Task Force on Climate-related Financial Disclosures

Guidance on Scenario Analysis for Non-Financial Companies

TCFD

TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

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Executive Summary

Climate change is spawning a host of long-term and short-term effects that affect businesses broadly and fundamentally. The World Economic Forum ranks climate risks among the top five business risks, saying "climate change is striking harder and more rapidly than many expected."

Companies will be affected by climate change across multiple dimensions (strategic, operational, reputational, and financial), along the entire value chain, across regions, and over long periods of time. But assessing and planning for these risks — and opportunities — is challenging given the associated uncertainties.

Scenario analysis helps companies in making strategic and risk management decisions under complex and uncertain conditions such as climate change. It allows a company to understand the risks and uncertainties it may face under different hypothetical futures and how those conditions may affect its performance, thus contributing to the development of greater strategy resilience and flexibility.

- **Scenario analysis is not new.** It is a long-established planning tool with a rich and extensive literature and practice.
- **Scenario analysis informs strategic management in a structured, systematic, and analytical way.** It provides new perspectives and unique insights, clarifies the predictable and uncertain elements in different futures, and reorients decision-makers' mental models.
- **Scenario analysis contributes to strategy resilience.** It broadens strategic thinking, and identifies options to address different climate-related circumstances. It "road-tests" different strategy options, and provides a lens through which to assess a company's strategic position.

"No matter how well we prepare ourselves, when the imagined future becomes the very real present, it never fails to surprise."

– Alan AtKisson, *Believing Cassandra*

- **Scenario analysis allows for the continual exploration of alternative strategies,** even if current strategies seem to be working. Scenario analysis can identify key drivers of change and pathways of development that a company can monitor to understand which futures are emerging and allow for "midcourse corrections." This is a cornerstone of resilient strategies.
- **Scenario analysis is used beyond climate issues.** Scenario analysis is applicable to a wide range of issues facing companies under conditions of uncertainty (e.g., the COVID-19 pandemic). Scenario analyses should be an integral part of a company's decision-making process.

Scenario analysis has limitations. Scenarios, for example, rely on a snapshot of external drivers that allow a company to explore only a limited range of uncertainties. Acquiring climate data at the right scale and granularity to craft a scenario also can be challenging.

Disclosure regarding strategy and scenarios is important. The Task Force on Climate-related Financial Disclosures (TCFD) recommends disclosure of "the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material" including "the resilience of the organization's strategy, taking into consideration different climate-related scenarios."

- **Adjustments to a company's strategy and financial plans represent a key disclosure element.** Investors (e.g., current and potential shareholders, debt holders, banks, and insurers) and other stakeholders want to understand how a company is positioning itself strategically, operationally, and financially in light of potential climate-related impacts.
- **Companies should disclose sufficient information** for investors and other stakeholders to (1) determine the potential impacts on the company of climate-related risks and opportunities, and how the company plans to address them in its strategy and financial plans; (2) understand the soundness of a company's scenario analysis; and (3) judge the resilience of the company's strategy to the material climate-related risks and opportunities that may emerge under different climate futures.

Getting started using scenario analysis is not difficult. A typical scenario analysis process often takes only a handful of full-time staff and less than a year (often three to nine months) depending on the size of the company and the scope of the decisions under consideration.

- **This guidance can help you to get started.** It provides a practical, process-oriented way for businesses to use climate-related scenario analysis. It extends and deepens the TCFD's 2017 *Technical Supplement* on *The Use of Scenario Analysis in Disclosure of Climate-related Risks and Opportunities*. This guidance, however, is not a checklist of everything a company should do to meet the TCFD's *Strategy c)* recommended disclosure. Rather, it is meant to illuminate common practices, considerations, and questions that a company needs to think about, taking into consideration its particular circumstances.
- **Before embarking on scenario analysis,** a company should think through its implementation of the full TCFD recommendation framework (Governance, Risk Management, Strategy, and Metrics and Targets). Scenario analysis is not standalone but is supportive of overall strategy, governance, and risks management.
- **Nothing in this guidance should be read as altering or adding to the TCFD's 2017 recommendations.** It provides suggestions for, and considerations about, process-oriented methods to assist in undertaking scenario analysis to assist with implementing the TCFD Strategy recommendation.
- **The target audience of this guidance is large- and midsized non-financial companies in the early stages of implementing climate-related scenario analysis.** However, small companies will also find useful information and considerations to help them undertake scenario analysis.
- **Senior executives and those tasked with sponsoring scenario analysis in their companies** will benefit from the highlights and key messages in the guidance. Those executives include corporate leaders in strategic planning, sustainability, corporate reporting, and risk management functions.
- **Those tasked with implementing a scenario program in their companies** may benefit from the more detailed content in the guidance and its appendices.

Contents

A. Introduction

A. Introduction

This section explains why this work has been carried out and the broader context that makes this contribution timely.

Key Messages

- Companies use scenario analysis increasingly as a tool in their climate-related risk management and strategy formulation processes, but they face challenges.
- In response to these challenges, the TCFD developed this guidance to assist non-financial companies wishing to implement climate-related scenarios as part of those risk management and strategy formulation processes.
- This guidance is aimed at non-financial companies at the early stages of using scenario analysis to assess climate-related risks and opportunities.

Scenario analysis is useful for assessing the business implications of climate change.

- Scenario analysis helps in making strategic and risk management decisions under complex and uncertain future conditions such as climate change.
- Scenario analysis allows a company to understand how it might perform under different hypothetical climate futures.
- Scenario analysis contributes to greater strategy resilience and flexibility by:
  - testing a strategy and strategy options against a set of scenarios;
  - identifying possible future threats or opportunities;
  - identifying trigger points to set contingency plans in motion; and
  - serving as a basis for continuous monitoring and strategy adjustment.

In July 2017, the TCFD issued a set of recommendations for disclosing clear, effective, and consistent information about the business risks and opportunities presented by climate change. Those recommendations form an integrated framework for assessing and disclosing climate-related risks and opportunities in the areas of governance, risk management, strategy, and metrics and targets.

The TCFD's Strategy recommendation calls on companies to disclose the strategic and financial implications of their material climate-related risks and opportunities, as well as to describe the resilience of their strategy to different climate-related scenarios.[1] This recommendation rests on four premises:

1. Strategic thinking, planning, and risk management are fundamental aspects of a business.
2. Climate change presents a number of strategic risks, opportunities, and uncertainties.
3. These uncertainties place a premium on forward-looking methods of strategy formulation.
4. Scenarios are a well-established tool for enhancing strategic thinking in uncertain conditions.

[1] The Strategy recommendation calls on companies to "disclose the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material." It further recommends that companies "describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario." TCFD, "Recommendations of the Task Force on Climate-related Financial Disclosures," 2017.

Companies are increasingly using scenario analysis as a tool in their risk management and strategy formulation processes, but they face challenges.[2]

Many companies find the TCFD Strategy recommendation to be one of the more challenging to implement, citing:

- difficulty developing relevant scenarios that are decision-useful in a business context;
- gaps in availability of business-relevant data and tools to support scenario analysis;
- difficulties quantifying risks, opportunities, and related financial implications;
- challenges around how to characterize strategy resilience; and
- concerns about disclosing forward-looking scenario analysis involving confidential information.[3]

In response to these challenges, the TCFD developed this guidance to assist large- and midsized non-financial companies wishing to implement climate-related scenarios as part of their risk management and strategy formulation processes.[4] Smaller companies will also find useful information and considerations that may help them with scenario analysis appropriate to their needs. This guidance extends and deepens the TCFD's 2017 *Technical Supplement* on *The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities* — by providing practical, process-oriented ways businesses could use scenarios to assess climate-related risks and opportunities. It should be read and applied in the context of the recommendations in the 2017 TCFD Final Report and the 2017 TCFD Technical Supplement.

In developing this guidance, the TCFD interviewed a number of companies regarding their challenges, needs, and experiences as regards the use of climate-related scenario analysis (Appendix 4). It also received input from an Advisory Group of companies and other organizations familiar with the use of climate-related scenarios. Finally, input was received from a number of external reviewers.

A number of challenging issues are touched upon in this guidance. Where the guidance is unable to provide definitive answers to particular challenges, it aims to raise and frame the appropriate considerations to assist companies in their own particular context.

WHY SCENARIO ANALYSIS?

Climate change is a systemic phenomenon, affecting ecological, social, and economic systems, including far-ranging implications for businesses.[5] These implications come at an economic cost but also present opportunity.[6] The physical and transition implications of climate change do not lend themselves well to traditional business planning methods or cycles for a number of reasons — such as complex interrelationships between causes and impacts, nonlinear behavior, differing spatial and temporal scales, delayed feedback, and uncertainties regarding the extent and timing of impacts and consequences.

[2] In its 2019 status report, the TCFD found that 56% of survey respondents (110 of 198 companies) said their companies use scenarios for strategy formulation purposes, while another 19% (37) said scenario analysis is in development or early stages of implementation. This corresponds to the 2019 trend among a larger group (2,514) of CDP reporting companies, where 50% (1,261) reported using scenarios and another 35% (882) said they were planning to use it in the next two years. TCFD, *2019 Status Report*, pp. 62–74.

[3] Disclosure of strategy resilience and scenario assumptions lags the use of scenarios — only 9% of reviewed companies (1,126) in 2018 disclosed information on their strategy resilience. TCFD, *2019 Status Report*, 2019.

[4] The Task Force decided to not include financial institutions in the scope of this guidance because of the number of initiatives underway by international and national groups, including regulators, in the area of scenario analysis and stress testing for financial institutions and the financial system around climate-related risks. See, for example, Network for Greening the Financial System (NGFS), *Guide to climate scenario analysis for central banks and supervisors*, 2020; UK Prudential Regulation Authority (PRA), *Enhancing banks' and insurers' approaches to managing the financial risks from climate change*, 2019; NGFS, *A call for action: Climate change as a source of financial risk*, 2019.

[5] Climate change, like all changes, generates risks and opportunities. For example, chronic or acute changes in the physical climate could directly affect business facilities, operations, and supply chains (Raymond, C. T., Matthews and R. M. Horton, *The emergence of heat and humidity too severe for human tolerance*, 2020). Climate change also drives changes in the ecosystem, which supplies raw materials and other inputs to businesses. (World Economic Forum, *The Future of Nature and Business*, 2020). Societal impacts of climate change generate transition risks in markets, policies, legal frameworks, and technological innovations, as well as other impacts (Mearns and Norton, *Social Dimensions of Climate Change: Equity and Vulnerability in a Warming World*, 2010; Watts, et al., *The 2019 report of The Lancet Countdown on health and climate change*, 2019). Climate-related risks also can diffuse through the outputs of one sector that are used as inputs to other sectors; products that compete for the consumers' finite budget; and sectors that compete for the primary factors of production (labor, capital, land, water) (Intergovernmental Panel on Climate Change (IPCC), "Fifth Assessment Report (AR5) Climate Change 2014: Impacts, Adaptation, and Vulnerability," 2014). Finally, businesses may be exposed to cascading effects from climate-related events that may impact production schedules, supply chains, distribution networks, and employee and customer mobility (Zscheischler, et al., *Future climate risk from compound events*, 2018; Lenton and Ciscar, *Integrating tipping points into climate impact assessments*, 2013; Center for Climate and Energy Solutions, "Business risks, opportunities, and leadership." Briefing Note. 2019).

[6] For economic costs of climate change, see Martinich and Crimmins, *Climate damages and adaptation potential across diverse sectors of the United States*, 2019; Delink, Lanzi and Chateau, *The sectoral and regional economic consequences of climate change to 2060*, 2017; Houser, Hsiang and Kopp, *Economic Risks of Climate Change: An American Prospectus*, 2015. For opportunities, see Morgan Stanley, *Climate Change Mitigation Opportunities Index 2017*; International Energy Agency (IEA), *Putting CO_2 to Use: Creating Value from Emissions*, 2019.

However, scenario analysis is a useful tool for strategic and risk management decision-making under such conditions, because it:[7]

- provides an integrated approach to thinking about and "picturing" the possible ways in which the world could evolve;
- allows a better understanding of the dynamics of change — the how and why different future outcomes may come about;
- offers a level of process transparency that enhances communication and utility in decision-making;
- helps to identify major leverage points at which a company may take action to start, accelerate, or change strategic initiatives;
- gives consideration to a wider range of opportunities, risks, and strategic options;
- helps to "rehearse" the future, allowing more rapid responses to changes;
- provides for a more thorough assessment of risks;
- reduces vulnerabilities by thinking through various futures and their company implications; and
- provides greater strategy resilience and flexibility by delivering:
  - strategy testing against a set of scenarios;
  - development of contingency plans to possible future threats or opportunities;
  - establishment of trigger points to set contingency plans in motion; and
  - basis for continuous monitoring and strategy adjustment.

Scenario-based planning circumvents the impossible task of trying to predict the future and instead focuses on the key uncertainties relevant to a company's strategic decisions. It does this by providing a structured method of developing new perspectives and unique insights, understanding the predictable and uncertain elements in different futures, and changing the mental models of decision-makers. In particular, scenarios describe pathways from today to tomorrow, helping executives to look at a number of plausible possibilities and to develop flexible options and timely responses.

For a company, the ultimate purpose of scenario analysis is to understand how it might perform under different hypothetical future climate states — thus positioning itself to make better strategic decisions and improve its strategy resilience. Climate-related scenarios allow an organization to build an understanding of how the physical and transition risks and opportunities of climate change might plausibly develop in different ways, and how the business might be impacted over time.[8]

Scenario analysis, however, should be conducted in a coherent way across physical and transition climate-related risks. Analysis of these risks should not occur in silos. Companies run the risk that they miss important feedback effects from physical risk that may be crystallized into transition risk. Physical risks are not solely an exercise in simple "projections of impacts" but often are subject to socioeconomic assumptions around adaptation, investment, and growth. Those should be consistent with the assumptions being made on the transition side.

[7] Adapted from Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

[8] Institute for Climate Economics, *Understanding transition scenarios: Eight steps for reading and interpreting these scenarios*, 2019.

B.
Getting Organized

B. Getting Organized

This section explains the elements of establishing organizational structures and processes to conduct scenario analysis and potential organizational pitfalls.

Key Messages

- Informing and educating decision-makers and internal stakeholders about scenarios and climate-related risks and opportunities is a necessary first step.
- Executive-level sponsorship of scenario analysis, sound governance arrangements, and clear reporting relationships are all important.
- A facilitator and an administrator play important roles on the scenario team.
- Sufficient internal and external resources are required. External expertise, especially, helps in transferring appropriate knowledge to, and embedding it in, the organization in order to make scenarios a repeatable, normal business process.

Why is organization of the scenario process so critical? Scenario analysis is often a new approach to planning and can challenge many traditional practices and structures within a company, as well as its culture. **For a company implementing climate-related scenario analysis for the first time, an effective organizational approach will help ensure success.**[9, 10]

1. INFORM, EDUCATE, AND ENGAGE[11]

A first step in the scenario process is often to inform and educate board members and senior management about the basics of climate change, its risk manifestations, and the potential business implications for the company. Informational sessions should also include heads of business lines and corporate functions, such as risk management, finance, procurement, and marketing. The goal is to create a general level of understanding about climate change, climate-related risks and opportunities, and the business implications.

Engagement of internal stakeholders in the scenario process promotes company-wide ownership and involvement. Failure to create understanding and buy-in among internal stakeholders is a key reason for scenario analysis to become ineffective. **Engagement is necessary to mobilize the involvement of business units and management throughout the company, and overcome inertia and resistance.**

A critical next step is to spell out the company's view on climate change in order to set the conditions for further scenario work. Without an endorsed company-wide view, personnel may feel permitted to express personal or political viewpoints on climate change during scenario engagements, resulting in clouded contributions, disruptions, and poor-quality input. A company view, for example, may take the form of an explicit statement by senior management or the board. Whatever its form, it should come from the board or the Chief Executive Officer (CEO) and spell out the company's view of climate change, be clear on the level of its commitment, set out some broad aspirational goals, and offer a timeframe.

[9] For a more in-depth discussion of organizational issues, we suggest Chapters 5–6 and 8–10 in Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006; Chapters 5 and 10–12 in Chermack, *Scenario Planning in Organizations: How to Create, Use, and Assess Scenarios*, 2011; and Chapter 2 in Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019.

[10] As an example of one organization's approach, a case study on scenario analysis conducted by the Danish healthcare company Novo Nordisk is described in several boxes throughout this guidance. Please see Box B1 (p. 11), Box C2 (p. 19), Box C4 (p. 24), and Box D2 (p. 37). Several other examples and perspectives from companies that conduct scenario analysis are also provided throughout the guidance.

[11] Also see Lendlease example in Box C3 (p. 22).

2. BUILD THE CASE FOR SCENARIOS

Closely aligned with informing and educating is making the case for scenarios, and gaining internal support for conducting the scenario analysis process. This can be facilitated by the development of a project proposal containing:[12]

- an explanation of the purpose and decision-oriented focus of the exercise;
- a description of how climate change could potentially affect the company;
- how scenarios might be useful in the company's current situation;
- a description of the recommended approach for using scenarios and making decisions;
- the benefits of the recommended approach and alternative approaches; and
- execution requirements (e.g., budget, resources, time).

Using the project proposal, an executive sponsor can engage key decision-makers and stakeholders to create understanding about scenarios, and to clearly explain the scenario project, addressing questions such as:

- What is and is not a scenario?
- What is the purpose of scenario analysis?
- What does the process of scenario analysis look like?
- What is the expected outcome?
- What is the expected effort from internal stakeholders?
- Why is the company starting the scenario analysis process?

Two Key Lessons from Downer Group's Experience with Scenario Analysis

- Education – working with people to demystify the challenge and understand the financial and commercial impacts
- Leadership – Board and Executive sponsors are required to help with learning, education, and advocacy

3. CLEAR GOVERNANCE AND EXECUTIVE-LEVEL LEADERSHIP

The scenario process needs well-defined governance roles and clear reporting relationships to senior levels. Ideally, the scenario process would report to the CEO as a critical strategic function. The CEO may choose to oversee the scenario process through a steering group consisting of relevant C-suite executives (e.g., Chief Financial Officer (CFO), Chief Strategic Planning Officer (CSO), Chief Risk Officer (CRO). The CEO or the designated executive sponsor of the scenario process should ensure that the board is aware of key developments in the scenario analysis process. The board can also take an active role by clearly assigning a committee to oversee the scenario process in alignment with the company's climate change policy. Failure to ensure top leadership support and poorly defined roles and reporting relationships are key pitfalls.

Many companies undertaking scenario analysis cite the critical importance of designating an executive-level sponsor. Executive sponsors are typically the CFO, CRO, and CSO.[13] Along with providing visibility and accountability, the sponsor will likely need to:[14]

- articulate the case for scenarios and gain support for establishing a scenario process;
- oversee the design of the scenario process and ensure it has the resources it needs;
- ensure decision-makers and stakeholders are engaged in the scenario process; and
- integrate scenarios into the company's strategy and risk management culture.

The executive sponsor is the champion for the scenario process. He or she not only promotes the process but also addresses any roadblocks and works with less cooperative parts of the organization to engage constructively in the process.

[12] Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019, p. 29; Chermack, *Scenario Planning in Organizations: How to Create, Use, and Assess Scenarios*, 2011.

[13] Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019, pp. 31–32.

[14] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

Box B1
Integration of Scenario Analysis at Novo Nordisk

Scenario analysis should not be treated as an independent, one-time exercise. Scenarios are most effective when integrated into a company's regular planning and risk management processes and cycles, as well as corporate reporting processes. It is important that the scenario process is seen by the whole business — supply chains, procurement, product development, operations, and distribution — as an integral part of the company's approach to planning across the value chain.

Novo Nordisk is a global Danish healthcare company, established in Copenhagen in the 1920s. It produces insulin for over 30 million diabetes patients across 169 different countries (more than 29% of the global market), as well as pharmaceuticals for other chronic diseases.

For Novo Nordisk, the main concern has been to minimize complexity by integrating scenario analysis into existing risk processes instead of creating a parallel process. In recent years, Novo Nordisk has expanded its enterprise risk management (ERM) processes to include emerging physical and transitional risks (3+ years). The company currently focuses on short-term risks of 0–3 years and emerging risks of 3–10 years. A long-term horizon at Novo Nordisk would be anything longer than 10 years. When planning new production facilities, for example, Novo Nordisk includes long-term risks (10+ years) related to climate change.

Novo Nordisk is currently using its existing enterprise risk management system, which ranks risks depending on likelihood and impact, and reports to executive management. However, in order to incorporate emerging long-term climate risks, Novo Nordisk is investigating how these can be benchmarked directly to other risk types. This effort includes experimenting with adding a time or urgency dimension to the risk matrix. Moreover, the ERM processes are being shaped so that smaller risks are handled locally (e.g., building improvements), while bigger risks are reported to executive management if relevant at the tactical or strategic level. In this way, the risks can be used for future strategic decisions and evaluation of existing strategies.

(Prepared by Novo Nordisk)

4. ESTABLISH A STRONG, DEDICATED SCENARIO TEAM

A dedicated scenario team comprised of business representatives is suggested for large- and midsized companies. Key positions on the scenario team often include a team leader, a facilitator, and an administrator. Team size depends on the scale and complexity of the company, but generally is only a handful of personnel working full-time on the scenario analysis effort while it is in process.[15]

The team leader should ideally be a senior person from the strategic planning or sustainability areas. The team leader manages the overall process, engages with stakeholders, communicates progress, and presents the results. They need strong project management and communication skills, as well as in-depth knowledge of the company and its industry.

Team members should possess multi-disciplinary expertise across the company's value chain, divisions, and functions, and understand different aspects of its business model, assets, operations, organizational structure, mission, and strategy. The team members should understand what scenarios are and what they are not, their purpose, and scenario characteristics. They should be able to apply historical, political, economic, social, and technological trends to the development of the scenarios. Finally, they should be able to draw upon specialists within the company or from the outside when necessary, and have a creative, imaginative, open-minded, and forward-looking mindset.

A facilitator plays a key role on the team. This role keeps the scenario team and internal stakeholders focused, stimulating open-mindedness and urging those involved to go beyond conventional thinking. The facilitator should understand and have strong experience with scenario planning methods, and no conflicts of interest with a company's scenario project. A facilitator can be someone internal or external to the company, as long as (s)he is acceptable to the executive sponsor and key executive decision-makers. Strong interpersonal and meeting facilitation skills are important.[16]

An administrator also plays an important role on the scenario team. It is important to have a dedicated administrator responsible for managing

[15] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006, p. 59, Figure 8-1.

[16] For further information on the facilitator's role, see Chapter 9 in Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

schedules, setting up meetings, maintaining internal communication mechanisms, and handling meeting logistics. Poor coordination of meeting logistics and other project activities can result in thinly attended workshops; in reduced learning, buy-in, and ownership; and in failure to implement project outcomes.[17]

Common pitfalls when forming a scenario team are failure to select the right leadership skills and expertise for the team, a lack of balance between line and staff people, poorly defined roles and reporting relationships, and unrealistic expectations.

5. INTERNAL AND EXTERNAL RESOURCE REQUIREMENTS

5.1 Internal Resources

The amount of internal resources and time devoted to scenario analysis will vary, depending on the scope of the analysis, the size of the company, and the decision focus. In their 2006 *Scenario Planning Handbook*, Ralston and Wilson indicate that scenario teams often range in size from four people, for smaller-sized companies and more narrowly focused decisions, to up to 20 people, for large-sized companies and major strategic decisions. A scenario team may spend from two to 40 days researching key topics, and two to 15 days writing scenarios depending on the nature of the decisions to be made and the company.[18] In their observation, workshops involving executives and other stakeholders generally ranged from two half-day workshops to four workshops of two to three days each. Senior leaders (e.g., C-suite level) typically spent one to four days involved over the course of the effort. Overall duration of a scenario planning exercise ranged from two weeks to six months, depending on the nature of the project.

These estimates are generally consistent with the processes conducted by companies on the advisory group for this guidance.[19] One large multinational company on the group indicated it had two full-time equivalent people on its scenario team who spent one to three months designing and writing the scenario narratives, and another two to 12 months quantifying various aspects of the scenarios. Senior leaders devoted about three days to workshops and other meetings on scenarios.

Another large multinational company on the advisory group said its scenario team consisted of fewer than five full-time personnel and that the overall duration of the project was less than a year, with about six months of that time spent researching and writing the scenario narratives. A third company on the group devoted three to five internal people (plus five external people for modeling), with three months to explore and write the scenario. The third company's overall process took about 12 months.[20]

The time commitments involved in a typical scenario process consist of initial meetings to discuss the scenario focus and scope, set a project schedule, and prepare briefing notes and readings; interviews of senior leaders, senior managers, and other internal and external thought-leaders on climate-related risks and opportunities facing the company in the future; a series of workshops to discuss various scenario aspects; and preparation of discussion papers, draft scenarios, final scenarios, and an assessment report and strategic options.[21]

Common pitfalls as regards internal resources include not allowing enough time and, related to that, a failure to keep on track.

5.2 External Resources

Companies often highlight the importance of external expertise for helping to transfer appropriate climate knowledge so that scenarios become a repeatable, normal business process. External expertise can support a sound climate-related scenario analysis process in the following areas:

- conducting desktop research to identify climate-related trends, milestones, and futures;
- identifying climate risks specific to a company's geographic footprint and type of business;
- understanding transition risks across the various jurisdictions in which a company operates;

[17] Chermack, *Scenario Planning in Organizations: How to Create, Use, and Assess Scenarios*, 2011.

[18] See Table 8-1, p. 59, Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

[19] See Acknowledgments.

[20] This company suggested that any companies initially undertaking scenario analysis with limited resources avail themselves of resources such as the TCFD Knowledge Hub, the NGFS Scenarios, and scenario materials produced by the Bank of England. Other resources also are provided in Appendix 3 and the References section of this guidance.

[21] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006, p. 58.

- facilitating a climate-oriented scenario development process, including workshops;
- challenging the process from an outsider and/or expert perspective;
- building and using climate-related models and conducting (quantitative) scenario analysis; and
- understanding and conveying important aspects of climate science.

Two of the common pitfalls in scenario analysis are groupthink and a business as usual (BAU) mentality. Engaging external experts may help to counter these pitfalls.

External experts may involve researchers, private-sector consulting firms, climate modeling experts, or companies with specialized datasets and tools. For example, some companies engage university researchers involved in climate scenario development and modeling. Researchers can help them understand relevant scenarios and models, identify relevant climate risks, and scale scenarios and models to the companies' needs. Appendix 3 provides a sample of selected services, tools, and data available commercially or as open source.

While external resources can be helpful and important, a company should carefully consider the roles that external experts will play and their relevance to a company's needs. Different types of experts can play different roles. For example, scientific researchers can assist in technical, methodological, climate change, and economic analysis, while consulting firms can serve as experts in establishing scenario processes and facilitation.

C.
The Scenario Process

C. The Scenario Process

This section describes scenarios as well as some of the misconceptions of scenarios, types of scenarios, and sources of scenarios. It also addresses the scenario development process.

Key Messages

- **Scenarios are descriptions of hypothetical, plausible futures** (not forecasts) that help companies to answer the question "What would be the potential implications for our strategy if the future described in a scenario came to pass?"
- **The number of scenarios should be sufficiently diverse** to create challenging "what-if" analyses and capture a wide range of insights about uncertain futures.
- **Publicly available scenarios (e.g., Intergovernmental Panel on Climate Change (IPCC), International Energy Agency (IEA)) are useful starting points and can serve to provide context, and as anchors for in-house-developed scenarios.**
- **Scenario analysis starts with a crisp, concise focal question** that provides direction for the analysis and a link to decisions and actions to which the analysis contributes.
- **Scenarios basically describe two things — an outcome at a certain time horizon, and a pathway from today to the selected outcome.**
  - A scenario's driving forces and assumptions about how those forces interact and develop over time define a pathway from the present to the future scenario outcome. There are multiple possible pathways to any particular outcome.
  - Scenarios should consider both transition risks and physical risks, and the interaction between them.
- **It is important to develop a sound scenario narrative first and then proceed to quantifying the scenario if necessary.** Quantification at some level should be a goal in a mature scenario process; investors expect a company to quantify potential impacts.
- **Scenarios should be high quality, periodically updated, and transparent to be an effective decision tool and to have credibility with investors.**

1. THE ABCS OF SCENARIOS

1.1 What Is a Scenario?

A scenario describes a plausible, but hypothetical, path of development leading to a particular future outcome. Scenarios are not forecasts or predictions — they are "what-if" narratives designed to inform and challenge strategic thinking (Table C1, p. 16).[22] Scenarios also are not intended to represent a full description of the future, but rather to highlight central elements of a possible future, draw attention to the key factors that may drive future developments, and explicitly identify critical uncertainties and assumptions around a path and outcome.[23] They help companies to answer the question: What may be the potential implications for our strategy if the future described in the scenario came to pass?

1.2 Types of Scenarios

The two main types of scenarios are (1) exploratory scenarios used to explore a range of different *possible* futures and (2) normative scenarios used to plan for a *preferred* future, as shown in Figure C1 on the next page.

For normative scenarios, scenario analysis starts with a preferred or desired future outcome and then back-casts plausible pathways from the preferred future to the present in order to inform decisions on what is needed to achieve that

[22] TCFD, *Technical Supplement: The Use of Scenario Analysis in Disclosure of Climate-related Risks and Opportunities*, 2017.

[23] Spaniol and Rowland, *Defining Scenario*, 2018.

Table C1

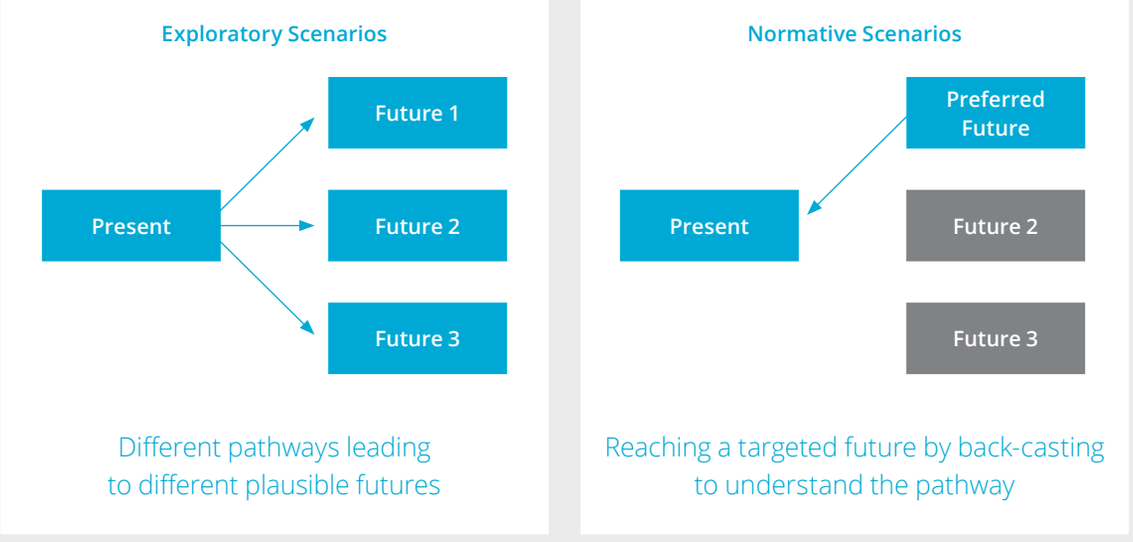
Key Elements and Misconceptions of Scenarios

Scenarios Are Not:	Scenarios Are:
• Predictions	• Descriptions of alternative plausible futures
• Variations of a single base case	• Significantly different views of the future
• Snapshots of endpoints	• Movies of the evolving dynamics of the future
• Generalized views of feared or desired futures	• Specific decision-focused views of the future
• Products of outside futurists	• Products of management insight/perceptions

Source: (Ralston & Wilson, 2006) Box 2-1, p. 16

Figure C1

Exploratory versus Normative Scenarios



preferred future. Examples of normative climate-related scenarios are those targeting net-zero emissions in 2050.[24] **Normative scenarios are typically used for assessment and setting of specific targets and implementation plans, rather than assessment of climate-related risks and uncertainties.**

Exploratory scenarios describe a diverse set of plausible future states. These scenarios are then used to assess potential climate-related risks and uncertainties, and test the resiliency of various strategies to a wide range of future conditions.

[24] Fifteen jurisdictions have established national sector road maps for net-zero emissions, and another seven support those targets with effective policy framework. Many investors also are now asking for how companies are planning to achieve net-zero emissions (e.g., the members of the Net-Zero Asset Owner Alliance). See World Economic Forum, *The Net-zero Challenge: Fast-Forward to Decisive Climate Action*, 2020.

Some companies use both approaches — the exploratory approach when testing their strategies for resilience, and the normative approach for setting specific targets such as net-zero emissions.

The TCFD Strategy recommendation and this guidance focus on the use of an exploratory approach (i.e., a company assessing a range of scenarios spanning a number of plausible futures). Companies may also use other special types of scenarios as part of their efforts to understand the implications of climate change as described in Box C1.

Box C1
Special Types of Scenarios

Stress tests are a type of scenario typically used in the financial sector, although some non-financial companies are beginning to use them. They use hypothetical, unfavorable scenarios to determine whether an organization has enough capital, earnings, and/or cash flow to withstand the impact of adverse developments. Stress tests focus on "tail risks" — risks that seemingly have a low probability but that could still present significant impacts.

A close cousin is the **reverse stress test**, which uses scenarios and circumstances that would make a business model unworkable; reverse stress tests focus on identifying potentially fatal business vulnerabilities. Stress tests and reverse stress tests are specialized forms of scenarios.

Another special type of scenario is the **reference scenario**, sometimes called a **baseline or business as usual scenario**. A reference scenario is used as a "yardstick" for comparing alternative scenarios. A reference scenario is based on future patterns of activity assuming that there will be no significant change in business priorities, or no major changes in external technology, economics, or policies, so that existing circumstances can be expected to continue unchanged. A reference scenario can take the form of a trend scenario. In this instance, existing development trends are extrapolated into the future. Or it can consist of a null scenario (i.e., one or more components are assumed to remain permanently or temporarily unchanged). A reference scenario can be helpful in highlighting the difference in change and impact between it (e.g., business as usual) and planning scenarios.

1.3 Scenario Structural Elements

A scenario is structured around a number of basic elements such as a **scope of coverage**, a **time horizon**, and the choice of the **number of scenarios** used.

1.3.1 Scope of the Scenario Analysis

To conduct an effective scenario process, a company needs to define the scope of its analysis. Ideally, scenario analysis should encompass the company as a whole, including supply and distribution chains.[25] This is in line with the intent of the TCFD recommendations regarding disclosure of how current and potential climate-related risks and opportunities affect the company. Initially, however, a company may focus on a particular critical business unit, product line, geography, asset, or input(s) that may be highly impacted by climate-related risks or opportunities before expanding the scope of its scenario analysis. This narrower focus allows a company to gain experience with scenario analysis while at the same time focusing on a climate-critical aspect of its business. However, a company should quickly expand its scope to all of its operations and its entire value chain in a mature scenario analysis process.

1.3.2 Time Horizon

Scenarios describe a future outcome at a particular time horizon. Choosing a time horizon involves a trade-off between too short — where developments may not be sufficiently differentiated — and too long — where uncertainties may overwhelm useful analysis. "The time horizon for scenarios should be short enough so that they are plausible but long enough for us to imagine that important changes with an impact on the future business can take place."[26]

In setting climate-related scenario time horizons, companies should challenge their thinking about traditional planning horizons, which are often too short. Scenario time horizons are typically longer than many corporate planning horizons. Scenario time horizons that are too short may result in simple extrapolations of current thinking and trends, and therefore not reveal the information needed to assess the resilience of the company's climate-related strategy.

[25] See Pettit, Fiksel and Croxton, *Ensuring Supply Chain Resilience: Development of a Conceptual Framework*, 2010; Norton, Ryan and Wang, *Business Action for Climate-Resilient Supply Chains*, 2014; Wei and Marshall, *Climate and Supply Chain: The Business Case for Action*, 2018; and CDP, *From Agreement to Action: Mobilizing suppliers toward a climate resilient world*, 2016.

[26] Lindgren and Bandhold, *Scenario Planning: The Link Between Future and Strategy*, 2009.

In setting time horizons for its scenario analysis, a company should consider:

- time horizons that are compatible with the company's (1) capital planning and investment horizons and (2) the useful life of major company assets and
- time horizons that are harmonized or anchored with those of national and international climate policy communities (e.g., 2030 and 2050). Harmonizing company scenario time horizons to key years and the cycle of the climate policy community can provide an important anchor to, and context with, global climate scenarios, as well as enhance comparability.

1.3.3 Number and Diversity of Scenarios

The range of scenarios should be sufficiently diverse in order to create challenging "what-if" analyses and capture a wide range of assumptions about uncertain futures. Analysis based on a single scenario will not be effective or provide the benefits of using more comprehensive scenarios. Multiple scenarios allow a company to explore how different assumptions about critical driving forces can yield very different outcomes. By considering these different outcomes, a company can better assess the range of its potential risks, opportunities, and uncertainties.

What is the optimal number of scenarios? Some companies undertaking scenario analysis for the first time begin with two scenarios, usually at opposite ends of temperature outcomes ("book-end scenarios"). While this may be a practical way to start, gain experience, and generate buy-in to the scenario process, there are drawbacks to only using bookend scenarios. For example, with two scenarios, there may be a tendency to interpret one as "good" for the company and one as "bad," introducing bias into the scenario analysis.

Most scenario methodologies recommend three or four scenarios.[27] While three scenarios can likely provide adequate diversity, a company should be careful to ensure true diversity. With three scenarios there is a tendency to have a preferred "probable" scenario as an anchor and to construct other scenarios around it in the form of high, medium, and low versions. This type of thinking reduces diversity and can negate the strength of scenario analysis.[28] Using four scenarios may help to avoid these pitfalls while keeping the exercise manageable.

The TCFD recommendations do not stipulate a suggested number of scenarios, but rather ask companies to disclose strategy resilience informed by "*different climate-related scenarios,* [emphasis added] including a 2°C or lower scenario." While this recommendation is not changing, **this guidance suggests that companies consider using three or four diverse scenarios as part of a mature scenario process** (see Appendix 2 for a further discussion).

No matter the number of scenarios a company uses, the key principle is that the differences between scenarios are sufficiently great to capture the key impacts and uncertainties of the drivers a company has identified.[29] A lack of scenario diversity (scenarios having too narrow a perspective) may be a signal that insufficient consideration is being given to different perspectives, a diversity of input is lacking, or critical challenge in the scenario process is lacking. Increasing inputs from, and engagement of, insightful people and thought-leaders, for example, can help to avoid this pitfall. Other pitfalls to avoid include scenarios based on uncertainties that are not really uncertain; scenarios that are detailed, but not comprehensive; and scenarios that are too general.

1.4 Sources of Scenarios: Public and In-House Scenarios

Companies tend to use either existing publicly available scenarios (e.g., IPCC, IEA, or the published scenarios), develop their own scenarios, or combine public and in-house scenarios. Each approach has benefits and drawbacks.

1.4.1 Public Scenarios

Publicly available scenarios are typically developed by international research or policy groups (see Appendix 1). Such scenarios include useful information about plausible pathways for emissions, physical climate change, environmental impacts, and socioeconomic conditions (see Box C2, p. 19). The benefits for a company of using public scenarios include:

- jump-starting a company's research by leveraging public scenarios' extensive analysis and modeling of key macro-factors such as demographic and energy demand projections, emission pathways, carbon budgets, and certain policy and technology assumptions;

[27] Amer, Daim and Jetter, *A review of scenario planning*, 2013; Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019; Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006; Lindgren and Bandhold, *Scenario Planning: The Link Between Future and Strategy*, 2009; Van Der Heijden, *Scenarios: The Art of Strategic Conversation*, 2010.

[28] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

[29] Trutnevyte, Guivarch and Lempert, *Reinvigorating the scenario technique to expand uncertainty consideration*, 2016.

- helping to identify blind spots or areas requiring further research;
- providing a starting point on the way to a more tailored, company-specific scenario process; and
- providing a larger contextual anchor for a company's scenario analysis.

Companies might use the insights provided by public scenarios in a qualitative or quantitative manner to highlight uncertainties to explore, to identify factors and considerations regarding physical and transition climate risks, to provide information on quantitative trends, or for general context.

Drawbacks of using public scenarios include:

- public scenarios are developed for research and policy purposes, not company-level or sector-level analysis of climate-related risks and opportunities;
- many public scenarios are at a global or sub-global scale, and not the local and regional scales meaningful to company- or sector-specific analysis (however, this is changing); and
- public scenarios often do not provide insights with sufficient granularity, nor provide meaningful quantitative benchmarks for assessing company-level risks.[30] In particular, a company should assess the pathway characteristics, feasibility of scenarios, economic cost, and assumptions about energy transformation, technology, and policy in these global scenarios.[31]

When using publicly available scenarios, therefore, a company should consider which ones are relevant to its analytical and decision-making needs and what role they can play in its scenario analysis.

Box C2
Companies' Use of Public Scenarios

Downer Group designs, builds, and sustains assets, infrastructure, and facilities. It is a leading provider of integrated services employing more than 53,000 people across more than 300 sites, primarily in Australia and New Zealand but also in the Asia-Pacific region, South America, and Southern Africa.

In its implementation of the TCFD recommendations, the Downer Group used climate scenario analysis as a key step to understand the resilience of the business under different climatic futures.

Global scenarios were used to inform a top-down assessment of how the physical climate might change, the hazards that its workforce might be exposed to, and how the services provided to key sectors and markets may change. This was particularly important to Downer as its purpose is to create and sustain the modern environment by building trusted relationships with customers. The scenario analysis informed strategic planning processes by looking longer-term to critically assess the products and services provided by the business in changing markets.

(Prepared by Downer Group)

Novo Nordisk is at the early stages of implementing scenario analysis as part of its TCFD implementation. As one of the first steps, Novo Nordisk chose to use the IPCC's Representative Concentration Pathway (RCP) scenarios.

The RCPs provide a uniform framework for exploring and analyzing climate impact, adaption, and vulnerability. The main value of the RCP scenarios comes from the fact that they are widely used in academic circles to perform and develop climate simulation modeling data. Therefore, by using RCP scenarios, Novo Nordisk's risk teams are given the opportunity to access and use a large range of standardized climate simulation data. Novo Nordisk has developed training materials utilizing this climate data to identify potential risks within operations and the value chain. This ensures that management and analysts get a common understanding and can draw lines from climate hazards at local sites and suppliers to corporate strategies — and vice versa.

The scenarios that Novo Nordisk uses represents a range of possible global temperature changes, depending on the future reduction in CO_2 emissions. The "business as usual" scenario is the IPCC RCP8.5 scenario where no change in emissions is expected and which leads to an increase in average global temperature of 3.2–4.5°C by year 2100. The "Paris Agreement" scenario is represented by the IPCC RCP2.6 scenario, where global emissions are reduced to net-negative and the global temperature only increases with 0.9–2.3°C by 2100. In between these two scenario extremes, Novo Nordisk has chosen the IPCC's RCP4.5 scenario, which represents a scenario with less ambitious carbon emission reductions than RCP2.6, but more than RCP8.5.

(Prepared by Novo Nordisk)

[30] Rose and Scott, *Review of 1.5˚C and Other Newer Global Emissions Scenarios*, 2020.

[31] For example, the most ambitious temperature targets (2˚C and lower) often assume negative emissions technologies (e.g., bioenergy with carbon capture and storage, afforestation); infeasibility arises when these technologies are not available or are constrained. Rose and Scott, *Grounding Decisions: A Scientific Foundation for Companies Considering Global Climate Scenarios and Greenhouse Gas Goals*, 2018; Rose and Scott, *Review of 1.5˚C and Other Newer Global Emissions Scenarios*, 2020.

1.4.2 In-House Scenarios

A company may choose to develop its own set of climate-related scenarios. There is rich and extensive literature on scenario development and use (see Appendix 2 and References).

The advantage of in-house climate-related scenarios is that a company can tailor the scenarios to the risks and opportunities it faces, as well as the key drivers and uncertainties most relevant to its planning and decision needs.

Drawbacks to in-house scenarios are that (1) they require a multiyear organizational commitment,[32] and (2) companies will need to ensure sufficient transparency around the process and content of the scenarios.

External stakeholders, such as investors, tend to consider in-house bespoke scenarios to be less transparent and less comparable than public scenarios. Companies, therefore, should have a robust and accountable process to ensure in-house scenarios are objective, diverse, and transparent, with strong disclosure practices.

2. THE SCENARIO DEVELOPMENT PROCESS

There are a number of ways to develop and construct scenarios. This section provides an overview of the high-level aspects of scenario development. For more detailed process steps, see Appendix 2.

2.1 Engaging Stakeholders

Engagement of stakeholders is a key input to the scenario development process.[33] Internal stakeholders include those management and functional leaders with important interests in strategic decisions, such as board members, senior executives, and function heads for risk, finance, sustainability, and strategy.[34] Investors and other external stakeholders also have an interest in a company's use of scenarios to inform strategy and may usefully be consulted in the development process.

Engagement should focus on decisions about the development and application of scenarios to strategy decisions. On the next page, Table C2 provides examples of select internal functions to engage and Table C3 shows some examples of topics and questions to discuss when engaging with stakeholders.

When engaging stakeholders, it is important to keep in mind three key points:

1. **Scenarios must be relevant for (and have legitimacy in the eyes of) the managers who will use them.** Scenarios that fail to capture the things that managers are concerned with in their everyday decision-making will have little impact.
2. **Excessive focus on quantification** permeating stakeholder discussions or scenario team deliberations can impair strategic thinking.
3. **Discussions dominated by business as usual mental models can impair the engagement process.** The company should be ready to challenge its own thinking about the organization and its business (model).

Engagement activities within a typical scenario process typically consist of the following:[35]

- initial meetings to discuss the scenarios' focus and scope, set a project schedule, and identify briefing notes to prepare and background readings to inform and educate;
- interviews with senior leaders, senior managers, and other internal and external thought-leaders on views regarding climate-related risks and opportunities facing the company in the future; and
- a series of workshops, such as:
  - a first workshop with senior leaders to agree on focus and key decision factors, identify initial forces/drivers, and set research topics for needed discussion/background papers;
  - a second workshop with a broader array of internal stakeholders to discuss background papers, conduct an impact/uncertainty assessment of drivers, agree on scenario logic and structure, and select scenarios for exploration; and
  - a third workshop with senior leaders to review draft scenarios and assess implications (opportunities, threats, issues, and strategy options).

[32] Such a commitment involves the establishment of organizational structures and processes, employment of expertise (possibly external expertise), and development of organizational learning; this takes time and resources.

[33] Engagement can take a number of approaches, including prescribed readings, videos, workshops, one-on-one interviews, and small-group discussions. See Figures 6-1 and 8-1 in Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006, for examples.

[34] Depending on how climate change is anticipated to affect a company, others may need to be involved, including functions such as procurement, production, distribution, corporate reporting, and legal (Reed, Kenter and Bonn, *Participatory scenario development for environmental management*, 2013).

[35] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006, p. 58.

Table C2

Examples of Internal Stakeholders to Engage in Scenario Analysis

Function	Relevant Expertise	How This Expertise Can Benefit the Scenario Analysis
Brands, Marketing, Product Development	• Conduct customer, market analysis for business as usual • Have already seen the impact of environmental, social, and governance (ESG)/climate change on customer/consumer behavior • Understand customer/consumer behavior, needs, expectations, and trends • Understand policy changes	• Provide a forward-looking view on market's evolution, customers, consumer change in behavior, need, expectation, social activism in different scenarios, and time horizon • Provide insight into possible political and legal evolution in certain markets
Procurement/ Supply Chain	• Understand the complexity of the supply chain • Have already seen the physical impact of ESG/climate change on suppliers and supplies	• Provide views on vulnerabilities and opportunities in the supply chain under a range of climate change impacts
Site/Operations	• Understand assets, technologies, infrastructure, market demand, and supply • Link between the upstream and downstream value chain	• Understand the implications of local climate changes on operations
Research and Development (R&D)/Innovation/ Technology	• Work on future technological development	• Provide views on plausible technological developments and breakthroughs
Advocacy/Public Affairs	• Global and regional policy trends	• Provide views on future developments of climate policy and international and national climate action
Sustainability/ESG	• Understand environmental and social impacts of business	• Provide insights on environmental and social cause-effect relationships of climate change

Table C3

Examples of Engagement Topics and Questions

Looking at the Current Situation	Looking Back	Looking Forward
• What current climate-related risks do you think the company faces today and that could affect business strategy and ambitions? • What climate-related risks do you think are being underestimated by the company in their ability to meet their business strategy and ambitions? • What is your recent experience of actual climate-related impacts on your specific activity (and more broadly on the company's business)?	• What previous trends, cycles, or risks related to climate do you think might reoccur and impact business strategy and ambitions?	• In your view, which climate-related risks do you think the company needs to get right to fulfill its ambition and mission? • What emerging trends or signals related to climate change concern you? • What do you think could be the potential implications on your specific activity (and more broadly on the company) for climate factors — such as (1) an increase in average global temperature and (2) a low-carbon economy — and when could these occur?

Box C3
Lendlease's Scenario Journey

Lendlease is an international property and infrastructure group with core expertise in shaping cities and creating strong and connected communities. Dick Dusseldorp, the founder, was an early pioneer of corporate responsibility, with a vision that was guided by two simple principles — doing the right thing and leaving a legacy for future generations.

In 2018, Lendlease committed to incorporating the TCFD framework into its disclosure regime. When it made this commitment, Lendlease knew it needed to make climate change easier to engage with and most importantly actionable by its senior leaders. One of the biggest challenges to any organization on this journey is to get busy business leaders to focus, understand, absorb, and assess the risks and opportunities of climate-related impacts.

Tailored Approach

To address this challenge, Lendlease decided to prepare its own climate scenarios that were relevant to its business and to design a scenario-planning process tailored to its business. Creating its own scenarios allowed Lendlease to break down the complexity of climate science and climate impacts for its senior leaders, making the scenarios relevant to Lendlease activities, and therefore, more readily understood and relatable. To do this, Lendlease took key data and indicators from "off the shelf" scenarios and climate-related research and translated that information into small vignettes and a collective narrative that told the story of plausible futures for Lendlease, across four different global warming scenarios.

To bring the scenarios to life, Lendlease produced a simple in-house video for each scenario that connected the key facts, indicators, and data to Lendlease, using real-life photography, written prompts, and thought-provoking questions, backed with a soundtrack, to fully immerse the audience in these future worlds. Using video provided a realism to the facts and data presented, such as pointing to actual events that signpost possible futures. The short videos made the data and the knowledge accessible to the point where senior leaders wanted to show the videos not only to their teams, but also to their friends and families. The videos conveyed information, evoked emotion, changed the conversation, and created an engaged audience.

In addition to the videos, each scenario was also supported by written "Pathways to the future" that provided a narrative on how the current world could unfold through the four scenarios, again using the same data, research, and information utilized in the videos.

Both the videos and the Pathway documents have been invaluable tools that received the support of the Global Leadership Team and the Lendlease Board, who approved the publishing and sharing of the Pathways with others, via the Lendlease website.

Risk and Opportunity Workshops

One-day "Risk and Opportunity Workshops," delivered to over 200 senior leaders globally, were another key mechanism to engage internal stakeholders. At the start of every workshop, Lendlease purposefully stated that it did not expect the participants to be climate science experts, but they did need to bring their business knowledge to the table. Nobody knows their business, market, clients, and suppliers like they do, so to truly unpack and understand the climate-related risks and opportunities to the business, Lendlease needed the uninhibited expertise that only they could provide.

The sessions were designed to educate the participants about scenario planning, the intent of TCFD, climate change (including physical and transition risks), and how to view these impacts through the lens of Lendlease's business activities. The immersion into each scenario began with viewing the scenario videos, followed by personal reflection and then group discussion. Once participants could visualize the future and possible climate-related impacts, they could unpack what that meant for Lendlease in terms of risks and opportunities and they could start to see and realize the impact they could personally have through their own roles in the business.

The level of engagement that was achieved through the process generated immediate actions during the workshops, enabling Lendlease's scenario team to identify strategic insights, both climate- and business-related, and ultimately, helped inform new sustainability metrics and targets that will allow Lendlease to measure its success in how it executed on its three global sustainability imperatives.

Business Transformation

When Lendlease made the decision to prepare its own scenarios, it hoped it would create greater engagement in assessing climate-related impacts within its business. It has found that the result has gone far beyond just assessing impacts, to taking action to manage the impacts. Engagement with internal stakeholders has also honed in-house capabilities, improved awareness, and fueled an important debate and discussion across the organization.

Lendlease believes that creating its own scenarios and designing its own scenario planning process has resulted in a deep engagement among senior leaders. As a result, scenario analysis has become part of Lendlease's short-term business planning and long-term strategic thinking and has enabled it to set new and ambitious sustainability targets, aligned with its TCFD work.

TCFD could just be seen as another layer of disclosure, but for Lendlease, it has helped transform the way the organization is positioning itself to respond to the climate crisis and the way in which it will be communicating and executing on its ambition to be 1.5°C aligned.

(Prepared by Lendlease)

2.2 Problem Definition

Scenario analysis needs crisp, concise, and focused questioning on the strategy decisions and actions to which the scenario analysis is meant to contribute.[36] Having such questioning "has two immediate advantages — it concentrates thinking about the future on the trends and forces that most affect the organization and on the decisions it has to make, and it provides a link to action."[37]

For instance, a company might start with broad questions such as: How might our identified climate-related risks and opportunities plausibly affect our [company, business unit, product, commodity input, customer segment] over [what time horizon]? What should we do? And when?[38] These broad questions can be further refined to focus on the relevant decisions and uncertainties around the climate-related risks and opportunity of most concern to the company. The following supplemental questions may help:

- What potential developments about climate-related risk and opportunities related to our business need to be probed?
- What variables need to be looked at to assist decision-making around strategy options?
- What climate-related forces and developments have the greatest ability to shape our future performance? What is their likely timing and potential impact?

2.3 Assessing Context and Identifying Driving Forces and Uncertainties

Before formulating scenarios, it is important for a company to understand the climate-related context in which it is operating. Techniques such as environmental scanning and trend analysis can assist a company in the identification of current and emerging risks, and more broadly for assessing a company's contextual situation.[39] Additional techniques, tools, and information are available and more are emerging.[40]

Driving forces (or "drivers") are external factors that influence the events, trends, and patterns that determine outcomes in the business environment.[41] In the context of a climate-related scenario analysis, important driving forces are the risks and opportunities that may result in material financial impacts on the company or affect the resiliency of the company's strategy. To be considered a driver, a factor needs to (1) be continuous over a period of time and (2) influence the outcomes of the focal question durably and consistently.

Some points to consider include:[42]

- the possible outcomes caused by the driver;
- what the driver will influence and what the driver is influenced by; and
- what the uncertainties are about the force or driver. Some drivers may be relatively certain and predictable, and others highly uncertain as to their development and impacts over time. It is important to identify these uncertainties and assess them as part of the scenario analysis.

[36] For further information, see Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006, p. 51–56, and Haigh (2019) p. 38–41.

[37] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

[38] Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019.

[39] Environmental scanning is the process of analyzing trends in those external factors that affect a company's performance in order to make assumptions about the future. Hayden, *The Handbook of Strategic Expertise*, 1986; Lustsig, *Strategic Foresight: Learning from the Future*, 2017; IPCC, *Fifth Assessment Report (AR5) Climate Change 2014: Impacts, Adaptation, and Vulnerability*, 2014, Chapter 10, pp. 1052–1062.

[40] European Bank for Reconstruction and Development, *Advancing TCFD Guidance on Physical Climate Risks and Opportunities*, 2018; Blackrock Investment Institute, *Getting Physical: Scenario Analysis for Assessing Climate-related risks*, 2019; Bank of England, *A framework for assessing financial impacts of physical climate risks*, 2019; ClimateWise, *Physical risk framework: Understanding the impacts of climate change on real estate lending and investment portfolios*, 2019; ClimateWise, *Transition risk framework: Managing the impacts of low carbon transition on infrastructure investments*, 2019; Institute for Climate Economics, *Getting started on physical climate risk analysis in finance: Available approaches and the way forward*, 2018; Institute for Climate Economics, *Understanding transition scenarios: Eight steps for reading and interpreting these scenarios*, 2019; Deutsche Asset Management, *Measuring Physical Climate Risk in Equity Portfolios*, 2014; Four Twenty Seven, *Scenario Analysis for Physical Climate Risk: Foundations* (website); Urban Land Institute, *A Guide for Assessing Climate Change Risk*, 2015; IPCC, "Fifth Assessment Report (AR5) Climate Change 2014: Impacts, Adaptation, and Vulnerability," 2014; United Nations Environment Programme Finance Initiative, *Changing Course*, 2019, p. 120; see also Appendix 3 of this guidance.

[41] Van Der Heijden, Bradfield and Burt, *The Sixth Sense: Accelerating Organizational Learning with Scenarios*, 2002; Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019.

[42] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

Box C4
Novo Nordisk's Assessment Approach

Novo Nordisk conducts training specifically focused on identifying and mitigating climate-related risks and uses risk managers as experts to identify local tendencies/weaknesses at operating sites and across the supply chain. Novo Nordisk differentiates between physical risks and transitional risks and, within these risks, first- and second-order risks.

- **First-order risks** exist as the direct impact from a physical hazard or transition — for example, property damage caused by storm surge and sea level rise for a coastal site. Physical risks can be investigated using probabilistic methods, while transition risks can be analyzed by investigating what transitions are needed to align with a given scenario outcome.
- **Second-order risks** are indirect risks from a given first-order risk or opportunity — for example, a shortage of manpower after an evacuation. Second-order risks are typically not as important if there is no evidence of a related first-order risk.

Climate Risk Impact Matrix

	Physical	Transitional
First Order	Acute or chronic climate hazards that directly affect: • Operations • Supply chains • Markets	Preliminary climate actions: • Legislative adaption • License to operate • Taxes, fees & fines • Shift in technologies
Second Order	Indirect climate hazards effects: • Support functions • Home communities of workforce • Local infrastructure	Reactive climate actions: • Shift in consumer behaviors • Reputation

(Prepared by Novo Nordisk)

There are many methods to identify relevant patterns, trends, driving forces, and related uncertainties.[43] A good starting point is the assessment of a company's climate-related context. A company also can use Social, Technology, Economic, Environmental, and Policy (STEEP) anaylsis to identify relevant drivers (see Figure C2, p. 25).[44] STEEP analysis can be applied at the local, national, or global levels to identify forces of consequence that may vary by scale.

Some pitfalls to avoid in assessing context and identifying driving forces and uncertainties are:

- identifying trends not based on observed change;
- too many trends;
- not supporting trends with evidence;
- selection of the wrong scenario dataset; and
- inability to identify the most relevant uncertainties.

2.4 Understanding and Describing Scenario Outcomes and Pathways

Once the focus questions for the scenario analysis are formulated, and a company's context and key drivers assessed, the scenarios can be developed. A key step is understanding the scenario outcomes and development pathways. Describing and discussing the pathways and outcomes will form the core of the scenario and differentiate one scenario from another.

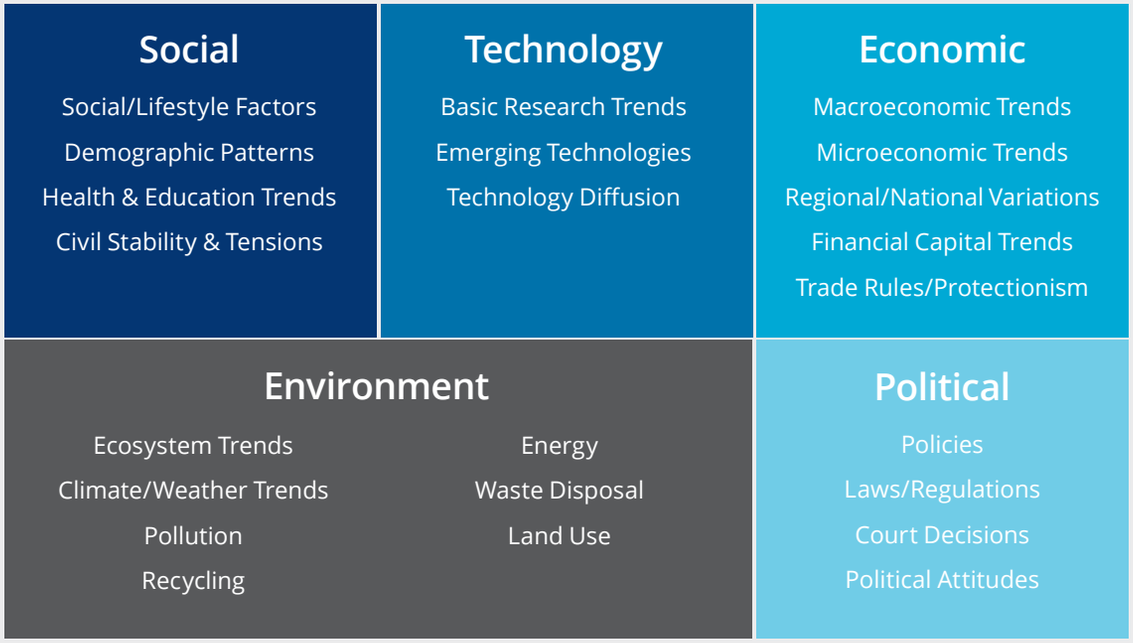
Climate-related scenarios describe both an outcome at the scenario time horizon and a pathway from today to the future outcome. A scenario's driving forces — and the assumptions about how those forces interact and develop over time — define a pathway. Vary the driving forces or assumptions and the pathway, the outcome, or both changes.

Scenario outcomes and pathways, therefore, are important considerations in company-level scenarios for at least two reasons. First, scenario outcomes describe the hypothetical context in which a company might find itself operating in the future — that is, the climate-related conditions

[43] Van Der Heijden, Bradfield and Burt, *The Sixth Sense: Accelerating Organizational Learning with Scenarios*, 2002, pp. 202–216; Van Der Heijden, *Scenarios: The Art of Strategic Conversation*, 2010, pp. 230–235; Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019, pp. 46–69; Lindgren and Bandhold, *Scenario Planning: The Link Between Future and Strategy*, 2009, pp. 59–74; Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006, pp. 87–92.

[44] STEEP is commonly used to gain insight into developments in the external environment during times of uncertainty. For further elaboration on possible climate drivers by STEEP category, see Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019, pp. 110–146, and column 1 in Figure 3 of the 2017 TCFD Technical Supplement.

Figure C2
STEEP Model of Driving Forces



and associated risks and opportunities it may face at the stated time horizon. Second, assumptions about how climate-related driving forces relevant to a company may develop over time (pathways) are important for understanding potential physical and transitional impacts on the company over the scenario's life cycle. By choosing or constructing scenarios with different pathway characteristics and outcomes, companies can better understand the landscape of their risks, opportunities, and uncertainties.

Typical climate-related scenarios are based on a targeted temperature outcome, with a corresponding set of underlying explicit or implicit emissions, energy, policy, and/or technology assumptions. This is how IPCC scenarios are constructed. For instance, scenarios may achieve a temperature outcome only assuming significant negative emissions in the future; this implicitly makes assumptions about available technology. Scenarios based on temperature outcomes are especially helpful to understand effects of physical risk and to anchor company scenarios with recognized temperature targets.

To complement these temperature outcome scenarios, companies may wish to supplement their analysis with scenarios that have stated policy and technology outcomes (i.e., without specifying a particular emissions or temperature outcome). The Principles for Responsible Investment's (PRI) Inevitable Policy Response (IPR) scenario and the De Nederlandsche Bank's (the Dutch central bank) Energy Transition stress test scenario are examples of this approach.[45] These scenarios may help in understanding the resilience of business models to transition risk created by different plausible sets of policy measures and technology developments.

2.4.1 Scenario Outcomes[46]

The scenario outcome should define the potential future climate state at a particular time horizon.[47] For example, a company may choose an outcome where global mean temperature has

[45] See PRI Inevitable Policy Response and Vermeulen, Schets and Lohuis, *An energy transition risk stress test for the financial system of the Netherlands*, 2018, pp. 17–35.

[46] Typically, scenario outcomes are defined in terms of temperature (e.g., a 2°C scenario), an emissions outcome (e.g., IEA scenarios), or a level of greenhouse gas (GHG) atmospheric concentration (e.g., RCP2.6, RCP4.5, RCP6, and RCP8.5).

[47] While many climate-related scenarios define outcomes in terms of a temperature target, a scenario outcome can also be stated in terms of a carbon budget, CO_2 atmospheric concentration, or emission outcomes.

been limited to a 2°C increase by 2050. Typically, companies choose two to four scenarios covering a range of outcomes at a regional or local scale and a time horizon at least ten years into the future. Among scenario outcomes, the TCFD has recommended disclosing the resilience of a company's strategy, taking into consideration different climate scenarios, including a "2°C or lower" scenario.

In thinking about outcomes for their scenarios, companies should consider the climate-related transition risks and physical risks they face. In general, transition risks tend to increase the more stringent the emissions or temperature target; conversely, physical risks tend to increase or tend to be increased with higher emissions and temperature outcomes. There are also important feedbacks and interrelationships between physical and transition risks.

Some companies attempt to capture both their transition and physical risks by choosing a range of scenario outcomes at both low and high temperatures and emissions, such as IPCC's RCP2.6, RCP4.5, and RCP8.5 scenarios, which imply a temperature range from 2°C or less to over 4°C.

In assessing transition risks, a company should consider using or developing a 1.5°C scenario for the "2°C or lower scenario" suggested by the TCFD. The TCFD recommendation calls on companies to take "into consideration different climate-related scenarios, including a 2°C or lower scenario."[48] A 1.5°C scenario would provide stronger diversity in assumptions about future policies and technologies. In combination with a scenario that models policy and technology as an outcome (e.g., PRI's IPR), a company could better highlight key transition risk uncertainties and their possible implications for the company.

A 1.5°C scenario also aligns with the latest scientific research from the IPCC, the growing momentum of pledges to limit emissions to net-zero by 2050, and the spirit of the Paris Agreement, demonstrating a company's alignment to recognized temperature targets. Since the publication of the TCFD recommendations, a number of policy makers, governments, and investors have embraced a 1.5°C ambition, and public information is now available to craft such a scenario.[49] A 1.5°C scenario, therefore, may be useful for risk assessment and planning purposes, irrespective of concerns about the achievability of such a target.

2.4.2 Scenario Pathways

An axiom of scenario analysis is that there is **no single pathway to a particular scenario outcome**. Different combinations of driving forces and assumptions will result in different plausible development pathways, even to the same temperature or emissions outcome. Multiple pathways reflect uncertainties "about climate system dynamics, economic conditions, energy use, available technologies, and the timing of policy action" resulting in different "ranges of global emissions, carbon budgets (cumulative emissions over time), and annual global [greenhouse gas] GHG reduction levels… consistent with a global temperature outcome."[50] Figure C3, on the next page, illustrates multiple pathways consistent with a 2°C outcome.

Understanding the underlying assumptions of different pathways is critical for understanding company-level risks, impacts, and uncertainties. Differences in assumptions (and hence different pathways) can make big differences in company-level impacts.

2.4.3 "Orderly" and "Disorderly" Pathways

Most global climate scenarios, such as IPCC scenarios, assume smooth and "orderly" pathways in order to simplify what are otherwise potentially complex development pathways. In other words, they often assume smooth physical changes in the climate over time, and a set of idealized climate policy and technology actions that are coordinated globally and applied with immediate effect to the global economy as a whole.

Companies need to be cautious about use of orderly pathways. Assumptions of orderly pathways are not intended to be predictions of "realistic" outcomes, but rather to test different combinations of assumptions, albeit in a simplified construct. Therefore, in all likelihood, different pathways may emerge in reality that may trigger different climate-related impacts or social-economic responses, which in turn may affect the costs of various sectors, individual companies, and individual investments.[51]

[48] "…and where relevant to the company, scenarios consistent with increased physical climate-related risks." TCFD, "Recommendations of the Task Force on Climate-Related Financial Disclosures," 2017.

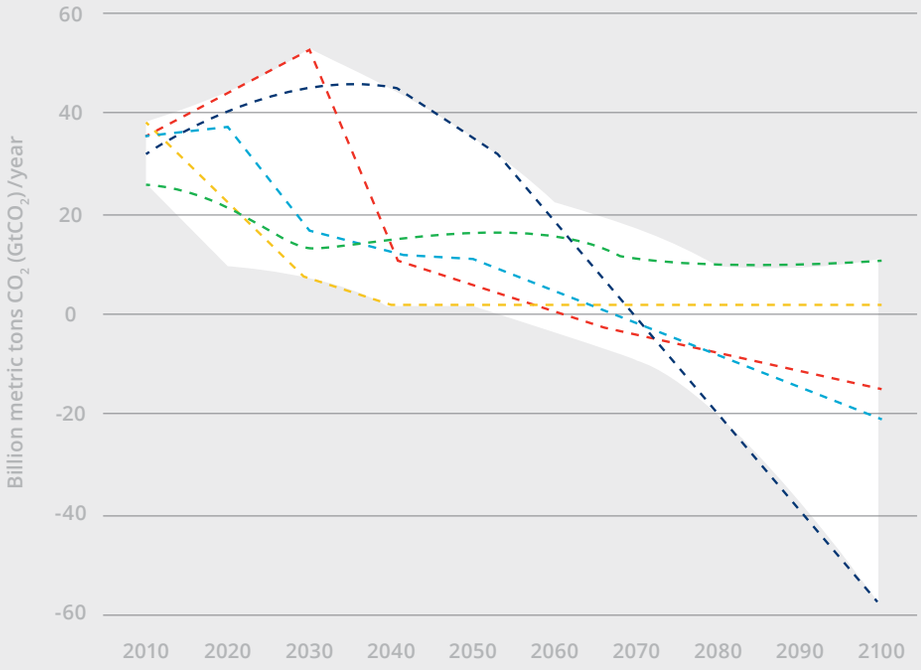
[49] IPCC, *Special Report – Global Warming of 1.5°C*, 2018. See also Investor Leadership Network, *Climate change mitigation and your portfolio*, (2020) for practical tools to evaluate companies' decarbonization scenarios in line with the Paris Agreement and a pathway to 1.5°C.

[50] Rose and Scott, *Grounding Decisions: A Scientific Foundation for Companies Considering Global Climate Scenarios and Greenhouse Gas Goals*, 2018.

[51] Rose and Scott, *Review of 1.5°C and Other Newer Global Emissions Scenarios*, 2020.

Figure C3

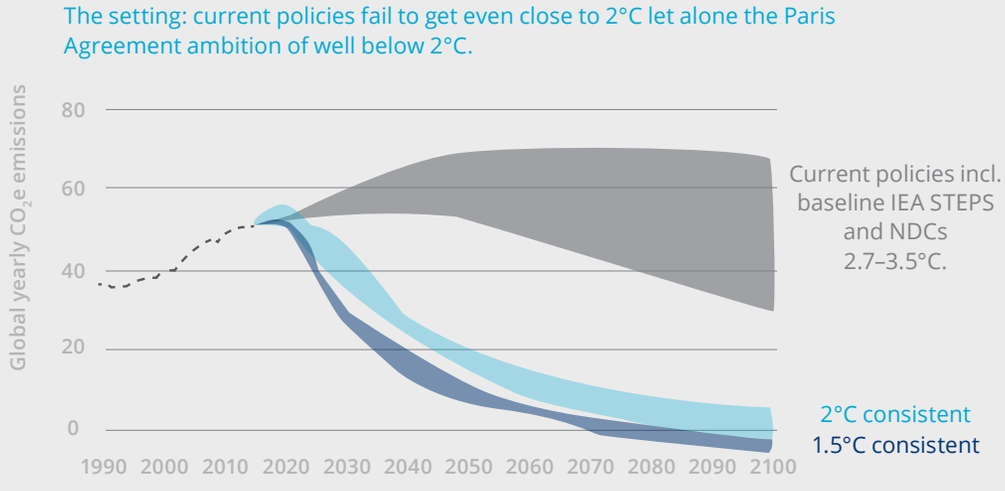
Multiple Emissions Pathways Consistent with 2°C Scenario



The range of 2°C pathways (white space) and selected emissions pathways (dashed lines) are based on 408 different scenarios.
Source: Rose & Scott, 2018

Figure C4

Current Policies versus 2°C Temperature Goal



Source: Climate Action Tracker, Dec 2018 update

To consider this possibility in its scenario analysis, a company needs to understand both the assumptions underlying "orderly" pathways and consider incorporating assumptions about potential "disorderly" pathways for the same scenarios. Ultimately, companies need to evaluate different policy designs and assumptions about technology innovation and diffusion to understand the uncertainties and risks of various pathways.

On the transition risk side, a "disorderly" pathway is likely to be characterized by variation in the speed and magnitude of changes along the pathway over time, driven by policy delays, uncoordinated or disjointed policy implementation, unanticipated technology transformations or disruptions, or abrupt market, social, or legal shifts in response to climate-related changes.

For example, current national climate policy commitments are projected to achieve a 2.7°C to 3.5°C temperature rise by the end of the century (Figure C4, p. 27). If the world is to achieve the international commitments of the Paris Agreement by transitioning to a below 2°C carbon footprint, these policies will require adjustment.[52] The uncertainty is how this adjustment will proceed — on a coordinated and timely basis, or on a delayed, potentially abrupt, and disjointed basis — with potentially different socioeconomic outcomes.

On the physical risk side, disorderly pathways may be driven by the existence of so-called climate system tipping points — the notion that small changes at critical thresholds can have large, long-term consequences, possibly irreversible, for the climate system (i.e., regime shifts).[53] These climate tipping points have business implications regarding physical impacts, ecosystem services, and biodiversity.

Therefore, when undertaking scenario analysis, companies should (1) understand and assess the potential policy, technology, and other socioeconomic assumptions in global or regional scenarios they might want to use, and (2) consider incorporating assumptions of a "disorderly" pathway into some of their scenarios around key policy and technology drivers and climate tipping points important to their business.

For companies just beginning their implementation of scenario analysis, use of global scenarios (e.g., IPCC, IEA) may be an easy way to start. However, such scenarios are not "plug and play." Understanding the assumptions of various pathways and the implications of those assumptions for the company is important.

As a company gains experience with scenario analysis, it may want to modify existing scenarios or develop its own scenarios that incorporate more realistic (to the company) "disorderly" assumptions around the transition to a particular temperature outcome. For example, a power company may want to evaluate plausible policy assumptions for renewable portfolio standards, carbon pricing policies, or carbon emission standards. Incorporating more specific assumptions around policy or technology drivers may assist a company in highlighting different risks from global scenarios based on idealized, "orderly" transitions. While not explicitly mentioned in the TCFD recommendations, "disorderly" scenarios are being emphasized by regulators and investors in recent publications.[54]

2.5 Writing Qualitative Scenario Narratives and Quantification[55]

A scenario narrative tells a story with a sequence of events; a plot; a beginning, middle, and end; characters, and a setting. The narrative describes developments in the scenario around different economic, technical, environmental, and social dimensions. The main reasons for formulating narratives or storylines are to:[56]

- help the company to think more coherently about the complex interplay between driving forces within each scenario and across alternative scenarios;
- make it easier to explain the scenarios to various stakeholders and user communities;

[52] See PRI Inevitable Policy Response.

[53] Such tipping points may trigger cascading impacts beyond the climate system. See Arctic Council, *Arctic Resilience Report*, 2016, sections 3.2 and 3.3, particularly Figure 3.4b, and Kinzig, Ryan and Etienne, *Resilience and Regime Shifts: Assessing Cascading Effects*, 2006. See also Gladwell, *The Tipping Point*, 2000; Lenton, et al., *Tipping elements in the Earth's climate system*, 2008; Lenton and Ciscar, *Integrating tipping points into climate impact assessments*, 2013; Lemoine and Traeger, "Economics of tipping the climate dominos," 2016; and Van Ness, et al., *What do you mean, 'Tipping Point'?*, 2016.

[54] As an example, NGFS has developed a scenario that includes a disorderly transition where policies with respect to carbon pricing would be delayed, resulting in sharper carbon price increases once a carbon price is introduced (NGFS, *Guide to climate scenario analysis for central banks and supervisors*, 2020). See also UK PRA, *Enhancing banks' and insurers' approaches to managing the financial risks from climate change*, 2019; NGFS, *A call for action: Climate change as a source of financial risk*, 2019; and PRI, *What is the Inevitable Policy Response?*, 2019.

[55] See Appendix 2 for a more in-depth discussion of turning STEEP analyses into scenario narratives.

[56] IPCC, *Special Report on Emissions Scenarios*, 2000, p. 27.

- make the scenarios more useful, in particular to company leaders and managers who contribute to a company's strategic, financial, and operational planning; and
- provide a guide for additional assumptions to be made in detailed planning analyses, because at present no single scenario can possibly respond to the wide variety of informational and data needs of the different users within a company and its external constituencies.

Scenario narratives are the qualitative part of a scenario that describes a hypothetical future in terms of a potential trajectory over time. The narrative is determined by key drivers, and assumptions about their development that leads to an outcome. It identifies and lays out the drivers, constraints, assumptions, and logical relationships that lead to and define that hypothetical future in terms of developments in physical and transition climate-related risks and in socioeconomic conditions (such as demographics, technology, and policies).

Each scenario narrative is internally consistent; logical, plausible, and credible; distinctive; and highlights central elements of a possible future, key factors that will drive future developments, and key uncertainties. Importantly, narratives challenge conventional thinking about the future.

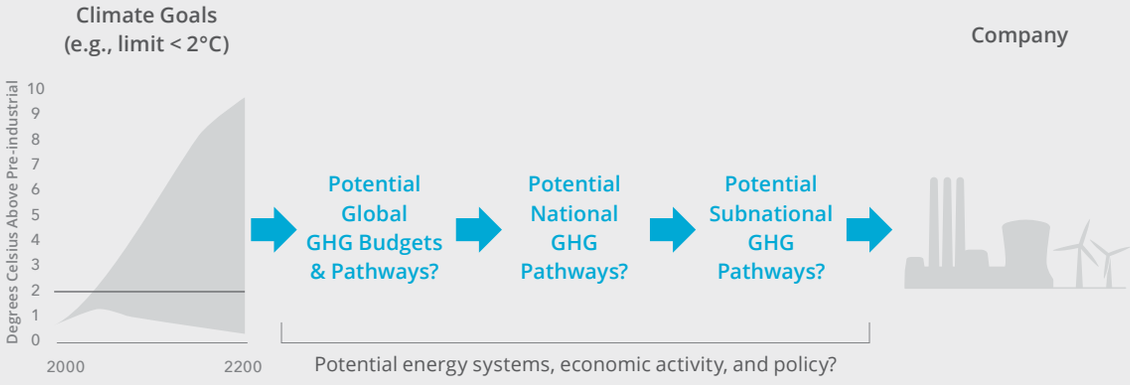
Scenario narratives seek to "stimulate, provoke, and communicate visions of what the future could hold…they aim for creativity, rigor, internal coherence, and plausibility."[57] Scenario narratives are based on the focal question, identification of risks and opportunities, critical driving forces, causal assumptions, and uncertainties.

Narratives consist of themes, logic, and a storyline. **Scenario themes** are developed around the driving forces with high impact and high uncertainty for a company.[58] **Scenario logic** describes the relationship between various drivers and resulting change, including the causal assumptions underlying the described relationship. In other words, it seeks to explain the hypothetical cause-effect relationship among drivers and the resulting development pathway. **Scenario storylines** link historical and present events with hypothetical futures by presenting a seamless and integrated narrative describing the causal train of events (pathways) and underlying drivers, assumptions, and affected systems. The objective is to create compelling stories that capture historical trends and forces and how they may unfold in the future according to the internal scenario logic.

A challenge in writing scenario narratives is linking global climate scenarios to a company-level scale, as illustrated in Figure C5. Use of a participatory scenario approach can help to visualize and craft local-scale scenario narratives.[59]

Figure C5

Understanding the Relationship Between Global Climate Goals and Companies



Source: Rose and Scott, 2018

[57] Rounsevell and Metzer, *Developing qualitative scenario storylines for environmental change assessment*, 2010.

[58] Appendix 2 describes approaches to developing scenario themes.

[59] Shaw, Sheppard and Burch, *Making local futures tangible — Synthesizing, downscaling, and visualizing climate change scenarios for participatory capacity building*, 2009; Fame, Lawrence and Reisinger, *Adapting global shared socio-economic pathways for national and local scenarios*, 2018.

2.5.1 Scenario Quantification

Scenarios may be "quantified" through the use of descriptive statistics or through the use of models. Models are a simplified representation of reality that attempt to explain assumption-effect relationships between key drivers and outcomes in a particular system (e.g., climate system, economic system, ecological system).

Scenario drivers, constraints, assumptions, and logic from the scenario narrative are often used as inputs to models. Models use this information to characterize the system in question, assign mathematical relationships to assumptions and effects, and quantitatively describe the pathway(s) and outcomes of the scenario that have previously been described qualitatively in the narrative.

Climate-related models can provide useful insights regarding uncertainties and the larger potential climate, socioeconomic, and ecological futures that might develop (context-setting), but will have limitations and caveats if they are used at more granular levels (e.g., sector or company levels). In particular, models may attempt to be "too precise" and come with layers of assumptions and limitations.

Do not rush to quantification. The first step is to understand the impacts of climate-related

Table C4

Factors to Assess in Checking Scenario Quality

#	Factor	Check That the Scenario Narrative:
1	Time Horizon	Has a future cutoff time that is sufficiently in the future (e.g., 2030, 2050, 2100)
2	Focal Question	Has well-formulated and focused critical question(s) or potential decision(s) the company seeks to assess by scenario analysis
3	Driving Forces	Has a clearly articulated set of underlying causes of change in relation to the focal question, and that these driving forces derive from external social, technological, economic, environmental, and policy processes
4	Scenario Logic	Has a clearly stated relationship between various drivers and change, including the causal assumptions underlying the described relationship, and an internal consistency between various statements and assumptions that underpin the scenario storyline
5	Pathways	Has a clearly described trajectory between the present and the future outcome of the scenario that results from the drivers and related cause-effect relationships laid out by the scenario logic
6	Uncertainties	Has explicitly described the uncertainties and their sources surrounding how drivers may play out
7	Storyline	Presents a seamless and integrated narrative describing the causal train of events (pathways) and underlying drivers, assumptions, and affected systems
8	Plausibility	Is possible and credible as to the events it describes
9	Distinctive/ Diverse	Focuses on different assumptions about key driving forces in each scenario, and should have enough scenarios to provide diversity in pathways and outcomes
10	Consistency	Is consistent in the application of the scenario logic between scenarios
11	Relevance	Contributes insight into the futures that relate to the strategic and/or financial decisions facing a company
12	Challenging	Challenges conventional wisdom and simplistic assumptions about the future

risks and opportunities from a qualitative perspective. Rushing to quantify a scenario may result in developing complex quantitative scenarios (mostly with external assistance), before the qualitative narrative, which should serve as a robust framework and communication tool, has been thought through and developed.

Quantification should proceed in steps; for example, by starting with a qualitative analysis followed by quantification of impacts through "orders of magnitude" or directional indications. More detailed quantitative approaches and models may be developed later once these impacts are well understood and the necessary data has been obtained.

Quantification, however, is a necessary goal in a mature process. Not only is quantification important for managing strategy and business outcomes, but also investors and other stakeholders expect a company to quantify its expected impacts from climate change.

2.6 Checking the Quality and Avoiding Pitfalls

For scenario analysis to be effective and credible with internal and external stakeholders, scenarios should be of high quality, decision-useful, and periodically updated. A quality assurance process for scenarios ensures their credibility with internal and external stakeholders. This involves such things as assessing the scenarios' overall structure, internal logic, plausibility, and the likelihood of assumptions, among other factors as outlined in Table C4 (p. 30). It may also involve a review of scenarios by selected external parties, such as investors, to get their feedback and suggested adjustments to scenarios.

Scenarios also have a shelf life, so a process to periodically refresh and update them is needed. This ensures continued relevancy and efficacy to a company's overall strategy planning process. The frequency with which scenarios should be updated is a matter of judgment driven by considerations of a company's planning cycles, the dynamics of its external environment, updates in scientific understanding of climate change, developments in climate-related policies, and developments in climate and emission projections. Companies generally update their scenarios from as often as annually to every three to four years.

Further Reading

The Scenario Planning Handbook: Developing Strategies in Uncertain Times. Bill Ralston and Ian Wilson. Thomson Corp., 2006.

Scenario Planning for Climate Change: A Guide for Strategists. Nardia Haigh. Routledge Press, 2019.

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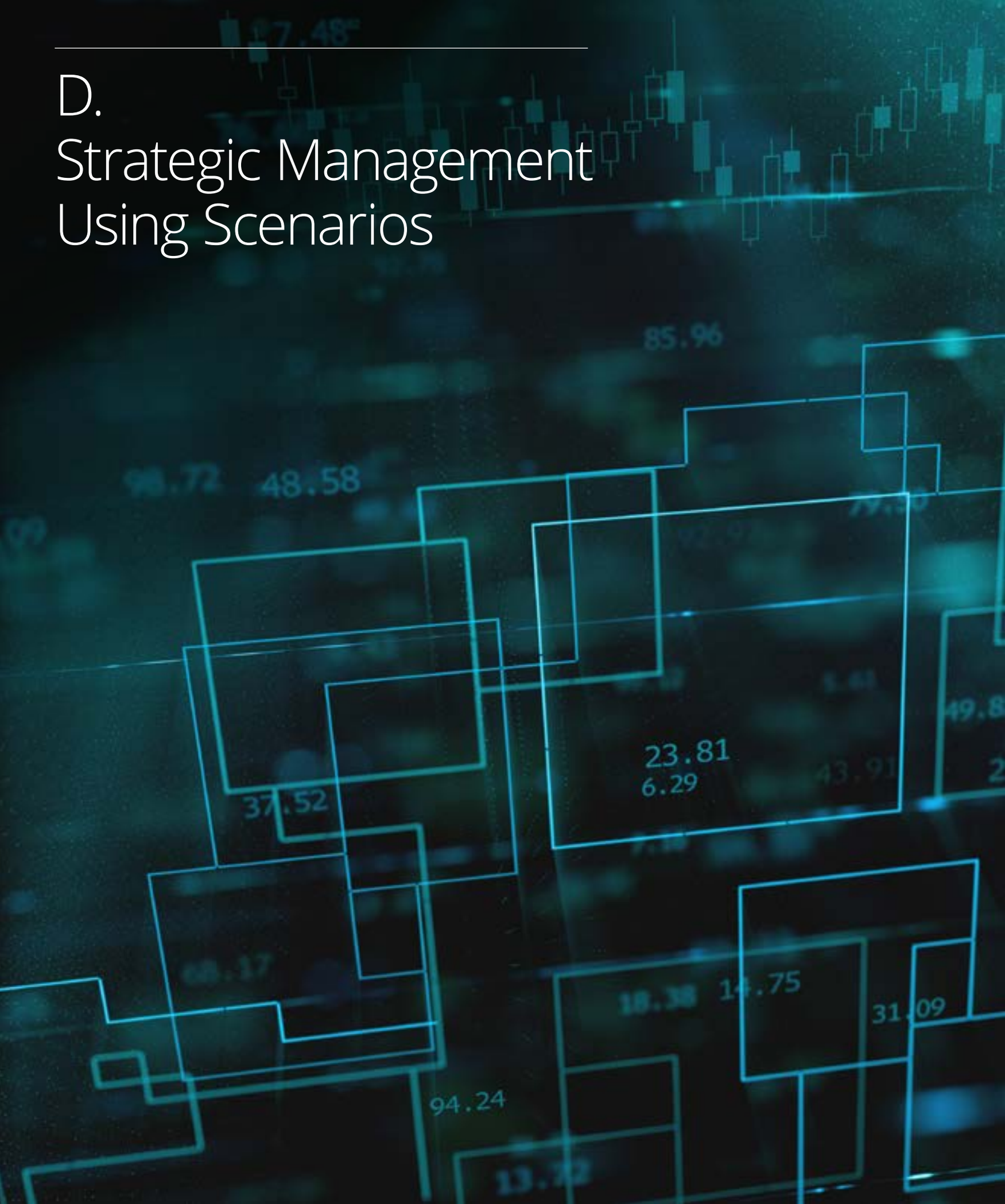
The Art of Scenarios and Strategic Planning: Tools and Pitfalls. Michel Godet. Technological Forecasting and Social Change, 65: 3–22, 2000.

Models of Scenario Building and Planning: Facing Uncertainty and Complexity. A. Martelli. 2014.

How to improve scenario analysis as a strategic management tool? Theo J. B. M. Postma and Franz Liebl. Technological Forecasting and Social Change, 72: 161–173, 2005.

Understanding transition scenarios: Eight steps for reading and interpreting these scenarios. Institute for Climate Economics, 2019.

D.
Strategic Management Using Scenarios



D. Strategic Management Using Scenarios

This section discusses how to apply the insights gained from scenario analysis to inform a company's strategy, enhance its resilience, and improve flexibility and adaptability to future climate change.

Key Messages

- **Scenario analysis is a useful tool for strategic management.**
  - It broadens views and considerations going into strategy formulation.
  - It contributes to strategy resilience.
  - It builds organizational capacity in planning for climate change.
- **Identifying the implications of scenarios for strategy starts with a simple question:**
  - How would our company's existing (or proposed) strategy likely perform under each scenario if it were true?
- **Applying scenario analysis to strategy involves identification of options that address the impacts suggested by the scenarios.**
  - Options that address impacts occurring across multiple scenarios are preferable to enhance resiliency.
- **Evaluating and selecting strategy options involve a number of criteria:**
  - strategic focus of the option and the level of the option's risk;
  - programs and products affected;
  - ability to execute (e.g., timeframes, resources required, success factors);
  - the potential value generated by the option; and
  - alignment with overall company strategy and business model.
- **When developing and choosing strategy options, companies should be mindful of blind spots — options existing beyond current operations, the nonlinear nature of climate-related risks, and business as usual interpretations.**
- **A climate-resilient strategy requires continual exploration of alternative strategies, even if the current strategy seems to be working fine.**
  - Monitoring and reassessing the external environment (e.g., using relevant indicators/signposts) is particularly important to allow for "midcourse corrections" and is a cornerstone of resilient strategies.

1. STRATEGIC MANAGEMENT AND STRATEGY RESILIENCE

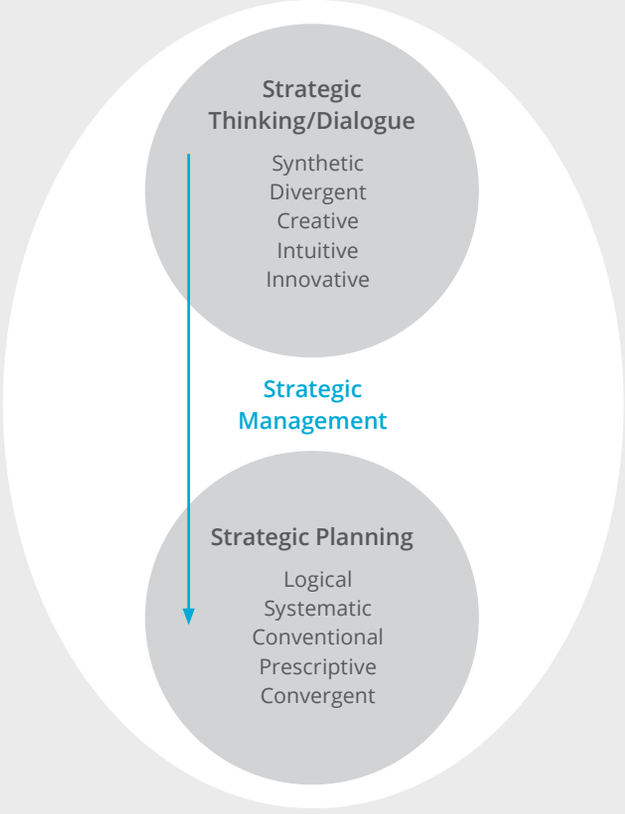
Strategic management consists of two interrelated and complementary processes — strategic thinking/dialogue and strategic planning (see Figure D1).[60] Strategic thinking and planning are "distinct, but interrelated and complementary thought processes" that sustain and support one another for effective strategic management. The role of strategic thinking is "to seek innovation and imagine new and very different futures that may lead the company to redefine its core strategies and even its industry." Strategic planning aims "to realize and to support strategies developed through the strategic thinking process and to integrate these back into the business."[61]

1.1 Scenarios and Strategic Management

Scenario analysis helps to broaden the views and considerations that go into strategic thinking, and also improve specific planning decisions to help strengthen the resilience of a company's strategy. In the context of strategic management, scenarios serve two broad functions (Figure D2, p. 35). First, they promote strategic thinking — the creative, intuitive, and innovative thinking about divergent futures that may affect a company. Second, scenarios provide a systematic and logical process to identify various strategy options in the light of these futures, and aid in the decision-making process to select among options.

Figure D1

Strategic Management Process



Role of Strategic Thinking/Dialogue
To seek innovation and imagine new and very different futures that may lead a company to redefine its core strategies and even its industry

Role of Strategic Planning
To realize and support strategies developed through strategic thinking processes and integrate these back into the business

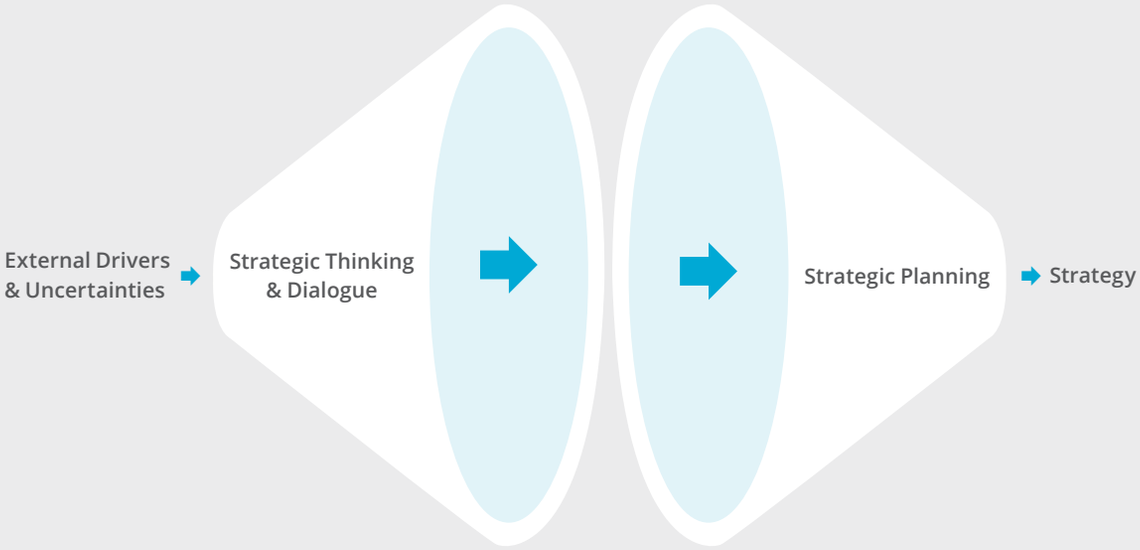
Adapted from: Graetz, F. (2002), "Strategic thinking versus strategic planning: towards understanding the complementarities," Management Decision, Vol. 40 No. 5, pp. 456–462

[60] Strategic thinking/dialogue involves exploring possible organizational futures and challenging conventional thinking to foster decision-making. Strategic planning is an organization's process of taking the results of strategic thinking, defining a strategy or direction, and making decisions on allocating its resources and determining actions to pursue this strategy.

[61] Graetz, "Strategic thinking versus strategic planning: towards understanding the complementarities," 2002.

Figure D2

The Role of Scenarios in the Strategic Management Process



These functions of scenario analysis serve companies well in the context of climate change, which is often termed a "wicked strategy problem" imbued with a great deal of uncertainty.[62]

1.2 Strategy Resilience and Scenarios

A key desire of investors and other stakeholders is to understand how a company's management is (or is not) positioning the company with regard to potential climate-related risks and opportunities (i.e., how resilient a company's strategy is to these risks).[63] **Resilience refers to the way in which a company's strategy supports and maintains a company's capacity to survive, adapt, and grow in the face of turbulent change under different climate-related scenarios.**[64] A resilient strategy is able to tolerate disruptions or adapt to changes or uncertainties in the business environment that might affect the organization's performance and to remain effective under most situations and conditions. Resilience has three characteristics — resistance, recovery, and robustness.[65]

> "A robust strategy is more than a specific company's emissions target or pathway; it is an approach that recognizes uncertainty, provides flexibility, and can respond appropriately to the future as it unfolds."
>
> – Rose and Scott, 2018

[62] Berkhout, van den Hurk and Bessembinder, *Framing climate uncertainty: socio-economic and climate scenarios in vulnerability and adaptation assessments*, 2013; Camillus, *Strategy as a Wicked Problem*, 2008; Lempert, Nakicenovic and Sarewitz, *Characterizing climate-change uncertainties for decision-makers*, 2004; L. Mearns, *The drama of uncertainty*, 2010.

[63] The TCFD's recommended disclosure *Strategy c)* calls for companies to "describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios...."

[64] Fiksel, *Sustainability and Resilience: Toward a Systems Approach*, 2006.

[65] Grafton et, al., *Realizing resilience for decision-making*, 2019.

- **Resistance** is the capacity of a business to actively or passively maintain desirable operational and financial performance in the face of change.
- **Recovery** is the time it takes for a business's operational and financial performance to recover to desired levels following adverse change.
- **Robustness** is the probability that a business will not cross an undesirable (and possibly irreversible) performance threshold following adverse change.

Scenario analysis contributes to all three characteristics — resistance by improving the range of strategy options effective under different climate circumstances; recovery by reducing the likelihood of surprises and identifying actions that can be taken to mitigate or adapt to potential risks if they occur; and robustness by broadening strategic thinking about plausible futures.

Scenario analysis also helps improve resilience by building organizational capacity through promoting systems thinking, personal mastery, new mental models, shared vision, and team learning as well as reducing organizational fragmentation, internal competition, and reactiveness.

Box D1
Applying Scenarios at Novo Nordisk

Novo Nordisk has developed a method that draws from current supply chain risk management practices to explore how scenario analysis is applicable for analyzing physical and transition risk across supply chains.

Assessment of scenario analysis results. When assessing physical risks at local sites, it is necessary to acquire data that is locally applicable. Novo Nordisk is currently investigating how downscaled regional climate model data can be made available to local risk managers to incorporate in their current processes. However, the use of climate model data is not a simple task. Therefore, Novo Nordisk is still investigating how risk managers can be trained in climate risks without diverting their focus from other risk types. Until this has been resolved, Novo Nordisk is using global climate model (GCM) data, which is easier to source and can be found at various sites by a simple user interface, noting that the results of the analysis only produce a rough estimate of a regional situation as the average resolution in CMIP5 GCMs is 200 km^2 per data point.

For transition risks, the assessment is also quite complex. To simplify the process, Novo Nordisk collects emission data from its supply chain, which in turn is used as the foundation to assess the risks associated with transitioning toward a certain RCP scenario. From this, the costs for a full transition or transition failure can be estimated. Transition failure is estimated by applying a carbon tax as an indicator. The carbon tax can be estimated using IPCC's guidelines, which provides an indication of the costs that are associated with each RCP scenario.

(Prepared by Novo Nordisk)

2. APPLYING SCENARIOS TO STRATEGY FORMULATION

Developing a climate-resilient strategy involves identifying the implications of scenarios, developing strategy options from the scenarios that enhance resiliency, and making strategic decisions.

2.1 Identifying the Implications of Scenarios for Strategy

Identifying the implications of various scenarios for a company's strategy is encapsulated in the basic question: **How would existing (or proposed) strategies, decisions, or actions perform under different futures (scenarios)?** Answering this question is more challenging. Answers require identifying the key uncertainties and potential consequences of a range of plausible climate futures, and how potential consequences and uncertainties are to be managed, including how to capture potential opportunities (see Box D2). The objective is to understand the potential implications of scenarios' hypothetical conditions for the company's strategy.[66]

In scenario analysis, each scenario describes a unique set of plausible future conditions that the company may find itself in based on the company's decided focal question(s) and the key drivers of interest to the company. These scenarios are a lens through which a company can think about the various climate-related risks and opportunities it faces, how the related impacts may evolve under different scenario conditions, how its current strategy might perform, and what adjustments to its strategy may be needed.[67]

Here are some principles of strategic thinking and some pitfalls to avoid:[68]

- think in paradoxes and visions;
- think in improvisation and pragmatism — sorting out what can be controlled from what cannot;
- think in time, resources, and life cycles;
- think in experiments and bets;
- avoid standard answers to nonstandard environments;
- avoid clinging to old strategies because they feel safe;
- avoid translating long-term strategies into short-term developments;
- avoid having the scenario information only used by a few; and
- avoid forgetting the future once the scenario process is over.

Using these principles and pitfalls, a company should brainstorm and identify a broad range of scenario implications and insights. Box D2 provides some questions a company can use in assessing its current strategy and new strategic possibilities through the lens of its scenarios.

Box D2
Questions to Ask Regarding Strategy Implications of Scenarios

- At the level of the company's external stakeholders:
  - For each group of external stakeholders, what value changes are involved in each scenario? What are the associated business opportunities?
  - What are the new bottlenecks in the market? Who is getting squeezed and what will they want to do about it?
- At the level of the company:
  - How does the company's current strategy, policies, and capabilities prepare it for the future described in each scenario?
  - Does the company's current strategy and associated strategic posture look sound across only one or several scenarios?
  - If you knew this scenario would occur, what opportunities and risks/threats would the company face based on the earlier identified vulnerability factors?
  - What strategies could you implement to best take advantage of the opportunities and remove the risks/threats?
  - What signposts or leading indicators might alert you that this scenario and associated dynamics are going to occur, or would signal that a particular strategy option should be implemented?

Sources: Drawn from texts by Chermack, Haigh, Ralston and Wilson, and Van Der Heijden. See References for full sources.

[66] Van Der Heijden, *Scenarios: The Art of Strategic Conversation*, 2010, pp. 273–287; Menzie, Cantor and Boehm, *Business planning for climate change: Identifying vulnerabilities and planning for changes in water, temperature, sea level, natural resources, health effects, and extreme events*, 2011.

[67] For alternative approaches using scenarios to identify strategic implications, see Star, Rowland and Black, *Supporting adaptation decisions through scenario planning: Enabling the effective use of multiple methods*, 2016; Maier, Guillaume and van Delden, *An uncertain future, deep uncertainty, scenarios, robustness and adaptation: How do they fit together?*, 2016; Dittrich, Wreford and Moran, *A survey of decision-making approaches for climate change adaptation: Are robust methods the way forward?*, 2016; and Milestad, Svenfelt and Dreborg, *Developing integrated explorative and normative scenarios*, 2014.

[68] Lindgren and Bandhold, *Scenario Planning: The Link Between Future and Strategy*, 2009. Also see Lustsig, *Strategic Foresight: Learning from the Future*, 2017.

2.2 Developing Strategy Options from Scenarios

Following an assessment of strategy implications informed by scenarios, a company should develop a set of suggestions for addressing the implications of each scenario and then cluster those suggestions into strategy options to be evaluated.[69]

Generally, a company should seek first to identify suggestions that address impacts occurring across multiple scenarios in preference to those addressing impacts occurring under only one scenario. However, some options may be "low-hanging fruit" that could be implemented regardless of the scenario.[70]

Suggestions for addressing the implications of the scenarios will likely fall into clusters around climate mitigation (e.g., emissions reduction), adaptation efforts a company might undertake to manage its risks, or actions to increase its opportunities. Strategy options in the adaptation cluster might be further framed as soft adaptation or hard adaptation.[71]

The resulting options may build on existing plans and strategies by reassessing and reprioritizing actions with a climate change focus or be new approaches to climate change risks and opportunities. For each scenario, the scenario team and internal stakeholders identify what they believe is an initial set of sound options to be evaluated. For each option, they can then work on a description of the strategic focus of the option, programs and products affected, resources required, success factors, timeframe, relevant indicators and signposts to monitor, and initial priorities to initiate the option.[72]

2.3 Moving From Strategy Options to Strategy Decisions

To evaluate the strategy options and select those to incorporate into the company's strategy, companies typically apply criteria that measure the level of risk and the value generated by the option, alignment with overall company strategy, and ability to execute.[73] Evaluation may be based on a combination of risk management criteria (e.g., degree of risk mitigation), financial criteria (e.g., potential change in financial performance), or competitive criteria.[74]

The following questions can also guide the evaluation of options:

- What strategy options are the most attractive (e.g., from a value or competitive standpoint)?
- What options could generate the most value in each scenario (high payoff)?
- What contingencies could protect high-payoff options against those scenarios in which the option is weak?
- What options could generate the most value across all scenarios?
- How could options be combined to increase value across the scenarios?
- What steps are needed to move to a higher-value, more resilient strategy?

When developing and choosing strategy options, companies should be mindful of several blind spots or shortfalls.[75]

Options "beyond the fence line." Options should consider the potential for scenario implications beyond a company's direct operations. Supply chains, employees, customers, and the communities in which a company operates also will be affected and, in turn,

[69] For suggestions, see Hallegatte, *Strategies to adapt to an uncertain climate change*, 2009; Kolk and Pinske, *Market strategies for climate change*, 2004; and Kolk and Pinske, *Business responses to climate change: Identifying emergent strategies*, 2005.

[70] Haigh, *Scenario Planning for Climate Change: A Guide for Strategies*, 2019, pp. 97–100.

[71] Soft adaptation approaches are substantive yet physically intangible responses to climate impacts, such as planning and de-risking processes, finance, knowledge generation and information flows, and human resources development. Hard adaptation approaches encompass such things as capital investments in technology or engineered infrastructure and sustainable management. Goldstein, Turner and Gladstone, *The private sector's climate change risk and adaptation blind spots*, 2019.

[72] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

[73] Ibid.

[74] Internal carbon prices are one method used by companies to evaluate the financial implications of various options. See Aldy and Gianfrante, *How to create the climate strategy your company needs*, 2019; Ackerman and Stanton, *Climate risks and carbon prices: revising the social cost of carbon*, 2012; Harpankar, *Internal carbon pricing: rationale, promise and limitations*, 2019; CDP, *Carbon Pricing Corridors: The Market View*, 2017; CDP, *Putting a price on carbon: Integrating climate risk into business planning*, 2017; CDP, *How-to guide to corporate internal carbon pricing – Four dimensions to best practice approaches*, 2017; TruCost S&P Global, *TCFD Scenario Analysis: Integrating future carbon price risk into portfolio analysis*, 2019.

[75] Research and experience have highlighted these points (Goldstein, Turner and Gladstone, Op. Cit., 2019).

affect the company. "Fewer than 3% of companies indicated that climate change would impact their business through 'wider social disadvantages.'"[76] Such a narrow view of risk leads to more narrowly focused strategic options.

Novo Nordisk stresses the importance of climate risks to upstream and downstream supply chain partners. It considers that its value chain is only as strong as its weakest link. Novo Nordisk shares data and approaches among its local sites and value chain partners in order to have holistic and realistic scenario analysis. It also believes it is important to support investors and financial institutions in their TCFD journey by providing TCFD relevant data from its supply chains.

(Prepared by Novo Nordisk)

Lack of clarity around value generated. Strategy options should clearly delineate the incremental costs and benefits relative to other options. The value of various options should also be distinguished from the value of initiatives and investments that a company would undertake even in the absence of climate change.

"Low regrets" options. Companies should consider what options may be effective under a range of future climate scenarios and/or provide co-benefits with low risks.[77]

The nonlinear nature of climate risks. Most climate scenarios presume quasi-linear pathways to a particular temperature outcome. In assessing and valuing strategy options, a company should consider the potential for nonlinearities and their implications for strategy.

Box D3
Scenarios and Strategy Decisions at Downer Group

Downer's scenario analysis is fed directly into strategy sessions and executive forums, where it is a permanent consideration of the Board's strategy process. Broader sustainability issues from scenario analysis are also built into Board-level discussions. From a tactical perspective, Downer undertakes an annual exercise to test its strategic position against the scenario analysis.

"The outcomes of the scenario analysis contributed to change in the overall strategy of the business," – Downer's Group General Manager Sustainability, Reporting and Data Analytics, Ricky Bridge

In February 2020, Downer CEO Grant Fenn announced that Downer would shift investment from high-capital-intensive activities to lower-capital-intensive and lower-carbon activities. Climate change and sustainability were also elevated with an intention to retain market share and to secure new customers.

(Prepared by Downer Group)

In other words, inputs and outputs from the climate system are not proportional, change is often episodic and abrupt, rather than slow and gradual, and multiple equilibria are the norm.[78]

"Business as usual" interpretations. Many companies too often translate the complexities of climate change into strategic options that align with business as usual practices.[79] The underlying assumption for business as usual interpretations is that "current economic and social conditions will continue to flourish regardless of unfavorable biophysical conditions in Earth's natural and climate systems."[80]

Whichever options are ultimately incorporated into the company's strategy, the strategy should be an adaptive one — one that can make midcourse corrections based on observations of the climate and economic systems. It should be adaptive so that it can take into account uncertainties around future developments; for example, the possibility of large and/or abrupt climate changes and/or of technology breakthroughs that significantly lower projected costs of strategic initiatives.[81]

[76] Goldstein, Turner and Gladstone, "The private sector's climate change risk and adaptation blind spots," 2019.

[77] Hallegatte, *Strategies to adapt to an uncertain climate change*, 2009.

[78] McNeall, Halloran and Good, *Analyzing abrupt and nonlinear climate changes and their impacts*, 2011; Rial, et al., *Nonlinearities, feedbacks, and critical thresholds within the Earth's climate system*, 2004; Schneider, *Abrupt Non-Linear Climate Change, Irreversibility and Surprise*, 2003.

[79] Wright and Nyberg, *An inconvenient truth: How organizations translate climate change into business as usual*, 2017.

[80] Winn, Kirchgeorg and Griffiths, *Impacts from climate change on organizations: A conceptual foundation*, 2011.

[81] Lempert, Schlesinger and Bankes, *When we don't know the costs or the benefits: Adaptive strategies for abating climate change*, 1996.

Adaptive strategies allow a company to make corrections in its strategy along the way and avoid significant errors.

The final step should be to assess if the selected options and recommended strategy (1) improves how well prepared the company will be for climate surprises or disruptions, (2) identifies important uncertainties and contingency plans for those uncertainties, and (3) strengthens resiliency.[82]

3. MANAGING STRATEGY RESILIENCE

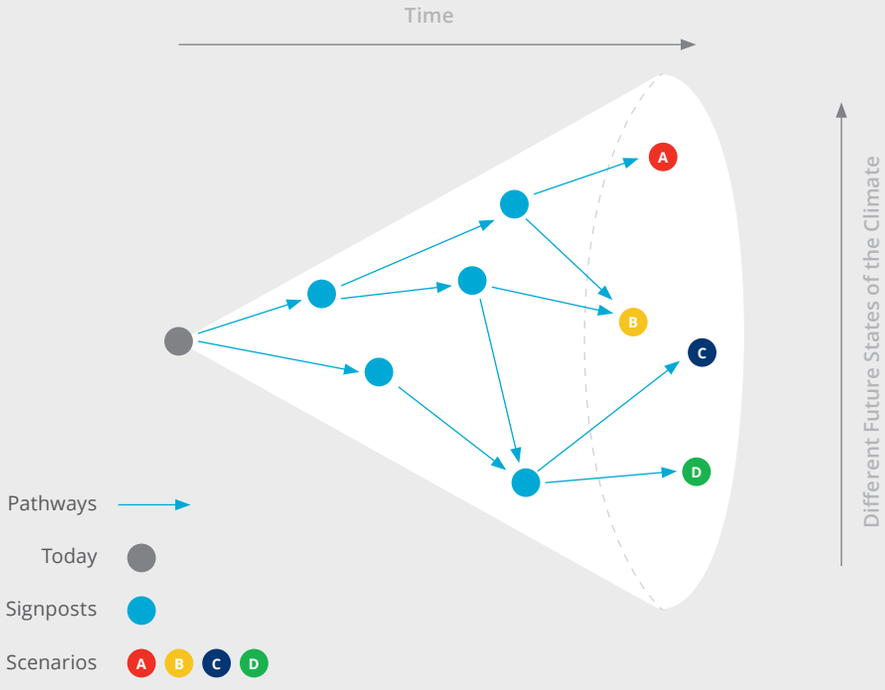
Managing strategy resilience involves the ongoing monitoring, adaptation, and transformation actions to influence the three characteristics of resilience: resistance, recovery, and robustness.[83]

Managing for resilient strategies requires adaptive probing — a continual exploration of alternative strategies, even if the current strategies seem to be working fine. This means periodic refreshment of a company's scenario analysis, regular monitoring of the key indicators and signposts of the external environment, and adjustments when necessary. Monitoring of the external environment starts with the key forces and drivers, and uncertainties, identified in a company's scenarios. A company should develop appropriate indicators and measures, or thresholds (signposts), to monitor the development of key forces and uncertainties over time and track whether they are evolving in a consistent or inconsistent manner with scenario assumptions.

One type of metric — signpost metrics — is particularly important in scenario analysis. Signposts help to monitor what scenario the world might be moving toward, as well as strategic options that might be increasing in value.[84] Signpost metrics are indicators of which key drivers and scenario development pathways remain consistent with assumptions or are deviating toward a different outcome (Figure D3).

Figure D3

Scenario Signposts



[82] For more information on fitting the pieces together, see Maier, Guillaume and van Delden, *An uncertain future, deep uncertainty, scenarios, robustness and adaptation: How do they fit together?*, 2016.

[83] See Helfgott, *Operationalizing systemic resilience*, 2018; Grafton et, al., *Realizing resilience for decision-making*, 2019; and Rowe, Wright and Derbyshire, *Enhancing horizon scanning by utilizing pre-developed scenarios: Analysis of current practice and specification of a process improvement to aid the identification of important 'weak signals'*, 2017.

[84] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

Signposts may involve such things as important trends, events, or dynamics (drivers) that determine scenario pathways, or junctures in pathways where uncertainties may indicate a critical threshold around the pathway direction. Examples of signposts used by companies include the following:[85]

- introduction of carbon prices in a certain jurisdiction and trends in carbon prices;
- changes in energy subsidies — fossil fuels versus renewables;
- costs of renewable energy sources (e.g., wind, solar, biofuels);
- trends in energy efficiency/intensity in major sectors;
- carbon capture developments (e.g., carbon dioxide removal, carbon capture and storage, deforestation, reforestation);
- development, costs, take up of certain technologies (e.g., battery technologies, electric vehicles);
- frequency and intensity of storms, droughts, and floods and locations; and
- climate policy developments (e.g., multilateral, national, sectoral).

A company should ensure that there is sufficient, easily available, cost-effective information for the signpost; that the information is reliable and trustworthy; and that signposts are reviewed regularly.

Further Reading

"Strategic thinking versus strategic planning: towards understanding the complementarities," Fiona Graetz, Management Decisions 40(5/6): 456–462, 2002.

Business strategies for climate change, Per-Anders Enkvist, Tomas Naucler, and Jeremy Oppenheim, McKinsey Quarterly, No. 2, 2008.

Business Responses to Climate Change: Identifying Emergent Strategies, Ans Kolk and Jonatan Pinkse, California Management Review, 47(3): 6–20, Spring 2005.

How Climate Resilient Is Your Company? Meeting A Rising Business Imperative, Marsh & McLennan Companies, Global Risk Center, 2017.

Resilience: The Concept, a Literature Review and Future Directions, Ran Bhamraa, Samir Daniab, and Kevin Burnarda, International Journal of Production Research, 49(18): 5375–5393, 2011.

Reporting Climate Resilience: The Challenges Ahead, Marsh & McLennan Companies, Global Risk Center and CDP, 2018.

[85] See also Figure A5 in TCFD, *Technical Supplement – The Use of Scenario Analysis in Disclosure of Climate-related Risks and Opportunities*, 2017.

E.
Disclosure: Demonstrating Strategy Resilience

E. Disclosure: Demonstrating Strategy Resilience

This section describes the importance of disclosure around strategy and scenarios, what should be disclosed, and challenges to disclosure.

Key Messages

- **Disclosure about a company's strategy and scenarios is an important demonstration of a company's attention to climate-related risks and opportunities.**
  - However, many companies do not disclose their strategy's resilience to climate-related risks and how a scenario process informed their strategy choices, or their disclosures have significant shortcomings.
- **A company should disclose, at a minimum, basic information regarding their scenario analysis, how it informed the company's strategy, and related financial implications. Among other things, investors want to understand:**
  - how a company assessed its potential climate-related future(s) and the insights it gleaned from scenario analysis;
  - what changes, if any, the company may be considering to its business model in response to its scenario analysis;
  - how resilient management believes the company's strategy is to various future climate states; and
  - where the uncertainties are regarding the company's strategy and its resilience to climate-related risks and opportunities.
- **Companies should approach disclosure of forward-looking information with the right mindset — instead of asking "What are we required to report?" companies should ask "What should we withhold?"**
  - Companies should be aware that materiality is not a static concept.
  - Companies are encouraged to disclose climate-related issues that could be *material in the future*.
  - Business confidentiality should not be used as an excuse for avoiding disclosure. Companies should err on the side of disclosure.
  - Companies are unlikely to face material legal risk in disclosing forward-looking climate-related information if they take necessary precautions to ensure that their disclosures are not materially misleading or inaccurate, including cautionary statements.
- **A company should ensure its strategy and scenario disclosures comply with sound corporate reporting principles and are subject to appropriate controls and quality checks, including oversight and review by boards, audit committees, and management.**

The central focus of the TCFD Strategy recommendation is on disclosure of "the actual and potential impacts of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning where such information is material." The recommendation goes on to say that as part of this disclosure, a company should "describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios."[86]

[86] TCFD, *Recommendations of the Task Force on Climate-related Financial Disclosures*, 2017.

Investors often view climate-related disclosure around strategy and scenarios as an important demonstration of a company's attention to climate-related risks and opportunities and the starting point for conversation and engagement with the company. Companies conducting scenario analysis need to provide investors (and other stakeholders) with sufficient information to understand the company's scenario process, assumptions, and outcomes, and how those scenarios have informed a company's resulting strategy with regard to climate-related risks and opportunities.

"Climate change will drive some of the most profound changes to businesses. Frequent and severe climate-related events are already causing major impacts on products and services, supply chains, loss of asset values, and market dislocation. These effects are now compounded by policy and regulatory change and investor demands. Companies are facing increasing pressure from investors to disclose more meaningful information related to climate change risks."

– Deloitte (2020) "Clarity in financial reporting: Disclosure of climate-related risks"

Unfortunately, many companies do not disclose information about their strategy resilience and scenario process or have significant shortcomings in their disclosures.[87] Among the observed shortcomings are:

- **Lack of clarity** around the type of information investors consider important.
- **Lack of information on key scenario drivers, assumptions, and pathways.**
- **Lack of quantitative information**, particularly around potential financial implications.
- **Lack of context.** Even when quantitative outputs are disclosed, presentations often lack important information needed to interpret the resulting analysis. This hampers clarity and makes it difficult, if not impossible, to interpret the analysis.
- **Telling half a story.** Many climate-related disclosures provide only half the story with regard to scenarios and strategy resilience: either an analysis of a company's climate risks (or opportunities) without disclosing a corresponding strategy to address those risks, or a description of the company's climate change strategy without any disclosure of the scenarios used to inform the strategy. Disclosures also often fail to discuss potential impacts specific to the company — what changes, if any, the company may be considering to its business model in response to its scenario analysis; how resilient management believes the company's strategy is under various future climate states; the uncertainties regarding the company's strategy and its resilience; and how the company is monitoring emerging climate-related issues.

In addition, scenario and strategy disclosures are hampered by the concerns of companies around materiality, confidential business information, and legal liability associated with forward-looking information. These concerns are not unique to climate-related issues and will be discussed later in this section.

1. WHAT INFORMATION DO INVESTORS AND OTHER STAKEHOLDERS DESIRE?

Investors want to understand how a company is positioning itself strategically in light of its climate-related risks and opportunities. They frequently indicate that climate-related risks and opportunities have a significant impact on their investment decisions.[88]

Investors often see climate-related disclosure around strategy as important. One study, in a survey of 439 institutional investors with a likely high awareness of climate risk, found "51% of respondents believe that climate risk reporting is as important as traditional financial reporting, and almost one-third considers it to be more important. Only 22% of respondents regarded climate reporting as less (or much less) important compared to financial reporting."[89] The study

[87] See European Financial Reporting Advisory Group, *How to improve climate-related reporting: A summary of good practices from Europe and beyond*, 2020; Goldstein, Turner and Gladstone, *The private sector's climate change risk and adaptation blind spots*, 2019; Massachusetts Institute of Technology (MIT), *Climate-Related Financial Disclosures: Use of Scenarios*, 2019; and TCFD, *2019 Status Report*.

[88] Morrow Sodali, *Institutional Investor Survey*, 2020.

concluded that "climate disclosure is perceived as more important among those investors who also believe more strongly that climate risks matter, and among those who expect larger global temperature increases due to climate change."[90] In a 2019 TCFD survey, investors rated information on the resiliency of a company's strategy and how its strategy might be affected by or changed to address potential climate-related issues as very useful.[91]

Some investors believe that "current quantitative and qualitative disclosures on climate risks are uninformative and imprecise."[92] A lack of transparency and appropriate disclosure drives investor uncertainty, which, in turn, generally increases risk premia and depresses the valuation of financial assets.

What are investors looking for in company disclosures about scenarios and strategy? In short, investors are looking for information that gives them confidence that companies are on top of climate-related issues (Table E1).[93]

Other disclosure elements that investors indicated would be very useful are:[94]

- how climate-related issues affect products and services;
- how climate-related issues affect capital expenditures and capital allocation;
- a company's sensitivity to carbon pricing, if applicable;
- the scenarios used by a company to inform its strategy, and their associated time horizon(s); and
- a company's identified material climate-related risks and opportunities over the long and medium term.

Table E1

Information Investors Desire

Disclosure Category	Purpose
Governance – Board oversight of strategy and scenario process	• Indicate an awareness and understanding of climate-related issues; level of expertise on or available to the Board on climate issues; reporting relationships to the Board regarding scenario analysis
Risk Management	• Indicate the risks and uncertainties evaluated through scenario analysis; how the company believes these risks may develop over time based on scenario analysis; how the company plans to manage or address these risks
Strategy – Scenario analysis process	• Describe processes used for scenario analysis; the range and assumptions of scenarios used; key findings; whether it is a standalone analysis or integrated with company's risk management and strategy processes
Strategy – Strategy resilience	• Indicate awareness and planning for the potential physical climate and transitional changes indicated by scenario analysis; indicate adjustments made to strategy in light of scenario analysis • Indicate whether financial plans are aligned with strategic plans related to climate risks and opportunities (e.g., capital expenditures, investments, R&D, etc.)
Targets and Metrics	• Indicate whether useful metrics have been identified related to strategy, strategy resilience, and scenario signposting; how these metrics are connected to the organization's strategy and scenario analysis; and how they are being used

[89] Ilhan, Krueger and Saunter, *Institutional Investors' Views and Preferences on Climate Risk Disclosure*, 2020.

[90] Ibid.

[91] See Table A5-5 in Appendix 5 in the *2020 TCFD Status Report*.

[92] Ilhan, Krueger and Saunter, *Institutional Investors' Views and Preferences on Climate Risk Disclosure*, 2020.

[93] Drawn from input provided by PRI investor signatories, including those on the Climate Action 100+.

[94] TCFD, *2019 Status Report*.

While investors are not a homogenous group, they are increasingly looking to standardize their climate-related disclosure requests of companies. A leading example of this is the Climate Action 100+, a group of 450 investors with $40 trillion in assets and an engagement program with 160 of the world's most carbon-intensive companies. This investor group is working to develop a benchmarking framework to compare sector peers and assess companies' progress against a standard set of key performance indicators. Other investors also are increasingly using other benchmarking tools provided by the Transition Pathway Initiative, Influence Maps, CDP, 2° Investing Initiative, and Carbon Tracker.

2. WHAT INFORMATION SHOULD BE DISCLOSED AROUND STRATEGY AND SCENARIOS?

To demonstrate a company's strategy resilience to climate-related risks and its ability to capture climate-related opportunities, a company should disclose publicly, at a minimum, some basic information regarding scenarios, how they impacted the company's strategic planning, and related financial implications.

2.1 Disclosure Around Strategy

The 2017 TCFD recommendation on strategy, in part, indicated that companies should "describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario."[95] **Among the information a company might disclose around the climate-related aspects of its strategy, it might discuss:**

- The company's strategy with regard to climate-related risks and opportunities and related targets (e.g., key performance indicators, key risk indicators), especially with regard to emissions, technology mix over time, and product mix over time.
- What effects have climate-related scenarios used by the company had on the company's strategy, including financial implications?
- What strategic alternatives/options were considered and chosen based on its scenario analysis?
- What general strategic positioning and specific actions are planned as a result of each option?
- What are the financial implications of those choices, including use of internal carbon prices?
- What changes, if any, the company may be considering to its business model in response to its scenario analysis.
- How resilient does management believe the company's strategy is under various future climate states?[96] For instance, how will the company's strategy:
  - enable the company to survive and flourish in any of the multiple, plausible future environments and
  - position the company to develop its business(es) in the right areas, considering its business model and the range of climate-related outcomes it may encounter?
  - overall, is the company well prepared to face the uncertainties of the future as portrayed in the complete set of scenarios?
- Where are the uncertainties regarding the company's strategy?
- How the company is monitoring its strategy for emerging climate-related issues (e.g., signposts, revisiting strategy, contingency plans).
- How flexible/adaptable does management consider its chosen strategy in light of the full range of relevant climate-related risks, opportunities, and uncertainties considered in its scenario analysis?

[95] TCFD, *Recommendations of the Task Force on Climate-related Financial Disclosures*, 2017.

[96] Strategy resilience refers to the way in which a company's strategy supports and maintains its operations under different climate scenarios in terms of a company's capacity to survive, adapt, and grow in the face of turbulent change. Fiksel, *Sustainability and Resilience: Toward a Systems Approach*, 2006. See also Grafton et, al., *Realizing resilience for decision-making*, 2019; Marsh & McLennan, *How Climate Resilient is Your Company?*, 2017; CDP, *Reporting Climate Resilience: The Challenges Ahead*, 2018; and Bhamra, Dani and Burnard, *Resilience: the concept, a literature review and future directions*, 2011.

2.2 Disclosure Around Scenarios

Investors want to understand how a company assessed its potential future(s) and the insights it gleaned from scenario analysis. Companies should consider disclosing:[97]

- a brief description of each scenario narrative, time horizon, and endpoints used by the company with a discussion of why the company believes the range of scenarios used covers its plausible risks and uncertainties;
- whether a company's scenarios were developed internally or externally and the methodology used;
- the key forces and drivers taken into consideration in each scenario and why they are important/relevant to the company;
- key inputs and constraints of the scenarios;
- a description of the various pathways in each scenario and the key assumptions underlying pathway development over time in response to the forces and drivers; and
- implications of scenarios for the company's strategy, if at all (e.g., how the scenario translates to changes in the company's markets, such as demand shifts), and operational changes that may be required in that scenario (e.g., changes to energy sources, technology deployment, feedstocks or raw materials, recycling, waste handling).

A company may also wish to describe the governance process it used to oversee and manage the scenario process, including the role of the board and senior management, engagement of internal and external stakeholders, and use of external experts.

Efforts at comparability should aim to increasingly harmonize the transparency around companies' scenario processes and the disclosure of results. Some investors are asking for greater comparability in disclosures about scenarios. Unfortunately, scenario analysis at some level inherently must take account of companies' different circumstances, geographic locations, business models, and value chains. Companies need to tailor scenarios to their particular risks and circumstances. At this time, a company's focus on comparability should be on improving disclosures in order to provide investors and other stakeholders with sufficient information to understand a company's scenario process, assumptions, and outcomes.

2.3 Disclosure of Financial Implications

The TCFD Strategy recommendation calls for "disclosure of the actual and potential impacts of climate-related risks and opportunities on the organization's business, strategy, and *financial planning* where such information is material [emphasis added]."[98] Better disclosure of the financial impacts of climate-related risks and opportunities is a key goal of the TCFD.[99] Disclosure of financial implications should be approached from two perspectives — the potential financial implications of the various scenarios and the financial implications of the company's strategy and related plans.

2.3.1 Sources of Climate-Related Financial Implications

Climate-related risks and opportunities often translate into financial risk or impacts, both at a macro- and microeconomic level. Figure E1 (p. 48) illustrates climate-risk-to-financial-risk transmission channels.

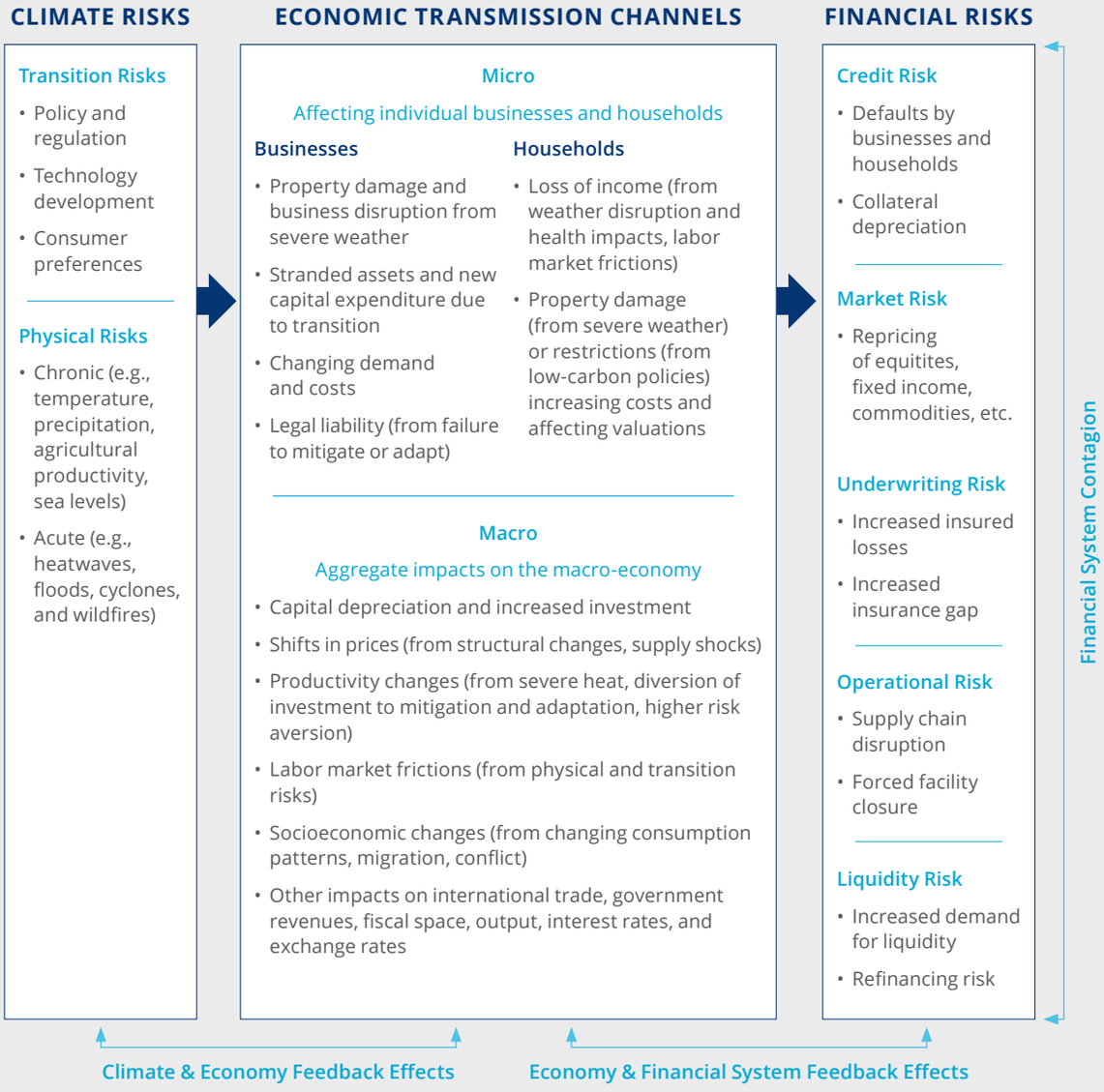
[97] See also Figure 3 in the TCFD, *Technical Supplement – The Use of Scenario Analysis in Disclosure of Climate-related Risks and Opportunities*, 2017.

[98] TCFD, *Recommendations of the Task Force on Climate-related Financial Disclosures*, 2017.

[99] Financial implications arising from climate change stem from (1) financial effects *on* the company from climate-related physical or transition impacts (either direct or indirect impacts) and (2) financial effects due to decisions *by* the company in response to climate-related risks and opportunities.

Figure E1

Climate-Related Financial Risk Transmission Channels



Source: Network for Greening the Financial System (NGFS)

Scenarios can help inform a company about these financial implications directionally, but only after formulating its strategy will a company be in a position to disclose more precise financial implications. Figure E2 shows how a company might think about disclosure of various financial implications and Table E2 (p. 50) provides some considerations around financial reporting concerning climate risks. For example, the financial effects of a company's strategy in a longer time horizon might be characterized in terms of broad financial pathways or broad directional shifts in capital expenditures; as the strategy is implemented over time, capital budgets, project plans, and operational plans provide progressively more concrete estimates of financial effects.

2.3.2 Financial Implications of Scenarios

Translating forward-looking scenarios into meaningful financial implications is difficult, but not impossible.[100] One difficulty is that scenarios do not develop precise financial implications; they are hypothetical futures that only provide relative and directional indications (good/bad, up/down) and orders of magnitude (a lot/a little).

For disclosures about the possible financial implications of scenarios, a company might consider disclosing qualitatively, and quantitatively where feasible, how a particular scenario might affect the potential orders of magnitude, ranges, or relative directional shifts in terms of the company's assets; capital investments; earnings before interest, taxes, depreciation, and amortization; and revenue potential.

Reverse stress test scenarios may be useful for assessing the outer limits of financial impacts. Reverse stress tests are scenarios that a firm uses to assess and identify potential circumstances that would make its business model unviable.

Sensitivity analysis around variations in carbon prices (internal or external), or variations in input prices (e.g., commodities, water, etc.), is another method for companies to explore the financial implications of various scenarios.

Figure E2

Determining Financial Implications by Time Horizon

[100] Rogelj, McCollum and Reisinger, *Probabilistic cost estimates for climate change mitigation*, 2013.

Table E2

Financial Reporting Considerations of Climate-Related Risks[101]

Impact on Financial Reporting	Thinking It Through
Asset Impairment	Climate-related risks could be an indicator of impairment for an entity's asset/group of assets. Entities must consider the impact of these risks on impairment calculations, for example, on forecasts of future cash flows, and any relevant disclosure requirements, where this impact is significant.
Changes in the Useful Life of Assets	Climate-related risks could reduce the expected useful lives of an entity's assets or create stranded assets. This would affect the depreciation/amortization expense recognized every year.
Changes in the Fair Valuation of Assets	The measurement of fair values of assets could be impacted by climate-related risks and this should be factored into the fair value calculations. This could, for example, impact the discount rate used or the forecast of future cash flows. Entities impacted by these risks should disclose the assumptions around including these in the fair value calculations.
Recognition of Provisions and Contingent Liabilities	Climate-related risks could lead to recognition of additional provisions and contingent liabilities, as outlined below: • provision for onerous contracts driven by potential loss of revenues/increased costs; • provision for decommissioning a plant or rehabilitating environmental damage in extractive industries as a result of shortened project lives or regulatory changes; and • contingent liabilities related to potential litigation and fines/penalties due to stricter regulations.
Changes in Expected Credit Losses for Loans and Other Financial Assets	Use of forward-looking information to recognize expected credit losses. The impact of climate-related risks on the borrower must be considered when determining whether credit risk of the financial assets has increased significantly since initial recognition.
Disclosure of Climate-Related Risks	Information related to climate-related risks will be relevant to the understanding of the financial statements, if investors could reasonably expect that these risks have a significant impact on the entity and this would influence their decisions. Relevant disclosure requirements may require disclosure of such information in the notes to the financial statements.

2.3.3 Financial Implications of a Company's Strategy and Related Plans[102]

For a formulated strategy and supporting plans, a company should be able to provide a better sense of its financial pathway and direction in terms of capital investments, asset impairment, operating costs, change in revenue mix, and other major financial factors. While this type of information is less precise at a longer-term strategy level than a shorter-term financial plan, it can nevertheless have significant value if it provides insight into where the company's strategy might end up on a scale from "minimal financial impact" to "major financial impact" and why.

[101] Also see KPMG, *Climate Disclosures within the Annual Report: An Australian Focus*, 2020, pp. 24–33 for examples of financial statement considerations for climate-related risks.

[102] Ibid.

Disclosure does not end at the strategy level. As climate-related investments, projects, and initiatives in the strategy are implemented via concrete capital, project, operations, and financial plans, a company should disclose more concrete quantitative financial implications, such as those in Table E2 (p. 50).[103]

For any given reporting cycle, therefore, a company should consider disclosing the financial implications of climate-related risks and opportunities across the complete planning horizon from near-term project, operating, and financial plans to longer-term strategy and scenarios. In other words, it should consider providing investors with information, as of the reporting date, on the financial implications of climate-related risks and opportunities in the current year and at various forward-looking intervals out to the scenario time horizon.

Finally, the information around financial implications desired by investors will likely vary. Companies should engage their investors to understand investors' expectations to help improve their disclosure. Further, industry consultation focusing on the financial implications of climate-related risks and opportunities and supporting methodologies also will help in facilitating disclosure improvements.

3. OTHER DISCLOSURE CONSIDERATIONS

Other considerations around strategy-and-scenario-related disclosure include: where to disclose, quality of disclosures, confidential business information, and liability around forward-looking information. Many of these concerns are not unique to climate-related disclosures.

3.1 Consideration 1: The Right Mindset

Companies need to approach the disclosure of forward-looking information with the right mindset. Instead of adopting a compliance-based approach and asking "What are we required to report?" companies should ask themselves "What should we withhold?"[104] This is particularly true in the case of climate-related disclosures.

3.2 Consideration 2: Where to Disclose

In the case of disclosures around strategy and forward-looking scenarios, companies should disclose material information in those portions of their annual report or integrated report dealing with strategy, management discussion and analysis of the company, and risks.[105] Material financial implications related to company's strategy should be disclosed in the appropriate financial statements or notes to the financial statements.[106, 107]

To the extent that additional detail and discussion of scenarios and strategy is warranted, which may not rise to the level of the annual report, companies should consider disclosing additional detail in other public reports, such as sustainability and non-financial reports, with appropriate cross-references in their annual reports and financial filings to alert investors to such information.

3.3 Consideration 3: Materiality

The cornerstone of most disclosure standards is a determination of materiality. In its 2017 report, the TCFD did not define materiality but rather deferred to existing reporting standards and legal requirements, stating that "organizations should determine materiality for climate-related issues consistent with how they determine the materiality of other information included in their annual financial filings."[108]

[103] Australian Accounting Standards Board/International Accounting Standards Board, *Climate-related and other emerging risks disclosures: Assessing financial statement materiality using AASB/IASB Practice Statement 2*, 2019; True Price, *The Business Case for True Pricing: why you will benefit from measuring, monetizing and improving your impact*, 2014.

[104] PricewaterhouseCoopers (PwC), *Guide to Forward-Looking Information*, 2007.

[105] See KPMG, *Climate Disclosures within the Annual Report: An Australian Focus*, 2020, p. 15 for disclosures of climate-related risks in annual reports and financial statements.

[106] The TCFD recommendations call for companies to disclose the material implications of climate change, including material strategy and financial implications, in annual financial filings. The TCFD also recognized that the structure and content of financial filings differs across jurisdictions and, therefore, believes companies are in the best position to determine where and how the TCFD disclosures should be incorporated in financial filings.

[107] If investors could reasonably expect that climate-related risks will have a significant impact on an entity, would influence their decisions, and would be relevant to their understanding of the entity's financial statements, relevant information may require disclosure in the notes to the financial statements. Deloitte, *Clarity in financial reporting: Disclosure of climate-related risks*, 2020.

[108] Certain organizations — those in the four non-financial groups listed in the TCFD recommendation — that have more than one billion U.S. dollar equivalent in annual revenue — should consider disclosing such information even when the information is not deemed material and not included in financial filings. TCFD, *Recommendations of the Task Force on Climate-related Financial Disclosures*, 2017, p. 17, footnote 37.

To help investors understand the context in which materiality determinations are made, companies could consider whether the following disclosure is helpful:

- **Reporting the basis of their materiality assessment of climate-related risks**, including the materiality threshold applied and over what period of time, to allow investors and other stakeholders to understand a company's approach in determining materiality and non-materiality.[109]
- **Disclosing whether climate-related risks could be material in the future.**[110] In such cases, a company might disclose climate-related information outside financial filings to facilitate the incorporation of such information into financial filings once climate-related issues are determined to be material.
- **Companies should be cognizant that materiality is not a static concept.** It is evolving over time in terms of what primary users view as material to their decisions; who beyond primary users might be an audience for the disclosure; and what type of information is desired.[111]

"Increasingly consistent evidence is amassing to conclude that investors and asset managers deem climate risk information as substantially significant in the decision to buy or sell securities."

– Griffin & Jaffe, 2018.

3.4 Consideration 4: Business Confidentiality

In a 2019 TCFD survey, 46% of 180 preparers said that disclosing scenario analysis assumptions is difficult because they include confidential business information.[112]

In considering whether particular aspects of a company's intended disclosure around strategy and scenarios constitutes confidential business information, a company should ask and challenge itself with the following:[113]

- Does the information bring any economic benefit to my business that translates into *competitive advantage* because it is kept confidential?
- Would making such information public cause the company to incur an economic loss? If not protected, could competitors use this information without having to bear the costs or risks? Would the company lose its competitiveness built on this information?

A company should not default to business confidentiality as a reason for avoiding disclosure. In determining where to draw the line, companies, as a matter of principle, should err on the side of disclosure.[114] Unlike information that a company may use to differentiate itself in the marketplace, climate-related risks affect the economy and companies systemically. How a particular company anticipates managing its climate-related risks may not be a source of material competitive advantage, especially in light of the cooperative and interdependent efforts needed to address such risks (climate-related opportunities may be another matter).

[109] Eccles and Krzus, *Implementing the Task Force on Climate-related Financial Disclosures Recommendations: An Assessment of Corporate Readiness*, 2019.

[110] TCFD, *Recommendations of the Task Force on Climate-related Financial Disclosures*, 2017, p. 17, footnote 36.

[111] See KPMG, *Climate Disclosures within the Annual Report: An Australian Focus*, 2020, p. 13, and International Financial Reporting Standards, *Climate-related and other emerging risks disclosures: Assessing financial statement materiality*, 2018, for considerations of materiality of climate-related risks; see Wilcox, *Corporate Reporting*, 2019, and Wasim, *Corporate (Non) Disclosure of Climate Change Information*, 2019, for some of the factors that are shaping and will continue to shape corporate reporting.

[112] TCFD, *2019 Status Report*, 2019.

[113] EU IPR Helpdesk, Confidentiality, European Intellectual Property Rights Helpdesk, 2015. Confidential business information has three characteristics — it has commercial value, it is not in the public domain, and it is reasonably protected and communicated to others in confidence.

[114] For example, pharmaceutical companies disclose details of their products — in terms of pipeline, stage of development, planned launch, and potential market size — without prejudicing their competitive position. Specific information on the underlying patent formulations is withheld. PwC, *Guide to Forward-Looking Information*, 2007.

3.5 Consideration 5: Liability and Other Legal Concerns Around Forward-Looking Statements

Scenario analysis and resulting strategy are by nature forward-looking information. Companies have expressed concern that disclosures could be misinterpreted or relied upon by investors, resulting in either legal liability or financial rating implications. Most laws, however, provide for "safe harbor" provisions for forward-looking information when "accompanied by meaningful cautionary statements identifying important factors that could cause actual results to differ materially from those in the forward-looking statement."[115]

- **Companies that take necessary precautions to ensure that their disclosures are not materially misleading or inaccurate, including cautionary statements, are unlikely to face significant legal risk.** "While legal risk is often cited in voluntary reporting, in fact there is little to no evidence that it exists if the disclosures are accurate and not misleading."[116] Similarly, "companies that make accurate disclosures and take advantage of the protections available under existing statutory and common law safe harbors are unlikely to face significant litigation risks from scenario analysis disclosures."[117]

- **Companies also can reduce their legal risks from disclosure of forward-looking information by a number of other actions.** For example, by actively complying with fiduciary requirements; keeping the board and management informed about climate-related risks and response options; consistently applying asset valuation policies; subjecting climate change and sustainability reports to a rigorous verification process to avoid material misstatements or omissions; making clear cautionary statements; and understanding the perspective of investors and other stakeholders.[118]

3.6 Consideration 6: Quality of Disclosed Information

A company should assess whether its strategy and scenario disclosures comply with sound corporate reporting principles and are subject to appropriate controls and quality checks, including oversight and review by boards, audit committees, and management. Principle 6 of the TCFD's Fundamental Principles for Effective Disclosure states that disclosures should be reliable, verifiable, and objective. Disclosures should be subject to internal governance processes that are the same or substantially similar to those used for financial reporting.[119]

Further Reading

Climate Change Risks: An Update on Current Litigation Trends (2019), Alert Memorandum, Cleary Gottlieb.

Identifying Natural Capital Risk and Materiality (2013), Association of Chartered Certified Accountants, Flora & Fauna International, and KPMG LLP.

Corporate (Non) Disclosure of Climate Change Information (2019), Wasim, Col. Law Rev, 119: 1311–1354.

Climate-related and other emerging risks disclosures: Assessing financial statement materiality (2019) International Financial Reporting Standards (IFRS).

[115] Wasim, *Corporate (Non) Disclosure of Climate Change Information*, 2019. In the United States, for example, the Private Securities Litigation Reform Act of 1995 shields companies from liability for certain written and oral forward-looking statements. See also BP's cautionary statement as an example.

[116] Eccles and Krzus, *Implementing the Task Force on Climate-related Financial Disclosures Recommendations: An Assessment of Corporate Readiness*, 2019.

[117] Anders, Silk and Lipton, *ESG Disclosures and Litigation Concerns*, 2020.

[118] Cleary Gottlieb, *Climate Change Risks: An Update on Current Litigation Trends*, 2019; Lydenberg, *On materiality and sustainability: The value of disclosure in the capital markets*, 2012.

[119] TCFD, *Recommendations of the Task Force on Climate-related Financial Disclosures*, 2017.

Conclusion

Conclusion

Climate change generates risks and opportunities. Many of these will be material for a wide variety of companies across many sectors, either today or in the near future.

Companies need to develop resilient strategies to address these climate-related risks and opportunities. This requires companies to embrace forward-looking planning tools, undertake adaptive strategic postures, and set aggressive targets. Climate-resilient strategies also demonstrate a company's ability to integrate governance, risk management, and strategy processes in a meaningful way to address climate change.

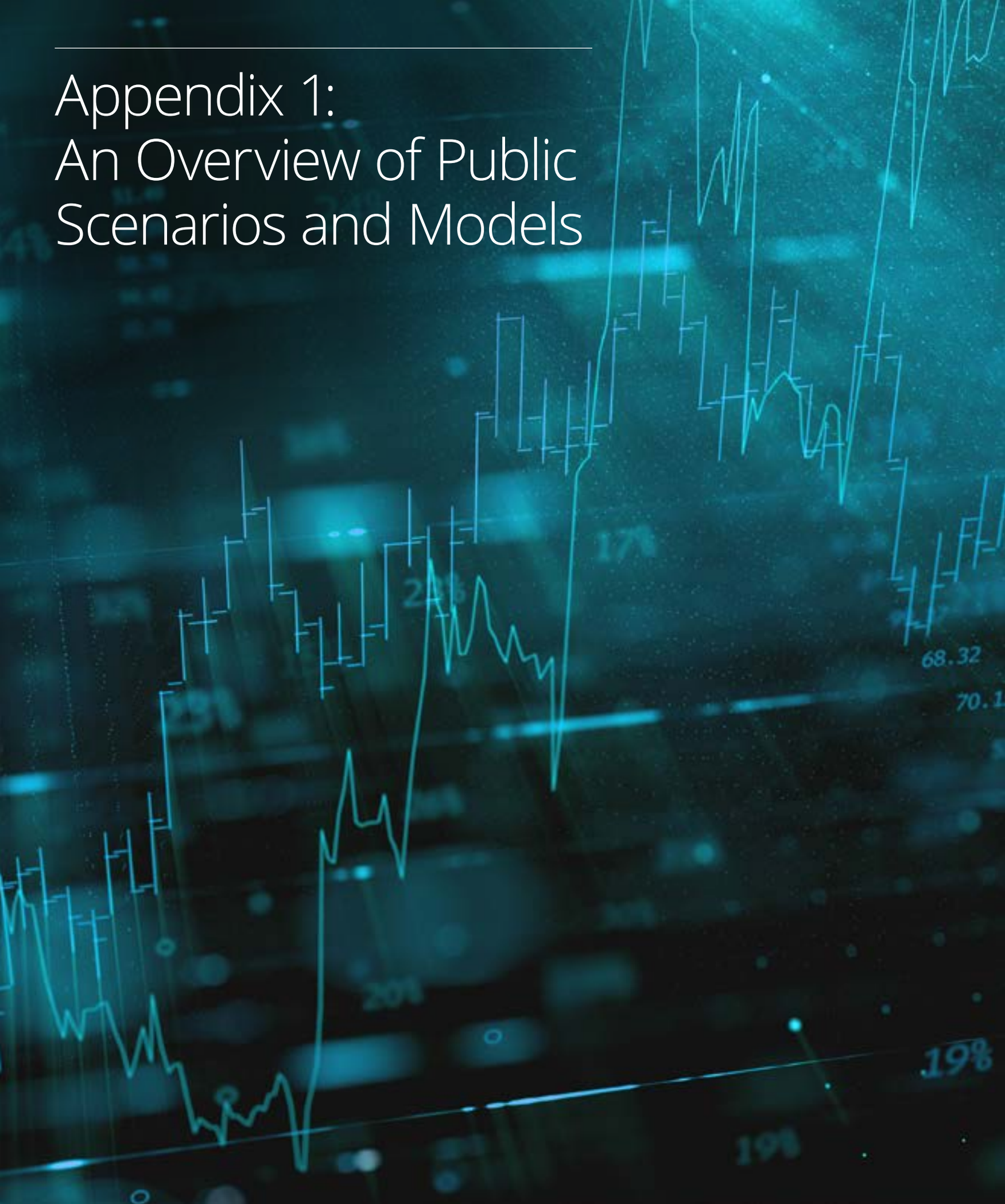
Scenario analysis is an effective tool for developing more resilient strategies. By identifying the key uncertainties, drivers, and potential consequences of a range of plausible climate futures, scenario analysis helps a company to improve its resilience to, and disclose more useful information about, the potential impacts of its climate-related risks and opportunities. In particular, scenarios help executives look at a number of plausible possibilities, prepare for contingencies, develop flexible strategies, and implement more speedy responses to emerging risks and opportunities.

This guidance provides a framework for getting started. It guides companies through the elements, considerations, challenges, limitations, pitfalls, and questions they may face in undertaking climate-related scenario analysis. It should be applied with judgment and adaptation to a company's specific circumstances.

Conducting scenario analysis and applying it to strategic and financial planning is challenging, but is readily doable. A company's commitment to scenario analysis brings with it a number of benefits — enhancing internal strategic thinking and planning capabilities, acquiring new perspectives and insights, increasing understanding of the predictable and uncertain elements in different futures, and changing the mental models of decision-makers in a manner that avoids both groupthink and fragmentation. A more climate-resilient and value-added company strategy is the result.

Companies should not delay getting started. Scenario analysis is a key tool in building climate-resilient strategies, but it requires effort and an iterative learning process. At the outset, neither perfection nor "big bang" results are expected, but rapid progress toward a mature process should occur and be achievable in a few planning cycles. However, it will not occur unless a company starts.

Appendix 1: An Overview of Public Scenarios and Models



Appendix 1: An Overview of Public Scenarios and Models

This appendix provides information about the types of scenarios and models that are used by the climate policy and research community. It provides a deeper understanding of these climate scenarios and models to help companies make better, more informed decisions on using these scenarios. For companies seeking to use these scenarios, it is important to understand whether — and, if so how — the scenarios and models can be adapted to a company's needs.

As an initial step to implement scenario analysis, many companies choose to use publicly available scenarios (also referred to as public scenarios) such as those developed by the Intergovernmental Panel on Climate Change (IPCC) and the International Energy Agency (IEA). Publicly available scenarios are typically designed for research and policy purposes and may not immediately be "fit for purpose" for a company's scenario analysis. This appendix discusses (1) the types of publicly available scenarios and models available, (2) how companies are using them, and (3) key considerations for using such scenarios and models.

1. TYPES OF PUBLIC SCENARIOS AND MODELS

1.1 Types of Scenarios[120]

The climate research community has formulated a number of different scenarios to investigate climate change and its attendant risks, including the following:

- **Climate scenarios** are plausible representations of future climate conditions (temperature, precipitation, and other aspects of climate) based on assumptions about radiative forcing driven by greenhouse gas concentrations as well as other atmospheric conditions and emissions.[121]
- **Emissions scenarios** describe future plausible pathways of greenhouse gases, aerosols, and other pollutants. These pathways are based on assumptions about driving forces such as patterns of economic and population growth, energy use, land use, and technology.
- **Vulnerability scenarios** describe potential vulnerabilities and impacts from climate change. Vulnerability scenarios depend on a wide variety of demographic, economic, policy, cultural, and institutional characteristics to evaluate the potential impact of climate changes, as well as examining how future patterns of economic growth and social change affect vulnerability and the capacity to adapt.
- **Environmental scenarios** focus on changes in environmental conditions that may occur because or regardless of climate change. Such factors include water availability and quality, sea level rise, land cover and use, and conditions affecting air quality.
- **Socioeconomic scenarios** focus on the plausible development pathways of society and the economy under different assumptions about population, demographics, technology, policies, economic growth, and other such factors.

[120] IPCC, *Scenario Background*, 2019.

[121] Radiative forcing is the difference between sunlight absorbed by the Earth and energy radiated back to space (expressed in watts per square meter). Positive radiative forcing means Earth receives more incoming energy from sunlight than it radiates to space. This net gain of energy will cause warming. Conversely, negative radiative forcing means that Earth loses more energy to space than it receives from the sun, which produces cooling. A system in thermal equilibrium has zero radiative forcing. All Representative Concentration Pathway (RCP) scenarios are based on positive radiative forcings from 2.6 to 8.5 watts per square meter.

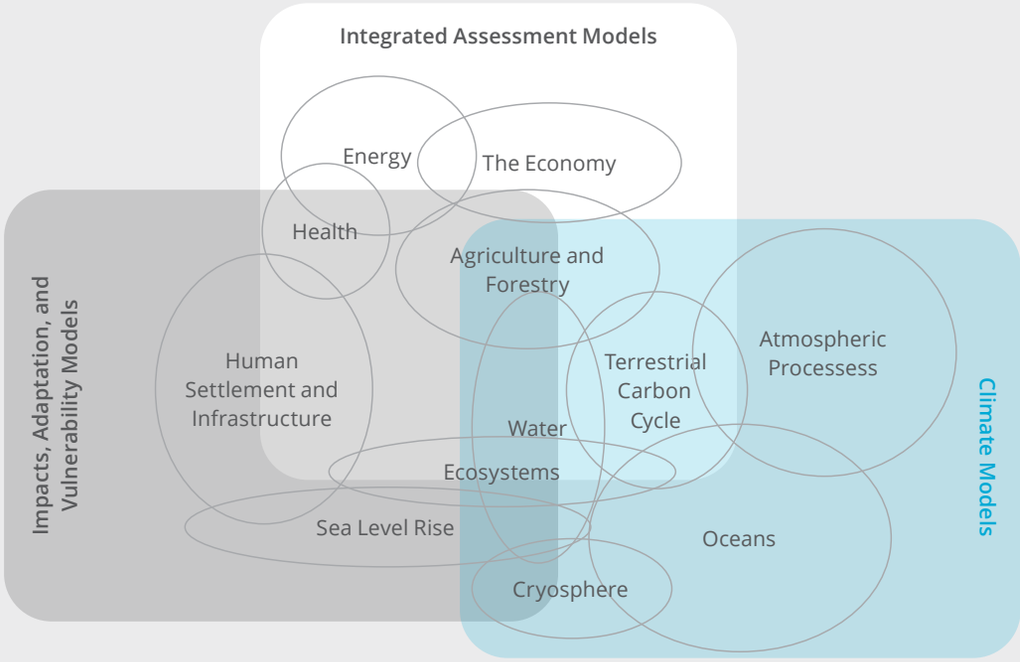
1.2 Types of Models

In the area of climate change, models are typically formal constructs — represented in mathematics and diagrams — that are used to understand more complex, real-world systems, such as the physical climate system. Climate models range in complexity and in their ability to explain climate-related phenomena and interactions.[122] Some of the major categories of models are listed below and in Figure A1-1 and representative model inputs and outputs are shown in Table A1-2 (p. 65) at the end of this appendix.

- **Physical climate models** help to understand changes in the physical climate based on different driving forces ("forcings") such as greenhouse gas concentrations. These models project physical climate changes such as the mean and distribution of temperatures, or where, when, and how much precipitation occurs (see Box A1-1, p. 59).
- **Impact, Adaptation, and Vulnerability (IAV) models** analyze the outputs of physical climate models to assess the potential impacts, vulnerabilities, and adaptation options for society. These models help decision-makers to understand or quantify exposures to either physical or transition climate risks.
- **Integrated Assessment Models (IAMs)** consider a number of economic, social, and technological factors. The term "integrated" refers to the fact that these models combine multiple specific sectoral models (energy, land use, etc.) to understand the socioeconomic drivers of emissions, feedbacks between economic growth and climate change, rate and direction of change toward a low-carbon future, and the role of different technologies, policies, and societal preferences.[123]

Figure A1-1

Relationship of Climate Models, IAMs, and IAV Models



Source: Moss, Edmonds, Hibbard, et al., 2010

[122] IPCC, *Special Report – A Global Warming of 1.5°C – Glossary*, 2018.

[123] Hamilton, ElSawah and Guillaume, *Integrated Assessment and modeling: Overview and synthesis of salient dimensions*, 2015.

- **Climate-Economic IAMs** are specialized IAMs focused on climate-economic interactions such as the following:[124]

  - Optimal growth (or welfare optimization) models represent the economy as a single all-encompassing sector. They are designed to determine the climate policy and investment levels that maximize welfare (future against present consumption) over time, by identifying the emission abatement levels for each time step.

  - General equilibrium models have a more detailed representation of the economy with multiple sectors and often include higher resolution of energy technologies and regional detail. Rather than seeking optimal policies, they consider the impacts of specific policies on economic, social, and environmental parameters. The richer representation of the economy comes at a cost of more complexity and modeling difficulties.

  - Partial equilibrium models provide a detailed analysis of the interaction between environmental impacts and a particular sector of the economy. These are usually used to assess potential climate-induced damages to a specific sector.

  - Energy system models can be considered as a sub-category of partial equilibrium models that provide a detailed account of the energy sector. These are used, among other reasons, to determine the least-cost ways of attaining greenhouse gas (GHG) emission reductions or the costs of alternative climate policies. They are often linked with general equilibrium or macro-econometric models in order to add insight to top-down approaches.

  - Macro-econometric models, like general equilibrium models, are used to evaluate alternative climate policies, but they differ in that they do not assume that consumers and producers behave optimally or that markets clear and reach equilibrium in the short term. Instead, they use historical data and econometrically estimated parameters and relations to dynamically and more realistically simulate the behavior of the economy.

Box A1-1
Things to Know About Physical Climate Models

- Climate models represent the physical processes in the atmosphere, ocean, land surface, and cryosphere.
- Climate models divide the globe into a three-dimensional grid of cells representing specific geographic locations and elevations and calculate the conditions (e.g., temperature, wind speed, humidity, pressure) of each gridded cell.
- Finer model resolution implies a larger number of grid cells and requires significant computing power.
- Climate models are generally available to the public through academic institutes or government bodies.
- Climate models vary in capability and complexity, and there is no single source of truth. Models differ regarding spatial resolutions (i.e., the size of the gridded cells); the representation of physical, chemical, or biological processes; the geographical focus of the model; and the model assumptions.
- Individually, climate models have strengths and weaknesses, so climate scientists use elements or combinations (ensembles) of models.
- Evolution in climate models is trending toward more complex models with interaction between physical, chemical, or biological factors.

Sources: IPCC, "Special Report – Global Warming of 1.5°C," 2018; Carbon Brief, *Climate Models*, 2018; Climate Change in Australia, *Climate Models*, 2016.

Models are typically used to quantify and project the various pathways resulting from scenarios. They use the drivers, constraints, and conceptual relationships described in a scenario to mathematically simulate the system in question and quantify the pathway(s) and outcomes of the scenario future. Models for physical risks, for instance, rely on climate science to project the physical climate changes being driven by emissions. Models of transition risks require a deeper understanding of socio-economic systems, their feedbacks, and potential responses to climate change, including potential changes in energy systems, policy changes, and technological changes.

[124] Nikas, Doukas and Papandreou, *A Detailed Overview and Consistent Classification of Climate-Economy Models in Understanding Risks and Uncertainties in Energy and Climate Policy*, 2019.

1.3 Some Models Need to Be Downscaled for Company-Level Use

Models produce outputs at different spatial scales. Typically, physical climate models operate at a global or regional scale.[125] In contrast, IAV models typically focus on regional and local scales. IAMs can work at both global and regional scales. See Box A1-2 on downscaling.

For companies using IPCC, IEA, or other model outputs, the scale is important. Often global scales do not produce the level of granularity or focus needed by companies with specific geographical footprints. To use IPCC or IEA outputs, companies typically need to translate the scenarios and model outputs to the appropriate regional or local scale.

Two initiatives to make regional climate model downscaling available are the World Climate Research Programme's Coordinated Regional Climate Downscaling Experiment (CORDEX) and the UK Met Office's PRECIS system. It is important to note that more granular resolutions do not necessarily mean better or more accurate outputs. Companies should consider whether the downscaling method used adds value to their analysis or provides a bias to their results.

Box A1-2
Downscaling

One of the challenges companies face in using the output of greenhouse gas (GHG) global climate models (GCMs) is scale or spatial resolution. GCMs typically produce gridded resolutions of between 75 and 300km in size, with the average around 200km. By way of comparison, the direct distance from London to Paris is 344km. This means using a 200km scale to infer uniform changes in climate may not be adequate to address a particular company's risk at smaller scales.

The process to translate climate data from the global resolution climate model outputs to a more regional or local resolution is known as downscaling. There are different ways to do this, with the two most common approaches known as statistical and dynamical downscaling.

Typical resolution for downscaling will depend on both the host model and regional climate model used. The standard downscaling protocol for Europe is 12km. Some agencies have provided regional downscaling to 2km, others between 12 and 50km.

Companies should be aware that results may be increasingly uncertain the finer the resolution of the model is as more factors and interactions are taken into consideration.

Sources: U.S. AID, *A review of downscaling methods for climate change projections*, U.S. Agency for International Development, Washington DC, 2014; UK Met Office, *Regional Climate Modeling*, 2019; CORDEX, "General Instructions for CORDEX integrations," 2009.

2. IPCC, IEA, AND OTHER PUBLIC SCENARIOS[126]

2.1 IPCC Scenarios

International climate researchers contributing to the IPCC assessments have developed hundreds of different emissions and socioeconomic scenarios at global, national, and other scales.[127] In recent years, researchers have developed a new basis for the construction of comparable scenarios across research and modeling groups — Representative Concentration Pathways (RCPs) and Shared Socioeconomic Pathways (SSPs).[128]

RCPs are "emissions scenarios" that include time series of emissions and concentrations of the full suite of greenhouse gases, aerosols, and chemically active gases, as well as land use/land cover. The word "representative" signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term "pathway" emphasizes the fact that not only the long-term concentration levels but also the trajectory taken over time to reach that outcome is of interest.

RCPs are used to develop climate projections by informing physical climate system models; these models, in turn, project how the physical climate may change under different levels of radiative forcing driven by greenhouse gas concentrations.

[125] A regional climate model is a smaller-scale version of a global model that simulates the climate at a local scale using more detailed regional topography and land-use characteristics (UK Met Office, *Regional Climate Modeling*, 2019).

[126] Additional information on these scenarios can be found in Box A-1, Box A-2, and Figure A4 in TCFD, *Technical Supplement – The Use of Scenario Analysis in Disclosure of Climate-related Risks and Opportunities*, 2017. Also see Table A1-3 (p. 66) of this appendix for benefits and limitations of these scenarios.

[127] IPCC, *IPCC Special Report on Emissions Scenarios*, 2000; Girod, Wieka and Mieg, *The evolution of the IPCC's emissions scenarios*, 2009.

[128] Moss, Edmonds and Hibbard, *The next generation of scenarios for climate change research and assessment*, 2010; Wayne, *The Beginner's Guide to Representative Concentration Pathways*, 2013; van Vuuren, Edmonds and Kainuma, *The representative concentration pathways: an overview*, 2011; O'Neill, Krieger, et al., *The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century*, 2017.

Table A1-1 shows the basic characteristics of the four RCP scenarios.[129]

In addition to the RCPs, researchers also use a common set of scenarios to explore diverging directions of socioeconomic development, known as Shared Socioeconomic Pathways. SSPs were developed to complement the RCPs with varying socioeconomic challenges to adaptation and mitigation.[130] The combination of SSP-based "socioeconomic scenarios" and RCP-based climate projections provides an integrative framework for climate impact and policy analysis.

The SSPs describe five alternative socio-economic futures over the course of the 21st century assuming no explicit policies to mitigate or adapt to climate change, as follows:[131]

- sustainable development (SSP1);
- middle-of-the-road development (SSP2);
- regional rivalry (SSP3);
- inequality (SSP4); and
- fossil–fueled development (SSP5).

The research community uses RCPs and SSPs as a common baseline to develop various climate, emission, environmental, and vulnerability scenarios and modeling for research and policy purposes. The qualitative and quantitative input characteristics of the SSPs (i.e., population, urbanization, and gross domestic product (GDP) serve as inputs to different IAMs developed by modeling groups to project plausible socio-economic development pathways on such outcomes as land use, energy use and mix, and the associated emissions trajectories.[132]

2.2 IEA Scenarios

In contrast to the IPCC approach, the IEA focuses on energy and emission scenarios. The IEA's World Energy Model runs three main scenarios describing the future energy mix:[133]

- **Current Policies Scenario (CPS).** The CPS would be considered by companies to reflect the "business as usual" (BAU) scenario, or reference scenario, in which the world continues on its current trajectory. The scenario takes into account policies that are in place at the preceding year of publication (i.e., mid-2019 for the 2019 World Energy Outlook), without any additional government policy intervention.

Table A1-1

Mean Temperature and Full Range Associated with Each RCP

Scenario	Atmospheric carbon dioxide concentrations in 2100	Temperature increase to 2081–2100 relative to a 1850–1900 baseline		Global mean sea level rise for 2081–2100 relative to a 1986–2005 baseline	
		Average	Likely range	Average	Likely range
RCP2.6	421ppm	1.6°C	0.9–2.3°C	0.40m	0.26–0.55m
RCP4.5	538ppm	2.4°C	1.7–3.2°C	0.47m	0.32–0.63m
RCP6.0	670ppm	2.8°C	2.0–3.7°C	0.48m	0.33–0.63m
RCP8.5	936ppm	4.3°C	3.2–5.4°C	0.63m	0.45–0.82m

Source: (IPCC, 2014)

[129] In 2018, the IPCC issued a fifth RCP scenario, RCP 1.9, that limits global warming to 1.5°C.

[130] O'Neill, Kriegler and Riahi, *A new scenario framework for climate change research: the concept of shared socioeconomic pathways*, 2014.

[131] O'Neill, Krieger, et al., *The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century*, 2017; O'Neill, Kriegler and Riahi, *A new scenario framework for climate change research: the concept of shared socioeconomic pathways*, 2014; Riahi, van Vuuren and Kriegler, *The Shared Socioeconomic Pathways and Their Energy, Land Use, and Greenhouse Gas Emissions Implications: An Overview*, 2017.

[132] A useful nontechnical primer can be found at the Senses website at www.climatescenarios.org.

[133] IEA, *World Energy Outlook*, 2019; IEA, *World Energy Model Documentation*, 2019.

- **Stated Policies Scenario (SPS).** This scenario, formerly known as "New Policies Scenario," is effectively the mid-case scenario of the IEA scenarios. This scenario is designed to explore all policies enacted in the preceding year, plus the policies that have been firmly communicated or committed to by national authorities. The SPS scenario assumes that there is a slow implementation of these policies, based on the IEA's assessment of the many political, institutional, and societal barriers that exist to a rapid transition.

- **Sustainable Development Scenario (SDS).** The SDS is the most ambitious of the three toward a low-carbon future. This scenario is based around a sustainable development narrative, assuming the world is successful in achieving Sustainable Development Goals by 2030. The SDS holds the temperature rise to below 1.8°C with a 66% probability without reliance on global net-negative CO_2 emissions.[134]

In addition, the IEA's Energy Technology Perspectives studies describe other scenarios.

IEA uses scenarios to explore, and models to look at changes in, emissions from energy sources. While these scenarios and models provide useful trajectories of future emissions, they do not directly model the resulting climate changes from those emission trajectories (e.g., temperature changes or other climate changes). Instead the scenarios look at the following:[135]

- explore the pathways in energy supply, demand, and mix by primary production and final energy consumption, across different sectors and geographies;

- explore the GHG emission pathways from these different energy futures;

- explore the effect of different policies that may expedite or limit energy demand, supply, trade, investments, and emissions; and

- explore investments needed for modeled future energy supply and demand; this includes infrastructure to support new energies and electric vehicles, for example.

2.3 Other Public Scenarios

While IPCC and IEA scenarios are the most prominent and widely used scenarios in the public domain, other organizations, such as the International Renewable Energy Agency, Greenpeace, the Deep Decarbonization Pathways Project (DDPP), and the Energy Watch Group, among others have published their own scenarios, which provide a different narrative and outlook to those listed above. Some of these groups have taken a specific focus, such as using 100% renewable energy, or built a regional-specific model that takes a deeper look into the energy mix for specific countries in the case of the DDPP.

Financial regulators have also been developing scenarios for macro-prudential purposes in the financial sector. Examples include the scenarios developed by the Network for Greening the Financial System (NGFS) and its member central banks.[136] NGFS scenarios are derived from IPCC pathways and scenarios from the Potsdam Institute for Climate Impact Research and the International Institute for Applied System Analysis. As mentioned in Section C, The Scenario Process, the UN Principles for Responsible Investment has produced an Inevitable Policy Response scenario focused on policy and technology outcomes rather than temperature outcomes.[137]

Most countries also have promulgated Nationally Determined Contributions (NDCs) under the Paris Agreement that outline their intended pathway to achieve the Paris Agreement goals. While not scenarios per se, they provide indications of temperature and emissions targets and related policy that countries are pursuing. NDCs are refreshed every five years in accordance with the Paris Agreement. Current NDCs, however, fail to achieve a 2°C temperature goal, so companies using NDCs as another basis of scenarios should understand both NDC pathways and limitations.[138]

Finally, other scenarios exist based on a variety of modeling and analytical approaches including "cost-benefit analysis, global regional and national modeling, nearer-term modeling, and nonintegrated assessment modeling, such as economic general and partial equilibrium global and sectoral modeling."[139]

[134] Under an extended version of the SDS scenario, the IEA gives a 50% chance of meeting the 1.5°C goal by using negative emissions technologies after 2070 to absorb around 300Gt of CO_2 — making up for overshooting the emissions limits that would keep temperatures below 1.5°C.

[135] IEA, *World Energy Model Documentation*, 2019.

[136] NGFS, *A call for action: Climate change as a source of financial risk*, 2019; NGFS, *Guide to climate scenario analysis for central banks and supervisors*, 2020; Vermeulen, Schets and Lohuis, *An energy transition risk stress test for the financial system of the Netherlands*, 2018.

[137] Principles for Responsible Investment, *What is the Inevitable Policy Response?*, 2019.

[138] European Capacity Building Initiative, *Pocket Guide to the NDCs under the UNFCCC*, 2018; United Nations Framework Convention on Climate Change, *NDC Registry*, 2020.

[139] Rose and Scott, *Grounding Decisions: A Scientific Foundation for Companies Considering Global Climate Scenarios and Greenhouse Gas Goals*, 2018.

3. THINGS TO CONSIDER WHEN USING IPCC AND IEA OR OTHER PUBLIC SCENARIOS

In using IPCC or IEA scenarios (or other publicly available research scenarios), it is important to understand their uses, limitations, and constraints and whether the outputs will be useful to a company (see Table A1-3, p. 66, for a summary of these scenario benefits and limitations and Table A1-4, p. 67, for common mistakes in using public scenarios).

The following are some key considerations for evaluating IPCC, IEA, or other scenarios and models. Many scenarios and models are complex and include several assumptions. A company, therefore, may need to seek external experts to assist with scenario and model evaluation, selection, and interpretation.

- **Not all scenarios are created equal.** Scenarios and models use a variety of methodologies and assumptions. It is important to determine whether the scenarios you have chosen are reputable, robust, and follow a validated scientific process.[140] While the models and scenarios identified in this paper were built upon decades of scientific testing and refinement, it is important to obtain an understanding of how chosen scenarios or models have been validated.

- **Downscaling does not always add value.** More granular resolution does not necessarily mean better or more accurate outputs. There is important context set at the global level, and companies should consider whether the downscaling method adds value to their analysis or provides a bias to their results by channeling a broad range of global output down through a single model or statistical analysis. Downscaling may simply add detail to the scenario exercise that does not necessarily help a company to navigate strategic decisions.

- **Beware of the limitations and key assumptions.** The user should be aware of the limitations and assumptions in each scenario or model. Assumptions matter for properly using scenario and model results; policy and technology assumptions, in particular, are important for companies to understand.[141] In addition, using global emissions and socioeconomic scenarios may be challenging for companies because such scenarios represent aggregate markets — not companies. They may also miss key uncertainties, have greater uncertainty the more disaggregated the results, and suggest uniform actions across all companies that may be economically inefficient.[142] Some additional limitations are highlighted in this appendix, under Table A1-3 – Benefits and Limitations of Selected Scenarios (p. 66). For example, the IEA has consistently underestimated global solar capacity in its scenarios from 2006 to 2019.[143] The use of a commercial service provider's proprietary scenarios and models also may be problematic if this information is not transparent and documented.

- **Understand the scenario likelihood.** Some scenarios are known as "improbable futures" within the science community based on the level of action already underway and emissions already committed.[144] The plausibility of these scenarios should be assessed if they are to be used.

- **Understand the pathways.** In a world of uncertainty, there are many pathways, both to different futures and to the same future outcome. Multiple pathways reflect uncertainties "about climate system dynamics, economic conditions, energy use, available technologies, and the timing of policy action" resulting in different "ranges of global emissions pathways, carbon budgets…and annual global GHG reduction levels…consistent with a global temperature outcome."[145]

- **Understand the uncertainties in the models.** The results of any modeling exercise are subject to uncertainty. In climate models, there are three main sources of uncertainty, as follows:[146]

  - **Scenario uncertainty:** We do not know how we will live in the future, and so we do not know which of the greenhouse gas scenarios may emerge as reasonable representations of the future. Policy design, for example,

[140] Huppmann, Rogelj and Kriegler, *A new scenario resource for integrated 1.5°C research*, 2018.

[141] Rose and Scott, *Grounding Decisions: A Scientific Foundation for Companies Considering Global Climate Scenarios and Greenhouse Gas Goals*, 2018; Rose and Scott, *Review of 1.5°C and Other Newer Global Emissions Scenarios*, 2020.

[142] Ibid.

[143] Carbon Brief, *Profound Shifts Underway in Energy Systems*, 2019.

[144] Hausfather and Peters, *Emissions – the 'business as usual' story is misleading*, 2020.

[145] Rose and Scott, *Grounding Decisions: A Scientific Foundation for Companies Considering Global Climate Scenarios and Greenhouse Gas Goals*, 2018.

[146] CoastAdapt, *How to understand climate change scenarios*, 2017.

is a key uncertainty for companies. Different assumptions about policy designs and instruments will result in different scenario impacts on a company.[147]

- **Model uncertainty:** We have an incomplete understanding of the Earth system and socioeconomic processes and, therefore, may not characterize them properly or completely in models.

- **Natural variability:** Global warming is driven by increasing concentrations of greenhouse gases over time from manmade and natural sources of emissions. In addition, the level of warming will be affected by natural variability in the climate system, including large-scale multiyear processes such as El Niño events.

Uncertainty in modeling relates to many aspects of the interaction of climate systems and socio-economic systems (e.g., uncertainty about the level of emissions, climate response, and economic and financial impacts). This results in scenario uncertainty, model uncertainty, and (missing) parameter uncertainty (e.g., solar costs in 20 years, which depend on techno-economic factors and not just policy factors).

- **Understand the use of models.**[148]

  - **Do not rely on a single model run.** Model runs are only one of many plausible futures. For this reason, the output from multiple model runs (either from the same model or from different models) is needed to evaluate futures.

  - **Use model output appropriately.** Always keep in mind that models only provide a plausible future — and not a prediction. Reality may be better, worse, or just different. Use model output accordingly — as a basis to explore system sensitivities and vulnerabilities and to identify appropriate options and their timing.

  - **Models have limitations.** Keep in mind the things the climate models do not address; for example, sudden shocks or the impact of events occurring simultaneously.

For hypothetical examples of companies using public scenarios, see Box A1-3.

Box A1-3
Hypothetical Company Examples of Using Public Scenarios

Company A understands that it is vulnerable to rising sea levels in a specific region and looks to global scenarios to evaluate the extent of its vulnerability. To undertake this work, *Company A* looks at the RCP emissions pathways (picking both a low- and high-emission scenario), modeled through global climate models to land on global ocean changes, and obtains region-specific downscaling of these models, from either CORDEX or its local meteorological or climate science institute. It then employs the use of impact, adaptation, and vulnerability models to ascertain the exposure of certain assets to coastal climate hazards, using the downscaled sea level rise from each scenario as an input.

Company B wants to understand how vulnerable it is to changes in a global carbon price. To do this, *Company B* looks to the SSP scenarios, picking a reference scenario (i.e., SSP2 - baseline), a fast transition scenario (i.e., SSP1-1.9), and a disorderly transition scenario (i.e., SSP4-2.6). From there, it is able to obtain projections across a number of models (IAMs), showing carbon pricing ranges among each of these scenarios.

Company C is more concerned about the future energy mix and the timing of thermal coal plant closures. It operates in specific regions and is predominantly concerned about the future of thermal coal in China, rather than at a global level. *Company C* has chosen the IEA World Energy Outlook to assist with its initial scenario exercise, using the CPS, SDS, and SPS scenarios. *Company C* obtains the future annual electricity generation demand and generation capacity, comparing coal to other technologies such as nuclear, solar, and wind. *Company C* understands it has only looked at one model — the IEA World Energy Model — and has not studied a more aggressive scenario (e.g., 1.5°C) so the company discloses this. It will include additional models in future periods to compare results.

Further Reading

Senses Climate Primer Website – https://www.climatescenarios.org/primer/.

Demystifying Climate Models, Andrew Gettelman and Richard B. Rood, 2016.

Modeling Earth's Future: Integrated assessments of linked human-natural systems, The Royal Society and the National Academy of Sciences, 2013.

How do climate models work? Carbon Brief. https://www.carbonbrief.org/qa-how-do-climate-models-work.

[147] Rose and Scott, *Review of 1.5°C and Other Newer Global Emissions Scenarios*, 2020.

[148] CoastAdapt, *How to understand climate change scenarios*, 2017.

Table A1-2

Representative Model Inputs and Outputs

Model Type	Examples of Model Inputs	Examples of Model Outputs[149]	Geographic and Time Scale/Intervals
Physical Climate Models	• Projections of emissions and other radiative forcing drivers (e.g., RCPs) • Incoming and outgoing solar radiation • Solar radiation reflection and absorbed • Observed historical climate	• Temperature changes[150] • Precipitation changes • Others such as wind speed, humidity, evapotranspiration, snow cover, snow melt, sea ice cover, and sea ice melt	• Typically, 1850–2100 with some to 2300 • Time intervals typically vary from hourly to seasonal or average annual • Geographic range typically 200 to 500km grids, with downscaling projects able to provide down to 1km grids (typically between 5 to 25km grids)
IEA World Energy Model	• Assumptions around GDP and population growth, as well as related regional consumption and demand • Projected price and demand curves for current and emerging energy sources; assumed carbon prices	• Total primary energy demand • Power generation and total final consumption by source (IEA, 2019) • Investment ($bn per annum) • Retirements, additions	• Time range is typically Present > 2040–2050 with five yearly intervals • Information provided at regional level and for major energy consumption/ production countries[151]
Integrated Assessment Models	• Socioeconomic development assumptions (e.g., SSPs) • Population • GDP • Assumptions around policy, climate, land use, existing and emerging technologies, etc.	• Various. The Integrated Assessment Modeling Consortium (IAMC) gives a detailed list of 598 possible output variables from these models (IAMC, 2019)	• Time range is typically Present > 2100 with five or ten yearly intervals • Most information provided at regional level, e.g., Asia, Middle East and Africa, Organisation for Economic Co-operation and Development
Impact, Adaptation, Vulnerability Models	• Inputs will depend on the topic studied. If related to agriculture, most inputs would focus on biological properties and physical climate conditions	• Various. Examples include: - **Agriculture –** a crop yield model can assess how changes in climate variables (such as available water, temperatures, and CO_2 concentration) interact to produce changes in the crop production quantity and quality - **Financial services –** insurance companies often use catastrophe (Cat) models to assess the economic impact of a natural disaster	• Various

[149] These include indices, which can be calculated from the raw model output.

[150] A full list of standard output GCM variables for CMIP5 can be found at https://pcmdi.llnl.gov/mips/cmip5/docs/standard_output.pdf?id=41.

[151] Information is available at a country level for certain countries (U.S., Brazil, China, Japan, India, Russia), and more granular subregions (Asia-Pacific, North America, EU, Middle East, etc.).

Table A1-3

Benefits and Limitations of Selected Scenarios

RCPs	**Benefits**	• Developed in parallel with the IPCC, the climate modeling community, the International Institute for Applied Systems Analysis (IIASA), and IAMC. • Defined emissions pathways, which can be input into global climate models to derive the physical climate futures. • Commonly known and used around the world by both research institutions and businesses.
	Limitations & Uncertainty	• Do not contain information regarding the socioeconomic conditions (GDP, population, etc.), technology, and regulatory landscape. • There are uncertainties in the translation of emissions profiles to concentrations and radiative forcing.
SSPs	**Benefits**	• Developed in parallel with the IPCC, the climate modeling community, IIASA, and IAMC. • Contain a narrative about what the world looks like from a socioeconomic perspective, including qualitative assumptions on important elements such as technology transfer, global cooperation, societal preferences, and the paradigm underpinning global development. See (IIASA, 2012) for details on storylines. • Designed to interact with the RCPs, as a complementary set of scenarios.
	Limitations & Uncertainty	• Do not explore conditions about the types and success of global and national climate policy. This requires further analysis using Shared Policy Assumptions. • Contain only qualitative information about the conditions described above, and as such may not help to quantify certain outcomes. • Designed to think about the rate of technology development and transfer broadly, and therefore do not explicitly explore all low-emission or carbon-dioxide removal technologies. • Allow for country-level data on GDP, population, and urbanization for certain countries; other is at a global or five regions.[152] • Each SSP provides a narrative and accompanying development assumptions, all of which relate to future uncertainty. To reduce uncertainty, it is advisable to consider the range of scenarios and the output of one SSP across multiple IAMs.
IEA	**Benefits**	• Available information is fairly granular in relation to the production and demand for fossil fuels. • Scenarios are widely used and accepted. • Regular (usually annual) updates are made to the scenarios to reflect changes in external environment.
	Limitations & Uncertainty	• IEA uses proprietary information, in particular in relation to the techno-economic assumptions underpinning the World Energy Model. This makes it harder for users to analyze and compare model assumptions. • Non-energy emissions are not included. • A limited range of climate outcomes is explored, without view as to the avoided climate impacts. • One model — World Energy Model — is relied upon heavily for all outputs for the IEA suite of scenarios. While this model interacts with a reputable climate model — Model for the Assessment of Greenhouse Gas Induced Climate Change — and gaps are filled by IPCC scenarios, this heavy reliance on one model will increase the risk that a wider range of outcomes are not considered.

[152] IIASA, SSP Database.

Table A1-4

Common Mistakes in Using Public Scenarios and Models

Pitfall	Description	How to Avoid
Incomplete range of scenarios **Physical & Transition**	With the inherent uncertainty associated with climate science, it is prudent not to limit your view to one single scenario.[153]	• Consider a full range of scenarios (for both physical or transition studies) and determine the most suitable diversity of scenarios to inform decision-making. Document decision-making process as this will help inform disclosures and reporting.[154] • When selecting scenarios, consider scenarios representative of the range of plausible outcomes.
Implausibility of scenarios **Physical & Transition**	It is important for a company to consider scientific views on how a scenario future might be. Scenarios at the lower or upper temperature bounds (for example, a **RCP1.9** (1.5°C) or **RCP8.5** (4°C+) face more uncertainties). Similarly, the **SSP narratives** contain some qualitative assumptions that may be considered unlikely. The SSPs (apart from SSP2) were intended to represent extreme futures.[155] **IEA scenarios** are intended to represent new policies enacted and committed each year, but some have noted these scenarios have underestimated the uptake rates of renewables such as solar.[156]	• It is important for companies to be transparent around the rationale for selecting scenarios. While scenario analysis is meant to stress test the resilience and vulnerability of companies under diverse futures, the scenarios need to be plausible. • Scientific opinions on the likelihood, limitations, and core assumptions of scenarios should be understood. • The choice of scenarios can have a large impact on the analysis, and should be subject to critical evaluation.
Failure to evaluate selected models **Physical & Transition**	"Models are stylized, imperfect representations of the world."[157] Models used by the research community are subject to peer review and evaluation techniques.[158] While these model evaluation techniques tend to be highly scientific and difficult for non-climate scientists to understand, they hold important information about whether a specific model should be used to inform decisions about specific climate factors (physical or transition).	• Companies should approach model selection with appropriate due diligence; model choice should be subject to critical evaluation. • Documenting the rationale of model selection is important to inform future decision-making processes. • Companies may wish to consult with experts who can provide information on the performance of models and assist them in understanding models' limitations or flaws.

Continued on next page

[153] Commonwealth Scientific and Industrial Research Organisation (CSIRO), *Common Mistakes When Using Climate Change Data*, 2016.

[154] Huppmann, Rogelj and Kriegler, *A new scenario resource for integrated 1.5°C research*, 2018.

[155] Carbon Brief, *How SSPs Explore Future Climate Change*, 2018.

[156] Carbon Brief, *Profound Shifts Underway in Energy Systems*, 2019.

[157] Rogelj, Popp and Calvin, *Scenarios towards limiting global mean temperature increase below 1.5°C*, 2018.

[158] IPCC, *Evaluation of Climate Models*, 2013.

Table A1-4: Common Mistakes in Using Public Scenarios and Models *(Continued)*

Pitfall	Description	How to Avoid
Cherry-picking scenarios or blending results **Physical & Transition**	Cherry-picking scenarios or blending results to obtain a desired outcome is a misuse of scenario analysis and analytically flawed.[159] In other words, it is not correct to join the results of different models together. Doing this breaks the internal consistency rule. For example, if a company looks at rainfall in one model and then looks at heat in another model, the company would not be able to join the results from the different models and make assumptions about these conditions occurring together or their interactions.[160]	• If a particular scenario or model is of interest based on the narrative or variables it contains, be careful on the conclusions that are drawn. Do not extend your conclusions to make generalizations across, for example, all 2°C futures. • Where you intend to investigate different variables across a number of models, do not draw conclusions on the ability of these variables to occur at once. For example, it might not be possible for a 2°C increase in temperature and a 20% increase in rainfall to coincide in a given region.
Not understanding when and how to downscale **Physical & Transition**	Companies should not assume that increased granularity from downscaling also means improved accuracy. Both the downscaling technique and the inputs used to downscale can impact results.[161]	• Model evaluation and comparing the results to other lines of evidence, such as observations and global scale model outputs, can provide companies with useful information to assess the results of downscaling. • The evaluation described above should be undertaken before deciding to seek downscaled information. • Companies may want to consult experts on whether the questions they are trying to explore through scenarios will require the use of downscaling. Experts may also help with the interpretation of downscaling outputs.

[159] Huppmann, Rogelj and Kriegler, *A new scenario resource for integrated 1.5°C research*, 2018.

[160] CSIRO, *Common Mistakes When Using Climate Change Data*, 2016.

[161] Ibid.

Appendix 2: Scenario Construction

Appendix 2: Scenario Construction[162]

Appendix 2 provides an overview of scenario construction, rather than an exhaustive treatment of the topic. Companies seeking further details should consult the References section of this guidance.

Scenarios are a method to explore a range of alternative futures that may significantly alter the basis for "business as usual" assumptions.[163] Scenarios may compare pathways resulting in a range of temperature outcomes (e.g., scenarios of 1.5°C and 4°C futures), different emissions pathways, or other climate-related outcomes. Scenarios define plausible pathways toward different potential futures; are built based on internally consistent, logical, and credible assumptions; and can be modeled to quantify outcomes.

Developing climate-related scenarios in-house allows tailoring of scenarios to the specific climate-related risks and opportunities a company faces. The process may also reap many other benefits including organizational learning, greater strategic dialogue, more innovative strategic thinking, and more resilient outcomes. The process can also be leveraged for other strategic issues — not related to climate change.

1. OVERVIEW

The three major steps in scenario analysis are problem definition, scenario development, and scenario application to strategy development (Figure A2-1).

Underlying these steps are several "soft" aspects important to effective scenario analysis, including the following:[164]

- **Engagement and Dialogue:** The sharing of ideas, experience, knowledge, beliefs, assumptions, and tendencies about both facts and data as well as ideas and perceptions regarding a company's strategy (i.e., strategic conversation).
- **Learning:** A core goal of scenario analysis is to re-perceive the company and how it fits with its environment. It involves the process of gaining knowledge about internal and external environments and their interactions.

Figure A2-1

High-Level Overview of the Scenario Analysis Process

[162] While there are a number of excellent reference materials on scenario construction, Ralston and Wilson, *The Scenario Planning Handbook*, 2006, and Haigh, *Scenario Planning for Climate Change*, 2019, provide useful step-by-step "how-to" approaches.

[163] CDP, *CDP Technical Note on Scenario Analysis*, 2017.

[164] Chermack, *Scenario Planning in Organizations: How to Create, Use, and Assess Scenarios*, 2011; Lindgren and Bandhold, *Scenario Planning: The Link Between Future and Strategy*, 2009; Van Der Heijden, Bradfield and Burt, *The Sixth Sense: Accelerating Organizational Learning with Scenarios*, 2002.

- **Mental Models:** A core goal of scenario analysis is to reveal the implicit assumptions, biases, and mental models of how leaders interpret the company and the world around it. Changing mental models is often a pre-condition for successful scenario analysis.
- **Decision-Making:** Another goal of scenario analysis is improving the information and mental models around key strategic decisions, considering broader strategic options, and explicitly thinking about critical driving forces and uncertainties.
- **Leadership Support:** Executive-level sponsorship and support is critical to successful scenario analysis given the degree to which it touches on broad aspects of a company's decision-making.

2. SCENARIO CONSTRUCTION

There are a number of approaches to developing scenarios.[165] This sub-section lays out six general steps for constructing scenarios (Figure A2-2, p. 72) and is meant as an introduction. **Companies seeking additional guidance on constructing climate-related scenarios should consult the References section.**

2.1 Step 1: Assess the External Environment

- **Identify past trends.**
- **Describe current climate state.**
- **Identify company's current climate risks.**

Before the process of scenario construction can begin, a company should develop a basic understanding of the climate context in which it operates and past climate-related trends and current circumstances surrounding its operations. A company may undertake this assessment drawing on available company studies and data, external sources, and key internal experts. The focus of information gathering should be on the past and current climate-related conditions affecting the company, including the basic climate-related physical and transition trends and the forces behind those past trends. Some questions to consider include the following:

2.1.1 General

- What past climate-related patterns, trends, events, or variables have significantly affected the company? How and why did these factors exert influence on the company?
- What are some other potential touchpoints, both physical and transition, where climate-related issues affect the company and its environment (e.g., supply chains, customers, operations)?

2.1.2 Physical Risk[166]

- What are the most material domestic physical hazards from extreme (acute) events (e.g., flooding, extreme temperature changes, windstorms) and from gradual (chronic) changes in climate (e.g., changes in agricultural yields or water availability, sea level rise, heating and cooling requirements)?
- What effects could there be on real estate, infrastructure, business continuity, people, and food systems?
- Are there any significant international transmission channels (e.g., trade or supply chains)?
- What kind of adaptation measures are being implemented (e.g., shift in crop types, water regulations, coastal protection measures)?

2.1.3 Transition Risk

- What type of government policies are being considered or implemented (e.g., carbon tax, direct regulation, subsidies)?
- Which technological trends could play a key role in the coming decades (e.g., renewable energy, carbon capture and storage, electrification of motor vehicles)?
- Are there any significant changes in consumer preference (e.g., transport demand, diets, energy-efficient housing, energy-efficient appliances)?
- Which sectors of the economy are particularly at risk of policy or technological disruption (e.g., energy sector, agriculture, construction, industry, mobility, and freight transport)?

[165] Amer, Daim and Jetter, *A review of scenario planning*, 2013; Varho and Tapio, *Combining the qualitative and quantitative with the Q2 scenario technique – The case of transport and climate*, 2013; Varum and Melo, *Directions in scenario planning literature – A review of the past decades*, 2010.

[166] Also see Tables A1 and A2 in TCFD, *Implementing the Recommendations of the Task Force on Climate-related Financial Disclosures*, 2017, pp. 72–73.

Figure A2-2

Detailed Overview of Scenario Process

SECTION C

Establish Organizational Requirements for Scenario Analysis
Structure, Governance, Processes, Stakeholders

STEP 1

Assess the External Environment
Past and current trends, company's current climate risks

STEP 2

Formulate Focal Question
How could climate-related physical and transition risks plausibly affect our company? What should we do? When?

Define Time Horizon(s)
(short, medium, long term)

STEP 3

Categories
S – Social
T – Technological
E – Economic
E – Environmental
P – Political/Policy/Legal

Identify Driving Forces
- External to company
- Relevant to focal question
- Directly affect company or one of its key stakeholders
- May bring positive or negative impacts

Rate and Rank Driving Forces
Identify and rank uncertainties
Identify and rank impacts

STEP 4

Formulate Baseline for Scenarios Using High-Impact/Low-Uncertainty Drivers
(i.e., those drivers and trends likely to occur under any/most future states)

Draft Narrative for Each Scenario
- Draft initial scenarios using high-impact/high-uncertainty drivers
- Describe how each driving force develops and its impact over the scenario time horizon
- Describe how the driving forces could interact
- Translate to a 2x2 matrix to determine scenario themes
- Develop scenario narratives describing assumed cause-effect relationships among drivers, how drivers play out into the future (pathways), and anticipated outcomes

STEP 5

Quantify Aspects of Scenarios Where Necessary and Possible
- Key (social, demographic, economic) trends and drivers
- Company and industry key performance indicators
- Plausible impacts on markets, suppliers, and customers
- Impacts on asset value, productivity, revenue, costs, etc.

Check Scenario Quality
Plausible; Internally consistent; Logical line of reasoning; Makes sense to the intended audience; Surprising/Challenges current assumptions

Scenarios presented for feedback and revised as needed

Finalize Scenarios

SECTION E

Draw Conclusions and Develop Strategy Options
- How would the scenarios affect the company (risks and opportunities)?
- How do the company's current strategies, policies, and capabilities prepare the company for the scenarios?
- What new strategy options should be considered now and in the future?
- What signposts/warning signals would trigger implementation of future options?

Feedback on Strategy Options

Use Selected Options to Inform Strategic Planning; Produce Strategic and Other Supporting Plans

STEP 6

Identify Signpost Metrics to Monitor Future Developments
- Identify thresholds for material changes in drivers
- Identify metrics to warn of shifts in key uncertainties

Iterate Scenario Analysis Periodically

Evaluate Scenario Analysis Process

From this information, a company should identify its current risks and opportunities from climate change (Figure A2-3) and understand the range of issues, knowledge gaps, and implications of those risks and opportunities.

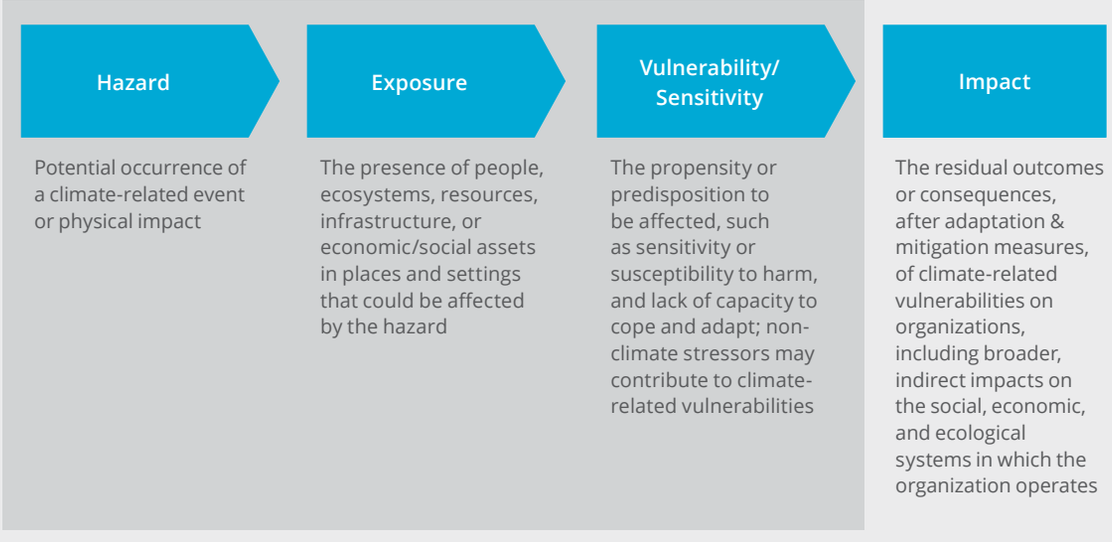
In assessing climate-related risks, companies should take a broad view. Climate change has the potential to generate significant changes across multiple social, economic, and ecological dimensions. For example, chronic and acute physical events can affect business facilities, operations, and supply chains either directly or indirectly.[167] Climate change also drives changes in the ecosystem, which supplies raw materials and other inputs to businesses. Finally, climate change can affect the social and economic systems in which businesses operate — markets, societies, policies, legal frameworks, and technological innovations. Companies should be sensitive not just to individual risks, but also to compound risks, risk dynamics, feedbacks, tipping points, and irreversible results.[168]

Even if a company believes it is not directly affected by climate change, climate-related risks may spread through (1) the outputs of one sector into the inputs of other sectors; (2) products that compete for the consumers' budgets; and (3) sectors that compete for the primary factors of production (labor, capital, land, water).[169]

More broadly, companies can be affected by the possible macroeconomic impacts of climate change in changes to investment, consumption, and prices. Many sectors could see impacts through indirect channels on production schedules, supply chains, distribution networks, and employee and customer mobility.[170] These climate-related effects can translate into impacts for businesses along multiple dimensions (strategic, operation, reputation, and financial), along the entire value chain, in multiple geographies, and at different temporal scales.

Figure A2-3

Framework for Risk and Opportunity Assessment



Adapted from Intergovernmental Panel on Climate Change (IPCC) 2014, Chapter 19 definitions

[167] For example, physical climate risk generates feedbacks to transition risk, which in turn affects the impacts from physical risks through socioeconomic assumptions around adaptation, migration, investment, and growth.

[168] Zscheischler, Westra and van den Hurk, *Future climate risk from compound events*, 2018; Lemoine and Traeger, *Economics of tipping the climate dominos*, 2016; Jurgilevich, Rasanen and Groundstroem, *A systematic review of dynamics in climate risk and vulnerability assessments*, 2017; Lenton and Ciscar, *Integrating tipping points into climate impact assessments*, 2013.

[169] IPCC, *Fifth Assessment Report Climate Change 2014: Impacts, Adaptation, and Vulnerability*, 2014, Chapter 10.

[170] Center for Climate and Energy Solutions, *Business risks, opportunities, and leadership*, 2019.

2.2 Step 2: Problem Definition

- **Define the focal question(s).**
- **Define the scope of coverage.**
- **Define the scenario time horizon.**

The next step is to identify the focal question(s) to which scenario analysis is to be applied. This step is important because focal questions are a key anchor point for many of the decisions made during scenario development and analysis.[171]

In thinking about focal questions, a company is seeking to flesh out the focus of scenario analysis around the broad question of "how could climate change plausibly affect our [company, business unit, product, commodity input, customer segment], what should we do, and when?" Some questions a company should consider are as follows:

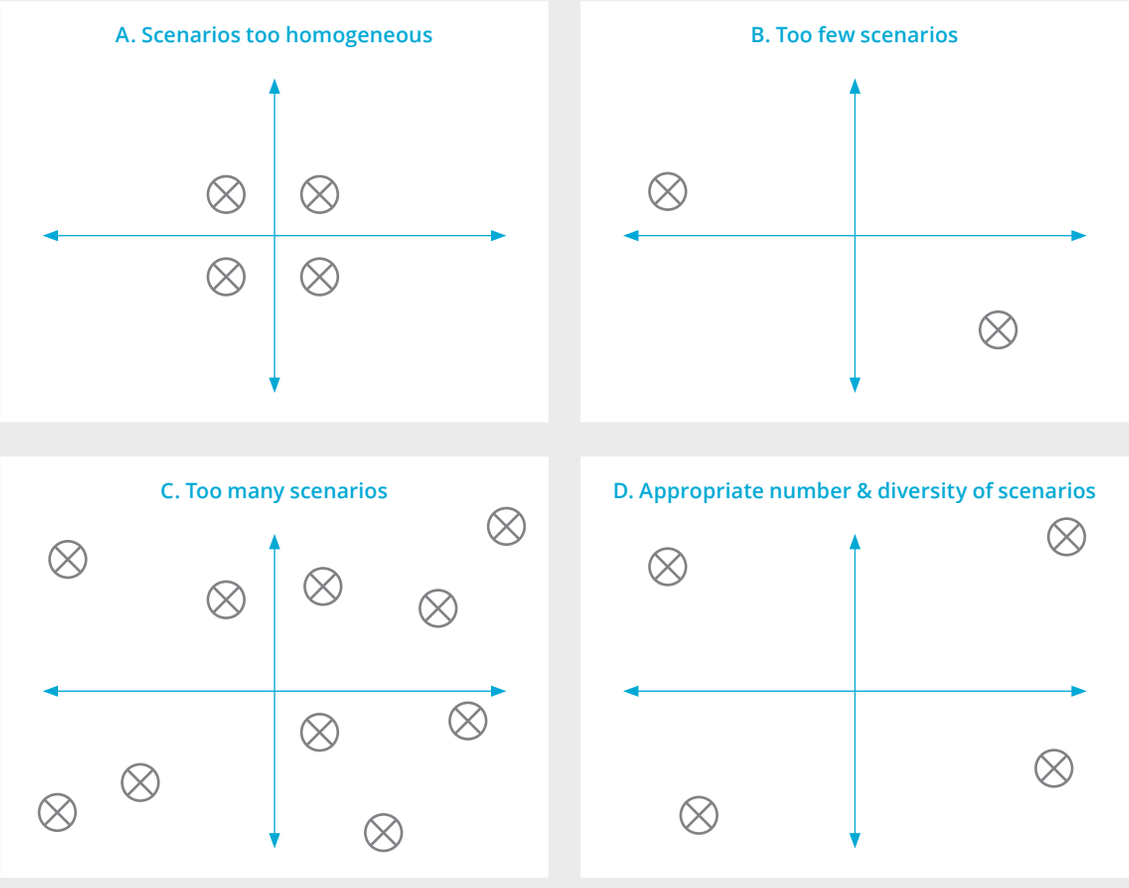
- What possible future developments need to be probed?
- What variables are needed to support decision-making?
- What forces and developments have the greatest ability to shape future performance?

Companies may be able to leverage publicly available global and regional scenarios, such as IPCC and International Energy Agency (IEA) scenarios, to help provide broader context, and better frame a company's focal question(s).

In articulating the focal question(s), a company should also define the scope of its analysis. Will scenario analysis encompass the company as a whole, a particular business unit or product line, or a critical input(s) such as a specific commodity? For companies just beginning to use scenarios,

Figure A2-4

Scenario Ranges



The vertical axis is "Driver Group A" and the horizontal axis is "Driver Group B." For an explanation of the two-axes approach for scenario development and the landscape of uncertainties, see Step 4 (p. 76) of this appendix.

[171] Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019.

it may be useful to start with a more focused boundary such as a critical business unit or specific commodity inputs and, as experience is gained, expand scenario analysis to the full company.

Next, a company should determine the time horizon over which the focal question(s) will be considered. For instance, will the scenarios address the focal question out to 2040, 2050, or some other time horizon? In determining the appropriate time horizon, companies may want to consider such factors as corporate capital planning and investment horizons, and the useful life of major company assets.

In addition, a company may want to align scenario time horizons with those used in the scenarios of the climate research community. For example, a company might consider time horizons that align with the cycles for major refreshes of Nationally Determined Contributions under the Paris Agreement.

"Using a time frame that extends only a few years into the future fails to take into account important questions whose answers might depend on climate change effects that will become perceptible several years or decades down the line, but which nonetheless might be deemed material to the value of a company today."[172]

Finally, determining the number of scenarios is important. Homogeneous assumptions about driver development or too few scenarios may impair the analysis. Too many scenarios can be overwhelming for decision-makers and complicate the use of scenarios. It is a judgment call as to the number of scenarios that will adequately cover the landscape of relevant impacts and uncertainties.

2.3 Step 3: Identify Driving Forces and Critical Uncertainties

- **Identify the driving forces of key patterns, trends, and variables relevant to the company's focal question(s).**
- **Identify critical uncertainties around the impacts of identified driving forces.**

Scenarios are built around a focal question(s) by examining and describing the external factors that may affect the outcomes to such a question.[173] The goal is to construct a conceptual understanding of the business environment and its various climate-related relationships.

2.3.1 Identifying Driving Forces

A typical method for identifying driving forces is a facilitated brainstorming session in a workshop setting. The workshop might be among scenario team members, internal stakeholders, or both. There are also other ways of identifying driving forces.[174]

A good starting point in identifying relevant driving forces is the assessment done in Step 1 (p. 71). A company may then extend that analysis into the future by brainstorming the climate-related physical and transition forces that are likely to continue playing out and that are critical to decisions related to the company's focal question(s). Some points to consider include the following:[175]

- the possible future outcomes caused by the force or driver;
- what the force or driver will influence; and
- what the force or driver is influenced by.

[172] Wasim, *Corporate (Non) Disclosure of Climate Change Information*, 2019.

[173] Chermack, *Scenario Planning in Organizations: How to Create, Use, and Assess Scenarios*, 2011; Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019. Such factors are typically called drivers, forces, or driving forces in the scenario literature, but also may be described as trends, conditions, events, and the like.

[174] Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019; Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006; Van Der Heijden, Bradfield and Burt, *The Sixth Sense: Accelerating Organizational Learning with Scenarios*, 2002.

[175] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

A company should systematically identify as many forces affecting decisions around the focal question(s) as feasible. One method is to use the STEEP framework (Figure A2-5, p. 77).[176] The identified driving forces can be grouped along three lines, as follows:[177]

- *macro-forces*: the broad social, economic, political, and technological context (frequently at the national or global level) in which the focal issue will evolve;[178]
- *micro-forces*: the more specific industry, market, and competitive conditions in which a climate-related strategy is developed; and
- *decision-forces*: the most important external factors that should be considered in developing a strategy to address company-level impacts.

2.3.2 Identifying Uncertainties

After identifying the relevant driving forces, the uncertainties around the impacts of those driving forces must be identified. This process helps a company to understand the key areas of uncertainty about how driving forces might play out in different plausible futures. Uncertainty in this regard refers to the uncertainties around impacts of the driving forces, not the uncertainty of the driving forces themselves or the resulting events from those driving forces. For example, the growth in the use and speed of technology is a predictable driving force/event — and therefore has low uncertainty as to its being a driving force — but the impact of this force on a particular company or industry may be highly uncertain.[179] To help identify uncertainties, it can be useful to separate driving forces into those that have a predetermined or predictable impact from those with an uncertain impact.

Box A2-1
Questions to Ask in Determining Uncertainty

What do we know and not know about the following:

- The factors that determine the historical, current, and future states of the driving force?
- The internal workings of a driving force — cyclical, permanent change, combination?
- The outcomes of historical trends, key events, disruptions in trend, and extremes?
- The current state of a driving force?
- The plausible states and outcomes at the chosen time horizon of a driving force?
- The most critical uncertainties of the driving force in a company's time horizon?

Source: (Haigh, 2019, p. 62)

2.3.3 Ranking Forces with High Impact and High Uncertainties

Once the relevant driving forces and related uncertainties are identified, the next step is to rank the driving forces on the basis of their degree of potential impact on the company (low to high) and the degree of uncertainty regarding those impacts (low to high). One method for carrying out such a ranking is an impact-uncertainty matrix as shown in Figure A2-5 (p. 77). The following definitions help to frame the ranking space:[180]

- **Definition of impact/importance:** Strength of the force's influence on future outcomes relevant to the key decision factors related to the focal question(s).
- **Definition of uncertainty:** The degree to which future developments and outcomes (of a force) are unpredictable within the time horizon of a scenario. One test of uncertainty is when experts within the company cannot agree on the outcome.

2.4 Step 4: Draft the Scenario Narrative

- **Determine range of scenarios.**
- **Determine scenario logic.**
- **Draft and refine scenario narratives.**
- **Check scenarios.**

The next step is to draft the scenario narrative or storyline. The goal of storylines is to "stimulate, provoke, and communicate visions of what the future could hold…they aim for creativity, rigor, internal coherence, and plausibility."[181] This step involves developing themes and logic.

[176] For further elaboration on possible climate drivers by STEEP category, see Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019, pp. 110–146.

[177] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

[178] This is one place where consulting IPCC and IEA scenarios may be useful and help a company's scenarios remain broadly aligned with current climate research.

[179] Van Der Heijden, Bradfield and Burt, *The Sixth Sense: Accelerating Organizational Learning with Scenarios*, 2002, pp. 206–208.

[180] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006, p. 108.

[181] Rounsevell and Metzer, *Developing qualitative scenario storylines for environmental change assessment*, 2010.

Figure A2-5
STEEP Model of Driving Forces

Social
- Social/Lifestyle Factors
- Demographic Patterns
- Health & Education Trends
- Civil Stability & Tensions

Technology
- Basic Research Trends
- Emerging Technologies
- Technology Diffusion

Economic
- Macroeconomic Trends
- Microeconomic Trends
- Regional/National Variations
- Financial Capital Trends
- Trade Rules/Protectionism

Environment
- Ecosystem Trends
- Climate/Weather Trends
- Pollution
- Recycling
- Energy
- Waste Disposal
- Land Use

Political
- Policies
- Laws/Regulations
- Court Decisions
- Political Attitudes

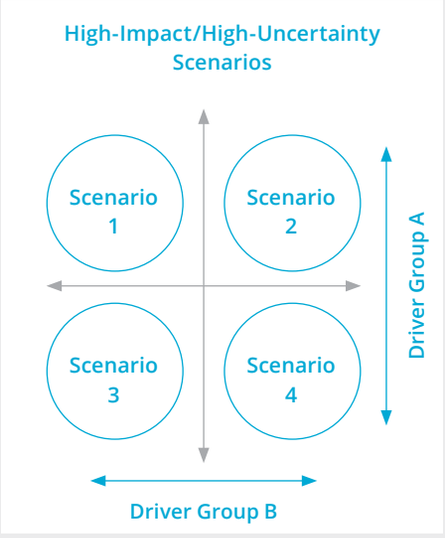
2.4.1 Scenario Themes

Scenario themes should be developed using the high-impact/high-uncertainty forces in the upper right cell of the impact-uncertainty matrix (Figure A2-7, p. 78). To do so, a company takes the two highest-ranked forces from that cell or groups the forces in the cell together into two clusters of similar forces. The two highest-ranked forces or the two clusters can then be used to determine two alternative hypotheses for how forces will play out in the future time horizon of the scenario. These two hypotheses form two axes that are plausible but extreme.[182]

The two axes form a 2x2 matrix focusing on the group of forces most relevant to a company's focal question(s). Each of the four cells of the matrix can be used to develop a scenario narrative around the drivers for that cell, resulting in four scenarios that cover the range of key uncertainties and drivers relevant to a company's focal question(s).

Figure A2-6 provides an example of this approach. These are scenarios developed using a 2x2 scenario matrix differentiated along axes of orderly/disorderly policy responses and meeting/

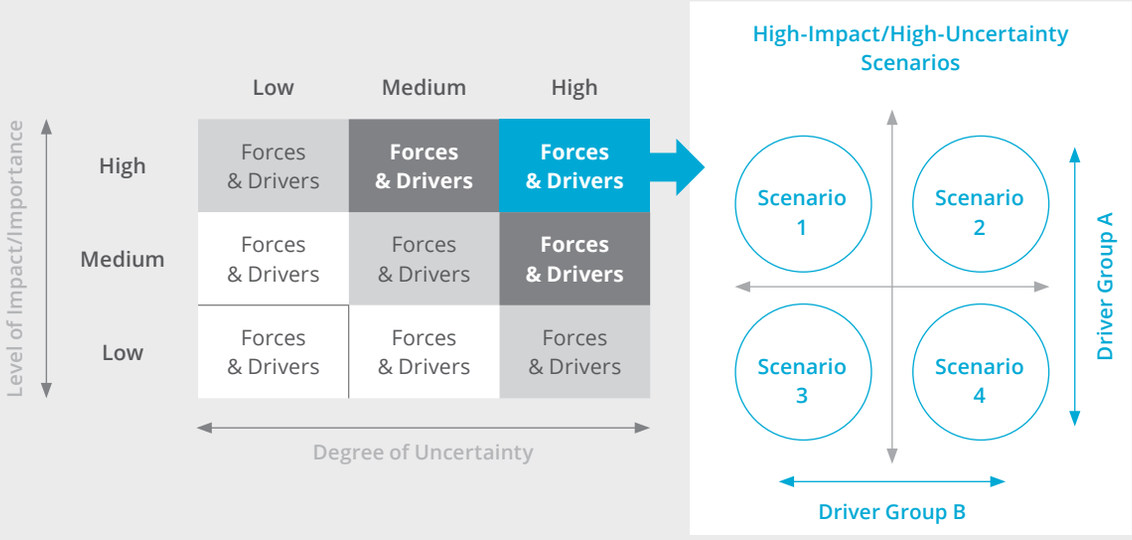
Figure A2-6
Scenario 2x2 Matrix



[182] See Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006, pp. 111–117 for a step-by-step overview of this approach.

Figure A2-7

Impact-Uncertainty Matrix (left) and Alternative Scenarios Matrix (right)

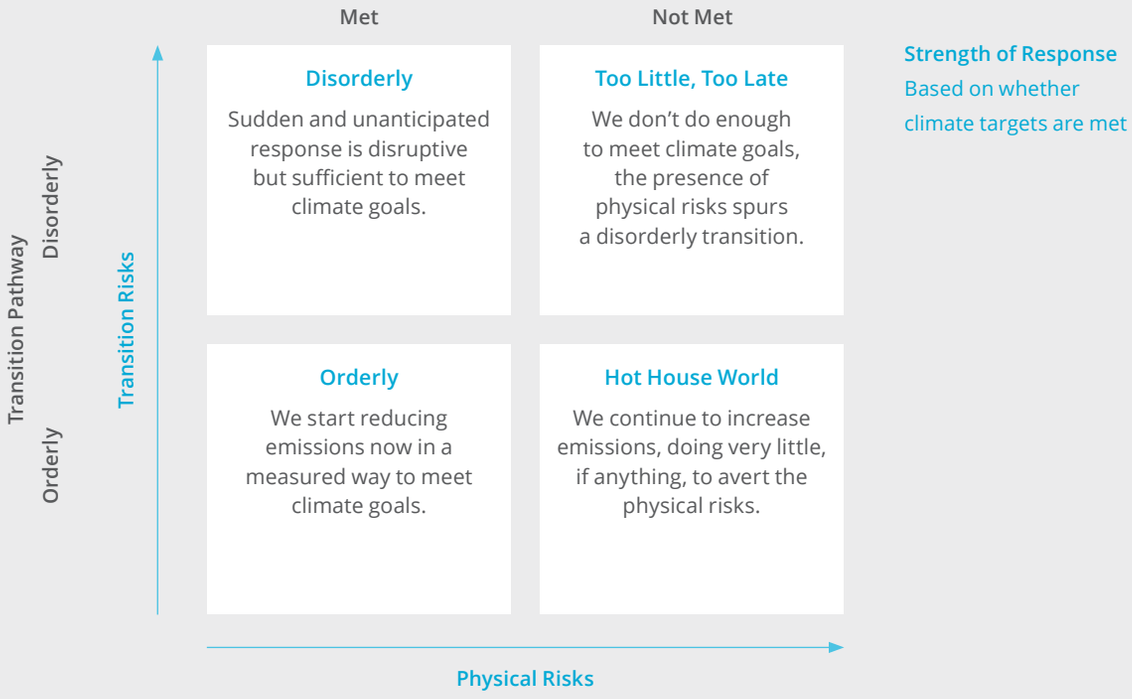


Note to Figure A2-7: Only a limited number of forces and drivers should be ranked in the high-impact/high-uncertainty category. One method to help with this ranking process is to set a percentage threshold (e.g., <25%) of drivers in the high-impact/high-uncertainty category. Such a target helps focus on the decision line between which forces should go into each cell of the matrix.

Source: Adapted from Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006

Figure A2-8

Scenario Matrix Based on Policy Responses



Source: Network for Greening the Financial System, A Call for Action: Climate Change as a Source of Financial Risk, 2019

not meeting climate targets. These particular drivers were set out by the central banks and supervisors in the Network for Greening the Financial System as the two most important dimensions when assessing the impact of climate risks on the macroeconomy and the financial system (their focal question).

2.4.2 Developing the Scenario Logic

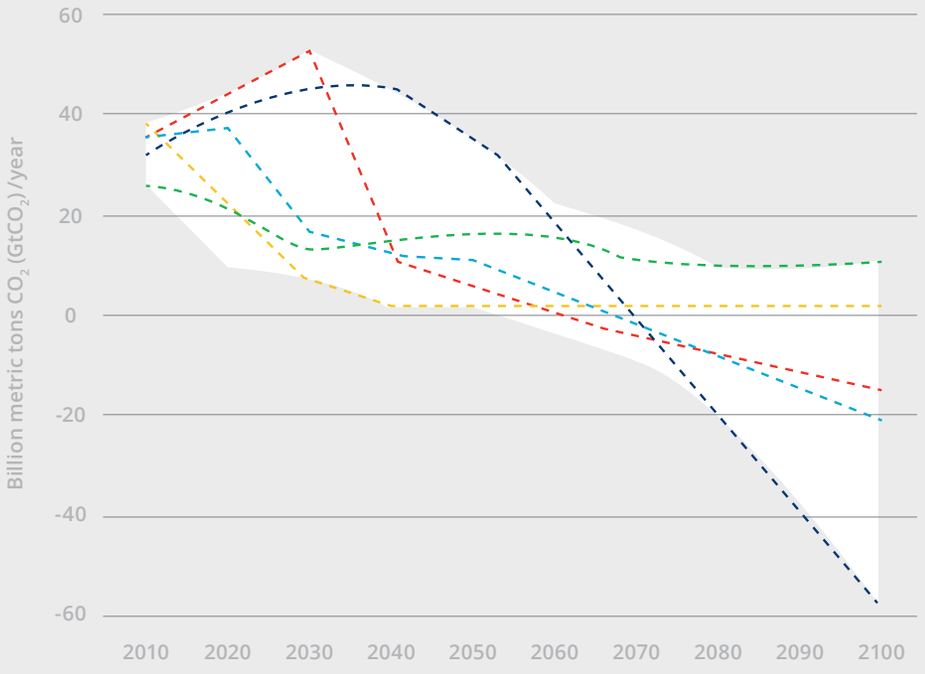
Another key aspect of a scenario narrative is its internal logic. Scenario logic describes the relationship between various drivers and resulting change, including the causal assumptions underlying the described relationship. In other words, it seeks to explain the hypothetical cause-effect relationship among drivers and the resulting development trajectory or pathway that those drivers may take to arrive at an outcome. As such, scenario logic establishes the internal consistency and plausibility of a scenario storyline.

The 2x2 matrix (Figure A2-6, p. 77) forms a starting point for developing the scenario logic. The scenario logic should describe scenarios that are broadly "representative" of each of the four quadrants of the matrix and best covers the "envelope of uncertainty" that a company faces.[183]

An important aspect of the scenario logic is describing the scenario pathway from the present to the future scenario outcome. Different combinations of driving forces and assumptions will result in a range of plausible development pathways, even leading to the same outcome. Multiple pathways can exist for any scenario, reflecting uncertainties "about climate system dynamics, economic conditions, energy use, available technologies, and the timing of policy action" resulting in different "ranges of global emissions, carbon budgets (cumulative emissions over time), and annual global GHG reduction levels…consistent with a global temperature outcome."[184] Figure A2-9 illustrates some of the multiple pathways consistent with a 2°C outcome.

Figure A2-9

Multiple Emissions Pathways Consistent with 2°C Scenario



The range of 2°C pathways (white space) and selected emissions pathways (dashed lines) are based on 408 different scenarios.
Source: Rose & Scott, 2018

[183] See Carlsen, Erikson and Dreborg, *Systematic exploration of scenario spaces*, 2016, and Lord, Helfgott and Vervoort, *Choosing diverse sets of plausible scenarios in multidimensional exploratory future techniques*, 2016, for technical approaches to generating sets of scenarios that are maximally diverse.

[184] Rose and Scott, *Grounding Decisions: A Scientific Foundation for Companies Considering Global Climate Scenarios and Greenhouse Gas Goals*, 2018.

In order to understand the underlying assumptions of different pathways, it is critical to set out potential company-level risks, impacts, and uncertainties. Differences in assumptions (and hence different pathways) can make big differences to company-level impacts. Some pathway characteristics that a company should consider include the following:

- the slope of a pathway (e.g., the speed of development);
- the shape of the pathway (e.g., when it reaches peak emissions and net-zero emissions);
- assumptions about technology deployment and timing, such as carbon capture and storage;
- assumptions about policy timing, type of policy instruments employed, sector coverage;
- assumptions about energy system transitions and their timing (e.g., energy mix, demand, efficiency); and
- assumptions about sector and geographical application.

Scenarios can have "orderly" or "disorderly" pathways. An orderly pathway typically assumes that globally coordinated climate policy actions are applied to the economy as a whole and with immediate effect. A disorderly pathway involves transition actions that may be delayed, lack sufficient coordination or coherence, or conditions that shift suddenly from a technology or social standpoint — such a pathway will likely entail higher risks and costs to particular sectors and industries or overall.

On the transition risk side, a "disorderly" pathway is likely to be characterized by variation in the speed and magnitude of changes along the pathway over time, driven by policy delays, uncoordinated or disjointed policy implementation, unanticipated technology transformations/disruptions, or abrupt market, social, or legal shifts.

On the physical risk side, disorderly pathways may be driven by the existence of so-called climate system tipping points. This is the notion that small changes at critical thresholds can have large, long-term consequences, possibly irreversible, for the climate system (i.e., regime shifts).[185] These climate tipping points have implications for physical impacts, ecosystem services, and biodiversity, and consequently implications for businesses too.

Finally, both physical and transition uncertainties may trigger larger climate-related impacts or more stringent socioeconomic responses, which in turn may affect the costs of various sectors, individual companies, and specific investments.[186]

In developing their scenarios, companies should consider incorporating assumptions about a "disorderly" pathway into one or more scenarios. Incorporating such assumptions could help them to highlight different risks posed by those scenarios based on idealized, orderly transitions.

2.4.3 Drafting and Refining Scenario Narratives

The scenario narrative should be written using the scenario themes and logic. The storylines of each scenario should link historical and present events with hypothetical futures by presenting a seamless and integrated narrative describing the causal train of events (pathways) and underlying drivers, assumptions, and affected systems. The objective is to create stories that capture the historical trends and forces and how they might unfold or evolve in the future. Each of the scenarios should focus on a different combination of key driving forces in order to be distinct and challenging; they should not be derivations of a single "base" case.

There are a number of ways to carry out a draft of a scenario storyline. Haigh[187] suggests starting by creating a baseline set of conditions that occurs in all four scenarios using the high-impact/low-to-medium-uncertainty forces in the upper left and center cells of the matrix (Figure A2-10, p. 81). These forces are deemed certain to have an impact on the company no matter what scenario ensues. Forces in the low-to-medium-impact categories can be left out at this stage.

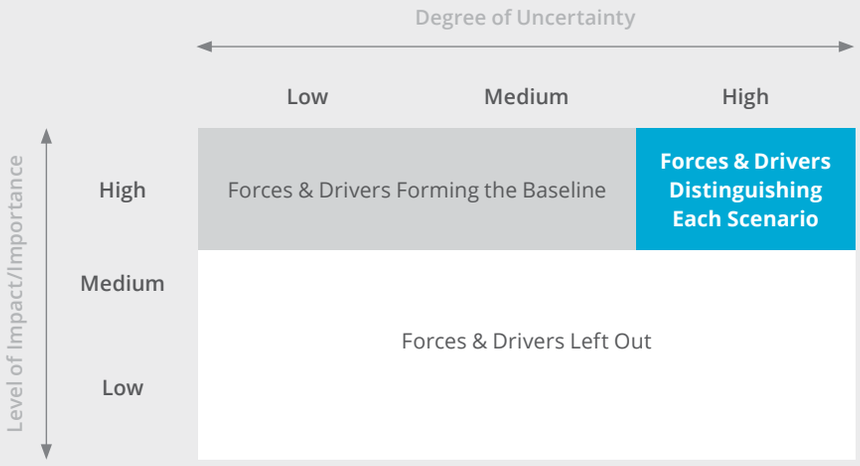
[185] Such tipping points may trigger cascading impacts beyond the climate system. See Arctic Council, *Arctic Resilience Report*, 2016, sections 3.2 and 3.3, particularly Figure 3.4b, and Kinzig, Ryan and Etienne, *Resilience and Regime Shifts: Assessing Cascading Effects*, 2006. See also Gladwell, *The Tipping Point*, 2000; Lenton, et al., *Tipping elements in the Earth's climate system*, 2008; Lenton and Ciscar, *Integrating tipping points into climate impact assessments*, 2013; Lemoine and Traeger, "Economics of tipping the climate dominos," 2016; and Van Ness, et al., *What do you mean, 'Tipping Point'?*, 2016.

[186] Rose and Scott, *Review of 1.5°C and Other Newer Global Emissions Scenarios*, 2020.

[187] Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019.

Figure A2-10

Baseline and Distinguishing Scenario Forces



Ralston and Wilson suggest starting by writing a brief one-paragraph description of each scenario and its resultant dynamics, major forces, and different outcomes. Using this description, a one- to two-page narrative for each scenario is drafted.[188]

Some guidelines for developing scenario storylines include the following:[189]

- Develop a beginning, middle, and end — showing the forces at work, how they evolve and interact, new forces that emerge, and changes in the strategic picture at the end of the story.
- Not everything changes, as some elements remain reasonably consistent across the scenarios (the baseline elements).
- Include characters, dramas, or conflicts to convey how the world is changing and who the actors are at play.
- Make each story unique and imaginative.

Other principles to keep in mind when writing scenario narratives include the following:[190]

- Think in dramas:
  - the players (who);
  - the events (what);
  - the timeframe (when);
  - the scene (where);
  - the props (how); and
  - the motives (why).
- Think in futures, uncertainty, and systems.

Drafting scenario narratives is an imaginative and creative exercise that entails thinking about how the future may unfold. How might the distinctive forces in each scenario affect the company and its key stakeholders? How do the forces interact? The goal is to be both plausible and surprising.

[188] After the scenarios are drafted, it may be helpful to develop a table that compares the key elements of each scenario future and how it plays out. The table helps to compare and examine the differences in which forces play out in each scenario and provides a check that scenario differences are reasonable, plausible, and cover the full range of possibilities (Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006, pp. 127–130).

[189] Ralston and Wilson, *The Scenario Planning Handbook: Developing Strategies in Uncertain Times*, 2006.

[190] Lindgren and Bandhold, *Scenario Planning: The Link Between Future and Strategy*, 2009.

Scenario narratives should be checked for whether the trends are compatible with the chosen timeframe, outcomes are combined in such a way that fits logically and scientifically, and scenarios are perceived as plausible (albeit challenging and possibly extreme).

Three criteria are particularly important in evaluating the quality of scenario narratives, which are relevance, credibility, and legitimacy. To ensure high relevance, scenarios should focus on a specific decision or issue (i.e., the focal question). High credibility involves applying a well-documented and applied scenario methodology combined with data and relationships that are valid and backed by scientific research. Legitimacy can be strengthened through broad and inclusive stakeholder consultation, transparency, and widely accepted and understandable outputs. The final scenario narrative should be checked to ensure that it covers the key factors shown in Box A2-2.

2.5 Step 5: Scenario Quantification

- **Agree on purpose of quantification**
- **Considerations in using models**
- **Other quantification tools**

Qualitative narratives may benefit from quantitative information.[191] Describing future conditions that a company might face in numerical terms through graphs and trend data, for example, may help communicate more detailed representations of future conditions.

2.5.1 Why Quantify?

There are a number of benefits from quantifying scenarios. First, quantification may help to illustrate key trends or forces in a more concrete and explicit manner. Second, certain audiences may be accustomed to the presentation of numbers and the use of them could therefore improve overall communication. Third, quantification may create greater rigor and sophistication in the scenario analysis.

Box A2-2
Basic Components and Characteristics of Scenarios

- **Horizon Year –** The chosen future scenario limit (e.g., 2050, 2100).
- **Focal Question(s) –** The critical questions or potential decisions that the company seeks to address.
- **Driving Forces or Drivers –** The underlying external causes of change in relation to the focal question, which derive from a number of broad processes within STEEP categories — social, technological, economic, environmental, and policy. For a process to be considered as a driver it needs to (1) be continuous over a period of time and (2) influence the outcomes of the focal question durably and consistently. A time-bound, episodic process may not be a driver but rather a crisis or shock.
- **Scenario Logic –** A description of the relationship between various drivers and change, including the causal assumptions underlying the described relationship. Scenario logic seeks to establish internal consistency between various statements and assumptions that underpin the scenario.
- **Development Pathways –** The trajectory between the present and future states resulting from the drivers and related cause-effect relationships laid out by the scenario logic.
- **Key Uncertainties –** The uncertainties surrounding how drivers, assumptions, and scenario logic may play out and, wherever possible, the source of these uncertainties.
- **Storyline –** A narrative that links historical and present events with hypothetical futures by presenting a seamless and integrated narrative describing the causal train of events (pathways) and the underlying drivers, assumptions, and affected systems.
- **Plausible –** The events in the scenario should be possible and the narrative credible.
- **Distinctive –** Each scenario should focus on a different combination of the key driving forces.
- **Consistent –** Each scenario should have strong internal logic. The aim of scenario analysis is to explore the way that factors interact, and each action should have a reaction.
- **Relevant –** Each scenario, and the set of scenarios taken as a whole, should contribute insight into the futures that relate to the strategic and/or financial decisions facing a company in light of its climate-related risks and opportunities.
- **Challenging –** Scenarios should challenge conventional wisdom and simplistic assumptions about the future. They should try to explore alternatives that will significantly alter the basis for business as usual assumptions.

[191] Alcamo, *The SAS Approach: Combining Qualitative and Quantitative Knowledge in Environmental Scenarios*, 2008.

2.5.2 How to Approach Quantification

Information should be quantified where it is possible and where it makes sense to do so. Any numerical descriptions should be clear and readily understandable to scenario users and serve a clear purpose in the scenario.

Quantification focuses on the two aspects of scenarios — descriptive aspects of the scenario narrative and driving forces including their development pathways and outcomes. At one end of the spectrum, quantification, for example, may involve the use of simple number descriptors of trends, events, and other aspects of the scenario narrative (such as gross domestic product growth, population growth, emissions increase). Quantification could also involve more sophisticated representations of scenario pathways and outcomes and often this use of quantitative information is generated by mathematical models. Companies should undertake quantification in line with their evolving and maturing experience using scenarios. Not all companies necessarily need to elaborate on quantitative scenarios or use sophisticated quantitative models in order to achieve quantification at the outset.

2.5.3 Use of Models and Other Tools to Quantify

Formal models may be developed and applied at this stage to quantify the consequences of each scenario, flesh out possible secondary effects, and further check plausibility. A company also might use in-house models for forecasting product demand or commodity prices to inform its scenarios. Appendix 3 lists some commercially available and open source tools and datasets that may help companies quantify their scenarios.

2.6 Step 6: Scenario Updating

- **How frequently**
- **Amend current scenarios or zero-based**

Scenarios are not static and scenario analysis is not a one-time process. Just as a company's plans should be updated as circumstances change, so too should its scenarios — as inputs to those plans. Scenarios should be updated periodically. Some companies refresh their scenarios prior to each full strategic planning cycle, while companies in a turbulent environment may wish to update them more frequently. It is important to keep in mind that clear signals from climate-related developments in a company's environment may take some time to play out before being factored into a scenario analysis update. Refreshing scenarios may involve reviewing the previous scenarios and updating them where necessary, or it may involve a more extensive zero-based recreation of scenarios. Haigh[192] argues for a zero-based approach, saying that "developing new scenarios will help to counter any tendency to cling to existing scenarios."

Further Reading

Scenario Planning Handbook: Developing Strategies in Uncertain Times, Bill Ralston and Ian Wilson, 2006.

Scenario Planning for Climate Change: A Guide for Strategists, Nardia Haigh, 2019.

Scenarios: The Art of Strategic Conversation, Kees Van Der Heijden, 2005.

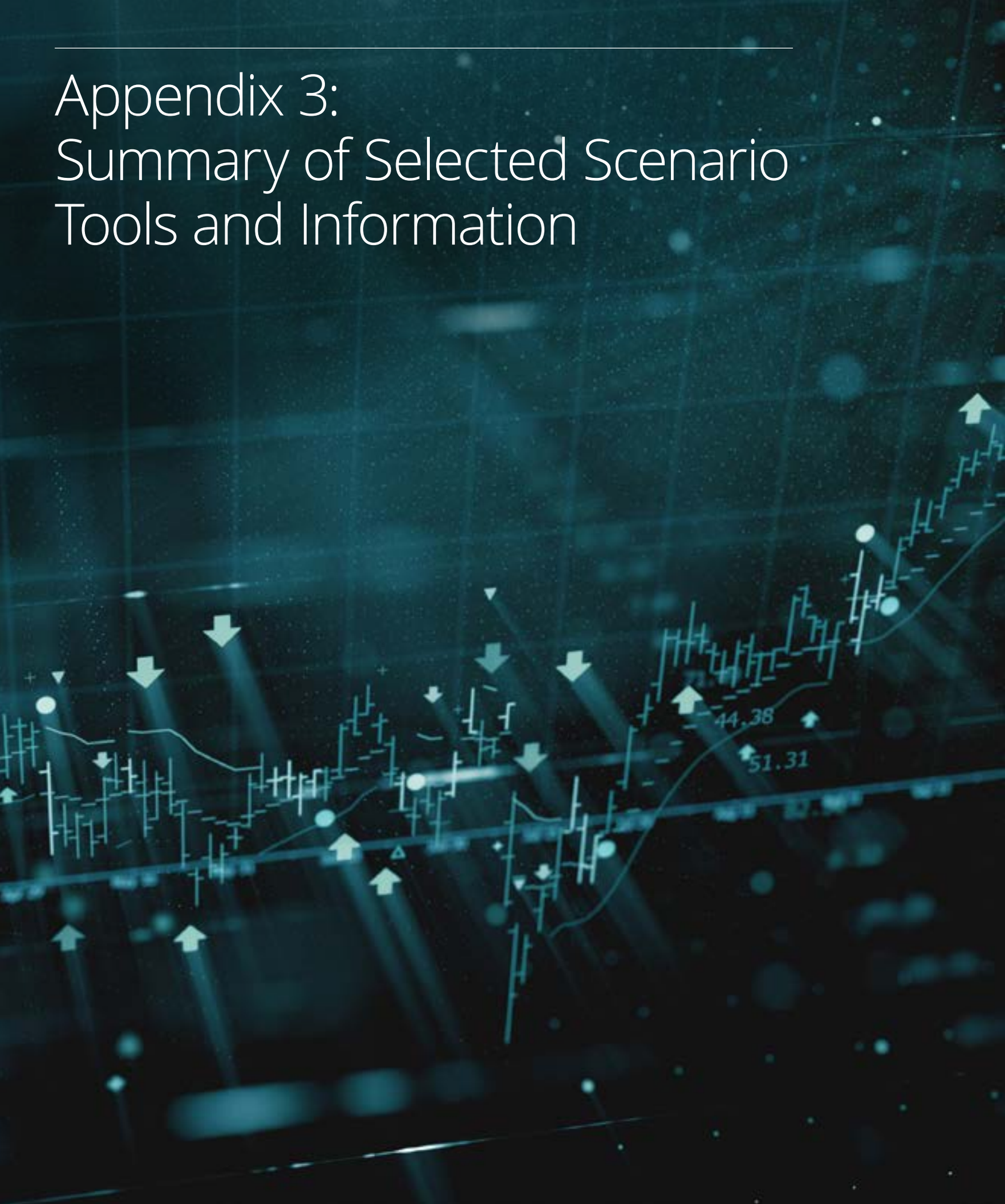
Scenario Planning in Organizations: How to Create, Use, and Assess Scenarios, Thomas J. Chermack, 2011.

Developing qualitative scenario storylines for environmental change assessment, Mark D. Rounsevell and Marc J. Metzger, WIREs Climate Change, 1: 606–619, 2010.

Methods of future and scenario analysis: overview, assessment, and selection criteria, DIE Research Project Development Policy, Bonn 2007 Deutsches Institut für Entwicklungspolitik ISBN 978-3-88985-375-2 (Kosow & Gabner, 2008).

[192] Haigh, *Scenario Planning for Climate Change: A Guide for Strategists*, 2019, p. 103.

Appendix 3: Summary of Selected Scenario Tools and Information



Appendix 3: Summary of Selected Scenario Tools and Information[193]

In using scenario analysis, companies should tailor their methodology, data, and scenarios to their particular business risks and opportunities. They should select an approach that is credible and applicable to their business and able to provide the desired outputs.

As part of their implementation efforts, companies are increasingly demanding tools, data, and information to support and facilitate their scenario analysis of climate-related risks. In response, there is a nascent and growing market of open source and commercial providers offering data, tools, and research to both support and conduct scenario analyses for physical and transition risks and opportunities. Further, methodological guidance is being developed to assist organizations in selecting and applying these resources.

The market is rapidly evolving in response to increasing stakeholder demands and the ongoing development of climate science. Individual providers are constantly evolving their offerings by developing new tools and resources, and expanding their coverage of geographic locations, sectors, emissions scenarios, time horizons, and risks and opportunities. Consolidation among providers is also occurring, providing for a larger scale and scope of services.

To assist companies in understanding and navigating the market of available scenario tools and data, the following tables summarize a selection of open source and commercial service providers. While exploring the various approaches outlined in the tables, readers should consider their company-specific circumstances, such as sector, geography, and relevant risks, in order to determine which approach best fits their needs. In addition, companies should carefully consider the methodologies employed by service providers. Of particular note should be the methods used to project emissions and temperature pathways and development paths of other company-important factors (e.g., assumptions, methods, logic), and methods used to downscale data to regional and local scales.

1. OVERVIEW OF THE CURRENT MARKET FOR SCENARIO SERVICES AND DATA

1.1 Providers offer a variety of approaches, ranging from climate data to analysis tools, for generating scenario analyses and climate risk assessments.

The solutions broadly fall under two categories: those that are designed to *conduct* a scenario analysis (Table A3-1, pp. 88–94) and those that provide data or information that can *support* a scenario analysis (Table A3-2, pp. 95–106). The former consists of analysis tools that assess the level of exposure or impact of climate-related risks and opportunities, based on a scenario analysis or climate risk assessment conducted on behalf of a client. The latter consists of providers that offer data, including research and analysis tools, which allows users to explore relevant climate-related risks and opportunities and prepare for a scenario analysis.

1.2 Most data and tools provide global coverage.

Most data and tools provide global coverage, albeit with varying levels of granularity (such as city level versus country level). Some data and tools focus on, or exclude, specific regions, but the majority cover more than 200 countries globally.

1.3 Most analysis tools are used within the financial sector, but can be adapted for other sectors.

Most analysis tools are primarily intended for use by the financial sector (e.g., banks, investors, asset managers), as outputs allow users to determine the climate-related risk of their investment portfolio, in addition to opportunity exposure and impacts. These tools use a bottom-up approach, whereby risks are assessed at the asset level and aggregated to the company or portfolio level. When selecting an approach, companies should assess how various methodologies correspond to their specific

[193] **Disclaimer:** Due to the rapidly evolving nature of the market, there may be new providers not represented in Tables A3-1 (pp. 88–94) and A3-2 (pp. 95–106), as well as acquisitions or partnerships that have occurred after initial research was conducted, and therefore may not be reflected. The tables are based solely on publicly available information retrieved from providers' websites and other relevant websites or publications. The information is not based on any additional consultation with the providers, and it is recommended that readers contact the providers directly for more information as needed. **The listing of any provider in the following tables does not represent, explicitly or implicitly, any endorsement, validation, or promotion of the provider, its approach, or its data by the TCFD or its members.** Rather, inclusion in the tables is solely a recognition that these providers advertise/offer relevant resources to support a scenario analysis. Companies should perform their own due diligence on providers' methodologies before engaging any third party to assist in conducting a scenario analysis.

needs. For example, financial companies may prefer a tool that is able to aggregate risks at the portfolio level, while a non-financial company may prefer one instead that is able to perform a detailed assessment of select assets.

1.4 The market for data and analysis tools on transition risks and opportunities is growing. However, some capabilities are limited and provider methodologies are often not disclosed.

Transition risks are more difficult to assess and quantify, yet there is an increasing number of providers that can support or conduct scenario analyses for transition risks and opportunities. However, companies will need to carefully evaluate the approaches used by service providers to know whether they are generating useful information regarding their specific climate-related risks. Further, service providers that conduct scenario analyses face limitations in their coverage and capabilities, such as shorter time horizons (e.g., some only extend 5–15 years into the future as opposed to 2050), less granularity of data (i.e., country or continent level), and a focus on specific sectors (i.e., the energy sector and energy-intensive industries).

There is also much less transparency in the methodology used to assess transition risks and opportunities. Descriptions of the methodologies for physical risk scenario analysis tools are quite detailed for some providers, as some provide the equations and data sources used; but this level of detail on methodology is often not disclosed for transition risks. This is likely due to the bespoke nature of the assumptions and scenarios used to conduct transition risk and opportunity assessments, as well as efforts to protect proprietary solutions.

1.5 Solutions are delivered through a range of platforms, although most are software-based analysis tools that are either proprietary or open source.

Some providers offer research and datasets, but many have developed software-based analysis tools that can either supplement or fully conduct a scenario analysis for climate-related risks and opportunities. Scenario analysis tools are typically proprietary and commercially available, resulting in limited publicly available information on data sources and methodology. For these tools, the analysis is typically conducted by the provider and outputs are made available for a fee.

Data and analysis tools that are web-based and open source (i.e., freely available) typically allow users to explore relevant trends related to climate-related risks and opportunities, which can be used as inputs to a scenario analysis. These tools can also be used to identify relevant risks and opportunities, which can help determine the scope of a scenario analysis.

1.6 Outputs range from exposure ratings to quantified financial impacts.

For tools that support a scenario analysis, outputs typically include trends related to climate, energy demand, or other socio-economic factors. Tools that conduct scenario analyses typically provide quantified financial impacts at both the asset and portfolio level, such as Value-at-Risk (VaR). Some tools also provide ratings, scores, or indicators (e.g., high, medium, and low risk) that are sometimes compared to benchmarks. Outputs are typically presented in time series plots or heat maps. Many platforms are interactive and some proprietary tools auto-generate reports for client use.

The value created by various outputs will depend on each company's needs. Some may seek quantified financial impacts of risks, while others may prefer qualitative or exposure-based outputs. When selecting an approach, companies should consider how they will use the information from their climate risk assessment in their risk management activities, strategic planning, and/or target setting, together with what types of outputs would be most desirable and meaningful. Finally, companies should evaluate any scoring or rating approaches to ensure that they are well supported on a scientific level, as well as whether benchmarking approaches are meaningful in a particular sector or industry.

2. EVALUATING TOOLS AND METHODOLOGIES

New research is emerging that is developing a technical foundation for climate-related risk assessment that informs methodological development and application. For instance, when selecting open source or commercial scenario tools or methodologies, or developing in-house capability for climate transition risk, companies should consider the following questions (Rose & Scott, 2020):

1. Are the following uncertainties considered and how?
   a. Temperature-emissions relationship?
   b. Global emissions pathway attainability?
   c. Policy design features?
   d. Non-climate-related reference conditions (e.g., markets, technology)?
2. Are global scenario results used and how are problematic issues addressed?
3. How is the company-specific context considered?
4. Is a uniform goal explicitly or implicitly imposed across companies, or are goals allowed to vary from one company to the next?
5. Given uncertainties, does the approach provide flexibility?
6. Is quantitative comparison of alternative strategies possible?
7. What is the approach for evaluating strategy robustness?
8. Is the full (system) value of company assets and investments considered?

Table A3-1

Selected Providers That Can Conduct a Scenario Analysis on Behalf of an Organization

Summary of Providers as of December 31, 2019

Note: The TCFD does not endorse or recommend any of these providers. Companies should perform their own due diligence before using any provider.

Legend:

Commercially available tools and data

Open source tools and data*

Name of Provider	Details		Web Link
2° Investing Initiative (2dii)	What services do they provide? Analysis Tool **Paris Agreement Capital Transition Assessment:** A free, web-based tool that analyzes exposure to climate-related transition risks in equity and fixed-income portfolios over multiple scenarios. (updated version pending for 2020) What are the outputs? Breakdown of portfolio exposure to low-carbon technology (benchmarked to market exposure) and graphs that show the alignment of technologies in the portfolio to different emissions scenarios; summarized in a customized, confidential report. What climate-related risks and opportunities are covered? Transition • Technology risks: Exposure to low-carbon and high-carbon activities across the fossil fuel, power, and automotive sectors	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** 2°C only **Time horizon:** 5 years (limited to time horizon of capital expenditures (CapEx) planning) What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Financial institutions **Sectors covered:** Focus on fossil fuel, power, and automotive (carbon-intensive) sectors What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global coverage **Resolution:** Can show regional exposure to high-carbon activities (e.g., coal mining) at country or continental level	Link
Acclimatise	What services do they provide? Analysis Tool **Aware for Projects™:** Offers an online tool that allows users to screen investments for climate risks by identifying hotspots of climate-related vulnerabilities. What are the outputs? • Indices that indicate vulnerability of organizations, populations, or infrastructure. • Provides a detailed report and graphical outputs including maps with hotspots of climate vulnerability. What climate-related risks and opportunities are covered? Both physical and transition • Physical risks: Multiple, including water stress, flooding, temperature change, and precipitation • Transition risks: Not disclosed	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Not disclosed **Time horizon:** Not disclosed What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Investors and corporations (details not disclosed) **Sectors covered:** Case studies are limited to oil and gas, mining, and international development banks. What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global coverage (referred to as "onshore and offshore") **Resolution:** Specific details not disclosed	Link

* It is important to note that some open source tools and data may have licensing restrictions. Users should review any relevant restrictions before selecting an approach.

Table A3-1: Selected Providers That Can Conduct a Scenario Analysis on Behalf of an Organization *(Continued)*

Name of Provider	Details		Web Link
Bloomberg Scenario Analysis Tool  *Included with access to Bloomberg Terminal*	What services do they provide? Analysis Tool **Physical Risk Assessment**: Maps assets against physical risks to highlight areas of exposure. **Scenario Analysis Tool:** Evaluates potential future CapEx at risk in the oil and gas industry under a 2°C scenario. What are the outputs? • **Physical Risk Assessment:** A map that highlights assets with greater exposure to specified physical risks. • **Scenario Analysis Tool:** Impact on CapEx and net present value. What climate-related risks and opportunities are covered? Both physical and transition • Physical Risk Assessment: Cyclones, floods, extreme heat, water stress, flood, storm surge, and wildfires • Scenario Analysis Tool: Changes to energy generation mix, changes to energy demand	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** • Physical Risk Assessment: 2°C and 4°C • Scenario Analysis Tool: 2°C scenario **Time horizon:** • Physical Risk Assessment: Up to 2040 (based on TD Bank case study) • Scenario Analysis Tool: Up to 2025 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Financial institutions **Sectors covered:** • Physical Risk Assessment: Any sector (case studies focus on energy and financial sectors) • Scenario Analysis Tool: Energy sector (focus on oil and gas) What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Not disclosed	Link 1 Link 2
Carbon Delta (an MSCI Company) 	What services do they provide? Analysis Tool **Climate VaR:** Provides investors with tools to measure the climate-related risks of their portfolio. What are the outputs? VaR (including impacts on cost, profit, and security valuation) aggregated at the sector, country, or portfolio level. What climate-related risks and opportunities are covered? Both physical and transition • Physical risks: Multiple, including heat, cold, wind, precipitation, snowfall, wildfires, hurricanes • Transition risks: Multiple, including carbon pricing,[194] green revenues from low-carbon technologies	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Multiple, including 3°C, 2°C, and 1.5°C **Time horizon:** 15 years into the future What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Financial institutions (investment managers, banks, asset owners, insurance companies). **Sectors covered:** All business sectors (22,000 companies and over 300,000 securities covered). Case studies include agriculture, services, manufacturing, mining and petroleum refining, construction, transportation, and utility service. What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Localized, downscaled data is available at the city level for most locations	Link

[194] A price on carbon emissions (typically expressed as a monetary value per ton of carbon dioxide equivalent) used as a policy mechanism to regulate emissions, usually in the form of an emissions trading system or carbon tax.

Table A3-1: Selected Providers That Can Conduct a Scenario Analysis on Behalf of an Organization *(Continued)*

Name of Provider	Details		Web Link
Carbone 4	What services do they provide? Analysis Tool **Mycris:** A high-level analysis of a company's exposure and vulnerability; used as a first step to identify relevant risks (free trial available). **Climate Risk Impact Screening (CRIS):** A more detailed assessment of climate risks at the company and portfolio level. What are the outputs? • A risk rating for securities and portfolios (ranging from 0 to 99), which can be compared to benchmark portfolios. • No evidence of financial outputs. What climate-related risks and opportunities are covered? Physical • Temperature rise, heat waves, drought, heavy rainfall events, sea level rise, extreme storm events	What emissions scenario(s) and time horizon(s) are covered? **Emission scenario(s):** Covers three (low, medium, and high emissions) Intergovernmental Panel on Climate Change (IPCC) scenarios **Time horizon:** 2050 and 2100 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Mycris focuses on the company level (sector not specified); CRIS designed for financial institutions. **Sectors covered:** All business sectors captured within 60 different "sectoral vulnerability profiles." Covers corporate, infrastructure, and sovereign assets. What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global (210 countries) **Resolution:** Not disclosed	Link
The Climate Service	What services do they provide? Analysis Tool **Climanomics:** A web-based software program that analyzes physical and transition risks in financial terms across multiple scenarios. What are the outputs? VaR (both revenue/expense and balance sheet impacts) aggregated from the asset level to the company level. What climate-related risks and opportunities are covered? Both physical and transition • Physical risks: Multiple, including extreme temperatures, coastal flooding, storms, drought, wildfire • Transition risks: Multiple, including carbon pricing, energy efficiency, materials cost, litigation risk, new technology	What emissions scenario(s) and time horizon(s) are covered? **Emission scenario(s):** Multiple Representative Concentration Pathway (RCP) scenarios (full range not disclosed) **Time horizon:** 2010–2100 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Provides specific tools for real estate, asset owners and managers, corporate sustainability and insurance. **Sectors covered:** Not disclosed What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Localized, downscaled data (resolution not disclosed)	Link

Table A3-1: Selected Providers That Can Conduct a Scenario Analysis on Behalf of an Organization *(Continued)*

Name of Provider	Details		Web Link
Four Twenty Seven (427) (with majority investment from Moody's Corporation)	What services do they provide? Analysis Tool **On-demand climate risk scoring:** Provides real-time screening of large portfolios through an online dashboard and full data downloads. **Company risk scores:** Evaluates listed company exposure to climate change hazards at the facility level, based on a database of over one million facilities linked to corporate parent entity. Also available for sovereigns and sub-sovereigns. What are the outputs? A climate risk score for each hazard compared to a country benchmark. If above the benchmark, the asset is given a "red flag" classification. **Company risk scores:** For each company, percent facility at low/medium/high risk for each hazard by country, as well as risk scores (1–100) for each hazard based on aggregate exposure of the company across its portfolio of facilities. What climate-related risks and opportunities are covered? Physical • Multiple, including flooding, hurricane-force winds, sea level rise, water stress, and heat stress	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** RCP 8.5 **Time horizon:** Up to 2040 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Financial institutions and corporations **Sectors covered:** All sectors covered, including energy, materials, consumer staples, information technology, utilities, real estate, and industrials. What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global (196 countries) **Resolution:** 25x25km for heat, precipitation, and cyclone risk, 90x90m resolution for flood risk and sea level rise, water basin for water stress	Link
ISS – Governance	What services do they provide? Data, Analysis Tool **Carbon Risk Rating:** Categorizes company's exposure to carbon risk as a result of business activities, at industry and sub-industry level. **Carbon and Climate Data:** Scope 1, 2, and 3 emissions for organizations. **Portfolio Climate Impact Report:** Provides detailed analyses of physical and transition risk exposure at the portfolio level. What are the outputs? **Carbon Risk Rating:** Score from 0 to 100 (ranging from "Laggard" to "Climate Leader") **Portfolio Climate Impact Report:** A summary report (details not disclosed) What climate-related risks and opportunities are covered? Both physical and transition • Details not disclosed	What emissions scenario(s) and time horizon(s) are covered? **Emission(s) scenarios:** 2°C, others not disclosed **Time horizon:** Not disclosed What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Financial institutions **Sectors covered:** All asset classes (details not disclosed) What geography is covered? At what resolution (if disclosed)? **Geography covered:** Not disclosed **Resolution:** Not disclosed	Link

Table A3-1: Selected Providers That Can Conduct a Scenario Analysis on Behalf of an Organization *(Continued)*

Name of Provider	Details		Web Link
Jupiter Intel	What services do they provide? Analysis Tool **ClimateScore™ Intelligence Platform:** Predicts the probability and climate impact of extreme weather events. Users can select parameters (probability threshold, type of hazard, scenario, etc.). What are the outputs? Hazard-specific outputs: For each asset. Financial outputs not disclosed. What climate-related risks and opportunities are covered? Physical • Multiple, including flood, fire, heat, drought, cold, wind, and hail events, supply chain disruptions	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Not disclosed **Time horizon:** Up to 50 years in the future What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Financial and public sector **Sectors covered:** Multiple asset types included (e.g., loading docks, hotel). Details not disclosed. What geography is covered? At what resolution (if disclosed)? **Geography covered:** New York City, South Florida, Houston, and Europe (global expansion is underway) **Resolution:** Hyper-local resolution (<1m for FloodScore™)	Link
Oasis HUB	What services do they provide? Analysis Tool **OASIS Loss Modelling Framework:** An open source, web-based tool that provides a platform for developing, deploying, and executing catastrophe models. Users input hazard, exposure, and vulnerability data and the tool calculates risk and financial cost of events. What are the outputs? Damage risk and potential financial cost of events (e.g., average annual losses), loss tables, and loss exceedance curves What climate-related risks and opportunities are covered? Physical • Fire, flood (additional hazards not disclosed)	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Not disclosed **Time horizon:** Not disclosed What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Primarily insurance and reinsurance, but seeks to provide tools and utility to all sectors **Sectors covered:** Not disclosed What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Not disclosed	Link 1 Link 2

Table A3-1: Selected Providers That Can Conduct a Scenario Analysis on Behalf of an Organization *(Continued)*

Name of Provider	Details		Web Link
Ortec Finance	What services do they provide? Analysis Tool, Data **Systemic Climate Risk Scenario Solution:** Proprietary, country-level scenarios to analyze portfolios at the sub-asset class level through a top-down approach. **Data:** Users can purchase the scenario datasets to perform their own analysis. What are the outputs? Impacts on average return and VaR under each scenario. Outputs are also plotted graphically. What climate-related risks and opportunities are covered? Both physical and transition • Physical risks: Multiple, including wildfires, coastal flooding, and effects on agricultural productivity • Transition risks: Multiple, including carbon pricing, energy efficiency programs, and phaseout of old technologies	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** 1.5°C, 2°C, and 4°C **Time horizon(s):** Up to 2100 with yearly granularity What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Financial institutions **Sectors covered:** Multiple (e.g., utilities). Details not disclosed. What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Not disclosed	Link
Vivid Economics (Net Zero Toolkit)	What services do they provide? Analysis Tool **Net Zero Toolkit:** Uses in-house models to estimate financial impacts of future climate policy under various scenarios. Scenarios are tailored for clients and results are estimated at the asset class, subclass, and asset level. What are the outputs? Quantified impacts on financial assets (details not disclosed) What climate-related risks and opportunities are covered? Transition • New technology, asset stranding, carbon pricing (full list not disclosed)	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Multiple (details not disclosed) **Time horizon:** Not disclosed What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Financial institutions **Sectors covered:** Energy, heavy industry, transport, agriculture, and construction What geography is covered? At what resolution (if disclosed)? **Geography covered:** UK (other regions not disclosed) **Resolution:** Not disclosed	Link

Table A3-1: Selected Providers That Can Conduct a Scenario Analysis on Behalf of an Organization *(Continued)*

Name of Provider	Details		Web Link
XDI *Easy XDI only* *All other tools*	What services do they provide? Analysis Tool **Easy XDI:** An open source tool for users to self-investigate climate risks at the asset level (not for commercial use, free version available). **XDI Globe:** Users access an online interactive platform to identify risk hotspots. **Adapt Infrastucture:** Assesses the effect of different adaptation measures on overall risk impact of particular hazards. What are the outputs? VaR and risk rankings. Outputs can be formatted into auto-generated report templates specified by the user (e.g., heat maps, graphs, etc.) What climate-related risks and opportunities are covered? Physical • Multiple, including forest fire, riverine/ fluvial flooding, overland/pluvial flooding, coastal inundation, heat extremes, subsidence (soil movement due to drought), extreme wind, freeze-thaw	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** RCP 8.5 (high emissions scenario) is used for stress testing. Additional scenarios not disclosed. **Time horizon:** Up to 2100, available in single-year time steps What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Designed for decision-makers, financial managers, and investors. **Sectors covered:** 94 different asset types available. Can also develop custom asset types for clients (for a fee). Existing asset archetypes include water, power, and communication networks; transportation; housing; commercial and industrial buildings; and health infrastructure. What geography is covered? At what resolution (if disclosed)? **Geography covered:** North and South America, Europe, Africa, East Asia, Australia, New Zealand **Resolution:** 10x10km, and 5x5m for flooding	Link

Table A3-2

Selected Scenario Tool and Data Providers

Note: The TCFD does not endorse or recommend any of these providers. Companies should perform their own due diligence before using any provider.

Legend:

Commercially available tools and data

Open source tools and data*

Name of Provider	Details		Web Link
Bloomberg (New Energy Outlook, Carbon Footprint Tool) *Included with access to Bloomberg Terminal*	What services do they provide? Data **New Energy Outlook:** Provides annual forecasts (production generation, trends, etc.) on energy and transportation. **Carbon Footprint Tool:** Provides data on company's emissions and compares to benchmarks. What are the outputs? **New Energy Outlook:** Energy trends (e.g., projections of power generation mix to 2050) **Carbon Footprint Tool:** Scope 1, 2, and 3 greenhouse gas emissions What climate-related risks and opportunities are covered? Transition • New Energy Outlook: Changes to energy generation mix, changes to energy demand. • Carbon Footprint Tool: Can be used to support analysis of transition risks such as carbon pricing.	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** • New Energy Outlook: Not disclosed • Carbon Footprint Tool: N/A **Time horizon:** • New Energy Outlook: Up to 2050 • Carbon Footprint Tool: N/A What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** • New Energy Outlook: Financial institutions, energy sector, energy-intensive sectors • Carbon Footprint Tool: Any sector **Sectors covered:** Same as above What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global coverage at the country level for the New Energy Outlook. **Resolution:** Not disclosed	Link 1 Link 2
Carbon Tracker Initiative	What services do they provide? Analysis Tool, Data (research) **2°C Scenario Analysis Tool:** See Bloomberg in Table A3-1 (p. 89) for details. **Data:** Publishes reports on the energy sector's transition to a low-carbon economy[195] in various scenarios. What are the outputs? Research reports, including recommendations, frameworks, and market insights, that can be used to support or guide a scenario analysis. What climate-related risks and opportunities are covered? Physical • Multiple datasets available, including sea level rise, heat waves, and cold spells	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Multiple International Energy Agency (IEA) and IPCC scenarios (depends on report)[196] **Time horizon:** Depends on report[197] What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Any (most relevant for financial institutions, energy sector, and energy-intensive sectors) **Sectors covered:** Focus on coal, oil, and gas What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Not disclosed	Link

[195] Noteworthy reports include *Breaking the Habit* and *The Speed of the Energy Transition.*

[196] *Breaking the Habit* report explores 1.5–2.7°C emissions scenarios.

[197] *Breaking the Habit* report explores scenarios up to 2040.

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
Climate Impact Lab	What services do they provide? Analysis Tool **The Climate Impact Lab:** (under development) Platform will provide projections of future climate impacts on various social indicators (health, labor, productivity, energy, conflict, etc.). Data **The Climate Impact Map:** An open source, web-based platform that allows users to access climate projections under various emissions scenarios. What are the outputs? **Climate Impact Lab:** Financial loss (e.g., loss of market value), relative exposure to climate risks (by sector and geography), change in energy demand **Climate Impact Map:** Climate projections (e.g., temperature) displayed on a heat map What climate-related risks and opportunities are covered? Both physical and transition • Climate Impact Lab: Not defined (depends on user's interpretation and use of information) • Climate Impact Map: Sea level rise, temperature, precipitation, humidity	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** • Climate Impact Lab: Not disclosed • Climate Impact Map: RCP 2.6, 4.5, 6.0, 8.5 **Time horizon:** • Climate Impact Lab: Not disclosed • Climate Impact Map: Up to 2100 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** • Climate Impact Lab Tool: Not disclosed • Climate Impact Map: Not customized for any sector(s) What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Not disclosed	Link 1 Link 2
Copernicus	What services do they provide? Data **Climate Data Store:** Provides freely available climate data through their Climate Data Store, which can be tailored to public or commercial needs. Also provides training to users of their data. What are the outputs? Time series plots, and maps showing historical or projected climate impacts. What climate-related risks and opportunities are covered? Transition • Risks related to the energy transition (shifting to low-carbon sources of energy).	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Depends on dataset (some cover RCP 2.6–RCP 8.5) **Time horizon:** Depends on dataset. Most datasets are historical rather than forward-looking. What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** Not defined (depends on user's interpretation and use of information) What geography is covered? At what resolution (if disclosed)? **Geography covered:** Depends on the dataset. Most focus on Europe. **Resolution:** Not disclosed	Link

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
En-ROADs (Developed by Climate Interactive, Ventana Systems, and MIT Sloan)	What services do they provide? Analysis Tool **Policy Simulation Model:** A freely available policy simulation model that allows users to explore the consequences of climate-related policies and uncertainties. The user can toggle variables (e.g., carbon price, energy supply breakdown, population, global temperature, etc.) to determine the relationship between all variables. What are the outputs? Interactive time series plots for each selected variable. What climate-related risks and opportunities are covered? Transition • Can be applicable to multiple transition risks, depending on the variables being analyzed. • Includes carbon price, technology, energy costs, and demand.	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** User creates own scenarios between 1.5°C and 4.5°C. **Time horizon:** Up to 2100 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** Not defined (depends on user's interpretation and use of information) What geography is covered? At what resolution (if disclosed)? **Geography covered:** (not disaggregated by region) **Resolution:** Not disclosed	Link

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
ERM	What services do they provide? Analysis Tool **Climate Financial Driver Analysis (CFDA):** Screening of transition and physical risks and opportunities using a proprietary tool; financial impact analysis of transition and physical risks and opportunities. CFDA customized for each client according to key geographies, operations, and value chains. **Climate Data Tool (CDT):** Climate physical data for any global location, providing data across all climate event types. Data includes global sources, as well as local datasets. What are the outputs? **CFDA:** For identification of material climate-related risks and opportunities, customizable across scenarios. Estimation and sensitivity analysis of financial impact under different scenarios. **CDT:** Tool that enables technically appraised data from quality open source providers showing climate change baseline and trends over any timeframe out to 2030, 2050, and 2100. What climate-related risks and opportunities are covered? Both transition and physical • Transition risks: Policy and legal, market/technology. • Physical risks: Acute and chronic, including cyclones and storms, floods, extreme heat and cold, water stress, landslides, and wildfires.	What emissions scenario(s) and time horizon(s) are covered? Transition • Approach is customizable and can use any scenario, including all IEA scenarios and IPCC 1.5°C scenarios. Physical • IPCC RCP 2.6, 4.5, and 8.5, as well as downscaled data where required. What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** All sectors What geography is covered? At what resolution (if disclosed)? Transition • Global, regional, and national, depending on the scenario selected. Physical • Global and local. Resolution varies, including data at a few meters for flood data.	Link

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
IEA	What services do they provide? Data **World Energy Outlook:** Published annually and projects global energy supply and demand, and provides detailed scenarios that map out the consequences of different energy policy and investment choices. What are the outputs? Scenarios and trends that can be used as inputs for a transition risk/opportunity scenario analysis. What climate-related risks and opportunities are covered? Transition • Depends on user application; most applicable to carbon pricing and demand for various types of energy.	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Scenarios that align with various temperature outcomes. **Time horizon:** Projections in 2019 report extend to 2040. Energy sector CO_2 emissions only. What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Not defined (depends on user's interpretation and use of information). Directly applicable to energy sector or energy-intensive sectors. **Sectors covered:** Energy sector What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global (trends are also divided by country) **Resolution:** Not disclosed	Link
Integrated Assessment Modeling Consortium (IAMC)	What services do they provide? Data **IAMC 1.5°C Scenario Explorer:** An interactive dashboard that presents quantified socioeconomic factors (e.g., land use, energy demand, carbon price) under multiple scenarios, based on models used by the IPCC. **Scenario database developed for the IPCC's Fifth Assessment Report:** Additional scenarios literature and resources (Database for the IPCC's Sixth Assessment Report is currently under development). What are the outputs? Time series plots for select factors (e.g., carbon price, per capita meat consumption, land use, etc.) in select scenarios and regions. What climate-related risks and opportunities are covered? Transition • Not defined. Can be used as an input to support a transition risk analysis for a variety of transition risks (based on user context and interpretation).	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** 1.5°C, 2°C, and higher (e.g., 3˚C, 4˚C) **Time horizon:** Up to 2100 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** Not defined (depends on user's interpretation and use of information) What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Data can be disaggregated into: Organisation for Economic Co-operation and Development + EU, Asia, Latin America and Caribbean, Middle East and Africa.	Link 1 Link 2

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
Inevitable Policy Response	What services do they provide? Analysis Tool Free-to-use tool and analysis on the abrupt transition scenario. What are the outputs? Policy, energy system, and financial analysis of a policy shock to financial markets. Data tables and an Excel tool are also provided. What climate-related risks and opportunities are covered? Analysis of market risks and opportunities in equities, fixed income, private equity, and infrastructure.	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Transition risks **Time horizon:** Up to 2100 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** All sectors What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Not disclosed	Link
Moody's Investor Service	What services do they provide? Analysis Tool, Data **Carbon Transition Assessment (CTA):** Provides sector-specific forward-looking scoring of corporate issuers based on exposure to and mitigation of transition risks (under development). **Data:** Country ratings based on sovereign credits' vulnerability to physical climate risk. What are the outputs? Sector ratings and scorecards: Corporate CTA scores indicating materiality of carbon transition for the issuer. What climate-related risks and opportunities are covered? Physical (transition pending) • Physical risks: Warming, snow cover, sea level rise, drought, wildfire, floods, storms, and cyclones. • Transition risks and opportunities under CTA.	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Not disclosed. **Time horizon:** • Sovereign ratings: Not disclosed. • CTA: Up to 15 years for longer-term resilience against IEA Sustainable Development Scenario. What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Generally applicable. Specific sectors or limitations not disclosed. **Sectors covered:** For CTA, carbon-intensive sectors are covered: Power, Oil and Gas, Autos, Airlines, Shipping, Cement, and Steel. What geography is covered? At what resolution (if disclosed)? • Sovereign ratings: Certain regions in South America, Africa, Middle East, and Asia as well as Greenland are not considered. • CTA: Applied globally to Moody's rated universe of issuers in the sectors.	Link 1 Link 2 Link 3

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
Moody's Analytics	What services do they provide? Data and analytic tools that leverage Moody's credit risk models and quantifies climate impacts in financial terms. What are the outputs? Climate-adjusted probability of default (Expected Default Frequency), VaR, Cross Industry/Sector, and Geolocation Overlay metrics to adjust internal rating, stress testing models, and scorecards. What climate-related risks and opportunities are covered? Both physical and transition risks • Includes risks and opportunities across all asset classes from sovereign, corporate, private firms, CRE, etc.	What emissions scenario(s) and time horizon(s) are covered? Aligned with the Network for Greening the Financial System (orderly transition scenario, late/disorderly transition scenario, and a "hot house" scenario), time horizons up to 30 years. Beyond, proceed to simulate macroeconomic and financial series (a combination of "real-life" (deterministic) paths and "stochastic" (simulated) projections) and offer flexibility to select any scenarios. What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** All What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Not disclosed	Link
NCAR	What services do they provide? Data Open source models, datasets, software tools, and user guides; analysis and visualization software for climate risk. What are the outputs? Datasets for physical risk (e.g., climate projections) What climate-related risks and opportunities are covered? Physical • Includes temperature, sea ice thickness, precipitation (full list not disclosed).	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Not disclosed **Time horizon:** Depends on dataset (some go to 2099) What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** Not defined (depends on user's interpretation and use of information) What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Not disclosed	Link 1 Link 2

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
Schroders (Carbon VaR only) Climate Progress Dashboard	What services do they provide? Analysis Tool **Carbon VaR:** A tool that provides an analysis of the impact of carbon pricing on cost structures and profits. **Climate Progress Dashboard:** Open source projections of various political and market trends in line with different emissions scenarios. What are the outputs? **Carbon VaR:** Impacts on profitability and demand, overall Value-at-Risk (from carbon pricing only). **Climate Progress Dashboard:** Graphs that correlate various external factors (e.g., fossil fuel production, renewable energy capacity) to multiple emissions scenarios. What climate-related risks and opportunities are covered? Transition • **Carbon VaR:** Carbon pricing • **Climate Progress Dashboard:** New technology (e.g., renewable energy capacity, electric vehicle adoption, market shifts, consumer preferences/concerns)	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** • Carbon VaR: Not disclosed • Climate Progress Dashboard: 2°C, 4°C, 6°C **Time horizon:** • Carbon VaR: Not disclosed • Climate Progress Dashboard: Up to 2025 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** • Carbon VaR: Multiple. Not specified • Climate Progress Dashboard: Can be applied to any relevant sectors **Sectors covered:** Same as above What geography is covered? At what resolution (if disclosed)? **Carbon VaR:** Has been applied to a global universe of public companies **Climate Progress Dashboard:** Not disclosed (based on data from international organizations)	Link 1 Link 2
Science Based Targets Initiative (SBTi)	What services do they provide? Analysis Tool Provide methodologies to support CO_2 target setting in alignment with <2° scenarios. What are the outputs? Defined pathways specifying how much and how quickly a company needs to reduce its greenhouse gas emissions. What climate-related risks and opportunities are covered? Transition	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** 1.5° Aligned Pathways **Time horizon:** Not disclosed What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** Apparel, Chemicals and Petrochemicals, Financial Institutions, Oil and Gas, Transport, Power Sector, Forest, Land and Agriculture, and Information and Communication Technology What geography is covered? At what resolution (if disclosed)? **Geography covered:** N/A **Resolution:** N/A	Link

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
SENSES Toolkit Potsdam Institute for Climate Impact Research	What services do they provide? Analysis Tool **The SENSES Toolkit:** Modules to help companies understand and communicate climate change scenarios. The modules utilize visualizations in an explanatory or exploratory way. What are the outputs? **Scenario Finder:** Allows you to quickly filter all available scenarios from the IAMC 1.5 database. **Scenario Explorer:** Presents an ensemble of quantitative, model-based climate change mitigation pathways. What climate-related risks and opportunities are covered? Both transition and physical	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Scenarios from the IAMC 1.5 database **Time horizon:** Aligned with the IAMC scenarios What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** N/A What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global and regional **Resolution:** Not disclosed	Link 1 Link 2
Transition Pathway Initiative (TPI)	What services do they provide? Analysis Tool An open source tool that assesses trends in emissions and rates the management of emissions and climate-related risks at the company and sector level. What are the outputs? Company ratings (from 0–4) of management of climate-related risks aggregated at the sector level. Time series plots of emissions intensity by company. What climate-related risks and opportunities are covered? Transition • Not specified, but relevant to carbon pricing and the energy transition	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** N/A **Time horizon:** Current state What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Not defined (depends on user's interpretation and use of information). **Sectors covered:** Multiple, including energy, manufacturing, industrial, transportation, etc. What geography is covered? At what resolution (if disclosed)? **Geography covered:** Companies span multiple regions, (e.g., North America, Europe, Asia). **Resolution:** Company level	Link

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
Trucost, part of S&P Global	What services do they provide? Data **Carbon Earnings at Risk:** Dataset that can be used to stress test a company's current ability to absorb future carbon prices and understand potential earnings at risk from carbon pricing on a portfolio level. **Trucost's Physical Risk:** Dataset that can be used to assess company exposure to physical risk at the asset level, based on a database of over 500,000 assets linked to 15,000+ listed companies. The dataset covers seven climate hazards under three different climate change scenarios. TCFD-aligned company and portfolio reporting services are also available covering both datasets. What are the outputs? **Carbon Earnings at Risk:** Unpriced carbon cost (expressed in impact on earnings before interest, taxes, depreciation, and amortization and/or profit margin) at the company and portfolio level. **Physical Risk:** Asset-level physical risk scores from 1 (lowest risk) to 100 (highest risk) across different climate hazards aggregated at the company and portfolio level. What climate-related risks and opportunities are covered? Both transition and physical • Transition risk: Carbon pricing risk. • Physical Risk: Physical risks including heat waves, cold waves, flooding, hurricanes, sea level rise, water stress, and wildfire.	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** • Carbon Earnings at Risk: Low (business as usual), Moderate (delayed action but aligned with Paris Agreement), High (fully aligned with Paris Agreement) • Physical Risk: Low (RCP 2.6), Moderate (RCP 4.5), High (RCP 8.5) **Time horizon:** • Carbon Earnings at Risk: 2020 to 2050 • Physical Risk: 2020, 2030, and 2050 What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Companies and Financial Institutions. **Sectors covered:** • Carbon Earnings at Risk: All sectors (coverage on 15,000+ companies). • Physical Risk: All sectors (coverage on 15,000+ companies and 500,000 underlying assets). What geography is covered? At what resolution (if disclosed)? **Geography covered:** • Carbon Earnings at Risk: Global (carbon price data for 44 jurisdictions) • Physical Risk: Global **Resolution:** Company level	Link

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
UK CIP	What services do they provide? Analysis Tool **Climate Adaptation Wizard:** Provides a framework and resources to help companies generate information to inform their own adaptation strategy. What are the outputs? Five-step process to help assess an organization's vulnerability to current and future climate change, identify options to address risks, and help develop and implement a climate change adaptation strategy. What climate-related risks and opportunities are covered? Physical risk	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** A set of four national level socioeconomic scenarios developed for use in UK-wide climate impacts and adaptation assessments. **Time horizon:** Depends on scenario What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** N/A **Sectors covered:** Agriculture and forestry; Business, industries, and services; Health and well-being; Natural environment; Buildings and infrastructure. What geography is covered? At what resolution (if disclosed)? **Geography covered:** United Kingdom, but methods and tools useful generally **Resolution:** Company level	Link
Vigeo Eiris (Moody's)	What services do they provide? Analysis Tool **Energy Transition Rating:** Provides a rating of the quality of strategic management to address risks and opportunities associated with the transition to a low-carbon economy. **Brown Share Assessment:** An assessment of corporate exposure to fossil fuels and potential emissions. **Green Share Assessment:** Share of revenues derived from the sale of green products and services. **Physical Risk Management:** Company assessment of its ability to anticipate, prevent, and manage the physical risks of climate change. **TCFD Climate Strategy Assessment:** An assessment of the degree to which climate change has been incorporated into corporate strategy. **Climate Controversies Assessment:** Real-time information on climate-related allegations against companies, and an opinion on companies' mitigation efforts regarding climate controversies. What are the outputs? See above. What climate-related risks and opportunities are covered? Both transition and physical	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Carbon Footprint Assessment; Scope 1, Scope 2, and Scope 3 emissions data for companies and sovereigns. **Time horizon:** Multiple What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended user:** All **Sectors covered:** All What geography is covered? At what resolution (if disclosed)? **Geography covered:** N/A **Resolution:** N/A	Link

Table A3-2: Selected Scenario Tool and Data Providers *(Continued)*

Name of Provider	Details		Web Link
Vivid Economics (ViEW)	What services do they provide? Analysis Tool **ViEW:** A dynamic model of economic activity, energy production, CO_2 emissions, and trade flows that can represent different countries. What are the outputs? Costs and benefits of different carbon policy options at the country or sector level (can be integrated with bottom-up models to provide a detailed analysis of individual sectors). What climate-related risks and opportunities are covered? Transition • Not specified, but relevant to carbon pricing and energy demand.	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** Not disclosed **Time horizon:** Not disclosed What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Not defined (depends on user's interpretation and use of information). **Sectors covered:** Energy sectors (renewable and non-renewable). Non-energy includes up to 12 agricultural sectors and 25 manufacturing sectors. What geography is covered? At what resolution (if disclosed)? **Geography covered:** Not disclosed **Resolution:** Not disclosed	Link
World Bank Global Facility for Disaster Reduction and Recovery	What services do they provide? Analysis Tool **ThinkHazard!:** A free, web-based tool that assesses the level of physical climate hazards for a user-specified location and provides guidance on how to reduce risks associated with development projects. What are the outputs? A map with highlighted regions based on hazard categories (very low, low, medium, high) and high-level recommendations to reduce associated risks. What climate-related risks and opportunities are covered? Physical • River flood, urban flood, coastal flood, cyclone, water scarcity, extreme heat, wildfire	What emissions scenario(s) and time horizon(s) are covered? **Emissions scenario(s):** N/A – current state **Time horizon:** Not disclosed What sectors can use this tool/data? What sectors are covered by the data or analysis? **Intended users:** Investors or stakeholders in development projects, development sector **Sectors covered:** Development projects and related assets What geography is covered? At what resolution (if disclosed)? **Geography covered:** Global **Resolution:** Not disclosed	Link

Appendix 4: Interviewed Organizations

Appendix 4: Interviewed Organizations

Company	Country	Sector
Aurizon	Australia	Transportation
BASF	Germany	Materials
BHP	Australia	Materials
China Power & Light (CPL)	Hong Kong SAR	Utilities
ENEL	Italy	Utilities
Kirin	Japan	Consumer Staples
Lafarge-Holcim	Switzerland	Materials
Lendlease	Australia	Real Estate
Mondi	UK	Materials
Nestlé	Switzerland	Consumer Staples
Olam	Singapore	Consumer Staples
South32	Australia	Materials
Syngenta	Switzerland	Materials
Unilever	UK	Consumer Staples
Vopak	Netherlands	Energy & Industrial

Glossary and Abbreviations

Glossary and Abbreviations[198]

GLOSSARY

ADAPTATION in human systems is the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.

- Incremental adaptation – Adaptation that maintains the essence and integrity of a system or process at a given scale. In some cases, incremental adaptation can accrue to result in transformational adaptation.
- Transformational adaptation – Adaptation that changes the fundamental attributes of a socioecological system in anticipation of climate change and its impacts.
- Adaptation limit – The point at which objectives (or system needs) cannot be secured from intolerable risks through adaptive actions.
  - Hard adaptation limit: No adaptive actions are possible that can avoid intolerable risks.
  - Soft adaptation limit: Options are currently not available to avoid intolerable risks through adaptive action.

CLIMATE MODEL is a numerical representation of the climate system based on the physical, chemical, and biological properties of its components, their interactions and feedback processes, and accounting for some of its known properties. The climate system can be represented by models of varying complexity; that is, for any one component or combination of components, a spectrum or hierarchy of models can be identified. They differ, in such aspects as the number of spatial dimensions, the extent to which physical, chemical, or biological processes are explicitly represented, or the level at which empirical approximations of complex or small-scale processes (parametrizations) are involved. There is an evolution toward more complex models with interactive chemistry and biology. Climate models are applied as a research tool to study and simulate the climate and for operational purposes, including the production of monthly, seasonal, and interannual climate predictions.

DOWNSCALING is a method that derives local-to-regional-scale (up to 100 km) information from larger-scale models or data analyses. Two main methods exist: dynamical downscaling and empirical/statistical downscaling. The dynamical method uses the output of regional climate models, global models with variable spatial resolution, or high-resolution global models. The empirical/statistical methods are based on observations and develop statistical relationships that link the large-scale atmospheric variables with local/regional climate variables. In all cases, the quality of the driving model remains an important limitation on quality of the downscaled information. The two methods can be combined (e.g., applying empirical/statistical downscaling to the output of a regional climate model, consisting of a dynamical downscaling of a global climate model).

DRIVING FORCE is a force driving the possible outcome of a critical uncertainty and has a relatively high level of explanatory power in relation to the situation being looked at.[199]

EXPOSURE is the presence of people, livelihoods, species or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected.

EXTREME WEATHER EVENT is an event that is "rare" at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as, or rarer than, the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classified as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season).

FINANCIAL IMPACT is when financial items such as physical assets, capital expenditures, operational expenditures, and revenues are affected, whether positively or negatively.[200]

[198] Unless otherwise noted, all terms and definitions in the Glossary are from IPCC, "Special Report – A Global Warming of 1.5°C – Glossary," 2018.

[199] Van Der Heijden, Kees, *Scenarios: The Art of Strategic Conversation*, West Sussex, UK: Wiley, 2010.

[200] Definition developed for this guidance.

HAZARD is the potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health effects, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems, and environmental resources. In this report, the term "hazard" usually refers to climate-related physical events or trends or their physical impacts.

HORIZON YEAR is the chosen cutoff time in the future of the scenario stories.[201]

IMPACTS (Consequences, Outcomes) are the effects on natural and human systems. In this report, the term "impact" is used primarily to refer to the effects on natural and human systems of extreme weather and climate events and of climate change. Impacts generally refer to effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure due to the interaction of climate changes or hazardous climate events occurring within a specific time period, and the vulnerability of an exposed society or system. Impacts are also referred to as consequences and outcomes. The impacts of climate change on geophysical systems, including floods, droughts, and sea level rise, are a subset of impacts called physical impacts.

IMPACT ASSESSMENT is the practice of identifying and evaluating, in monetary and/or non-monetary terms, the effects of climate change on natural and human systems.

INTEGRATED ASSESSMENT is a method of analysis that combines results and models from the physical, biological, economic, and social sciences and the interactions among these components. This is done in a consistent framework to evaluate the status and the consequences of environmental change and the policy responses to it. See also Integrated Assessment Models (IAMs).

INTEGRATED ASSESSMENT MODELS (IAMS) are models that integrate knowledge from two or more domains into a single framework. They are one of the main tools for undertaking integrated assessments. One class of IAM used in respect of climate change mitigation may include representations of multiple sectors of the economy, such as energy, land use, and land-use change; interactions between sectors; the economy as a whole; associated GHG emissions and sinks; and reduced representations of the climate system. This class of model is used to assess linkages between economic, social, and technological development and the evolution of the climate system. Another class of IAM additionally includes representations of the costs associated with climate change impacts, but includes less-detailed representations of economic systems. These can be used to assess impacts and mitigation in a cost–benefit framework and have been used to estimate the social cost of carbon.

NARRATIVES are qualitative descriptions of plausible future world evolution, describing the characteristics, general logic, and developments underlying a particular quantitative set of scenarios. Narratives are also referred to in the literature as "storylines." See also Scenarios, Scenario Storyline.

PATHWAYS are the temporal evolution of natural and/or human systems toward a future state. Pathway concepts range from sets of quantitative and qualitative scenarios or narratives of potential futures, to solution-oriented decision-making processes to achieve desirable societal goals. Pathway approaches typically focus on biophysical, techno-economic, and/or socio-behavioral trajectories and involve various dynamics, goals, and actors across different scales. Types of pathways include Adaptation pathways, Development pathways, Emissions pathways, Mitigation pathways, Overshoot pathways, Non-overshoot pathways, Representative Concentration Pathways, Shared Socioeconomic Pathways, and Transformative pathways.

QUALITATIVE SCENARIO ANALYSIS is analysis that focuses on the identification of trends and on the overarching narratives of the scenarios, often providing insight into less quantifiable company characteristics such as strategy, agility, philosophy, vision, and culture. This kind of analysis can weave together multiple trends of various scales and complexity into a narrative to provide context relevant to a company's strategy.[202]

QUANTITATIVE SCENARIO ANALYSIS is analysis that refers to the use of quantified information within a scenario. It can take many forms, from numerical descriptions of trends and other factors, to the use of techniques such as trend analysis, sensitivity analysis, and modeling of a company's climate-related risks.[203]

[201] Definition developed for this guidance.

[202] MIT, *Climate-related Financial Disclosures: Use of Scenarios*, Office of the Vice President for Research, Cambridge, MA: Massachusetts Institute of Technology, 2019.

[203] Ibid.

RESILIENCE is the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure while also maintaining the capacity for adaptation, learning, and transformation.

RISK is the potential for adverse consequences from a climate-related hazard for human and natural systems. These result from the interactions between the hazard and the vulnerability and exposure of the affected system. Risk integrates the likelihood of exposure to a hazard and the magnitude of its impact. Risk also can describe the potential for adverse consequences of adaptation or emission mitigation responses to climate change.

RISK MANAGEMENT is the process of identifying potential threats, assessing organizational vulnerabilities, determining risks, and implementing appropriate risk management techniques to minimize the negative impact they may have on an organization. The most common types of risk management techniques include avoidance, mitigation, transfer, and acceptance.[204]

SCENARIOS are a plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are used to provide a view of the implications of developments and actions.

- **BASELINE OR REFERENCE SCENARIO**, in much of the literature, is synonymous with the term business as usual scenario, although the term "BAU" has fallen out of favor because the idea of business as usual in century-long socioeconomic projections is hard to fathom. In the context of transformation pathways, the term "baseline" refers to scenarios that are based on the assumption that no emission mitigation policies or measures will be implemented beyond those that are already in force and/or are legislated or planned to be adopted. Baseline scenarios are not intended to be predictions of the future, but rather counterfactual constructions that can serve to highlight the level of emissions that would occur without further policy effort. Typically, baseline scenarios are then compared to emission mitigation scenarios that are constructed to meet different goals for greenhouse gas emissions, atmospheric concentration, or temperature change. The term "baseline scenario" is often used interchangeably with "reference scenario" and "no policy scenario."
- **EMISSION SCENARIO** is a plausible representation of the future development of emissions of substances that are radiatively active (e.g., greenhouse gases, aerosols). It is based on a coherent and internally consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change, energy, and land use) and their key relationships. Concentration scenarios, derived from emission scenarios, are often used as input to a climate model to compute climate projections.
- **MITIGATION SCENARIO** is a plausible description of the future that describes how the (studied) system responds to the implementation of mitigation policies and measures.
- **SOCIOECONOMIC SCENARIO** is a scenario that describes a possible future in terms of population, gross domestic product, and other socioeconomic factors relevant to understanding the implications of climate change.

SCENARIO OUTCOME refers to the endpoint of a scenario, usually a temperature target such as limiting the level of temperature rise by 2100 to 2°C.[205]

SCENARIO PATHWAYS refer to the political, technological, and economic developments and associated risk drivers (e.g., which sectors and regions bear the most emissions reductions, or which energy technologies win out in different economies) that lead to a particular scenario outcome; there can be distinctively different pathways leading to the same outcome. Also see Pathways.[206]

SCENARIO STORYLINE is a narrative description of a scenario (or family of scenarios), highlighting the main scenario characteristics, relationships between key driving forces, and the dynamics of their evolution. Also referred to as "narratives" in the scenario literature.

[204] Definition developed for this guidance.

[205] MIT, *Climate-related Financial Disclosures: Use of Scenarios*, Office of the Vice President for Research, Cambridge, MA: Massachusetts Institute of Technology, 2019.

[206] Ibid.

SOCIAL COSTS are the full costs of an action in terms of social welfare losses, including external costs associated with the impacts of this action on the environment, the economy (GDP, employment), and on the society as a whole.

SOCIAL-ECOLOGICAL SYSTEMS are integrated systems that include human societies and ecosystems, in which humans are part of nature. Their functions arise from the interactions and interdependence of the social and ecological subsystems. The system's structure is characterized by reciprocal feedbacks, emphasizing that humans are a part of, not apart from, nature.

STRANDED ASSETS are assets exposed to devaluation or conversion to "liabilities" because of unanticipated changes in their initially expected revenues. These may be due to innovations and/or evolution of the business context, including changes in public regulations at the domestic and international levels.

STRATEGY RESILIENCE is the characteristic of a company's strategy that allows it to adapt to climate-related changes materially affecting its business, while maintaining operations and profitability and safeguarding people, assets, and overall reputation. Strategy resilience has two main pillars: vulnerability and preparedness. Vulnerability incorporates the elements of exposure, sensitivity, and adaptive capacity. Preparedness incorporates the elements of strategic planning and adaptive capacity. Strategic planning is primarily a forward-looking exercise. Assessment of adaptive capacity involves both present and forward-looking aspects.[207]

STRESSORS are events and trends, often not climate-related, that have an important effect on the system exposed and can increase vulnerability to climate-related risk.

SUPPLY CHAIN is the linear sequence of processes, actors, and locations involved in the production, distribution, and sale of a commodity from start to finish. [208]

SUPPLY NETWORK is the complex network that connects multiple nodes directly and indirectly in the production, distribution, and sale of a commodity. It differs from a supply chain in that it expands a linear process to include all the factors that may impact it, extending it to external nodes and multidirectional connections.[209]

TIPPING POINT is a level of change in system properties beyond which a system reorganizes, often abruptly, and does not return to the initial state even if the drivers of the change are abated. For the climate system, it refers to a critical threshold when global or regional climate changes from one stable state to another stable state.

UNCERTAINTY is a state of incomplete knowledge that can result from a lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from imprecision in the data to ambiguously defined concepts or terminology, incomplete understanding of critical processes, or uncertain projections of human behavior. Uncertainty can therefore be represented by quantitative measures (e.g., a probability density function) or by qualitative statements (e.g., reflecting the judgment of a team of experts).

VULNERABILITY refers to the propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

ABBREVIATIONS

AR5 — Fifth Assessment Report of the IPCC

BAU — Business as Usual

BSR — Business for Social Responsibility

C2ES — Center for Climate and Energy Solutions

CAPEX — Capital Expenditures

CDT — Climate Data Tool

CEO — Chief Executive Officer

CFDA — Climate Financial Driver Analysis

CFO — Chief Financial Officer

CCIA — Climate Change in Australia

CORDEX — Coordinated Regional Climate Downscaling Experiment

CPS — Current Policies Scenario (IEA)

CRIS — Climate Risk Impact Screening

[207] MIT, *Climate-related Financial Disclosures: Use of Scenarios*, Office of the Vice President for Research, Cambridge, MA: Massachusetts Institute of Technology, 2019.

[208] Definition developed for this guidance.

[209] Definition developed for this guidance.

CRO — Chief Risk Officer

CSO — Chief Stategic Officer

C-SUITE — Executive officers of a company

CTA — Carbon Transition Assessment

DDPP — Deep Decarbonization Pathways Project

EPRI — Electric Power Research Institute

ERM — Enterprise Risk Management

ESG — Environmental, Social, and Governance

GCM — Global Climate Model

GDP — Gross Domestic Product

GHG — Greenhouse Gas

IAM — Integrated Assessment Model

IAMC — Integrated Assessment Modeling Consortium

IAV — Impact, Adaptation, and Vulnerability

IEA — International Energy Agency

IFRS — International Financial Reporting Standards

IIASA — International Institute for Applied Systems Analysis

IPCC — Intergovernmental Panel on Climate Change

IPR — Inevitable Policy Response (PRI)

MIT — Massachusetts Institute of Technology

NDC — Nationally Determined Contributions

NGFS — Network for Greening the Financial System

PRI — Principles for Responsible Investment

PWC — PricewaterhouseCoopers

RCP — Representative Concentration Pathway

R&D — Research and Development

SDS — Sustainable Development Scenario (IEA)

SPS — Stated Policies Scenario (IEA)

SSP — Shared Socioeconomic Pathway

STEEP — Social, Technology, Economic, Environmental, and Policy

TCFD — Task Force for Climate-related Financial Disclosures

UK PRA — UK Prudential Regulation Authority

U.S. AID — U.S. Agency for International Development

VAR — Value-at-Risk

WCRP — World Climate Research Programme

WEF — World Economic Forum

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