An enhanced assessment of risks impacting the energy system

KPMG

June 2021

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The global risk landscape continues to change – constantly and at pace. Disruption, driven by environmental, social, governance (ESG) and technological risks and underscored by the challenges of responding to the COVID-19 pandemic, means business must constantly respond and adapt to ensure long-term success, strategic resilience and value preservation.

The need for robust risk management capabilities is of particular relevance to the energy system, which faces significant risk from the changing ESG landscape and evolving business operating models in response to the transition to a net-zero global economy.

The energy system in particular faces a multitude of ESG-related risks, challenges and opportunities as the system transitions from fossil-based systems of energy production and consumption to renewable energy sources. Participants in the sector must demonstrate how they will continue to operate effectively whilst balancing the security of energy supply, affordability and decarbonization. Close coordination and alignment are required across sub-system sectors to optimize the total system performance and to coordinate responses to system risks.

However, ESG-related risks can be difficult to identify, quantify and prioritize. It requires a deep understanding of the business operating environment and leadership that acknowledges, accepts and responds to the evolving external landscape. On a technical level, the process must move beyond traditional impact vs. likelihood analysis to consider the interconnectivity and speed of onset of risks.

To address these challenges, the World Business Council for Sustainable Development (WBCSD) and its member companies worked with KPMG, through its process known as Dynamic Risk Assessment, as described in this report.

KPMG's Dynamic Risk Assessment (DRA) is an evolution of more traditional risk assessment methodologies that incorporates future trends and potential downstream threats into risk management processes and expands analysis to estimate how risks might connect with each other to result in business impacts that are potentially more severe than would be assessed using other methods for estimating severity and risk event rates.

The critical importance of a resilient and sustainable energy system to economies, society and the environment makes it essential that the key dynamics, risks and dependencies are well understood and strategically addressed across the wider sector.

This report shares perspectives from a group of energy system participants of these dynamics, risks and dependencies. The report seeks to stimulate focus and present views on potential actions to inform the strategic and effective management of these key factors.

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2 Executive summary

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Companies operating within the World's energy system are experiencing radical and unprecedented change as they seek to deliver the commitments of the Paris Agreement goal of limiting global average temperature increase to below 2°C above pre-industrial levels.

As we transition from fossil-based systems of energy production and consumption to renewable energy sources, system leaders, policy makers and governments are being challenged to balance the security of energy supply, affordability and decarbonization. Close coordination and alignment are required across sub-system sectors to optimize the total system performance.

In parallel – and accelerated by the COVID-19 pandemic – the changing business context and evolving operational practices require system participants to strategically manage and respond to shifts in technological development, consumer preferences and investor perspectives.

The critical importance to economies, society and the environment of a resilient and sustainable energy system makes it essential that key dynamics, risks and dependencies are understood and strategically addressed across the sector. Strategic management of system risks and vulnerabilities is fundamental to the long-term, sustainable provision and consumption of energy essential to the function of the modern global economy.

To assess the complex characteristics of the energy system and the high degree of interaction between participants, a dynamic, network-focused approach to assessing risks and connections is required.

By considering risks as an interconnected network, it is possible for firms to identify the most influential risks and better target and apply risk mitigation techniques to positively impact key challenges facing the industry.

This report presents analyses from the application of an enhanced risk assessment technique – KPMG's Dynamic Risk Assessment methodology – to the risk landscape represented by the perspectives of companies operating across the energy system.

Key findings from the report include:

- Physical risks of climate change (in addition to transition risks) are at crisis level;
- The experts identified six distinct near-term scenarios with aggregate severities ranging between 84% and 99% of total sector value (i.e. today's value of its future earnings capacity), meaning the experts see the sector's future earnings capacity as materially at risk unless mitigative actions are taken;
- Transition risks are magnified by limited and fragmented leadership from governments and regulators which critically undermine the strategic approach to the energy transition and impact on the setting and attainment of transition targets and commitments;
- Companies are facing increasing pressure from a wide range of stakeholders – including investors and consumers – and challenges to strategically balance financial, operational, sustainability and reputational performance while addressing current and emerging regulation;
- Companies can and should focus on the mitigation of the following risks: viability risk; changing customer behaviors; collective efforts on energy storage capacity; and adverse, unforeseen impacts of low-carbon energy sources. The mitigation of these risks will maximally reduce system-wide exposures in the absence of national government strategy and regulation.

The analysis illustrates the importance of considering connected clusters of risks and exploring how the occurrence of one risk may change the likelihood of a connected risk being triggered. The analysis also highlighted greater severity and higher velocity of risks when viewed as clusters, compared to the impacts of individual risks captured using traditional approaches.

Six near-term risk clusters were identified in the study including three primary clusters with the greatest aggregated impact:

- Cluster 1 – National government strategy; Regulation; Tax and subsidies
- Cluster 2 – (Physical) Climate change impacts; National government strategy; Regulation; Transition risks
- Cluster 6 – (Physical) Climate change impacts; Geopolitics, National government strategy; Regulation

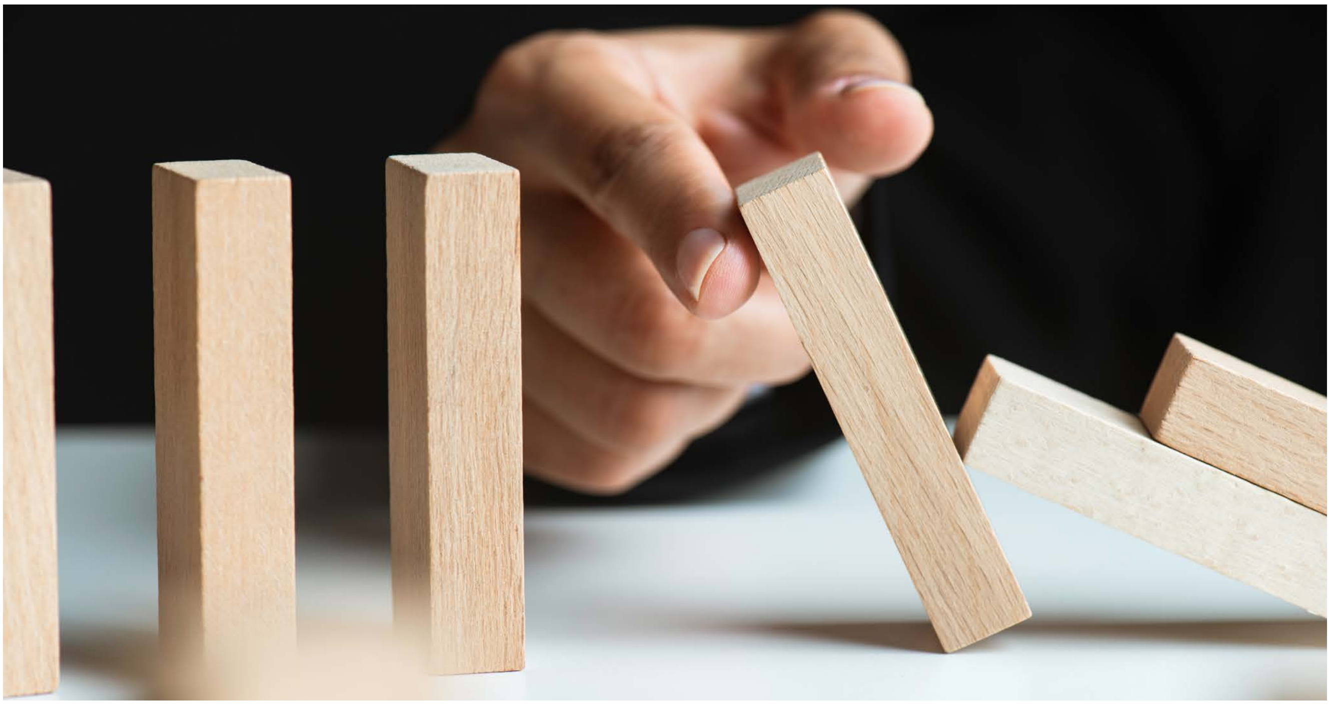
Specific conclusions for organizations operating in the energy system include:

1. The **urgent need for consistent, coordinated leadership and action by governments and regulators** are the highest priorities to address vulnerabilities to the risks faced by the sector. Renewed strategic focus by these public bodies is essential for the energy system to meet future energy demand and securely supply energy in a sustainable manner.
2. The scale of the energy system transformation means **strong, well-coordinated partnerships are critical to achieve desired outcomes**.
3. Organizations need to perform **climate change scenario analysis** to identify and quantify the impact of physical risks and the transition to a decarbonized society on their business model and strategy.
4. Organizational risk mitigation activities should be aimed at those risks which, if mitigated, will have a **positive impact on the system risk network and reduce vulnerabilities.** In particular, organizations should focus on actions that will:

- Inform and motivate governmental strategy and the regulatory framework;
- Positively influence the transparency and viability of long-term investment strategies;
- Drive changes in consumer behavior;
- Accelerate technology development and digitization of energy processes and performance.

This report is intended to help companies more effectively assess their exposure to energy system challenges and opportunities and integrate this knowledge into target setting and solution building.

It will enable readers to act as advocates for energy system transformation by responding proactively to the critical risks and opportunities identified in this report.



3 Introduction

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Traditional risk management methodologies assess risks individually in terms of their impact on business performance and the likelihood of the risk occurring. Organizations typically apply risk management and mitigation activities to address risks that are assessed as most likely and most impacting business performance. There are recognized limitations in the adequacy of this traditional approach, particularly for assessing the multi-faceted and complex characteristics of ESG-related risks.

At the same time, companies are facing increased stakeholder expectations and demands to demonstrate effective integration of robust ESG-related risk management into business decision-making and performance to drive strategic resilience of the company.

The need for robust risk management capabilities is of particular relevance to the energy system, which faces significant risk from the changing ESG landscape and evolving operational and business models in response to the transition to a net-zero global economy.

The ESG-related risks impacting the energy system are particularly complex due to the role in propelling economic development and job creation, lowering greenhouse gas (GHG) emissions, the severity of climate change impacts, and improving the well-being of people. The interactive, reinforcing nature of the energy system produces systemic exposures and opportunities for companies on the path to a sustainable energy system in 2050 that provides reliable and affordable net-zero carbon energy for all. As such, the identification and quantification of systemic features require a non-traditional, systems-orientated approach.

KPMG's Dynamic Risk Assessment methodology is designed to offer companies an enhanced capability to examine, understand and manage the inter-connections, complexity and aggregated impacts of those risks that might impact their business performance and strategic resilience. In particular, the analysis highlights the need for companies to extend risk management methodologies to effectively manage ESG-related risks.

This report highlights critical areas of focus and action for the energy system to more effectively manage critical systemic risks to the sector, improve understanding of risk management and strengthen business resilience.

4 Assessing and prioritizing ESG-related risks

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4.1 INTEGRATING ESG-RELATED RISKS IN ENTERPRISE RISK MANAGEMENT

Effective risk management balances risk exposures, benefits and expenditures. Strong ESG-related risk management capability is necessary for companies to assess and address the impact of risks on business strategy and objectives.

ESG-related risks can be challenging to identify, assess and prioritize. By their nature, the financial and business implications of ESG-related risks may not be immediately clear or easily measurable. This challenge may be exacerbated by a company's limited knowledge of ESG-related risks, varying risk emergence periods relative to financial or operational risks, and challenges to quantify risks and assess outcomes.

Companies are further challenged by the increasingly complex and interconnected global context and the evolution of markets. Disruption of markets, shifts in global economic power and changes in internal and external stakeholder expectations are driving the need to demonstrate stronger, more transparent and robust management of ESG-related risks across business activities and operating models.

With the link between ESG factors and risk becoming increasingly explicit, companies must find ways to bring new functions and leaders into the ESG conversation.

4.2 TRADITIONAL RISK ASSESSMENT APPROACHES

An effective risk assessment examines the extent to which identified risks and opportunities may impact a company's strategy and business objectives.

To support the integration of broad ESG-related and systemic risks into the enterprise risk management process, WBCSD worked with the Committee of Sponsoring Organizations of the Treadway Commission (COSO) to develop guidance to enhance companies' resilience as they confront the increasing prevalence and severity of ESG-related risks.

The guidance helps risk and sustainability practitioners speak the same language, communicate the broad impacts and dependences of the company, and address how these might translate into risks. Core components include consideration of how risks may impact company strategy and business objectives and how companies can assess and prioritize risks.

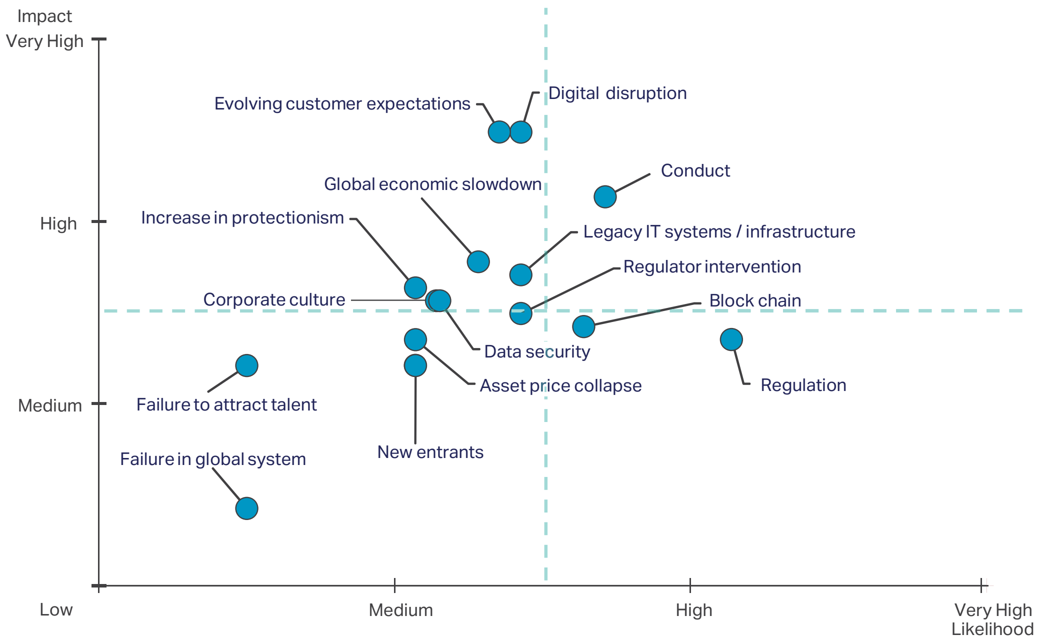
The guidance highlights that companies typically achieve this by:

- Identifying the impacts and effects that a risk may have on the entity; and
- Selecting the most appropriate approach, data and assumptions for the assessment.

Once a risk is identified, understanding the potential business impacts and effects allows management to prioritize risks and allocate resources to respond and monitor the risk over time. To achieve this, risks are translated into a common language that captures the risk magnitude.

Traditionally, risk severity is expressed in terms of impact and likelihood. Overviews and examples of these approaches are presented in Chapter 3b (Performance for ESG-related risks: Assess and Prioritize) of COSO and WBCSD's guidance[2]. An illustration of an impact and likelihood assessment matrix is presented in **Figure 1**.

Figure 1: Illustration of an impact and likelihood risk matrix



Source: KPMG's Dynamic Risk Assessment, p28, KPMG, November 2018)

Although impact and likelihood are common criteria for assessing risk severity and prioritizing risks, there are recognized limitations in the effectiveness of their application to ESG-related risks. Some of the characteristics of ESG-related risks that cause challenges, include:

- ESG-related risks can be more unpredictable and may manifest over a longer and often uncertain time frame;
- For ESG-related risks, it can be difficult to find historical precedence and data to estimate the potential quantitative impact of the risk and;
- Risks may be outside of an entity's control and responding to a risk may rely on collaboration, or on the actions of other parties.

Specifically, and critically,

- ESG-related risks are macro, complex, multi-faceted and interconnected and can affect the business across many dimensions (including different forms of capital and value).

These complexities and interconnectivities mean it is crucial that companies review and assess risks both individually and as an interconnected, aggregated and dynamically dependent group.

4.3 MOVING BEYOND IMPACT AND LIKELIHOOD

To overcome the challenges highlighted above, it is important that companies use criteria beyond impact and likelihood that extend the assessment of risk exposure and present results in a way that supports effective decision-making. For example, an assessment of how vulnerable a company is to a risk (i.e. the capability to adapt or to recover) may better reflect how the severity of a risk is assessed and prioritized beyond simply assessing likelihood.

The choice of assessment criteria is further influenced by the type of ESG-related risks which may be new to business decision-makers. For example, the use of social media has shortened the time period between stakeholder identification and communication of ESG issues. This has served to accelerate the speed at which markets, stakeholders and companies are informed of issues, reducing the time available for companies to respond. By way of another example, new legislation in some countries holds businesses accountable for modern slavery risks throughout their extended value chain anywhere in the world.

Heightened scrutiny, regulation and awareness of ESG-related challenges require companies to assess risks and impacts beyond traditional, internal business activities and assets – extending risk assessment requirements to, for example, the external environment, the full supply-chain and value creation across a broad range of capitals (e.g. financial, manufactured, intellectual, human, social & relationship, natural) and resources.

A list of example criteria provided by COSO for assessing and prioritizing risks and the relevance of ESG-related risks are presented in **Table 1**.

Table 1: Application of prioritization criteria to ESG-related risks

CRITERIA	DESCRIPTION	RELEVANCE FOR ESG-RELATED RISKS
Adaptability	The capacity of an entity to adapt and respond to risks	A risk may be significant and unpredictable; however, an organization can build in adaptability mechanisms to respond to or absorb the risk. For example, in the 1980s, Shell diversified its portfolio and used scenario planning to prepare and adapt to potential oil price fluctuations that were generally considered unforeseeable.
Complexity	The scope and nature of a risk to the entity's success	Many ESG-related risks are interrelated, global, industry-wide and constantly changing. For example, health care companies are aware of the complex relationship between climate change and health. Climate change impacts may lead to potential disruptions to operations, while also leading to health impacts on individuals (increasing the demand for health care services). CPA Australia, KPMG and GRI reported that companies that incorporated megatrend analysis into the risk processes tended to focus on one characteristic and did not deal with the "complex and systemic megaforce whose impacts are over the short, medium and long term." For example, companies with exposure to water scarcity are more likely to focus on immediate water efficiency than investigating the risks associated with future water scarcity. Similarly, companies looking at resource scarcity and deforestation are considering efficient consumption of energy, water and paper as well as recycling initiatives but are less likely to explore deeper issues of changing land use practices and systemic impacts on ecosystem design.
Velocity or speed of onset	The speed at which risk impacts an entity	ESG-related risks are often emerging and unforeseen until swift events result in extreme consequences. Climate change impacts often manifest in the form of more extreme or frequent occurrences of known events, such as droughts and floods, and are best understood by studying longer temporal horizons than are usually associated with typical risk management.
Persistence	How long a risk impacts an entity	Risk severity should consider the extent to which the impact will be an acute, onetime impact (e.g., cyclones, hurricanes or earthquakes) versus a chronic issue that will cause ongoing impacts (e.g., sustained higher temperatures or droughts).
Recovery	The capacity of an entity to return to tolerance	Consider how quickly the business would recover if a risk occurred today. For some ESG issues, impacts are irreversible. For example, in the food, beverage and agriculture sector, the impacts of climate change have the potential to alter growing conditions and seasons, increase pests and disease and decrease crop yield. Recovery from these impacts requires enhancing capacity to manage and respond to the risk.

Source: WBCSD-COSO, (2018), Applying enterprise risk management to ESG-related risks, available at: https://www.wbcsd.org/erm

Against this backdrop, companies need to enhance their capabilities for assessing ESG-related criteria to support business resilience, adaptability, long-term sustainability and capacity for growth. This requires a forward-looking, sophisticated approach to risk assessment that examines the complexity, interconnectivity and aggregated nature of risks.

5 Understanding the energy landscape

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Energy exists in different forms – including electricity, heat and solid, liquid or gaseous fuels – and the energy system is defined as everything involved in the production, conversion, delivery and use of energy. On the energy supply side, the system includes coal and uranium mining, thermal and renewable generation plants and the extraction and refining of oil and gas. The system also includes modes of delivery including oil and gas pipelines, shipping and electricity transmission and distribution networks.

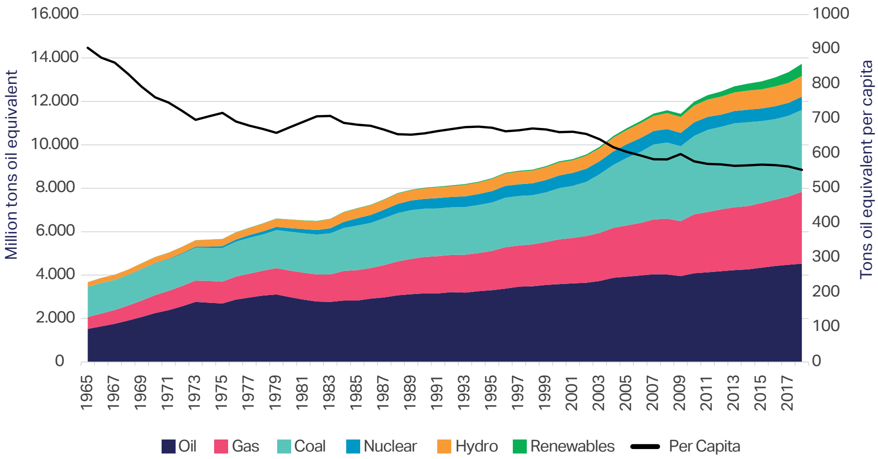
The current energy system has reached a tipping point. Over the last 100 years, annual energy requirements have increased from 20,000 TWh to 160,000 TWh. At the same time, our understanding of the negative impacts of carbon emissions from the use of fossil fuel energy sources on the planet's climate have become clear. The increased understanding of these negative impacts and the risks they result in is evidenced in the 2021 WEF Global Risks Report in which the top three risks by likelihood are extreme weather, climate action failure and human environmental damage. As a result of the increased understanding, stakeholders from customers to employees and investors to regulators have stepped up pressure on energy companies and other energy sector stakeholders to operate their business in a sustainable manner.

Policy changes, new technologies and the need to limit climate change have led to a transformation in the global electricity sector and a shift in the electricity mix over the last ten years in many regions. However, coal, gas and oil continue to provide the vast majority of global energy consumption and the pace of change in the energy system overall is not fast enough to meet the requirements set out in the Paris Agreement or the UN Sustainable Development Goals (SDGs).

Companies need to act now to keep global temperature rise to within 1.5°C above pre-industrial levels and create a sustainable energy system. Only those leading the transformation of their business and their sector will maintain their license to operate, capture new business opportunities, adjust to the redistribution of financial flows and manage emerging physical and digital risks.

The energy system has been long dominated by major oil and gas companies but that balance is now shifting. The combined market capitalization of the seven major oil and gas companies fell by 30% from 2015 to 2020[4], whereas the market capitalization of once traditional utilities such as Enel and Iberdrola rose by 122% and 68%[5] respectively. To demonstrate the shift in value, the market capitalization of Ørsted (a renewables company with revenue of only $10.98bn)[6] surpassed BP (one of the oil and gas majors with revenue of $282.6bn)[7] in 2020. With a greater shift to electrification of end uses, utility companies are expanding their operations from national to global players (e.g., EDF from France, EDP from Portugal, CLP from Hong Kong).

Graph 1: World Energy Consumption 1965-2018



Source: The Geography of Transport Systems, World Energy Consumption, 1965-2018, BP Statistical Review of World Energy. Population data from World Bank: https://transportgeography.org/contents/chapter4/transportation-and-energy/world-energy-consumption/

But the required shift to a decarbonized and sustainable energy system is not easy: it requires the biggest transformation to how our economies and societies produce and consume energy since the industrial revolution. Issues such as the transformation of infrastructure for heating, energy efficiency of buildings, and the growth of renewable technologies will dominate the headlines for years to come. All new technologies come with their set of benefits and risks and it is crucial that they retain and improve the resilience of global energy systems. The investment needed to transform the global energy system has been estimated at around USD $22.5 trillion[8].

Alongside the fast development of technologies and business models, there have been increased commitments from governments around the world, with 66% of Global GDP now covered by net-zero commitments[9].

However, there is an absence of comprehensive, globally aligned plans on how to achieve these commitments. New policies need to be put in place to ensure an effective price on carbon emissions, including carbon border adjustment taxes. Regionally aligned policies will also be needed to transform energy supply chain infrastructure to deliver on new green energy carriers, such as low-carbon hydrogen. As it stands, with limited global and regional plans in place, the energy system is having to second guess where policies and regulations are heading while balancing the changing sentiment of investors, consumers, employees and wider stakeholders which are, in some instances, moving before policies are in place. This uncertainty is ultimately increasing the cost of the energy system transformation.

The quality of Nationally Determined Contributions brought to COP26 in 2021 will be key to evaluate the strength of direction governments are willing to provide at this point in time. As we look ahead, we need a sustainable energy system that provides reliable and affordable net-zero carbon energy for all by 2050 at the latest. A sustainable energy system will drive economic development, create jobs, reduce carbon emissions and the severity of climate change impacts, protect natural ecosystems (land and water) and support people's well-being. Leading companies are progressing their own energy transition and, at the same time, playing a leading role in delivering wider impact in their value chains.

The critical importance of a resilient and sustainable energy system to economies, society and the environment makes it essential that the key dynamics, risks and dependencies are well understood and strategically addressed across the wider sector. A dynamic, network-focused approach to assessing and connecting risks is required.

6 KPMG's Dynamic Risk Assessment methodology

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6.1 BACKGROUND

When risk was first defined as volatility in the early 1950s[10], the macro-economic environment was very different to that of today. Foreign direct investments, exports, international travel, the reach of technology and use of derivatives played a fraction of their roles today in the then 'global economy'. Back then, economies were markedly more isolated. This allowed for risk to be represented by essentially localized stock market volatility. Furthermore, the only dimensions of a risk event / exposure that required analysis were its return period (or likelihood) and its impact (or severity).

The previous cycle of isolation came to an end during the 1980s as democratization, deregulation and floating currencies became the *de rigueur*. Foreign direct investment, international exports and travel, the use of derivatives and the reach of technology skyrocketed – connecting domestic economies and their citizens to an extent not observed before. With these connections came interdependencies and an expansion of exposures – a new domain of risk not provided for by historic volatility measurements. Risks that previously remained isolated became endowed with ways to interconnect and spread. Measuring only their likelihood and severity was no longer adequate; analysis of their interconnectedness and velocity (time to impact) was also required.

As a result, today's macro-economic environment requires us to include measurements of risks' contagion and velocity. Risks pertaining to the energy system cannot be investigated without considering these attributes; individual risks and their potential mitigation pose knock-on consequences which also require consideration. The energy system can be thought of as a 'part' of a bigger 'whole' – the health and sustainability of the planet. In this way, it meets the requirements of systems theory: the 'part' – energy system's risks – cannot be analyzed without considering its impact on the 'whole' – the sustainability of the planet.

Acknowledging the knock-on consequences of individual risks within the energy system and its 'part' in the wider 'system' of climate change and sustainability, the sector's risks will be analyzed by means of network theory to accommodate (i) the contagion of individual risks and (ii) the consequences of their interaction on the wider 'system' of climate change and sustainability.

6.2 KPMG'S DYNAMIC RISK ASSESSMENT (DRA)

KPMG's Dynamic Risk Assessment methodology is an evolution in traditional risk assessment that is designed to:

1. Incorporate future trends and their potential downstream exposures into risk management processes, injecting a forward-looking analysis and assessment and making results no longer solely reliant on historical data;
2. Expand the analysis of the resulting risks to estimate how the risks might connect to each other and with what velocity they may do so, in addition to more traditional measurements of severity and risk event rates;
3. Apply the sciences of expert elicitation and behavioral finance to extract the information and
4. Apply graph (network) theory to represent the findings and interpret the results.

In the above manner, the approach seeks to capture the wisdom of a selected crowd of experienced industry professionals through a scientifically structured approach, harnessing their collective and diverse knowledge and representing these mathematically as a network. This facilitates joint analysis of the usual likelihood and severity with the expected contagion and velocity. The process enables many insights that are almost impossible through a traditional two-by-two likelihood-and-severity heat map.

The process generates a non-individually dominated and non-groupthink, debiased quantitative view of an industry's best thinkers – its experts – who endow a mathematical network with their thinking on future and current risks through a scientific and replicable process. Performed studiously, Expert Elicitation can produce results at times of rapid environmental, macro-economic and geo-political change that are more accurate about the future than any subject matter expert's individual modelling or forecasts[11].

6.3 THE DYNAMIC RISK ASSESSMENT METHODOLOGY

The process comprises of four steps that can be applied at industry, company, business unit, project and risk theme levels.

The first two steps form the risk identification phase that aims to capture past risks that may re-occur, over-the-horizon risks and completely new risks. For the latter purposes, historical data is redundant and Expert Elicitation science underpins how experts are identified and the protocols that form the first two steps[12].

Step three introduces technology into the process in the form of an interactive software tool[13]. The tool facilitates the quantification of experts' views on the risks the industry faces as well as the collection of independent and anonymous estimates.

The fourth and final step identifies key steps for prioritization, mitigation and controls as numerical analyses highlights historically unobservable risk combinations and relationships.

Table 2 outlines the approach and performance of the four process steps as applied in this assignment of the energy system.

Table 2: Steps in KPMG's Dynamic Risk Assessment methodology

STEP I: EXPERT IDENTIFICATION AND INTERVIEWS	Forty-two experts from across the industry participated to capture a diverse range of perspectives. They represent a variety of roles across twelve different companies, multiple continents and positioned in different parts of the value chain. Individual interviews were structured in accordance with Expert Elicitation protocols and were conducted with twenty-four of the experts. The objective of the interviews was to obtain a base-level understanding of the risks faced across the industry.
STEP II: GROUP INTERVIEW	All experts participated in a group interview process, structured in accordance with Expert Elicitation protocols. This included de-biasing training elements and guided participants to consider both internal and external risks as well as trends that may pose current or downstream risk consequences to the industry.
STEP III: SURVEY	Each expert accessed a patented, interactive software tool which facilitates the collection of data points on their individual perspective of the four dimensions of each risk: likelihood, severity, interconnectivity and velocity. The survey is scientifically structured to: • Apply non-linear thinking processes;[14] • Reduce the effects of survey fatigue; • De-bias results;[15] • Avoid categorical analyses and promote continuous-valued data collection; and • Support consistent quantification of even the most challenging risks – such as those that fall within the ambit of ESG.
STEP IV: FINDINGS	A risk network was generated and analyzed to produce key insights. We presented the findings back to industry experts and discussed the next steps with them.

7 Energy study – insights and findings

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7.1 PROJECT BACKGROUND

Thirty-three WBCSD members across the energy system collaborated with WBCSD and KPMG to produce a network view of the risks and opportunities faced by the industry.

They do not represent the whole sector but are considered indicative based on the expert input received, their geographical spread and industry focus.

7.2 THE RISK LIST

Table 3 sets out the risks identified for the industry based on Expert Elicitation conducted by means of individual and group interviews – i.e. the first two steps of the process set out in Chapter 6.

Table 3: Expert-identified industry risks

NO.	RISK NAME	RISK DESCRIPTION
1	**Adverse, unforeseen impacts of low-carbon energy sources**	The transition from fossil fuels introduces reliance on different volatile or waste producing sources or technology that generate new problems for the environment and/or health of people, as well as additional costs
2	**Changing customer behaviors**	Changes in customer behaviors and opinions, e.g. resistance to solar or wind farms in local areas, concerns about nuclear power, and high carbon footprint across the product lifecycle impact adoption rates of new technologies
3	**(Physical) Climate change impacts**	Failure to mitigate climate change risks results in increased severity of storm activity, water scarcity, heatwaves, firestorms and other extreme weather events that damage or destroy infrastructure, negatively impact people and delay transition efforts
4	**Competition and margin reductions**	Immature speculation in the renewables sector and below cost bidding prices drive down margins and overinflate asset values, making it challenging to recover capital expenditure and compete in the market
5	**Cyber security**	Cyber-attacks disrupt energy supply to communities, businesses and/or countries. This results in negative impacts for dependent users and industries and reputational, revenue and cost impacts for producers
6	**(Secondary) Disruptive events**	Disruptive events such as pandemics, war and natural disasters damage infrastructure, cause fluctuation in demand, disrupt supply chains and detract focus from decarbonization
7	**Energy affordability**	The adoption of new technology, infrastructure and energy sources leads to energy price increases and reduced affordability and accessibility, exacerbating inequality within and between nations
8	**Energy storage capability**	Failure to develop and implement appropriate energy storage capability impacts the speed and ability to transition from fossil fuels and the costs for producers and users
9	**Geopolitics**	Lack of global co-ordination, leadership, stability and common goals result in uncertainty in the future direction, increased costs and inadequate consideration of vulnerable / poor countries
10	**Health and safety**	Health and/or safety incidents such as explosions, collapse of dams and oil leaks impact people and/or the environment, increase costs and reduce trust and revenue for energy producers
11	**National government strategy**	National governments fail to provide clarity on national climate, energy and industrial strategy, engage with energy producers and incentivize with appropriate policies. This results in investment uncertainty and lack of energy security for individuals, businesses and critical services
12	**Poor health of financial system**	Poor financial system health reduces the ability of governments, investors and producers to invest in the assets and capabilities required, delaying transition and reducing the ability to meet decarbonization targets

NO.	RISK NAME	RISK DESCRIPTION
13	**Regulation**	Failure of regulatory authorities to take a leadership role and reduce uncertainty by regulating appropriately and designing energy markets to support decarbonization efforts and efficient market operation. This negatively impacts decarbonization efforts, resilient energy supply and costs
14	**Reliability of energy**	The number and composition of suppliers and increasing variety of energy sources in the energy market increase complexity and operational challenges in managing the grid and securing a reliable energy supply
15	**Stakeholder management**	Poor stakeholder management, narrow framing of environmental challenges and lack of a clear narrative regarding the balancing of long- and short-term interests result in investors, energy users and governments disengaging, ultimately leading to financial distress and/or organizational failures
16	**Talent**	Failure to attract and invest in talent / skills required to transition to low-carbon energy system results in additional costs and impacts the ability to keep pace with the change required
17	**Tax and subsidies**	Differences in tax regimes and the existence of fossil fuel subsidies result in inconsistent economic incentivization that adversely impacts decarbonization targets and strategies
18	**Technology development and digitalization**	Failure to develop and adopt technology or sufficiently digitalize to ensure efficient balancing of the energy system through effective generation, transmission, distribution and use of energy. This impacts the ability to meet decarbonization requirements and costs for users and producers
19	**Transition risks**	The failure to correctly judge the pace and timing of transitioning from primarily fossil fuel to low-carbon energy sources and/or misjudging the adoption of energy efficiency measures result in financial distress and loss of market opportunities for energy producers
20	**Viability**	Inability to provide investors with sufficient returns (e.g. due to low oil and electricity prices) and ongoing uncertainty lead to underinvestment which, in turn, negatively impacts transition from fossil fuels

The individual risks ranked most severe and likely were *Physical Climate change impacts*, *Secondary Disruptive events* and *Regulation*. This analysis does not take account of the systemic interaction of all the risks, which Dynamic Risk Assessment analyses address and which we discuss later in this Chapter.

A typical corporate time horizon for risk time-to-impact scales is one to five years. However, the energy system has a longer lead time due to its complex infrastructure and planning requirements. For this reason and acknowledging its significant role in climate change and sustainability, we applied a risk duration scale of ten years.

The numbers used to mark out the risk scales for likelihood and severity use values developed as standard with infrastructure heavy industries for these types of risk analyses.

7.3 SCALES

Understanding and applying relevant risk scales is essential for effective risk management. Scale labels allow us to consistently interpret terms such as ‘minor’ and ‘likely’.[16] When used in conjunction with the analogue-collected values, we have the raw estimates for the analysis presented in this Chapter. This collects data in their natural units and avoids the problems caused by using coarse-rounded risk categories.

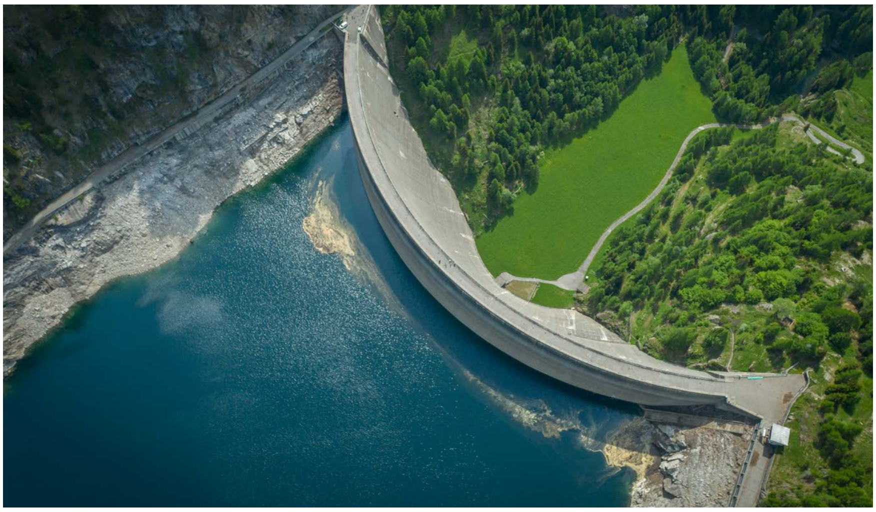


Table 4: **Severity and likelihood quantitative risk scales**

SEVERITY (IMPACT ON ENERGY SYSTEM VALUE (%))	Trivial 0% - 1%	Minor 1% - 3%	Major 3% - 10%	Critical 10% - 30%	Crisis 30% - 100%
LIKELIHOOD (% PROBABILITY OF OCCURRENCE/YR)	-	Unlikely 1% – 3%	Possible 3% - 10%	Quite Likely 10% - 30%	Likely 30% - 100%
VELOCITY	3 months	1 year	3 years	6 years	10 years

7.4 INITIAL ANALYSIS

The analysis generates:

1. A graph-like, **high resolution heat map** which shows each risk in two dimensions according to its severity and likelihood over the time period (i.e. the *anticipated event rate*), and

2. A **risk network** from which we calculate five key **risk contagion insights.**

Expert panel estimates were obtained using an analogue-style, high resolution user interface custom-built for Expert Elicitation of risk contagion data – an improvement on the traditional risk-reporting heat map where attention is usually focused in the upper right box. We present our improvement of the traditional heat map, together with the risk network, to compare them and highlight key differences.

Specifically, the risk contagion insights are impossible to find with the traditional approach:

- **The near-term scenarios, or risk clusters:** our panel most expects these risk combinations to spread to each other and occur jointly;

- **The longer-term risks most expected to eventuate:** these risks in the network are most vulnerable to other risks that can trigger them directly or indirectly;

- **The most influential intervention points:** these risks are the most potent at affecting other risks in the network - directly or indirectly;

- **Velocity:** the expected time to impact of each risk, which drives the time of onset of risk clusters – how rapidly the risks' consequences will impact the sector once triggered;

- **Tendrils:** these are slow, low-expected impact risks which are not highlighted by the risk network analysis and are not likely to act as super-spreaders in a risk event.

7.4.1 Findings of the risk heat map depiction

The traditional heat map depiction of individual risks is by means of a two-by-two block matrix. KPMG's Dynamic Risk Assessment presents a two-dimensional graph of the individual risks accurately positioned by likelihood and severity. The placement of each risk corresponds to the group average of these risk metrics. **Figure 2** presents the relative positioning of the risks identified for the energy system. These are predominantly located towards the top right corner of the graph, implying they are all near or within the *quite likely* to *likely* band of values (equal to 1-in-10 year through 1-in-3 year event rates) and around the *critical* to *crisis* impact (equal to 10% to 30% of sector value) bands, even before their potential interconnectedness and expected aggregation is analyzed (Section 7.5).

Figure 2: Typical 2-dimensional risk heat map

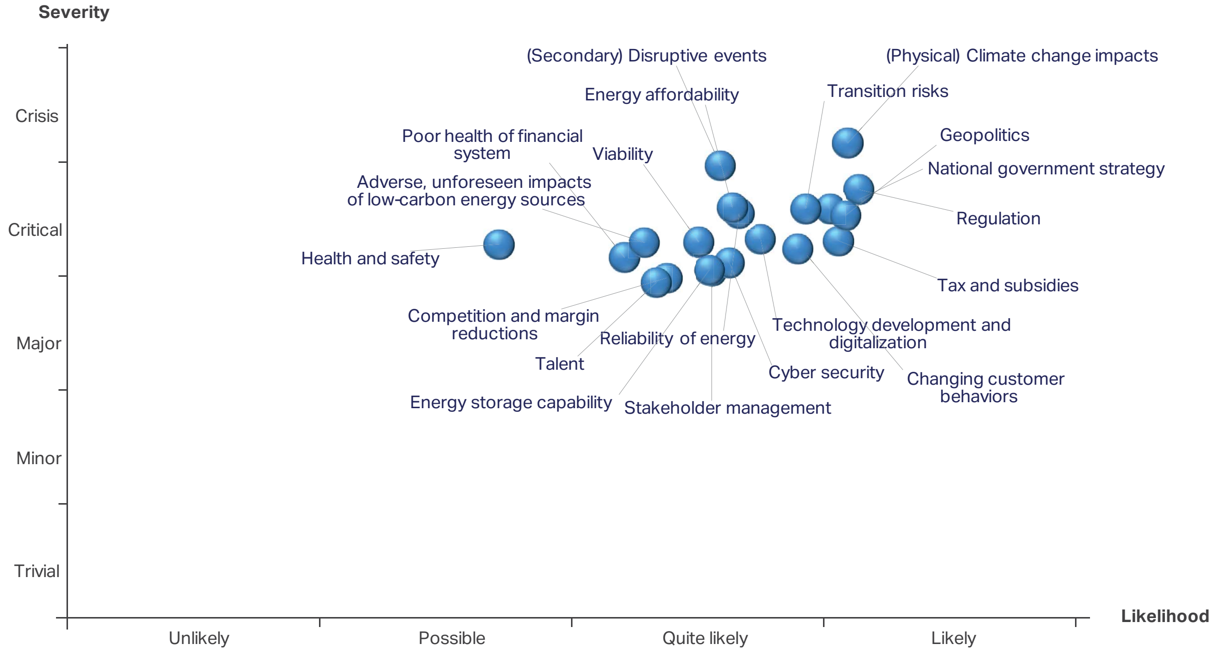
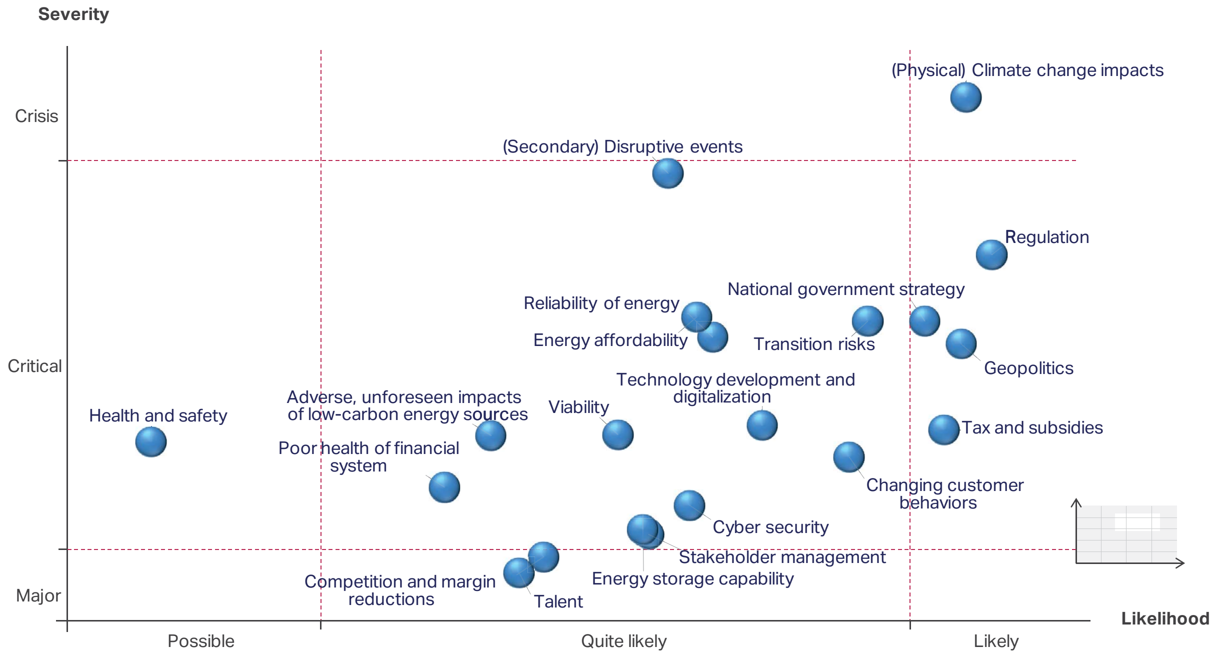


Figure 3 provides a magnified view of **Figure 2**, showing that the most severe and likely risk is (*Physical) Climate change impacts*, followed by *Secondary disruptive events* and *Regulation*.

Figure 3: Close up of the risks in the previous the severity-likelihood heat-map



(Physical) Climate change impacts is near certain[a] to occur at *crisis* severity level with a 36.5% of sector value as a lower estimate of its impact. So certain[b] are the experts that its *Secondary disruptive events* are considered quite likely to occur and also ranked at near-crisis level. The focus around climate change is normally on how to prevent the climate crisis, rather than the changes needed to adapt to the physical impacts of climate change that are already occurring. This analysis shows that the panel of experts recognize that irreversible physical impacts of climate change are already impacting the energy system and need to be focused on, as well as the measures to limit further negative impacts.

Regulation, *Geopolitics*, *Tax and subsidies* and *National government strategy* are similarly near certainties, each with a *critical* impact level. Except for *Talent* and *Competition and margin reductions* every risk is ranked at *critical* severity or above.

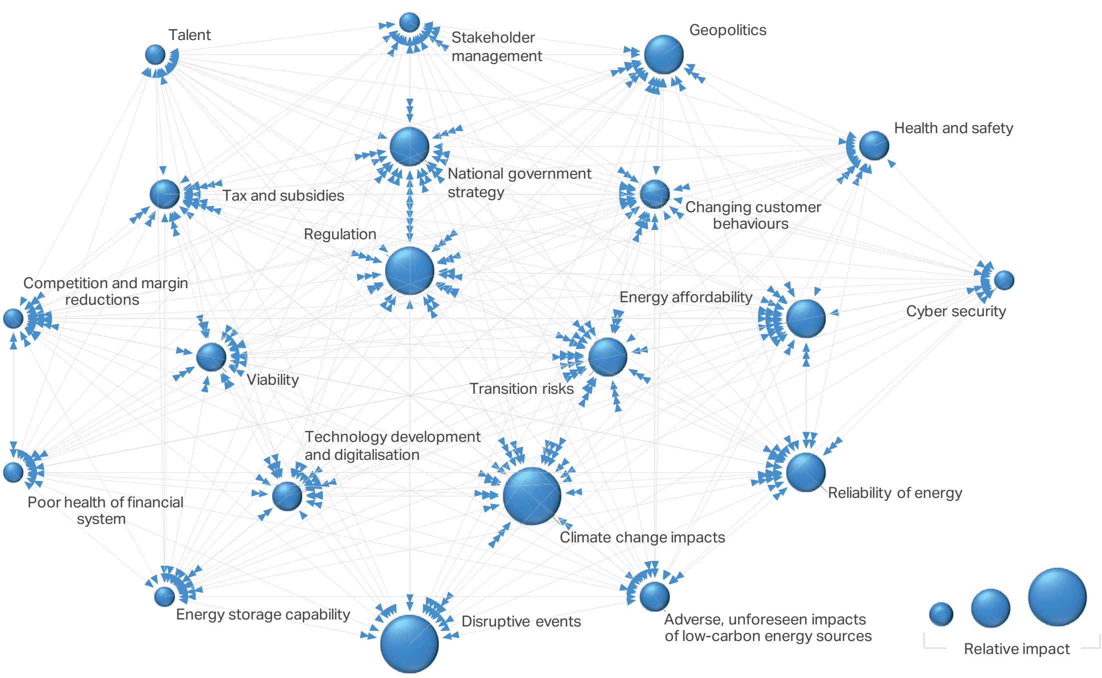
All but one risk, *Health and safety* are *quite likely* or *likely* to occur. The expert panel assessment of these risks at high event rates shows a sector aware of the dire need for risk mitigation. The panel of experts recognize an important role in a broader context of longer-term sustainability and climate change, and so the acute estimates of the risks presages mounting follow-on consequences for sustainability and climate change.

Without further information, **Figure 3** exhausts our analysis of the energy system's risk environment. When we extend the analysis to include the causal connections and velocities of the risks, a deeper risk dynamics analysis is possible. We present this in the following sub-chapters.

7.4.2 Findings of the network risk map depiction

Figure 4 shows a graphical representation of the network and displays how the expert panel expects individual risks to interact and affect each other. The network uses inputs from all participants and gives a sector-participant-wide comprehensive view. The circles represent the risks and the circle diameter depicts the severity. These are consistent with the severity and likelihood results presented in **Figure 3**. Most importantly, the enhanced analysis in **Figure 4** captures the expected connections between the risks. The direction of contagion flow is indicated by the direction of the arrow heads and the strength by the number of arrow heads. **Figure 4** depicts the complex web of data collected from the participants.

Figure 4: A raw network view of the risks identified including relative impact and connectivity



[a] The return rate is just over one event every three years.
[b] The experts' likelihood rate estimate is 0.34 events p.a. – a little more frequently that a crisis event every three years.

Figure 5 shows the same network as presented in **Figure 4** but displaying only the highest consensus connections. Over 45% of participants individually called out these contagion connections with a consensus weight of 28.9% or greater. We suppress the weaker links between risks in the visual illustration to highlight its main features. However, while the network visualization in **Figure 5** displays only those connections with votes above the 28.9% consensus weight level, we do not use this network in the quantitative analyses. Instead, we use every vote by every participant to analyze the network characteristics and develop interpretations.

7.5 INSIGHTS FROM THE ANALYSIS

In this section we present key insights from the analysis.

7.5.1 Insight #1: The expected near-term scenarios, or risk clusters

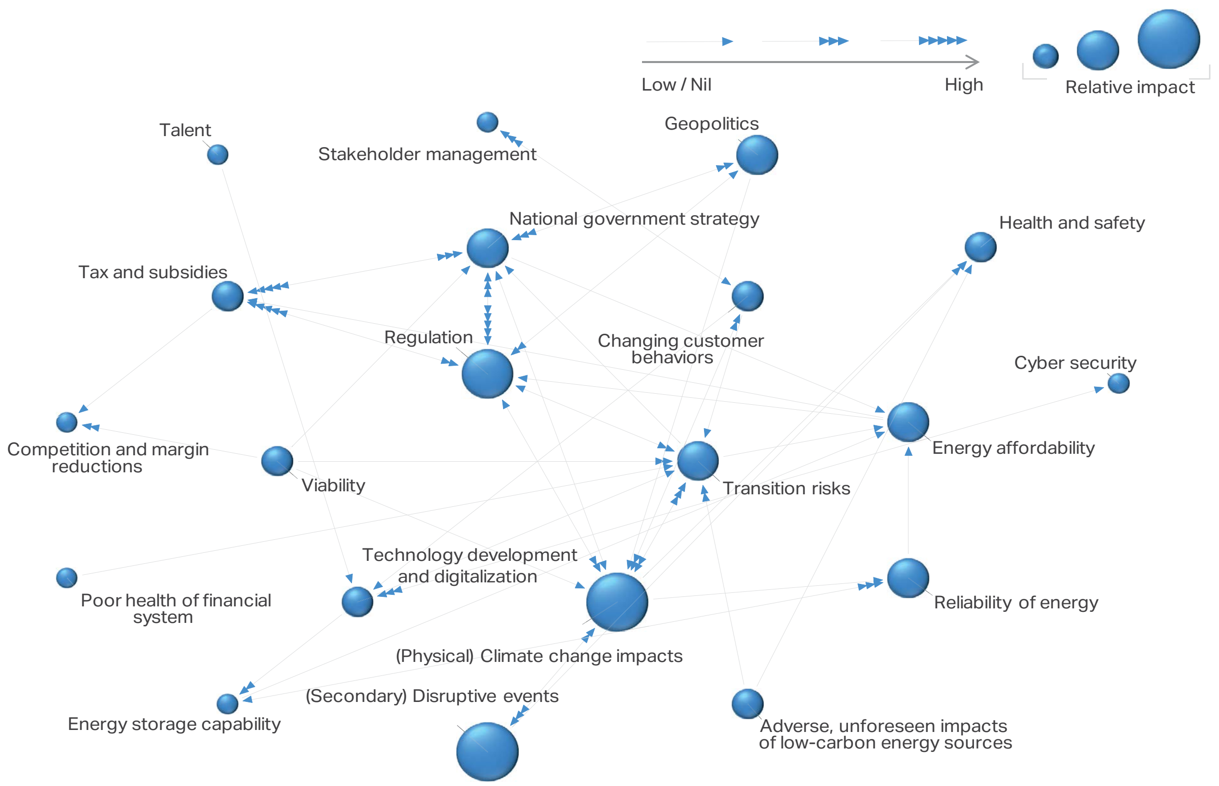
Linking individual risks to form a network permits the identification of *risk clusters*. These are smaller parts of the network, consisting of three or more risks, where the experts agree that all internal contagion paths have the strongest two-way connections. They represent the combined risk scenarios of individual risks that the experts most expect will connect to each other, in whichever direction, if any of them triggers. In other words, the *clusters are scenarios the experts most expect to encounter in the near-term.*

Approximately 40 to 70 percent of experts[c] from different organizations and positions along the energy sector value chain agree on six distinct near-term scenarios. We list these in **Table 5**: Six expected near-term scenarios. **Figure 6** highlights the individual risks expected to link up in the near-term within the network to form those scenarios.

Our algorithms characterize the near-term scenario by the *minimum expert consensus level* (in %) we need to identify them. We order by this agreement measure with the first ones having the greatest agreement among the expert panel.

The six scenarios each have lower-bound estimated aggregate severities ranging between 84% and 99% of total energy sector value (i.e., today's value of its future, aggregate earnings capacity).

Figure 5: A network view of the risks identified showing only the highest consensus connections

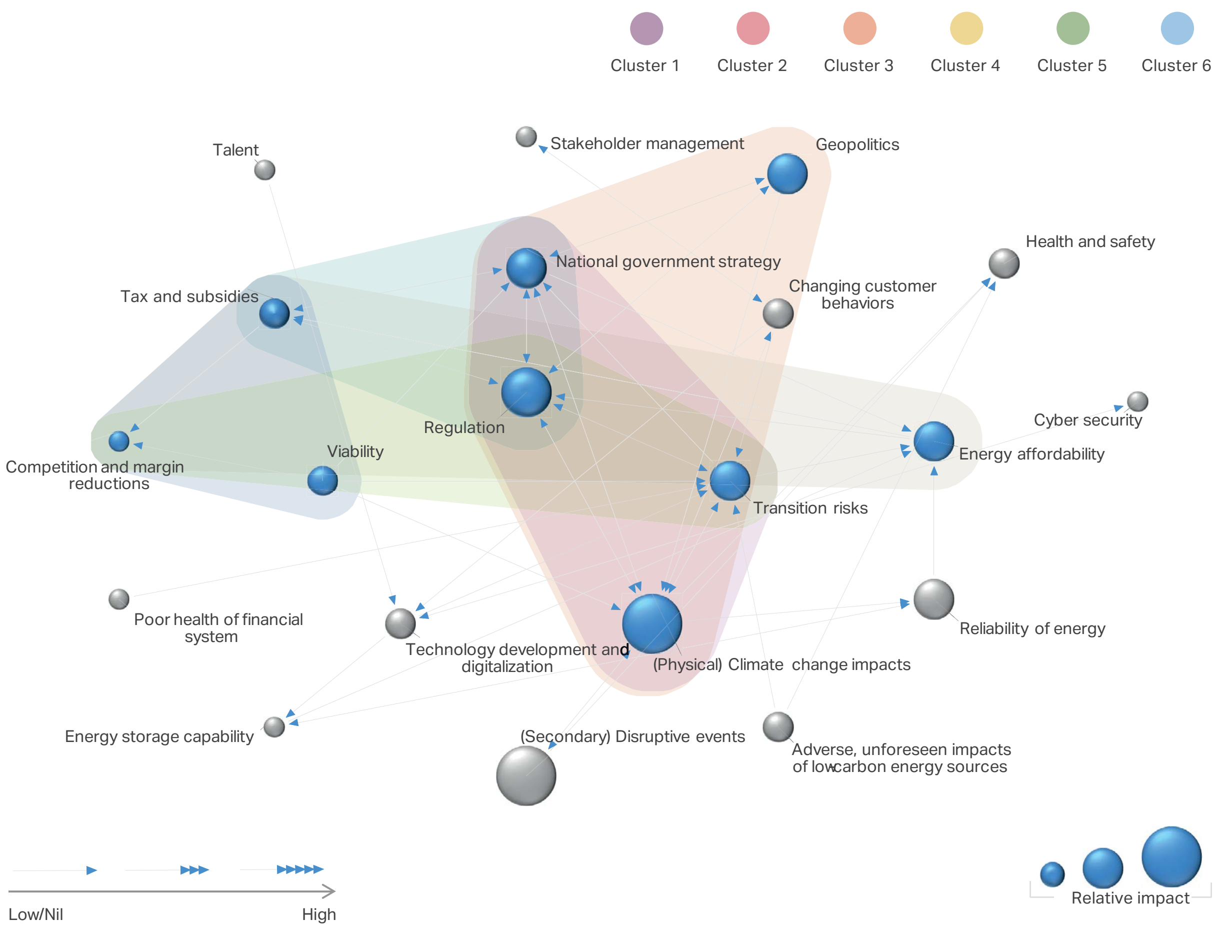


[c] This corresponds to between 23-41% of expert consensus weight generated by the expert's contagion assessments.

Table 5: Six expected near-term scenarios

NO	CLUSTER	NO	CLUSTER
1	National government strategy Regulation Tax and subsidies	4	Competition and margin reductions Regulation Transition risks
2	(Physical) Climate change impacts National government strategy Regulation Transition risks	5	Competition and margin reductions Tax and subsidies Viability
3	Competition and margin reductions Energy affordability Regulation Tax and subsidies	6	(Physical) Climate change impacts Geopolitics National government strategy Regulation

Figure 6: A network view of the risks identified in the six near-term scenarios



The primary near-term scenario, with experts recognizing a minimum level of contagion of 41% between every two-way link, is the scenario of *National government strategy* linking to *Regulation* and *Tax and subsidies*.

The expert panel defined the *National government strategy* risk as governments failing to provide clarity on national climate, energy and industrial strategy so that it results in investment uncertainty and lack of energy security. *Regulation* refers to the failure of regulatory authorities to take a leadership role. *Tax and subsidies* represent inconsistent economic incentives that adversely impact decarbonization targets and strategies. Experts assessed each one of these risks as *likely* and *critical* in **Figure 5**, implying that (i) their aggregated severity is at full-scale crisis level and (ii) the likelihood of occurrence is near certain (see **Figure 7**).

The second anticipated near-term scenario, with a 30% consistency measure, manifests when the three risks in the first scenario link up with a fourth – (*Physical) Climate change impacts*. This highlights the criticality of the first cluster which, together with the fourth risk, aggravates the collective impact. The aggregate severity nears the upper 99% severity scale edge, implying the expert panel sees the sector's future earnings capability as materially at risk unless mitigative actions are adopted. Within this exposure, vast shifts in value across the sector should be expected to produce significant winners and losers. Note the risk severity positioning of the inset within the broader scale of **Figure 7**.

Figure 7: The aggregated view of the most expected cluster and its time-to-impact

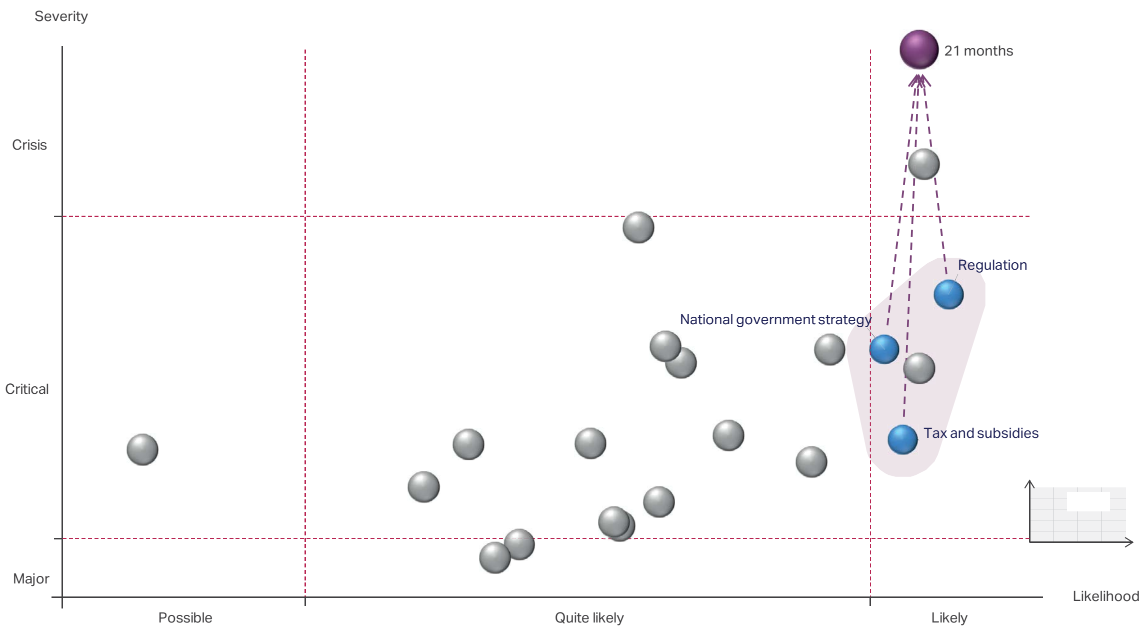
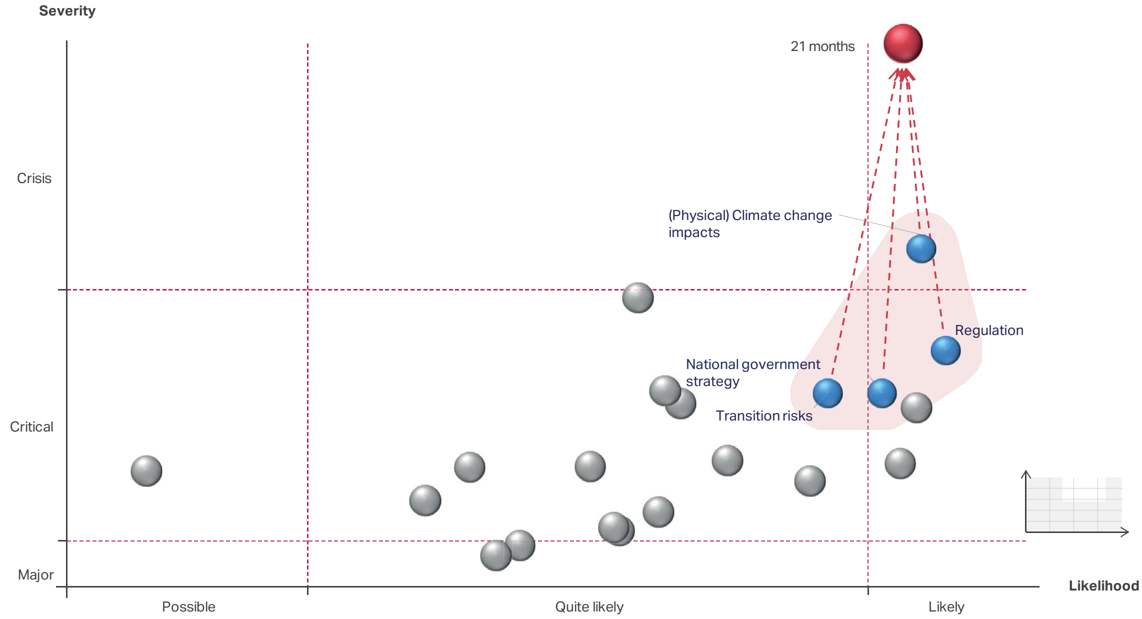


Figure 8: The aggregated view of the second most expected cluster and its time-to-impact



The scenario's certainty and severity magnitude raise the question whether the sector can risk waiting any longer for guidance from national governments and regulators. The short-term tenure of political leaders who in some regions align more and more with populist and nationalist forces, show no sign of moderation in the geopolitical risk caused by unilateralism and demonstrate a lack of global cooperation.

With both scenarios already at *crisis* level, the case for the private sector to take the lead gains support from

- the response to the COVID-19 pandemic where the pharmaceutical sector spearheaded the reduction of threat levels through the development of vaccinations amidst an absence of coherent government interventions (with few exceptions);
- the aftermath of the 2008 global financial crisis when it became uncontestably clear that the purpose of enterprise cannot be reduced to the optimization of a single metric of shareholder return. Instead, it carries an entrenched responsibility to society and the environment, even though the latter's economic costs, absence of a carbon price, are still treated as 'externalities'.

The third most expected scenario, with a 26% minimum consistency in the selection of pathways between risks by individual participants, involves *Competition and margin reductions*, *Energy affordability*, *regulation* and *Tax and subsidies*.

This scenario calls out, in the absence of regulation and the presence of different tax regimes and fossil fuel subsidies, the risk of immature speculation in the renewables sector. In addition, bidding prices below cost drive down margins and inflate asset values and the adoption of new technology, infrastructure and energy sources lead to unaffordable energy price increases that exacerbate energy inequality.

The third cluster is closely linked to the fourth, in which *Competition and margin reductions* combine with *Regulation* to trigger *Transition risks*. This cluster has a consensus level on par with the previous cluster at 26%. Two of the risks in cluster four, *Competition and margin reductions* and *Tax and subsidies*, are expected by 24% of participants to develop into cluster five when they trigger viability risks as organizations become unable to provide investors with expected returns.

The third, fourth and fifth clusters

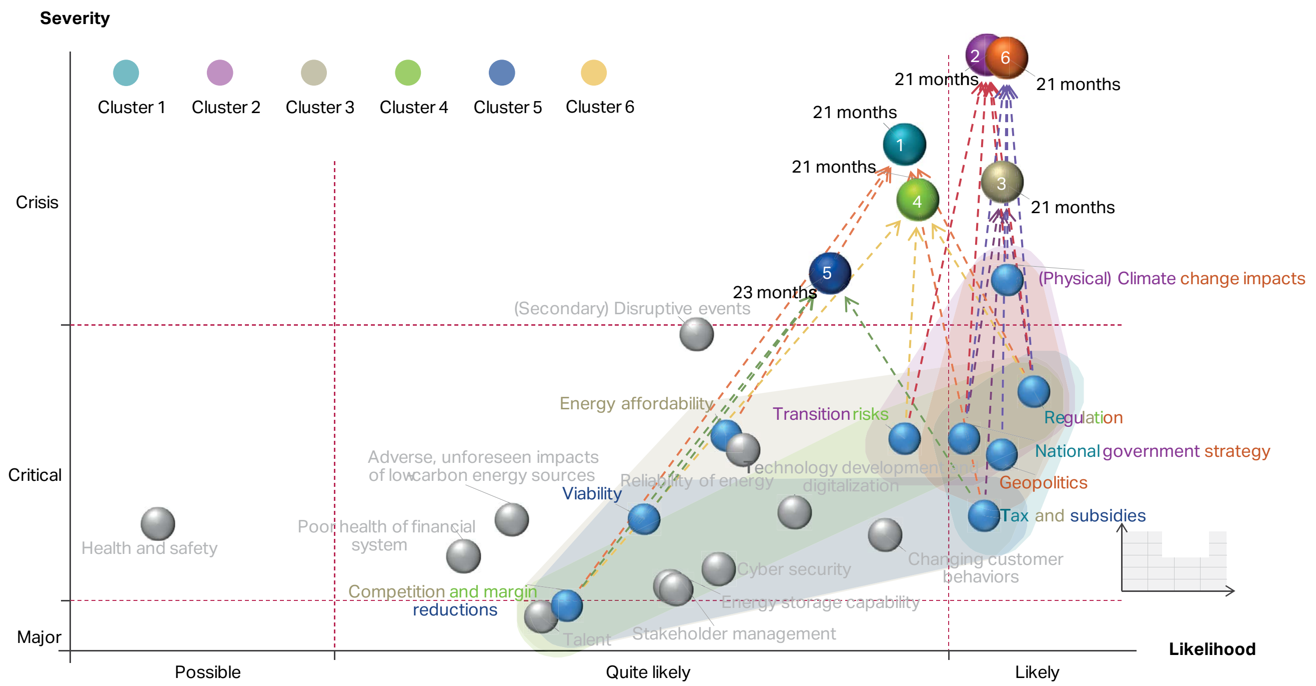
focus on the sector's concerns of fragmented responses to the challenge of decarbonization. Directors and those charged with governance typically owe, in terms of statute, a responsibility towards 'the company'. Moreover, shareholders by and large still hold them accountable on measures of preservation of company value, consistency of performance, profitability and growth. Corporate performance appraisals still regard meeting sustainability targets and transforming to sustainable practices as *externalities*. Even though the rhetoric in the market from certain investors is that there is a focus on the ESG credentials of their investments, this is often not reflected in the reality of the transactions and the absence of investor pressure in this analysis reflects that. As a result, there is no incentive to *break ranks* from other sector players by investing in technologies that expose an organization to margin reductions, reputational damage (e.g., as a result of affordability issues), transition risks and/or viability concerns. This *decision-making architecture* reinforces the persistent system dynamic shown in clusters one and two.

The scenario in cluster six joins together the (i) lack of global co-ordination, leadership and common goals and its resulting uncertainty in future direction to (ii) the lack of clarity on national climate, energy and industrial strategies from national governments to (iii) the absence of regulation and, hence, to (iv) *(Physical) Climate change impacts*. It is similar to cluster two, with *Geopolitics* replacing *Transition risks*. Fewer panelists identified every link in this cluster (23%), but its aggregate severity is almost identical to cluster two (see **Figure 8**). The expert panel poses a question through this scenario – *Can the sector afford not to act given the regulatory vacuum at national and international levels?*

The relative positioning of the clusters can be seen in **Figure 9**.

The key to breaking up clusters one, two and six is the mitigation of corporate performance risks called out as margin reductions, affordability, transition risks and viability. Namely, the economic structures and incentives that lead rational organizations to make decarbonization investments at the company level are not system wide. One structure that does this is the introduction of a carbon price. However, the risks of *National government strategy*, *Regulation* and *Geopolitics* cast doubt whether this solution would be timely and feasible.

Figure 9: The aggregate view of the most expected scenarios and their time-to-impact



Once triggered, the six risk scenarios exhibit high velocities, with estimates of between 21 and 23 months to full impact. This is concerning in an industry that has long planning and investment horizons.

Local or state government legislation can also create the incentive to decarbonize. Although well-intended and a welcome action, this does not overcome the risk of regulatory or legislative arbitrage. These actions trigger risks of *Tax and subsidies* and invite inconsistent economic incentives that adversely impact decarbonization targets and strategies.

Energy system players creating interest groups and umbrella organizations is a possible solution. They could formulate their own standards and decisions on future pathways and self-governance to mitigate the risks of margin reductions, affordability, transition risks and viability. A modest first step could be to target the prevention and / or mitigation of (Physical) Climate change exposures.

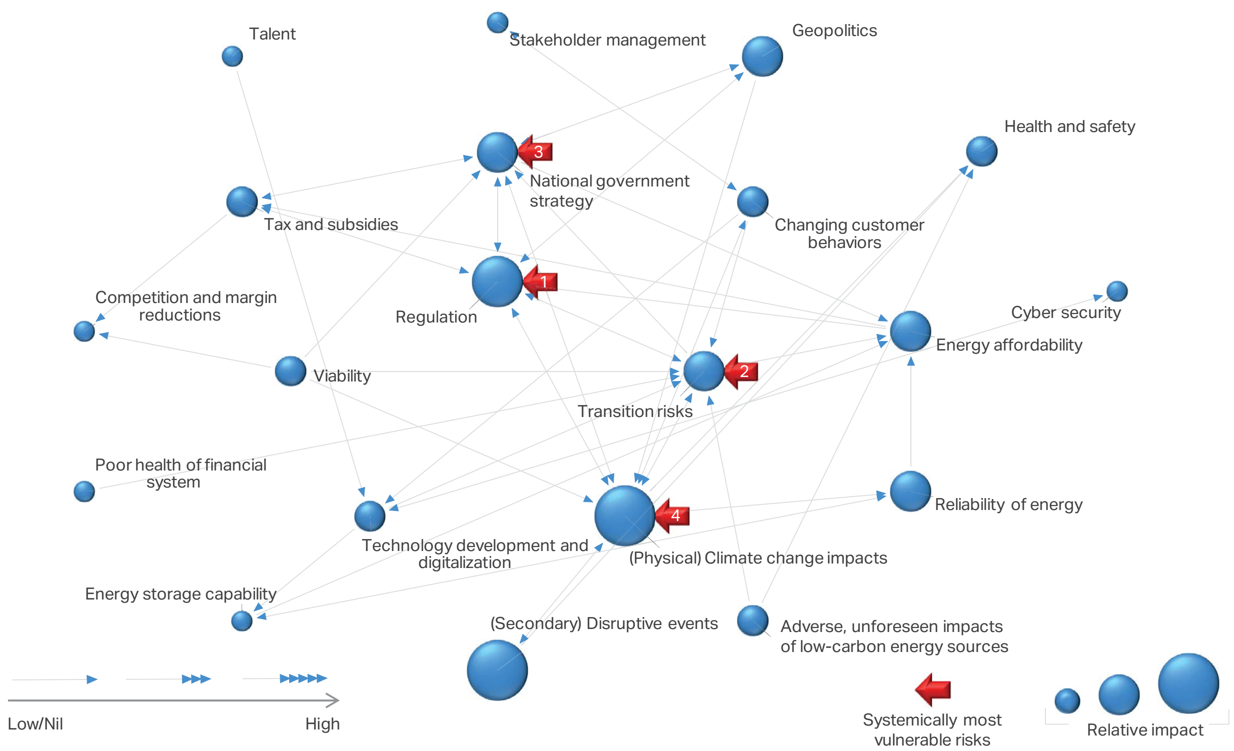
7.5.2 Insight #2: Longer-term risk arc

Over time, the operation of any two-way incomplete[d] network (such as the one in **Figure 4** and **Figure 5**) will inevitably result in points of vulnerability to emerge. These are the *pressure points* – a result of the causal flows within the network. The network structure and the combination of direct and indirect flow strengths determine where they will occur, and this is calculated mathematically. The first is comparatively benign in systemic (network-wide) threat levels, the next will be less so, the third marginally more threatening and so on. Ultimately, the risks where we expect the greatest pressure form the network's most vulnerable failure points. Networks often change state rapidly and there frequently exist inflection points at which catastrophic failures occur. If this chain of events, or arc of vulnerability, occurs within the energy system network, a rapid change of state can occur to trigger a chain reaction of events that could activate every risk pertinent to the sector.

This longer-term arc of emerging network failures, where risks do not trigger by their own root causes but as a result of their position and dynamics in the broader network, operate on a longer time sequence. It describes on average the network's vulnerable pathway. Over this longer-term, it represents a structural failure mode unless we apply the corrective actions we describe in Section 7.5.3.

The greatest pressure points in the network and their overall vulnerability rank– the *tail end* of the arc of vulnerability – appears in **Figure 10**.

Figure 10: The most vulnerable risks in the network, or 'tail end' in the arc of energy system vulnerability



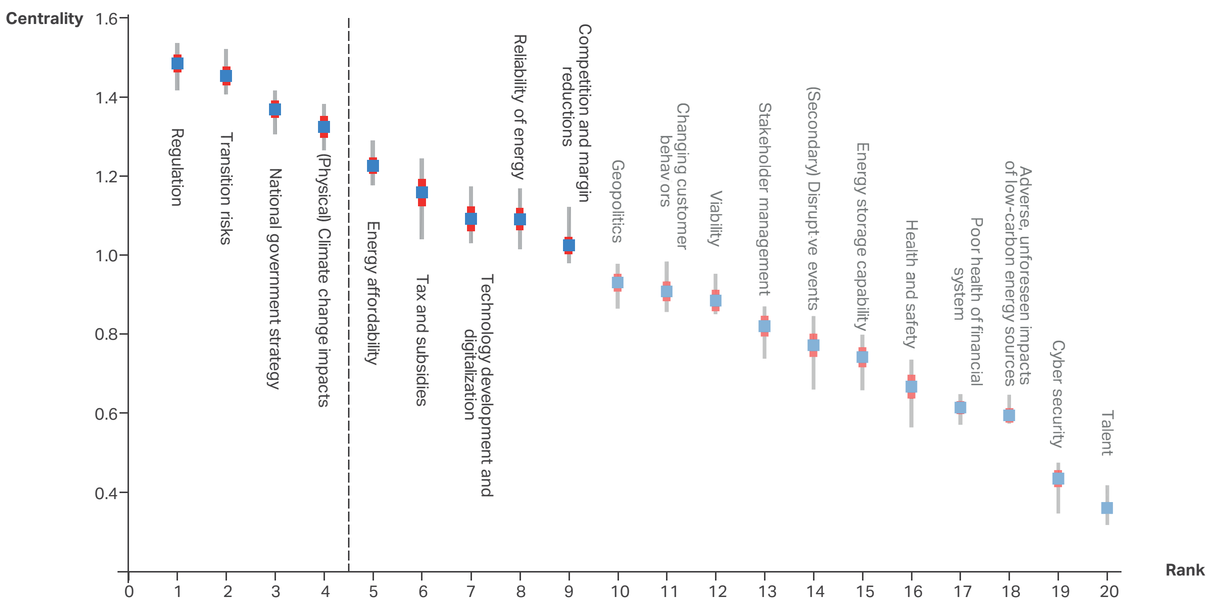
d In graph theory, we call networks where every node is not directly connected to each other incomplete.

The rank ordering of risks' vulnerability results from their different positions in the network: some risks receive risk contagion directly or through other risks from only a few neighbors while others are more exposed. A few risks receive nearly every other risk's contagion flowing towards them, with great cumulative force along one pathway or another. These are the most systemically vulnerable risks in **Figure 10**. When triggered in this way, we can't manage them as standalone risks. Instead, we must stop the supply of contagion from the neighboring risks. This requires a network-based mitigation plan (see Section 6.5.3). The more vulnerable a risk is to contagion from other risks – the higher the rank order of vulnerability in **Figure 11** - the more complete we require the network-based intervention to be.

The full graph of the risk vulnerability[e], in descending rank, appears in **Figure 11**. We obtain the longer-term risk arc by starting at the right (rank 20) and following the sequence with increasing levels of certainty to the left (rank 1). The extent of each risk's exposure to every other risk can be seen on the vertical scale. The higher it appears on the vertical scale the more certain that it will occur via systemic, network-induced failure unless we mitigate the occurrence of the most influential risks as discussed in Section 7.5.3.

Uncommonly, the four most vulnerable risks (*Regulation*, *Transition risks*, *National government strategy* and (*Physical*) *Climate change impacts* that, from the discussion above, should ordinarily be expected to manifest sometime in the future – once the network has had time to generate the pressure points – have all already been classified as *likely* to *quite likely* (near certain) in **Figure 3**. In other words, we have already reached the 'end of the line' in the risk arc. There is no more time left. The systemic mitigation steps in Section 7.5.2 therefore require immediate attention and implementation.

Figure 11: Complete rank order of systemic vulnerability of risks, denoting the longer-term risk arc



The vertical axis indicates the relative level of vulnerability of each discrete risk towards the operation of the network. The black dashed line demarcates a notable step down in this level of vulnerability. The first four risks, Regulation, Transition risks, National government strategy and (Physical) Climate change impacts constitute the systemically most vulnerable risks.

[e] The vertical axis indicates the eigenvector centrality of the risk and is the relative level of vulnerability of each discrete risk towards the operation of the network. The black dashed line marks a step down in the significance of this vulnerability measure. The first four risks, Regulation, Transition risks, National government strategy and (Physical) Climate change impacts form the systemically most vulnerable risks. Without systemic mitigation action the network dynamics are most certain to trigger these risks over a long time via contagion flow.

7.5.3 Insight #3 The network's most influential intervention points

While some risks are more affected by other risks, certain risks will also be more powerful in affecting others. Just as with vulnerability, this is due to the position within the network and the number and strength of connections to its neighbors. The more central a risk is in the network, the more influence it has. By this measure, influential risks are more potent when connected to other influential risks. As with the vulnerability calculation, we find these points mathematically and present them in **Figure 12**.

Risks that are highly influential are network leverage points and offer important points of intervention. Due to the strength and reach of their influence, positive actions on these risks will propagate through the network to optimally reduce whole-of-system risk. Using the causal flows of the network to our advantage, we can get the highest mitigation payoff by focusing on these intervention points. It is this wide-reaching systemic effect that we need to counter the adverse, network-induced systemic outcomes described in Section 7.5.2.

Figure 12: Most influential intervention points

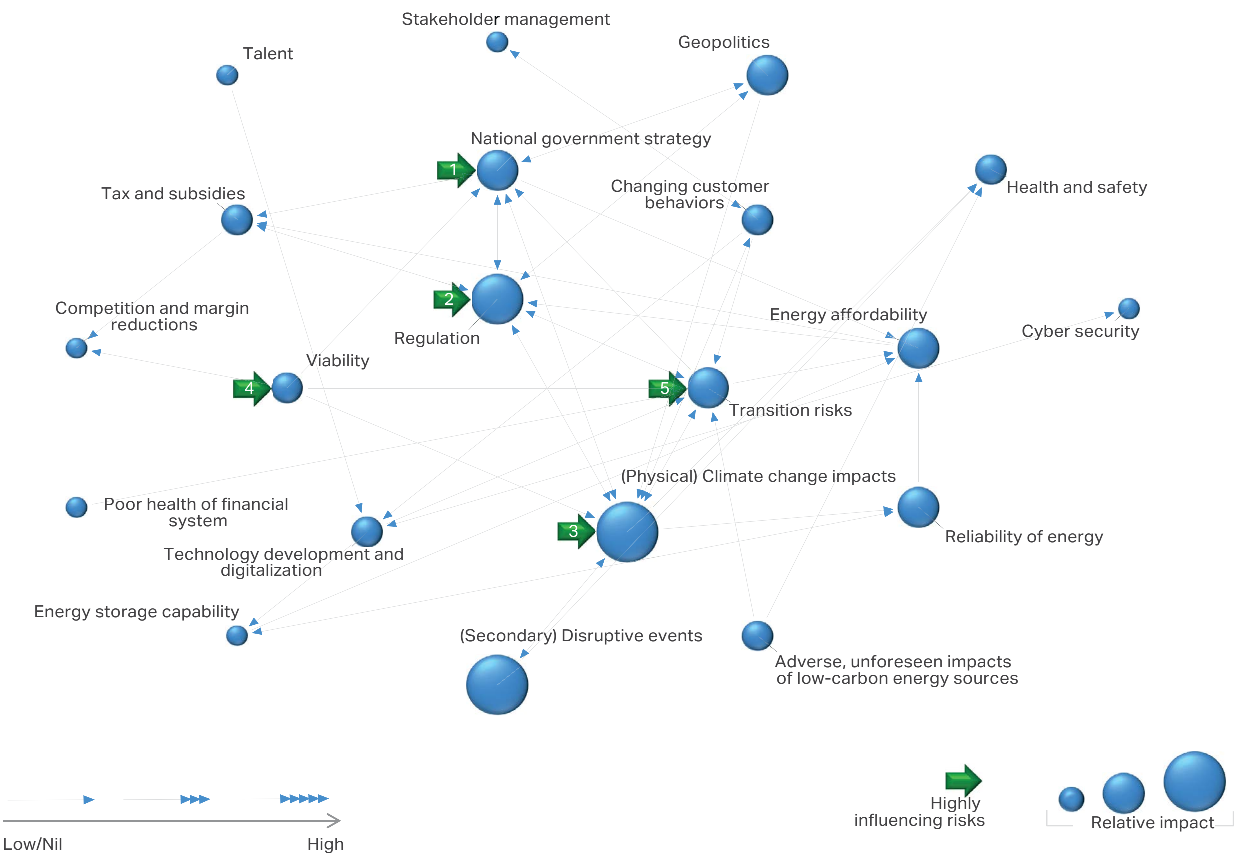
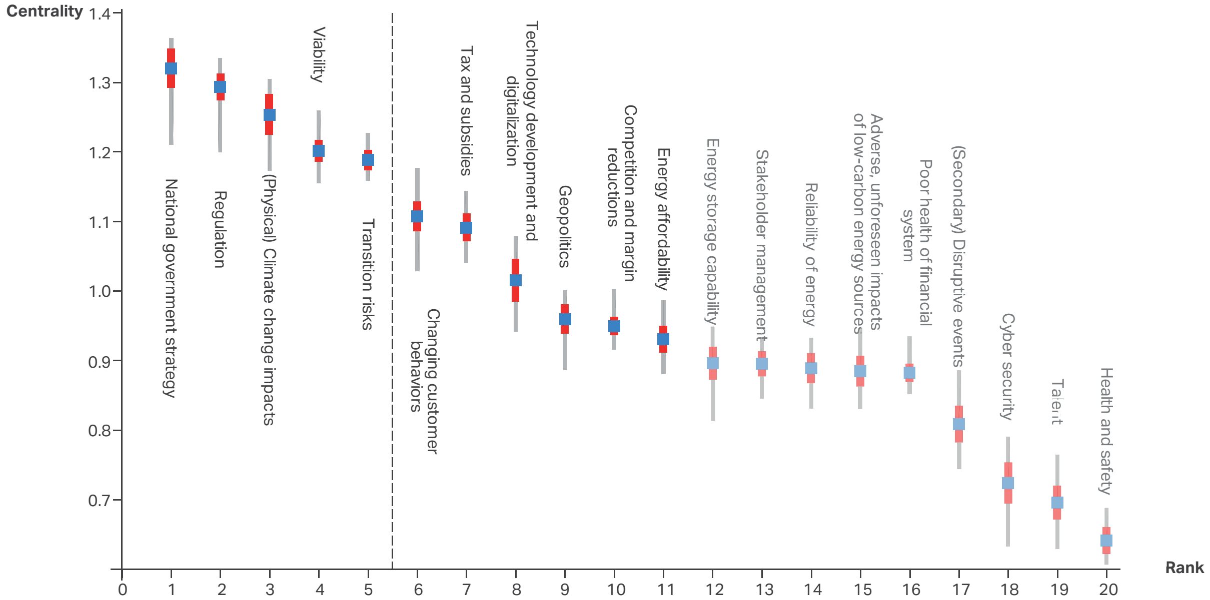


Figure 13 depicts the influence values we calculated against their rank.

Figure 13: Rank order of influence of individual risks



The vertical axis indicates the relative level of influence of each risk upon the rest of the networked risks. The black dashed line indicates a notable step down in this level of influence. In this manner it can be seen that the first five risks, National government strategy, Regulation, (Physical) Climate change impacts, Viability and Transition risks are the most significant levers for driving large scale, systemic change.

The strongest mitigants and the ones most potent to reduce every other risk are *National government strategy* followed by *Regulation*. These two points in the network are the most powerful intervention junctures to mitigate the third ranked risk: *(Physical) Climate change impacts*.

As discussed in Section 7.5.2, all three of these risks are already manifesting and the panel expects them to continue with near certainty (see **Figure 3**). The absence of detailed guidance on the first two risks puts organizations in a difficult position as they face mounting pressure from investors and consumers to adopt more sustainable practices without detailed guidance how to achieve this within a level playing field. Furthermore, in the absence of detailed guidance on the first two risks means the third, *(Physical) Climate change impacts,* receives unconstrained, accumulative aggravation through contagion from every other risk. This resonates with Section 7.5.2 that found *(Physical) Climate change impacts* to be highly vulnerable to network-wide contagion: it was ranked fourth in terms of vulnerability to contagion from every other risk in Figures 11 and 12.

How, then do we mitigate the systemic risk of the energy system if detailed mitigation of *National government strategy* and Regulation cannot be expected anytime soon?

For this, we need to identify the most net accretive influential intervention points within the network, as undertaken in Section 7.5.4.

7.5.4 Insight #4 The most net accretive, influential intervention points

There is a more efficient way to reduce network effects that create the pressure points in Section 7.5.2. It involves using the network effect optimally to our advantage. This is done by focusing on the most influential intervention points (Section 7.5.3) which also have the property that they affect the other risks more, on net, than they are affected by the other risks. An alternative way of thinking about it is to deselect the most influential intervention points for mitigation if and when they are also highly (or more) affected by the other risks. In this manner we isolate the most 'net' influentially accretive intervention points – see **Table 6**.

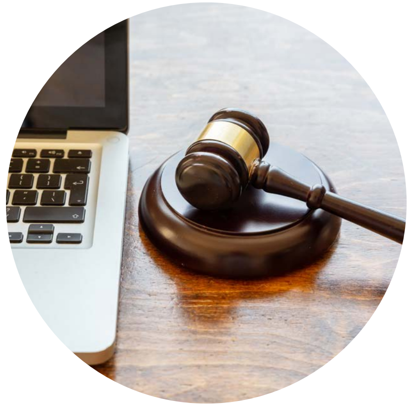
Table 6: Net influential leverage points

RANK ORDER OF INFLUENCE	RISK	RANK ORDER OF VULNERABILITY	RISK
1	National government strategy	1	Regulation
2	Regulation	2	Transition risks
3	(Physical) Climate change impacts	3	National government strategy
4	Viability	4	(Physical) Climate change impacts
5	Transition risks	5	Energy affordability
6	Changing customer behaviors	6	Tax and subsidies
7	Tax and subsidies	7	Technology development and digitalization
8	Technology development and digitalization	8	Reliability of energy
9	Geopolitics	9	Competition and margin reductions
10	Competition and margin reductions	10	Geopolitics
11	Energy affordability	11	Changing customer behaviors
12	Energy storage capability	12	Viability
13	Stakeholder management	13	Stakeholder management
14	Reliability of energy	14	(Secondary) Disruptive events
15	Adverse, unforeseen impacts of low-carbon energy sources	15	Energy storage capability
16	Poor health of financial system	16	Health and safety
17	(Secondary) Disruptive events	17	Poor health of financial system
18	Cyber security	18	Adverse, unforeseen impacts of low-carbon energy sources
19	Talent	19	Cyber security
20	Health and safety	20	Talent

Table 6 lists the risks in order of their influence on others on the left, and the rank order in which they are affected by the other risks on the right. For example, *National government strategy* is more influential over other risks with a first rank on the left, than it is influenced by the other risks (third rank on the right). This makes its influence 'net' accretive. The same applies to *(Physical) Climate change impacts*, *Viability*, *Changing customer behaviors*, *Energy storage capacity*, *Adverse, unforeseen impacts of low-carbon energy sources*, *Poor health of financial system*, *Cyber security* and *Talent*.

The identification of these risks offers organizations in the energy sector alternative opportunities to reduce system-wide exposures despite an absence of detailed guidance in *National government strategy* and *Regulation* mitigation initiatives. The key is to mitigate these alternative, net-mitigation accretive risks in a coordinated way.

Organizations might mitigate *(Physical) Climate change impacts* through application of varied responses and climate adaption activities: for example driving understanding and planning for volatilities to energy demands and supply systems; strategically integrating lower carbon development objectives into energy planning; scaling up renewable energy sources and efficiency measures; and leveraging new technologies and innovation to pursue loss reduction and cleaner fossil fuel technologies.



Mitigation of *Viability* risk offers extraordinary potential systemic relief: while many visionary fund managers are clear in their support of sustainable energy, panelists call out that too many still emphasize meeting or exceeding historical performance benchmarks. This induces a decision-making architecture that renders it structurally incentive-irrational to defy these expectations, for example by investing in riskier, future technologies.

Changing customer behaviors displays broadly similar potential for systemic value at risk relief: A climate conscious attitude by retail investors can bring pressure to bear on pension fund managers to refrain from a narrow framing of shareholder return as a singular indicator of stewardship performance. It can similarly exert pressure (mitigate) *Geopolitics*, *Competition and margin reductions*, the *Reliability of energy*, investment in *Technology* as well as *Tax and subsidies* – the state of California being a case in point[17].

A collective effort by the sector to address *Energy storage capacity* will systemically mitigate *(Secondary) Disruptive events*, *Stakeholder management* and *Viability*. A similar, coordinated focus on *Adverse, unforeseen impacts of low-carbon energy sources* will capitalize on the sector's systemic topography to disproportionally mitigate (reduce) the risks of *Poor health of the financial sector*, *Health and safety* and *Energy storage capacity*.

Minor systemic relief for the sector's risk profile can be attained by securing *Cyber* and improved management of *Talent*.

7.6 IN SUMMARY

There are very few industry sectors where the assessment of longer-term risks (Section 7.5.2) are already near certain (**Figure 5**) and approximating sector value. As before and as such, unless corrective steps are taken the exposure to the industry is expected to be colossal. In the context of this exposure, vast shifts in value are to be expected and will lead to significant winners and losers.

Unless organizations take collective initiative and mitigate the most influential, net accretive intervention points, an implosion looms. The only remedy then is for already overborrowed, fiscally bankrupt governments to borrow even more from future generations. Or, as was the case in the Great Depression and in Greece more recently, for citizens to dramatically and near permanently lower their living standards. By every analysis, the time to mitigate the risks identified in Section 7.5.4 has arrived with great urgency.

8 Key themes and possible actions

8 Key themes and possible actions

Based on the analysis using KPMG's Dynamic Risk Assessment, key themes and possible actions are presented below. While the profile of participant companies may not be fully representative of the entire energy system, the themes and actions presented highlight potential areas of focus for companies and possible sector-level actions.

The themes and possible actions fall under three main thematic areas that reflect the potential type of response:

- **Reinvigorating governmental and regulatory leadership** – e.g., governments and regulators to provide clarity on national and global climate, energy and industrial strategy to stimulate investment confidence, energy security and consistent decarbonization incentives.
- **Business collaboration to self-determine the direction of travel** – e.g., the private sector to assume responsibility and take the lead to drive the energy system transformation via collective initiatives, cross-industry alignment and coordinated system approaches; and
- **Individual organizational actions** – e.g., steps individual organizations can take to address or mitigate risks that will yield a net-positive impact on the resilience and performance of their company and system-wide risks.

Reinvigorating governmental and regulatory leadership

The manifestation of the most vulnerable risks (*Regulation, Transition risks, National government strategy* and (*Physical) Climate change impacts*) are regarded as near certain by the expert panel in this analysis.

The analysis highlights the potentially calamitous impact if national governments and regional administrations continue to fail to provide clarity and coordinated policy on national climate and energy strategies. With an associated absence of regulatory leadership, the stability of energy markets is undermined, investment uncertainty increases and strategic decarbonization and transition responses are undermined.

The urgent need for consistent, coordinated leadership and action by governments and regulators are the highest priorities to address the vulnerabilities to risks faced by the sector. Renewed strategic focus by these public bodies is essential for the energy system to meet future energy demands and securely supply energy in a sustainable manner.

Clear and workable frameworks must be established to address sector challenges in the long term (in particular in relation to local and national government strategies, regulation and tax/subsidies) and comprehensive stakeholder participation and partnerships must be sought with the international community.

Business collaboration to self-determine the direction of travel

The energy system transformation requires international cooperation at different levels. The system's performance and risks cannot be adequately addressed by individual national institutions or companies acting on their own. Collaboration among all stakeholders is needed.

The analysis has highlighted the criticality and urgency of a systemic response to the challenges facing the energy system. It is clear that the response of government and regulators is too slow and is failing to provide sector participants with confidence to formulate long-term decarbonization, energy supply and transition strategies.

1. There is a need for the private sector to take the lead to spearhead the direction of travel with regards to the creation of a sustainable energy system and to prioritize system risk responses. Clear industry initiatives can, in turn, critically inform and stimulate leadership from government and regulators. Energy companies can change the narrative for their sector rather than relying on national policy and regulations to drive their future direction.

2. The scale of the energy system transformation means strong, well-coordinated partnerships are critical to achieve the required outcomes. Cross-industry initiatives seeking alignment and confidence can be leveraged to manage and mitigate individual or clustered risks – e.g., changing consumer behaviors, energy affordability, technology development and digitization.

3. Sector-wide action to build a better understanding of energy system practices and challenges among all stakeholders, including government and policy makers, will be essential. It will be particularly important to provide a strong understanding of these practices among regulatory bodies to ensure regulation is supportive of sustainable performance while enabling the delivery of business objectives.

4. The private sector should equally focus on implementing mitigating approaches within company boundaries and through collaborations to reduce the manifestation of risks related to viability, changing consumer preferences and technology and innovation.

5. Transparent collaboration across companies and stakeholders within key, prioritized geographies to represent combined demands, impacts and dependencies on resources and capital. Such an approach will support companies to form a better understanding of the aggregated risk position and, consequently, to manage and mitigate their own risk exposure – for example, energy storage, stakeholder management.

Individual organizational actions

1. Focus on the most influential intervention points applicable that can be addressed at an organizational level.

   Organizational risk mitigation activities should be aimed at those risks which, if mitigated, will have a positive impact on the system risk network and reduce vulnerabilities. In particular, organizations should focus on actions that will:

   a) Inform and motivate governmental strategy and the regulatory framework;

   b) Positively influence the transparency and viability of long-term investment strategies;

   c) Drive changes in consumer behaviors and

   d) Accelerate technology development and digitization of energy processes and performance.

2. Establish risk monitoring thresholds for the most influential and influenced risks.

3. Apply different approaches to risk management as a tool for cross-functional engagement and collaboration within the company. For example, applying a Dynamic Risk Assessment -style approach to inform strategic planning and to assess and review risks formally recorded in the risk register, which are typically assessed on an impact-likelihood basis.

4. Identify appropriate core metrics which are representative, leading indicators of current and emerging risk profiles of other ESG-related risks.

9 Conclusion

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The energy system is facing unprecedented challenges to deliver GHG emission reductions and to transition to a reliable and affordable net-zero carbon economy while meeting growing global energy demands. This transition requires implementation of integrated strategic solutions across a complex interconnected system.

Companies operating within the sector need to apply robust sustainability and risk management capabilities to understand the risks they face, build strategic resilience and deliver effective operational performance across complex business models, changing risk landscapes and diverse global markets.

This report highlights that traditional risk management approaches are inadequate for capturing and assessing the complex, interconnected groups of risks that must be managed by companies operating in the energy system. There is a clear need for companies to broaden the lens of risk management, to extend risk assessment methodologies, and to apply sophisticated risk management techniques.

A dynamic risk assessment process provides companies with an enhanced capability to examine, understand and manage the inter-connections, complexities and aggregated impacts of the range of risks that might impact their business performance and strategic resilience.

Application of the dynamic risk assessment approach to the energy systems has specifically highlighted:

1. The critical and urgent need for coherent global leadership from governments, regulators and policy makers.
2. The need for companies to lead the sector response in the absence of consistent governmental leadership and find confidence in a jointly determined direction of travel.
3. Key opportunities for a company's risk management actions to positively impact system-wide risks.
4. The need for companies to manage clusters of risks and their connections, specifically in risk clusters comprising:
    - Cluster 1 – National government strategy; Regulation; Tax and subsidies
    - Cluster 2 – (Physical) Climate change impacts; National government strategy; Regulation; transition risks
    - Cluster 6 – (Physical) Climate change impacts; Geopolitics, National government strategy; Regulation

WBCSD resources

1. Accelerating action: an SDG Roadmap for the oil and gas sector - https://www.wbcsd.org/lfvtj
2. Sector Transformation: An SDG Roadmap for Electric Utilities - https://www.wbcsd.org/emtob
3. Setting science-based targets: A guide for electric utilities - https://www.wbcsd.org/4p7cv
4. Guidelines for an integrated energy strategy: helping companies achieve their sustainable energy objectives - https://wbcsdpublications.org/integrated-energy-strategy/
5. Disclosure in a time of transition: Climate-related financial disclosure and the opportunity for the electric utilities sector - https://www.wbcsd.org/dittcr
6. Climate-related financial disclosure by oil and gas companies - https://www.wbcsd.org/u5ky

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ACKNOWLEDGEMENTS

We would like to sincerely thank the organizations and WBCSD member companies who were involved in this project.

- ACCIONA
- CLP Group
- Dow
- EDG Group
- Energias de Portugal, S.A.
- Eletrobras – Centrais Elétricas Brasileiras S.A.
- Eni S.p.A.
- Greif, Inc.
- The Kansai Electric Power Co., Inc.
- Mahindra & Mahindra Limited
- Novartis International AG

We would also like to thank the KPMG Dynamic Risk Assessment team from across KPMG firms in Australia, India, the United Kingdom and the United States for their support in delivering this project. In particular, we would like to thank colleagues for coordinating the DRA project as well as their contributions to this report.

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This publication is funded by the Gordon and Betty Moore Foundation as part of a conservation and financial markets collaboration. For more information, please see http://www.moore.org/FinancialMarkets.