



IIGCC

The Institutional Investors
Group on Climate Change

Navigating climate scenario analysis

A guide for institutional investors

Acknowledgements

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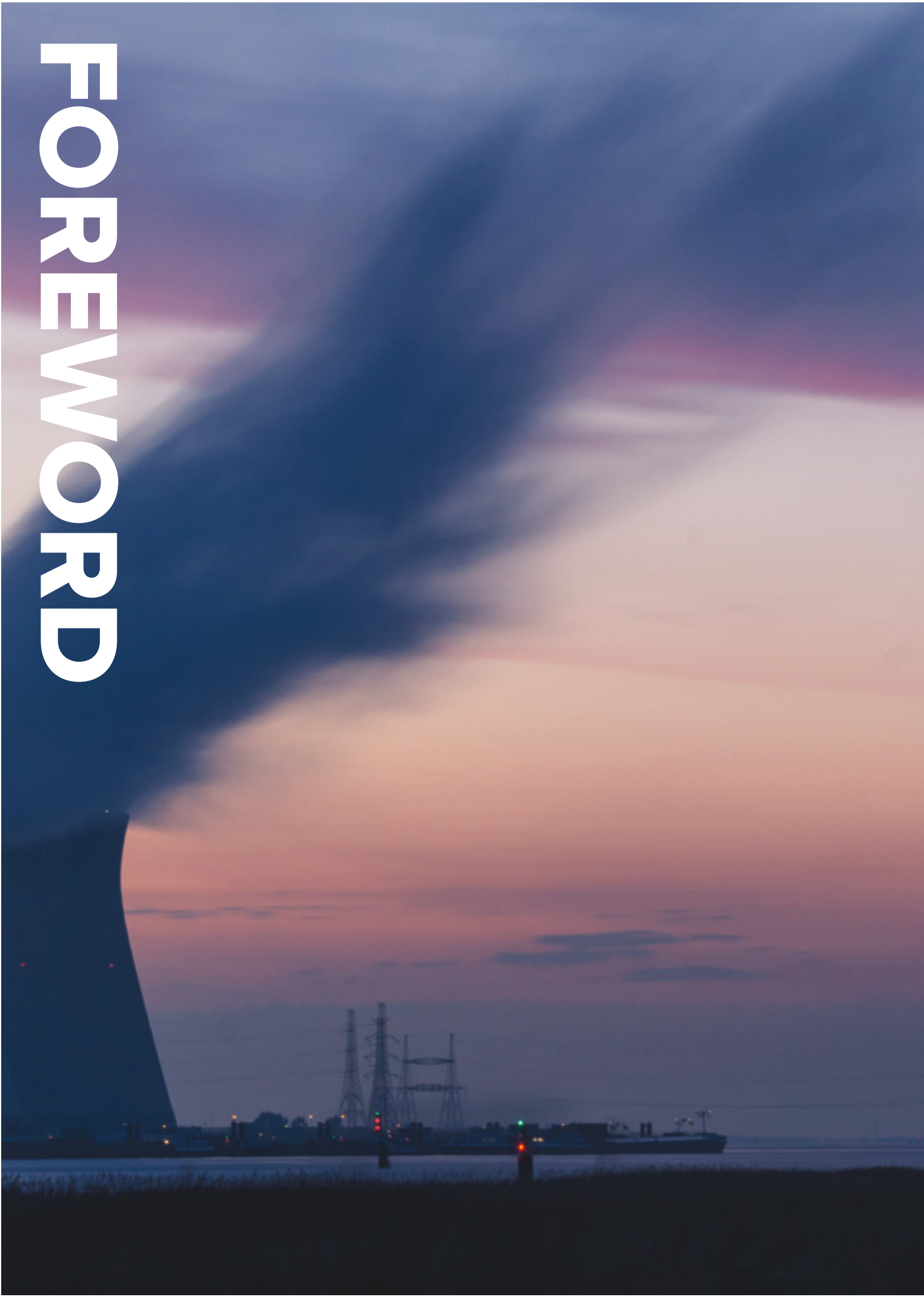
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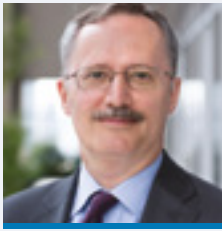
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FOREWORD



FOREWORD



Climate change presents a potential systemic risk to the financial system, with the large-scale and long-term nature of the problem causing unique challenges¹. This risk is real and present and not just in the future. Investors therefore need to assess and evaluate the material risk implications for their assets.

In June 2017, the Task Force on Climate-related Financial Disclosures (TCFD) presented its recommendations with the aim of establishing a consistent global standard for climate-related financial risk disclosures, covering both corporates and the financial sector². Mark Carney, Governor of the Bank of England, expressed the ultimate aim: “With better information as a foundation, we can build a virtuous circle of better understanding of tomorrow’s risks, better pricing for investors, better decisions by policymakers and a smoother transition to a lower-carbon economy.”³

Investors sit at a central point in this process. We need disclosure of the risks and opportunities by the companies and assets we invest in; and we ourselves as institutions are expected to improve our own disclosures in order to provide a full system-wide picture of risk.

A key recommendation of the TCFD was for organisations to conduct scenario analysis in order to understand how different possible climate futures would affect their business. This guide aims to serve as a ‘how-to guide’ for institutional investors (asset owners and asset managers), who are beginning to construct and conduct scenario analysis. Building on previous work, including recent reports from the IIGCC⁴ and UN Principles for Responsible Investment (PRI)⁵, our aim is to go deeper into the options available for investors looking to undertake this type of analysis, with a focus on how to make it relevant to investment and ownership decisions.

The investment community is still at an early stage in developing its thinking in this area. However, we have been encouraged by the richness of learning achieved by undertaking the scenario analysis process. Institutions that have experimented with methodologies have had discussions, debates and even disagreements, that have led them to a higher level of understanding of the nature of risks and opportunities that climate change poses. Ultimately, we believe scenario analysis can support a culture change within the investment community – where investment decision-makers at all levels take into account the profound systemic and broader macroeconomic effects of climate change as a normal part of their strategic thinking and investment analysis.

Russell Picot Chair of the Trustee board of the HSBC Bank (UK) Pension Fund, Special Advisor to the Task Force on Climate-related Financial Disclosures, and Chair of IIGCC’s Investor Practices Programme

A large, textured iceberg floats in a body of water, with its tip visible above the surface and a much larger portion submerged below. The water is a deep blue, and the sky is a lighter, hazy blue. The iceberg's surface is rugged with various cracks and ridges.

10 KEY MESSAGES

This guide highlights ten key messages for investors on climate scenario analysis:

- 01 Scenario analysis is already a **well-established tool in investment risk analysis**. Its application to climate change offers significant potential benefits for identifying both risks and opportunities, but there are challenges in implementation arising from the unique nature of the issue.
- 02 The investment industry is still at a **relatively early stage** in developing methodologies – but there is rapid innovation taking place.
- 03 In some areas, corporates are already ahead of investors in their analysis and reporting, but **significant data gaps** remain. Disclosure needs to improve throughout the value chain in order to provide a full picture of risk to stakeholders and regulators.
- 04 **No single methodology can fulfil the needs of all investors**. Different tools and approaches will be relevant depending on the type of investor, what their objectives are and the level of the investment process at which the analysis takes place.
- 05 Scenario analysis is best undertaken through a **cross-functional approach** involving experts in areas including risk management, investment and Environmental, Social and Governance (ESG). This gives the best chance of producing outputs which are actionable and investment-relevant.
- 06 **Understanding the assumptions** behind scenarios and the methodologies used to apply them to investments is critical. These assumptions drive the results. Without knowing how they work, the outputs of analysis will be challenging to rely on for investment purposes.
- 07 Investors need to consider how to balance **comprehensiveness with simplicity**. More complex models may be able to better capture the full range of climate change impacts, but simpler models can be more practical to apply and interpret.
- 08 Many of the benefits of scenario analysis come through **undertaking the process**, rather than the end result. Experimenting with methodologies can be a valuable opportunity for investors to learn about the ways in which climate change drives financial impacts.
- 09 Scenario analysis should be viewed as a **dynamic process** which is repeatable and can be embedded into mainstream risk management and investment functions.
- 10 By providing a structured way to think about the climate transition, scenario analysis provides a starting point for investors to monitor the **early warning signs** about which scenario is most likely to materialise and to take action accordingly – improving the ability to be resilient to the changes ahead.

DEFINING SCENARIO ANALYSIS

01



01

DEFINING SCENARIO ANALYSIS

THIS SECTION

- Defines scenario analysis as a methodology
- Introduces the concept of climate scenarios
- Explores how climate scenario analysis differs from existing investment industry risk management techniques

In December 2015, the Financial Stability Board mandated the TCFD to draw up recommendations for reporting to help stakeholders in financial markets understand their climate-related risks and opportunities.

The final report of the TCFD published in 2017 includes recommendations across four pillars: governance, strategy, risk management, and metrics and targets⁶. One of its key recommendations is for corporates and financial institutions to “describe the resilience of the organisation’s strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario and, where relevant to the organisation, scenarios consistent with increased physical climate-related risks”.

1.1 What is scenario analysis?

Scenario analysis is a tool for forward-looking assessment of risks and opportunities. Scenarios are not predictions; rather, they are descriptions of plausible future states of the world. These may be quantitative, qualitative or have elements of both. Scenario analysis in effect describes a process of assessing how a country, organisation or investment portfolio might perform in those different future states, in order to understand key drivers and possible outcomes.

The idea of using scenario analysis is well established as a method of forward-looking analysis within government policy and organisational strategy⁷. However, its application to climate change and investment is relatively recent.

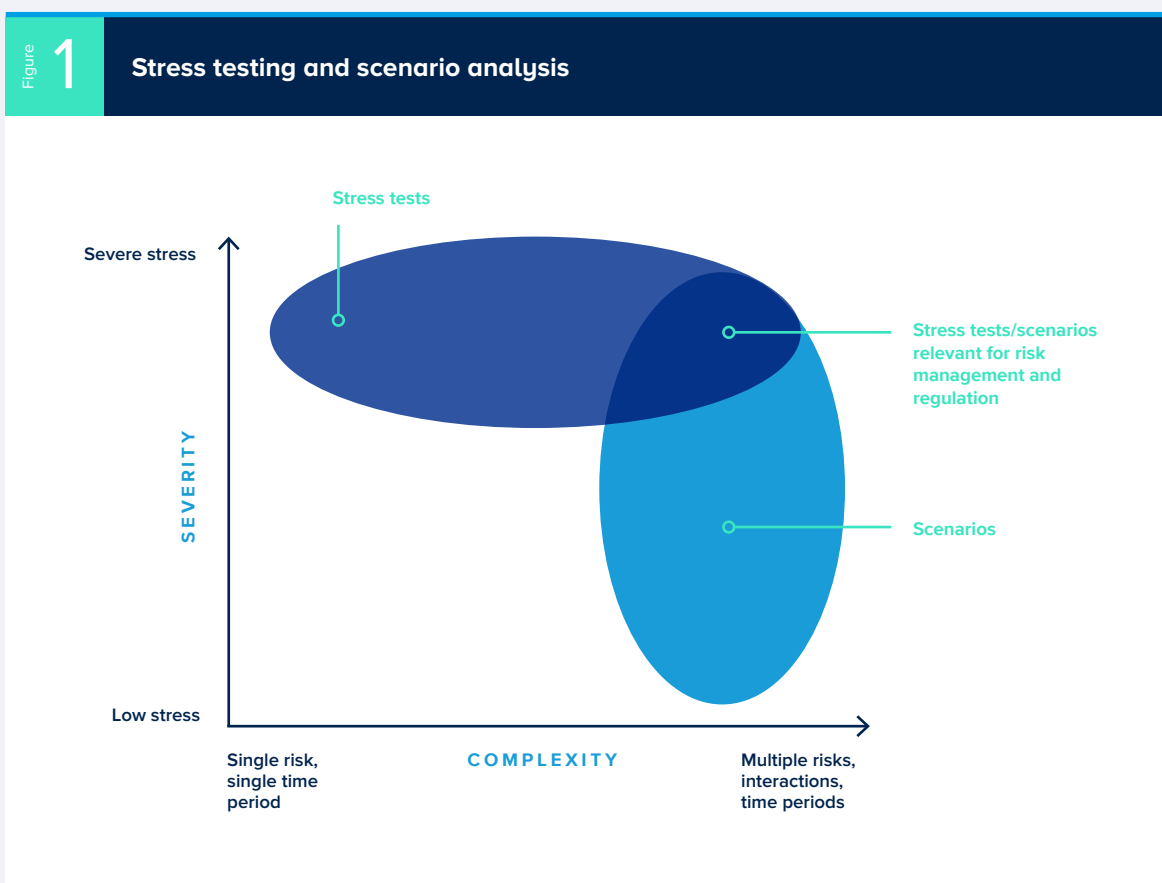
Often the terms ‘scenario analysis’, ‘sensitivity analysis’ and ‘stress test’ are used interchangeably. Whilst definitions differ, the International Actuarial Association has provided a useful distinction of the terms, as outlined below.

Scenarios, sensitivity analysis and stress testing

Scenario: A scenario is a possible future environment, either at a point in time or over a period of time. One or more events or changes in circumstances may be forecast, often over multiple time periods. Scenarios can also be complex, involving changes to, and interactions among many factors over time, perhaps generated by a set of cascading events. It can be helpful in scenario analysis to provide a narrative to support the scenario and put it in context.

Sensitivity analysis: The effect of a set of alternative assumptions regarding a future environment. A scenario used for sensitivity testing usually represents a relatively small change in these risk factors or their likelihood of occurrence.

Stress test: A projection of the financial condition of a firm or economy, under a specific set of severely adverse conditions. This may be the result of several risk factors over multiple periods of time, or one risk factor that is short in duration.



Source: International Actuarial Association (2013), https://www.actuaries.org/CTTEES_SOLV/Documents/StressTestingPaper.pdf

1.2 What are climate change scenarios?

The use of climate scenarios is recommended by the TCFD as a way for organisations to identify and assess how various combinations of climate-related risks may affect their business and financial performance. These scenarios focus on two distinct but interlinked sets of risks and opportunities, the relevance of which will depend on the type of investment under consideration:

Transition risk scenarios model different pathways for the evolution of greenhouse gas intensive economic activities, such as energy generation, industrial production and transportation. Policy, technology, market and reputational risks are examples of transition risks. These are often designed to be consistent with a pre-determined level of warming. The TCFD recommendations specifically state that organisations consider a set of scenarios, including a '2°C or lower scenario', in reference to the 2015 Paris Agreement.

Physical risk scenarios focus on changes to the climate, including variables such as temperature rise, sea level rise, and changes to the frequency

and severity of extreme weather events, including droughts and storms. These variables may in turn impact on investments directly through damage or loss of assets, or indirectly through the effects on supply chain costs (such as commodity price spikes caused by drought) or reliability.

As well as its direct impacts, climate change also acts as a risk multiplier, exacerbating existing sustainability challenges such as food and water shortages, pollution and geopolitical tensions, among other examples.

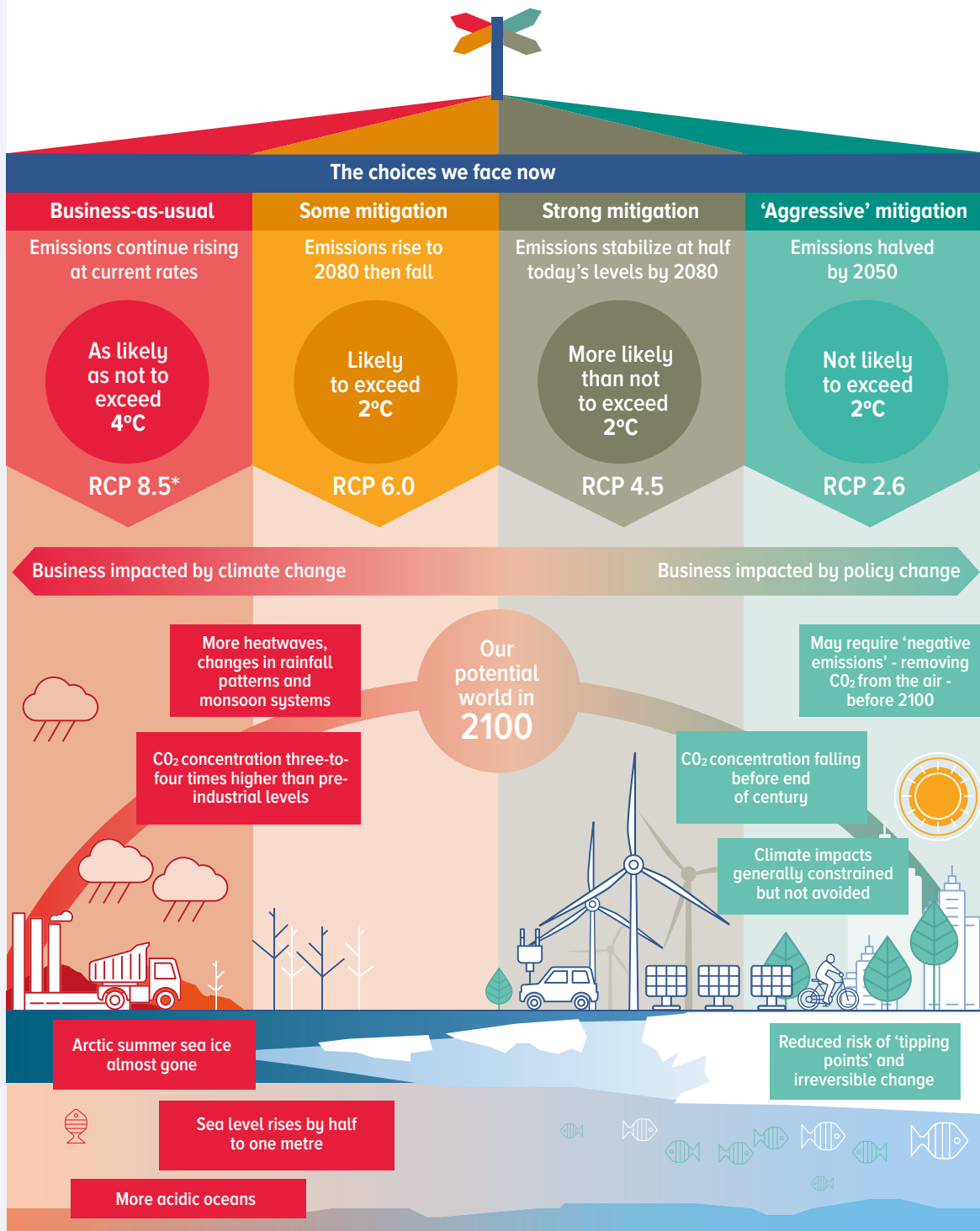
The two sets of risks are interdependent, as the greater the degree of transition that takes place, the lower the physical risks and vice versa. Many climate scenarios focus on modelling either transition risk or physical risk in isolation, but some aim to model both to capture the interaction. The Intergovernmental Panel on Climate Change (IPCC) sets this out conceptually in their 'Carbon Crossroads' illustration over page. Section four of this report further describes how climate scenarios are constructed and the commonly-used 'reference scenarios' available.

Figure 2

Interplay between transition and physical Impacts

Carbon crossroads

The IPCC explores four potential futures depending on what policies governments adopt to cut emissions.



Source: IPCC (2013), Fifth Assessment Report (AR5), Climate Change: Action, Trends, and Implications for Business, <https://www.cisl.cam.ac.uk/business-action/low-carbon-transformation/ipcc-climate-science-business-briefings/climate-science>

1.3 How does climate scenario analysis compare with existing investment industry risk modelling?

Risk management is a key element of the investment process. The TCFD recommendations aim to make the analysis of climate risk as systematic as possible, as is currently the case with other types of investment risks.

Ideally, in order to mainstream climate risk modelling, it would be embedded into existing risk management processes. However, there are some key differences between climate risk and other types of risk already commonly modelled by investors. A recent report by the Bank of England's Prudential Regulatory Authority summarised some of the distinctive features of climate scenario analysis in comparison with existing risk management techniques⁸. Whilst the report was focused on the banking sector, the points have equal relevance to investment.

Table 1	Distinctive elements in climate scenario analysis
Element	Description
Far-reaching in breadth and magnitude	The financial risks from physical and transition risk factors are relevant to multiple lines of business, sectors and geographies. Their full impact on the financial system may therefore be larger than for other types of risks, and is potentially non-linear, correlated and irreversible.
Uncertain and extended time horizons	The time horizons over which financial risks may be realised are uncertain, and their full impact may crystallise outside of many current business planning horizons (tragedy of the horizon). Using past data may not be a good predictor of future risks.
Foreseeable nature	While the exact outcome is uncertain, there is a high degree of certainty that financial risks from some combination of physical and transition factors will occur.
Dependency on short-term actions	The magnitude of future impact will, at least in part, be determined by the actions taken today. This includes actions by governments, financial market participants and a range of other actions.

Source: Bank of England (2018), Transition in thinking: The impact of climate change on the UK banking sector, <https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/report/transition-in-thinking-the-impact-of-climate-change-on-the-uk-banking-sector.pdf>

UNDERTAKING SCENARIO ANALYSIS

02



02

UNDERTAKING SCENARIO ANALYSIS

This report aims to provide a practical guide to applying the principles of scenario analysis in understanding climate risks and opportunities in portfolios.

It is worth emphasising that some of the methodologies involved in constructing scenarios and applying them to investments can be technically complex by nature of the fact that climate change is itself a complex and multi-dimensional issue. However, investors should not assume that all scenario analysis needs to be a complicated, expensive or onerous process. As the guide sets out, both qualitative and quantitative approaches can be useful, and even more simplistic approaches or estimation techniques can provide valuable insights into drivers of change, future risk areas and potential opportunities.

Analysis itself may also be iterative rather than linear, with learnings from early efforts feeding into the thinking about future approaches. A key point emerging from discussions with investors

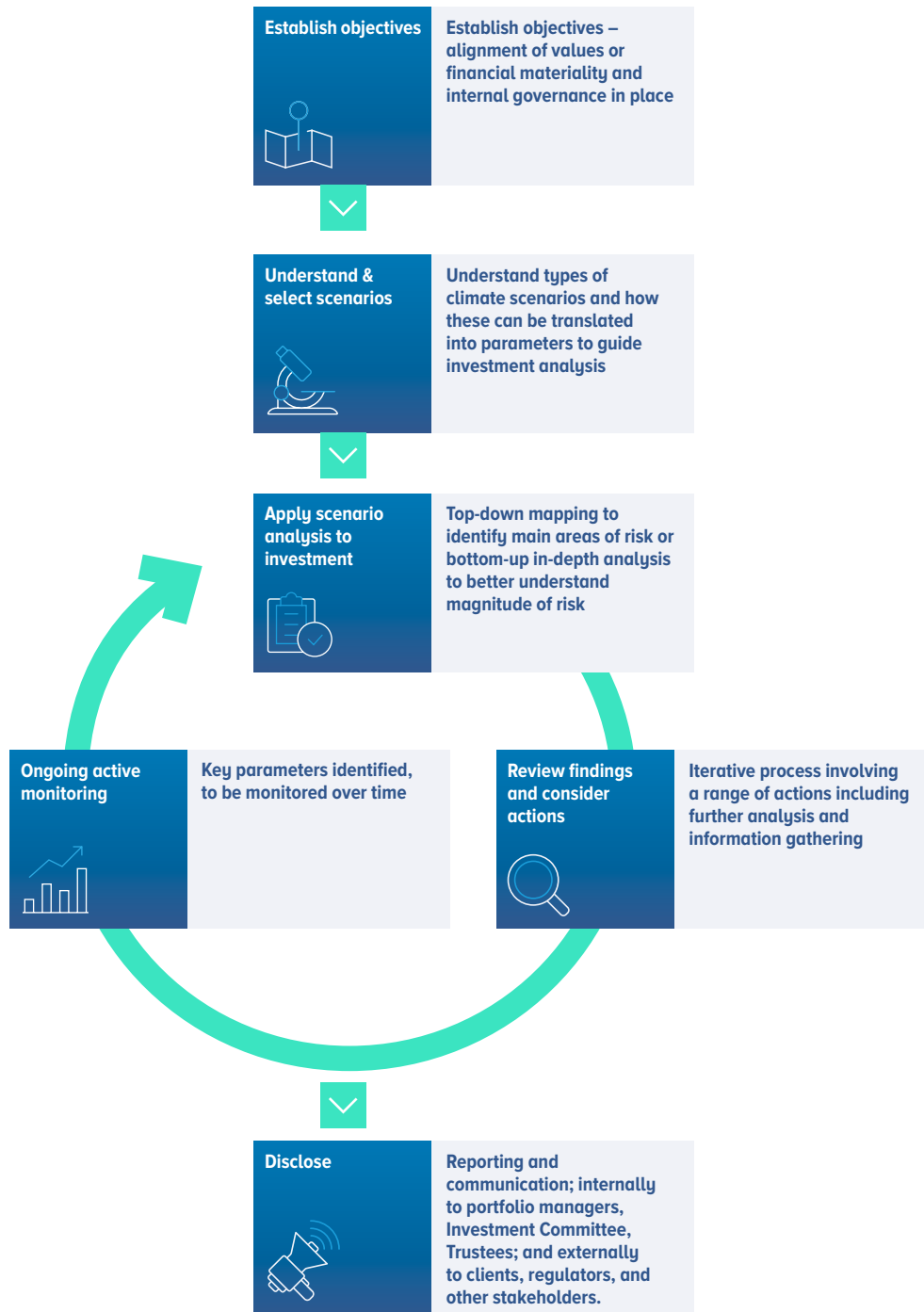
in production of this guide was that piloting or experimenting with methodologies is more valuable than waiting for the perfect solution.

This guide introduces an investor framework and the key components involved in undertaking climate scenario analysis – as depicted in Figure 3 over page. The following sections each provide an elaboration of the methodologies and approaches captured by this framework.

It is important to emphasise that scenario analysis should be approached as a dynamic and iterative process. Some investors may find it more useful to start by understanding the various climate scenarios before going back to establishing their objectives. This could help to strengthen their process of choosing the right scenario analysis approach that will be relevant to their portfolio(s) and type of organisation.

Figure 3

Investor framework for climate scenario analysis



ESTABLISHING OBJECTIVES FOR SCENARIO ANALYSIS

03

ESTABLISHING OBJECTIVES FOR SCENARIO ANALYSIS

THIS SECTION

- Sets out the fundamental objectives of scenario analysis, differentiating financial risk / opportunity and alignment approaches
- Discusses the importance of objectives related to internal and external engagement and education
- Suggests other factors to take into account when scoping scenarios work



Establish
objectives

Establish objectives – alignment of values or financial
materiality and internal governance in place

Scenario analysis is one part of the TCFD requirements. It can act as one element of a comprehensive climate risk and opportunity assessment that supports integration of relevant climate information along the whole investment life cycle – from review of available assets, due diligence, acquisition, oversight, through to company engagement.

Establishing clear objectives for scenario analysis is important, as the objectives and scope of the work are fundamental in determining the relevance of different methodologies and approaches.

3.1 Determining the focus: financial impact and alignment

Financial impact: The focus of the TCFD recommendations is on the use of scenario analysis as one of a set of tools to support potential financial impact. Through building an understanding of the key drivers of the low-carbon transition - and the ability to challenge the assumptions of underlying scenarios - scenario analysis enables the assessment and pricing of climate-related risks and opportunities.

From an institutional investor perspective, this may translate into setting objectives to assess financial risk and opportunity at one or more levels. This can be an understanding of the potential impact on the institution as a whole, to the analysis of individual investments.

Alignment: Some institutional investors are seeking to make commitments to align their portfolios with a 2°C or lower future. The motivation for this may be, for example, because the institution wants to play an active role in avoiding severe climate change, as they believe this would have negative implications for the economy and their investments as a whole. For other institutions, such as a religious institution or environmental endowment, an alignment approach may be chosen in support of their mission and/or investor beliefs. This more normative or values-driven objective may require a different set of tools to be used in scenario analysis, as described further in Section 5 of this guide.

The following table illustrates how these objectives may apply to different types of investors, and how they relate to different elements of the investment process.

Table 2

High-level objectives of scenario analysis for institutional investors

Objective	Most relevant to	Feeds into
Understand impact of climate change on overall solvency, ability to pay liabilities.	Asset owner / fiduciary manager.	Asset liability management.
Incorporate climate change into selection of investments.	Asset owner / fiduciary manager Fund of funds manager.	Strategic asset allocation, manager selection.
Assess risks / opportunities to financial performance of portfolios, sectors or individual assets.	All investors (asset owners and asset managers).	ESG integration processes, identification of investment opportunities, engagement / proxy voting.
Alignment to a 2°C or lower future.	Asset owners with specific climate investment beliefs or objectives. Mission or values-driven institutions, such as endowments. Asset managers designing products.	Depends on approach taken.

3.2 Objectives relating to communications and stakeholder engagement

Investors who have undertaken scenario analysis found that one of the most important benefits was gained in the learning and communication that took place throughout the process, often involving colleagues in the institution who previously may have had little exposure to ESG issues.

Investors stressed the importance of thinking at an early stage about who the right people are to be involved in the scenario analysis process, both in a governance/oversight capacity and in the project itself. Issues around the governance of climate-related risks are covered in depth elsewhere, notably in the TCFD report itself⁹, and IIGCC's recent report "Addressing climate risks and opportunities in the investment process"¹⁰. The results of analysis may also need to be presented at a different level of detail, depending on the audience for the work (for instance, CIO, investment committee or trustee).

In terms of the project team, several investors highlighted the importance of taking a cross-functional

approach to scenario analysis, in order to ensure that the outcomes of the scenario analysis are relevant and usable to existing internal processes. It is important to involve individuals from a number of disciplines, including portfolio management and risk management, to ensure key stakeholders are engaged.

Stakeholder communication is also becoming more important. The TCFD is supported by numerous regulators globally, and the Bank of England¹¹ and De Nederlandsche Bank¹² have recently published papers setting out their views on the importance of climate stress testing.

Specific objectives in this area may include:

- Preparing for future **regulatory reporting** such as climate stress tests.
- Promoting **internal communications and awareness** about climate change with boards, senior management, portfolio managers and internal teams.
- Supporting **external communication and engagement** through reporting to beneficiaries, clients and other stakeholders.

3.3 Setting a scope for the analysis

Before starting the process of analysis, as well as establishing objectives, investors may set some initial parameters around the scope of the project. Examples from the experience of investors include:

- Deciding on the **scope of assets under consideration** such as whether to consider a single fund, a sector, a whole asset class or multiple asset classes. Some investors choose to pilot an approach at a small scale before rolling out more widely.
- Taking a view on **which type of risk** to focus on (transition risk, physical risk or both).
- Practical considerations around **internal resource, budget** and **timescale**.

Bringing this all together, the case studies below provide an example of how an asset owner designed and scoped a scenario analysis process, and used this information to analyse their asset allocation decisions.

CASE STUDY 1

TPT Retirement Solutions



TPT is a master trust providing work place pensions in the UK market with assets under management of £9bn in defined benefit and £1.2bn in defined contribution schemes.

At its 2016 Investment Strategy Day, TPT's Investment Committee identified four macro-existential risks facing the portfolio, that would have the potential to adversely impact the long-term funding status of the fund: deflation, geo-politics, longevity and climate change. At this meeting it was agreed that climate change risk was the least understood and hardest to quantify.

TPT set two objectives which drew on scenario analysis to inform their thinking on climate risk:

- The primary objective was to assess the financial impact and materiality of climate change on different asset classes within the portfolio and to understand the implications for Strategic Asset Allocation.
- A secondary objective was to understand, and report on, the extent to which the portfolio was aligned with the 2°C pathway set by the Paris Agreement.

In establishing and agreeing the rationale for undertaking this analysis, TPT's Responsible investment manager worked closely with the CIO and Investment Committee.




In order to quantify the impact of climate change on their portfolio, TPT engaged Mercer to undertake a one-off climate risk analysis. The findings of Mercer's climate change portfolio analysis reaffirmed investment strategy decisions that had been taken by the investment committee.

In particular:

- The intention to reduce reliance on equity markets could potentially reduce climate risk in the portfolio (subject to sector allocations).
- The intention to increase illiquidity and exposure to real assets may protect against 'existential risks' and help identify additional sources of return.

In terms of understanding how the portfolio aligns with the 2°C pathway, TPT also worked with 2° Investing Initiative (2°ii) to measure the alignment of their portfolio under the 2°C pathway as defined by the International Energy Agency (IEA).

Further details of TPT's process to assess climate risk and opportunities in their portfolios can be found in their 2016 Climate Change Disclosure Report.



Four macro-existential risks facing the portfolio were identified as having the potential to adversely impact the long-term funding status of the fund: deflation, geopolitics, longevity and climate change. Climate change risk was the least understood and hardest to quantify.

The background of the slide is a photograph of an industrial facility, likely a refinery or chemical plant. In the foreground, there are large, dark blue pipes and structural elements. In the background, several tall smokestacks are visible, some of which are emitting a bright orange glow, possibly from fires or molten materials. The sky is a pale, hazy blue, suggesting a dawn or dusk setting. The overall color palette is dominated by blues, greys, and the warm orange of the industrial lights.

UNDERSTANDING AND SELECTING SCENARIOS

04

UNDERSTANDING AND SELECTING SCENARIOS

THIS SECTION

- Sets out commonly-used ‘reference scenarios’, and how different inputs and assumptions determine outputs
- Discusses how these can be translated from high-level policy-orientated approaches into variables for use in investment analysis
- Describes some alternative, simplified scenario approaches that have been developed for the purposes of investor scenario analysis
- Provides some questions for investors seeking to understand and select climate scenarios



Understand &
select scenarios

Understand types of climate scenarios and how these can be translated into parameters to guide investment analysis

The starting point for the analysis itself is to identify which scenarios, or future states of the world, will be used to provide a view of the potential implications of climate change on investments.

Although there are commonly-used ‘reference scenarios’, by their nature, scenarios represent different visions of the future and none is right or wrong. The important action for investors is to understand the key assumptions that drive these climate scenarios, as these assumptions will have significant implications for the ultimate outcomes of their scenario analysis work. They can in their own right also inform investors’ views on and understanding of the climate transition as a dynamic process over various timescales.

A point to note here is that scenario analysis typically involves the selection of more than one scenario – in the words of the TCFD report, “a critical aspect of scenario analysis is the selection of a set of scenarios (not just one) that covers a reasonable variety of future outcomes, both favourable and unfavourable¹³”. The expectation of the TCFD is that at least one of the scenarios to be considered should be a “2°C or lower” scenario, where climate change is tackled in line with the Paris Agreement commitments.

4.1 Scenarios based on integrated modelling techniques

Commonly-referenced climate scenarios, such as those published by the IPCC and the IEA, set out comprehensive future pathways, based on the use of modelling techniques which convert a set of assumptions, inputs and constraints into a set of outputs. These scenarios commonly make use of integrated assessment modelling (IAM) techniques, which are mathematical models designed to simulate the behaviour of an entire complex and interconnected system, such as energy or the climate.

The scenarios published by the IPCC, which focuses on physical risk, and the IEA, which analyses energy markets transition, are the most frequently used by investors and third-party data/service providers, as well as by companies when conducting climate-related scenario analysis.

It is nevertheless important to note that these are not the only scenarios available. Governments also have their own scenarios such as those used by the UK Met Office and the UK Committee on Climate Change, and others have been developed by NGOs, academics and commercial providers. Corporations within the energy sector, including BP, Royal Dutch Shell and Equinor, have worked with scenario analysis for many years.

Table 3 below summarises some of the most commonly-used reference scenarios. The TCFD Technical Supplement on Scenario Analysis also provides extensive information on climate scenarios.¹⁴

<div>Table 3</div> Reference scenarios						
Organisation	Relevant reports / research	Latest report	Brief Description	Type of organisation	Coverage	Types of risks addressed
International Energy Agency (IEA)	World Energy Outlook (WEO)	2017	<ul style="list-style-type: none"> Scenarios range from 2°C to 6°C. The WEO provides a policy perspective and its scenarios describe future pathways for the global energy system to 2040 under different assumptions. The ETP scenarios provide a technology perspective with an objective to identify economical ways to reach a desired outcome. Detailed information about IEA's scenarios can be found in Appendix II. NB: The IEA will be publishing the new WEO report in November 2018. 	IEA, an autonomous body within the OECD framework, provides analysis of global energy markets. IEA's scenarios are the most common reference used by both corporations and data/service providers.	Energy sector	Transition
	Energy Technology Perspectives (ETP)	2017				
Inter-governmental Panel on Climate Change (IPCC)	Fifth Assessment Report (AR5)	2014	<ul style="list-style-type: none"> IPCC's work provides the scientific base for organisations developing scenarios. In AR5, there are four Representative Concentration Pathways (RCP2.6, RCP 4.5, RCP 6.0 and RCP8.5) and greenhouse gas concentration trajectories - based on more than 1,000 scenarios which have been published and peer-reviewed. NB: As of October 2018, IPCC published a special report on the impact of a global warming of 1.5°C. 	The Intergovernmental Panel on Climate Change (IPCC) is a scientific and intergovernmental body under the auspices of the United Nations and dedicated to the task of providing the world with an objective, scientific view of climate change and its political and economic impacts.	All sectors	Transition & physical risk
	Special Report, Global Warming of 1.5°C	2018				
Potsdam Institute for Climate Impact Research	Research	2017	<ul style="list-style-type: none"> Research into climate change impact, socio-economic effects, and uncertainties at different levels of global warming (1.5°C, 2°C, 3°C and 4°C). 	Potsdam Institute (PIK) is a non-profit organisation that addresses crucial scientific questions in the fields of global change, climate impacts and sustainable development.	All sectors	Transition & physical risk
Greenpeace International	Energy [R]evolution scenario	2015	<ul style="list-style-type: none"> A 100% renewable energy scenario in 2050 is presented as well as a scenario with 83% renewables. 	Greenpeace is a non-profit organisation, present in 40 countries across Europe, the Americas, Africa, Asia and the Pacific.	Energy sector	Transition
Deep Decarbonization Pathways Project (DDPP)	Pathways to deep decarbonisation pathways	2015	<ul style="list-style-type: none"> The DDPP framework has been developed by a consortium led by The Institute for Sustainable Development and International Relations (IDDRI) and the Sustainable Development Solutions Network (SDSN). 	The Deep Decarbonization Pathways Project (DDPP) is a collaborative global research initiative to understand how countries can transition to a low-carbon economy.	Energy sector	Transition
Bloomberg New Energy Finance (BNEF)	New Energy Outlook	2018	<ul style="list-style-type: none"> An annual long-term economic analysis of the world's power sector up to 2050. NEO focuses on technology that is driving change in markets and business models across the sector. The report also includes forecasts for coal, oil and gas around the world, and assesses the impact of the energy transition on fossil fuel demand and materials. 	BNEF is a research firm which provides independent analysis and insight.	Electricity system	Transition
International Renewable Energy Agency (IRENA)	Global Energy Transformation: A Roadmap to 2050	2018	<ul style="list-style-type: none"> REmap scenarios represent worldwide renewable energy potential. The analysis is based on a sector and technology bottom-up approach. 	IRENA is an intergovernmental organisation supporting countries in their transition to a sustainable energy future.	Energy sector	Transition
DNV GL	New Energy Outlook 2017	2018	<ul style="list-style-type: none"> Long-term economic forecast of the world's power sector focused on the electricity system. 	DNV GL is a global consultancy company with Oil & Gas and Renewables & Power as two of its business areas.	Electricity system	Transition
Shell	New Lens Scenarios: A shift in perspective for a world in transition	2016	<ul style="list-style-type: none"> Shell has three scenarios: Sky, Mountains and Oceans. Mountain and Ocean are presented in New Lens scenarios. In the Sky scenario the goals of the Paris Agreement are reached. In this scenario net-zero emissions are achieved by 2070. 	Royal Dutch Shell plc, commonly known as Shell, is a British-Dutch oil and gas company headquartered in the Netherlands and incorporated in the United Kingdom. It is one of the six oil and gas "supermajors".	Energy sector	Transition
	Sky: Meeting the goals of the Paris Agreement	2018				

Organisation	Relevant reports / research	Latest report	Brief Description	Type of organisation	Coverage	Types of risks addressed
Equinor	Energy Perspectives	2018	<ul style="list-style-type: none"> Three scenarios are presented: Reform, Renewal and Rivalry. Reform builds on the policy in the National Determined Contributions from Paris in 2015, but given the uncertainty on policy after 2020 the scenario puts more emphasis on market and technology development. 	Equinor ASA is a Norwegian multinational energy company headquartered in Stavanger, Norway. It was previously known as Statoil.	Energy sector	Transition
BP	BP Energy Outlook	2018	<ul style="list-style-type: none"> Three scenarios are presented: Evolving transition, Faster transition and Even faster transition. The emission reductions in the Even faster transition scenario is in line with the IEA's Sustainable Development Scenario. 	BP plc is a British multinational oil and gas company headquartered in the UK. It is one of the six oil and gas "supermajors".	Energy	Transition


Source: Summarised by IIGCC based on information on IEA, IPCC, Potsdam Institute, Greenpeace International, Deep Decarbonisation Pathways Project, Bloomberg New Energy Finance, International Renewable Energy Agency, DNV GL, Shell, Equinor and BP.

The scenarios in Table 3 mostly address either transition or physical risk. An example of scenarios covering both is provided by Mercer¹⁵. It worked with the London School of Economics and Vivid Economics to develop four scenarios, based on the interplay of four key drivers – technology, resource availability, impact and policy. Inputs were taken from a variety of sources, including the IEA's World Economic Outlook, and integrated assessment modelling used to produce the scenarios themselves. Mercer is expected to publish an update of their methodology, scheduled for early 2019.

Figure 4

Mercer climate scenarios

Scenario



- Transformation**

More ambitious climate change mitigation action that puts us on the path to limiting global warming to 2°C above pre-industrial temperatures this century.
- Transformation**

Policies and actions are aligned and cohesive, keeping warming to 3°C above pre-industrial temperatures this century.
- Fragmentation (lower damages)**

Limited climate action and lack of coordination result in warming rising to 4°C or above pre-industrial temperatures this century.
- Fragmentation (higher damages)**

As above, coupled with assumed higher damages.

4.2 Understanding climate scenario assumptions

Energy transition scenarios, in particular, can vary widely in the assumptions they make. Understanding and analysing the range of assumptions is important both in order to understand the implications for any subsequent analysis, and as a useful tool to inform investors' views on how the climate transition could unfold and what market signals to watch.

Some key differences between models are summarised over page. The 'TCFD Technical Supplement' on scenario analysis contains a more detailed breakdown of the assumptions and outputs of specific transition scenarios on these and other variables.

Table 4 Key assumptions in energy transition models

Temperature limits used and probability of achieving these	Energy transition scenarios may have different temperature limits, and different probabilities of achieving them. The IEA 450 scenario (from the 2017 IEA World Energy Outlook (WEO) report), for instance, chooses a greenhouse gas trajectory which would lead to a 50% chance of limiting the global temperature rise to 2°C in 2100, whereas the Beyond 2°C scenario in the IEA's Energy Transition Pathway (ETP) is based on a 50% chance of meeting a 1.75°C limit.
Time horizon	Different time horizons may be used depending on the methodology applied.
Emissions reduction trajectory	<p>Scenarios may differ in their assumptions on exactly when emissions reductions take effect, and whether this happens in a linear fashion or as a sudden disruptive change.</p> <p>Models also differ in whether 'overshooting' is permitted – in other words, whether the stock of greenhouse gases in the atmosphere can temporarily rise above a defined temperature, on the assumption that 'negative emissions technologies' (for example large-scale tree planting) can be used to remove the excess greenhouse gases later. This can make a major difference to the overall carbon budget.</p>
Distribution of emissions reductions between sectors	Models vary on where the largest weight of emissions reductions lies between sectors (for instance, transportation versus industry) and countries.
Policies	Scenarios may assume different policies are used to achieve these reductions.
Use of carbon capture and storage to meet limits	Some models assume substantial use of carbon capture and storage (CCS) technologies, which support the continued use of fossil fuels – which has been controversial given that these technologies have yet to reach commercial scale. The IEA's Beyond 2°C scenario, for instance, assumes that CCS captures over 5 billion tonnes of CO ₂ by 2040.

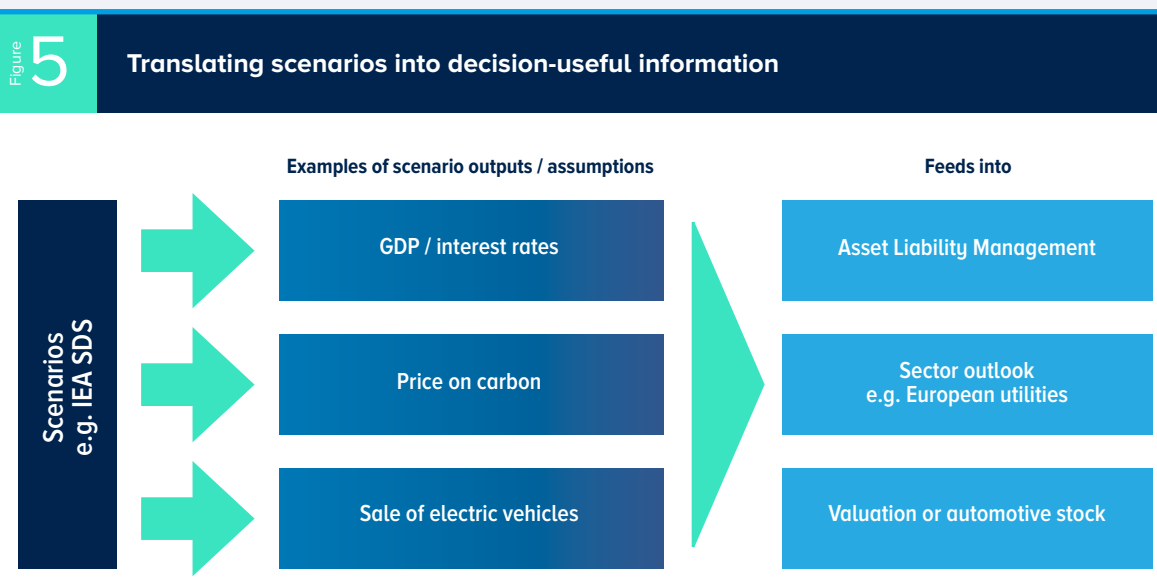
These assumptions may appear technical - but they can have a major impact on the trajectories for key variables emerging from the scenarios, and therefore for the outcomes of any scenario analysis undertaken by investors.

A scenario which combines ambitious assumptions on CCS and the ability for greenhouse gas concentrations to overshoot their equilibrium level, will for instance, paint a significantly more optimistic picture for the future use of fossil fuel use than one which assumes the opposite. As an example, Greenpeace's 2015 Advanced Energy Revolution scenario, which makes conservative assumptions on many of the factors above, concludes that 100% of energy supply will be from renewables by 2050.¹⁶ IEA's SDS scenario predicts renewables to have a share of roughly 29% of the energy demand in 2040.¹⁷ In Shell's Sky scenario, the share of renewables in total primary energy is 30% in 2040, 45% in 2050 and 73% in 2100.¹⁸ The disparity in these numbers

illustrates for an investor analysing risks, for instance, how the utility sector will come up with potentially very different conclusions on the risks the sector faces, depending on the scenario they select.

4.3 Translating scenarios into investment-relevant variables

Scenarios such as those produced by the IEA and IPCC have been designed for policymakers rather than investors. In order to make them usable for practical investment purposes, investors need to extract from these scenarios data points or other information that they can then use as an input to investment analysis at various levels, as shown conceptually over page. Section five of this guide discusses how this analysis takes place.



The Energy Transition Risk Project (ET Risk), has produced a comprehensive report which translates high-level energy transition scenarios into investment-relevant data points.

Transition Risk-O-Meter

The Energy Transition Risks & Opportunities (ET Risk) initiative is a research consortium which aims to provide research and tools to assess the financial risks and opportunities associated with the transition to a low-carbon economy.¹⁹

One of the ET Risk outputs is the Transition Risk-O-Meter report. This takes as its basis the IEA scenarios, uses these to create two scenarios (Ambitious Climate Transition and Limited Climate Transition), and then maps out a set of forward-looking indicators for each scenario. This is based on an assessment of what the most material climate transition risks are likely to be, on a sector by sector basis covering eight of the most energy intensive sectors. Examples of indicators for the cement sector are below.

The future trajectories for these indicators can then be used by analysts as inputs to sector-level or company-level analysis in order to produce ‘best-case’ or ‘worst-case’ valuations, depending on the scenario chosen.

Figure 6 Parameters involved in highlighted scenarios in the cement sector

	PRODUCTION AND TECHNOLOGY	
	Cement production (Mt) Clinker to cement ratio (%) Energy intensity clinker production (GJ/t clinker)	CCS deployment (%) CO ₂ Intensity (tonne CO ₂ / tonne cement) Share of Alternative fuel use (%)
	MARKET PRICING	
	Secondary fuel prices (US\$/tonne)	
	POLICY MANDATES, INCENTIVES & TAXES	
	Allocation of free CO ₂ allowances (%)	

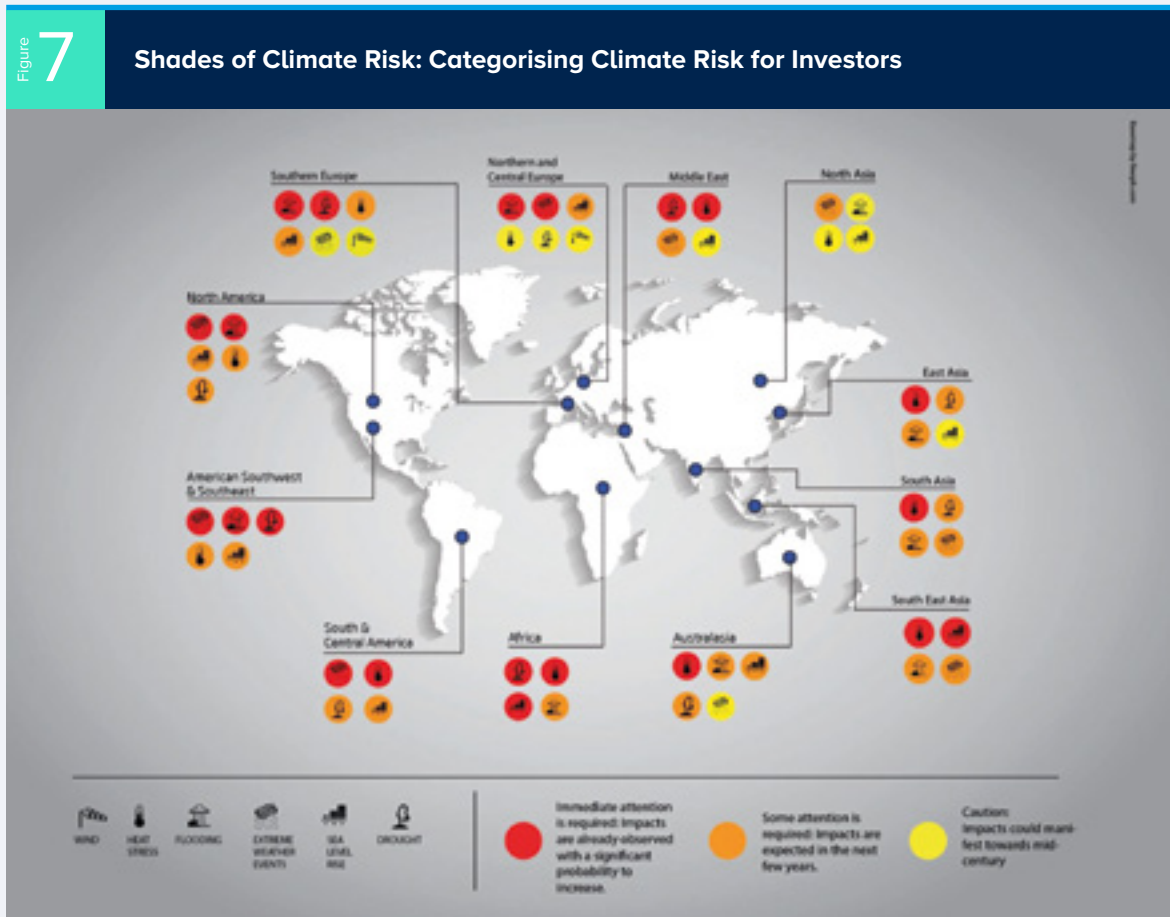
Source: ET Risk (2018), 2ii Transition Risk Scenarios: Cement Sector, <http://et-risk.eu/>

Once these trajectories are drawn out, investors should review them to see if they seem plausible, and fit with any views they may hold in-house. At this point they may wish to vary the trajectories, in order to better match their own beliefs or to correct for any model assumptions they may not agree with.

So, for instance, if an investor's own automotive sector analyst is significantly more optimistic than the IEA on electric vehicle adoption, then the investor may wish

to use a steeper trajectory than the reference scenario when it comes to the modelling process.

The same challenges apply to physical risks, where high-level, complex and detailed scenarios such as those provided by the IPCC need to be translated into data that investors can apply. "Shades of Climate Risk: Categorizing climate risk for investors" by CICERO, is an example of research which aims to synthesise climate projections into investment-relevant variables.



4.4 Simplified scenario approaches

Rather than starting with a comprehensive fully-modelled scenario (or set of scenarios) and then extracting the most relevant variables, an alternative approach for investors is to identify or design simplified or stylised scenarios, or even a single variable, as a basis for their forward-looking analysis.²⁰ Whilst this approach loses the comprehensiveness and nuance of the more complex approaches described above, investors who have taken this route have indicated that taking a simpler approach means they fully understand the assumptions being made.

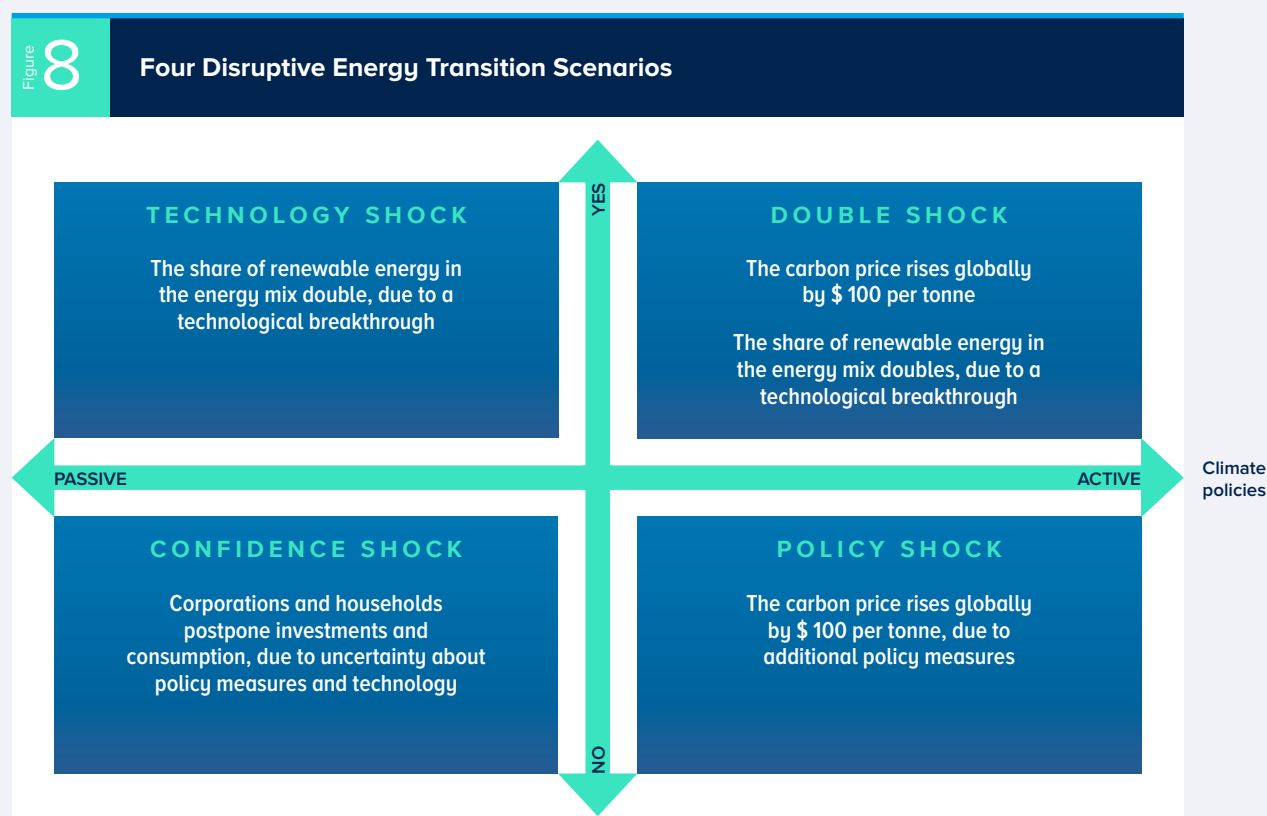
An example of this type of approach would be the use of a carbon price assumption, with a high carbon price being a proxy for a scenario in which governments take aggressive action to mitigate climate change, in line with the Paris Agreement. For instance, one academic study reviews the literature and concludes that the carbon price consistent with limiting global warming to 1.5°C would be more than US\$100 per tonne of CO₂ equivalent by 2020, about three times higher than the price required to stop warming of more than 2°C.²¹

Another example of a simplified scenario approach is provided by De Nederlandsche Bank's (DNB's) 'stress' scenarios (see below), which are based on imposing severe climate-related shocks on the economy, using a \$100 carbon price and a doubling of renewable energy as two of the key variables determining the scenarios.

De Nederlandsche Bank "stress" scenarios²²

DNB's approach aims to quantify the worst-case impacts on financial institutions arising from energy transition risk. It has designed scenarios that are "severe but plausible" in order to do this, stating that "the probability that [such scenarios] will actually materialise is small". Because the purpose of the analysis is defined in this way, they do not include the use of a "business as usual" or central scenario.

Scenarios are defined according to two types of shock – technological shock and policy shock. DNB then use these scenarios in order to run macroeconomic stress tests, as shown in Figure 8 below.



Source: DNB (2018), An energy transition risk stress test for the financial system of the Netherlands, https://www.dnb.nl/en/binaries/OS_Transition%20risk%20stress%20test%20versie_web_tcm47-379397.pdf (page 18)

A more qualitative approach is also possible, where scenarios are viewed not as a source of data to feed into models, but rather as a narrative in order to provoke a discussion about overall investment strategy or the prospects for a particular sector or region. Allianz Global Investor’s climate risk scenarios are an example. These were developed together with Allianz Climate Solutions, using structural climate risk schemes as illustrated in Figure 9. They encompass technology, regulatory and physical climate change risks, taking into account IPCC scenarios on different

degrees of global warming. The ultimate objective is to have a qualitative “what if” asset allocation discussion accounting for selected climate scenarios.

Whilst not fitting into some of the definitions of scenario analysis as described in Section 1, a qualitative approach is consistent with the recommendations of the TCFD, and can be an important way to build internal knowledge and understanding, perhaps ahead of taking a more quantitative approach later.

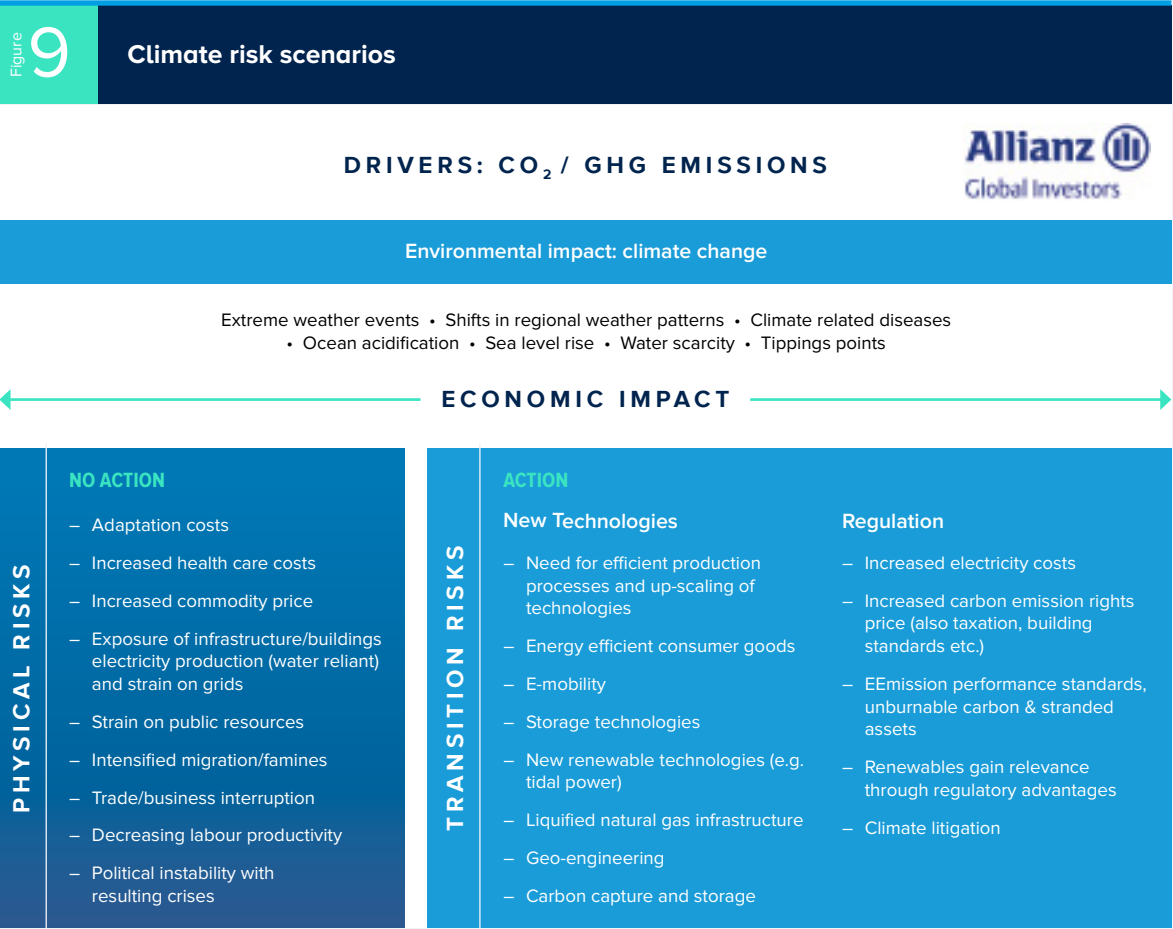


Figure designed in consultation with Allianz Climate Solutions. Derivation of heat maps per asset class from impact chain. Source: Allianz Global Investor (2018)



4.5 Questions to ask when selecting scenarios

With the wide range of scenarios available, investors need to understand the importance of the assumptions that underpin these models. The questions below are intended to provide a checklist of points to consider in selecting scenarios.

Considerations for investors in selecting scenarios

General questions:

- Is my focus on transition risk, physical risk or both?
- What timeframe do I want my analysis to cover?
- Is the purpose of the scenario to inform quantitative analysis or a more qualitative discussion?
- Do I want to use one of the common ‘reference scenarios’, or develop my own?
- If I do use a ‘reference scenario’, do I take its assumptions as given, or adjust them to fit my own beliefs?
- Do I want to focus the analysis on ‘stress scenarios’ – in other words, those which consider extreme but unlikely outcomes - or on scenarios that are more likely to materialise?
- What is the right balance between a sophisticated but complex scenario and a simplified but more easily understandable one?

Examples of questions relating to specific assumptions in transition models:

- What temperature limit is the model based on, with what probability of meeting it?
- What considerations are made for carbon capture and storage as well as for overshooting?
- What are the key assumptions or inputs such as the prospects for certain technologies (such as electric vehicles or renewables)?
- How do these assumptions fit with my own beliefs (if any) and can I vary them?



APPLYING SCENARIO ANALYSIS TO INVESTMENTS

05



05

APPLYING SCENARIO ANALYSIS TO INVESTMENTS

THIS SECTION

- Describes a range of methodologies that seek to use scenarios as a basis for analysing investments:
 - Asset liability management / strategic asset allocation approaches
 - Portfolio-level tools
 - Tools for bottom-up analysis at the company or asset level
 - Approaches combining portfolio-level and bottom-up analysis
 - Physical risk analysis
- Provides some questions for investors seeking to understand and select climate scenarios



Apply scenarios analysis to investment

Top-down mapping to identify main areas of risk or bottom-up in-depth analysis to better understand magnitude of risk

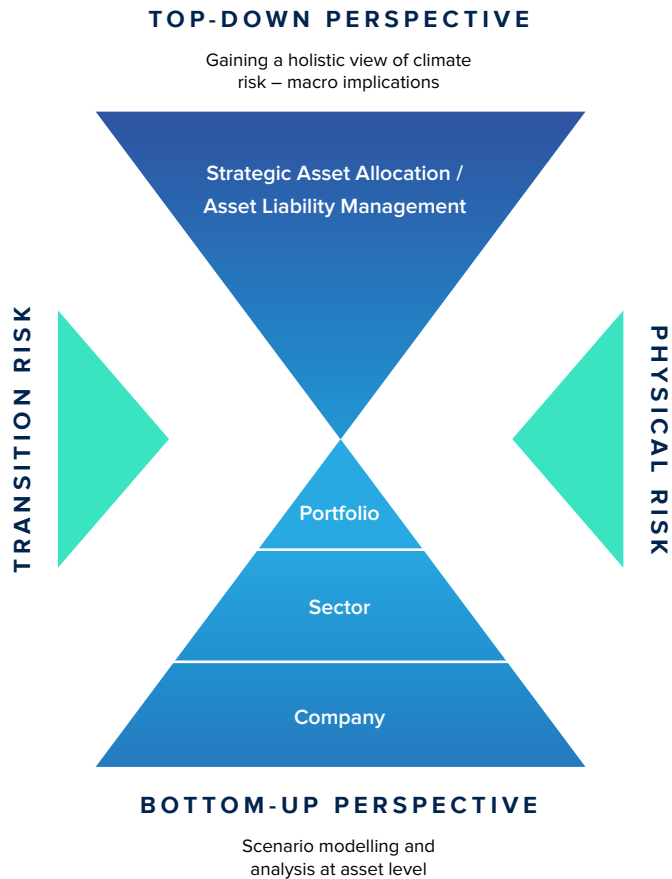
A key message from investors who have used climate scenario analysis is that no one methodology is able to meet every objective. Each has its own strengths and weaknesses and is suited to different objectives.

For example, simple data points such as sector exposure or corporate carbon footprints may be helpful in order to identify the assets at higher risk, which then merit deeper analysis. Asset-level analysis might support a more detailed understanding of the probability of physical risks and identify geographical zones at risks that require more analysis. Furthermore, a deep analysis of trends and scenarios can help provide a more dynamic understanding of the transition process over time.

The following sections aim to help investors make choices appropriate to their own aims and circumstances, and to set out the benefits and limitations of the available options.

Figure 10

Applying scenario analysis to investments



5.1 Scenario analysis at asset liability management / strategic asset allocation level

The investment industry considers variations in future macroeconomic and market parameters such as GDP, interest rates and the equity risk premium as part of existing risk management techniques. In the case of asset owners with a stream of future liabilities to pay, these factors are critical considerations in their ability

to meet these obligations. Strategic asset allocation is then perhaps the most important tool to manage these risks for the institution as a whole.

The systemic nature of climate change risk means that it may have implications for these macroeconomic and market parameters, particularly in more extreme 'stress' scenarios. Some scenario analysis techniques are now seeking to capture these, with a view to drawing conclusions for asset liability management (ALM) and strategic asset allocation (SAA) decisions.

Examples of climate scenario analysis at ALM / SAA level

DNB: Taking the four “stress test” scenarios outlined in Figure 8 (Disruptive energy transition scenarios), DNB uses modelling techniques to estimate the potential impacts on GDP, inflation, interest rates and stock prices, then to translate these into sectoral impacts and finally to impacts on the financial sector (banks, insurers and pension funds). It finds that, under the most negative scenario (Confidence Shock), the funding ratio of Dutch pension funds could decrease by up to 6%.

Mercer: In its study ‘Investing in a time of climate change’, Mercer takes the four drivers of its scenarios as outlined above in Section 4 (Technology, Resource Availability, Impact and Policy), and estimates the sensitivity of different asset classes to future trajectories for these drivers, dependent on the scenario used. The next iteration of the model being developed is expected in early 2019.

a.s.r.: a.s.r. Nederland is the 3rd largest insurance company in the Netherlands. As an insurer, climate change is a direct risk to their business, both to the claims they pay out and to the value of their investments. a.s.r. asset management has engaged Ortec Finance, in collaboration with other financial institutions and academia, to integrate top-down climate scenario analysis in strategic asset allocation. The methodology is based on linking scientific climate data to ALM/SAA tooling, with the first results of the pilot expected in the first half of 2019.

A challenge with these approaches is that by doing analysis at the level of the global economy and markets, some of the most severe regional and sectoral impacts of climate change may be netted

out within the models, particularly when analysing diversified portfolios. PGGM’s experience is an example of the challenges encountered by a large institutional investor.



CASE STUDY 2

PGGM



Scenario analysis is integrated into the annual review of PGGM's clients' asset allocation. Pathways for key economic variables such as GDP growth, interest rates and inflation are translated into expected returns that ultimately feed into asset allocation decisions.

Last year, as a separate exercise, PGGM explored the impact of climate change through a scenario exercise. Two key drivers were identified: public policy (e.g. carbon prices) and technology. This leads to a 2 x 2 matrix of scenarios, one of which (coordinated policies and rapid technological progress) would be aligned with the goal of the Paris Agreement (2°C or less). At present, however, PGGM's central economic scenario is more in line with a 3°C scenario (rapid technological progress, but fragmented policies).

Fully integrating climate change in the standard economic scenario set has proved challenging:

- Climate change is only one of many economic factors, and arguably not the dominant one in the chosen investment horizon (15 years). A first crude risk assessment revealed that, largely due to diversification, the financial risks of climate change are relatively mild compared with other risks. This has reduced the sense of urgency.
- Climate change scenarios generally lack the necessary level of granularity for investment decisions. The main impact of climate change occurs at sectoral and regional level, while asset allocation decisions are made at asset class level.
- Deriving market expectations to assess which climate scenarios is implicitly priced by the market remains a qualitative exercise.

Insights from climate change permeate the investment process at various levels in different ways. For private investments and corporate bonds, climate change is taken into account in individual investment decisions, as well as in portfolio management. At the portfolio level, quantitative stress tests are performed, for instance through carbon pricing. On an asset allocation level, quantification is more of a challenge, but – together with other megatrends – climate change is used to qualitatively assess risks and opportunities in asset classes. As such, there is a channel through which climate change can have an impact on asset allocation.

Scenario analysis at ALM / SAA level – benefits and limitations

Benefits – Analysis at this level can offer the asset owner a holistic view of climate risk and opportunity, allowing consideration of the implications not only for assets, but also for liabilities. This type of analysis can potentially also be embedded into existing risk systems that model macroeconomic variables such as GDP and inflation.

Limitations – Quantitative models at this level can be complex, due to the scale and scope of impact they are attempting to cover. If such tools are to be useful, the investor needs to invest the effort to fully understand the modelling techniques, which may be beyond the resourcing capabilities of some schemes. This high-level view may understate the importance of sectoral or regional impacts, if these impacts are 'netted out' in the end results.



5.2 Scenario analysis of transition risk: portfolio-level tools

Portfolio-level approaches seek to combine data derived from climate scenarios with company-level data (most often listed equity issuers), aggregating these in order to produce analysis of the impact of scenarios across a portfolio.

5.2a Alignment focus

Some tools focus on alignment, namely the extent to which portfolios are consistent with a particular scenario pathway, which is most often a 2°C scenario. An example of this approach is the Paris Agreement Capital Transition Assessment (PACTA) tool.

Figure

11

PACTA Tool

The Paris Agreement Capital Transition Assessment (PACTA) tool, supported by PRI, is a free online tool based on analysis by the 2°C Investing Initiative.

The tool, which covers equity and bond issuers, is based on analysis of companies' investment and production plans in both high-emissions activities (such as oil & gas or coal-fired power generation) and low-carbon solutions (such as renewable energy or electric vehicles), both now and in the coming five years.

These are then compared with the technology and energy mix which would be consistent with the trajectory towards a given climate scenario. A range of scenarios are available, including the IEA 2°C and 1.75°C scenarios.

The output is a 'technology exposure gap', showing the degree to which the investment and production plans within a given portfolio is aligned with a given climate scenario. This alignment analysis may in itself meet the investor's objectives on climate change; it might alternatively be used as a tool to inform deeper analysis in areas/sectors with misalignment, or for product design.

With a growing number of asset owners announcing their intention to align their portfolios with a 2°C or lower future, specific alignment investment products are starting to be developed.

CASE STUDY 3

UBS Asset Management



In 2017, UBS Asset Management partnered with a UK pension fund client to create the Climate Aware fund, as a rules-based equity strategy. The approach aims to be forward-looking and uses a probabilistic framework to capture the inherent uncertainty surrounding carbon data.

A key building block of the fund is the alignment of investments with a 2°C scenario. A quantitative model compares the company's carbon footprint trend with the emission reduction required by the IEA's 2°C scenario. An estimate of "glide path probability" shows how close the company is to the necessary trajectory. A number of scenarios were considered in the design of the strategy, and the final choice took into account both the granularity of projections at sector and geographical level, and the regularity of the updating cycle.

This quantitative model is combined with a range of other quantitative and qualitative information including companies' climate disclosures, policies, objectives and/or initiatives related to carbon efficiency; carbon footprint; renewable energy generation and technologies; and power generation from coal and companies owning coal, oil and gas reserves.

This is supported by a voting and engagement programme, with the glide path probability and other information helping to identify companies that are a priority for engagements.

Scenario analysis at portfolio level with alignment focus – benefits and limitations

Benefits: Alignment analysis can serve as a useful way to identify areas of the portfolio where there is a mismatch between portfolio holdings and a 2°C or lower trajectory, providing a focus for further analysis.

For investors who wish to align their investments with a low-carbon future to fit with their investment beliefs, or report to their stakeholders on the extent to which they are doing this, alignment analysis provides a useful guide. It can also capture opportunity alongside risk.

Limitations: This type of analysis does not provide information on the financial impacts of climate change. It tends to focus on one scenario only – usually the 2°C scenario – meaning that it does not capture the full range of possible risks and opportunities.

The revenue and capital expenditure data on which such tools are based only captures near-term plans, which limits the time horizon considered and will not capture the ability of some companies to adapt their business plans over the longer-term.

5.2b Financial focus

More often, top-down tools and approaches take the analysis a step further by estimating financial impact, or the potential downside risk (or upside opportunity) a portfolio may be exposed to in a range of climate scenarios. A number of such tools are commercially

available. Examples of some of these third-party tools/ methodologies are described in further detail in a supplementary guide available on the IIGCC website (see Appendix I for more information).

Examples of commercially-available scenario analysis methodologies – Transition risk

Carbon Delta:²³ Uses country-level emissions targets to allocate carbon constraints at sectoral, company and individual facility level, then uses emissions reduction cost forecasts to calculate the cost of cutting emissions to meet those constraints. Positive revenue opportunities are also estimated, using relevant patents as a proxy for low-carbon innovative capacity.

ET Risk Project /CO-Firm:²⁴ As set out in Section 4, the ET Risk Project constructed two scenarios to model a limited carbon transition and an ambitious transition. The CO-Firm's Climate Xcellence model combines these with asset-level data covering over 30 countries and 200,000 factories and products in order to model the associated risks. This is based on a sectoral approach which aims to estimate potential impacts on financial metrics including cashflows and capital expenditure.

Bloomberg / Carbon Tracker Initiative:²⁵ Available to Bloomberg subscribers, this tool (2D Scenario Analysis Tool) uses specialist oil and gas industry data from Rystad Energy, combined with Bloomberg market data, to provide company-level modelling of climate transition risk for the oil and gas sector. The tool is based on previous work by the Carbon Tracker Initiative, which has used detailed project-level cost information to differentiate how companies may be impacted dependent on their cost structure.

Innovation has also been taking place as asset owners and managers develop their own methodologies and approaches. The AP2 case study sets out how one asset owner took the IEA scenarios as a starting point for a more focused analysis of a single sector. Hermes Investment Management use

a sector-orientated approach, identifying key drivers for future trends as a basis for deeper analysis. Finally, the Impax Asset Management model is an example of a methodology applied on a more portfolio-wide basis.



CASE STUDY 4

AP2

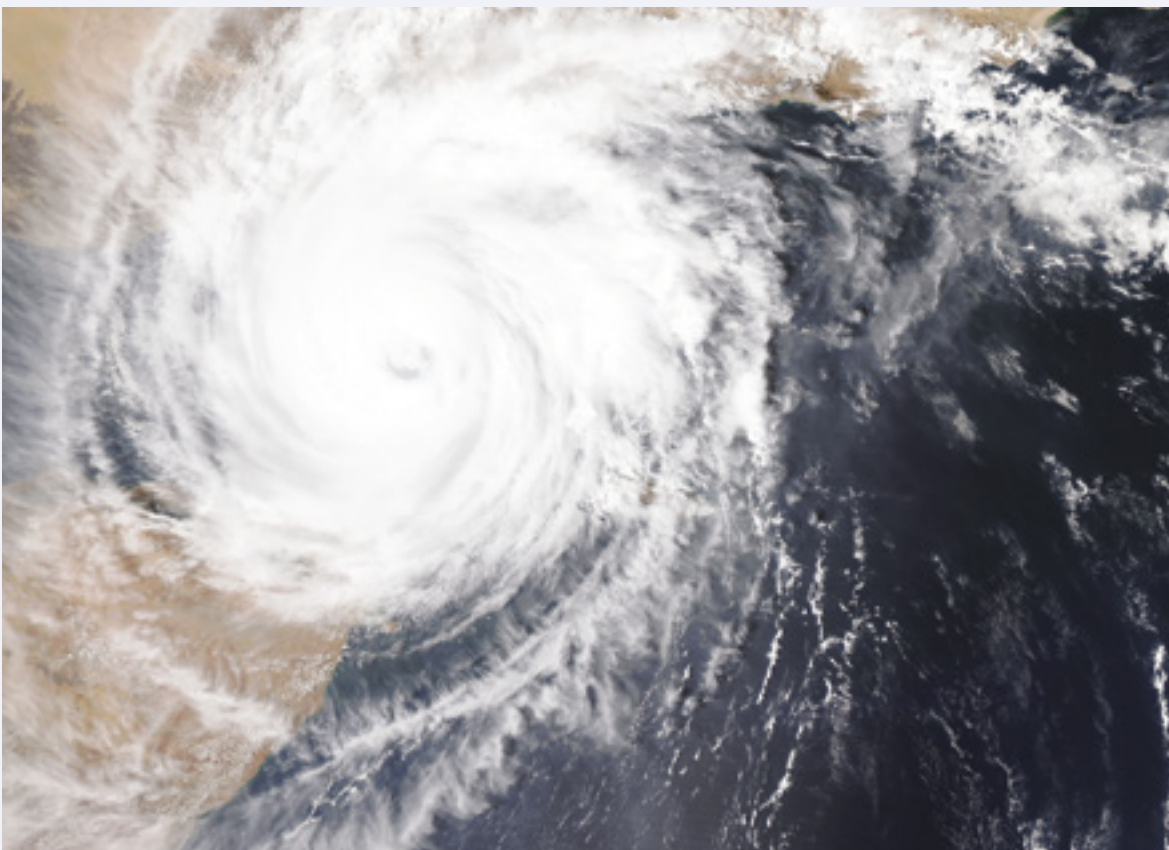


Swedish pension fund AP2 focused on oil and gas as a single sector, in conducting a scenario analysis exercise undertaken jointly by analysts from its sustainability and equities teams. The objective was to gain a greater understanding of the financial risk arising for the sector in future climate scenarios.

The initial step was to undertake in-house sector research to form their own view on the risks and opportunities the sector is facing. AP2 used multiple approaches to reach this point, one being scenario analysis. AP2 reviewed the IEA scenarios to select one which could represent a 2°C aligned future. They chose the IEA 2DS, both because it offers a long timescale and because the IEA provides a visualization tool which enables users to see the impact of changes in assumptions.

AP2 used the IEA 2DS scenario, with some small modifications to the assumptions to better reflect AP2's beliefs, in order to calculate a cumulative global oil consumption trajectory for every year up to 2100. This was then used to produce a long-term break-even price for oil in a 2°C world, based on a supply/demand analysis combining consumption trajectories with data on global oil resources. The break-even price was then used, together with other fundamental valuation tools, to decide which companies would be exposed to risks if this oil price materialised.

AP2 has analysed the oil and gas sector since 2014 and has divested from 20 fossil fuel companies due to financial climate risks.



CASE STUDY 5

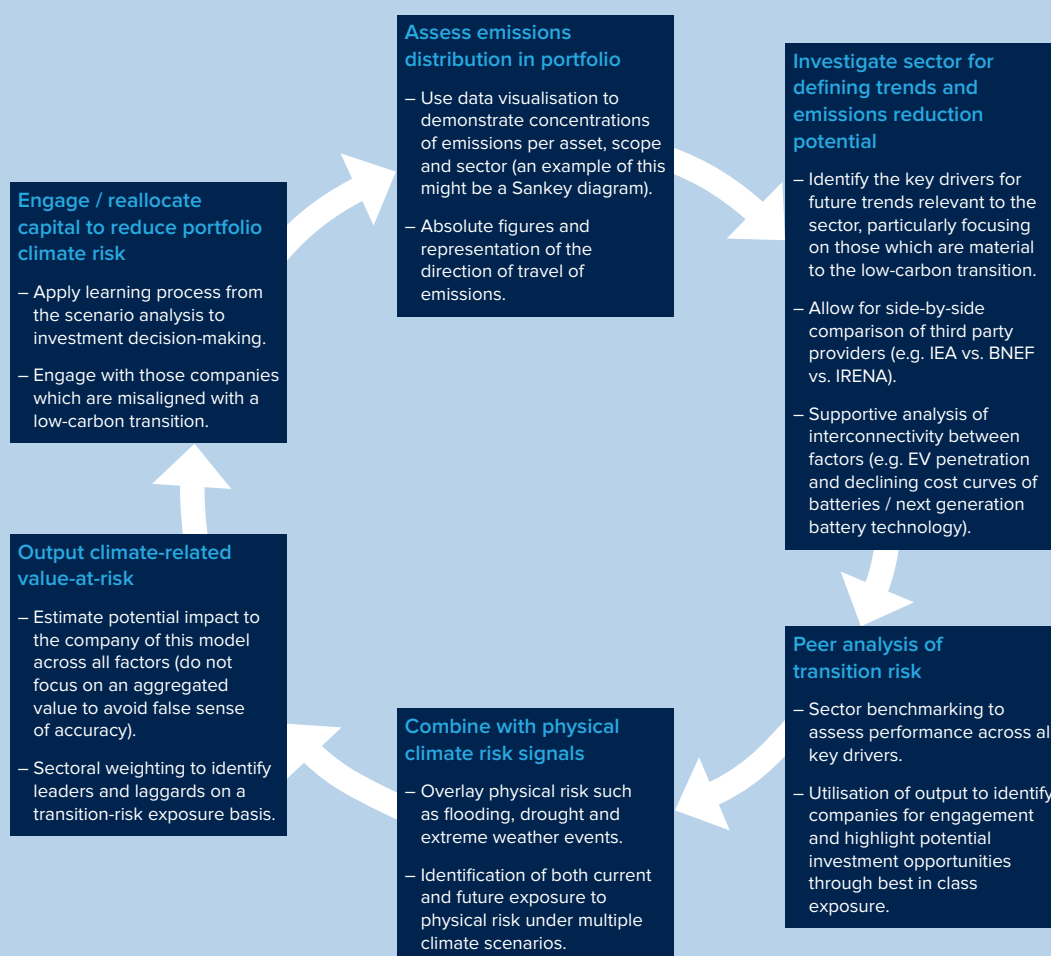
Hermes Investment Management



Hermes Investment Management incorporates scenario analysis as part of its portfolio climate risk and opportunity management process.

Whilst Hermes does not discount the use of a climate value-at-risk output, given the degree of uncertainty baked in, it is used as one element of the story, and is complemented by analysis of trends and scenarios aiming to paint the full story of companies and underlying progress on climate scenario analysis. Engagement is a key part of the loop, with climate assessment helping identify assets at risk, and data gathered on engagement helping to provide a more dynamic approach and refine understanding of real long-term risks.

Hermes disaggregates the process so that investors, portfolio managers and other stakeholders are able to understand the key drivers of the transition, and challenge assumptions, either of companies or of third-parties data/service providers.



CASE STUDY 6

Impax Asset Management



Since 2015 Impax Asset Management developed a Smart Carbon Adjusted MSCI World Index portfolio that takes account of the stock-level risk arising from climate change transition scenarios. The Impax Smart Carbon scenario analysis focuses on future commodity prices and carbon (pricing) policy.

Its approach focuses on 'cash flow impairment' as a risk measure, as opposed to carbon footprinting, as it is considered both forward-looking and takes into consideration a company's ability to pass on higher costs (from carbon pricing) to its customers. The analysis focused initially on the energy sector, where companies are typically heavy emitters and have weak pricing power. Since 2017, Impax has extended the analysis to the rest of the global index, with 'utilities and materials' having the largest exposure as sectors. The model is updated semi-annually to take account of changing risk information.

Assessing a specific portfolio through the Smart Carbon approach allows Impax to:

- Understand the under / overperformance by stock under different scenarios, as well as a probability-weighted loss; and
- Produce recommendations to optimise the portfolio by reducing the overall climate risk.



Scenario analysis at portfolio level with financial focus – benefits and limitations

Benefits: Using commercially-available portfolio-level tools has the advantage of broad coverage, and of allowing investors to avoid the significant resource and data requirements of attempting to conduct such analysis in-house. They are particularly suitable for diversified equity / fixed income portfolios.

Practical experience of using the models is that the inevitable simplifications and assumptions made, alongside the inherent uncertainties about the scenarios themselves, means that any outcomes have to be treated with a high degree of caution. However, investors have found them valuable in certain respects given that:

- While they can only provide an approximation of relative financial risk, they can be viewed as a heat map which then helps in the identification of high-risk areas, which can subsequently be subject to more detailed analysis.
- They can also be useful in providing consistent comparative analysis between funds.
- By providing broad coverage, these tools are useful in being able to produce reporting to meet external stakeholder and compliance needs.

Limitations: The range of assumptions used, and the problems of data gaps due to a lack of corporate disclosure, means that estimates can have a high degree of uncertainty attached. Using tools at this level without fully understanding the assumptions and uncertainties can provide ‘false precision’ and be detrimental to the overall objective of managing climate risk.

Adopting a portfolio-wide approach fails to take into account many company-specific factors and the dynamic element of business strategies.

5.3 Scenario analysis of transition risk: company/asset-level tools

Methodologies of this type consider climate scenario risks within fundamental stock-level or asset-level analysis. Such a ‘bottom-up approach’ may also be used when considering alternative or unlisted asset classes and where off-the-shelf data is not available.

This type of analysis can serve multiple purposes including:

- Informing valuation analysis of a company or other asset – such as input to a discounted cashflow model (both risk and opportunity).
- Informing portfolio construction decisions.
- Enabling an approach to stock selection or divestment which takes into account 2°C or lower alignment.
- Analysing how a company’s own scenario analysis compares with an investor’s in-house view.
- Informing engagement and proxy voting.

5.3a Alignment focus

As with the top-down approaches, there are alignment approaches at the company level, which aim to identify businesses whose strategies are consistent with a 2°C future. Two examples of initiatives here are the Transition Pathway Initiative (TPI) and Science-based Targets (SBT) initiative. More sector-specific work has been carried out by organisations such as Carbon Tracker Initiative.

Whilst less comprehensive in their coverage than the PACTA tool mentioned above, these can allow for a more qualitative judgment on companies’ alignment strategies, in particular taking into account strategic issues such as whether companies are setting long-term, forward-looking targets.

Figure 12

Approaches aligned with the Paris Agreement



Launched in January 2017, TPI is a global initiative led by asset owners (with over \$9.3 trillion combined AUM) and supported by asset managers. Aimed at investors and free to use, it assesses company preparedness for the transition to a low-carbon economy.

TPI's methodology is based on ranking the management quality and carbon performance of companies, with analysis tailored to individual sectors (including oil & gas, mining, cement, steel and utilities). These rankings are publicly available.

Source: Transition Pathway Initiative



The SBT initiative aims to provide companies with advice on by how much and how quickly they need to reduce their greenhouse gas emissions in order to be consistent with climate goals.

Targets adopted by companies to reduce greenhouse gas emissions are considered science-based if they are in line with the level of decarbonisation required to keep global temperature increase below 2°C, in line with IPCC analysis. At the time of writing, almost 500 companies have committed to taking this approach.

The SBTI methodology can also be applied to unlisted asset classes – particularly real estate.

Source: Science Based Targets

Scenario analysis at company / asset level with alignment focus – benefits and limitations

Benefits: This type of analysis is forward-looking and some methods cover more qualitative aspects including company strategy. It can also be particularly useful in informing company engagement.

Limitations: Tools so far have limited coverage, so may not be suitable for a comprehensive portfolio-wide analysis or providing results that can easily fit into reporting and disclosure.

5.3b Financial focus

Again, most investors have sought to go beyond alignment to model the potential financial impact on their holdings. Climate risks can be translated into company valuation models, such as discounted cashflow models in a variety of ways. Examples include:

- **Revenues:** Reduction in revenues (volumes and/or price) for carbon-intensive products and increase in revenues from climate solutions.
- **Costs:** Costs of compliance with climate policies (e.g. emissions trading schemes) and costs of extreme weather events, such as increased prices of raw materials in the supply chain.

- **Capex:** Increased capex due to R&D in new technologies, decreased capex from cancellations of high-carbon projects and capex in building weather resilience for assets in areas of high risk of extreme weather.

The ultimate impact of any such changes on the valuation of a company or asset will also depend on market factors, such as the ability of the company to pass on additional costs to the consumer, and the regulatory environment in which it operates.

CASE STUDY 7

HSBC Global Asset Management



Low-carbon transition scenarios: exploring scenario analysis for equity valuations

HSBC Global Asset Management has undertaken scenario-based analysis of low-carbon transition impacts on equity valuations²⁶. Their report presents six illustrative climate transition scenarios to explore how policy timing and future technology costs influence both the sector and company level for a diversified equity portfolio.

The analysis breaks down climate impacts into three main transmission mechanisms: direct carbon costs imposed on emitters, lower demand for carbon-intensive products and higher demand for 'clean tech' products. Direct carbon costs affect all emitting companies, but value impairment depends on a firm's abatement potential and ability to pass on costs to consumers. Some emissions-intensive companies may even benefit from climate action as they win market share and reap windfall profits from rising prices. Exposure in the fossil fuel sector will depend on the individual firm's production mix, investment horizon and extraction costs. For green technologies, performance depends on competitive advantage and innovation potential, as well as general market growth.

The six illustrative scenarios highlight the risk associated with policy and technology uncertainty as valuation impacts within and across sectors vary considerably across different scenarios.

HSBC Global Asset Management's report illustrates how investors can use climate scenarios to assess the risks and opportunities from the low-carbon transition at an individual security level.

Policy Timing:



No Policy Action - Provides a baseline reflecting existing climate policies and predicted technology cost trends, with no further policy changes



2020 Action - Policy change from 2020 which has at least a 50% chance of limiting warming to 2°C



2030 Action - Policy change from 2030 which has at least a 50% chance of limiting warming to 2°

Future Technology Costs

(while maintaining 2020 Action scenario policy assumptions):



Renewable Revolution - Reduced costs for solar and wind energy



CCS Storm - Reduced costs for Carbon Capture and Storage, a technique to reduce atmospheric greenhouse gas concentrations



Efficiency Boost - Increases in energy productivity

In comparison with some of the top-down methodologies discussed above, analysis at this level is potentially better able to capture not only the exposure of portfolio companies to climate risk, but also their ability to manage or mitigate this risk. Examples of how companies may mitigate risk through their strategic approach include their ability to pass on costs, insurance against physical risk including investment in new technologies and diversification.

Further guidance on the relevance of climate scenarios to company valuation can be found in publications from organisations including the ET Risk Project²⁷, whose reports provide detailed methodologies for modelling transition risks in high-emissions sectors including utilities, autos, steel and cement.

Scenario analysis at company / asset level with financial focus – benefits and limitations

Benefits: Applying scenario analysis techniques at individual company or asset level allows for a high degree of company-specific tailoring, such as allowances for local regulatory regimes or the fact that a single company may have a mix of relevant goods and services. It can take into account a company's future strategic direction and ability to adapt, including information obtained through company engagement.

Methodologies at this level can be embedded into existing stock or credit analysis processes.

These approaches can also be applied to unlisted asset classes (e.g. private equity, infrastructure or property).

Limitations: Scenario analysis at a company level may, depending on the methodology used, require a large amount of data and resource.



5.4 Combining approaches

One way of making the analysis process more manageable is to think about combining a top-down approach to identify key risk areas with bottom-up analysis of a smaller subset of companies, utilising scenario assumptions within existing valuation techniques. The top-down analysis then can be viewed as a way of creating a ‘heat map’ which informs further actions.

An example of application is in the work done by the UN Environment Finance Initiative (UNEP FI) for the banking sector, the principles of which can also be applied to equities and corporate credit.

Combining portfolio-level and bottom-up analysis

The UNEP FI has worked with global banks and consultants to produce research on the application of scenario analysis for the banking sector.

Their first report proposes a methodology for the assessment of transition risk²⁸. It is based on three modules: scenario selection, portfolio impact assessment and borrower-level calibration. The borrower-level calibration is based on a deep analysis of climate risk for individual borrowers in order to assess the implications for credit risk. Rather than attempting to calculate this for every borrower, a sampling approach is needed, based on splitting borrowers into representative sectors which have similar characteristics, and then analysing a small number of companies within each sector. This impact assessment is then aggregated up to a portfolio level in order to understand the total impact.

An important methodological point is that some key sectors may need to be sub-divided as climate impacts may vary dependent on their characteristics. Barclays, for instance, divided electric utilities into those operating in regulated and unregulated markets, and those with a low and high carbon intensity, on the basis that company sensitivity to climate risks could differ widely dependent on these variables.

Having also completed a report on physical risks for the banking sector, UNEP FI is now working on a pilot project on implementing scenario analysis for investors, covering both transition and physical risk, expected to be published in 2019.

More generally, an investor may combine one of the top-down methodologies described in Sections 5.1 and 5.2, in order to identify key risk areas, then supplement this with the application of more intensive company-level analysis focused on these risks.

Benefits: A combination of top-down risk mapping and bottom-up analysis of higher-risk sectors, companies and/or assets can potentially offer the combination of broad coverage, and the depth of analysis needed to have more confidence in quantifying financial impacts where these are most material.

Limitations: This is a resource-intensive approach.

CASE STUDY 8

AXA Investment Managers



In 2018, AXA Investment Managers set up a partnership with Carbon Delta and Beyond Ratings to measure the exposure of investments - both corporates and sovereign - to climate risks and opportunities. They are developing a combined approach, using scenario analysis to test alignment of investments with various climate objectives. This will be done by combining a 'strategic view', based on cross-asset investments and temperature monitoring, with a 'tactical view' using a bottom-up climate qualitative analysis and sector-specific engagement process with companies.

AXA Investment Managers Climate Approach:

Use of quantitative scenario analysis models and qualitative engagement frameworks as decision making tools for portfolio allocation

Identify risks
STRATEGIC VIEW
Measure and quantify exposure to climate risks across asset classes using macro-level top-down approach

Create an asset mix that seeks to provide the optimal balance between climate risks and green opportunities

– Measure exposure to climate risks focusing on:

- Carbon emissions reduction requirements at macro level
- Extreme weather risks heat map across regions
- Companies' businesses and operations mix
- Companies' overall exposure to green opportunities and new technological green businesses
- Countries' dedicated KPIs (primary energy supply mix, resilience to physical risks...etc)

– Measure overall cross-asset alignment with warming scenarios focusing on:

- Countries' National Determined Commitments (NDCs)
- Sector science based carbon emissions reduction targets
- Carbon budget by companies and countries

TACTICAL VIEW
Forward looking approach to assess companies' preparedness and climate resilience through dialogue

Position a portfolio into assets, sectors, or individual stocks, in taking into account relative climate resilience progress

– Construction of climate engagement frameworks with cross-asset internal sector leads (financial analysts and portfolio managers) and climate experts
– Constitution of two groups of sectors:

- Supply-side sectors at stake: energy, utilities, materials and transportation
- Demand-side sectors at stake: consumers, ICT, capital goods and real estate

– Produce list of names considered at risk (not aligned with a 2° scenario in particular) to initiate engagement process
– Set "science based" targets and objectives with companies engaged and monitor progress made
– Take into account companies' track record on climate objectives into ESG analysis
Engage/dialogue and track progress made

5.5 Scenario analysis of physical risk

To date, there has been a greater focus on transition risk methodologies than physical risk within the investor community as a whole. This is not due to physical risk being less material than transition risk. Indeed, given the concentrations of greenhouse gases already in the atmosphere, future changes to the climate are not a distant risk but a near certainty. A report by CICERO notes that “many physical impacts that scientists had originally anticipated over a much longer time horizon are being observed today across the globe, and will continue to increase in the next 10-20 years regardless of the greenhouse gas emission trajectory.”²⁹

However, the analysis of this type of risk presents some methodological challenges. Forecasts at a global or even regional level of variables such as temperature rise are difficult to tie to financial impacts; highly granular data is needed both on the physical impacts themselves, and the potential assets at risk. A recent report by the Institute of Climate Economics (ICE), lays out in detail this and other challenges for further physical climate risk analysis, based on a review of third party analytical approaches.

Corporate action is probably ahead of investors at this point in time, with some companies in highly-exposed sectors such as insurance and food production active in addressing these challenges and developing highly sophisticated approaches to the analysis of physical risk.

5.5a Physical risk impacts on portfolios

The most obvious way that physical risk could impact portfolios of listed assets is through the impact of weather events such as heatwaves, droughts, storms and floods on the productive assets of a company.

More indirectly, physical risks can also have consequences across the value chain (from suppliers to the market) and the broader socio-economic environment for businesses. For asset-heavy companies operating in more vulnerable countries, the potential costs can have a significant impact on current market value. However, with few analytical techniques able to capture these more indirect impacts, they are difficult to model.

Figure 13

How climate change affects corporate value chains

EXAMPLE OF CLIMATE CHANGE IMPACTS ON COMPANIES

	Supply chain	Production	Logistics	Sales
Assets	Shortage of inputs or raw materials	Damage to production facilities, stock & equipment	Damage to transportation infrastructure	
Expenditures	Increased cost of supplies due to scarcity	Increased insurance premiums and capital costs	Cost of delays due to degraded transport conditions	
Revenue		Reduction or disruption in production capacity	Loss of revenue due to failed delivery or service disruption	Damage to market for product or service

Source: Carbone4 Finance, Climate Risk Impact Screening (2017), http://crisforfinance.com/wp-content/uploads/2017/11/CRIS-Guidebook_Publicversion_Nov2017.pdf



Despite the challenges, data, analytical tools and methodologies are becoming available which aim to map physical risk data with company-level information in order to inform the analysis of physical risk. The following are some examples:

Examples of commercially-available scenario analysis methodologies – Physical risk

Four Twenty Seven³¹: combines global climate data with a proprietary database of over one million individual corporate facility sites. Using the IPCC ‘worst-case’ scenario based on high global temperature rise (RCP 8.5), Four Twenty Seven scores listed companies for climate risk. These scores cover operational, supply chain and market risks arising from physical climate risks. The analysis is also applied to sovereigns, municipalities and real estate.

Carbone4 Finance³²: provides a bottom-up approach, combining analysis of geographical exposure, sectoral and sovereign vulnerability across seven direct climate hazards, both acute (event-driven) and chronic (long-term shifts) and nine indirect climate hazards. This multi-model approach is based on three IPCC scenarios and three time horizons. Their physical risk assessment and scoring is available via a web platform and the methodology has been adapted to bank loan books.

Acclimatise³³: use the outputs from climate impact models under multiple IPCC RCP scenarios, to understand changes in production or performance of selected assets or investments. These productivity changes are then translated into changes in revenues and costs where possible. These assessments are bespoke in nature across various sectors such as agriculture, banking, energy, infrastructure, mining, oil and gas, retail and transportation.

Beyond these examples, it has not been possible in the timeframe of production of the guide to provide detailed guidance on physical risk analysis. We have identified sources of further advice, which include:

- Mapping of physical risk methodologies by the Investor Group on Climate Change.³⁴
- A research report by DWS, produced in collaboration with Four Twenty Seven and Trucost, which aims to provide guidance on how to assess physical climate risk in equity portfolios.³⁵
- UNEP FI’s report on the assessment of physical risk scenarios for the banking sector, which contains examples of methodologies that could also be applied by asset owners or managers.³⁶
- A technical review of third party analytical approaches by Research Institute for Climate Economics (I4CE).³⁷
- On-going work by the international, scientific consortium behind the ClimINVEST project, which aims to assess climate impacts and develop tailored climate services and tools.³⁸



5.6 Questions to ask when selecting a methodology

Investors need to be clear of the benefits and limitations of different types of methodologies, and how well they may fit the initial established set. The questions below can help to frame the decision-making process.

Considerations for investors in selecting a methodology

Investors may ask some of the following questions when evaluating tools/methodologies:

General questions:

- What questions does this tool/methodology help my organisation answer?
- Can my organisation get an answer on this question in another simpler way?
- Do I understand the method in such a way that I can explain it to a non-expert?
- Can I explain the outcomes to a non-expert?
- How will my organisation use the outcome?
- Will my organisation be able to take action on the outcome?
- How would this tool help in assessing the value at risk of investments in my portfolio?
- Can I incorporate this tool into my existing risk, investment and/or engagement processes?
- Will my organisation be able to better identify relevant market signals to watch in regards to climate risks?
- Will this exercise help identify growth opportunities?

Questions to potential third-party service providers

- What is the main objective of the tool? For instance, is it designed to support alignment analysis or financial analysis?
- What climate scenarios can you use and can I vary the assumptions?
- Do you provide a clear description of the assumptions made on factors including policy action and future technology costs, and what are the sources?
- Is your data provided in a form that can be easily imported into my existing portfolio management systems?
- What is your coverage (number of issuers and across types of asset classes)?
- What are your data sources and what estimation techniques are used where data is missing?



REVIEW OUTCOMES AND CONSIDER ACTIONS

06

REVIEW OUTCOMES AND CONSIDER ACTIONS

THIS SECTION

- Suggests some points to consider in reviewing the outcomes of analysis
- Reviews actions that can be taken in response to:
 - Refining or extending the methodology
 - Incorporating into risk and investment processes
 - Informing company engagement
 - Stakeholder reporting and disclosure
- Discusses how investors can monitor the ‘early warning signs’ about which scenario is emerging to inform their ongoing risk monitoring and actions



Review findings
and consider
actions

Iterative process – range of actions including further
analysis, information gathering

The TCFD report emphasises that scenario analysis should be an integral part of an overall structure of climate risk management, not a stand-alone exercise. This section of the guide considers how to interpret the outcomes of a scenario analysis exercise, and what type of actions investors may take in response.

A recurring message from investors is that the end result of scenario analysis should not be viewed solely as the quantitative outcome. Much of the value lies in the wider process of discussion and analysis.

6.1 Reviewing outcomes

The exact interpretation of scenario analysis results will depend on the methodology chosen, but some key points for investors to consider include:

- **Scale:** What is the order of magnitude of the potential impact?
- **Timeframe:** What can I conclude about the possible timescales over which this will emerge?
- **Asset classes and sectors:** What does my analysis tell me about the differential impact of climate change on different asset classes and/or sectors?
- **Valuation:** Can I draw out lessons from the way I value individual companies or assets (quantitative or qualitative)?
- **Trends and drivers:** What does the analysis tell me about the signals to watch for in order to track climate risks in specific asset classes, sectors or companies?

6.2 Actions to consider

Once results have been reviewed, investors may consider a range of actions.

Possible actions required	Description	Examples
Refine or extend the methodology	The experience of investors undertaking scenario analysis is that it is a learning process, and an iterative process enabling them to improve their knowledge and identify better approaches for future iterations. Many investors take a pragmatic approach of piloting scenario analysis on a small scale and then extending it more widely later.	<ul style="list-style-type: none"> – Selecting a different scenario, adjusting assumptions or trialling a different approach. – Rolling out the methodology to more asset classes, funds or sectors.
Incorporate into risk and investment processes	Changes to investments may be implemented directly, or in the case of fund selectors through dialogue with asset manager(s).	<ul style="list-style-type: none"> – Changes to overall investment strategy or beliefs, such as a commitment to allocate capital to climate solutions. – Changes to investment allocations, taking into account findings on risk and opportunity affecting strategic asset allocation, asset class, fund or sector level, depending on the scope of scenario analysis. – Integration of climate scenario analysis into existing risk reporting systems – this can be implemented via risk dashboards or quarterly investment reports. – Sharing climate risks/opportunities data with trustees/management and/or external stakeholders. – Changes in holdings of individual companies / assets including: <ul style="list-style-type: none"> • Adjustment in size of position held if analysis suggests that climate risk is not sufficiently priced in and/or mitigated. • Divestment of companies misaligned with a 2°C future. • Investment in companies well aligned with climate solutions. – Development of new funds or products based on climate scenario techniques.
Company engagement	Engagement with companies may have one or more purpose.	<ul style="list-style-type: none"> – Complete gaps in the investor's knowledge where the company has not disclosed information. – Compare investors' own scenario analysis with any such analysis conducted by the company itself. – Encourage companies to take a stronger strategic approach to acting on climate risks and opportunities, in line with TCFD recommendations. The Climate Action 100+ engagement initiative is aligned with this action.

Possible actions required	Description	Examples
Stakeholder discussions and disclosure	The process of scenario analysis can help to inform discussions with the wider stakeholder base as well as disclosure.	<ul style="list-style-type: none"> – Engagement with stakeholders, particularly peers and beneficiaries. – Engagement with regulators – scenario analysis can help pre-empt and inform regulator dialogue. The TCFD is supported by regulators in numerous countries, and the UK and Dutch central banks have published papers on scenario analysis and financial sector risk. – Disclosure and reporting: scenario analysis is one of the main pillars of the TCFD recommendations, and the process and outcomes of scenario analysis should feed into disclosure in line with these recommendations.

A final point is that scenario analysis should, in principle, be a dynamic rather than a static process. Thinking about possible future states enables investors to better plan for the future, to notice when the predicted changes are materialising and to respond in a timely way. This is explored in the next section.

6.3 Ongoing monitoring

Whilst climate scenario analysis is forward-looking, it can still only assess risk at a point in time. In reality, over the timescales we are considering, investment portfolios change; companies themselves adapt and evolve; and the balance of the risks themselves will change, depending on the speed and ambition taken to decarbonise the global economy.

Scenario analysis, as with any type of risk analysis, should be subject to regular review and oversight. Once the methodology is developed, analysis can take place on an ongoing basis to monitor change as part of regular risk reporting.

Investors also stressed that scenario analysis offers a structured way to think about how they should respond to this dynamic picture of changing risks. By considering the potential responsiveness of investments to different states of the world, the investor will be far better prepared to respond once it becomes clearer which state of the world we are headed towards. In the words of one investor, scenario analysis “builds memories of the future”.

Even if the results of scenario analysis do not result in any changes to investments at first, the exercise is not wasted. Rather, it can be a starting point for the investors to begin to monitor the early warning signs about which scenario is most likely to materialise and then react quickly to changing circumstances, rather than waiting until after any market corrections have already happened.

This monitoring process can be structured in various ways, from a more qualitative, light-touch assessment of evolving market trends to a more formal system whereby an investor selects certain leading indicators to track. One example of this approach is provided by the consultant Ecofys, whose methodology focuses on identifying key indicators of change (or signposts), which can be used to track progress towards one scenario. Another example is the Schroders Climate Progress Dashboard, which monitors twelve indicators such as carbon prices, electric vehicle sales and climate finance in order to show the progress being made in realisation of a low-carbon global economy.

FUTURE DEVELOPMENTS

07



07

FUTURE DEVELOPMENTS

Since the publication of the TCFD recommendations, the pace of innovation in the area of climate scenario analysis has been rapid. We are hugely encouraged by this and believe that this approach, whilst still in its infancy, offers great potential to support investors in understanding the key drivers of climate change and the energy transition, and in developing a strategic forward-looking response.

In the course of writing this guide, some areas where further work is still needed became clear. These include:

- **Data:** As with many ESG issues, a lack of consistent and comparable data is a challenge to any type of analysis. The investor community has a role to play here in encouraging companies to report using the TCFD recommendations, as well as itself providing reporting to its stakeholders.
- **Physical risk:** The publication of the IPCC's 1.5°C report is a reminder that the physical impacts of climate change are not a distant and theoretical risk, but a present one. Investor methodologies in this area lag the corporate sector and we believe this area will need more attention from investors going forward.
- **Real assets:** Many of the approaches in this document relate to listed asset classes, particularly equities. However fixed income and real assets in most markets make up a high, and often growing, proportion of assets. Further work is needed to take some of the ideas and principles developed for equities and apply these more widely.
- **Liabilities:** Most methodologies focus on the potential impact of climate change on assets. However, the systemic nature of climate risk means that there are questions around how it impacts the ability of asset owners to meet their liabilities. There are approaches emerging which address these questions, but they remain in early stages of development.
- **Impact:** As discussed in this guide, whereas the focus of the TCFD is on financial risks and opportunities, many investors are also interested in alignment of their portfolios to a 2°C or lower future. Fully exploring the ways in which investors can actively support the climate transition – beyond protecting their own assets – has been outside the scope of this guide but is a key issue meriting further discussion, and also relates to investor efforts to support the Sustainable Development Goals (SDGs).

In conclusion, although many of the methodologies available for investors are focused on the management of risks, it is important to highlight that scenario analysis can also be used to identify investment opportunities. As the quality and transparency of data improves and various methodologies continue to develop, investors should increasingly integrate both risks and opportunities into the scope of their on-going work on climate scenario analysis.

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APPENDICES

Appendix I: Supplemental guide to third party data/ service providers on scenario analysis for investors

Supplemental guide: methodologies

As part of the empirical research for this guide, a supplementary study was undertaken to provide a broad overview of the various third party data/service providers supporting investors on climate-related scenario analysis. Kindly note that it is by no means an exhaustive list and any omission of other tools available have not been intentional. Climate-related scenario analysis for investors is still very much in development, hence products and services offered

to investors will only continue to evolve and improve as data quality and disclosure progresses.

This supplemental guide has been developed primarily for IIGCC members, but can be shared with third parties on a case-by-case basis on request. For further information, please contact Lewis Ashworth (lashworth@iigcc.org).

Appendix II: Understanding IEA scenarios

The IEA, an autonomous body within the OECD framework, provides analysis of global energy markets. One of its key publications is the annual World Energy Outlook, which shows what the latest data, technology trends and policy announcements mean for the future of the energy sector to 2040.

The scenarios included in the World Energy Outlook are policy-driven, which means that the differences in outputs between the scenarios depend on the policy assumptions made. They are modelled using the World Energy Model (WEM), a large-scale simulation model designed to replicate how energy markets function. Key WEO scenarios include the New Policies Scenario (NPS), which assumes that governments meet their Paris Agreement commitments as described by their Nationally Determined Contributions;

Sustainable Development Scenario (SDS), which is a 2°C scenario; and the Current Policies Scenario, which is best understood as a “business as usual” scenario with no new policies implemented.

The IEA also produces other scenarios not included in the World Energy Outlook. These include technology-driven scenarios, which means that the outcome of the scenarios is influenced by assumptions in technology developments. These scenarios are instead based on the Energy Technology Perspectives model (ETP), and include the Beyond 2°C Scenario.

The table below provides an illustration of the IEA scenarios that are relevant to understand when conducting climate-related scenario analysis.

Name	Abbreviation	Objectives of the scenario	Definition	Status	Time horizon for the scenario
Current Policies Scenario	CPS	To provide a baseline that shows how energy markets would evolve if underlying trends in energy demand and supply are not changed.	Policy driven scenario. It considers only the impact of policies already in force, no new policies are considered.	Included in the World Energy Outlook. Updated yearly.	2040
New Policies Scenario	NPS	To provide a benchmark to assess the potential achievements (and limitations) of recent developments in energy and climate policy.	Policy driven scenario. Governments implement (most of) the policies they have already announced, and no more policies are assumed to be implemented in the future.	The main scenario in the World Energy Outlook. Updated yearly.	2040
450 Scenario	450S	A pathway to limit long-term global warming to 2 °C above pre-industrial levels.	Policy driven scenario. Policies introduced sufficient to achieve 50% probability of staying below 2°C.	Obsolete - it was included in the yearly World Energy Outlook until 2016.	2040
Sustainable Development Scenario	SDS	A pathway to concurrently achieve universal energy access (SDG 7), set a path towards meeting the objectives of the Paris Agreement on climate change and significantly reduce air pollution (SDG 3.9).	Policy driven scenario. Governments implement policies sufficient to achieve Sustainable Developments Goals on climate, energy access and air pollution.	Introduced as a 2°C-scenario in the 2017 World Energy Outlook.	2040
Faster Transition Scenario	FTS	Developed as a contribution to a joint study by IEA and IRENA in 2017.	A climate-focused pathway. Policies introduced sufficient to achieve 66% probability of staying below 2°C.	One-off scenario published in standalone publication in March 2017, bur appears briefly in World Energy Outlook 2017, with limited data.	2050
Beyond 2 Degrees Scenario	B2DS	Explores how far deployment of technologies that are already available or in the innovation pipeline could take us beyond the 2 Degrees Scenario.	Technology driven scenario. Technology improvements and deployment are pushed to their maximum practicable limits across the energy system in order to achieve net-zero emissions by 2060.	Included in the Energy Technology Perspectives. Latest update 2017.	2050

Table footnotes

- * The CPS scenario changes the outcome of the temperature increase every year, since it is yearly updated with new policy requirements that have come into force.
- ** The NPS scenario changes the outcome of the temperature increase every year, since it is yearly updated with new policy requirements that have come into force or are announced.
- *** The WEM model has three main modules: 1. final energy consumption; 2. energy transformation including power generation and heat, refinery and other transformation; 3. and energy supply. Outputs from the model include energy flows by fuel, investment needs and costs, CO₂ emissions and end-user pricing. Output depends inter alia on differences in policy assumptions. For more information regarding the WEM model, see IEA.org.
- **** All technology options introduced in ETP are already commercially available or at a stage of development. Costs for many of these technologies are expected to fall over time, making a low-carbon future economically feasible. The ETP analysis takes into account those policies that have already been implemented or decided. For more information regarding the ETP model, see IEA.org.
- ***** Other parameters where different scenarios predicts different outcomes are inter alia deployment of CCS, deployment of renewables, use of negative emissions technologies, energy intensity, assumptions on future policies and investments trends. These parameters can change from year to year in the scenarios.

Differences in output of the scenarios*****

Model	Predicted temperature increase in year 2100	Probability of limiting global warming to the predicted temperature increase	Carbon budget from 2015 through 2100 (cumulative GtCO ₂)	Year which energy-related emissions peak	The year that energy-related emissions turns net-zero	GtCO ₂ emission at year 2040
Policy driven scenario The World Energy Model (WEM)***	Extreme*	N/A	N/A	No peak are predicted in the scenario.	Net-zero emissions are not predicted.	42.7
	2,7°C**	N/A	N/A	Possible peak between 2035 and 2040.	Net-zero emissions are not predicted.	35.7
	2°C	50%	1,140	Before 2020.	Net-zero around 2100.	18
	1,7-1,8°C	50%	1,222	2020	Net-zero between 2050 and 2100. If emission go to net-zero 2100, this scenario will lead to a temperature increase of 2°C. To increase the likelihood of a lower temperature rise, emissions will need to decline more quickly to zero, and potentially turn negative.	18
	2°C	66%	790	Before 2020.	Net-zero around 2060.	13
Technology driven scenario The Energy Technology Perspectives (ETP) model****	1,75°C	50%	750 (between year 2016-2100)	Have already peaked.	Net-zero around 2060.	12

About IIGCC

The Institutional Investors Group on Climate Change (IIGCC) is the European forum for investor collaboration on climate change and the voice of investors taking action for a prosperous, low-carbon future. IIGCC has more than 160 members, mainly pension funds and asset managers, across 11 countries, with over €21 trillion assets under management.

IIGCC's mission is to mobilise capital for the low-carbon transition by collaborating with business, policymakers and fellow investors. IIGCC works to support and help define the public policies, investment practices and corporate behaviours that address the long-term risks and opportunities associated with climate change. Members consider it a fiduciary duty to ensure stranded asset risk or other losses from climate change are minimised and that opportunities presented by the transition to a low carbon economy – such as renewable energy, new technologies and energy efficiency – are maximised.

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