



WORLD ENERGY COUNCIL

2024 SCENARIO FOUNDATIONS

ROCKS AND RIVERS

ABOUT

WORLD ENERGY COUNCIL

The World Energy Council is the world's oldest independent and impartial community of energy leaders and practitioners. Through our Humanising Energy vision, we involve more people and communities in accelerating clean and just energy transitions in all world regions. Formed in 1923, the Council has convened diverse interests from across the full energy ecosystem for a century, and today has over 3,000 member organisations and a presence in nearly 100 countries. Our global network draws from governments, private and state corporations, academia and civil society, as well as current and future energy leaders. We effectively 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](#) and [Twitter](#).

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ABOUT WORLD ENERGY SCENARIOS

Scenarios are equally plausible but divergent stories of the future that serve as platforms for strategic conversations. While forecasts may predict an "official future" built on the past, scenarios help leaders practice dealing with the unpredictable.

Scenarios are tools that help energy leaders grapple with uncertainties in energy transition and make sense of the important policy and strategy choices for them for the future. The current World Energy Council Scenarios refresh has re-examined the future of energy transition to 2050, in light of shifting geopolitics, rising climate and social risks, and divergent regional policy and technology choices. The World Energy Council is committed to using scenarios to surface opportunities for alignment and collaboration to accelerate transition. At Congress we will be using the scenarios, including their quantification, to explore what they mean for national and sectoral strategies.



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FOREWORD

Societies everywhere are facing the rapids of Grand Energy Transitions.

We may be on different boats and moving through the turbulent waters of transition at different speeds, but the future of energy is not something to fear, it is a boundless ocean of new and better possibilities!

As we look to what lies beyond, there is always hope: a new space in energy for people and planet is emerging.

The World Energy Council Scenarios can help to guide our journey through the fogs of unpredictable uncertainty and doldrums of ideological polarisation.

The value of scenarios is derived in use. Please join us in using these stories to clarify choices in redesigning energy systems for billions of better lives and a healthy planet.




Angela Wilkinson

Secretary General & CEO
World Energy Council

CONTEXT

The recent Covid-19 pandemic, the war in Ukraine, the conflict in Gaza, geopolitical realignments, the rise of AI, and the devastating consequences of severe, climate-change-related weather events have all profoundly affected the global economy and global energy system. An in-depth project to build new scenarios to 2050 is needed. While support for this project is being built, the Council is offering reflections on how the future envisioned in the 2019 scenarios has changed—and what a new set of scenarios to 2050 might look like.

This document offers a glimpse of the foundations on which a new scenario set might be built to 2050, with views on designing for the future to realise significant opportunities. These new scenarios arise from elements of the 2019 World Energy Council scenarios and the lessons of experience learned subsequently (see [Appendix](#)), and recommend the key questions that leaders of all kinds need to grapple with now to achieve better outcomes for their institutions.

NEW SCENARIO FOUNDATIONS: ROCKS AND RIVERS

The disruptions and tensions of recent years have essentially ruled out a cooperative globalized world for the foreseeable future, which means that a more fractured world has to be assumed in all scenarios. The following Rocks and Rivers outlines explore two different key modes of cooperation that could emerge from the fragmentation, with strong consequences for the future.

ROCKS is a world of new modes of *collaboration* within or between familiar established institutions that have power over financial, natural, military, or human resources, many of them becoming platform-based and operating at different scales. These may be focused on national sovereignty, or within a single company or companies within an industry, or within a country, a region, or an international ‘circle of cities’ sharing best practice.

Even though policies can change, in general, national policy frameworks are often more stable than commercial ventures or ad hoc alliances in that they can be built upon and, with the inclusion of others, they can scale. Within the pluralistic and differentiated nature of the world as it is now, the **ROCKS** world would also highlight the role of deliberate collaboration in communities, regions, and nations, emphasizing the role of *design*—intentional institutional choices that become focused on the relatively narrow conception of self-interests (local and near-term) of specific actors in society.

RIVERS is a world of new modes of *alignment*, often more suited to the new digitally-enabled economy. These can be rapidly scaled in aggregate in order to reach transformative impact at the system level – such as happened in the telecommunications, media, and virtual-working domains, and, in the energy system, the explosive take-off in light-duty electric vehicle sales and wind/solar power generation. These alignments form not simply among actors in the same region or industry, but also among diverse actors recognizing emerging opportunities and common interests from their diverse perspectives.

RIVERS explores the huge potential to accelerate positive changes by getting the ‘right subsets of stars to align’ for various desirable transitions, for instance, by starting from the end-user and driving change up the supply chains in which energy production and use are embedded. The emphasis is on multi-actor choices emerging from common pressures and opportunities which then reflect a broader conception/constellation of self-interests.

SCENARIOS COMPARISON

The future may well include a combination of both these scenarios and of others, but in order to see – and discuss – these complex dynamics more clearly, we differentiate them into two distinctly different scenarios.



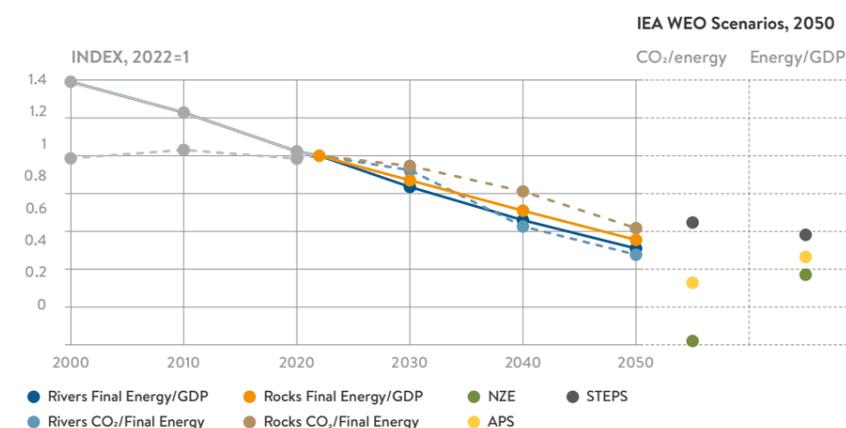
GEOPOLITICS	Blocs	Shifting alliances
TRADE	Blocs with leaky barriers	International in principle, but with security carve-outs
ENERGY SYSTEMS	A long tail of fossil fuel use with deep electrification and decarbonization in some blocs	Turbulent but swift fossil fuel substitution (electricity, hydrogen, biofuels) and cross-border connections enabled by technology
AGENTS OF CHANGE	Mission-oriented government leaders collaborating to design policy for national interests	Entrepreneurs, CEOs, policymakers, and consumers with aligned emerging interests
MODES OF COOPERATION	Policy convergence and deliberate collaborations among like-minded powerful actors with common interests; community collaborations at multiple levels	Emerging alignments driven by common pressures, market opportunities, and innovation

PRELIMINARY EXPLORATORY MODELLING: ENERGY CHOICES, EMISSION OUTCOMES, AND EFFICIENCY

Enerdata’s exploratory modelling confirms the assessment of various global energy outlooks that progress on decarbonisation is still too slow and that more needs to be done to avoid a failure to achieve the aspirations of the Paris Agreement. This understanding will also become increasingly apparent in real-world developments over the coming years, and the disappointment will feed

back into social and political dynamics in all future scenarios, altering some of their details and hence some of the underlying assumptions for the quantification. Our iterative process of scenario development and quantification will continue over the coming period, but we can already draw important lessons from the exploratory modelling.

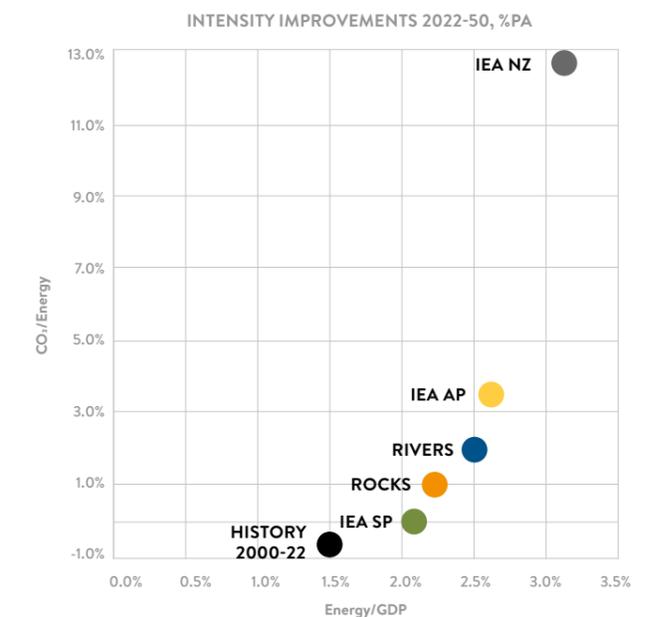
Decomposition of the emission reductions



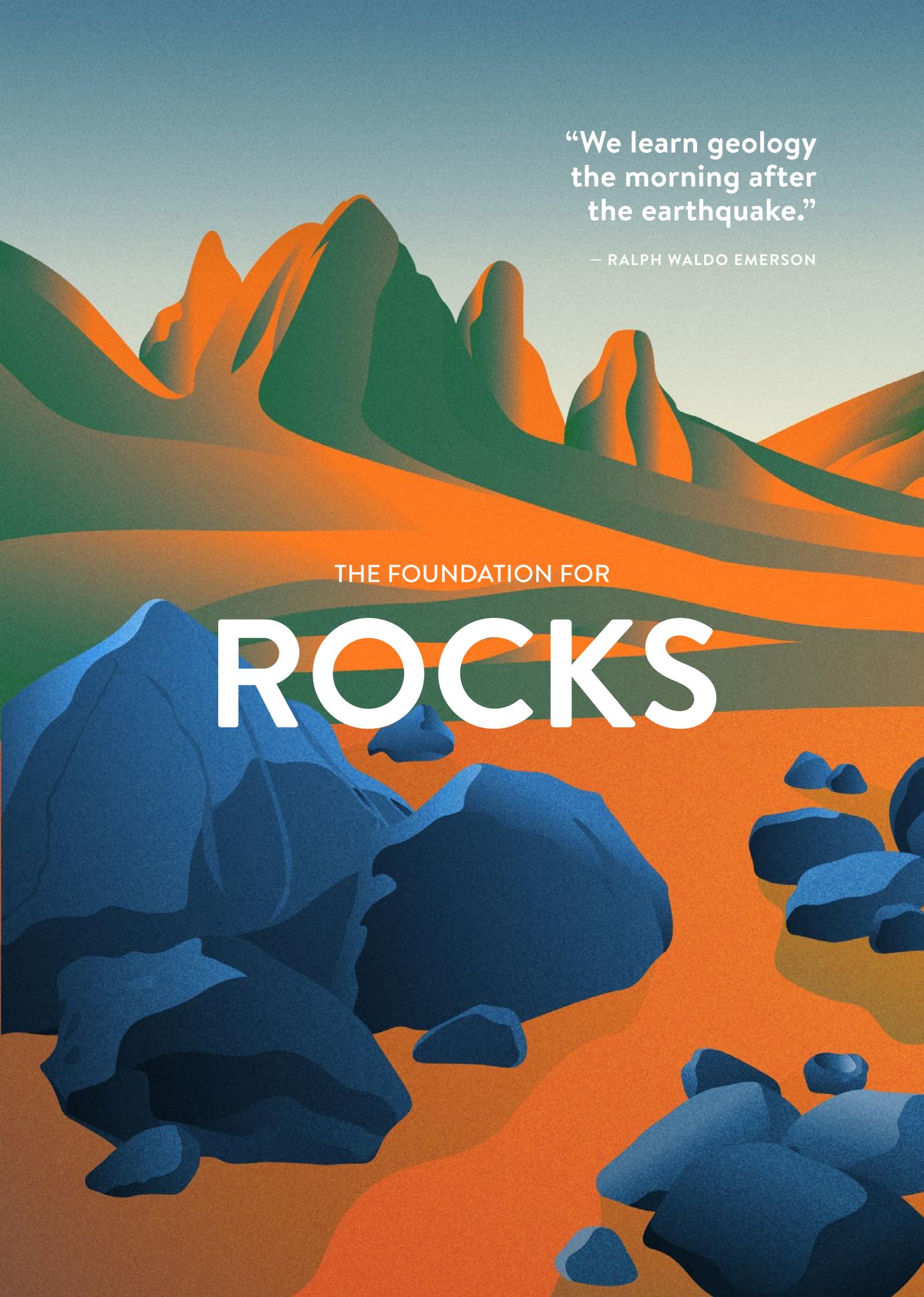
- Energy intensity of GDP keeps decreasing at a similar pace as historical progress.
- Emission intensity of energy marks a sharp decrease after 2030, with increased efforts in Rivers (division by 2 by 2050).
- Despite different narratives, results are in the same range as the STEPS and APS scenarios of the IEA’s WEO 2023.

Source: Enerdata / World Energy Council 2024 Scenario Refresh

One such lesson is the importance of gains in energy efficiency, which is perhaps generally underplayed and misunderstood. The downward global trend of the measure of Energy/GDP, is driven by the fact that a lot of global economic growth is arising in already-industrialized economies where GDP growth comes largely in low energy-intensive service sectors. But a focus on energy efficiency is required at a deeper level than just overall GDP. Rather, the trajectory of energy/capita over time is important, particularly in economies going through their most energy-intensive phases of development. Beyond more efficient products (light bulbs, car engines, etc.), the energy efficiency of human activity is also important. More efficient human activity is driven by structural factors such as the compactness of urban developments and the integration of power, heat, waste, water, and transport systems. As the preliminary modelling shows, gains in efficiency are better in **RIVERS** than **ROCKS**, but insufficient compared to the aspirations of the Paris Agreement.



Source: Enerdata / World Energy Council 2024 Scenario Refresh

A stylized landscape illustration. The background features rolling hills in shades of orange and green. In the foreground, several large, dark blue rocks are scattered across an orange ground. The overall style is flat and graphic.

“We learn geology
the morning after
the earthquake.”

— RALPH WALDO EMERSON

THE FOUNDATION FOR

ROCKS

In Rocks, the global hopes and national promises associated with the Paris Climate Accord are threatened by intense pressures for energy security, industrial competitiveness, and other aspects of national self-interest—a ‘new tribalism’. In many parts of the world, plans for the phasing out of fossil fuel have been moderated or delayed, and NDCs are barely being met. Energy subsidies are the most direct way to meet increasingly powerful populist demands in a world where leaders emphasize national strength rather than international agreement or responsibility. The idea of the whole world succeeding in meeting UN sustainable development goals seems to belong to a long-ago, simpler time.

GEOPOLITICS

Nations in Rocks respond to the breakdown of the post-cold war global order by establishing alliances for security with political allies and alliances for trade with regional partners. Sometimes, as in Australia, the divergence

between security blocs and trading blocs poses challenges. A number of countries outside the two major blocs (US-Europe-Middle East and China-Russia-Iran) find opportunities in moving from one bloc to another.

ECONOMIC GROWTH

Economic growth continues steadily, although slowly, but the onshoring and ‘friend-shoring’ of supply chains means that fewer economies of scale develop, which, in the past, have helped lift the poor out of poverty. China, Central Asia, and the Middle East experience relatively high levels of productivity growth compared with Europe, which is facing difficulties in balancing energy security with environmental sustainability.

In this fragmented world, the benefits of economies of scale, global standardization, technology diffusion, and the efficiencies arising from inter-regional trade are significantly

diminished. Occasionally, when conditions come together, a deployment of new approaches leads to localized explosive growth—but these successes are rare.

During the late 2030s, the confluence of surging national debt levels, stubborn inflation, and weakening currencies strains the global economy. Manufacturing sectors, particularly those that are hard to abate, are earmarked for green transition but find themselves adrift due to lack of investor confidence in the private sector and revenue constraints in the public sector.

MANAGING THE ENERGY TRILEMMA

Latin America, lacking the commercial incentives for deep change, splits its focus between hydro- and commodity export, depending on the country. The spirit of ‘Patria Grande’ is fractured; nations turn inward and towards political allies abroad. Venezuela and

Brazil, rich in oil and gas reserves as well as biofuel and hydropower resources, use their fossil fuel wealth to serve Asia’s emerging powers, Malaysia and Indonesia. Africa, lacking adequate investment and governance for anything else, coal-fires and gas-fires its path

to greater basic access. Meanwhile, the Middle East and North Africa deepen cooperation with the BRICS in search of new markets for fossils.

Governments, responding to populist imperatives based on narrowly-conceived fears and resentments in their constituencies, and wrestling with ballooning expenditures and diminished tax bases, have to make hard choices. The promised public investments in renewable energy infrastructures are deferred, one fiscal quarter at a time. Steel plants, chemical factories, and cement producers continue to belch out emissions, as the vision of a cleaner industrial economy remains elusive.

In spite of these challenges, progress towards environmental sustainability in some areas is steady, given developments already established, and sustainable solutions are gradually becoming more affordable. But the rate of progress is too slow to meet the Paris 1.5 goal. In Europe a policy-led green agenda is pushed through in spite of sporadic instances of populist resistance to specific measures. The Middle East pursues a pragmatic CCUS-enabled transition pathway, while the US experiments with a patchwork of sustainability solutions, including state-based carbon-offset regimes to counterbalance increased gas production, new solar and wind installations, tax incentives to support electric vehicles, and the ramp-up of modular nuclear developments.

While a number of developed countries have committed to rapid changes in their energy

structures, many others are primarily concerned with the new security agenda and “who pays” for the additional costs of the transition. China, leading the expanded BRICS grouping of nations, forges ahead with an ambitious, alternative energy framework across south and central Asia and Africa, positioning itself as a counterbalance to Western energy policies.

In spite of the rapid transition to renewable energy by light industry and households, the cohesive global efforts once hoped for in addressing climate change never develop. Countries increasingly retreat into ‘energy blocs’, prioritizing national interests and energy security over global cooperation. A focus on inward-looking policies in response to economic and political constraints leads to heavy reliance on traditional energy sources for industrial load and a patchwork of energy policies.

Increasingly, destructive weather-related events prompt populist backlashes against authorities deemed to have neglected the climate issue. These disruptive reactions often lead to knee-jerk policy interventions, not all of which are effective.

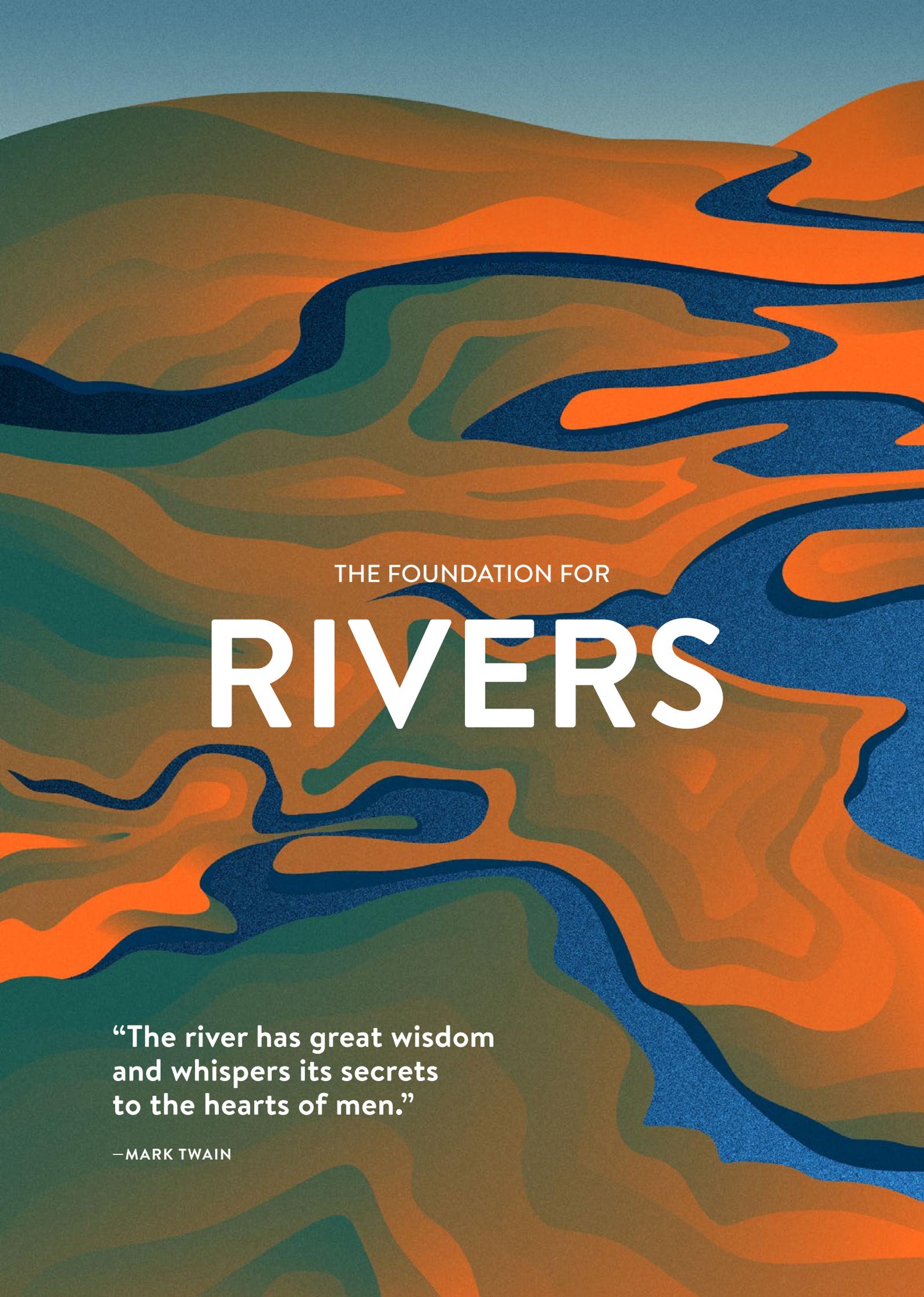
The patchwork of policies creates a mosaic of progress and stagnation, with some pockets forging ahead with clean energy while others cling to the comfort of carbon. Energy transition is as diverse as its ecosystems, a reflection of a world where global unity in energy policy has given way to national pragmatism.

COLLABORATION

Within the Rocks circles of connection, ‘anticipatory’ governance efforts periodically bring business and civil society to the table to work together toward shared goals, including making progress towards net zero for local security or economic advantage. One of

the by-products of this inward focus is a greater emphasis on creating “design spaces” where best practice, technology innovation opportunities, and shared insight from collaborative foresight initiatives encourage multi-sectoral action.





THE FOUNDATION FOR

RIVERS

“The river has great wisdom
and whispers its secrets
to the hearts of men.”

—MARK TWAIN

In Rivers digital advances and market dynamics transform energy supply and demand. Economic growth moves in sporadic yet dramatic bursts, rewarding companies that adopt new technologies and supply-chain alignments ahead of demand surges. As the old system of international collaboration comes under strain, new forms of cooperation emerge at many different levels: sustainability projects within shared value chains, sharing of best practice among citizen groups, ‘carbon clubs’ and other incentive-based mechanisms, as well as new efficiencies resulting from technology innovation. Increased digital transparency allows connected energy actors to make strategic choices in their domains rather than respond to policy edicts from above.

GEOPOLITICS

The geopolitical context of Rivers is one of a fragmented international consensus. But while nations act in their own immediate self-interest, they also come together in ad hoc alliances at different levels. Politicians tap

into the aspirations and fears for the future of their constituencies to build support for green industrial policies aimed at domestic competitive advantage and generating good jobs in emerging areas.

ECONOMIC GROWTH

Economic growth is sporadic and dramatic, with significant rewards for companies that have placed bets on the early development of new technology and supply-chain alignments in good time for the explosive take-offs of demand that occur when the stars align between leading market sectors and supportive policies. Rivers

is a highly digitally disruptive, innovative, market-driven world. With the weakening of global supply chains, innovations develop within individual trade and security ecosystems, especially where security-related cyber concerns are involved.

MANAGING THE ENERGY TRILEMMA

Progress towards environmental sustainability is rather slow at first—and then, with more investment and deployment of alternative technological approaches at scale, various clusters of business-chains and countries leap forward. AI is increasingly important in these ecosystems, enabling more efficient use of infrastructure through predictive maintenance and better forecasting of wind and PV production as well as user behavior. Many systems become learning systems, increasing resilience by adapting to potential changes.

The rise of digital platforms enables smaller-scale, localized energy initiatives and particular business-chain alignments, linking revenues from the sale of end-use goods and services to reward investments in upstream high-emissions industrial sectors. However, these efforts struggle to achieve significant scale without broader national and international support. Nevertheless, copy-cat behaviours drive explosive growth in demand for particular activities once pioneers demonstrate the prospect of success.

In this world a shift occurs in the way energy transitions are perceived and understood. Lessons are drawn from both new developments and the continuing explosive growth in battery-electric vehicle sales and renewable power generation.

Instead of seeing energy transition largely as a single slow-moving, costly, and supply-led ‘hard slog’, it is increasingly seen as a series of potentially fast, opportunity-rich, modest-cost, and demand-led tipping points of uncertain timing. Driven by competitive dynamics, individual transitions are almost always explosively fast and disruptive once the stars align—but this can happen ‘early’ or late’. The recognition that perfect timing for investment is impossible to predict means that the strategic question for decision-makers becomes, “Is it better to err on the side of acting too soon? Or too late?” In an increasing number of instances, the conclusion is that acting early is the low-regret choice. Strategic attention moves to aligning the right stars effectively.

In addition, the notions of ‘tipping points’ and ‘low-regret actions’ play into thinking not only about investment and business opportunities but also about threats such as environmental tipping points and whether it is better to err on the side of acting sooner rather than later.

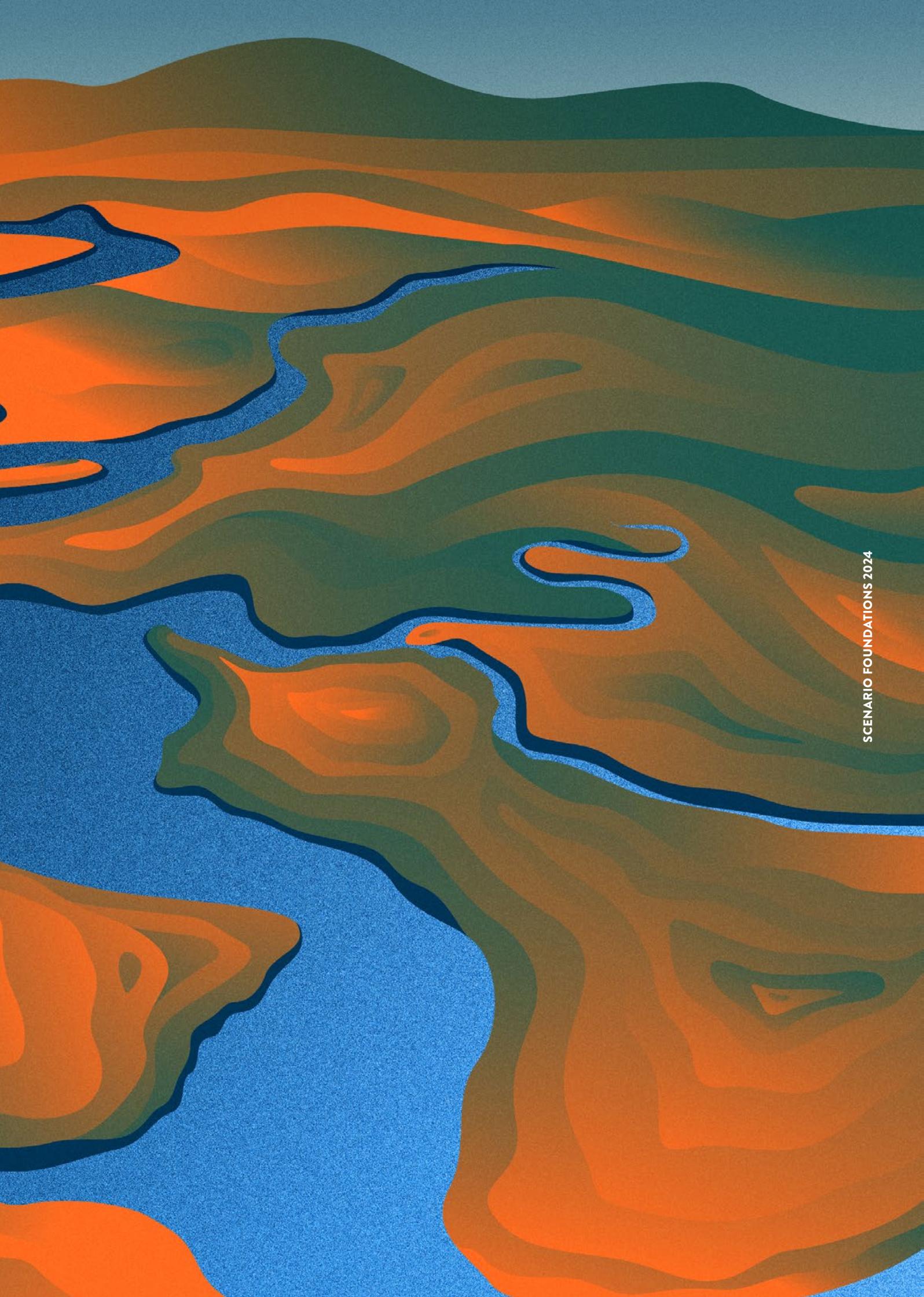
As the 2050s dawn, the global energy transition has taken on a more humanized face as local action networks and business-chain alignments, rather than international accords, become the vanguards of change. Often within the context of supportive national policy frameworks, neighborhood cooperatives and citizens networks harness communal investments and diverse solutions, including micro-grids, giving them direct control over their direct energy needs. In addition, business-chain alignments are driving and funding industrial decarbonisation in satisfying the regular consumption needs of people.

As climate risks ratchet up, this grassroots revolution, stitched from myriad local efforts, weaves a tapestry of resilience, rendering the energy transition an intimate and collective journey. Energy transition is demand-led, and viewing business-chains from the final end-use demand perspective is a powerful lens that drives change. This ‘democratisation of energy’ means that more users, in more ways, have more power in the system, with new streams for value creation emerging and merging, like rivers moving in the same direction towards the sea.

ALIGNMENT

In Rivers a key driving force is the alignment of actors in the layer of agency that sits between the policy lever framework and the actual end-use of energy on the ground. In that layer sit the decision-makers who decide what energy kit to build or buy and how to operate it: householders deciding to install PV on their rooftop or to buy an EV; power utilities deciding to invest in

grid-scale storage; municipal bus companies switching to electric or hydrogen bus fleets. The policy levers work (to the extent that they do) by influencing those decisions. The world of Rivers represents the aggregate outcomes of all those decisions, flowing independently in the same direction.



DESIGNING FOR THE FUTURE—OPPORTUNITIES

In learning from previous scenarios, assessing the current state of the world, and preparing the foundations for new scenarios, there is already much that can be understood. This surfaces considerable opportunities as well as clear risks.

The global energy system will continue to grow, underpinning a global economy growing along with population and the pursuit by people around the world of a decent material quality of life. But there will also be fundamental transformations, affected by disruptions in the international order and the current volatile socio-political events, which will develop over the years ahead in one form or another. These are the conditions and uncertainties that scenarios need to illuminate.

Nevertheless, in all outlooks, the main techno-economic and environmental fundamentals will determine the general direction of travel. The differences will come in the important details of the timing, location, and exact features of developments.

Potential energy and emissions growth will be moderated by the reducing energy intensity of the economy and the emissions intensity of energy, driven by both policy and business interests. There will be much deeper electrification of most economies, with an increasing proportion of power supplied from renewable resources. In heavy-duty applications where molecular fuels will still be required, there will be increasing substitution of fossil fuels by bio-fuels, hydrogen derivatives and eventually synthetic fuels. And there will be growth in carbon capture and removal through natural or technological means.

In many cases, the first new approaches to become established in any given arena will continue to be dominant as long-duration infrastructures are established and as commercial competition drives down costs through learning curves and economies of scale.

Also, in many cases, strong competitive forces will drive an explosive pace of change once the conditions are attractive enough to kick this off. The big strategic uncertainty is whether these conditions occur ‘sooner’ or ‘later’.

The distributed nature of new energies, along with substantial growth in the numbers and economic power of the global middle-class, will increase the citizen-centric and consumer-centric nature of the energy system. Increasing climate turbulence over the coming decades is also already locked-in, which will steadily provoke broader mass attention to emissions and feed into populist, possibly knee-jerk, policy interventions.

So, in one way or another, change will often happen disruptively at an explosive pace and in a generally understood direction but with uncertain timing and a volatile socio-political context. This will bring opportunities for those embracing lessons from the full range of future scenarios and acting accordingly. Once available, the full World Energy Council scenarios, developed on these foundations with input from this Congress, will be able to provide more granular guidance.

From what is understood already, however, we strongly recommend to different groups of readers that already addressing, and acting on, at least the following questions will be vital to designing ‘future-ready’ organisations, economies, and societies.



ENERGY BUSINESS LEADERS

- Where is the greater competitive risk—investing too late or investing too soon in preparation for inevitable fast-paced changes, or even driving them for advantage?
- Where is it best to be already on the front foot in new business and technology developments?
- How can you understand and position your enterprises for disruption in business chains and the accelerating shift to consumer-centric energy systems?
- Where will the new customer-centric growth opportunities in electrification, storage, power-to-X, bio-fuels, and the new hydrogen economy be found?
- Where are the best opportunities and alignments to address Scope 3 emissions, ultimately driven by end-user needs, and to secure associated rewards?

BROADER INDUSTRY LEADERSHIP

- What strategic choices are growing in significance as the potential ramifications of geo-political disruptions and energy transitions expand?
- What are the implications of value-creation shifts from being commodity-centric to customer-centric? In what ways can energy transition be a source of volume and value growth more broadly?
- What business chains can be aligned profitably to channel revenue from premium customer activities to motivate and fund the major upstream industrial investments required for decarbonisation? Where are the sweet spots where high-value retail activities meet high-emissions supply chains and industrial activities (e.g., restaurants–food–crops–fertiliser–ammonia–hydrogen)?
- How might opportunities be seized in potentially disruptive and fast-moving areas by being on the front-foot and early into developments? Where will this be more successful than hoping to be a fast-follower and arriving late at the party?
- How can industry leaders avoid infrastructure needs being underestimated?

GOVERNMENT POLICYMAKERS

- Which new decarbonisation policy developments can boost domestic industrial competitiveness in deploying new technologies? Where does being too late rather than too soon pose the greater risk to industrial competitiveness or social benefit?
- Which new and different policy instruments and support are appropriate for new technology approaches at different phases of development, i.e., basic research, pilot-scale testing, early-phase deployment, and mass-scale deployment?
- What forms of proactive energy infrastructure action plans will enhance systems resilience, e.g., in addressing power generation intermittency and seasonal variability through short- and long-duration energy storage?
- What are the mechanisms to identify integrated policy innovation opportunities and implement sector-coupling policies? Which advantageous new alignments can be orchestrated through convening customers and business and community leaders involved in high-emissions business chains under pressure to lower emissions?
- Can policymaking that enables energy system integration also encourage demand-side participation for better connectivity among actors (consumers, prosumers, and suppliers) and for improved consumer access?

POLITICAL LEADERS

- How can leaders build political support for promoting the under-recognised opportunities to develop fast-growing, energy-transition business activities?
- How can the under-recognised interests of young people in having secure jobs in emerging technology and green activities be leveraged? How can the fears of being 'left behind' be harnessed to support domestic industrial policies?
- How can the interests of people in having clean, safe, and attractive neighborhoods without poverty and deprivation be channeled?
- How can the aspirations of people for the well-being of themselves and their offspring through good education, healthcare, and a healthy environment be harnessed?
- How can leaders promote the political, economic, environmental, and energy-system benefits to everyone of improving leadership opportunities, education, and access to modern contraception for women around the world?

INTERNATIONAL COMMUNITY LEADERS

- What avenues are still available for encouraging cross-border, cross-sector, and cross-vector strategic partnerships?
- How might efforts be renewed to facilitate technology transfer, secure new investment, and progress regional investment integration where it improves the matching of energy sources and demand?
- How can the international community raise awareness of the interdependence of food-energy-water systems and enhance adaptability and resilience of these systems in response to climate challenges?
- How might emissions-reduction monitoring and verification standards and approaches be deepened, harmonised, and integrated into business opportunities?
- How can attention to girls' education and access to modern contraception, with strong links to future economic, energy, environmental and social benefits, be prioritized in regions where this is still poor?

DESIGNING FOR DISRUPTIONS

Moving to a mindset of 'disruption-as-usual' and 'minimising potential regrets' from acting either early or late in preparing for changes.

Recognising that once the stars align, competitive dynamics at the business and policy level often propel growth and change much more rapidly than expected .

Staying on top of emerging technology, policy, business, and societal trends.

Expanding knowledge of, and access to, broader business ecosystems.

Seeking to replicate the explosive growth in the IT-related industries that have spilled over into energy transition forerunners like Tesla, Nextera, and Iberdrola.

Seeking to replicate the types of ecosystems that developed around Tesla (Panasonic) and Apple (LG, Samsung), which have driven the battery electric vehicle and battery technology industries, and are now emerging in green steel/automotive collaborations.

Extending the association of clean energy investments with the more populist jobs agenda— the IRA and IIJA in the US, for example, and the Chinese 5-year plans focused on dominating market share in selected industrial sectors

Supporting standard-setting organisations and processes that drive both change and alignment— for example, ISO (standards), IASB/ IFRS (accounting), IMO (shipping), or IATA/ICAO (air travel).

APPENDIX: FROM 2019 TO 2024

THE 2019 SCENARIOS

The 2019 **HARD ROCK** scenario envisioned a fragmented world with low global cooperation. With nations focusing on their own priorities, the energy transition was obstructed by a patchwork of policies and markets.

The focus in the **MODERN JAZZ** scenario was on entrepreneurial activity, using market forces to capture the benefits of innovation, especially digital disruption. People still cared about social and environmental issues, but looked to tech entrepreneurs to provide the solutions.

The **UNFINISHED SYMPHONY** scenario envisioned a world in which circularity and resource efficiency were central to energy systems, with a focus on reducing waste and increasing the efficiency of resource use. The scenario assumed that there would be greater cooperation between developed and developing countries, with a shared focus on sustainability and reducing carbon emissions.

WHAT HAS REMAINED THE SAME—AND WHAT HAS CHANGED

The 2019 scenarios were based on eight key drivers – four predetermined factors (common across the scenarios) and four critical uncertainties (differentiated across the scenarios).

PREDETERMINED FACTORS

- Slowing growth rate of global population
- Rise of new technologies
- Appreciation of planetary boundaries
- Shift in economic power to Asia

CRITICAL UNCERTAINTIES

- Pace of innovation and productivity gains
- International governance and geopolitical changes
- Priority given to climate change and connected issues
- Policy tools in action

For the 2024 scenario foundations, we have moved the state of geopolitics from its previous role as a key uncertainty to a new role as a predetermined factor, ruling out the cooperative globalized world for the foreseeable future and assuming a more fractured world in all scenarios.

Then for two of the critical uncertainties (“productivity” and “climate priority”) we have reduced the degree of differentiation. For “productivity” the more fragmented world rules out the previous “high” case. And for “climate priority” we assume most people recognize the urgency now, so it is “relatively high” for all scenarios, with the main differentiation being how it is expressed—what actions are taken and when, and what the outcomes of these actions might be.

Finally, we have taken the “policy tools for action” critical uncertainty and expanded it to include “layers of agency” —the “who” in addition to the “how,” including two major modes of cooperation which provide a thematic basis for differentiating the new scenarios: collaboration and alignment.



PREDETERMINED FACTORS—A CLOSER LOOK FOR 2024

Reorientation of global population towards Africa and Asia, where basic energy access remains a priority and drives demand, while slowing population growth with workforce implications and aging impacts challenge advanced economies

Important additional considerations include questions such as: How will population growth or decline, migration, and the quality of rapid urbanization affect energy system design, demand management, and supply choices? How will the quality of governance enable or inhibit constructive developments?

The effects of new technologies, including digitalization and especially AI

The development of AI has raised awareness of possible tipping points and take-off dynamics. Digitally enabled economies are emerging, promising to revolutionize research and innovation, data management, and decision-making, including energy system management. New AI tools will be adopted by the rich ahead of the poor and by high-tech sectors ahead of hard-to-abate industrial sectors, further increasing the digital divide and producing new structural inequalities.

Breaking up of the economic global order into trading blocs, with shifts in economic and geopolitical power to China and India

The fall-out from Covid, such as supply chain interruptions, coupled with challenges to China's long-term economic rise, such as population slowdown and ageing, along with rising competition are disrupting long-standing trade and security alliances. Onshoring and 'friend-shoring' of supply chains, nationalist and protectionist technology regulation, and new trade barriers and tariffs seem to be leading to the formation of trading blocs in which allegiances will shift, both in terms of energy sources and trade.

Growing consciousness of planetary boundaries

More frequent and intense climate events have accelerated this consciousness, leading to a focus on resilience. Many young people, especially, experience the climate crisis with deep pessimism about the future. On the upside, these extreme weather events are leading to increased research on environment and sustainability in almost every field, even including architecture and public policy.

Fragmentation of the geopolitical world order

The global pandemic, with its isolation and inward-turning emphasis, followed by the first war of conquest in Europe since World War II, the expansion of the Chinese military presence in the South China Sea, and the rise of nationalistic, authoritarian populism in many democracies mark the end of 'the end of history'—the post-Cold War world order.

NEW SCENARIO FOUNDATIONS

In this fractured geopolitical context, there is no longer a credible short- or medium-term scenario of international cooperation towards an energy transition by 2050—at least not one that has been created by globalized cooperation among nations. The **UNFINISHED SYMPHONY** world is no longer plausible, leaving the future landscape looking more like **HARD ROCK** or **MODERN JAZZ**.

A key element of the original **UNFINISHED SYMPHONY** was how people work together to achieve net zero. The new scenario foundations explore how what's left of the elements that drove **UNFINISHED SYMPHONY** can be folded into a world (like the original **HARD ROCK**) where separate nations are mostly interested in domestic strength and energy security, and how selected elements of **UNFINISHED SYMPHONY** can be folded into a world (like the original **MODERN JAZZ**) of shifting alliances and new technologies. Behind the scenes, in a way, **UNFINISHED SYMPHONY** becomes an actor in the remaining two scenarios—but with the emergence of new patterns of collaboration and alignment.

In one future world, the elements of global collaboration highlighted in **UNFINISHED SYMPHONY** are breaking down into smaller pieces, each concerned with its own national or regional well-being in a more dangerous, disruptive world. Elements of **HARD ROCK** help to form the foundation for a possible new scenario called **ROCKS**. Individual strength and

energy security are key concerns in **ROCKS**, but in support of these, regional circles of collaboration form to encourage progress in energy transitions in a diversity of ways.

The foundation for the second future world recognises the entrepreneurial dynamism of **MODERN JAZZ**. In the scenario to be constructed on this foundation, cooperation does not always initially come about through conscious collaboration; instead, individual entities experience similar pressures and find themselves in alignment, seeking opportunities in the same direction— like separate streams meeting and joining up with other streams to become rivers on the way to the sea. In **Rivers**, countries and companies move separately to seize opportunities, and sometimes meet others going in the same direction, joining to create synergies with sometimes surprising results.

In **ROCKS** and **RIVERS** the “constellations of disruptions” that were a feature of the 2019 scenario set are more significant than ever, with even more disruptions emerging. Such disruptions are rarely comfortable, but they bring new opportunities as well as threats.

In these future worlds, critical uncertainties arise most significantly from changes in the political and economic environment, and in parallel, the evolution of the energy system at the techno-economic level, especially through industry structure and infrastructure.

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