

Transition risk framework

Managing the impacts of the low carbon transition on infrastructure investments

Public Report



ClimateWise

ClimateWise is a global network of leading insurers, reinsurers, brokers and industry service providers who share a commitment to reduce the impact of climate change on the insurance industry and society.

ClimateWise is a voluntary initiative, driven directly by its members and facilitated by the University of Cambridge Institute for Sustainability Leadership (CISL). All members produce a detailed annual report providing evidence of action against the ClimateWise Principles. As of 2019, the ClimateWise Principles are fully aligned with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations.

In 2016, the ClimateWise Insurance Advisory Council was established to lead research into ways the insurance industry can support the transition to a low carbon economy. The Council is formed of a group of C-suite executives from across the ClimateWise membership and is currently chaired by Dominic Christian, Global Chairman, Reinsurance Solutions at Aon.

The University of Cambridge Institute for Sustainability Leadership

The University of Cambridge Institute for Sustainability Leadership (CISL) is a globally influential Institute developing leadership and solutions for a sustainable economy. We believe the economy can be 'rewired', through focused collaboration between business, government and finance institutions, to deliver positive outcomes for people and environment. For over three decades we have built the leadership capacity and capabilities of individuals and organisations, and created industry-leading collaborations, to catalyse change and accelerate the path to a sustainable economy. Our interdisciplinary research engagement builds the evidence base for practical action.

Rewiring the Economy

Rewiring the Economy is our ten-year plan to lay the foundations for a sustainable economy. The plan is built on ten interdependent tasks, delivered by business, government, and finance leaders co-operatively over the next decade to create an economy that encourages sustainable business practices and delivers positive outcomes for people and societies.

Publication details

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The authors of this report and the accompanying framework were Tara Schmidt, Charles Allison, Molly Iliffe, Max Crawford and Ivet Manolova at ERM, with input from colleagues James Stacey, Alex Cox and Lee Solsbery. We are grateful for the guidance of the ClimateWise Insurance Advisory Council and for the advice and feedback received from members of the Advisory Panel which was established for this project. With special thanks to Finance Dialogue for their support.

ERM

ERM (www.erm.com) is the largest global management consultant with a core focus on sustainability. ERM's deep experience of supporting client companies to prepare for climate change and low-carbon transition led to it being invited to author the TCFD Technical Supplement on scenario analysis.

Reference

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February 2019

Executive summary

“With better information and risk management as the foundations, a virtuous circle is being built with better understanding of tomorrow’s risks, better pricing for investors, better decisions by policymakers and a smooth transition to a low carbon economy.”

Mark Carney, Chair of the G20 Financial Stability Board’s Task Force on Climate-related Financial Disclosures (TCFD) and Governor of the Bank of England; April 2018.

The transition to a low carbon economy carries both risk and opportunity and could unfold gradually over time or through sudden shocks. Transition risks include policy changes, reputational impacts, and shifts in market preferences, norms and technology. Transition opportunities include those driven by resource efficiency and the development of new technologies, products and services, which could capture new markets and sources of funding. These risks and opportunities vary across geographies, sectors, time horizons and in line with government and business commitments to limit global temperature rises.

In today’s low-interest-rate environment, investment in infrastructure offers stable income and portfolio diversification. However, several types of infrastructure asset are likely to be exposed to significant transition risk, with implications for financial returns. Further, infrastructure will need to play a key role in delivering a lower carbon economy. This exposure could grow significantly in the decade to 2030 as the market recognises these emerging risks and opportunities. This is particularly true in a 2°C scenario, in which more aggressive government policies and more rapid changes in technology and markets move the global economy away from business-as-usual to limit as far as possible global temperature rise. Consequently, investors will be under increasing pressure to enhance their capabilities to manage transition risks and capture opportunities from the transition to a low carbon economy.

The ClimateWise Transition Risk Framework helps investors and regulators manage risks and capture emerging opportunities from the low carbon transition. This unique framework was developed through the ClimateWise Insurance Advisory Council, and builds on the recommendations from the Task Force on Climate-related Financial Disclosures (TCFD). The ClimateWise Transition Risk Framework is designed to help investors to:

1. assess the breadth of asset types exposed to transition risk and opportunity across an investor’s portfolio (across different sub-sectors, regions and time frames)
2. define the potential financial impact from the low carbon transition down to an asset level
3. incorporate transition impacts into their asset financial models.

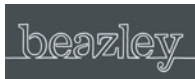
The framework is set out in three steps, which can be used independently or combined to explore transition risks and opportunities. Each of the three steps highlights practical actions investors might take in order to manage risks and capture opportunities. The framework applies this analysis to an array of global infrastructure asset types.

By applying the framework, investors will benefit from an enhanced understanding of how the costs and revenue drivers of assets within their portfolios could be impacted by the low carbon transition. This should lead to beneficial outcomes for investors: an increased ability to manage risk, to capture opportunity and (in alignment with the TCFD) to disclose the impact of transition risk.

Investors can use and adapt the framework in multiple ways, depending on their specific needs. To demonstrate the practicality of the developed methodology, the framework has been applied to three real-life portfolios. This includes the portfolios of two of the world’s largest insurance companies and one of the global top five investors in infrastructure. Feedback from regulatory bodies and industry stakeholders has been used to confirm that the framework is applicable to a broad range of investments.

While this report focuses on the application of the framework to infrastructure portfolios, the approach could be adapted to have wider applications across the financial community. It could also be expanded to cover physical risks and a greater variety of low carbon transition scenarios.

ClimateWise members 2019



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Forewords



Dominic Christian

We convened the ClimateWise Insurance Advisory Council to help understand the increasingly complex nature of risk affecting the financial services sector.

Our aim is to inform stakeholders of the true nature of the 'physical', 'transition' and 'liability' risks affecting our industry while identifying ways that insurance expertise can support other parts of the financial services sector in their response. The ClimateWise Transition Risk Framework is one of the first of our outputs.

The G20's Global Infrastructure Hub estimates that US\$94 trillion will be required globally, by 2040, to meet the world's growing infrastructure needs. Yet it is crucial that this infrastructure both supports our transition to a low carbon future and is financially resilient to the inevitable (social, economic and technological) impacts this transition will bring.

Exposure to infrastructure investments stretches across the financial services sector. Yet few asset owners are truly considering transition risk. This framework provides an open-source model for how infrastructure assets are likely to be impacted. The accompanying Practitioners' Step-by-Step Guide directly supports asset owners to integrate transition risk into their own financial models. We would like to see this open-source ClimateWise Transition Risk Framework be further adopted and developed.

There is no question our industry faces unprecedented challenges, on both the underwriting and investment sides of our business. However, this project highlights how effective the insurance industry can be when working collaboratively on a response.

A handwritten signature in blue ink, appearing to read 'D Christian', written over a light blue horizontal line.

Dominic Christian
Chair, ClimateWise
Global Chairman Reinsurance Solutions at Aon



Geoff Summerhayes

Climate change – and society’s responses to it – are now widely recognised as foundational drivers of risk and opportunity within the global economy.

Over the past two years, I have witnessed a critical paradigm shift in the way financial supervisors and regulators consider climate change as a core prudential risk. Many of the world’s leading supervisory authorities and central banks are seeking to build their understanding of how physical, transition and liability risks may affect the safety and soundness of individual firms, and of the sector as a whole. At the global level, the Sustainable Insurance Forum (SIF) is working with the International Association of Insurance Supervisors (IAIS) to explore how climate change poses risks to insurance firms, and how supervisors may seek to respond to challenging issues such as transition risks.

As chair of the SIF, and a representative of a supervisory authority, I recognise the importance of having multi-stakeholder approaches to the climate risk challenge, which will be critical to delivering the innovative solutions that industry and supervisors can draw upon in their efforts to better understand and address climate-related financial risks. The ClimateWise Transition Risk Framework introduces a compelling methodology, and accompanying tools, to help asset owners and managers gain a better understanding of transition risk, and integrate into their own financial decision-making. I welcome the work of the ClimateWise Insurance Advisory Council in facilitating collaboration that can support our collective response to climate risk, not only within the insurance industry, but further afield across the financial services sector.

Geoff Summerhayes
Chair, UNEP Sustainable Insurance Forum
Executive Board Member,
Australian Prudential Regulation Authority



ClimateWise Insurance Advisory Council (2018)

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William McDonnell	Chief Risk Officer, RSA Insurance Group
Rowan Douglas	CEO for Capital, Science and Policy Practice, Willis Research Network, Willis Group
Alex Hindson	Chief Risk Officer, Argo Group International Holdings, Ltd
Huw Evans	Director General, Association of British Insurers (ABI)
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Martyn Parker	Chairman Global Partnerships, Swiss Re
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Simon Beale	CEO, MS Amlin
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Steve Weinstein	Group General Counsel and Chief Compliance Officer, RenaissanceRe

With thanks to previous representatives of the ClimateWise Insurance Advisory Council.

Maurice Tulloch	Chair of ClimateWise (2015-2017), CEO International Insurance, Aviva
Scott Egan	Chief Financial Officer, RSA
Charles Philipps	previously CEO, MS Amlin

ClimateWise Transition Risk Advisory Panel

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Santosh Pandit	Senior Technical Specialist, Bank of England, Prudential Regulation Authority
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Introduction

The global investment community is facing a fundamental turning point. Many investors, shareholders and regulators are beginning to integrate climate change risks and opportunities into future financial planning, to mitigate systematic risk to the global economy and to ensure robust investment strategies for companies and governments.

In particular, the G20 Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) is a paradigm shift for the financial services sector. The TCFD provides a universal framework to communicate the likely responses to the physical, transition and liability risks of climate change. ClimateWise is wholly committed to supporting the global insurance sector and the wider investment community as it shifts towards a more informed financial focus on climate change, and delivers on the TCFD recommendations.¹

The TCFD draws on the same climate-related risks outlined in the Bank of England Prudential Regulation Authority's (PRA's) 2015 report: physical, liability and transition. It calls for publicly listed companies to disclose the material financial impact they face from climate-related risks. The TCFD outlines how investors, among others, should assess climate-related risks associated with scenarios of the low carbon transition, determine the potential financial impact and formulate appropriate strategic responses.²

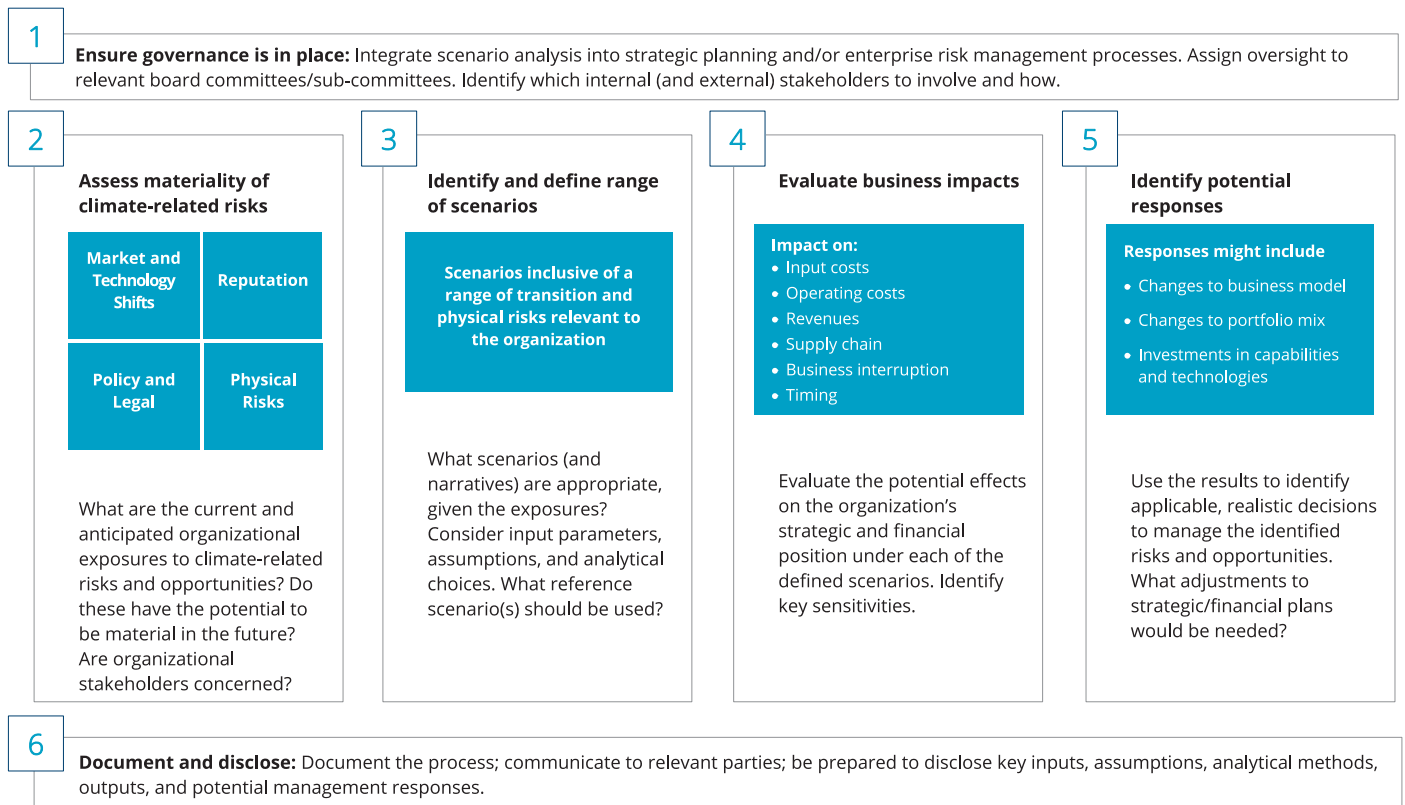


Figure 1: TCFD scenario analysis approach to assess and disclose climate-related risks and opportunities²



For over a decade, ClimateWise members have been annually disclosing their response to climate change through the ClimateWise Principles. The ClimateWise Principles overlap considerably with the TCFD recommendations and are recognised by the TCFD as a valuable framework supporting insurers to meet their disclosure requirements. The ClimateWise Principles were revised to ensure the TCFD recommendations are fully incorporated – as such, from 2019, all ClimateWise members will comply with TCFD requirements through the ClimateWise Principles reporting process.

Steering the ClimateWise membership's ambition to help address "the tragedy of the horizon"³ is the ClimateWise Insurance Advisory Council. The Council was formed following the Bank of England PRA's 2015 report on *The impact of climate change on the UK insurance sector*⁴ which ClimateWise supported by facilitating private sector input to the report. The Council consists of 15 C-suite representatives from ClimateWise members and has the following objectives:

1. to support global regulators to better understand the true impact of climate change for the insurance sector;
2. to explore how insurance can support system-wide responses to climate risk right across the financial services markets.

In 2018, the ClimateWise Insurance Advisory Council launched a unique open-source framework to support investors and regulators in assessing climate-related financial risk. The ClimateWise Transition

Risk Framework is designed to help investors assess how transition risks, such as market and technology shifts, policy and legal changes and reputational risks, have the potential to financially impact the performance of infrastructure investment portfolios. In today's low-interest-rate environment, investors are increasingly turning to infrastructure investments to generate a stable income and diversify their portfolios. However, some infrastructure asset types are increasingly exposed to transition risk and could financially impact investors' financial returns.

A more rapid, disorderly transition to a low carbon economy presents significant risks of 'stranded assets' across a variety of asset types. Stranded assets are where assets are impacted by downward revaluations or are converted to liabilities driven by the low carbon transition. Stranded assets can be caused by changing policy or regulation, reputational impacts, and shifts in markets and technology. Asset stranding could affect a variety of infrastructure assets. However, the impacts vary across geographies, sectors, time horizons and in line with commitments to limit global temperature rises.

While the low carbon transition presents material financial risks for some infrastructure asset types, for others (such as renewables and low carbon transport), it also presents material opportunities. It should be noted, where we reference 'transition risk' throughout the report, we are referring to both downside and upside impacts.



Task Force on Climate-related Financial Disclosures: four types of climate-related risk

The G20 Financial Stability Board's TCFD has defined four types of climate-related risk for organisations including insurance companies, the first three of which are 'transition risks':¹

Market and Technology Risks

"While the ways in which markets could be affected by climate change are varied and complex, one of the major ways is through shifts in supply and demand for certain commodities, products, and services as climate-related risks and opportunities are increasingly taken into account.

"Technological improvements or innovations that support the transition to a lower-carbon, energy-efficient economic system can have a significant impact on organizations. For example, the development and use of emerging technologies such as renewable energy, battery storage, energy efficiency, and carbon capture and storage will affect the competitiveness of certain organizations, their production and distribution costs, and ultimately the demand for their products and services from end users. To the extent that new technology displaces old systems and disrupts some parts of the existing economic system, winners and losers will emerge from this 'creative destruction' process. The timing of technology development and deployment, however, is a key uncertainty in assessing technology risk."

Policy and Legal Risks

"Policy actions around climate change continue to evolve. Their objectives generally fall into two categories—policy actions that attempt to constrain actions that contribute to the adverse effects of climate change or policy actions that seek to promote adaptation to climate change. Some examples include implementing carbon-pricing mechanisms to reduce GHG emissions, shifting energy use toward lower emission sources, adopting energy-efficiency solutions, encouraging greater water efficiency measures, and promoting more sustainable land-use practices. The risk associated with and financial impact

of policy changes depend on the nature and timing of the policy change. Another important risk is litigation or legal risk. Recent years have seen an increase in climate-related litigation claims being brought before the courts by property owners, municipalities, states, insurers, shareholders, and public interest organizations. Reasons for such litigation include the failure of organizations to mitigate impacts of climate change, failure to adapt to climate change, and the insufficiency of disclosure around material financial risks. As the value of loss and damage arising from climate change grows, litigation risk is also likely to increase."

Reputation Risk

"Climate change has been identified as a potential source of reputational risk tied to changing customer or community perceptions of an organization's contribution to or detractor from the transition to a lower-carbon economy."

Physical Risk

"Physical risks resulting from climate change can be event driven (acute) or longer-term shifts (chronic) in climate patterns. Physical risks may have financial implications for organizations, such as direct damage to assets and indirect impacts from supply chain disruption. Organizations' financial performance may also be affected by changes in water availability, sourcing, and quality; food security; and extreme temperature changes affecting organizations' premises, operations, supply chain, transport needs, and employee safety."

The financial materiality of transition risk

The Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) was established alongside the signing of the Paris Agreement at the 2015 United Nations Climate Change Conference (COP21) in December 2015.

The mission of the TCFD was to “develop voluntary, consistent climate-related financial risk disclosures for use by companies in providing information to investors, lenders, and insurance underwriters in understanding material risks”.¹ It aims to enable companies to better evaluate, manage and disclose climate financial risk. This will allow investors and regulators to make more informed decisions on where to allocate capital and empower better evaluation of risk over different time periods. Some of the world's largest stock exchanges, sustainability reporting mechanisms and asset managers – besides regulators – support the TCFD recommendations.¹ There are expectations that disclosing against the TCFD will become mandatory.

At the heart of the Paris Agreement is the commitment to hold “the increase in the global average temperature to well below 2°C above pre-industrial levels”.⁵ Achieving that objective will require a significant change in global energy consumption across all sectors (Figure 2). This brings material financial implications for companies, governments and the wider global economy. A reallocation of global capital “consistent with a pathway towards low greenhouse gas emission and climate-resilient development” will be required.⁵

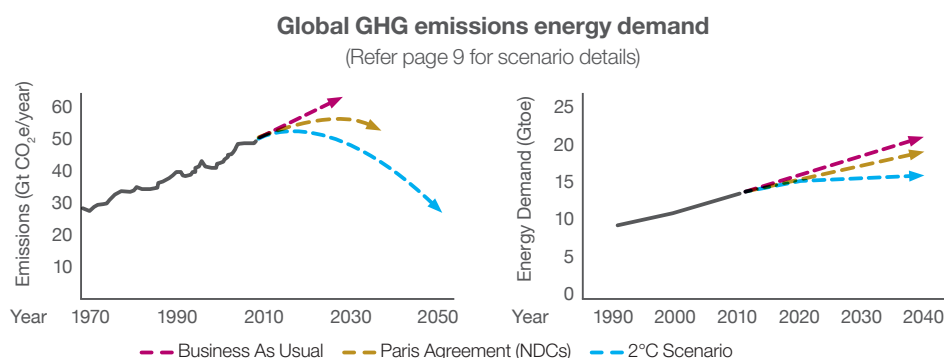


Figure 2: Global GHG emissions and energy demand, versus policy-driven and technology-dependent low carbon transition scenarios

Source: ERM; Intergovernmental Panel on Climate Change Fifth Assessment Report; United Nations Framework Convention on Climate Change (UNFCCC); International Energy Agency World Energy Outlook

In order to limit global warming to below 2°C, the remaining global carbon budget must remain below 1,000 GtCO₂.⁶ However, the carbon potential of the earth's known fossil fuel reserves is more than 2,860 GtCO₂.¹ Consequently, if global action on climate policy accelerates, or the target of 2°C is enforced, many carbon-intensive reserves will become unburnable, with implications for the

infrastructure that serves them. Under current estimates, this could cut upstream oil and gas companies revenues by US\$20 trillion, and coal companies' revenues by US\$5 trillion.⁷ Consequently, there will be a considerable knock-on impact along the value chain, ranging from transportation to manufacturing and chemicals to power.

Transition risk example: the impact of low carbon policies on German utilities

The transition to a low carbon economy is underway – driven by intensifying climate policy, changing investor sentiment, technological advances and fundamental shifts in market demand. Germany is a perfect example of how the low carbon transition is financially impacting a whole industry sector. Germany's energy transition strategy, 'Energiewende', has significantly changed the business

model of the major German utilities. Companies like E.ON and RWE have split their renewable energy generation businesses from their fossil-fuel generation businesses. This has sent a global warning to investors and regulators across the energy-related sectors, to proactively assess and manage the risks and opportunities emerging from the low carbon transition.

The ClimateWise Transition Risk Framework

The ClimateWise Transition Risk Framework provides an open-source, step-by-step guide (see the Practitioners’ Step-by-Step Guide in the Appendix and at www.cisl.cam.ac.uk/transition-risk) on how to manage risks and capture emerging opportunities from the low carbon transition.

This new model aims to empower investors and regulators with an enhanced understanding of how the transition to a low carbon economy could financially impact infrastructure investments. The framework is intended to provide real, practical value for Chief Investment Officers (CIOs), asset managers and owners, regulators and the wider financial community.

The framework:

1. provides an enhanced understanding of how transition risks drive the financial performance of investments in infrastructure
2. identifies the circumstances under which exposure to low carbon transition risks could become material
3. demonstrates a transparent, adaptable and robust methodology for assessing the financial implications of a low carbon transition to the performance of investments in infrastructure over relevant time periods.

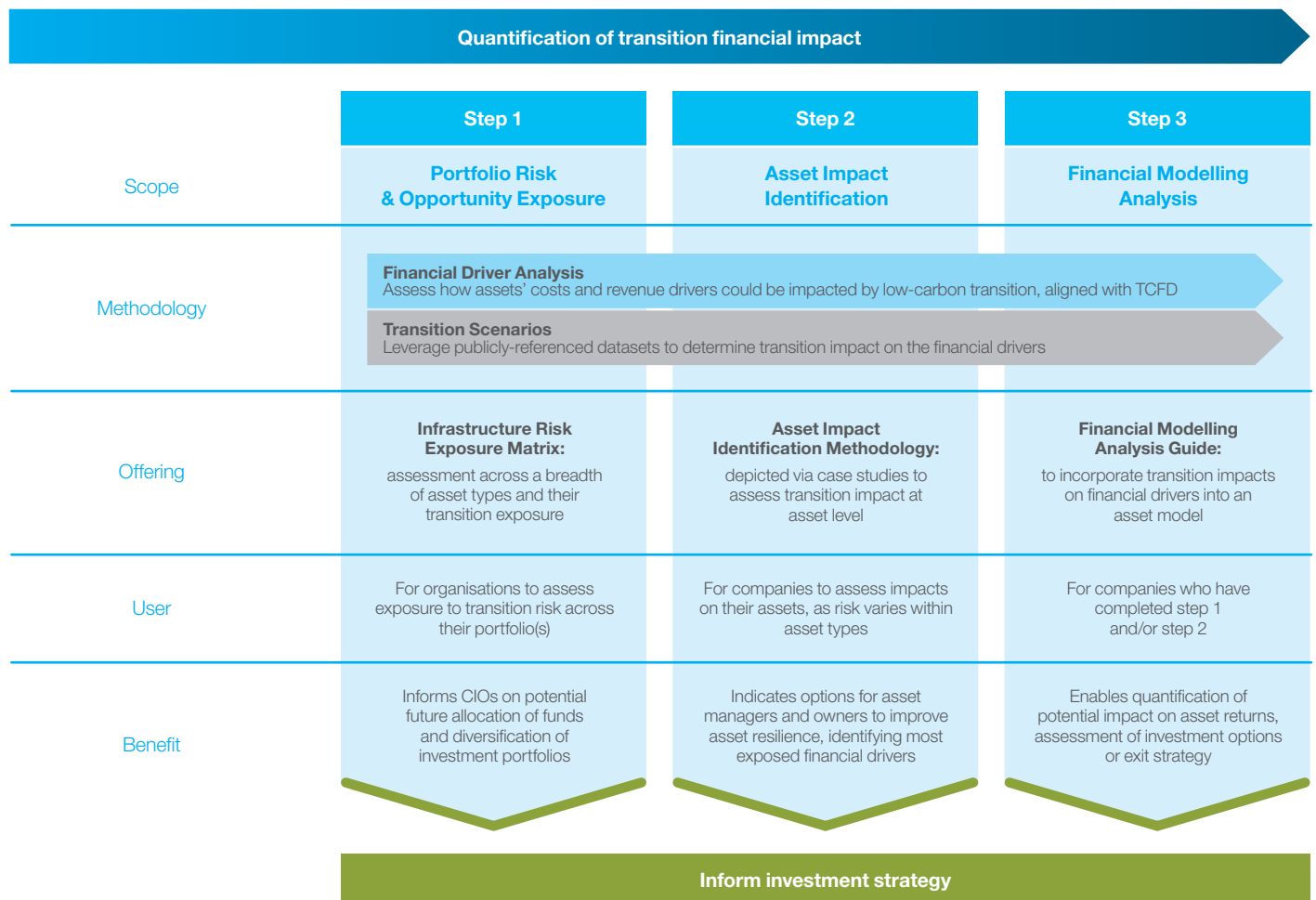


Figure 3: ClimateWise Transition Risk Framework

A flexible framework for investors

Investors can use the framework in multiple ways. First, they can start with a high-level assessment of risk exposure across their portfolios. Second, they can use the framework to complete a deep-dive and third, they can incorporate the quantifiable impacts of transition risk into their own financial models.

Each step of the framework can be used independently to inform various levels of risk mitigation and investment strategy. If all three steps are completed, the framework can provide a more thorough assessment and measurement of financial exposure to transition risk:

- Step 1 – Portfolio risk and opportunity exposure:** Financial exposure to the low carbon transition varies across the breadth of infrastructure asset types. This depends on geography, sector, sub-sector and time horizon. The ClimateWise Transition Risk Framework provides users with an already developed, insightful and practical tool. The Infrastructure Risk Exposure Matrix (see Practitioners' Step-by-Step Guide, Step 1), can help to identify at an asset type/geography level an investment portfolio's exposure to transition risk and to help inform the future allocation or diversification of funds.
- Step 2 – Asset impact identification:** Transition risks vary within asset types, down to an asset-specific level due to an asset's specific location, competitive positioning, carbon intensity and exposure to low carbon technologies. The Asset Impact Identification Methodology (see Practitioners' Step-by-Step Guide, Step 2) provides asset managers and owners with an approach to define financial impact on an asset and to identify options to improve asset resilience. This step requires additional resources for the more granular analysis, but is particularly useful for highly exposed assets or for direct application to a smaller, less-diversified investment portfolio.
- Financial modelling analysis:** The asset impact assessment is used to build risk and contingency scenarios within in-house asset financial models. This will enable stress testing and opportunity identification through quantifying the potential financial impact from transition risks directly within financial models. Investors are then able to assess transition risk drivers on asset financial performance, helping to identify investment options for improving asset resilience or for an exit strategy, as well as supporting delivery of the TCFD recommendations. The portfolio or lending manager can then use the matrix to update their valuation models (eg net present value or discounted cash-flow models) by inputting the estimated scale of the transition risk driver into their models. For example, they could increase the expected revenues from their gas distribution network by X per cent by 2030 in a low carbon scenario where a swifter shift to gas as a bridge fuel is likely to occur. The Practitioners' Step-by-Step Guide in the Appendix of this report provides guidance on how to integrate the ClimateWise Transition Risk Framework directly into an investor's own financial models.



Adaptable methodology to address specific needs

Across the global investment community, investors hold a wide variety of infrastructure portfolios. This results in a range of diverse needs to manage the exposure of portfolios to the risks and opportunities presented by a low carbon transition. This framework is adaptable and therefore accommodates the diversity of investors' needs.

Financial driver analysis at the core of the framework

At the core of the framework is the analysis of the financial drivers of transition risk. It allows users to assess financial impacts from different transition scenarios and across a range of time horizons. For each asset type, the financial cost and revenue drivers (eg typical inputs for the financial model of that asset type) are identified and assessed for any potential impact from transition risks. The framework can also be used as a starting point for building customised scenarios by allowing users to sense check the underpinning financial drivers within the low carbon scenarios and tailor these in line with in-house views on the direction and speed of the transition.

Low carbon transition scenarios: the key enabler

The framework leverages a scenario-based approach, as introduced by the TCFD. This helps to assess the potential financial impacts transition risk may have for an asset's financial drivers and future financial performance. Companies typically use scenarios to test a variety of alternative views of the market. This ensures a robust future investment strategy. These scenarios provide plausible alternative views on how the transition to a lower carbon economy could evolve over time, including a more rapid, disorderly transition.

Aligned with the TCFD recommendations, the framework relies on scenario data sets to assess potential impacts from the low carbon transition. While the framework is adaptable to a variety of scenarios being applied, the approach is demonstrated with scenarios from the International Energy Agency (IEA):

1. for their transparency as a publicly referenced source
2. as a potential emerging benchmark for investors and the TCFD
3. for their ability to provide a holistic view on global market demand, supply, prices and technology shifts across the broad range of energy-intensive sectors.

While a variety of transition scenarios could be applied to the framework to assess financial impacts, the Infrastructure Risk Exposure Matrix tool uses the Nationally Determined Contributions (NDCs) submitted at COP 21 in 2015 (which currently falls short of the Paris Agreement's ambition) and the 2°C consistent scenarios from the WEO. This provides a range of plausible climate outcomes aligned with the signatory country governments' current NDCs submitted at COP21, as well as the Paris Agreement's ultimate target.

Where required, any gaps in the scenario data sets have been supplemented with other publicly referenced sources. This includes the World Bank and government policy-driven scenarios.

Some investors may also choose to stress test against a 1.5°C scenario to ensure the robustness of their portfolios. They may also consider alternative pathways to a 2°C scenario which focus on specific technological advances (eg energy storage, carbon capture and storage) rather than policy changes or carbon taxes.

Financial drivers

Financial drivers are identified by analysis of the typical inputs for the financial model of that asset type. Impacts on future asset revenues and costs are defined by: market and technology shifts, emerging policy and legal requirements, and mounting reputational pressures and investor sentiment as defined by the transition scenarios and outlined in the TCFD framework.

Financial impacts	Transition risk	Financial drivers
Revenue	Market and technology shifts	Consumer and market demand (eg number of cars on the road)
CapEx	Emerging policy and legal requirements/ Mounting reputational pressures	Property, plant or equipment related costs (eg emission reduction technologies)
OpEx	Emerging policy and legal requirements	Regulatory and compliance costs (eg emissions monitoring, carbon pricing)

Figure 4: Examples of financial drivers of financial impacts



Figure 5: Transition scenarios versus business-as-usual baseline to assess risk exposure

Source: ERM; Intergovernmental Panel on Climate Change AR5 SPM; United Nations Framework Convention on Climate Change

Time frames

Investment time frames typically vary: banks (five years), infrastructure investment companies (ten to 15 years), governments considering asset life (20 years or more). While the framework can be adapted to cover any year (as scenario data sets typically cover a year-by-year basis), the Infrastructure Risk Exposure Matrix focuses on 2020, 2030 and 2040 to cover as broad a range of investment horizons as possible.

Infrastructure asset types

A variety of asset types were selected to demonstrate the breadth of potential transition risks. Selected sectors were chosen based on primary and secondary research on key infrastructure investments across Organisation for Economic Co-operation and Development (OECD) and non-OECD economies. Asset types were split into sub-categories, to untangle all sector-specific transition risk issues. For instance, power assets were divided into sub-categories from coal to renewable power generation:

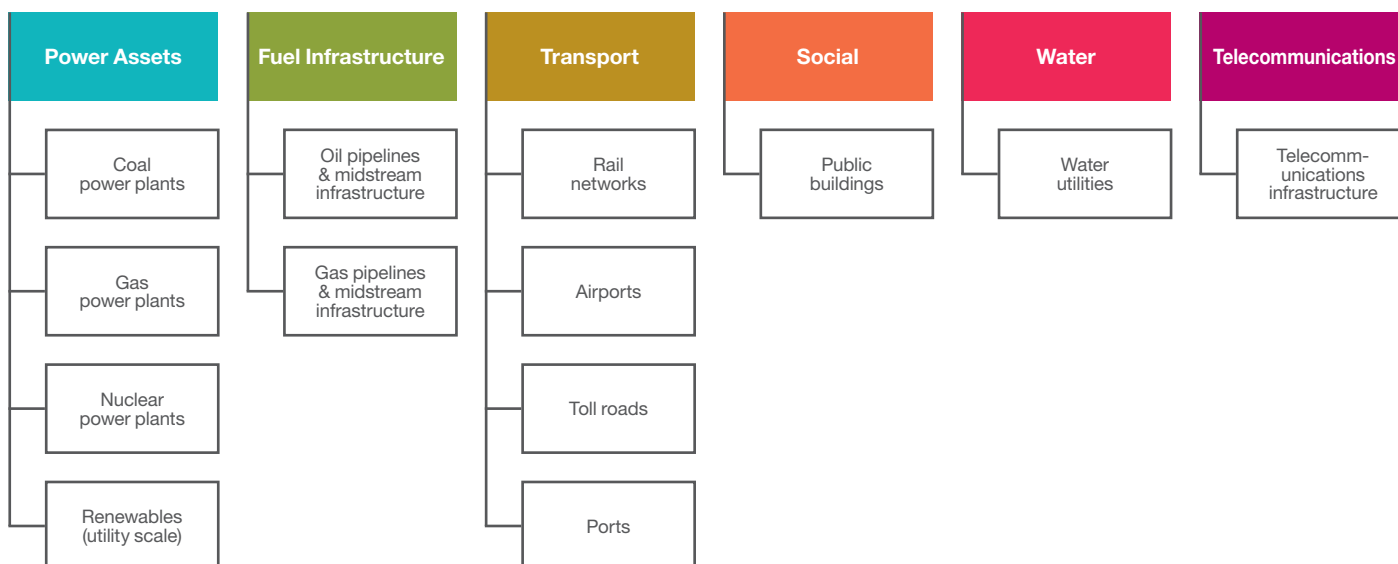


Figure 6: Infrastructure assets in transition risk assessment

Geographies: EU, US and India

Geographies were chosen to illustrate how transition risks could vary in different parts of the world. This ensures relevancy for all investment portfolios. The geographies chosen focused on: (1) governments with an interest in infrastructure aimed at supporting economic growth; (2) countries that are amenable to foreign investment and (3) countries offering substantial investment potential. Two OECD markets and one non-OECD market were selected: the US, EU and India. These geographies cover three of the largest markets in the world. Each varies greatly from the other in how the low carbon transition will take hold (eg US shale gas displacing coal-fired generation, the broad uptake of renewables in the EU and India's conundrum for coal versus solar).

Scope limitations

The aim for the project is to demonstrate the robustness of the framework's approach, albeit with a limited project scope, and its potential wider application for investors in infrastructure assets worldwide. The ClimateWise Insurance Advisory Panel provided insights to ensure selected asset types, geographies and time horizons were aligned with, and most relevant for, insurers' investment portfolios. Further development of this analysis could include coverage of other infrastructure asset types (eg electricity transmission and distribution grids, district heating networks) and additional geographies.

Robust tried-and-tested approach

To demonstrate the practicality of the developed methodology, the framework has been applied to three real-life portfolios. This includes two of the world's largest insurance companies and one of the global top five investors in infrastructure. Feedback from regulatory bodies and industry stakeholders has been used to confirm that the framework is applicable to a broad range of investments.



Figure 7: Methodology for ensuring the robustness of the framework

The framework: step by step

While investors are advised to undertake all three steps to gain a full understanding of the materiality of transition risk, they can also start from the step where there is an immediate value for the company (eg Step 2 for assessing a specific, transition-exposed asset).

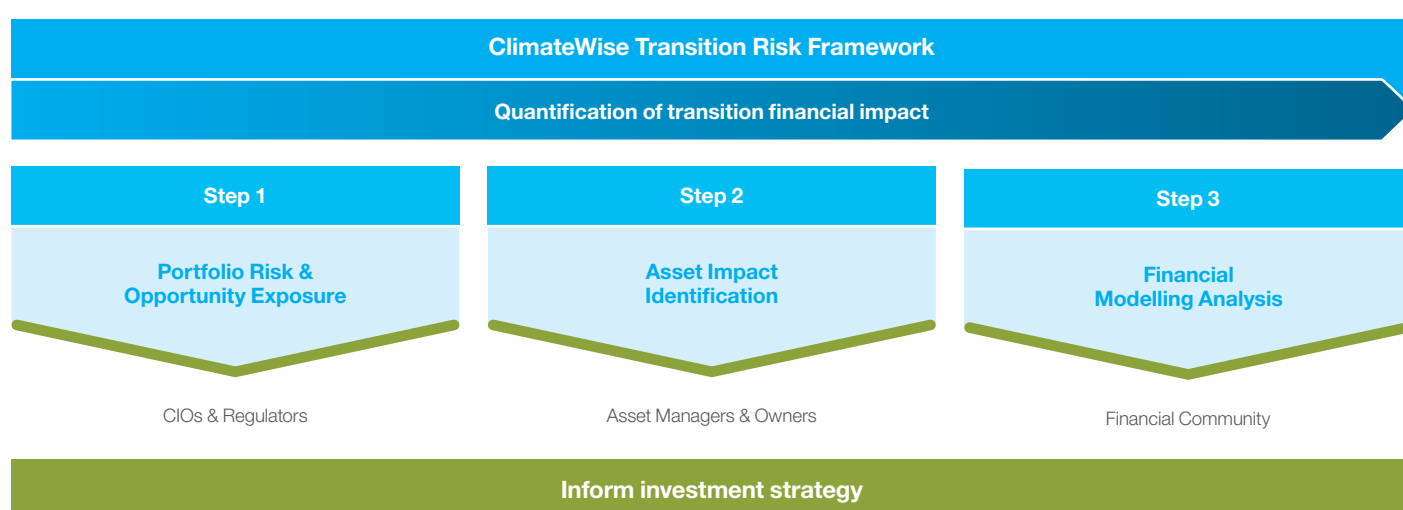


Figure 8: Target audience for each step of the framework

Testing the robustness of the framework: real-life portfolios

The practicality and robustness of the framework has been validated by applying it to three separate case studies based on investors' real-life portfolios – including two of the world's largest insurance companies and one of the global top five investors in infrastructure. We started by developing a tool to assess transition risk and opportunity exposure for investors' portfolios, then applying this to the case studies. In highlighting the three most exposed assets in each portfolio, we developed a methodology to assess transition impact at an asset level – and finally we completed step-by-step guidance for incorporating the assessment directly into the investors' own asset financial models.

Step 1: Portfolio risk and opportunity exposure

Step 1 allows investors to quickly identify the material financial impacts from transition risks across a large portfolio, by applying the Infrastructure Risk Exposure Matrix. This tool helps to assess potential exposure to transition risk across a breadth of asset types, geographies, climate scenarios and time frames. See figure 9 on the following page.

Applying the Infrastructure Risk Exposure Matrix to an investment portfolio provides insights on how financial exposure to transition risk could materially increase through time. This helps to inform future allocation or diversification of funds across a portfolio and is also used as a starting point for both Step 2 and Step 3. See figure 10 on the following page.

Infrastructure Risk Exposure Matrix									
Transition risk by infrastructure asset type				Paris Agreement (NDCs)			2°C Scenario		
Sector	Sub-sector	Asset Types	Geography	2020	2030	2040	2020	2030	2040
Power Generation	Coal	Coal-fired power plants	U.S.	Minimal	Med Risk	Med Risk	Med Risk	High Risk	High Risk
			EU	Med Risk	Med Risk	High Risk	Med Risk	High Risk	High Risk
			India	Low Risk	Med Risk	Med Risk	Low Risk	Med Risk	High Risk
	Gas	Gas-fired power plants	U.S.	Minimal	Minimal	Minimal	Minimal	Low Risk	Med Risk
			EU	Minimal	Low Risk	Low Risk	Low Risk	Med Risk	High Risk
			India	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
	Nuclear	Nuclear power plants	U.S.	Med Risk	Med Risk	Med Risk	Med Risk	Low Risk	Low Risk
			EU	Med Risk	Med Risk	Low Risk	Med Risk	Low Risk	Low Risk
			India	Low Opp	Med Opp	Med Opp	Low Opp	Med Opp	Med Opp
	Renewables	Utility-scale wind and solar farms	US	Low Opp	Med Opp	Med Opp	Low Opp	Med Opp	High Opp
			EU	Low Opp	Med Opp	Med Opp	Low Opp	Med Opp	Med Opp
			India	Low Opp	Med Opp	Med Opp	Low Opp	Med Opp	High Opp
Oil & Gas Infrastructure	Oil	Pipelines and associated midstream infrastructure	U.S.	Med Risk	Med Risk	Med Risk	Med Risk	Med Risk	High Risk
			EU	Low Risk	Med Risk	Med Risk	Low Risk	Med Risk	High Risk
			India	Minimal	Minimal	Minimal	Minimal	Minimal	Low Risk
	Gas	Gas distribution infrastructure	U.S.	Minimal	Low Risk	Low Risk	Low Risk	Med Risk	High Risk
			EU	Minimal	Med Risk	Med Risk	Low Risk	Med Risk	High Risk
			India	Minimal	Low Risk	Low Risk	Minimal	Low Risk	Low Risk
Transportation	Aviation	Airports	U.S.	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
			EU	Minimal	Minimal	Minimal	Minimal	Med Risk	Med Risk
			India	Minimal	Minimal	Minimal	Low Risk	Med Risk	Med Risk
	Roads	Toll roads	U.S.	Minimal	Minimal	Minimal	Minimal	Minimal	Low Risk
			EU	Minimal	Minimal	Minimal	Minimal	Minimal	Low Risk
			India	Minimal	Low Risk	Low Risk	Low Risk	Low Risk	Med Risk
	Shipping	Ports	U.S.	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
			EU	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
			India	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Mass Transit Systems	Railways, subways, trams (excludes buses)	U.S.	Minimal	Low Opp	Low Opp	Minimal	Low Opp	Low Opp	
		EU	Minimal	Minimal	Minimal	Minimal	Minimal	Low Opp	
		India	Minimal	Minimal	Minimal	Minimal	Minimal	Low Opp	
Social	Buildings	Hospitals, schools, nursing homes, military	U.S.	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
			EU	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
			India	Minimal	Minimal	Minimal	Minimal	Minimal	Low Risk
Water	Water utilities	Water treatment, desalination facilities, sewers/tunnels	U.S.	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
			EU	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
			India	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal
Telecommunications	Telecommunications infrastructure	Television broadcast towers, wireless communications towers, cable systems, satellite networks	U.S.	Minimal	Minimal	Minimal	Low Risk	Minimal	Minimal
			EU	Minimal	Minimal	Minimal	Low Risk	Minimal	Minimal
			India	Minimal	Minimal	Minimal	Minimal	Minimal	Minimal

Figure 9: Summary of the Infrastructure Risk Exposure Matrix for the infrastructure asset types considered

Portfolio risk and opportunity exposure: case study examples

Applying the Infrastructure Risk Exposure Matrix to three different case study portfolios indicates how financial exposure to transition risk could materially increase through time, and could also vary greatly across portfolios depending on what asset types a company invests in. Risks (and in some cases opportunities) are more pronounced in

the 2°C scenario, indicating the importance of appropriate scenario selection in line with TCFD recommendations. Sectors exposed to risk may not necessarily be intuitive and consequently demonstrate the benefit of a portfolio-wide approach to risk assessment.

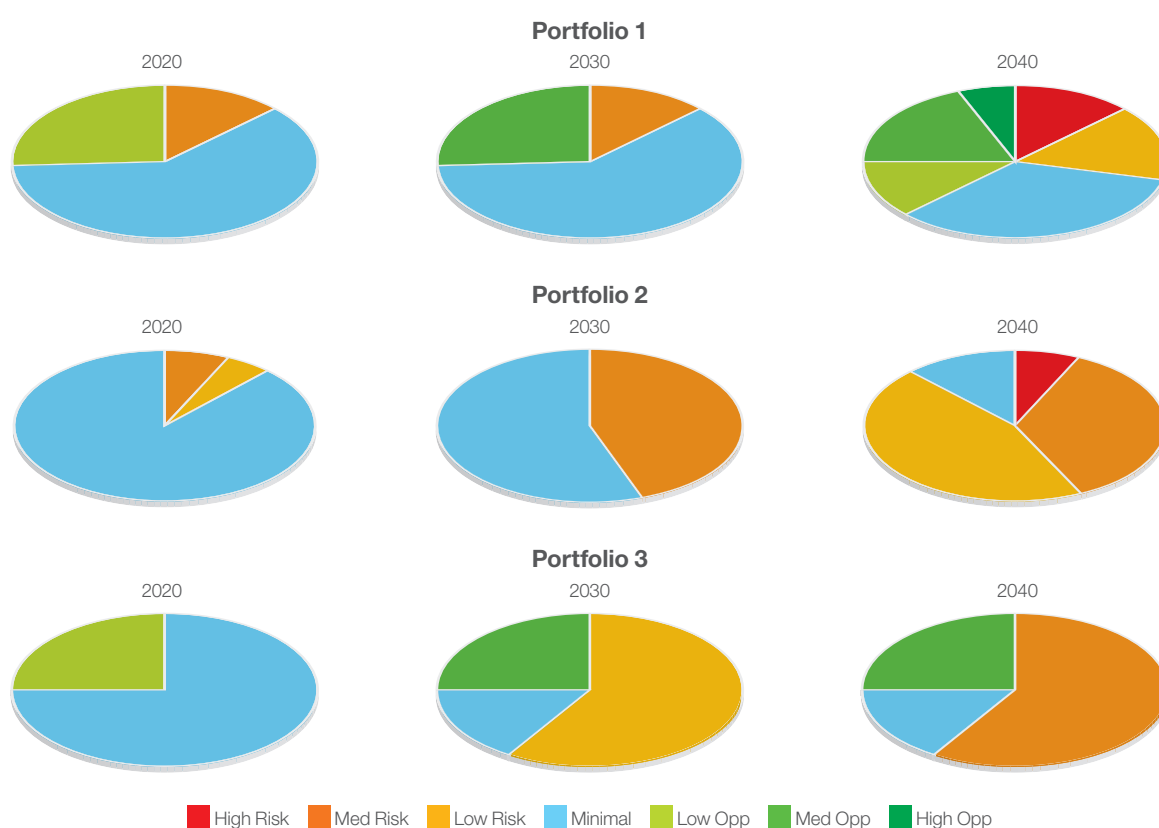


Figure 10: Example of an investment portfolio facilitates analysis of exposure to transition risk and opportunity across infrastructure asset types

Portfolio risk and opportunity exposure: most-exposed asset types

The Infrastructure Risk Exposure Matrix provides insights on the infrastructure asset types most exposed to the low carbon transition:

- The most significant risk is coal-fired power generation globally and oil & gas infrastructure in the US and EU. These risks are more pronounced in the 2°C scenario compared to the Paris Agreement (NDC) scenario.
- There is minimal risk associated with gas-fired power generation in India, as well as globally in telecommunications, ports and water utilities (excluding physical climate change risk).
- The greatest opportunities exist in the renewables sector globally, and to a lesser extent in mass transit.

Step 2: Asset impact identification

Step 2 allows investors to assess the financial impact from the low carbon transition at an asset-by-asset level, which provides insights on ways to improve asset resilience. Risks vary considerably between assets of the same type, depending on their geography, carbon intensity, technology (for example solar versus wind) and competitive positioning in the local market. Therefore, investors gain significant benefit in conducting an asset-level specific analysis.

Depending on an investor's portfolio size and risk appetite, the Asset Impact Identification Methodology can be re-applied asset-by-asset to an entire portfolio, or to the most exposed assets identified by overlaying the Infrastructure Risk Exposure Matrix. Additionally, stress testing of the portfolio under different time frames and scenarios will produce a more holistic understanding of transition risk and opportunity. For example, using asset-specific data, a gas distribution business in Germany was found to have a medium financial risk in 2030 and low risk in 2040 under the Paris Agreement (NDC) scenario, but a low risk in 2030 and medium risk in 2040 under the 2°C scenario – these were driven by shifts in the local market from coal to renewables.

Step 3: Financial modelling analysis

Step 3 allows investors to incorporate the potential impacts of transition risk directly into their own financial models. This allows for a granular approach to defining asset impact, and allows investors to develop an in-house view based on their conviction of the probabilities linked to the key transition drivers outlined in the framework. This is done by integrating the financial drivers identified in Steps 1 and 2 into investors' own in-house financial models.

Referring to the relevant scenario data sets, the potential impact on asset revenue and costs can be quantified.

Leveraging this analysis, asset managers and owners can:

- evaluate investment profiles required under different scenarios
- determine impacts on key revenue and cost drivers under different scenarios, with the resulting impact on cash flow, valuation, return on equity and other metrics as required
- explore investment options to improve asset resilience or exit strategies.



Asset impact and financial modelling: gas distribution asset example

Leveraging the Infrastructure Risk Exposure Matrix and the Asset Impact Identification Methodology, investors can identify how a specific asset, its cost and revenue drivers, could be impacted by transition risk (or opportunity). While an asset may be identified as having high exposure due to the sector or geography it operates in, it could be impacted in different ways due to the asset’s specific location.

relationship between demand and asset utilisation, this suggests declining asset revenues. However, German gas demand will fall at a slower pace than the rest of the EU, as a substantial coal market is still being phased out in the near term. Thus the impact in Germany is lower than in the rest of the EU, due to local market conditions and government policies on specific assets.

In this instance, a gas distribution company in Germany is less impacted by the low carbon transition than the rest of the EU, thus altering the risk profile for the asset. The Infrastructure Risk Exposure Matrix (shown below in Figure 11) indicates a risk to gas demand in the EU, with a potential decline of more than 25 per cent by the early 2030s compared with the base case, according to the International Energy Agency (IEA) 2°C scenario. Assuming a direct

An asset manager or owner investing in this gas distribution company, could quantify the potential financial impact at an asset level by incorporating the outputs of the Infrastructure Risk Exposure Matrix or Asset Impact Identification Methodology in their own financial models. The financial drivers affected by the low carbon transition, specific to the gas distribution company, are listed in the Infrastructure Risk Exposure Matrix and highlighted in Figure 12.

Infrastructure Asset Type		Financial Driver Analysis		Infrastructure Risk Exposure Matrix						Asset Impact Identification					
Asset Name	Sector	Impact Category	Financial Driver	Asset Type Region	Data Sources & Indicators	Comments	2020	2030	2040	Asset Location	Data Sources & Indicators	Comments	2020	2030	2040
[Name]	Gas Distribution	Revenue	Rev: Utilisation of gas distribution infrastructure	EU	IEA WEO Natural gas demand (TPED)	EU gas demand could fall by nearly 50% (IEA 450 vs CP)	Minimal impact (<10%)	Low Risk	Low Risk	Germany [country]	EU Commission [country specific scenarios]	This country's gas market will fall at a slower pace with its substantial coal market still being phased out in the near-term.	Minimal impact (<10%)	Low Risk	Low Risk
			CapEx & OpEx: Emission reduction requirements		EU Commission policy and technology trends (internet)	Methane emission reduction requirements are expected to become increasingly stringent; costs will vary across the gas distribution value chain	Med Risk	Med Risk	Med Risk		Government policy and asset specific (carbon intensity)	Gas network likely less impacted by regulations than LNG transport. This depends on efficiency and age of network, as well as distance covered.	Low Risk	Low Risk	Low Risk
		Cost	OpEx: Carbon pricing		World Bank EU ETS Historic data; IEA WEO	EU ETS price is expected to increase to \$100/tonne in the IEA 450 scenario and could rise more quickly than anticipated with upcoming new measures.	High Risk	High Risk	High Risk		EU ETS IEA WEO [country specific regulations]	EU ETS is undecided regarding fugitive emissions and sectors to include in the future. Assume some impact on gas network, but less extreme than LNG.	Med Risk	Med Risk	Med Risk

Financial driver contribution to asset returns: High Medium Low
Scenario vs BAU impact on financial driver: High Risk Med Risk Low Risk
 Minimal impact (<10%) Low Opp (10-25%) Med Opp (25-50%) High Opp (>50%)

Figure 11: Example impact assessment of financial drivers for general asset and specific asset

Risk Impact			Data Sources & Indicators
Impact Category	Financial Driver	Methodology	IEA Regional Assessment
Revenue	Rev: Utilisation of gas distribution infrastructure	(1) Quantify changes in renewables power demand (IEA 2C vs BAU scenario) to determine macro impact	IEA WEO Natural gas demand (Total Primary Energy Demand)
	CapEx & OpEx: Emission reduction requirements	(1) Review existing government policies and future projections	National NDCs Paris Agreement Target Emission reduction requirements and estimated associated costs
Cost	OpEx: Carbon pricing	(1) Incorporate latest views on carbon pricing outlook by country	Government ETS Historic data set of carbon pricing, government policy to achieve Paris Agreement target IEA WEO Carbon pricing assumption

Figure 12: Potential impact on asset financial drivers is determined using scenarios

Taking these outputs and the suggested scenario data sets, asset managers can interpolate potential changes in revenue and cost (Figure 12), incorporate them into an asset financial model and quantify the potential impact on the value or returns of the asset (Figure 13). Accounting for potential increases in costs and a decline in asset utilisation,

financial modelling indicates that earnings before interest and tax (EBIT) for the specific asset could fall by more than 70 per cent against base case, under a 2°C scenario (Figure 14).

Asset Scenarios: Gas Distribution Asset									
Year ended 31 December	[Unit]	2018	2019	2020	2021	2022	2023	2024	2025
Revenue assumptions									
Relative utilisation									
Client base case	1		100%	100%	100%	100%	100%	100%	100%
Client base case	%		100%	100%	100%	100%	100%	100%	100%
Paris Agreement	%		100%	97%	96%	95%	94%	93%	92%
2C Scenario	%		100%	96%	95%	93%	91%	89%	87%
Cost assumptions									
Opex impact of carbon pricing									
Client base case	1		-	-	-	-	-	-	-
Client base case	EUR million		-	-	-	-	-	-	-
Paris Agreement	EUR million		-	-	-	-	-	-	2.6
2C Scenario	EUR million		-	-	2.9	3.5	4.2	5.0	6.1
Emission reduction requirements (capex and opex)									
Client base case	1		-	-	-	-	-	-	-
Client base case	EUR million		-	-	-	-	-	-	-
Paris Agreement	EUR million		-	1.7	1.7	1.7	1.7	1.7	1.7
2C Scenario	EUR million		-	1.9	1.9	1.9	1.9	1.9	2.0

Figure 13: Financial drivers can be interpolated into the asset financial model

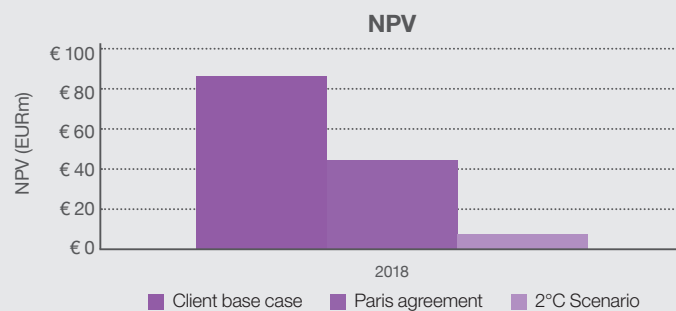


Figure 14: Effect of transition risk on asset net present values

Inform investment strategy and risk management

The framework has been developed to empower investors to take practical actions to mitigate their exposure to transition risks, capture opportunities and disclose their exposure to key stakeholders.

Across the three case studies, each step of the framework was applied to inform investment strategy and risk management. Insights were provided on how the framework could inform investment decisions and guide strategic responses to transition risk.

Take for instance the EU gas distribution company example.

- Step 1 identified this asset as one of the more exposed assets in the investor's portfolio in 2040 – highlighting options for specific risk monitoring as part of the portfolio investment strategy.
- Step 2 defined the impact of transition risk on the asset's key revenue and cost drivers. This included a fall in pipeline utilisation, and a rise in capital and operation expenditure due to emission reduction and carbon pricing – and options for asset managers and owners to improve the asset's resilience to transition risk.
- Step 3 integrated the analysis through a financial model to determine the impact on the asset's financial performance in line with the Paris Agreement (NDCs) and 2°C scenario – and explored investment options to improve asset resilience.

Company type	Country	Paris Agreement (NDCs)	2°C scenario
Gas distribution	EU country	Up to medium risk	Up to medium risk
Investment guidance	Investment strategy	Asset managers	
Although it is relatively low risk, the timing of when the asset is most at risk will depend on the time frame for reducing power-sector emissions. In the 2°C scenario, gas generation benefits from the accelerated retirement of coal generation.	Monitor national policy and market developments to avoid potential risk	Investigate options for adapting the gas pipeline for distribution of hydrogen. This could mitigate risks from a fall in pipeline utilisation due to a transition to low carbon alternatives.	

Figure 15: Guidelines on investment strategy for CIOs and asset



Conclusions

The ClimateWise Transition Risk Framework supports investors and regulators to assess the financial impact of transition risk. It enables quantification of potential impact, as called for by the TCFD. It enhances investors' and regulators' ability to manage risk and capture opportunity.

Transition risk could increase significantly by 2030. The framework demonstrates that the low carbon transition could financially impact a variety of infrastructure asset types. However, it also unpacks transition risk according to sector, geography and time horizon.

Investors and regulators can enhance their understanding of how the financial performance of their infrastructure portfolios and assets could be affected. The framework provides them with the ability to:

- assess portfolios for risk and opportunity exposure
- define potential financial impact down to an asset-specific level
- incorporate transition risk directly into asset managers' and owners' own financial models.

Across the global investment community, investors hold a variety of infrastructure portfolios, and therefore, have a range of diverse needs to manage exposure to transition risk. The framework has been designed to allow for this variation in investors' needs, by providing an open-source and adaptable methodology.

Next steps

Further pilot testing of the framework is being considered to gather insights as to how it could be improved. If your organisation would like to participate, please do get in touch: climatewise@cisl.cam.ac.uk. Feedback from this process will be pooled and used to produce a second version of the framework.

While the scope of the initial project was constrained, the aim was to demonstrate the robustness of the framework's approach and its potential wider application using infrastructure assets worldwide as a case study. As part of a next phase of work, it would be beneficial to expand coverage to more geographies and asset types. Significant differences can exist within asset types, and across national boundaries, for example for renewable power in different European countries. Asset types not yet covered include district heating systems and electricity transmission infrastructure.

To ensure and demonstrate the practicality of the developed methodology, the framework has been applied to three real-life portfolios through case studies – including two of the world's largest insurance companies and one of the global top five investors in infrastructure. Feedback from regulatory bodies and industry stakeholders has been used to confirm the framework is applicable to a broad range of investments.

CIOs, asset managers and owners, and the wider financial community can take practical actions to mitigate transition risks, capture transition opportunities and communicate their strategic response plans to key stakeholders. Each step of the framework provides opportunities to inform investment strategies from a large portfolio down to asset-specific levels. Likewise, this methodology can be leveraged by regulators to inform future risk mitigation approaches and policies.

The framework has been developed to empower investors and deliver real value. The accompanying Practitioners' Step-by-Step Guide provides more detailed methodology, tools and case studies to demonstrate how to quantify variations in transition risk across portfolios and within asset types.

In terms of future plans for development, the framework application in this report focuses on infrastructure, but could equally be adapted to any type of asset and serve as a tool for a broad range of investors. The approach could also be expanded to wider applications across the financial community, incorporating physical risks and a variety of low carbon transition scenarios.

In line with TCFD recommendations, investors may wish to adapt this framework and embed these processes in the organisation's risk management processes, metrics and targets, and governance framework.

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Feedback from interviews with regulators, investors and organisations participating in the case studies has indicated how key stakeholders regard the framework, helping to inform investment strategies and risk management:

█

“If we can efficiently and effectively measure transition risk, we can better manage it. This approach is a good step forward in achieving this.”

A major EU regulator

█

█

“Transition risk is becoming a material factor; this approach really helps to demonstrate how transition risk plays out at an asset level and what options are available to mitigate the risk. I want to share this framework with one of our asset managers.”

One of the world’s largest insurance companies

█

█

“I love this framework. Portfolio managers will wake up when I show them the potential transition impact on financial metrics.”

A multinational bank

█



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