives, and complementary across sectors.

Prioritisation at this stage involves not only identifying what can be done, but also determining what should be done first, at what scale, and in what sequence. The 3R framework can support this process by helping stakeholders assess how different interventions contribute to strengthening reliability, resilience, and responsiveness, and where combinations of actions may deliver reinforcing benefits. In practice, this often means focusing on interventions that address multiple risks simultaneously or unlock enabling conditions for further action.

Reflecting on trade-offs—such as cost, regulatory constraints, political feasibility, and social impacts—can further strengthen the design process. Rather than treating these constraints as barriers, they can be used to refine and stress-test proposed interventions, ensuring that selected options are both impactful and implementable. At the same time, seeking interventions that generate co-benefits across energy security objectives and broader development goals can help maximise value and build wider support.

Engaging stakeholders throughout this process increases the likelihood that interventions reflect practical realities, draw on specialised expertise, and account for interdependencies within the energy system. It also helps align expectations across actors, clarify roles, and identify potential synergies or conflicts between interventions, supporting a more coherent and strategically coordinated approach to strengthening energy security.

Step 3: Implement, Monitor, and Adapt

The third step focuses on translating co-designed interventions into practice while establishing robust mechanisms to monitor progress and adjust strategies over time. Developing clear implementation plans with defined responsibilities, timelines, and performance indicators provides structure and supports accountability during execution. In practice, this also involves coordinating across institutions and levels of governance to ensure that interventions are carried forward in a consistent and timely manner, particularly where responsibilities are distributed across multiple actors.

Ongoing monitoring plays a central role in this process, offering insight into how risks evolve, how the energy system is performing, and how effectively interventions are delivering intended outcomes. This requires not only tracking predefined indicators, but also maintaining visibility over emerging risks and unintended consequences that may arise as interventions are implemented. Complementary tools such as scenario analysis and stress testing can help sustain a forward-looking perspective, allowing stakeholders to assess how systems and interventions may perform under different future conditions.

An adaptive management approach helps ensure that interventions remain relevant as technologies, markets, and geopolitical dynamics evolve. By creating feedback loops between implementation, monitoring, and decision-making, stakeholders can respond proactively to new information, recalibrate priorities, and refine approaches where necessary. This reinforces the importance of treating energy security planning as an iterative and continuously evolving process, rather than a one-time exercise.

Step 4: Institutionalise and Sustain Practices

Over time, it becomes increasingly important to embed the application of the framework into routine decision-making processes in order to support long-term resilience. Institutionalisation involves moving from ad hoc or project-based application toward more systematic integration within planning cycles, policy development, regulatory processes, and investment decision-making. This helps ensure continuity of effort, even as priorities shift or stakeholders change.

Capturing lessons learned from implementation and monitoring is a key part of this process. Regularly refining risk assessments, updating priorities, and adjusting intervention design enables the framework to remain responsive to evolving conditions. At the same time, knowledge sharing and capacity-building efforts—both within and across institutions—can strengthen system-wide resilience by improving the ability of stakeholders to engage with complex and interdependent risks.

Structured coordination mechanisms further support alignment across sectors and actors, helping to sustain a shared understanding of priorities and reduce fragmentation over time. By reinforcing linkages between technical expertise and system-level planning, these processes help ensure that interventions remain coherent, strategically aligned, and mutually reinforcing.

Regular review and adjustment ultimately reinforce the framework's proactive and anticipatory orientation, enabling stakeholders to maintain focus on evolving energy security objectives while ensuring that actions remain aligned with broader policy and development priorities.

7 Concluding Reflections

Energy security has reemerged as a central policy concern, shaped by the convergence of geopolitical tensions, evolving energy systems, and a rapidly shifting risk landscape. As recent events have demonstrated, traditional vulnerabilities associated with fossil fuel dependence, particularly exposure to external supply disruptions and geopolitical shocks, remain highly relevant. At the same time, the ongoing energy transition is introducing new dynamics, reshaping both the sources of risk and the mechanisms through which they materialise.

This paper has argued that energy security can no longer be understood through a singular or static lens. Instead, it must be approached as a multidimensional and evolving challenge, where risks differ across countries and change over time as energy systems develop. The transition to cleaner and more diversified energy systems does not eliminate risk, but it offers an opportunity to reconfigure risk profiles in ways that are more balanced, more manageable, and, in many cases, more within the control of individual countries.

A central implication of this analysis is that context matters. Countries face distinct energy security challenges depending on their resource endowments, domestic capabilities, energy mixes, institutional capacities, and geopolitical positioning. As such, there is no universal blueprint for achieving energy security. Effective strategies must be grounded in a clear understanding of local conditions, while remaining adaptable to global developments and emerging risks.

Given this complexity, translating context-specific insights into effective action requires structured and coordinated processes. The stepwise approach outlined in this paper—from assessing risks and readiness, to co-designing interventions, implementing and adapting measures, and embedding these practices over time—provides stakeholders with a structured pathway for translating analysis into action. By linking technical insights with coordinated decision-making across sectors, this approach supports more coherent, context-sensitive, and forward-looking energy security strategies.

Ultimately, energy security should not be viewed solely as a defensive objective, but as a strategic opportunity. Countries that proactively navigate the transition—by strengthening system flexibility, investing in resilient infrastructure, and aligning policies across sectors—can reduce their exposure to external shocks while positioning themselves to capture broader economic, social, and environmental benefits.

In an increasingly uncertain and interconnected world, the challenge for policymakers is not just to react to disruptions, but to shape energy systems that are robust, adaptive, and future-ready. By adopting forward-looking, context-specific, and integrated approaches, countries can move towards energy systems that are not only secure, but also better aligned with long-term development and sustainability goals.

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ADDITIONAL RESOURCES

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