



WORLD
ENERGY
COUNCIL

WORLD ENERGY TRILEMMA 2026

REBALANCING WORLD ENERGY

Trade-Offs and Transformations

ABOUT

WORLD ENERGY COUNCIL

The World Energy Council is the world's oldest independent and impartial energy leadership community. Through our Humanising Energy vision, we involve more people and communities in accelerating clean and inclusive energy transitions in all world regions.

Formed in 1923, the Council is a UN-accredited global energy body that has convened diverse interests from across the full energy ecosystem for a century. Today our global network has over 3,000 member organisations and a presence in more than 100 countries, drawn from governments, private and state corporations, academia and civil society, as well as current and future energy leaders. We collaborate on impact programmes and inform local, regional and global energy agendas in support of our enduring mission: to promote the sustainable use and supply of energy for the benefit of all people.

Further details at www.worldenergy.org and on [LinkedIn](#)

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World Energy Council

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VAT Reg. No. GB 123 3802 48

Registered Office

Hamilton House, Suite 101-102,
1 Temple Avenue
London,
EC4Y 0HA

WORLD ENERGY TRILEMMA

The World Energy Council defines the energy trilemma through three core dimensions: Energy Security, Energy Equity, and Environmental Sustainability.

The Trilemma is not a target to be reached but a set of trade-offs to be governed. Progress on one dimension can create pressure on another, and the right balance is never fixed – it moves with a country's circumstances and its wider operating environment. Managing these trade-offs, deliberately and repeatedly, is what distinguishes energy systems that endure from those that stall.



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REBALANCING A WORLD ENERGY SYSTEM UNDER STRAIN

A century ago, the World Energy Council was founded in the aftermath of geopolitical upheaval and at the dawn of a new technological age.

There is a sense of déjà vu.

Today's world is different, but it is no less unsettled. Geopolitical fragmentation is reshaping trade and investment. Environmental pressures are intensifying. Artificial intelligence is creating new patterns of energy demand. Industrial competitiveness is being redefined by access to affordable, reliable and productive energy services.

The first phase of energy transitions was shaped by deployment. Renewable technologies scaled rapidly, costs fell, and electrification accelerated. Important progress was made, and that progress continues.

The next phase will be different.

Many of the easier gains have already been captured. The challenge of the last decade was deployment; the challenge of the next is integration.

Building new generation capacity remains essential, but the bottlenecks are shifting. Increasingly, the questions concern grids, storage, flexibility, markets, supply chains and systems integration. The challenge is less about optimising parts (i.e. individual technologies and assets) and more about stewarding the whole system, including more active and intelligent demand. This means understanding how different parts of increasingly complex systems work together.

The leadership challenges are also changing. Integration within systems must be matched by interoperability between them: enabling technologies, standards, markets and institutions to work together across companies, countries and regions.

In both senses, the 'how to' depends on the 'who with'.

The people and institutions involved in shaping energy systems matter as much as the technologies themselves. World energy is much more than a sector. It is the operating system of civilisation: an increasingly critical interface of industry, finance, digital technology, communities and a healthy planet.

The health of these connections is becoming a defining factor in the performance of national and increasingly diverse, regional energy systems.

At the World Energy Council, we describe this as a continuous process of rebalancing energy security, equity and environmental sustainability outcomes in a world in motion.

Trade-offs have not disappeared. Their nature and relative weight continue to shift. Decarbonisation is no longer simply an environmental agenda. It is increasingly an industrial, economic and strategic agenda. Balance is not a destination that can be reached once and maintained indefinitely. It must be continuously renewed.

For more than twenty years, the World Energy Trilemma has provided a practical framework for making the uncomfortable realities of tensions and trade-offs visible and discussible. As its use across the world energy community grows, the World Energy Trilemma is helping leaders identify emerging synergies and co-benefits.



This World Energy Trilemma report suggests that one of the defining leadership disciplines of the next decade will be rebalancing energy. New ways of connecting energy and data, industry and community are essential and already emerging. The leadership agenda is moving beyond supply to value-in-use, with attention to access to more reliable, affordable and productive energy.

This opportunity extends across supply, individual technologies, and energy assets to the connected systems that enable them to work together. Connected systems lower emissions and create more resilient economies, more competitive industries, better jobs, healthier communities, and greater human flourishing.

These are the transformations we need to inspire. And these are the transitions we now have to deliver.

I look forward to continuing this conversation with the world energy community at the World Energy Congress in Riyadh next April.



Angela Wilkinson
Secretary General & CEO
World Energy Council

EXECUTIVE SUMMARY

The world energy system is under unprecedented strain. The World Energy Issues Monitor 2026 records a leadership landscape more fragmented, polarised, and digitally noisy than at any point in the Trilemma's history. The relatively easy gains of the past two decades – falling clean-technology costs, efficiency improvements, and early fuel-switching – have largely been captured. The decisions now facing energy leaders carry real costs for identifiable communities, industries, and voters today, and, where deferred, for future generations.

For over twenty years the World Energy Trilemma has helped leaders balance security, equity, and environmental sustainability. What has changed is not the existence of these competing priorities but the context in which they are managed. Trade-offs have not disappeared: they have **moved** from generation to grids, storage, and system integration; they have become **more consequential**; and they have become **more local**. Because conditions now shift faster than decision cycles can settle them, balance must be actively and continuously re-achieved. This report calls that emerging capability, “rebalancing.”

Across five Regional Leadership Exchanges, convening more than 275 senior leaders from 65 countries, five trade-offs emerged as recurring in every region:

The trade-off	For dialogue
1 Investing in tomorrow's system vs. managing today's costs	At what point does deferring investment cost more than building it – and who needs to be in the room to make that call?
2 Redesigning markets vs. living with current market realities	Where have market rules already been redesigned successfully – and what made that politically possible?
3 National competitiveness vs. cross-border interdependence	Which dependencies can we live with, and which are worth paying a premium to avoid?
4 Speed of transitions vs. social legitimacy	What should be included in project design to earn social legitimacy?
5 The institutions we need vs. the institutions we have	What new cross-sectoral architectures do we need, and how can they be built?

None of these can be resolved at the level of technology or finance alone. What distinguishes the systems that manage them well is a set of five recurring leadership practices: **framing** the trade-offs honestly; **working the interfaces** where energy meets digital, industry, finance, communities, and nature; **governing** through institutions with the authority to change the rules, not merely to administer them; **building legitimacy as infrastructure** rather than communication; and **seeking synergies** as actively as managing trade-offs. Together these constitute rebalancing as a leadership capability.



The World Energy Trilemma Index will continue to measure what is globally measurable. Alongside it, the Council's **Rebalancing Dialogues** will extend leadership attention to what is not yet measurable – structured exchanges in which leaders test live decisions against emerging tensions. This is not a new index; it is a new Trilemma leadership conversation. The Council's contribution is not a set of answers but a leadership capability, and the trusted space in which it is developed.



Image from the World Energy Council's
Humanising Energy Series featuring Climeworks
(Finland) produced by BBC StoryWorks.



INTRODUCTION

The World Energy Council and its unique membership community across 100 countries exist to provide system-level intelligence, to promote practical cooperation, and to convene energy leadership for the common good.

A NEW ERA OF ENERGY FOR PEOPLE AND PLANET IN A SYSTEM UNDER STRAIN

The challenges of sustainable development, which emerged in the late 1980s, led the World Energy Council to pioneer a more balanced approach to world energy leadership, called the “World Energy Trilemma.” The aim was to develop shared understanding and to accelerate practical learning on policies that deliver energy security, equity (access and affordability), and environmental sustainability outcomes, in parallel, with an emphasis on balancing the three legs of the Trilemma triangle.

In February, the annual World Energy Issues Monitor 2026 highlighted shared and growing concerns that the world energy system is experiencing an unprecedented and severe level of strain. Today’s world energy leadership landscape is increasingly fragmented, and polarised, and the digitalisation of the energy system is resulting in an abundance of data but a shortage of guidance for decision-making.

Rather than depending on more data to solve problems, policymakers need innovative approaches and collaborative learning in order to keep pace with technology development in a faster and more fundamentally shifting world.

This is a pivotal moment in world energy leadership. To meet this challenge, the World Energy Trilemma work is evolving beyond an annual static index into a dialogue and learning process to support decision-making in the new context of intelligent systems economies and emerging energy shocks.

INSTABILITY IS CHALLENGING; BALANCE IS ASPIRATIONAL

Progressing world energy leadership in an era of energy for people and planet cannot be achieved with a one-size-fits-all or single-issue agenda. Instead, it requires managing the connected challenges of energy security, equity, and environmental sustainability.

Balancing competing priorities and improving overall outcomes has always been aspirational and not easy to achieve in practice. Policy tensions and trade-offs have not disappeared as greater volumes of distributed and variable renewable energy sources have been added to the energy mix. Instead, they have moved to new parts of the system (e.g., from generation to grids) and have become more consequential for increasingly diverse energy users and uses, including non-energy sectors and households both with and without reliable and affordable energy access.

Managing demand and supply has never been simple. Today, with the drive for digital, industrial, and human development, global energy demand is growing at an unprecedented and unpredictable rate. A global electrification super-cycle is triggering new concerns about underestimated and growing energy deficits in all regions. Scaling clean, affordable, and reliable power services to meet digital, industrial, and human development presents new technical and institutional challenges, including grid stability, storage regulation, permitting and licensing, interoperability standards, and the need for new skills and capabilities.

Questions of balance are also geopolitical. How to maintain the current world energy system, whilst building a new one? How to deliver global climate change commitments while also providing energy security, affordability and resilience? How to engage in long-term planning and investments in the midst of sudden reversals in national energy policy?

The rise of the intelligent systems economy creates a new context. Interoperability has become a strategic capability. Energy security and resilience are common concerns.

INTER-OPERABILITY IS EMERGING AS THE CRITICAL STRATEGIC CAPABILITY FOR THE NEXT CENTURY

World energy leadership is shaped by many more and new diverse leaders beyond the classic energy industry. The leadership focus is shifting from supply-centric security and optimisation to the interface of the digital-industrial-human development nexus and to building resilience in response to new energy shocks emerging suddenly both from within the system (grid instability) and from without (extreme weather, cyber attacks, geopolitical conflicts).

Balance now involves the much harder work of delivering clean, resilient, affordable, productive energy services to billions more people and increasingly diverse energy uses and users amidst geopolitical uncertainty, more frequent and severe extreme weather events, and an accelerating pace of digital innovation.

THE NEW SHAPE OF THE WORLD ENERGY SYSTEM

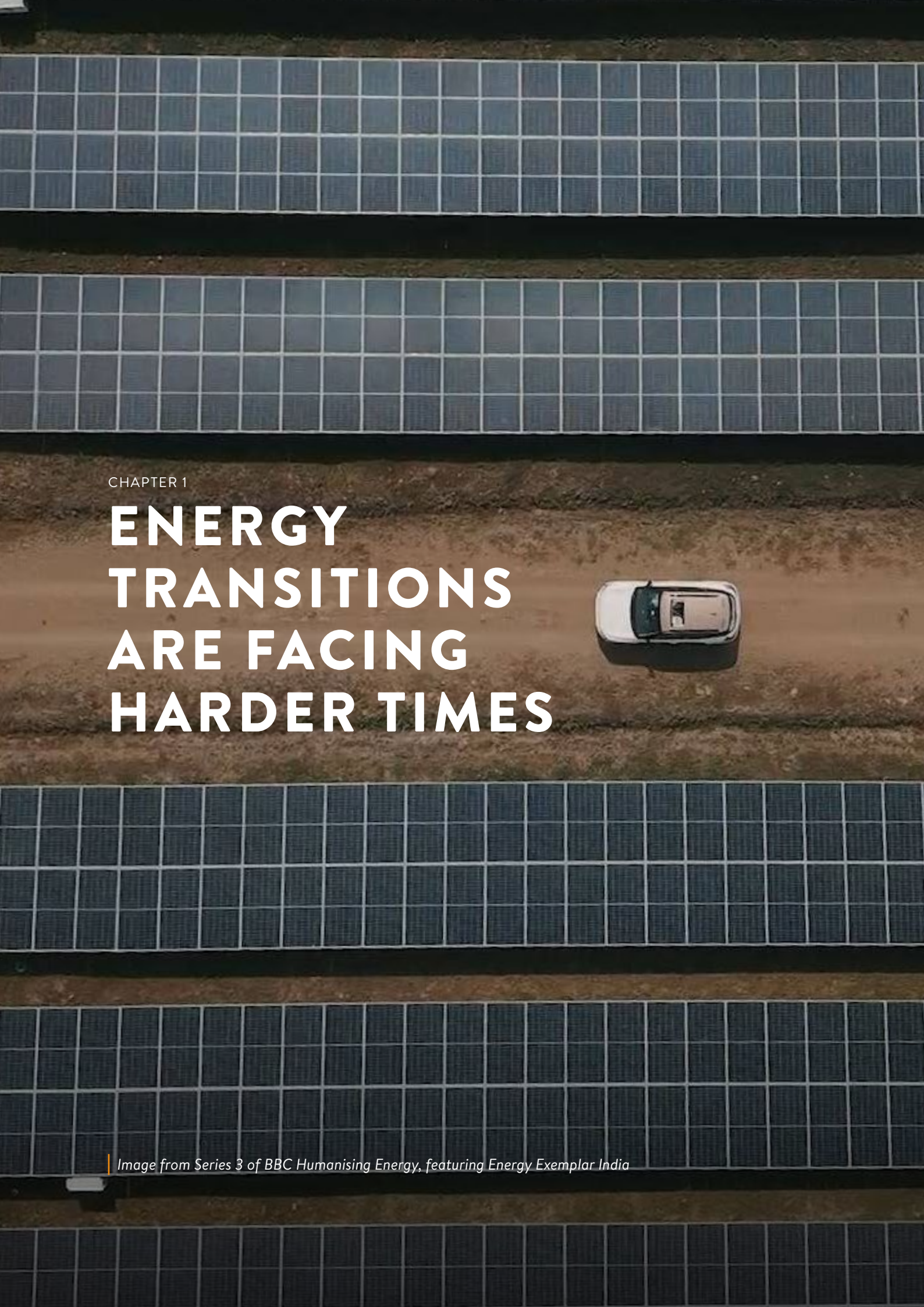
This report introduces five key trade-offs world energy leaders are now facing, and explores the implications of an emerging new leadership capability – rebalancing. These trade-offs were identified through a process of sustained engagement across a full spectrum of energy interests and leadership experiences represented by World Energy Council members from every region.

The World Energy Trilemma is represented by a simple triangle – a useful way to visualise complex realities. At the same time, the World Energy Council recognises there is no one-size-fits-all pathway for balancing the three major aspects the triangle represents. Energy leadership is increasingly a matter of learning from regional diversity and about specific constraints, enabling flexibility rather than imposing uniformity.

This report adds a circle around the Trilemma triangle to represent the context in which today's trade-offs are made, and the dialogue through which leaders manage them. At a deeper level, this circle also represents the World Energy Community, centred on shared purpose and enabled by data, dialogue, and the emerging leadership challenge of rebalancing.

REBALANCING IS A COLLECTIVE LEADERSHIP CAPABILITY THAT NEEDS TO BE WIDELY PRACTISED

Dynamically balancing competing priorities as the world energy system undergoes transitions and transformations is best achieved through cooperation – using real-time data, real-time dialogue, and action learning. AI and automation can support and mimic but not yet replace the role of human leadership and judgement. This capability matters because the decisions now facing energy leaders carry real cost – for identifiable communities, industries, and voters today, and, where those decisions are deferred, for future generations. Rebalancing is a practice exercised by individual leaders, developed collectively across the Council's community, and built into institutions themselves.

An aerial photograph of a solar farm. The image shows several long, parallel rows of dark blue solar panels stretching across the landscape. Between the rows of panels is a dirt path. A small white car is parked on this path, positioned to the right of the main text. The overall scene is captured from a high angle, looking down at the panels and the car.

CHAPTER 1

ENERGY TRANSITIONS ARE FACING HARDER TIMES



| Image from Series 3 of BBC Humanising Energy, featuring Energy Exemplar India

CHAPTER 1

ENERGY TRANSITIONS ARE FACING HARDER TIMES

Why the world's energy transitions are becoming more difficult – and why dynamic balancing (“rebalancing”), rather than conventional supply-demand balance (optimisation) is the necessary leadership capability to meet this challenge.

A PIVOTAL MOMENT

The strategic choices facing energy leaders have never been easy. What has changed is not that hard choices have become easier – it is that the easy gains have largely been captured.

For two decades, the falling costs of clean technologies, combined with efficiency improvements and early fuel-switching, enabled a world-wide renewable power revolution. The decisions facing energy leaders now incur costs for identifiable communities, industries, and voters. Meanwhile, the consequences of deferring these decisions will be borne by future generations.



“We spent quite a while on one of the edges of the Trilemma. Now we’re definitely being torn apart by all three edges.”

—
Claudio Seebach, Chair, Latin America and the Caribbean, World Energy Council

Latin America & Caribbean Regional Leadership Exchange

The disruption of shipping through the Strait of Hormuz has drastically reduced energy flows, with roughly a fifth of global oil supply and a comparable share of LNG trade exposed through a single chokepoint. Instability on this scale damages producers and consumers alike and degrades the market-stability mechanisms – spare capacity, strategic stocks, insurance, shipping norms – on which all sides depend.

But the impacts of this crisis are uneven because countries have very different levels of conventional energy security preparedness. Import-dependent emerging economies, particularly in South and Southeast Asia, have absorbed the sharpest shocks to fuel availability and prices – and some are defaulting back to coal, in a pattern that recalls the aftermath of the 1970s oil shocks, when a supply crisis redirected national energy strategies that were then difficult to change. The question is whether this crisis will redirect energy strategies towards resilience or simply towards retrenchment.

NO EASY SUPPLY-SIDE CHOICES

In parts of the global energy system, the rapid entry of new supply, led by renewables in the power mix, is shifting the defining condition. Yet even where clean electrons are plentiful, the Trilemma trade-offs have not disappeared. Three things have happened to them instead.

- **TRADE-OFFS HAVE MOVED.** The binding constraints now sit less in generation and more in what surrounds it – grids, storage, system integration, supply chains, land, water, and workforce skills.
- **TRADE-OFFS HAVE BECOME MORE CONSEQUENTIAL.** Decisions carry larger, longer-lived distributional effects and are increasingly taken ahead of the demand that would justify them, raising difficult issues: who pays for infrastructure built ahead of need, which industries remain competitive, and which communities pay for what gets built?
- **TRADE-OFFS HAVE BECOME MORE LOCAL.** Trade-offs vary from place to place, shaped by specific constraints – resource endowment, institutional capacity, fiscal space, public trust. Because there is no universal pattern, trade-offs are becoming a challenge not simply of applying best practice but of making the right trade-offs visible, discussable, and actionable.



These three new challenges in Trilemma trade-off decision-making operate in the context of five compounding system pressures that make this phase of the energy transitions even more difficult than the last:

- **ELECTRICITY DEMAND GROWTH RISING FASTER THAN SYSTEMS CAN ACCOMMODATE**, as a result of development in the global South, the exponential growth of data centres and AI, and industrial electrification.
- **POST-TRUTH FRAGMENTATION** of the shared factual basis for energy decisions – costs, risks, and trade-offs are increasingly contested terrain on which common ground is harder to establish and hold.
- **AFFORDABILITY PRESSURES** – cumulative cost-of-living strains are narrowing the political space for any decision that raises near-term energy prices.
- **INDUSTRIAL COMPETITIVENESS** – energy policy has always included an industrial dimension, but now energy policy and industrial policy are inseparable, raising the stakes of every technology and trade choice.
- **CLIMATE OVERSHOOT AND THE FOOD-ENERGY-WATER STRESS NEXUS** – physical climate impacts are arriving inside planning horizons, linking energy security to water and food security in ways that current frameworks do not capture.

Across every regional dialogue the Council convened, leaders identified a shift in the binding constraint of their individual energy transitions from energy generation to systems problems – grids, storage, and systems integration. Just as consistently, human capabilities also appeared as a binding constraint: trust, skills, institutional capacity, and the systems leadership¹ needed to hold competing priorities together.

Another, more subtle binding constraint is a politicised context that penalises leaders for honest and open discussion of trade-offs – for acknowledging that every option carries costs, and that the immediacy of crisis crowds out attention to the structural choices that will matter in the long run. The conversations that are most important have become the hardest to hold precisely when they are most necessary.

¹ Systems leadership is the practice of convening actors across boundaries and using dialogue to surface interconnected trade-offs, enabling better shared judgement at the interfaces between systems – so that competing priorities can be governed with legitimacy, and the system can continue to learn and adapt as conditions change.

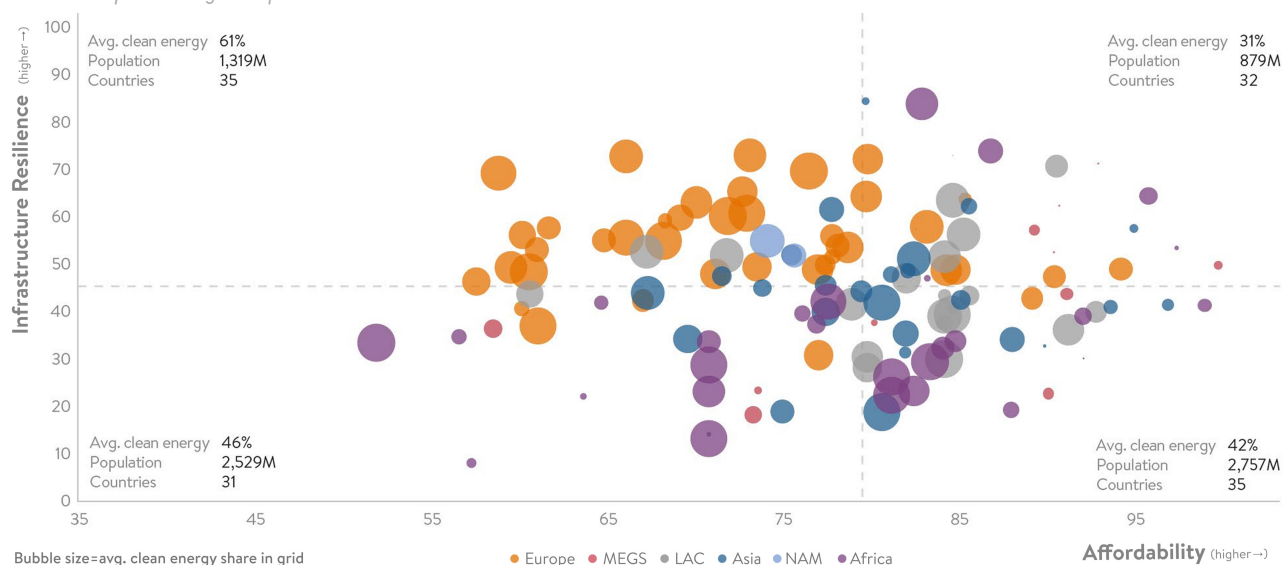
Image from Series 2 of BBC StoryWork's "Humanising Energy" featuring ACEN



	 AFRICA	 ASIA	 EUROPE	 LAC	 MEGS
DOMINANT TRADE-OFF TENSION	Development Imperatives vs. Transition Conditionality	Growing Demand vs. System Resilience	Transition Ambition vs. System Resilience	Resource Potential vs. Institutional Fragility	Economic Diversification vs. Energy Legacy
 ENERGY SECURITY	Access expansion constrained by weak transmission, integration, and delivery capability	Electricity demand growth outpacing infrastructure and system flexibility during coal transition	Grid and system not ready for electrification and renewable integration	Hydro dependence exposed to climate variability and transmission bottlenecks	Geopolitical exposure and resilience risks in highly interconnected and increasingly digitalised systems
 ENERGY EQUITY	600 million without electricity	Maintaining affordability and industrial competitiveness during large-scale system transformation	Rising transitions costs testing affordability, industrial competitiveness, and political support	Fossil fuel subsidies politically irresistible; distributed solar creating regressive cross-subsidies	Managing subsidy reform while maintaining social stability and affordability
 ENVIRONMENTAL SUSTAINABILITY	Fastest development pathway constrained by international finance withdrawal from gas	Rapid demand growth vs. persistent fossil-fuel reliance and clean energy expansion	Deployment constrained by permitting delays rather than by financing or policy	Political and regulatory volatility undermining long-term transition investment and delivery	Expansion and optimisation logic, not replacement; need for CCUS and decarbonisation
LEADERSHIP CHALLENGE	Building institutional and financial capability while expanding access	Coordinating fragmented pathways amid explosive demand growth	Maintaining legitimacy and competitiveness while managing system strain	Sustaining long-term policy continuity and investment confidence	Balancing strategic diversification with geopolitical and economic stability

TENSION #1: INVESTING IN TOMORROW'S SYSTEM VS. MANAGING TODAY'S COSTS**Infrastructure Resilience vs Affordability**

Computed using data from Enerdata



Reaching today's dual goals of low cost and reliability may be coming at the expense of tomorrow's transition to clean energy. Systems which have achieved both affordability and resilience today show the lowest average share of clean energy (32%), even lower than quadrants still struggling on cost or resilience. The largest population bloc (3.1bn) is affordable-but-less-resilient, at just 39% clean, reflecting the mutual dependency on infrastructure resilience and renewable development. Many European countries are resilient-but-unaffordable, with the highest share of clean energy on average (60%) reflecting the importance of maintaining affordability while systems evolve towards the systems of tomorrow. African countries cluster below the resilience median, likely to shift as infrastructure develops. Some countries manage all three dimensions, with high performance across clean energy, affordability and resilience – the trade-off is real, but not absolute.

SCALING TRANSITIONS BY REBALANCING NOW

Meeting this moment is a leadership challenge before it is a technology or financing challenge – and it cannot be met by the energy sector alone. The systems that must now be balanced extend across a much wider ecosystem: the power system (utilities, generators, network operators), the digital systems it increasingly depends on and increasingly powers (telecommunications, cloud and data infrastructure, cybersecurity), the financial systems that mobilise capital and shape investment decisions, the industrial systems energy enables (manufacturing, transport, water, critical supply chains), and the policy frameworks that influence public acceptance and investment timing.

The World Energy Trilemma remains the Council's enduring framework for understanding energy systems. Its Index will continue to evolve as better global data becomes available at every level. But the Trilemma is more than an index referenced once a year. It provides the framework for practising the leadership capability of rebalancing. The Index helps make trade-offs visible. Dialogue helps leaders interpret them in context. Rebalancing is the discipline of acting on them. This report does not offer a new Index; it aims, instead, to strengthen leadership capability, enabling a more productive conversation about the choices the numbers cannot yet see.

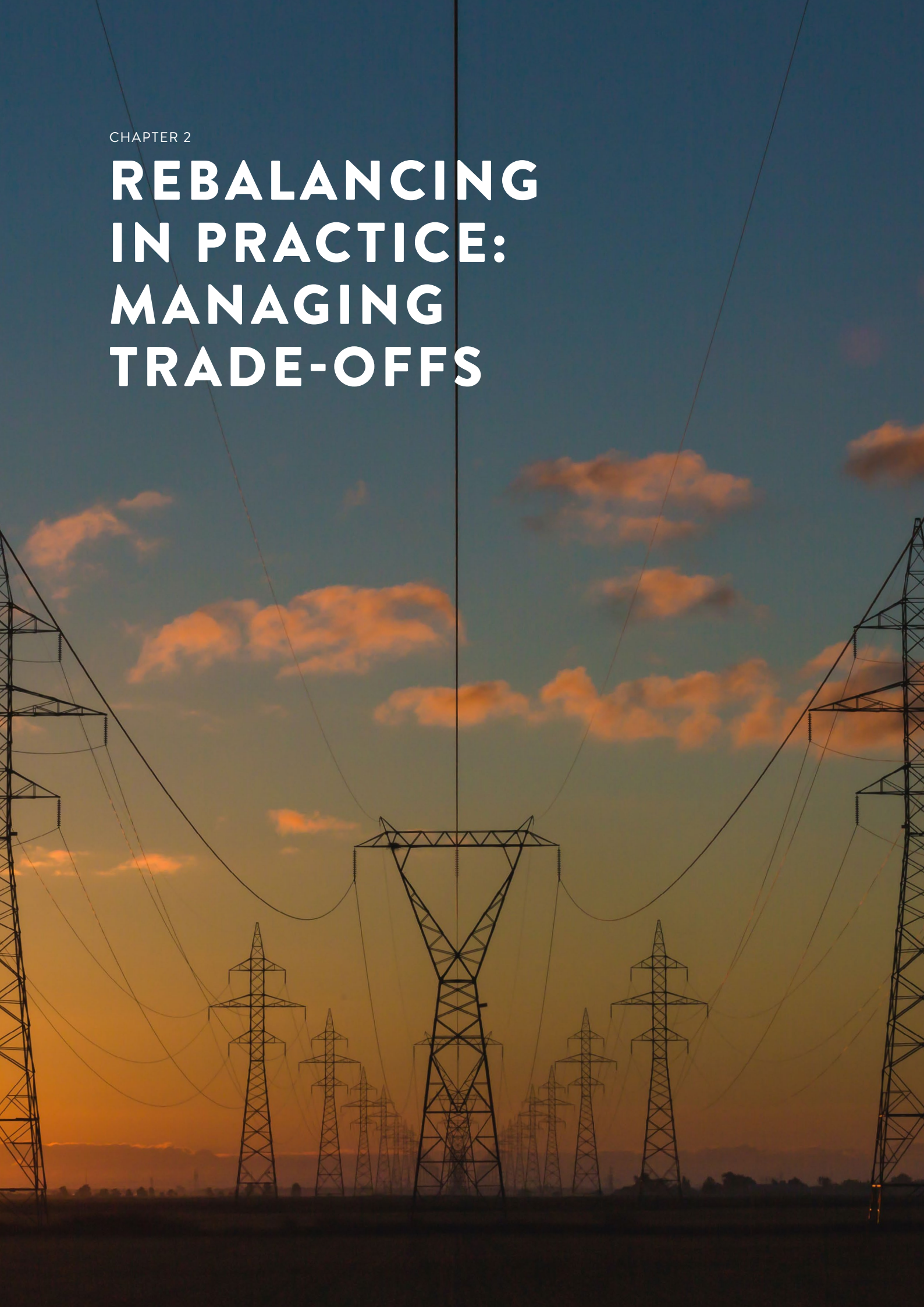


The Trilemma makes trade-offs visible. Rebalancing is the leadership capability of continuously holding them in balance together, as conditions change.

The chapters that follow set out what the Council's community is learning about how to lead across the changing ecosystem: first the five Trilemma trade-offs leaders are facing now, surfaced through the Council's community engagements; and then the key leadership skill necessary to meet them.

CHAPTER 2

REBALANCING IN PRACTICE: MANAGING TRADE-OFFS



CHAPTER 2

REBALANCING IN PRACTICE: MANAGING TRADE-OFFS

Five key trade-offs – what leaders are struggling with

The Council's Regional Leadership Exchanges identified five key trade-offs from across all five regions. For each trade-off, the leaders explored:

- 1 What is at stake?
- 2 Where is the challenge greatest?
- 3 What are the Trilemma implications?
- 4 Which contextual issues are critical uncertainties as seen in the World Energy Issues Monitor 2026?

The Trilemma provides a common language for understanding these trade-offs. Some sit primarily between two dimensions – for example security and affordability – while others involve balancing all three. Still others emerge where the Trilemma meets wider economic, social, and geopolitical realities.



Image from Series 3 of BBC StoryWork's
'Humanising Energy', featuring Acumen Ampersand

TRADE OFF #1

INVESTING IN TOMORROW'S SYSTEM VS. MANAGING TODAY'S COSTS

Every leader in every region identified grid and system integration infrastructure as the binding constraint of energy transitions. The necessary investments in transmission, storage, and flexibility to enable integration is directly in tension with the affordability pressures that make it politically difficult to fund. Deferring grid investment makes the transition harder and more expensive over time; but pushing ahead imposes higher real costs on households and industries already under pressure. Capacity built ahead of need means today's customers paying for tomorrow's system.

A FINANCING-AND-SEQUENCING TRADE-OFF, NOT A TECHNOLOGY ONE

EUROPE | POLAND

COAL RETIREMENT

Coal phaseout outpacing grid and storage readiness; no credible replacement at scale without grid investment.

Grid readiness sets the pace; the constraint is capacity to build, not ambition.

MEGS | SAUDI ARABIA

HYBRID ENERGY MIX

50% renewables by 2030 requires storage duration beyond today's four-hour capability, so gas-fired flexible plants remain the necessary complement.

Competitive procurement has driven record-low battery storage costs; extending duration is the next frontier.

EUROPE | ROMANIA

VIRTUAL POWER PLANTS

Independent aggregators combine distributed generation, storage, and flexible demand into a single dispatchable resource – grid stabilisation and affordability without large-scale centralised investment.

Enabler / constraint: regulatory design decides who benefits.

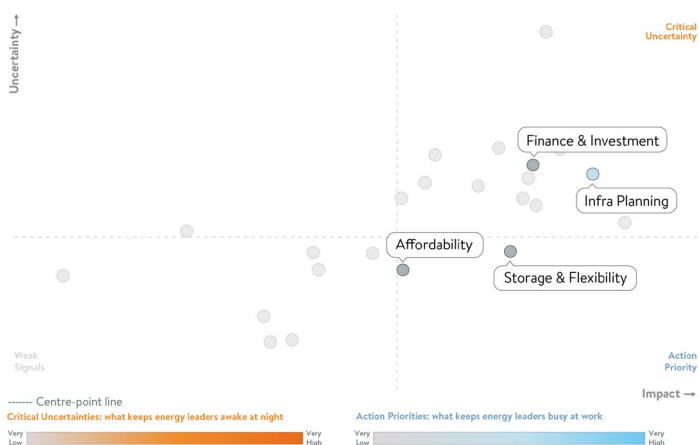
ASIA | AUSTRALIA

GAS BRIDGE VS. RENEWABLES

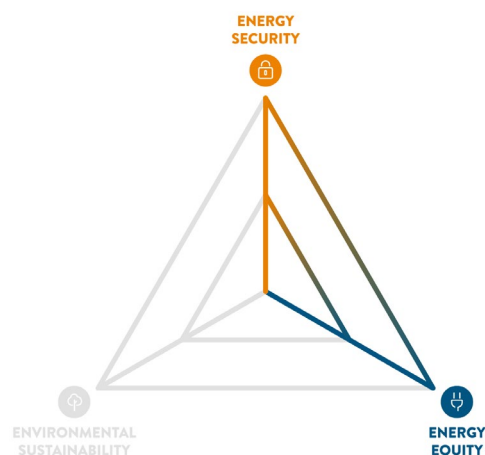
Transmission is the binding constraint on both options as the coal fleet retires.

Planning timelines slow both routes.

CONTEXT ISSUES IN PLAY



THE CHALLENGE



TRILEMMA IMPLICATIONS



Deferred grid investment creates supply gaps and instability as coal retires and renewables grow.



Consumers bear the cost of both options – higher bills now, or higher transition costs later.



Grid readiness is the binding constraint on renewable deployment.



At what point does deferring investment cost more than building it – and who would need to be in the room to make that call?

TRADE OFF #2

REDESIGNING MARKETS VS. LIVING WITH CURRENT MARKET REALITIES

Markets that price only today's energy cannot fund tomorrow's infrastructure. This tension runs across every region but takes fundamentally different forms. In developed economies the trade-off is about market design that fails to reward long-term system value such as flexibility; in developing economies it is about the lack of investable market conditions. Accepting current market realities to avoid near-term political and affordability costs leads to governance problems that weaken long-term investment signals.

POLICY DECISIONS AND FINANCIAL CONSEQUENCES

ASIA | CHINA

ADMINISTERED TARIFF STABILITY

Tariffs unchanged for 20 years as a deliberate social-stability instrument; market reform risks affordability shocks. Market-based trading has already lowered industrial and commercial costs, while residential tariffs are held stable by design.

Provincial markets are being integrated into a national one – basic unification is targeted for 2030, with completion by 2035, designed to sequence reform without exposing consumers to price shocks.

AFRICA | NIGERIA

COST-REFLECTIVE TARIFF REFORM

Below-cost tariffs bankrupt the utilities the poor depend on; cost-reflective reform, sequenced with private participation, would be an access enabler.

Institutional capacity to sequence pricing and protection is the binding constraint.

LAC | BRAZIL

DISTRIBUTED SOLAR LOCK-IN

Brazil's net-metering form of compensation is shifting towards partial network cost recovery for new installs, but the existing 47 GW is grandfathered until 2045. Compensation recovers fixed grid costs from a shrinking grid-dependent base.

Prosumer market design is the prerequisite; confronting the grandfathered lock-in is a governance challenge.

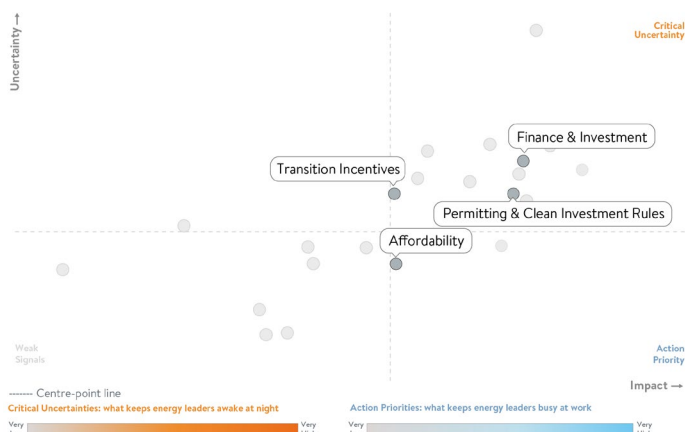
AFRICA

MISSION 300 – AMBITION VS. FINANCING

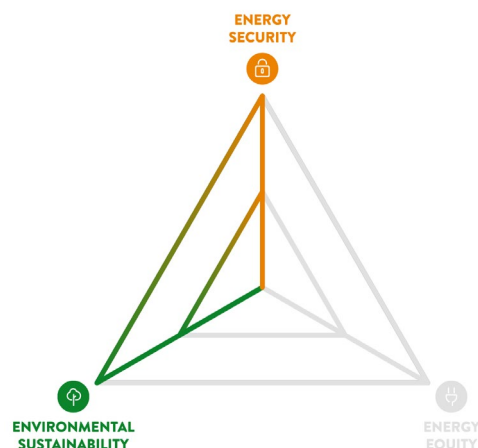
Those to be connected cannot pay the cost of connection – subsidies from other customers, taxpayers, or donors are required to reach 300 million people by 2030.

Mission 300 makes fiscal reform the precondition for finance.

CONTEXT ISSUES IN PLAY



THE CHALLENGE



TRILEMMA IMPLICATIONS



Long investment cycles need signals beyond current pricing horizons; without reform, reliability degrades as demand grows.



Who bears the cost of electricity price reform determines whether low-income consumers are protected or penalised.



Private capital does not flow without long-term regulatory certainty; political volatility is a sustainability risk.



Where have market rules already been redesigned successfully – and what made that politically possible?

TRADE OFF #3

NATIONAL COMPETITIVENESS VS. CROSS-BORDER INTERDEPENDENCE

Energy is not just an input to industry – it increasingly is industrial strategy itself. A country's industrial competitiveness now depends on securing energy that is affordable, reliable, and not hostage to a rival, so the question of where energy comes from is inseparable from the question of whether industry can compete. Few countries face a clean binary. The real decision involves three possible options: produce domestically, in some instances at a higher cost than importing; import from an ally, rarely the cheapest source; or import from the lowest-cost supplier, who may not be an ally. Framed this way, the greatest challenge is not competitiveness but dependence – on whom a country is willing to depend, for what, and at what price.

A DEPENDENCE QUESTION – ON WHOM, FOR WHAT, AT WHAT PRICE

EUROPE | EU

BETWEEN TWO MANUFACTURING SUPERPOWERS

Industry loses investment to US subsidies and cost competitiveness to Chinese manufacturing, as falling industrial electricity demand signals early-stage erosion. Europe's response is acknowledged as a strategic gap.

Coherence must fit diverse national starting points.

ASIA | CHINA

MANUFACTURING DEPTH AS ENERGY SECURITY

China turned energy security from a resource problem into a manufacturing-capacity problem – then won both on domestic capacity and exports.

Increasing domestic production across solar, wind, batteries, and grid equipment.

LAC | ARGENTINA

VACA MUERTA AND REGIONAL GAS

A major non-conventional gas reserve offers the prospect of a regional security buffer offsetting hydro variability, but political volatility creates investment risk for the enabling infrastructure.

Political volatility is the binding constraint.

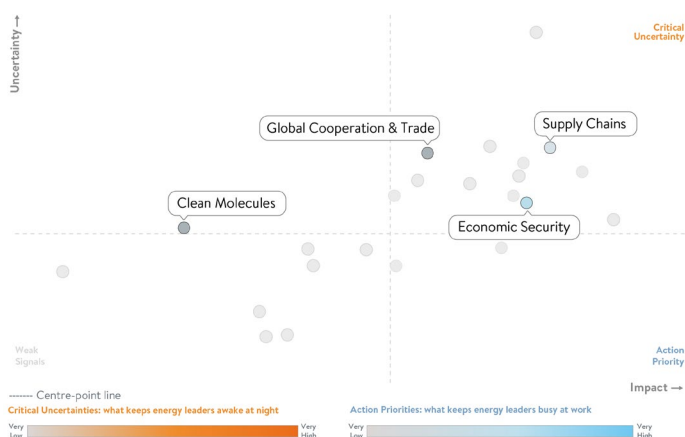
LAC

CRITICAL MINERALS – ENDOWMENT VS. GOVERNANCE

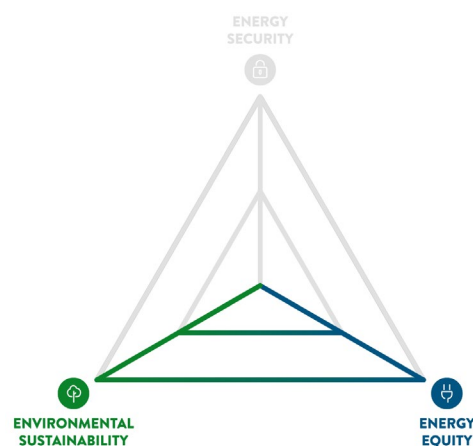
LAC holds 40% of global copper and lithium reserves, but these become a strategic asset only if they attract durable investment and move up the value chain into processing. That requires investment policy and contract stability that hold across political cycles.

Institutional strength converts reserves into a durable investment and industrial position.

CONTEXT ISSUES IN PLAY



THE CHALLENGE



TRILEMMA IMPLICATIONS



Supply-chain sovereignty reduces exposure but requires industrial investment few can afford; interdependence is efficient but vulnerable.



Industrial strategy aligned to transitions can sustain industrial employment through reskilling; without that alignment, costs fall on workers in energy-intensive industries.



Carbon displacement – exporting the burden while decarbonising at home – remains unresolved in every region.



Which dependencies can we live with, and which are worth paying a premium to avoid?

TRADE OFF #4

SPEED OF TRANSITIONS VS. SOCIAL LEGITIMACY

In most regions, binding constraints consist of permitting delays, community resistance, and regulatory fragmentation – not policy ambition or, increasingly, finance or technology, none of which can be used to build assets when projects stall. Where the transitions does begin to move, it often outruns the social and institutional groundwork that would let it move further – and that groundwork, not capital or technology, is what is now missing. Technical solutions cannot substitute for societal trust, but trust builds on a slower clock than climate and security imperatives require. This mismatch in timing is the tension.

TRUST IS THE PACING FACTOR

EUROPE | POLAND

COAL PHASE-OUT UNDER SYSTEM-READINESS CONSTRAINT

The EU's most coal-dependent major economy is pacing its coal exit through a hybrid pathway – renewables, transitional gas, nuclear – where grid readiness and social acceptance together set the speed, not ambition. Neither can be outrun without destabilising the system or losing public support.

The binding constraint is sequencing: moving no faster than grid and coal-regions can jointly bear.

ASIA | JAPAN

NUCLEAR RESTART LEGITIMACY

A decade after Fukushima, restart became possible because of strengthened post-Fukushima safety reviews, while affordability, energy security pressure, and rising demand converged to shift public acceptance.

Legitimacy moved slowly, and only when multiple pressures aligned – not a pace that can be forced.

LAC | COLOMBIA

COMMUNITY BLOCKAGE

Communities increasingly block renewable infrastructure where consultation is insufficient and local returns compare unfavourably to mining and hydrocarbon projects. Colombia's Empresas Públicas de Medellín (EPM), a publicly-owned municipal utility, is the counterexample: social licence is earned through shared benefit design from the outset, not negotiated under pressure.

The binding constraint is trust: social licence must be designed in through shared benefit, not recovered once opposition has hardened.

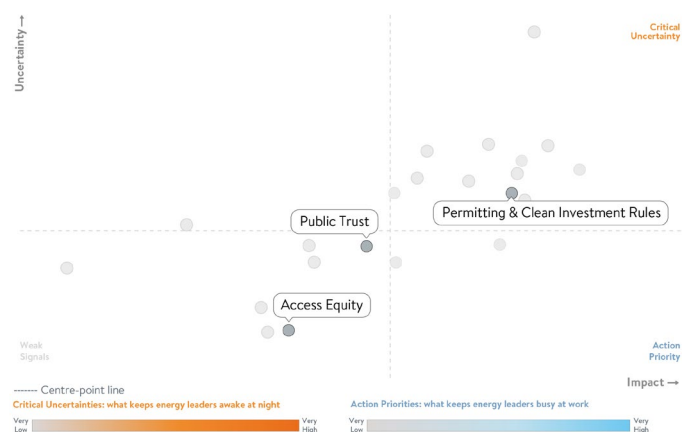
MEGS | LEBANON

PRIVATE SOLAR

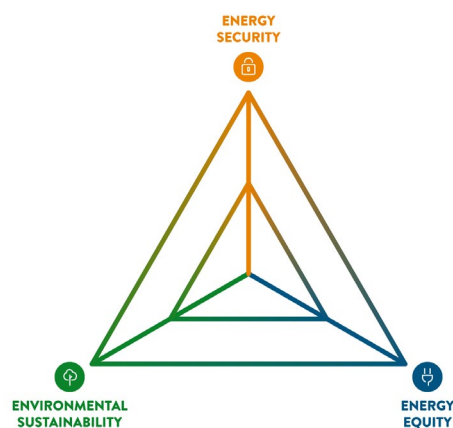
When 1.2 GW of solar was built by the private sector without the state, a two-tier energy system emerged: those who could afford solar could self-supply, while those who could not remained dependent on the collapsed grid or costly diesel generators.

Regulatory design needs to prevent cost-shifting to non-solar customers.

CONTEXT ISSUES IN PLAY



THE CHALLENGE



TRILEMMA IMPLICATIONS



Without community acceptance, energy infrastructure is increasingly difficult to build.



The equity failures most likely to produce backlash arise from communities forced to bear disruption without sharing in benefits.



Permitting is the binding constraint on deployment – targets that cannot be permitted are not credible targets.



What should be included in project design to earn social legitimacy?

TRADE OFF #5

INSTITUTIONS WE NEED VS. INSTITUTIONS WE HAVE

Institutions designed for a stable, centralised, fossil-fuel energy system are being asked to manage a distributed, intermittent, rapidly evolving one. This is not a trade-off between two goods — it is the gap between the institutions the other four tensions require and the ones currently in place. Where that gap is wide, none of the other tensions can be well governed. The question is not whether existing institutions can improve — most can, incrementally — but whether incremental improvement is sufficient for the speed and complexity of transformations now required. Across the regions, the answer emerging is that it is not. What is required now is not simply choosing between options within an agreed frame, but constructing the frame itself: how trade-offs are surfaced, what voices shape them, and how legitimacy is built for the choices that follow. Integrated planning requires new cross-sectoral coordination architectures and the leadership capability to work within them.

THE TRADE-OFF THAT DETERMINES WHETHER THE OTHER FOUR CAN BE GOVERNED AT ALL

AUSTRALIA

STATE VS. FEDERAL SPLIT

Energy policy split across jurisdictions, creating planning incoherence over ageing infrastructure.

Energy disruptions will force decisions people do not want to make.

AFRICA | UGANDA

NASCENT REGULATORY CAPACITY

Transmission is lagging generation; regulatory capacity is at an early stage; private participation is newly opened.

The binding constraint is calibration — setting the pace of market opening against the regulatory capacity each system actually has.

MEGS | SAUDI ARABIA

SUPREME COMMITTEE MODEL

Cross-sectoral integration at the highest level provides a governance framework for managing complex energy trade-offs across government institutions.

Institutional capacity to coordinate cross-sectoral trade-offs and make timely decisions.

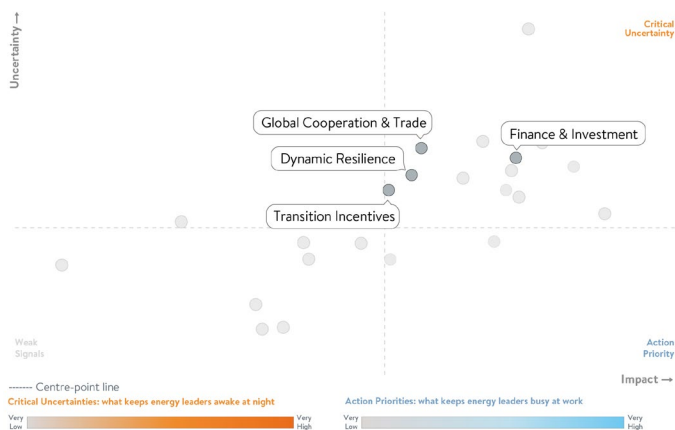
EUROPE

EU COHERENCE VS. NATIONAL SOVEREIGNTY

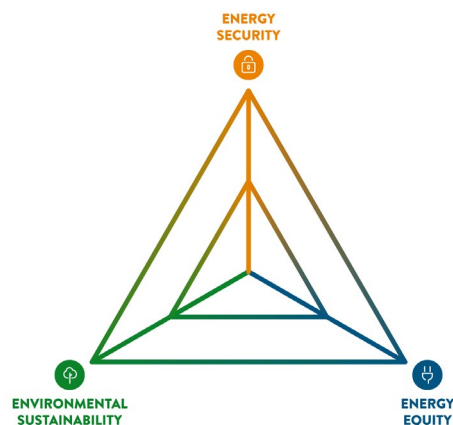
A framework that gives stability and investment signals but constrains national technology choices, such as nuclear.

Finland's technology-neutral policy is an enabling governance innovation.

CONTEXT ISSUES IN PLAY



THE CHALLENGE



TRILEMMA IMPLICATIONS



Fragmented governance creates security gaps that no amount of investment can fill without coordination architecture.



Governance failures are equity failures — costs fall disproportionately on those with least capacity to absorb them.



Long-term decarbonisation requires policy continuity that short political cycles systematically undermine.



What new cross-sectoral architectures do we need, and how can they be built?

FIVE KEY REMAINING ISSUES FOR FUTURE DIALOGUES

Across all five Regional Leadership Exchanges, these key issues were either absent from the dialogue or were raised only to be set aside. These are not peripheral issues. They will produce the next wave of consequential tensions that current leadership agendas are not yet equipped to navigate.

Water–energy nexus	Water-energy nexus issues include cooling-water dependency for data centres and for nuclear and thermal generation, hydro vulnerability to drought, the need for water for solar-panel cleaning, and desalination energy costs. In addition, climate change is making the water-energy nexus a first-order security issue.
Cybersecurity	AI-enabled attack sophistication is growing as grids become more interconnected and digitally managed. But while cybersecurity was explicitly identified as the next frontier of energy-system vulnerability, it was not a focus of any regional security conversation.
Critical minerals governance	Africa holds significant cobalt, copper, and rare-earth reserves, and LAC holds 40% of global copper reserves. Discussion about governance of extraction, processing, and export – and the communities that live with the impacts – was absent despite being central to transition supply chains.
Workforce and human capability	The engineering, grid-operation, project development and digital skills required for system transformation were mentioned, but the problems associated with training workers were not examined. The transitions are increasingly a human capability challenge, not only a technology or financing one.
Demand-side transformation	Discussions of consumer behaviour, AI, data centres, demand flexibility, prosumer regulation, and the shape of industrial electricity demand were largely absent – yet demand management is central to system integration at high renewable penetration.

These emerging issues are not separate problems. They intersect with the leadership tensions explored throughout this report and will increasingly shape how those tensions are navigated. Their absence from today's conversations is itself a signal. It suggests that leadership capability must evolve not only to manage today's trade-offs, but also to anticipate tomorrow's.



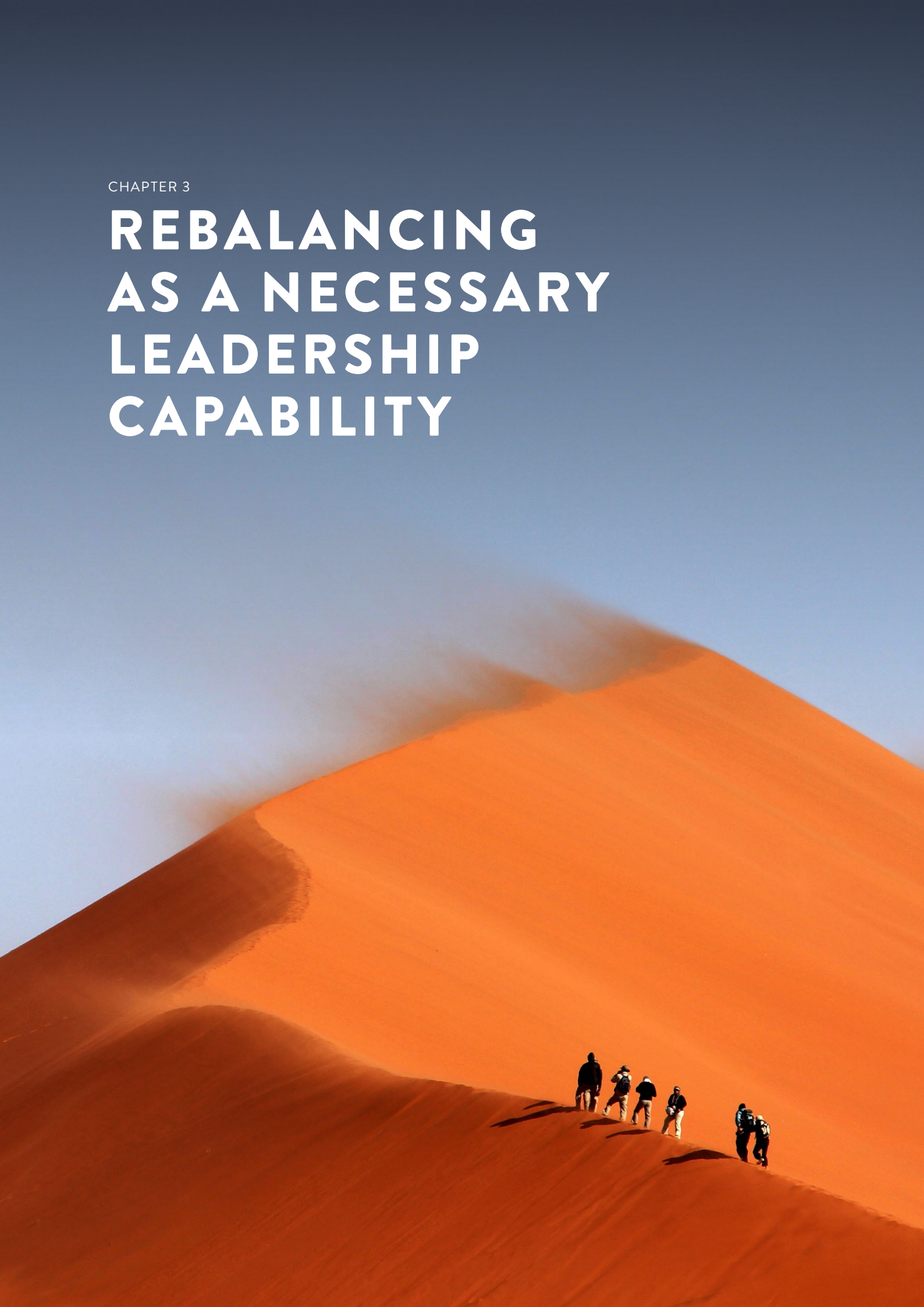
“Cybersecurity is something that deserves more attention. You don’t have to attack a power plant – you can have a cyber attack from anywhere in the world and shut it down.”

—
Eng. Fahad Alajlan, President, KAPSARC; Chair, Middle East & Gulf States

Middle East & Gulf States Regional Leadership Exchange

CHAPTER 3

REBALANCING AS A NECESSARY LEADERSHIP CAPABILITY



CHAPTER 3

REBALANCING AS A NECESSARY LEADERSHIP CAPABILITY

As energy transitions unfold alongside broader economic, technological, and societal transformations, success increasingly depends on the capability to quickly rebalance competing priorities under changing conditions.

A CHANGING LEADERSHIP CONTEXT

The World Energy Trilemma has always recognised that energy systems require continuous balancing between security, equity, and environmental sustainability. What has changed is not the existence of these competing priorities, but the context in which they are managed.

Energy transitions are unfolding alongside profound geopolitical, technological, economic, and societal transformations. Decisions are increasingly made in an environment characterised

by accelerating change, deeper interdependencies, and greater uncertainty. The assumptions that informed yesterday's decisions may no longer hold by the time those decisions are implemented.

This new context calls for new leadership skills in relation to Trilemma trade-offs. The balance the Trilemma describes was always aspirational and never fixed; what is new is that this balance must now be actively and continuously re-achieved, because conditions change faster than decision cycles can settle them. That is the shift rebalancing responds to: not balance itself, but the pace at which it now has to be re-achieved.

Across five Regional Leadership Exchanges, which convened more than 275 senior energy leaders from 65 countries, participants identified four foundational capacities needed for succeeding in the new dynamic energy context.

1. INSTITUTIONS DESIGNED FOR REBALANCING CAPACITY

Systems that manage the Trilemma well over time share one feature: the place where trade-off decisions are made is designed for that purpose. An effective rebalancing institutional architecture considers competing priorities at a level where they can actually be weighed against one another.



“The energy trilemma should not be viewed as a fixed balance to achieve once and maintain forever. It means making decisions realistic enough to preserve security, affordable enough to sustain public confidence, and ambitious enough to move the system forward.”

—
Eng Muhsin AlGarni, GM of General Department of Electricity Policies, Ministry of Energy (Saudi Arabia)

Middle East & Gulf States Regional Leadership Exchange

Region case

What it demonstrates

MEGS
SAUDI ARABIA – SUPREME COMMITTEE

Cross-sectoral committees chaired at the head-of-government level integrate electricity, hydrocarbons, industry, regulation, and consumer perspectives into a single decision framework – ensuring that transition decisions remain orderly, coordinated, dynamic and sustainable over time.

EUROPE
FINLAND – TECHNOLOGY-NEUTRAL POLICY

Consistent long-term policy signals, rather than technology mandates, enable 96% fossil-free electricity – a capability built through regulatory architecture, not resource endowment.



2. TRADE-OFFS MANAGED AT THE SYSTEM LEVEL, NOT THE TECHNOLOGY LEVEL

What looks like a technology problem is frequently a system-architecture problem in disguise – ‘too much renewable energy’ is often a proxy for too little grid. Trade-offs that can’t be resolved at the technology level can often be resolved at the system level.

Region case	What it demonstrates
ASIA CHINA – UHV GRID ARCHITECTURE	Nearly 50 UHV projects across China, producing over 420 GW of cross-regional capacity – a systemic answer to the geographic mismatch between renewable resources and load centres. China now has the world’s most advanced long-distance transmission system.
LAC BRAZIL – THE GREEN BONUS	90% renewable electricity at competitive cost – the security–sustainability trade-off is resolved where the cheapest expansion option is also the most sustainable.
EUROPE ROMANIA – VIRTUAL POWER PLANTS	Grid stabilisation and affordability improvement together, through distributed-asset aggregation – capability through system design, not technology substitution.

3. SOCIAL LEGITIMACY TREATED AS A CHALLENGE OF INFRASTRUCTURE, NOT COMMUNICATION

Across every region, the most technically sound and financially viable projects succeeded – or stalled – based on whether communities accepted them. Legitimacy built from the start is a form of infrastructure, and it cannot be retrofitted.

Region case	What it demonstrates
LAC COLOMBIA – EPM ENGAGEMENT MODEL	An academia–public–private partnership in Medellín, building social licence through shared-benefit design – acceptance treated as a project prerequisite, not a communications exercise.
ASIA JAPAN – NUCLEAR REASSESSMENT	Public acceptance of a previously rejected technology shifted as a credible multi-dimensional case – affordability, energy security, and rising demand – replaced a single-issue debate. Legitimacy can be rebuilt, but only when the case for it addresses several priorities at once, not one.
MEGS SAUDI ARABIA – AGRICULTURAL SOLAR	A spontaneous shift from diesel irrigation to solar and batteries on 7–8-month payback – adoption driven by direct economic benefit, not mandate.

4. PREPAREDNESS DEVELOPED THROUGH ADAPTATION AND LEARNING, NOT PREDICTION

Disruption cannot be reliably predicted. The institutions that come through it best are not those with the best forecasts but those that adapt under pressure and learn from real events and foresight skills – security drawn less from the accuracy of the plan and more from the adaptive capacity of the institution.

Region case

MEGS
**MIDDLE EAST – PLANNING
FOR RAPID RECOVERY**

What it demonstrates

Active regional conflict shifting security planning from reliability-based indices towards resiliency-based ones, creating scenarios that help systems prepare for uncertainty, detect threats, react, recover rapidly, learn and adapt.

These four foundations for rebalancing do not represent four independent reforms or a checklist for institutional change. Across regions they appear in different forms, reflecting different national circumstances. Together they point to a common pattern: leaders strengthen their ability to navigate competing priorities by designing institutions, thinking systemically, building legitimacy, and learning through practice.

Trade-offs themselves have become more dynamic, more interconnected, and more consequential. When the conditions surrounding a decision continue to shift after that decision has been made, balance ceases to be a fixed state and becomes a continuous practice. Rebalancing is the capability to recognise emerging tensions, weigh competing priorities, identify opportunities for synergy, and adapt as conditions change.



Image from BBC Humanising Energy

REBALANCING AS A LEADERSHIP CAPABILITY

Rebalancing consists of five key practices, each already visible in the foundations above. They are recurring leadership practices through which rebalancing capability is developed.

FRAMING THE TRADE-OFFS

Identifying a trade-off explicitly, including aspects that metrics cannot yet capture, so it can be discussed before a choice is forced by events. The surfacing of trade-offs is a core feature of World Energy Council Trilemma dialogues.

WORKING THE INTERFACES

Exercising judgement where energy meets digital, industry, finance, communities, and nature.

GOVERNING THE TRADE-OFFS

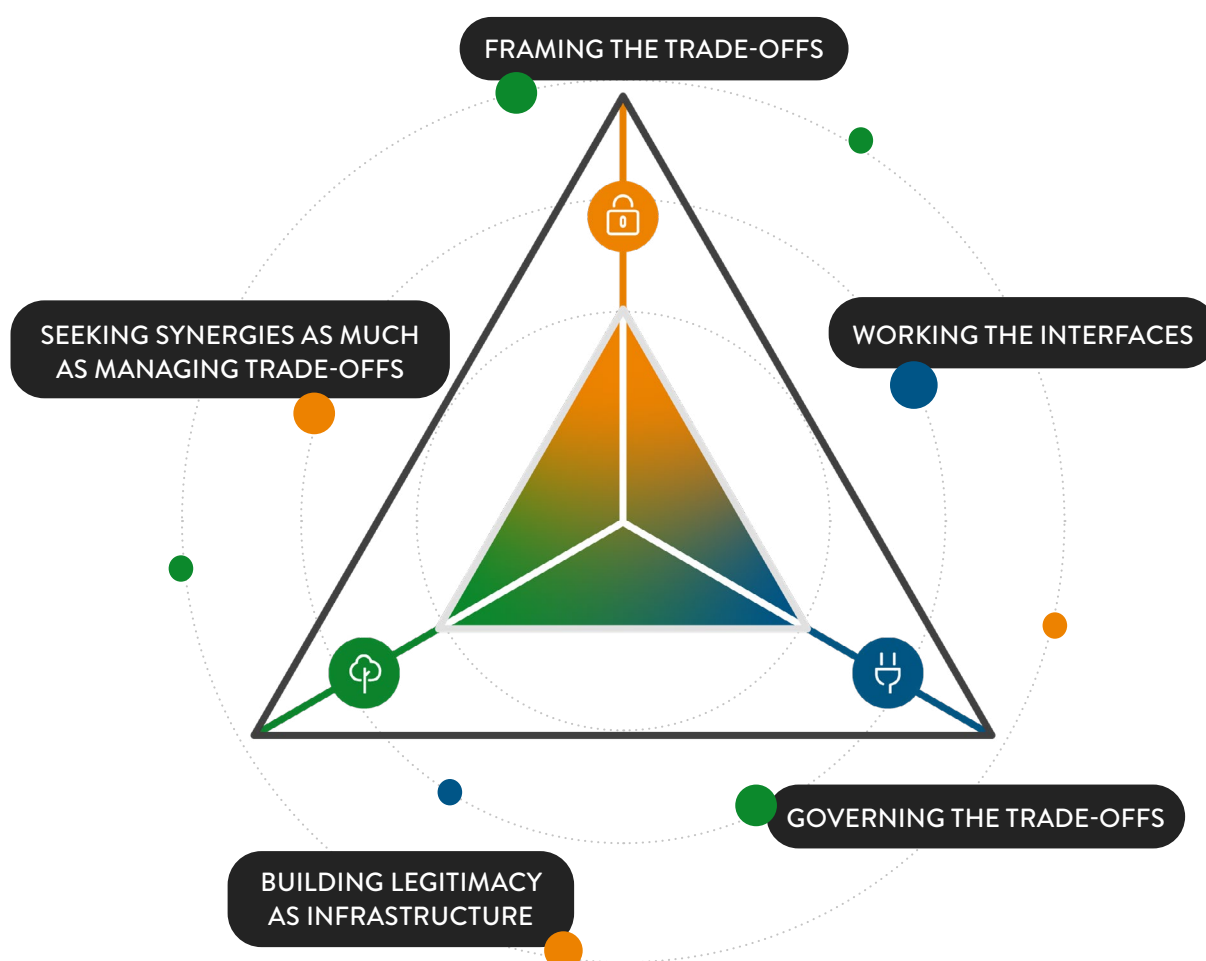
Building governance with real authority over resources, distinguishing the stable rules of the governance context from the adjustable moves within it, and orchestrating pathways over time without political flip-flops.

BUILDING LEGITIMACY AS INFRASTRUCTURE

Treating social licence as a project prerequisite, not a communications exercise.

SEEKING SYNERGIES AS MUCH AS MANAGING TRADE-OFFS

The same discipline that holds a tension can find the move that turns two pressures into one gain.





CASE STUDY

REBALANCING IN PRACTICE – BRAZIL

Thiago Barral, Undersecretary of Carbon Markets Implementation, Ministry of Finance, Brazil

At first glance, Brazil appears to have resolved Trilemma trade-off by offering around 90% renewable electricity at low cost. But success has created a new problem. Adding more solar with the same daily profile has pushed generation curtailment to record-high values. Renewable power is wasted, investors lose revenue, and pressure to share these losses with consumers is increasing. In this context new projects have stalled, requiring attention to the risk of a shortfall of reliable energy in the coming years. The Trilemma trade-off did not disappear – it moved into how the market is designed. Looking at the Brazilian Trilemma through the rebalancing challenge indicates how a constructive dialogue could take shape.

Declaring the missing piece. Brazil's strategy has been guided by solving one Trilemma trade-off: expand renewables at the lowest cost and proactive grid planning and investment. The missing side of the Trilemma is security: specifically ensuring price signals are unambiguous and steer investment towards system flexibility to meet adequacy criteria.

Framing the trade-offs. The trade-off: fast deployment of low-cost solar today versus the rising cost of fitting it into the system. Because the cost arrives in the future, the choice is easy to defer – which is precisely why a rebalancing dialogue belongs in the present.

Working the interfaces. Because hydro dominates the system, Brazil's power prices are set largely by rainfall, with seasonal and interannual variability. Rainfall moves prices, prices decide whether loans can be repaid, and pricing drives investment in energy, capacity, and flexibility. Energy decisions and financing decisions are currently made in different rooms. How can they be integrated or aligned?

Governing the trade-offs. Brazil's long-term market signal – the 25-year-old system-adequacy framework – is now insufficient. With heavy curtailment undermining solar revenues, investment in new power generation has largely stalled. Attention has shifted to non-renewable capacity mechanisms, but balancing capacity is not the same as balancing energy supply and demand. The short-term and long-term market signals were produced separately – who convenes a co-ordinated response?

Building legitimacy as infrastructure. A power shortage is the moment hidden costs become visible. Curtailment, deferred investment, and price signals that don't reflect scarcity are costs the system is already absorbing. The dialogue question is one of timing: should the costs be made explicit and allocated deliberately now or left to surface later, all at once?

Seeking synergies as much as managing trade-offs. Options that need no grand plan are already available – hourly pricing power, virtual power plants, and incentives to shift user demand. Each option turns two pressures – cost and integration – into one gain, and buys time for the bigger fix. Which option to choose can be put on the table for dialogue now.

What comes out of a rebalancing dialogue is an agenda for discussing trade-offs and timing as well as whether the market signals need redesigning together, which near-term options to weigh and in what order, and when the public conversation should start and when it should reconvene.



CASE STUDY

REBALANCING IN PRACTICE – INDIA

Nishant Sharma, Deputy General Manager, NTPC India

India offers one of the world's most encouraging Trilemma success stories. It crossed 50% non-fossil installed capacity in 2025, a full five years ahead of its pledge, and has since raised its ambition to 60% by 2035, backed by a record ~45 GW of solar added in a single year. With this remarkable pace, the leadership conversation is now shifting productively from building capacity to integrating it fully, ensuring that every clean electron is put to use. India's Trilemma, read through the rebalancing practices, shows how a forward-looking dialogue turns rapid success into durable system strength.

Declaring the opportunity. India has already delivered on two Trilemma goals at once, expanding renewables at record pace while keeping power broadly affordable. The next value-creating step is system flexibility: adding storage, transmission, and smart balancing so that clean generation increasingly displaces higher-cost sources and delivers its full economic value.

Framing the trade-offs. The choice is a constructive one - how best to sequence low-cost solar today with the flexibility investments that maximise its value tomorrow. Having that dialogue now lets India capture the gains early. The momentum already in place makes this an ideal moment to act.

Working the interfaces. India's system blends abundant daytime solar with dependable evening capacity from coal, hydro, and gas to meet a peak of ~270 GW. The opportunity is for several agencies to coordinate planning in order to integrate generation, storage, transmission, and distribution.

Building legitimacy as infrastructure. India's transparent, consultative approach, evident in FICCI/CEA forums and public policy consultations, means the value case for flexibility and storage can be made openly and early, building broad stakeholder confidence in the investments ahead.

Seeking synergies. The near-term wins are readily available and cost-effective: analysis suggests a modest addition of midday battery storage could unlock significant surplus solar, in line with the CEA's ~82 GWh storage target for 2026-27. Paired with time-of-day pricing, demand shifting, and faster transmission in solar-rich Rajasthan and Gujarat, each step turns two goals - affordability and clean-energy integration - into a single gain.

What comes out of a rebalancing dialogue is an agenda for value creation: how to align dispatch and adequacy signals, which flexibility options to prioritise first, how storage scales alongside a strengthening discom sector, and when to reconvene.

The Council's Rebalancing Dialogues are structured exchanges in which leaders can test live decisions against emerging tensions. A country's resource base, institutional capacity, and political economy set the terms of every trade-off it faces. Because those terms differ, the value of the dialogue is not specific transferable best practices but shared understanding – a common basis for finding, within each context, where the trade-offs open room for opportunity.

The World Energy Trilemma Index continues to measure what is globally measurable, and its metrics will keep evolving. Now World Energy Council Rebalancing Dialogues will extend leadership attention to what is not yet measurable. This is not a new Trilemma index; it is a new Trilemma leadership conversation.



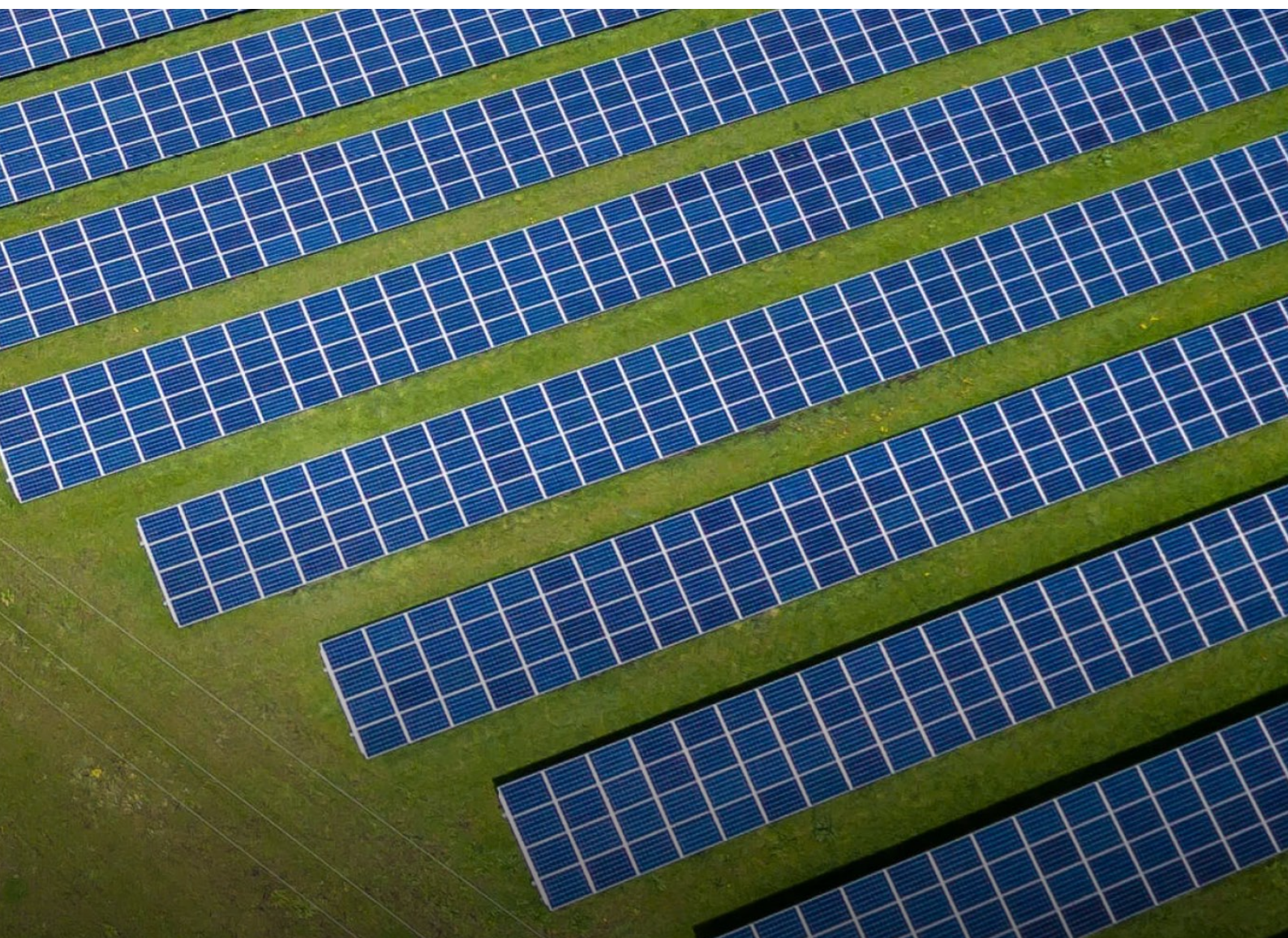
THE COUNCIL'S CONTRIBUTION

This report does not tell energy leaders how to run their systems. That has never been the Council's role. For more than a century the Council has convened the world energy community across geographies, technologies, and system interfaces, creating trusted spaces where leaders can make better sense of shared challenges together, and turn that sense into practical cooperation. This report is an expression of that work: the insights that surfaced when the Council's community reasoned through its hardest trade-offs together.

What surfaced is that while there are shared tensions across energy systems, there is no single pathway for resolving these tensions. Different starting points, resources, and societies move at different speeds, and progress comes through learning across those differences rather than imposing a common template on them. But while no single solution pathway emerged from the Council dialogues, what did emerge in common across the regional dialogues were the five practices of rebalancing - recurring patterns in how leaders are already learning to navigate competing priorities in their own systems.

Naming these patterns is how a common practice becomes a capability: visible, shared between peers, and available to the next leader facing the same tension. That is the contribution - not a general set of answers, but a leadership capability and a trusted space in which it is developed.

The ability to govern competing priorities with legitimacy - to surface trade-offs, work the interfaces, and continually rebalance as conditions change - must now be built into institutions themselves. That is the deeper task the five tensions point to and the dialogue and learning space in which the Council's convening role matters most.



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WORLD ENERGY COUNCIL PRINCIPAL CONTRIBUTORS

Dr Angela Wilkinson (Secretary General & CEO), Jo Bootle (Chief Operating Officer), Andrew Vickers (Senior Advisor, Communications & Engagement), Xiaowei Liu (Asia Director & Senior Advisor to Secretary General), Adnan Amin (Chair), Rafael Cayuela Valencia (Chair, Insights & Foresight Committee), John Carnegie (Chair, Finance Committee), Omar Zaafrani (Chair, Communications & Strategy), Barbara Terenghi (Chair, Strategic Community Committee), Naomi Hirose (Chair, Impact), Thaddeus Anim-Somuah (Chair, Future Energy Leaders), Burkhard von Kienitz (Chair, Regional Initiatives), Omar Farouk Ibrahim (Chair, Africa), Kim Yin Wong (Chair, Asia Pacific & South Asia), Claudio Seebach (Chair, Latin America and the Caribbean), Fahad Alajlan (Chair, Gulf States and Middle East), Dr Naïf Mohammed Alabbadi (Chair, 2027 World Energy Congress), Shota Lemondzhava (Head of Government Relations), Oluwadabira Abiola-Awe (Regional Manager, Africa), Maria Haydeé Jimenez (Senior Regional Manager, Latin America and the Caribbean), Masha Lukyanchuk (Senior Regional Manager, Europe), Keisuke Narahashi (Senior Regional Manager, Asia), Michelle Lee (Asia Relationship Manager), Michel-Ange Medlej (Senior Manager, Regional Activation and Middle East), Michelle Arellano (Senior Manager, Membership), Aditya Iyer (Senior Manager, Communications & Engagement), Rachelle Cooper Kulkarni (Senior Manager, Insights), Tanvi Varma (Manager, Marketing and Communications).

REGIONAL LEADERSHIP EXCHANGE PANELISTS

Dr Adnan Ali Alhosani (UAE), Angela Magalhães Gomes (Brazil), Aurélie Orcibal (France), Craig Froome (Australia), Eero Haapaalehto (Finland), Eng. Fahad Alajlan (Saudi Arabia), Fernando Monteverde (Argentina), Francisco J. Monaldi (US), Hector Cotes (Panama), Humphrey Asiimwe (Uganda), Joseph Law (Hong Kong), Dr Maja Czarzasty-Zybert (Poland), Eng Muhsin AlGarni (Saudi Arabia), Olivian Savin (Romania), Ou Xiaoming (China), Raúl Lancheros (Colombia), Salwa El-Samanoudy (Egypt), Taiwo Okwor (Nigeria), Thierry Abi Nader (Lebanon), Wale Shonibare (Côte d'Ivoire), Yu Guiyong (China).

CO-CHAIRS AND ADVISORY

Andy Calitz (World Energy Laureate), Sandra Winkler (Senior Director, Insights), Thiago Barral (Executive Co-Chair, World Energy Trilemma), Diana Mangalagu (Executive Co-Chair, World Energy Trilemma), Nishant Kumar Sharma (Executive Co-Chair, World Energy Trilemma), Jeremy Bentham (Co-Chair, Scenarios), Marius Oosthuizen (Director, Scenarios), Paul Appleby (Senior Advisor, Insights), Burak Yitgin (Türkiye), Chadia Abreu-Fellmann (Dominican Republic), Charles Weymuller (France), Christian Diendorfer (Austria), Dr Nawal Alhaneaee (United Arab Emirates), Dr Rares Hurghis (Romania), Dr Salwa El-Samanoudy (Egypt), Dr Yu Nagatomi (Japan), Guillaume Gillet (France), Haider Alabdulaal (Saudi Arabia), Keith Katyora (South Africa), Luis Manuel Santos Moro (Spain), Monique Motty (Congo), Raul Lancheros (Colombia).

WORLD ENERGY TRILEMMA TEAM

Betty Sue Flowers (Lead Editor), Reshma Francy (Associate Director, Policy Pathfinding & Trilemma), Jun Kondo (Senior Manager, Insights), Ana Gonzales (Research Assistant, Insights), Gabrijela Jerkovic (Insights Executive), Lucila Galtieri (Designer).

TRUSTEES

ADNAN AMIN

Chair

NAOMI HIROSE

Chair – Impact

FAHAD ALAJLAN

Chair – Middle East and Gulf States

OMAR FAROUK IBRAHIM

Chair – Africa

JOHN CARNEGIE

Chair – Finance

THADDEUS NII ACQUAH AFUTU ANIM-SOMUAH

Chair – Future Energy Leaders

RAFAEL CAYUELA VALENCIA

Chair – Insights & Foresight Committee

KIM YIN WONG

Chair – Asia

BURKHARD VON KIENITZ

Interim Chair – Europe

Chair – Regional Initiatives

OMAR ZAAFRANI

Chair – Communications & Strategy Committee

CLAUDIO SEEBACH

Chair – Latin America and the Caribbean

NAIF ALABBADI

Chair – World Energy Congress

BARBARA TERENCE

Chair – Strategic Communities Committee

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<u>Greece</u>	<u>Saudi Arabia</u>	

Hamilton House, Suite 101-102,
1 Temple Avenue
London,
EC4Y 0HA
T (+44) 20 7734 5996
F (+44) 20 7734 5926
E info@worldenergy.org

www.worldenergy.org | @WECouncil