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HOW TO IMPROVE CLIMATE-RELATED REPORTING

SUPPLEMENT 2: SCENARIO ANALYSIS PRACTICES

ASSESSING RESILIENCE, RISKS AND OPPORTUNITIES

Project Task Force on Climate-related Reporting

February 2020

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Disclaimer

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This supplement, *Supplement 2: Scenario analysis practices*, the related main report *How to improve climate-related reporting: A summary of good practices from Europe and beyond* and the first accompanying supplement, *Supplement 1: Climate-related reporting practices* have been prepared by the European Lab Project Task Force on Climate-related Reporting (PTF-CRR) for making available in the public domain. The contents of the main report and its two supplements are the sole responsibility of the PTF-CRR. The European Lab Steering Group Chair has assessed that appropriate quality control and due process had been observed and has approved the publication of the main report and its two supplements.

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References to specific screenshots from corporate reports as 'good reporting examples' do not imply that the overall climate-related reporting of the associated company is considered to be good. Screenshots from corporate reports may not provide all the relevant information, and further information and context may be provided in the associated corporate report. For each screenshot, a reference to the corporate report, or other source from which it was extracted, is included.

This supplement, the related main report and the second accompanying supplement include interactive links to facilitate readers accessing the source documents of the good reporting examples and reference material included. All such links were active and functioning at the time of publication.

Questions about the European Lab and its projects can be submitted to EuropeanLab@efrag.org.

EFRAG receives financial support from the European Union – DG Financial Stability, Financial Services and Capital Markets Union. The contents of the main report *How to improve climate-related reporting: A summary of good practices from Europe and beyond* and its two supplements, *Supplement 1: Climate-related reporting practices* and *Supplement 2: Scenario analysis practices*, are the sole responsibility of the European Lab Project Task Force on Climate-related Reporting (PTF-CRR) and can under no circumstances be regarded as reflecting the positions of the European Union.

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INTRODUCTION

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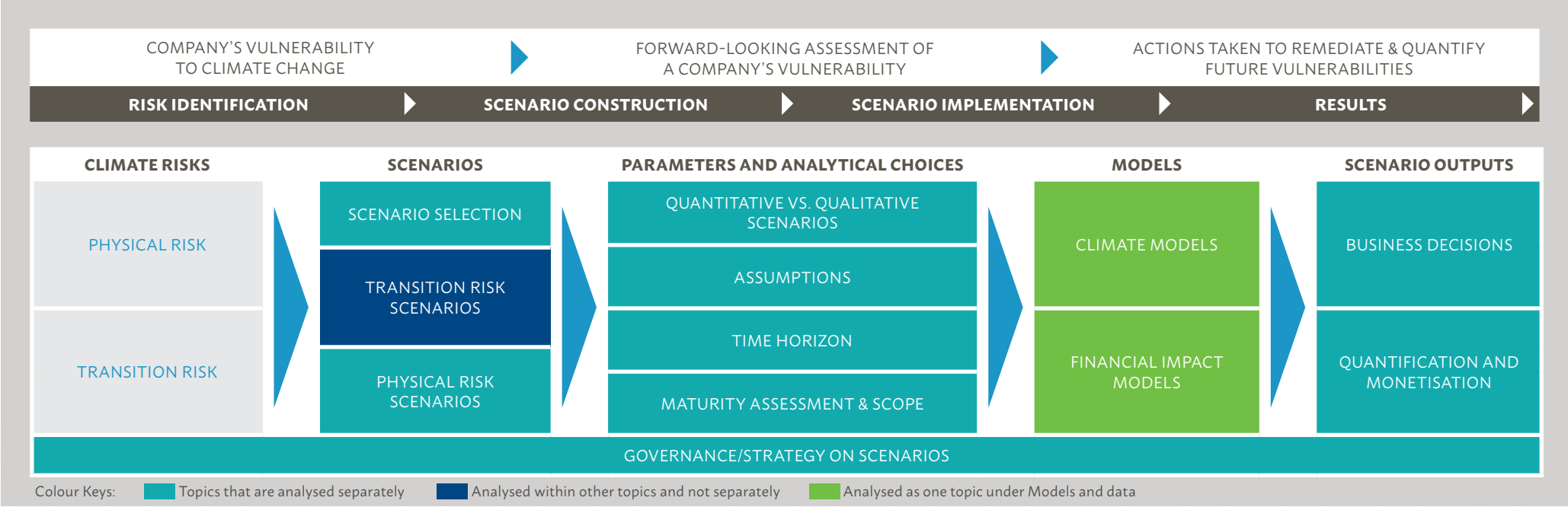
Introduction

In order to provide insights on useful scenario analysis information, the PTF-CRR focused on identifying good scenario analysis practices that could inspire companies in their implementation of Task Force on Climate-related Financial Disclosures (TCFD) recommendations.

To do this, scenario analysis was broken down into a set of building blocks (see diagram below). A detailed topic analysis was carried out for the key building blocks, based on the review of a targeted sample of companies as described in the 'Sample selection' section *How to improve climate-related reporting: A summary of good practices from Europe and beyond*.

There is an overall analysis of ten topics. Climate models and Financial impact models are treated as one topic under 'Models and data'. It should be noted that 'physical risk scenarios' is a topic of analysis but there isn't a separate analysis of 'transition risk scenarios' because of the following: companies more frequently report on transition risk than they do on physical risk; and transition risk is incorporated within the rest of the analysed topics.



Introduction

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Below is a high-level overview of what is covered in each of the ten topics, as well as the names and sectors of the companies that are referred to as examples of good reporting for that topic. Overall, 39 examples (38 examples from 21 companies and one mock-up example) are included within the analysis of the ten topics.
The 21 companies include 19 large capitalisation companies (i.e. market capitalisation greater than €15 billion), two medium capitalisation companies (CNP Assurances and Landsec) and one unlisted company (ATP). Multiple illustrative examples have been included because scenario analysis is a relatively new and challenging climate reporting aspect. Therefore, showing many illustrative examples on different aspects of scenario analysis will benefit both reporting preparers and users.

Topic	What is covered?	Examples
GOVERNANCE/STRATEGY ON SCENARIOS		
Governance/strategy on scenarios	Governance in relation to scenarios and integration into strategic decisions	BP (oil and gas), Eni (oil and gas), Unilever (consumer goods)
PARAMETERS AND ANALYTICAL CHOICES		
Quantitative vs. qualitative scenarios	Choice between qualitative, quantitative or 'directional' scenario analysis approach	Lendlease (property development), Oil Search (oil and gas), Société Générale (banking)
Assumptions	Transparency on qualitative and quantitative assumptions	Arcelor Mittal (steel), ATP** (pension fund), Citibank (banking), Oil Search (oil and gas)
Time horizon	Integration of time horizon into scenario analysis and specific meaning of short term, medium term and long term	Aviva (insurance), Rio Tinto (mining), South32 (mining), Société Générale (banking)
Maturity assessment and scope	Progress on scenario reporting journey and portion of operations and value chain that are included in the scenarios	Citi (banking), CNP Assurances* (insurance), Equinor (oil and gas), Rio Tinto (mining), South32 (mining), Oil Search (oil and gas)
SCENARIOS AND MODELS		
Scenario selection	Choice of scenarios and disclosure of process and rationale for scenario selection	EDP (utility), GALP (oil and gas), Iberdrola (utility), Rio Tinto (mining), South32 (mining)
Physical risk scenarios	Physical risk disclosure	Commonwealth Bank of Australia (banking), Landsec* (real estate), South32 (mining)
Models and data	Transparency and clarity on the models and data used for scenario modelling	Aviva (insurance), ATP** (pension fund), Citibank (banking), CNP Assurances* (insurance), Unilever (consumer goods)
INTEGRATION INTO BUSINESS DECISIONS		
Scenario outputs and business decisions	Translation of scenario results into business decisions	AXA (insurance), Eni (oil and gas)
Quantification and monetisation of scenario outputs	Disclosure of impacts within scenario reporting (e.g. financial impacts such as EBITDA, NPV)	AXA (insurance), BHP Billiton (mining), Equinor (oil and gas), mock-up example

**Medium capitalisation (market capitalisation less than €15 billion)* ***Unlisted*

Introduction

The analysis of each topic consists of current reporting practices, areas for improvement, and examples of good reporting practices. It also addresses the perspectives of both preparers and users of corporate reports on good reporting practices for each topic. The analysis is structured as follows:

Sub-heading	Question(s) addressed
Rationale for consideration	What is being addressed as part of the scenario topic? Why is this topic important for preparers and users? Why is it essential to tackle this topic?
Summary of current reporting practices	How do the companies whose scenario-related disclosures were reviewed by the PTF-CRR generally address the particular scenario topic?
Preparer and user perspective	What do preparers try to achieve, what challenges do they face? What do users of scenario analysis information expect to find in climate-related reports?
Areas for improvement	How can companies practically improve the quality of their current reporting on the scenario topic?
Selection of good reporting practices	What are good examples the PTF-CRR has identified for the scenario topic and why are they considered good examples?

GOVERNANCE/ STRATEGY ON SCENARIOS

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Rationale for consideration

The analysis below focuses on climate-related disclosures in terms of governance, management's role and responsibilities in relation to climate scenario analysis, and the integration of outputs from climate scenario analysis into overall strategy, policies and operations.

The TCFD final report explains that companies need to ensure that their governance process (1) integrates scenario analysis into strategic planning and/or enterprise risk management processes, (2) assigns oversight to the relevant board committees/sub-committees, and (3) identifies which internal (and external) stakeholders to involve, and how boards are accountable to shareholders for the long-term health of their companies. As such, they are also responsible to shareholders for overseeing the effective management of climate-related impacts on their companies.

Summary of current reporting practices

Among the reports reviewed by the PTF-CRR, there is limited evidence of adequate governance oversight of the scenario analysis process. For instance, there are only a few examples of companies

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Governance/strategy on scenarios

disclosing processes demonstrating that the executive management and board are involved in climate-related decisions based on climate scenario analysis results. There is limited disclosure of both the governance structure supporting climate scenario analysis and the role of the board or senior management in the validation of the scenario analysis results is rarely mentioned. Companies also generally fail to detail how internal climate expertise is being developed and embedded into all operational teams impacted by climate change. However, the PTF-CRR did observe some good examples of linkages between scenario analysis and strategy or business objectives.

Preparer and user perspective

PREPARER PERSPECTIVE

Reporting on governance in relation to scenario analysis is a useful indicator for stakeholders of the maturity and sophistication of climate-related scenario analysis within companies. At the same time, the governance around scenario analysis needs to ensure that all relevant internal stakeholders are properly involved in the scenario analysis and strategic decision-making processes. The involvement of all key functions within the company is paramount if all relevant aspects of the impact of climate change adaptation and mitigation (e.g. socio-economic, technological, regulatory, environmental change) are to be taken into account, and to ensure optimal buy-in to the outcomes of the analysis. Because scenario analysis deals with uncertainties and calls for the review of a company's resilience in diverse, extreme and, from a company perspective, potentially uncomfortable future states, management needs to take a strong leadership role to keep the exercise on track. They will also have to guide debates on controversial findings towards conclusions about the current status and how to improve robustness of scenario outcomes. The objective of this work is to make senior management comfortable with the assumptions used, the nature of the models they rely on, and the output obtained.

USER PERSPECTIVE

It is important to have a scenario analysis process and accompanying disclosure that reassures users that the company's board has considered how the company's business model and strategy may be affected by climate change. This includes how the board takes risks and opportunities into consideration, as well as their continuous, consistent management in view of changes in the environment over time. As investors increasingly factor in climate resilience when forming an investment view of a company, the board's approval of scenario analysis outputs has become an important source of reassurance for investors. As a result, the sophistication of the climate governance process can be seen by some investors as a proxy indicator of a company's performance. Any corporate strategy put forward by the board should integrate a range of potential climate scenarios in order to increase the directors' confidence that their strategic decisions are resilient. Investors also expect boards to demonstrate solid competence on climate change, be it amongst members themselves or via access to climate expertise.

Areas for improvement

Companies can improve how they report and demonstrate their maturity in strategy and governance on scenario analysis by making further disclosures around the following aspects:

- Governance: Disclosures around the governance oversight of the scenario analysis process (including its scope and narrative) and who is accountable for it. In particular, disclosures about the involvement of the board or senior management in the validation of the assumptions, parameters and models used. Boards should have enough collective awareness and understanding of potential business impacts of climate change, or at least have access to the expertise.
- Strategy: Disclosures about the use of scenario analysis to (1) understand the range of risks and opportunities associated with various scenarios, and (2) support the board/senior management's strategic decisions.
- Resources and competence: Disclosures detailing how internal climate expertise is being developed and embedded into all operational teams impacted by climate change, and what training senior management is receiving on the topic. It would also be useful to understand the resourcing strategy applied to the scenario analysis work.

Examples

On the next page are three examples of good reporting practices on governance around scenario analysis.

Governance/strategy on scenarios

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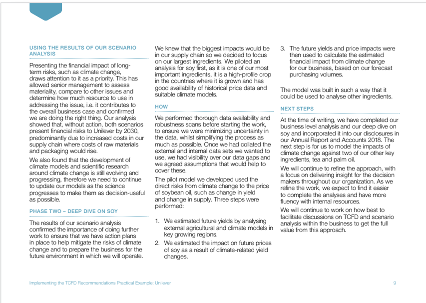
Unilever

Unilever company presentation, page 9

Why this example is selected

In a company presentation available on the Accounting for Sustainability (A4S) website, Unilever's management explains that scenario analysis has allowed senior management to assess materiality of climate change risk, compare this issue to other issues, and determine the resources needed to address it, i.e. it contributes to the overall business case and confirms that Unilever is integrating climate factors.



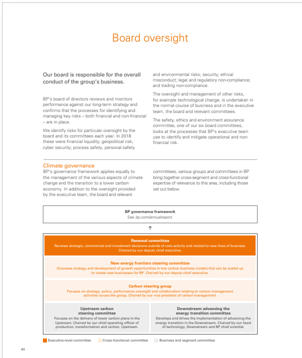
BP

BP (2018) Sustainability Report 2018, page 64

Annual report and Form 20-F 2018, page 9

Why this example is selected

BP's Sustainability Report provides details of its climate governance framework and explains the executive accountability that is in place. It also relies on scenarios when defining long-term strategy.

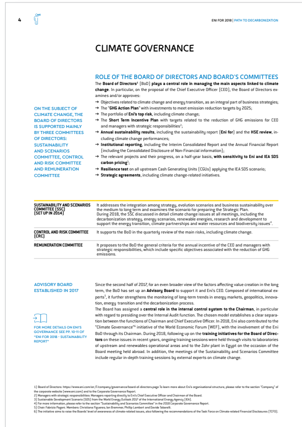


Eni

Eni (2018) Path to Decarbonization report, page 4

Why this example is selected

Eni's climate change report explains that the company has a dedicated Sustainability and Scenarios Committee that examines climate scenarios as part of the preparation of its Strategic Plan.



PARAMETERS AND ANALYTICAL CHOICES

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QUANTITATIVE VS. QUALITATIVE SCENARIOS

Rationale for consideration

The analysis and examples below are related to the choice of quantitative versus qualitative scenarios by companies that may be at different stages of maturity in the exploration or adoption of scenario analysis reporting. Companies in the earlier stages could start with qualitative narratives or storylines to explore the potential range of climate change implications. Experienced companies with greater sophistication in the use of datasets could be more inclined to have quantitative scenario analysis.

Summary of current reporting practices

Only a few of the reviewed companies with disclosed scenario analysis conduct in-house quantitative scenario modelling, while several others use quantitative scenarios from external providers. Some of the advanced examples of comprehensive quantitative scenario modelling are from the oil and gas sector, where scenario analysis thinking is more established, and from financial institutions that are participants in the UNEP- Financing Initiative.

Quantitative vs. qualitative scenarios

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Many of the reviewed companies that disclose scenario analysis tend to have qualitative descriptions of scenarios with minimal disclosure of quantitative scenario assumptions, models and outputs. There also are a few companies that disclose exclusively qualitative scenario narratives/storylines. The observed examples of exclusively qualitative scenarios lacked a description of possible company-specific implications and instead focused on the broad implications of climate-risk adaptation and mitigation at an industry, market and/or national economy level.

Preparer and user perspective

PREPARER PERSPECTIVE

Discussions and stakeholder outreach by the PTF-CRR highlighted that there is sometimes a difference between companies' internal progress on scenario analysis and the quantified information that they choose to disclose. For example, companies choose not to disclose quantified impacts for various reasons, including concerns about legal risk, commercial sensitivity of forward-looking information, and to minimise the risk of users misinterpreting the uncertain albeit plausible quantified long-term impacts.

Some preparers indicated that narrative scenarios can be helpful in fostering internal awareness and buy-in and ensuring alignment across different departments on the responses that should be made by the company to climate change risk. These scenarios can also be useful for educating investors about the potential implications of transition risk choices on the business model.

USER PERSPECTIVE

Both qualitative/narrative-driven and quantitative scenarios can be informative for users and are often seen as complementary. In outreach to stakeholders, users acknowledged the inherent uncertainty associated with quantified scenario analysis information. Nevertheless, they expressed support for quantitative scenarios, as these can be a step towards providing users with comparable scenario analysis information. As elaborated in the 'quantification and monetisation of scenario outputs' topic, quantified scenario analysis information could also be potential inputs to or help contextualise financial statements information (e.g., asset impairment). Users also indicated that they saw the benefit of qualitative scenarios, as these can reveal unquantifiable effects that companies are taking into consideration while analysing their resilience to climate change effects. They also show that management is at least considering the impact of climate risk on the business.

Areas for improvement

Explanation of choice: The PTF-CRR recognises that companies that are in the early stages of their journey in conducting and disclosing scenario analysis may start off with qualitative scenarios. At the same time, as noted earlier, some of the more advanced companies may be reluctant to disclose internally quantified scenarios due to concerns about commercial sensitivity and legal risk.

Therefore, it would be helpful for users if companies that choose exclusively qualitative scenarios could be more transparent about the reasons for their choice. These could include whether a qualitative scenario approach is the most meaningful choice for their business model or whether it has only been adopted as a transitional choice whilst they are in the early stages of scenario analysis reporting, before adopting a quantitative approach. Similar transparency would be helpful from companies that either do not provide any scenario analysis information or only provide partly quantified and largely qualitative scenarios.

Company-specific focus: Qualitative scenarios that are focused on the broad implications for the economy and/or industry and include qualitative descriptions of cause and effect relationships can provide useful contextual information for the analysis of companies' risk. However, such qualitative scenarios could be even more informative if they outlined specific implications for the company – even if only by using qualitative descriptions or directional indicators of possible impact on specific variables (e.g. production capacity, production mix, product profile demand, profitability).

Examples

The next page has three examples of quantitative and exclusively qualitative scenarios from different sectors including financial, oil and gas and property investment.

Quantitative vs. qualitative scenarios

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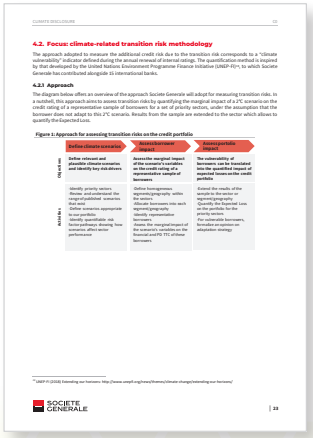
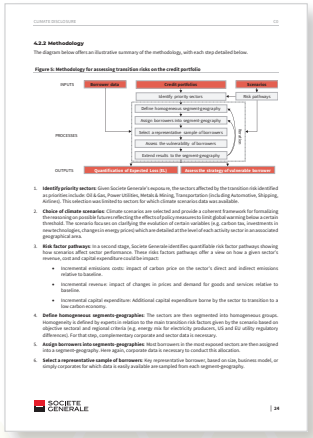
Société Générale

Société Générale (2019) Climate Disclosure – Société Générale's Task Force on Climate-related Financial Disclosures Report, pages 23 and 24

Why this example is selected

Société Générale's TCFD report outlines the borrower impact assessment and the portfolio impact assessment to explain the quantitative scenario approach. Its disclosure of quantitative modelling is helpful in detailing its approach to assessing the adverse financial impact of climate change at the corporate borrower and investee level. This type of disclosure is insightful as stakeholders may have questions on how financial institutions model their borrower and investee companies' exposure to climate risk given the usually incomparable and unquantified climate-related reporting by many companies.





Oil Search

Oil Search (2017) Climate Change Resilience Report, page 20

Why this example is selected

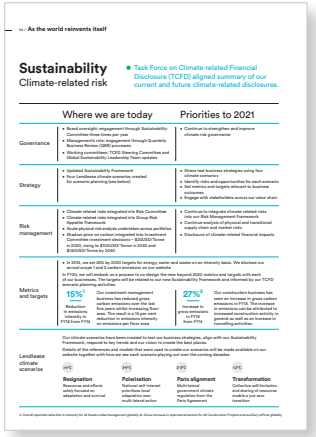
Oil Search's Climate Change Resilience Report discloses quantitative scenario analysis, outlining how it generates oil and price forecasts based on third-party scenarios and applies these forecasts to internal models and resilience assessment. Furthermore, in other parts of its report, Oil Search discloses an outline of related quantitative assumptions and a summary of possible portfolio impacts.

Lendlease

Lendlease (2019) Lendlease Annual Report 2019, page 54

Why this example is selected

Lendlease's Annual Report includes an example of qualitative, narrative scenarios. Lendlease indicates that details of references and models used for these scenarios will be available on its website. Furthermore, the concise, easily understandable disclosure gives a sense of where Lendlease is on a journey towards what seems to be the possible consideration of quantitative scenarios at a future date (e.g. stress testing business strategies is included in 'Priorities to 2021').



ASSUMPTIONS

Rationale for consideration

The analysis and examples below are related to the disclosure of qualitative and quantitative assumptions applied for scenario analysis. The disclosure of qualitative and quantitative scenario parameters and assumptions can help preparers to highlight circumstances that are unique to their companies and enable users to contextualise and interpret the reported scenario analysis outputs, including companies' expected financial impact and business decisions. Such disclosure is consistent with the TCFD's fundamental principles of effective disclosure, which recommend that disclosures should be specific and complete, and further note that *"For future-oriented data, this includes clarification of the key assumptions used. [...] Where appropriate, the organization should also demonstrate the effect on selected risk metrics or exposures to changes in the key underlying methodologies and assumptions, both in qualitative and quantitative terms."*

Summary of current reporting practices

There are varied practices in the disclosure of scenario assumptions across the companies reviewed by the PTF-CRR. Among these companies, some have comprehensive disclosure of their relevant

Assumptions

scenario-related assumptions, but many do not adequately disclose these assumptions. Some companies tend to only disclose market outlook or industry level scenario related assumptions with no clear link or outline of implications for the companies' specific circumstances.

Preparer and user perspective

PREPARER PERSPECTIVE

The varied levels of disclosure of scenario assumptions could reflect a struggle by preparers to determine what assumptions to disclose without having a sufficient understanding of what would be helpful for users. Many respondents to the EU Non-Binding Guidelines (NBG) consultation felt that the current guidelines would not enable comparable reporting by companies and that for scenarios to actually be used in the market, more direct guidance was needed (e.g. on which scenarios to use, across which time horizons, and based on which assumptions). The need for additional guidance on assumptions was echoed by some preparers participating in the PTF-CRR outreach.

Concerns about legal risk and commercial sensitivity is also a factor that influences the willingness of preparers to disclose quantified inputs used in scenario analysis.

USER PERSPECTIVE

During the PTF-CRR internal discussions and stakeholder outreach, users indicated that they recognise that scenario analysis is intended for companies to assess and communicate their resilience to climate change risk, and that it is not a prediction of companies' future cashflows or a projection of exposure. This is because probabilities of occurrence are not considered when conducting scenario analysis.

Nevertheless, to contextualise this information, users expect transparency on key quantitative assumptions related to the inputs and models used to conduct scenario analysis. These include assumptions about carbon prices under different scenarios, implications of key supply/demand assumptions and any other key model inputs. Users expressed the need to understand how carbon price assumptions and policy choices translate to specific sectoral and company-specific impacts.

The disclosure of quantitative assumptions can, to some extent, enable users to have a sense of the comparability of quantified scenario analysis information across reporting companies. But as confirmed during the PTF-CRR outreach, users also recognise that key quantitative assumptions will differ across sectors, and that there are potential limitations with some of the disclosed key assumptions as highlighted in the 2019 Massachusetts Institute of Technology (MIT) publication. For example, a question could arise about whether any underlying carbon prices included in the scenario analysis have taken co-operative and coordinating actions across jurisdictions into account, and whether different carbon prices should be applied across different jurisdictions. In addition, the assumptions could include unproven technologies (e.g. carbon capture storage and net emissions technologies).

Some users assess the resilience of companies starting from financial statements information and therefore emphasised the usefulness of an alignment between assumptions related to scenario analysis and financial statements information (e.g. outlook of commodity price in scenario analysis versus asset impairment-related commodity assumptions, discount rates etc.) or alternatively, of disclosures that highlight and explain any differences.

In addition to the usefulness of quantitative assumptions, users also expressed the importance of disclosure of qualitative assumptions in helping them better understand companies' strategic adaptation choices.

Areas for improvement

Companies could consider communicating key scenario assumptions in a manner that is comprehensive and informative on the specific business context of the company (i.e. that goes beyond only giving a broad market and industry outlook). Companies could also consider explaining if, how and why any key assumptions that were applied for scenario analysis may differ from similar assumptions related to their financial statements information (e.g. asset impairment-related assumptions such as discount rate, or time horizon related to financial asset impairment).

Examples

The four examples shown on the following pages include disclosures of both qualitative and quantitative assumptions relating to transition risk and physical risk.

Assumptions

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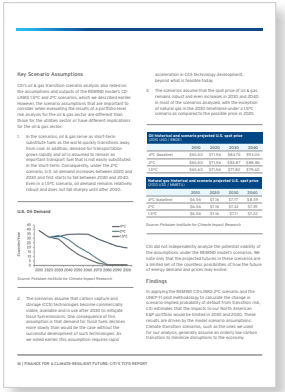
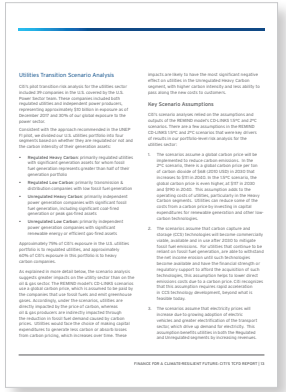
Citibank

Citigroup (2018) Finance for a Climate-Resilient Future – Citi's TCFD Report, pages 16,13 and 12

Why this example is selected

Citibank's TCFD Report discloses the underlying assumptions for transition scenarios related to two sectors (oil and gas, and utilities). It also discloses assumptions for the underlying REMIND model. As noted in the 'models and data' topic analysis, model assumptions are useful for assessing scenario analysis outputs.



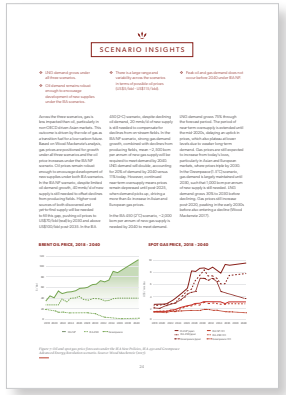


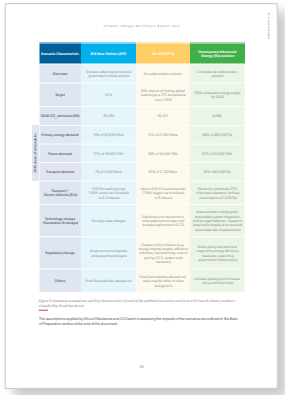
Oil Search

Oil Search (2017) Climate Change Resilience Report 2017, pages 24, 25, 34

Why this example is selected

Oil Search's Climate Change Resilience Report discloses underlying transition risk assumptions related to three reference scenarios and presents them in a reader-friendly table. Oil Search separately discloses its internally applied assumptions. It also has a 'Scenario insights' section that explains underlying assumptions of the three reference scenarios, includes oil and gas price projections and signposts the key takeaways.





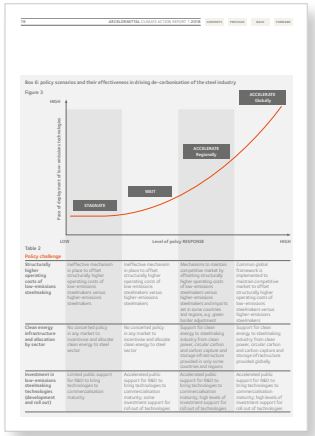
Assumptions

Arcelor Mittal

Arcelor Mittal (2019) Climate Action Report 1, pages 18 and 19

Why this example is selected

Although the below example of narratives/qualitative scenarios from Arcelor Mittal's Climate Action Report only outlines industry information, there is a qualitative description of the assumptions behind each scenario, and a graph that highlights two key transition risk levers (policy response and technology choice). These assumptions give context to the description – made elsewhere in the report and outside the scenario analysis section – of how adopting six new technologies could have a potential impact (in percentage terms) on Arcelor Mittal's operating and capital expenditure.

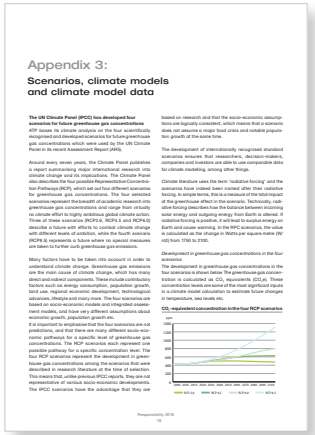


ATP

ATP (2018) Responsibility Statement, pages 78 and 79

Why this example is selected

ATP's Responsibility Statement describes the assumptions used for four Representative Concentration Pathway (RCP) scenarios. These scenarios model different levels of temperature rise while assessing the climate change exposure of its five forest investments.



Appendix 3:

Scenarios, climate models and climate model data

TIME HORIZON

Rationale for consideration

The analysis and examples below relate to the extent to which companies integrate time horizon assumptions into scenario analysis, and disclose what they specifically consider to be short-, medium- and long-term horizons. The TCFD guidance calls for companies to disclose what they consider to be short-, medium- and long-term horizons taking into account the useful life of their assets, and what they consider to be the implications of timing in the scenarios used. Similarly, REQ-02 of the Climate Disclosure Standards Board (CDSB) Framework, highlighted in the 2019 SASB-TCFD implementation guide, requires that disclosures include the timelines, targets, and KPIs used to assess the effectiveness of an organization's environmental strategy and policies.

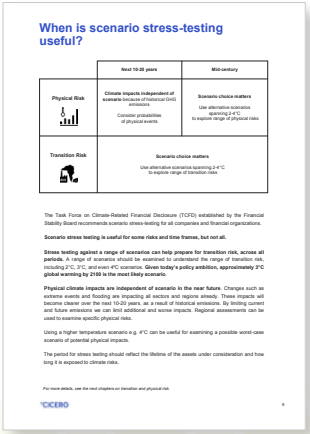
Time horizon disclosure informs on possible risk impacts across different time frames: The impact of climate risk factors can vary according to time horizons and can depend on the choice of measures to limit global warming (e.g. carbon taxes, adoption of new environmentally friendly technologies) under different scenarios. For example, in the long term, the crystallisation of physical risk exposures

Time horizon

will depend on the choice of mitigation measures. While measures implemented to ensure a 2°C or lower rise in temperatures will likely limit medium- to long-term physical risk exposures, other transition scenarios (e.g. limiting to a 3 or 4°C temperature rise) or late political response may lead to increases in physical risk exposures in the future. In contrast to long-term physical risk exposures, short-term physical risk exposures are likely to be more certain and difficult to offset.

Relevance of time horizon for analytical choice: The appropriateness of conducting scenario analysis and the choice between qualitative and quantitative scenarios can depend on the time horizon being considered. For example, a 2018 Cicero Climate Finance publication suggests a differentiated approach towards the analysis of physical risk according to the time horizon being considered (see below diagram). A similar view was expressed in the May 2018 European Bank for Reconstruction and Development (EBRD) publication, which stated that for shorter time horizons, taking the probabilities of events into account is more appropriate than performing scenario analysis.

Cicero-Climate Finance, Climate Scenarios Demystified 2018, page 9



When is scenario stress-testing useful?

	Next 10-20 years	Mid-century
Physical Risk	Climate impacts independent of scenario because of historical GHG emissions Consider probabilities of physical events	Scenario choice matters Use alternative scenarios spanning 2-4°C to explore range of physical risks
Transition Risk	Scenario choice matters Use alternative scenarios spanning 2-4°C to explore range of transition risks	

The Task Force on Climate-Related Financial Disclosure (TCFD) established by the Financial Stability Board recommends scenario stress-testing for all companies and financial organizations.

Scenario stress testing is useful for some risks and time frames, but not all.

Stress testing against a range of scenarios can help prepare for transition risk, across all periods. A range of scenarios should be examined to understand the range of transition risk, including 2°C, 3°C, and even 4°C scenarios. **Given today's policy ambition, approximately 3°C global warming by 2100 is the most likely scenario.**

Physical climate impacts are independent of scenario in the near future. Changes such as extreme events and flooding are impacting all sectors and regions already. These impacts will become clearer over the next 10-20 years, as a result of historical emissions. By limiting current and future emissions we can limit additional and worse impacts. Regional assessments can be used to examine specific physical risks.

Using a higher temperature scenario e.g. 4°C can be useful for examining a possible worst-case scenario of potential physical impacts.

The period for stress testing should reflect the lifetime of the assets under consideration and how long it is exposed to climate risks.

For more details, see the next chapters on transition and physical risk.

CICERO

Summary of current reporting practices

Only a few of the reviewed companies' disclosures specified what they considered to be short-, medium- and long-term horizons and how these different time horizons are integrated into scenario analysis and the related business decisions. In many cases, companies only have qualitative descriptions of time horizon, or none at all.

Preparer and user perspective

PREPARER PERSPECTIVE

The disclosure of climate risk factors according to clear and distinct time horizons can help companies and their stakeholders identify, analyse and mitigate climate risk exposure (i.e. physical and transition risk) and/or capitalise on opportunities. In other words, a clear breakdown of time horizons can enhance business planning and decision making.

Furthermore, the PTF-CRR internal discussions and stakeholder outreach confirmed that, to be meaningful, the time horizons applied in scenario analysis should extend to climate change time horizons (e.g. considering the impacts that may arise in 2050 and 2100). However, there is an acknowledgment that the climate change time horizons may extend beyond the planning horizon for some business models, and that this may explain why some companies do not specify what short term, medium term and long term means for them.

USER PERSPECTIVE

During PTF-CRR discussions and the stakeholder outreach, users emphasised the importance of the visibility of companies' specific definition of time horizon. This helps users compare and assess time horizon definitions across similar companies, and lets them challenge companies that appear to have unusual definitions. Users also highlighted that companies tend to quantify short-term horizon impacts and qualitatively consider impacts due to long-term risks and opportunities.

The importance for users of the disclosure of time horizons has also been highlighted by several publications including a 2018 Climate scenario compass report by Kepler Chevreux that was informed by the viewpoints of 150 analysts. It highlights that climate-related risks tend not to be fully captured and priced by current financial models, analyses or recommendations, and that they are considered unevenly across sectors. This noted failure to incorporate climate risk could, in part, arise due to the difficulty users may face in distinguishing the climate-related risks and opportunities that relate to different time horizons. A 2018 Principles for Responsible Investment (PRI) publication on environmental, social, and governance (ESG) issues and credit risk also raises the importance of time horizon for investors. The PRI publication notes that time horizon considerations depend on the visibility of future risks, the probability that they will materialise, and whether they impact investee companies' cash flow and balance sheet and companies' ability to adjust their business models.

Hence, the disclosure of which time horizons are being considered can potentially help inform users about the uncertainty associated with companies' future cash flows, and to identify which possible future impacts could be meaningfully included in valuation and risk analysis models.

Areas for improvement

The disclosure of time horizon assumptions and their effective integration into scenario analysis is an area for possible improvement for many companies. Consideration of long-term climate change-relevant time horizons further enhances scenario analysis. Finally, the time horizon-based disaggregation of risk factors will make reports more informative for users if it is done for all material climate risk factors.

Examples

On the following pages are four examples of good reporting practices in specifying and integrating time horizon into scenario analysis.

Time horizon

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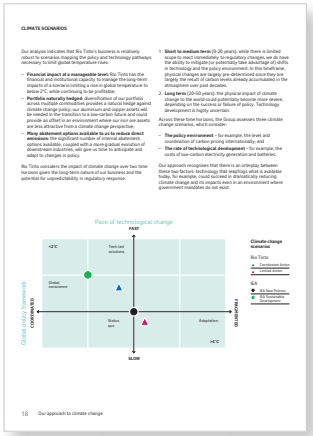
Rio Tinto

Rio Tinto (2018) Our approach to climate change 2018, pages 18 and 23

Why this example is selected

Rio Tinto's climate change report discloses sensitivity analysis and scenario analysis information related to both physical and transition risk. The disclosure clarifies the meaning of time horizon as follows: short to medium term (0 to 20 years) and long term (20 to 50 years). Furthermore, Rio Tinto distinguishes the potential impact of a 2°C scenario on its commodity product profile (iron ore, copper and aluminium) by time horizon. In a different section of the report, it also highlights that the analytical approach to physical risk exposure depends on time horizon.

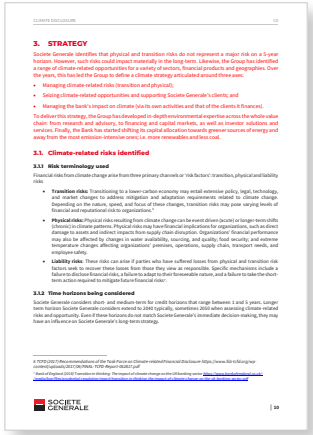


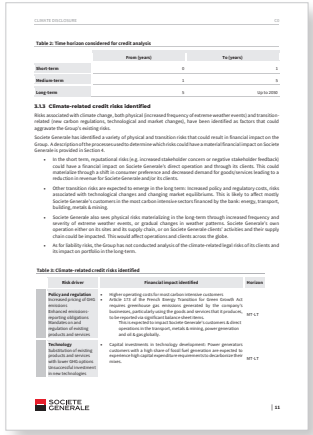
Société Générale

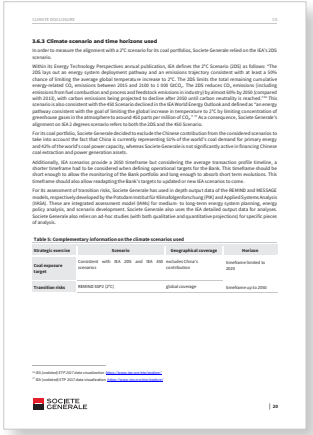
Société Générale (2019) Climate Disclosure – Société Générale's Task Force on Climate-related Financial Disclosures Report, pages 10, 11, 20

Why this example is selected

Société Générale's Climate Disclosure includes time horizon considerations for credit analysis purposes, and highlights that while climate risks and opportunities may not influence immediate decision-making, they could influence long-term strategy. Société Générale then discloses how different climate scenarios are applicable for different time horizons.







Time horizon

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South32

South32 (2018) Our Approach to Climate Change 2018, page 17

Why this example is selected

The South32 climate change report disclosure includes an outline of how different time horizons are mapped to different transition risks (policy, legal, reputation, shareholder action, technology, market changes), the most relevant scenarios as well as mitigation and opportunities. The footnote clarifies time horizons as follows: short term (next 3 to 5 years), medium term (6 to 10 years) and long term (11 to 50 years).

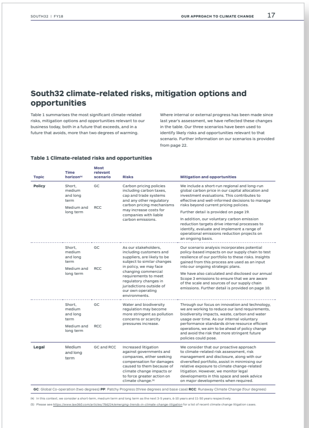

South32 climate-related risks, mitigation options and opportunities

Table 1 Climate-related risks and opportunities

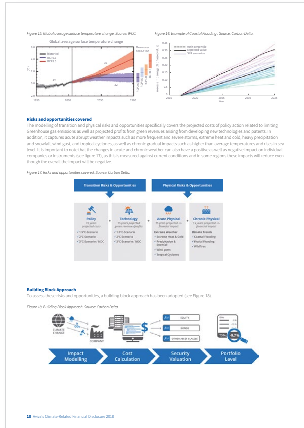
Aviva

Aviva (2018) Aviva's Climate-Related Financial Disclosure 2018, pages 17 and 18

Why this example is selected

Aviva's TCFD report disclosure highlights a 15-year horizon for the scenario analysis (Climate Value-at-Risk approach). It also communicates the likelihood of physical risk exposure over the next 15 years and over longer time horizons (until 2100).


Appendix: Climate VaR Modelling Approach



MATURITY ASSESSMENT AND SCOPE

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Rationale for consideration

In its 2017 Final Report, TCFD noted that greater *"rigor and sophistication in the use of data and quantitative models and analysis may be warranted for organizations with more extensive experience in conducting scenario analysis"* and expects *"that organizations will evolve and deepen their use of scenario analysis over time"*. As companies have differing levels of experience with scenario analysis, stakeholders find it useful to have information on where companies are in their journey of conducting and reporting scenario analysis. This kind of disclosure allows stakeholders to understand the applicability of the results and how much confidence they can place in related conclusions.

Transparent and clear disclosed information on the maturity and potential limitations of companies' scenario analysis approaches is helpful for users. This is especially the case when such disclosures address methodological aspects (e.g. quantitative vs. qualitative scenario and time horizon – see the respective topic analyses), overall scope and granularity of the analysis (e.g. parts of value chain, businesses, types of assets, geographies and/or sectors considered, risk types included).

Maturity assessment and scope

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Summary of current reporting practices

Companies that report on scenario analysis rarely give explicit information on the level of completion, maturity of the analysis and scope of coverage. Those that provide more advanced reporting typically disclose information on the level of completion and maturity of their scenario analysis (e.g. complete, partially complete, initial assessment). Their description of the status of the assessment includes information on significant scope exclusions (e.g. limited regional coverage, selected business areas), data gaps and/or conceptual weaknesses. If gaps have been identified, the summary is accompanied by an outline of next steps to enhance the analysis.

Preparer and user perspective

PREPARER PERSPECTIVE

Disclosure and clarity on the maturity and scope of the scenario analysis helps reporting companies and their stakeholders to understand both the usefulness and limitations of scenario analysis as a tool for specific internal risk assessments and strategic decisions. Furthermore, disclosing the maturity and scope sets a clear starting point for formulating a path to enhance the analysis over time. A detailed scenario analysis supported by a transparent scope ensures that senior management will understand the impact of the analysis on the various business lines and geographical location of operations, and will be able to make appropriate decisions.

USER PERSPECTIVE

Disclosure of the maturity and scope of scenario analysis helps users of company reports identify where companies are in the journey of conducting and reporting scenario information. This information can enhance users' decision making by helping them assess what the scenario results address, which data gaps exist (i.e. what further work needs to be undertaken by preparers), and what level of confidence they can have in the conclusions of the analysis.

Areas for improvement

As noted, companies that report on scenario analysis rarely give explicit information on the level of completion and maturity of the analysis. It would be helpful if companies that are still in the early stages of scenario reporting could consider disclosing basic key messages about the overall status of the assessment, major limitations as well as plans to enhance the scenario analysis process. With progress in scenario assessment, companies can consider advanced reporting of the maturity level by outlining details of any gaps in the scope of assessment, scenario inputs and analytical choices, business impacts and adaptive strategic decisions made.

Finally, users would benefit from a consolidated, structured presentation of the detailed information (e.g. lists, tables). Presentation is a potential area for improvement for all report preparers.

Examples

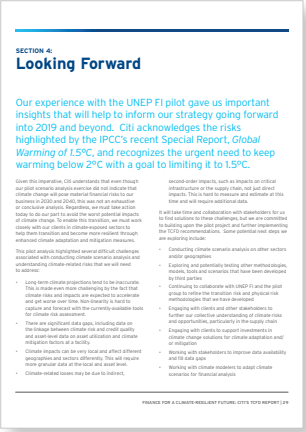
On this and the following pages are six examples of advanced reporting on maturity assessment and scope drawn from companies in different sectors.

Citibank

Citigroup (2018) Finance for a Climate-Resilient Future – Citi's TCFD Report, page 29

Why this example is selected

Citibank's TCFD Report notes that Citibank conducted a pilot scenario analysis and has identified a set of challenges associated with conducting climate scenario analysis. The report also outlines a series of potential next steps to find solutions for these issues.



SECTION 4:
Looking Forward

Our experience with the UNEP FI pilot gave us important insights that will help to inform our strategy going forward into 2019 and beyond. Citi acknowledges the risks highlighted by the IPCC's recent Special Report, *Global Warming of 1.5°C*, and recognizes the urgent need to keep warming below 2°C with a goal to limiting it to 1.5°C.

Given this imperative, Citi understands that even though our pilot scenario analysis exercise did not indicate that climate change will pose material financial risks to our business in 2030 and 2040, this was not an exhaustive or conclusive analysis. Regardless, we must take action now to help mitigate the potentially severe consequences of climate change. To enable this transition, we must work closely with our clients in climate-exposed sectors to help them transition and become more resilient through enhanced climate adaptation and mitigation measures.

This pilot analysis highlighted several difficult challenges associated with conducting climate scenario analysis and understanding climate-related risks that we will need to address:

- Long-term climate projections tend to be inaccurate. This is made even more challenging by the fact that climate risks and impacts are expected to accelerate and get worse over time. Non-linearity is hard to capture and forecast with the currently-available tools for climate risk assessment.
- There are significant data gaps, including data on the linkage between climate risk and credit quality and asset-level data on asset utilization and climate mitigation factors at a facility.
- Climate impacts can be very local and affect different geographies and sectors differently. This will require more granular data at the local and asset level.
- Climate-related losses may be due to indirect, second-order impacts, such as impacts on critical infrastructure or the supply chain, not just direct impacts. This is hard to measure and estimate at this time and will require additional data.

It will take time and collaboration with stakeholders for us to find solutions to these challenges, but we are committed to building upon the pilot project and further implementing the TCFD recommendations. Some potential next steps we are exploring include:

- Conducting climate scenario analysis on other sectors and/or geographies
- Exploring and potentially testing other methodologies, models, tools and scenarios that have been developed by third parties
- Continuing to collaborate with UNEP FI and the pilot group to refine the transition risk and physical risk methodologies that we have developed
- Engaging with clients and other stakeholders to further our collective understanding of climate risks and opportunities, particularly in the supply chain
- Engaging with clients to support investments in climate change solutions for climate adaptation and/or mitigation
- Working with stakeholders to improve data availability and fill data gaps
- Working with climate modelers to adapt climate scenarios for financial analysis

FINANCE FOR A CLIMATE-RESILIENT FUTURE: CITI'S TCFD REPORT | 29

Maturity assessment and scope

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South32

South32 (2018) Our Approach to Climate Change 2018, page 29

Why this example is selected

South32's climate change report gives a clear description of the progress the company has made in terms of scenario analysis in the past years and of intended extensions in the current year.

SCENARIOS USED: GLOBAL COOPERATION SCENARIO[1&2]

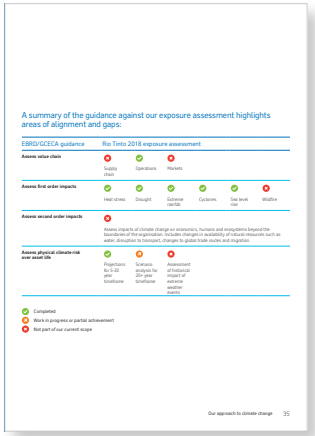
Our portfolio resilience to transition risks

Rio Tinto

Rio Tinto (2018) Our approach to climate change 2018, page 35

Why this example is selected

Rio Tinto's climate change report provides a clear and comprehensive overview of the level of completion of its assessments in the area of physical risks.



A summary of the guidance against our exposure assessment highlights areas of alignment and gaps:

EBRD/GCECA guidance | Rio Tinto 2018 exposure assessment

Assess value chain

Assess first order impacts

Assess second order impacts

Assess physical climate-risk over asset life

Completed

Work in progress or partial achievement

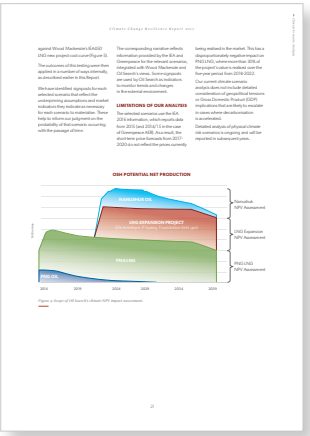
Not part of our current scope

Oil Search

Oil Search (2017) Climate Change Resilience Report 2017, page 21

Why this example is selected

Oil Search's Climate Change Resilience Report summarises the limitations of its scenario analysis in a separate chapter.



LIMITATIONS OF OUR ANALYSIS

P50 LNG

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Maturity assessment and scope

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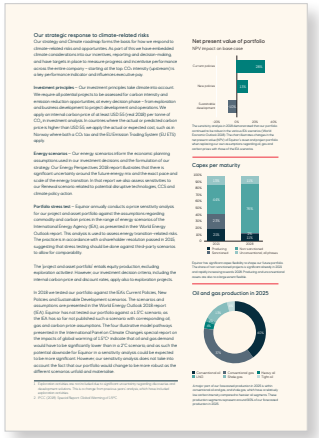
Equinor

Equinor (2018) 2018 Sustainability Report, page 18

Why this example is selected

Equinor's Sustainability Report highlights the scope of the portfolio resilience stress test that it conducted.

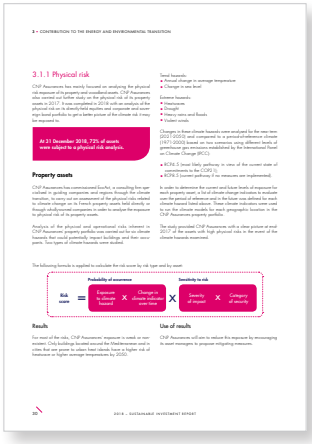


CNP Assurances

CNP (2018) 2018 Sustainable Investment Report, page 30

Why this example is selected

CNP Assurances Sustainable Investment Report highlights the use of scenario analysis to make conclusions on physical risks and gives a clear indication of the scope of assessment and level of coverage.



SCENARIOS AND MODELS

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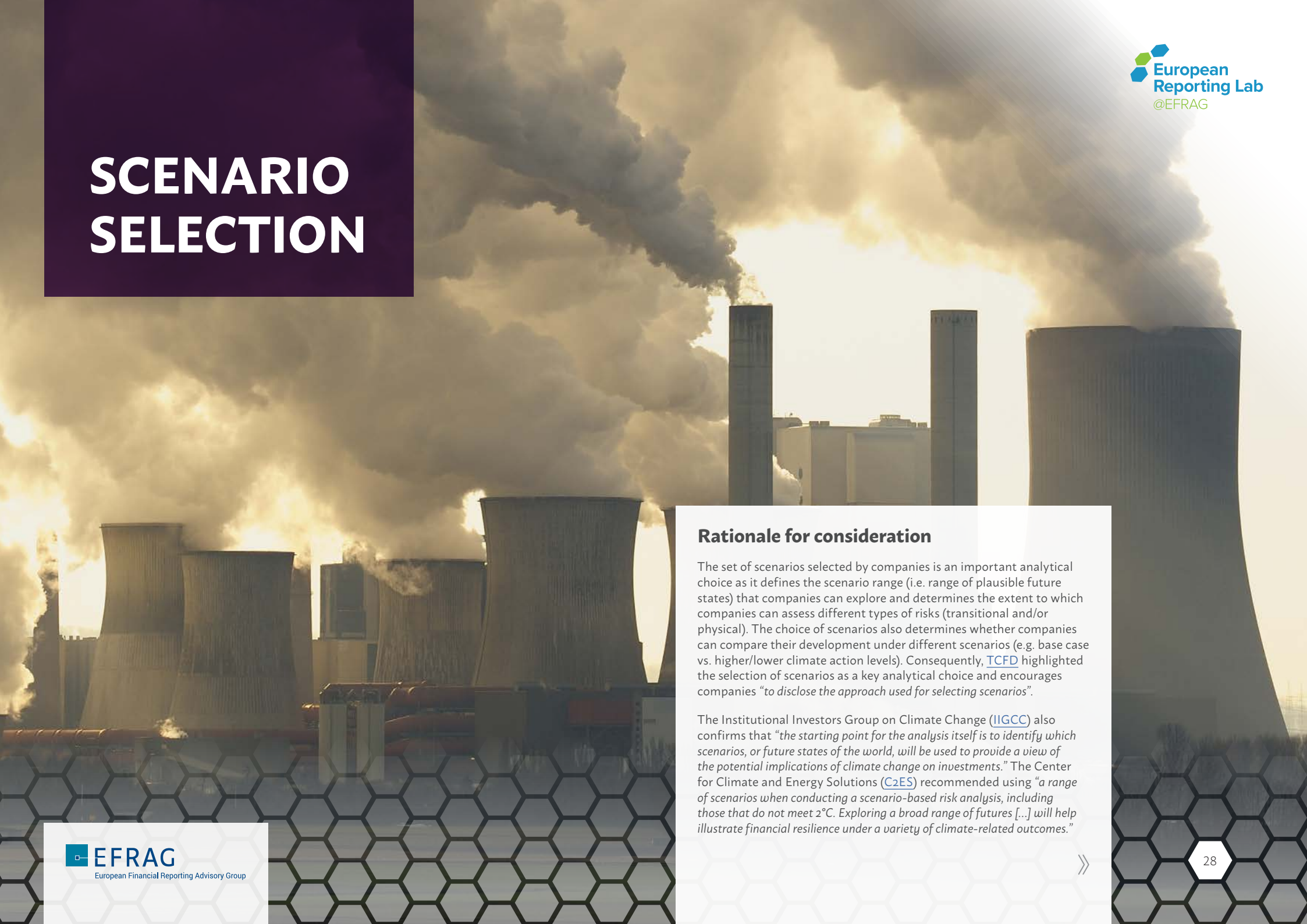
SCENARIO SELECTION



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Rationale for consideration

The set of scenarios selected by companies is an important analytical choice as it defines the scenario range (i.e. range of plausible future states) that companies can explore and determines the extent to which companies can assess different types of risks (transitional and/or physical). The choice of scenarios also determines whether companies can compare their development under different scenarios (e.g. base case vs. higher/lower climate action levels). Consequently, TCFD highlighted the selection of scenarios as a key analytical choice and encourages companies *"to disclose the approach used for selecting scenarios"*.

The Institutional Investors Group on Climate Change (IIGCC) also confirms that *"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."* The Center for Climate and Energy Solutions (C2ES) recommended using *"a range of scenarios when conducting a scenario-based risk analysis, including those that do not meet 2°C. Exploring a broad range of futures [...] will help illustrate financial resilience under a variety of climate-related outcomes."*

Scenario selection

In line with C2ES, CDSB concludes that *"it is necessary to consider a number of plausible future paths to stress test the organization at the extremes of the "wedge" of future risk and opportunity and use scenario analysis to test an organizations' resilience and strategy responses to these."* Defining a range of scenarios should allow companies to assess transition risks (e.g. under a global warming well-below 2°C scenario) as well as physical risks (e.g. under a high warming scenario).

Summary of current reporting practices

Companies that report on scenario analysis tend to provide rather short descriptions of their process and rationale for defining the scenario range. In some cases, companies use a single scenario for the analysis, which is not in line with TCFD recommendations.

The more advanced companies, in line with TCFD, define a set of scenarios (including a 2°C scenario) which include a range of transitional and physical risks relevant to the company. The description of the scenario range outlines the rationale for selecting a scenario (e.g. coverage of a certain type of risks relevant to the company, build-up of a reference case) and provides information about potential interdependencies with external reference scenarios (e.g. full/partial adoption of an International Energy Agency (IEA) or Intergovernmental Panel on Climate Change (IPCC) scenario). Furthermore, it gives an insight into the positioning and relationship of the scenarios included in the scenario range.

Preparer and user perspective

PREPARER PERSPECTIVE

Selecting appropriate scenarios is a major challenge for preparers. Referencing external scenarios for company-specific analysis can be constrained by a range of factors such as limited public access to output data, gaps in the overall coverage of the scenario and insufficient level of detail in the results for certain business sectors. Internal scenarios can be tailored to company-specific needs but require a level of expertise in scenario preparation that is typically not available within companies. Consequently, during the PTF-CRR outreach, several preparers expressed the need for guidance on selecting appropriate scenarios.

USER PERSPECTIVE

In assessing the decision-usefulness of companies' scenario selection, users think about the number, type, plausibility and information content of scenarios that are applied. Companies consideration of a range of scenarios, covering both physical and transition risks and reflecting unfamiliar and unfavourable outcomes, represents a good practice in this context. Many users expect better comparability and standardisation of applied scenarios across similar companies within sectors. Sector-specific scenario development or the use of common databases were proposed as a way to foster standardisation. Some feedback during the PTF-CRR outreach noted a trade-off between user needs for comparable information across companies and information that reflects company-specific situations. A combination of external reference scenarios with internal scenario elements may help to overcome this trade-off between the need for comparable versus company-specific information.

Areas for improvement

As noted earlier, companies reporting on scenario analysis tend to mainly provide short descriptions of their process and rationale for defining the scenario range.

Companies that are at a basic level of reporting on scenario selection often only describe scenarios using simple, short outcome-oriented phrases (e.g. '2°C scenario' to indicate the level of global warming that the scenario represents) or by short reference to certain widely used scenarios (e.g. IEA Sustainable Development Scenario). This kind of description lacks context about the rationale for scenario selection (i.e. the overall relevance for the company and the relevant risks addressed) and whether there are correlations between multiple applied scenarios.

As noted earlier, companies that are more advanced in their reporting tend to disclose more information about the set of scenarios selected including the rationale for their selection, and their positioning in the scenario range. Disclosure of these different aspects of scenario selection in an integrated and non-dispersed manner, is a potential area for improvement for all preparers.

Examples

On the following pages are five examples of good reporting on scenario selection drawn from companies in different sectors.

Scenario selection

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EDP

EDP (2018) Sustainability Report 2018, page 108

Why this example is selected

Energias de Portugal's (EDP) Sustainability Report indicates that separate scenarios were used for the analysis of physical risks and transition risks, and outlines the scenarios that were considered relevant for each risk type.

Galp

Galp (2018). Galp Integrated Report 2018, page 34

Why this example is selected

Galp's Integrated Report outlines a range of scenarios at the level of technological disruption and political consensus, which are considered the main uncertainties for its sector. The key characteristics, positioning and relationship of the scenarios are summarised in an overview figure.

Iberdrola

Iberdrola (2018) Statement of Non-Financial Information. Sustainability Report 2018, page 61

Why this example is selected

Iberdrola's Sustainability Report gives a clear overview on the number of scenarios considered and their purpose (transition or physical risk analysis).

Scenario selection

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Rio Tinto

Rio Tinto (2018) Our approach to climate change 2018, pages 18-19

Why this example is selected

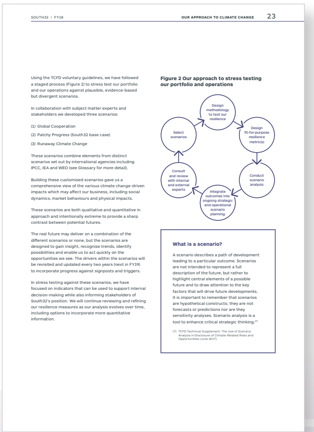
Rio Tinto's climate change report explains that three scenarios, reflecting different political framework and technological conditions, were used to assess the resilience of its businesses over clearly defined time horizons. One scenario serves as a reference case, and the positioning of the scenarios is shown clearly in a 2 × 2 matrix (i.e. choice of policy versus pace of technology adoption). The disclosure covers the main differences between the chosen scenarios and the anticipated impact for each scenario in relation to the reference case.

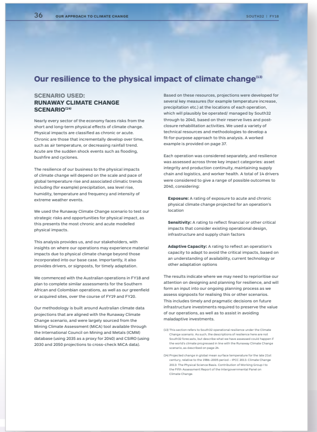
South32

South32 (2018) Our Approach to Climate Change 2018, pages 23, 29, 36

Why this example is selected

South32's climate change report notes the use of three scenarios, which are characterised as divergent and intentionally extreme, to assess business resilience in a range of contrasting futures. One scenario is clearly marked as a base case against which business impacts due to transition risks and physical risks, each represented by another scenario, are assessed. South32 also notes that the three customised scenarios combine elements from well-known external scenarios (including IPCC, IEA and World Economic Outlook (WEO)). At some level, this link of custom scenarios to external reference scenarios could help to balance users' needs for both company-specific and comparable information.





PHYSICAL RISK SCENARIOS

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Rationale for consideration

TCFD recommendations identify climate-related physical risk and transition risk as the two main types of risk that financial sector and non-financial sector companies should disclose. Physical risk is one of the main ways climate change will impact companies. Climate change can impact physical risk through:

- Acute (event-driven) risk such as extreme weather events (e.g. floods, droughts, storms, heat stress, cold snaps etc.); and
- Chronic risks (those due to longer-term shifts in climate patterns such as an increase in average temperature or a change in average precipitation).

Climate change can impact the chronicity of physical risk and the severity and geographical location of extreme weather events. This leaves companies with the uncertainty of how potential climate-related physical risk may affect their operations and value chain.

Transition risk within TCFD recommendations has a goal of limiting temperature rise relative to pre-industrial levels to at least a 2°C or below. Transition risk and physical risk are inversely related (i.e. policy action, technology and business model adaptation that limit carbon emissions increase transition risks and opportunities, but limit long-term physical risk exposures).

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Physical risk scenarios

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Given the relevance of climate-related physical risk, information about the extent to which companies have assessed the physical impact on their portfolio of assets and incorporated physical risks into investment screening and future business strategy is an important element of disclosure (see also CDP technical note). There is also a need to consider if physical risk has impacts across companies' value chains (supply chain, distribution networks and markets).

Summary of current reporting practices

Physical risk is one of the most challenging aspects of scenario analysis, and physical risk disclosures are less often provided and less developed than those of transition risk. So far, not many companies have performed and disclosed physical risk scenario analysis. At this stage, the leading reporters provide only some description of the models but not key assumptions. Often the analysis is partial, performed for only part of the portfolio and stressing only some of the physical risk variables.

There are usually some high-level figures or maps provided to help the users judge the materiality of the results, but no comprehensive financial impact assessment is provided. Potential action points and adaptation strategies are outlined but there is no disclosure of specific adaptation plans that will be undertaken as a result of the physical risk assessment.

Preparer and user perspective

PREPARER PERSPECTIVE

During PTF-CRR discussions and stakeholder outreach, preparers highlighted the challenge of assessing the impact of physical climate risk because it requires granular details of the exposure of companies' facilities and information about both companies' value chains and supply chains that are difficult to gather. Indeed, many companies lack this level of information and there are also challenges in obtaining this data from third-party providers as highlighted in a March 2019 publication from Cicero on physical climate risk. The Cicero publication highlights the limited availability of counterparty-specific information and notes that data service providers offer limited coverage of climate data and make limited use of scenarios reflecting long-term climate change.

USER PERSPECTIVE

Due to the limitations of currently disclosed information and alternative datasets, investors struggle to integrate physical risk exposure into their portfolio analysis. Even when asset location data is available, there are still challenges in identifying the potential impact and risk mitigation measures (e.g. property and business interruption insurance).

During the stakeholder outreach, some investors indicated that they would find it useful if companies disclosed both asset-level and supply chain-related physical risk exposure, as well as the type of event creating physical risk (e.g. extreme precipitation, sea level rises, extreme heat) and a quantification of the impact.

Given that very few companies have quantitatively assessed their exposure to physical climate risk and that those who have, have done partial assessments, the usefulness of current disclosure is limited and likely falls short of user expectations of best practice. Nevertheless, even when there is only qualitative disclosure, this is still useful as it shows that companies are taking the first steps to assess and adapt to the impact of physical climate risk.

Areas for improvement

Current reporting on physical risk is less developed than the reporting of transition risk. This is likely to be due to greater uncertainty associated with assessing physical risk compared to transition risk, be this in terms of time horizon or climate developments. The main area for improvement is to perform full rather than partial analysis of the exposure to physical climate risk, to disclose the financial impact and to provide more detail on actions taken to adapt. In order to do so, companies need to source the necessary exposure and climate data, which may require significant efforts given the challenges in obtaining them internally and externally.

Examples

On this and the following pages are three examples of more advanced reporting practices on physical risk.

South32

South32 (2018) Our Approach to Climate Change 2018, page 37

Why this example is selected

South32 climate change report discloses that South32 performed a partial analysis covering only their Australian business, while providing an outlook on plans to expand the analysis to cover other operations. The disclosure includes a high-level description of the scenario and model used.

For one mine, there is more detailed information which includes a qualitative description of the expected impact and the resilience of the operations. For other mines in Australia, the only information disclosed is the high-level impact.

The company has outlined the adaptation options that are available. However, it has not indicated what specific adaptation actions will be undertaken.


ASSESSMENT EXAMPLE: WORSLEY ALUMINA RUNAWAY CLIMATE CHANGE SCENARIO AT 2040

Physical risk scenarios

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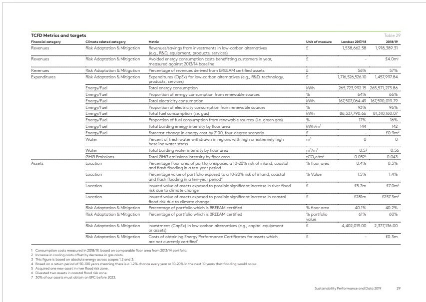
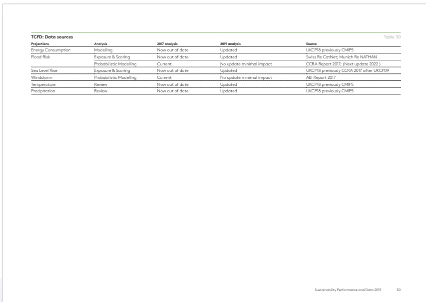
Landsec

Landsec (2019) Sustainability Performance and Data 2019, pages 25, 28-30

Why this example is selected

Landsec's Sustainability Performance and Data report provides a high-level description of the scenario and model used. A largely qualitative description of the impact is disclosed. The only financial metrics provided are the proportion of assets exposed to flood risk in the next ten years. Available adaptation options are disclosed but there is no information on what specific adaptation actions will be taken.





Physical risk scenarios

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Commonwealth Bank of Australia

Commonwealth Bank of Australia (2019) 2019 Annual Report, pages 56, 59-60

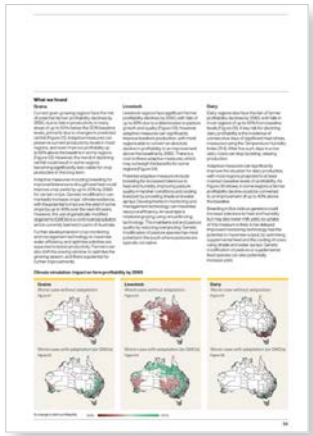
Commonwealth Bank of Australia (2018) Annual Report 2018, pages 53-54

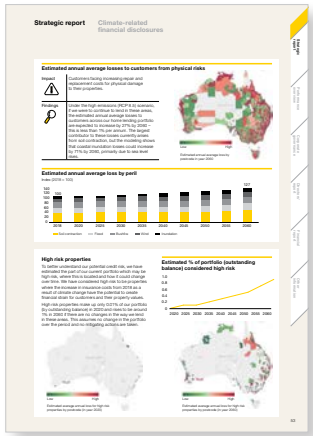
Why this example is selected

Commonwealth Bank of Australia (CBA) Annual Report discloses that every year the CBA performs a physical climate scenario analysis on a different portfolio. The table below shows the progress up to FY 2019 and the plans for FY 2020-2021. The approach intends to cover a broad range of activities, but the analysis is still partial.

There is a detailed description of the analyses performed. However, key assumptions are not disclosed.

CBA presents results of the impact on their counterparties through risk maps and high-level risk impact, concluding that impacts on the company's own balance sheet are minimal. Also, the report provides a summary of the actions CBA may take based on the analyses performed. The report states that the analyses are still a work in progress and the strategic responses in the near future will not be based on these preliminary assessments.





MODELS AND DATA

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Rationale for consideration

The analysis and examples below relate to transparency on the models and data used for conducting and disclosing scenario analysis. As outlined in a 2019 Institute for Climate Economics (I4CE) publication, scenarios are quantified using the following models:

- Models that are a representation of human activities that ultimately impact the climate and that occur within the economy and via the energy system and/or land use. These models are applied in transition and other human activities' scenarios.
- Climate or circulation models that simulate the climate response to human activities (e.g. response to current and future greenhouse gas emissions) and depict the evolution of temperature, precipitation and sea-level rise, often until the year 2100. These models are applied in climate change scenarios.
- Models that represent the impact of climate change on the economy (e.g. financial impact). These models are applied in climate impact scenarios.

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Models and data

A detailed description of different models (climate models, energy system, land use, hazard, integrated assessment and macroeconomic models) can be found in the 2019 UN Environment – Finance Initiative (UNEP-FI) publication and 2019 MIT publication. The choice of models, related implicit and explicit scenario input data and underlying assumptions (e.g. technology development and energy consumption assumptions), as well as information on the focus of the scenario analysis (e.g. specific asset, portfolio of assets, physical location) can significantly impact the results of a scenario analysis.

Companies' disclosure of any models and related data applied whilst conducting scenario analysis can help users to interpret scenario outputs and compare information across companies. Transparency on models and the underlying data also enable users to assess the credibility of underlying assumptions and validity of the outcomes. More specifically:

- Disclosure of the underlying models, including the methodologies applied, allows readers of companies' scenario analysis information to assess: the expectations and plausibility of technology developments implicit in the scenario(s) such as negative emissions technologies; emission reduction pathway assumptions; and whether the underlying model is an integrated model or consists of aggregated subsector models.
- Disclosure of the underlying data can inform on the coverage of the analysis (e.g. whether the analysis has been performed globally). It can also shed light on the nature of data applied (e.g. carbon emissions data, financial performance or technology innovation data such as the type of steel plants or vehicles) for specific sectors, companies, or projects.
- Disclosure of models can help users determine the appropriateness of the application of these models by companies (e.g. whether the interaction and process flow between different models is logically coherent, or whether there is a logical linkage between carbon budget, other assumptions and the translation to climate and financial impacts).

Furthermore, as highlighted by the 2019 MIT publication, some models are a highly simplified representation of the interaction between economic, emission activities and the climate system response. They can be only partial representations of energy systems, with potentially unrealistic assumptions for specific sectors being considered. The need for a critical review of assumptions is discussed in detail in the 'assumptions' topic analysis. In effect, many of the existing models were not designed for corporate reporting purposes and therefore transparency on how they are used, and their limitations is important.

Another limitation is the unavailability of key data (i.e. data gaps) on sector and geography. Financial companies also face challenges related to sourcing relevant climate risk data for scenario modelling purposes related to their borrower and/or investee companies. Hence, stakeholder awareness of the choices made by companies and third-party service providers they rely on to address model limitations and data gaps, can be helpful in the interpretation of model outputs.

Summary of current reporting practice

Current disclosure does not consistently provide transparency on the models and data underlying the scenario analysis. While some companies disclose climate and energy system models, the disclosure on financial impact models and the data describing the item being analysed (project, specific asset, portfolio of assets, physical location) is often lacking.

Preparer and user perspective

PREPARER PERSPECTIVE

Clarity on the model and data choices enables report preparers to illustrate thoroughness, quality and validity of the analyses performed.

During the PTF-CRR outreach, several preparers from both financial and non-financial companies expressed the challenges they face in obtaining suitable data for scenario modelling. Some highlighted the current unavailability of sectoral pathways for their sectors. Several financial companies noted the challenges that arise due to a lack of climate risk data related to their borrower and/or investee companies (e.g. lack of adequate multi-year data that can be inputs to risk prediction and measurement models). The lack of relevant data is more pronounced for Small and Medium-Sized Enterprises (SMEs) due to their relative immaturity in climate reporting. At the same time, SMEs can be a significant customer base for financial companies. Another challenge lies in the limited transparency on the concepts, assumptions and data integrated in many externally available models (e.g. energy system models providing respective external reference scenarios).

The combination of model and data gaps may create a need for companies to have to develop and apply their own assumptions to address these gaps but it may also, in some cases, make it difficult to model quantitative information about climate-related risks, especially for longer time horizons. In such cases, disclosure of qualitative information by companies can be more meaningful until these methodological and data issues are adequately addressed.

USER PERSPECTIVE

For users to interpret and apply reported scenario analysis information, they need to both understand and be able to trust the underlying models and data. Additionally, some users might want to compare reported information across companies whilst anticipating possible future states arising due to climate change risks. Such analysis is only possible if there is transparent and clear communication of the underlying scenario analysis models and data. During the stakeholder outreach, some users observed the need for improved clarity in reporting and overall transparency on the climate models and data including their source and how they are applied.

Models and data

Areas for improvement

Transparency and clarity in reporting on models and data can enhance the understandability and credibility of scenario analysis outputs. Disclosure of the following can help contribute towards clarity on the role of models:

- Overview of type of scenarios (i.e. transition and other human intervention, climate change or climate impact scenarios), models and data;
- A clear description of the function, inputs, interaction with other models, outputs and any limitations of different models;
- If applicable, methodology, and potentially model(s) used to derive financial impact on the company;
- An illustration of the level of analysis, and the sources of the data;
- The approach chosen to address any model and data gaps.

Examples

On this and the following pages are five examples of good practices of reporting scenario models and data. To a varying extent, they include the following:

- Explanation of the model and dataset choice;
- Differences between models and some detail on the type of models;
- Details of different data sources (external and internal) and related sources;
- Limitations of models and steps taken to overcome these.

Aviva

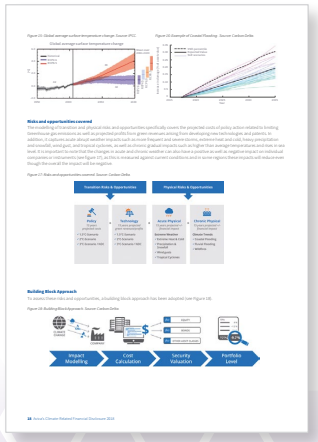
Aviva (2018) Aviva's Climate-Related Financial Disclosure 2018, pages 17, 18, 20, 21

Why this example is selected

Aviva's TCFD report provides a clear linkage between the in-scope scenarios, outputs and underlying models. After outlining four scenarios considered for its Climate VaR measure, Aviva outlines the model used (REMIND through Carbon Delta) and gives a high-level description of the model outputs, including financial metrics and some of the capabilities (i.e. consideration of socioeconomic pathways where population, economic growth, urbanisation and rate of technological development are considered). In a different section of the TCFD report, Aviva describes the methodology it applies to translate climate change effects to financial impacts, and the underlying limitations of the analysis.


Appendix: Climate VaR Modelling Approach

CARBON DELTA
the environmental fintech



Models and data

Citibank

Citigroup (2018) Finance for a Climate-Resilient Future – Citi's TCFD Report, page 11

Why this example is selected

In its TCFD Report, Citibank explains its review of different climate models considered for transition risk and the reasons for its choice of two integrated assessment models (IAMs), namely REMIND and MESSAGE, and the related model developers. There is clarity on the application of these models for Citibank's pilot objectives (coverage of the agricultural sector, 1.5°C scenario). Citibank notes the limitation of the chosen models for the purpose of financial analysis. It also gives a high-level description of the steps taken with the model developers to address these scenarios in order to select the most appropriate ones.

Unilever

Unilever (2018) Annual Report and Accounts 2018, page 34

Why this example is selected

Unilever's Annual Report has an example of a financial impact model. At a high level, it discloses the modelling steps used to derive the financial impact of climate change on one of its key commodities, soybean oil. Unilever indicates that the impact analysis is a pilot, and that it intends extending the analysis to palm oil and tea for which suitable climate change models will be available in 2019. In the narrative following the example shown, Unilever outlines results and aspects that were outside the scope (e.g. catastrophic events and policy responses). However, there is no disclosure or indication of any limitations of the methodology.

CNP Assurances

CNP (2018) Sustainable Investment Report, page 31

Why this example is selected

In its Sustainable Investment Report, CNP Assurances gives a high-level description of the database and methodology service providers used to calculate the physical risk exposure. This is an example of the type of high-level minimum disclosure that could be useful during the early stages of companies' reporting on scenario analysis.

Models and data

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ATP

ATP (2018) Responsibility Statement, page 29

Why this example is selected

ATP's Responsibility Statement describes the role and type of climate models used in modelling temperature rise under four Representative Concentration Pathways (RCP) scenarios. It considers the implications of climate change exposure on its five forest investments. ATP highlights the sources of data.

nomic pathways for a specific level of greenhouse gas concentrations. The RCP scenarios each represent one possible pathway for a specific concentration level.[4]

Structure of climate models

Modern climate models are highly complex and comprise an enormous variety of factors. This complexity is due to a desire to enable very accurate modelling of the Earth's climate and be able to describe geographical variations in many different scenarios. The greenhouse effect is one of the most important climate factors.

However, a climate model also has to include other impacts and factors to more accurately calculate changes in temperature. However, a climate model also has to include other impacts and factors such as cloudiness, snow and ice cover and a description of the global oceans to more accurately calculate changes in temperature. In addition, climate models also include descriptions of temperature, humidity, precipitation, atmospheric particles, ocean currents and many other factors. The various factors also interact, and these complex relationships must also be addressed in the climate model.

The most commonly used climate models, known as general circulation models, cover all these factors as accurately as possible.

The climate models can be used to examine the implications of external influences. These may be man-made changes in the atmospheric content of greenhouse gases. Different scenarios, for example the four RCP scenarios, can be used as input and serve as a starting point for greenhouse gas concentrations. It can also be examined how 'natural' impacts such as major volcanic eruptions may affect the climate. External influences, both man-made and natural, may give rise to positive or negative feedback mechanisms.

A more detailed description of the greenhouse effect and the modern climate models is provided in Appendix 3.

Future temperature increases in five of ATP's forest investments

Based on data from many of the climate models on which the Climate Panel has based its recent Assessment Report (AR5),[5] ATP has examined temperature increases in five forestry investments in the four different RCP scenarios.

The temperature increases were determined by calculating the average of all available data from the climate models via the CMIP5 database. Appendix 3 contains a complete list of the model data used in the calculations. The appendix also shows an example of the method used (specifically the forest in Queensland in RCP8.5).

The table shows the temperature increases in the four different RCP scenarios in the geographical locations of ATP's forest investments through ATP Timberland Invest K/S. Due to lack of historical data on forest temperatures, the temperature increase from 2006 to 2100 is shown and not for the period 1986-2005, which is the reference period commonly used in the Climate Panel's recent Assessment Report (AR5). The temperatures will rise in all four scenarios. The increase is most pronounced in RCP8.5, however.

The temperature increases show that the forests Northwoods, Wolf River and Upper Hudson are located in regions that are likely to see greater increases in temperature in the future and may even be more climate-sensitive regions than, say, the forest in Queensland, Australia. This confirms to ATP the relevance of including climate considerations when assessing forestry investment opportunities and our forest management.

4 The RCP scenarios are named after the level of radiative forcing that each scenario produces which is a measure of the total greenhouse effect in the scenario. Technically, radiative forcing describes how the balance between incoming solar energy and outgoing energy from Earth is altered. If radiative forcing is positive, it will lead to surplus energy on Earth and cause warming. In the RPC scenarios, the value is calculated as the change in Watts per square metre (W/m2) from 1750 to 2100. A more detailed review of the RCP scenarios is provided in Appendix 3.

5 Data from the international research programme "Coupled Model Intercomparison Project Phase 5" (CMIP5) which was used by the UN Climate Panel in its Fifth Assessment Report (AR5).

Responsibility 2018
29

INTEGRATION INTO BUSINESS DECISIONS

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SCENARIO OUTPUTS AND BUSINESS DECISIONS

Rationale for consideration

TCFD recommends that companies use scenario analysis with the objective to *"assist investors and other stakeholders in better understanding:*

- *the degree of robustness of the organisation's strategy and financial plans under different plausible future states of the world;*
- *how the organisation may be positioning itself to take advantage of opportunities and plans to mitigate or adapt to climate-related risks; and*
- *how the organisation is challenging itself to think strategically about longer-term climate related risks and opportunities".*

In applying scenario analysis, companies should consider general implications for their strategies, capital allocation, and costs and revenues, both at enterprise-wide level and at the level of specific regions and markets wherever material implications of climate change for the company are likely to arise. Financial sector companies should consider using scenario analysis to evaluate the potential impact of climate-related scenarios on individual assets, underwriting or lending activity when relevant, as well as to assess the resilience of their aggregated portfolios.

Scenario outputs and business decisions

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Summary of current reporting practices

Current reporting practices show very different levels of maturity. This is largely linked to the degree of uncertainty of climate change developments either on time horizons or in terms of the consequences on business models. Below are some observations on the state of reporting based on the sample of companies reviewed:

- Energy and material companies are most advanced when translating their scenario analyses into business decisions. The transition risk is material and a low degree scenario (2°C or lower) is most often referred to when using scenario analysis for business decisions.
- Consumer companies are at an early stage of translating scenario results into business planning even when their strategy already integrates strong environmental concerns.
- Financial sector companies provide information on their investment portfolios largely relying on external consulting support.

TCFD recommendations call for more in-depth analysis. But companies are struggling with developing integrated scenarios linking climate change (and potential mitigation/adaptation measures) with key economic/business metrics in a time horizon that is compatible with their financial and business planning. As a result, poor information is currently available on potential adaptation of business models and strategy under various climate change scenarios.

Preparer and user perspective

PREPARER PERSPECTIVE

From the report preparer's perspective, integration of scenario outputs into decisions and the corresponding disclosure of that integration is one major step in the scenario analysis process. It should ultimately help companies to better position themselves in a changing environment, including by influencing and informing stakeholders on companies' adaptation to climate-related risks and opportunities. However, given the current limitations and uncertainties around scenario analysis, companies may be cautious about taking strategic decisions based only on outputs of their scenario analysis models. Nevertheless, conducting scenario analysis is still a useful exercise to increase internal awareness. It may help frame strategic decisions by offering complementary information.

Regarding disclosure of strategic decisions taken based on scenario analysis, report preparers also have to weigh transparency against potential concerns about confidentiality and business sensitivity.

USER PERSPECTIVE

During the stakeholder outreach, users confirmed the importance of disclosing the linkage between scenario analysis outputs and companies' strategic decisions. For example, some users that cover the oil and gas sector highlighted the importance of disclosure on sanctioned investment projects.

Several users highlighted the current lack of transparency on decisions arising from scenario analysis outputs. Some considered this to be the biggest gap in current scenario reporting. They expected visibility of a feedback loop that shows how strategy affects scenario analysis and, where applicable, how scenario outputs lead to the re-orientation of the strategy and business model.

From the investor decision-making perspective, the translation of scenario outputs into investment decisions can be used differently depending on their analytical needs:

- When taking investment decisions, investors may want to better understand the positioning of companies in respect to climate risks and opportunities, and assess the impact on the companies' business models. The analysis and required reporting information can be sector-specific as it helps investors to perform sound analysis prior to their investment decisions.

- At portfolio monitoring level, where capital has been allocated across different sectors, investors seek more comparable information to assess the resilience of their entire portfolio in selected scenarios. In this context, sector-specific information may be too customised to allow for aggregation at portfolio level and is therefore only partially useful for portfolio monitoring.

In effect, investors are interested in having both sector-specific information and comparable information across sectors as they make investment decisions and monitor the risk of their portfolios.

The linkage between scenario analysis and strategic decisions is still at a preliminary stage. Furthermore, users may be waiting for more robust information before applying it to investment decisions and portfolio monitoring. Meeting investor expectations and their needs for better comparability may require additional scenarios, stress tests or sensitivity analyses.

Scenario outputs and business decisions

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Areas for improvement

Even in the most advanced reports, the translation of scenario results into business decisions seems to be at an early stage. This may be due to a lack of maturity or robustness of scenarios and the underpinning methodologies. It can also be that companies consider this information as too sensitive to be disclosed.

- Energy and material sectors companies: these companies are starting to disclose results of their scenario analyses, either in a qualitative or in a quantitative manner. Disclosures mostly intend to demonstrate the resilience of companies to climate change thanks to their positioning or decarbonisation path. Clear business decisions taken as a result of their scenario analyses are still missing.
- Consumer sector companies: some disclosures on how climate strategy is designed are available but there is no clear link between scenario outcomes and strategic decisions.
- Financial sector companies: even if extensive analysis is performed, links with strategy are not clearly stated. The most promising approaches in portfolio monitoring are: 1) the 'temperature' of the assets portfolio, which provides information on the alignment with a 2°C path, addressing the 'inside out' effect on climate change (i.e. companies' impact on the environment), and 2) stress tests assessing potential physical and transition losses a portfolio may face under different scenarios. The impacts of these results on business decisions are however missing at this stage. Investors that perform these analyses stress that these are currently more experimental than practical.

Examples

Two examples of good reporting practices are shown on this page.

Eni

Eni (2018) Path to Decarbonization report, page 23

Why this example is selected

Eni's climate change report provides a good explanation of the use of sensitivity analysis. The scenario used is mentioned, as well as the low impact on the business. To further improve the disclosure, a clear link between the results of the sensitivity analysis and decisions taken to (re-)position the assets portfolio and/or decide on new investments could be elaborated.

LOW CARBON OIL & GAS PORTFOLIO

-50%

$25 A BARREL

PORTFOLIO RESILIENCE

AXA

AXA (2019) 2019 Climate Report, page 19

Why this example is selected

AXA's Climate Report explains how the portfolio shows resilience to transition risk in line with the strategic analysis of 'green patents'. AXA also explains the strategy leading to lower physical risks in its real estate portfolio. The use of scenario results to decide on the portfolio positioning may be strengthened to clearly address the third TCFD recommendation on strategy, i.e. *"c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario".*

Green patents: a proxy to identify the "winners" of the energy transition?

Is future regulation likely to impose emissions reductions with the help of carbon pricing?

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QUANTIFICATION AND MONETISATION OF SCENARIO OUTPUTS

Rationale for consideration

TCFD's primary focus is to ensure that climate reporting by companies is useful to the institutional investor.

"The FSB Task Force on Climate-related Financial Disclosures (TCFD) will develop voluntary, consistent climate-related financial risk disclosures for use by companies in providing information to investors, lenders, insurers, and other stakeholders [...] The work and recommendations of the Task Force will help companies understand what financial markets want from disclosure in order to measure and respond to climate change risks and encourage firms to align their disclosures with investors' needs." (TCFD's mission)

For many investors, especially those allocating capital based on an analysis of companies' fundamentals, 'useful climate reporting' would include scenarios/sensitivity with inputs and outputs that are quantified and monetised (i.e. translated into financial impacts). Quantified scenario inputs and outputs can potentially help investors to normalise and compare information across similar companies.

The topic analyses on 'qualitative vs. quantitative scenarios' and 'assumptions' focus on the quantification of analytical choices and

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Quantification and monetisation of scenario outputs

scenario modelling inputs. The focus of the current topic analysis is on the quantification and monetisation of scenario analysis outputs. It is closely linked to the topic analysis on 'scenario outputs and business decisions' where it is noted that scenario outputs should translate into decisions.

Summary of current reporting practices

Of the reviewed companies, and as highlighted in the 'quantitative vs. qualitative scenarios' and 'assumptions' topics, very few quantify their scenarios. The few quantified scenarios are most often related to the business outlook/market development, but are rarely calculated specifically for the company itself.

Regarding the companies that provide company-specific approaches, scenarios are often performed as sensitivity analyses, where the company considers one quantified risk/opportunity factor at a time. The more advanced companies also monetise the potential impact on the company.

Preparer and user perspective

PREPARER PERSPECTIVE

During the stakeholder outreach, some report preparers indicated a trade-off between transparency and competition risks. Too detailed and prescriptive requirements for quantitative scenarios can be inappropriate for some situations, as they may raise confidentiality/competition issues. In some cases where confidentiality concerns exist a workaround for companies is that the information is provided at an aggregated level.

In some jurisdictions, the reporting of opportunities within scenario analysis may pose a problem that could potentially lead to litigation from users to whom it may not be clear that such opportunities may not necessarily be realised. The challenges of legal risk and confidentiality are also highlighted in the analyses of 'quantitative vs. qualitative scenarios', 'assumptions' and 'scenario outputs and business decisions'.

USER PERSPECTIVE

As noted in the analysis of 'qualitative vs. quantitative scenarios', some users consider quantified scenarios to be complementary to qualitative scenarios. However, during the stakeholder outreach, users also noted the insufficient quantification and lack of comparability of scenario analysis inputs and outputs. Some users expressed concerns about the use of scenarios with limited plausibility that are not comparable across companies or industries. This is particularly problematic when there is limited transparency on the underlying assumptions and no linkage made between the assumptions of companies' scenarios and those of the more well-known external reference scenarios.

Below are some of the user expectations expressed during the PTF-CRR outreach in respect to the reporting of scenario analysis outputs and impacts:

- Though visual illustrations of impact (e.g. different circle sizes and colour codes) can be informative, users find it difficult to apply this information when there is no accompanying quantitative data. Visual representations tend to be company-specific and incomparable across companies, and possibly even incomparable across reporting periods for the same company. Thus, graphics/visuals need to be supplemented with quantitative data to allow comparison.

- Some users emphasise the importance of, and expect, an alignment of the assumptions related to scenario analysis and to financial statement information. This is especially the case for those that are potentially related to risk outcomes. Moreover, existing International Financial Reporting Standards (IFRS) accounting standards already require that material risks be reflected in financial statements information. Assumptions where there could be an alignment between scenario and financial statements information include: impairment-related assumptions such as commodity price and discount rate projections; costs and liabilities due to physical risk exposure; provisions; and asset depreciation time horizon. Alignment would not be expected in all cases, especially as scenarios are neither a prediction of the future nor a projection of companies' specific exposure. Nevertheless, scenarios should reflect plausible outcomes and where appropriate, an alignment between scenario and financial statements information can also help users' assessment of companies' risk profiles (e.g. assessment of balance sheet resilience).

- Some users prefer scenario analysis outputs that consider the effects of multiple interacting variables at the same time, including adverse outcome factors, rather than only outputs derived from sensitivity analyses that consider the effects of a single factor at a time.

Areas for improvement

As noted earlier, scenario reporting is primarily qualitative and rarely quantitative, and monetisation of impacts is found even more rarely. In general, there is a need for more quantification and monetisation of both scenario inputs and outputs.

In many cases, non-quantified reports conclude that the potential impact is immaterial, which may be why the individual company chooses not to report the quantified and monetised impact. To contextualise unreported, immaterial impacts, it could be helpful for users to at least be made aware of the basis of companies' materiality assessment, including the materiality threshold applied. Transparency on companies' materiality threshold can enable users (investors) to better assess whether the potential impact of unreported quantified amounts is also immaterial for their analytical and investment decision-making purposes (e.g. where users normalise this information).

Currently, monetised scenarios are often based on sensitivity analysis, where one factor is quantified at a time, and then monetised. A scenario analysis that reflects the impact of the change in all factors at the same time would require consideration of possible correlations

Quantification and monetisation of scenario outputs

and interdependencies between the different factors. This is likely to be much more complex than a sensitivity analysis. It is also easier for companies' financial department personnel to focus on the calculation of impacts through sensitivity analysis within financial statements, as such reporting is based on IFRS requirements (IFRS 7 *Financial Instruments Disclosures*) (CDSB 2018).

There might be lessons to be drawn from the existing application of IFRS requirements for sensitivity analysis reporting in financial statements that could perhaps be extended to the reporting of scenario analysis outputs. For example, guidance for the reporting of scenario information, as called for by many respondents to the EU Non-Binding Guidelines (NBG) consultation, could facilitate the ability to provide related assurance and increase the likelihood of inclusion of quantified and monetised scenario outputs in the mainstream report, as recommended by the TCFD.

It is also worth noting that many companies are disclosing this information in special TCFD/climate reports, outside the mainstream reports, which could be minimising the review and application of this information by users. The reporting of monetised scenario outputs that include financial impacts is even more helpful if the information is included in the mainstream report. When this is the case, users can more easily make linkages between related information (e.g. on asset impairments), and it may also help mainstream investors to consider climate risk as a financial risk.

Finally, companies should consider the analytical challenges users face when scenario outputs are only represented by graphs and other visual illustrations but with no accompanying data tables that can facilitate comparative analyses. What can be helpful is a user-friendly presentation of scenario reporting information with related data presented in tables to enable users' easier access and comparative analyses (i.e. to compare similar data across companies). Where available, it is useful to have year-to-year comparative data to allow trend analysis.

Examples

On this and the following pages are examples from three companies that report on financial impact due to climate change, plus a mock-up example illustrating an approach to describing the impacts.

BHP Billiton

BHP Billiton (2015) Climate Change: Portfolio Analysis, pages 13-14

Why this example is selected

BHP Billiton's climate change report highlights the impact of a 2°C scenario on the commodity market and the financial impact on the company under these conditions. It also outlines the impact of what is described as a 'shock event':

Quantification and monetisation of scenario outputs

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Equinor

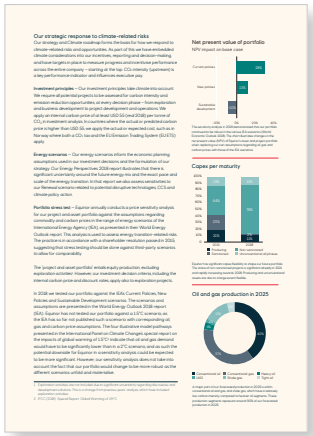
Equinor (2018) 2018 Sustainability Report, page 18

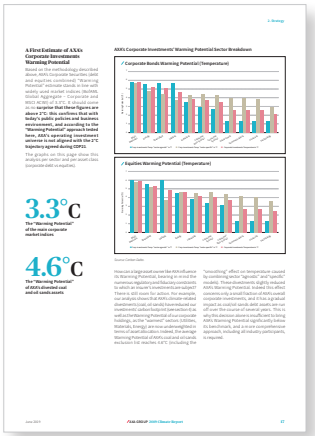
Equinor (2018) 2018 Annual Report and Form 20-F, page 84

Why this example is selected

Equinor's Sustainability Report provides an overview of what the Net Present Value (NPV) impact on the asset portfolio would be in the event of changes in policies and a change in oil and gas prices according to IEA's predictions for a 2°C scenario. Equinor also outlines an adverse impact scenario where there would be a decline in the value of its asset portfolio.

It is notable that Equinor's Annual Report (financial statements) contains an even more monetised and user-friendly stress test, where the company analyses its resilience towards changes in oil and gas prices and currency change. This approach is potentially more useful to investors, as Equinor indicates what the quantified change is, and what the assumed impact of that change would be. In this way, investors can normalise and aggregate the impact to portfolio level, and thereafter assess the risk-profile for the portfolio (i.e. investors can normalise if companies in the portfolio have disclosed similar scenario/stress testing).





AXA

AXA (2019) 2019 Climate Report, pages 17, 19, 24

Why this example is selected

AXA's Climate Report discloses the 'warming potentials' (also highlighted as an example in *Supplement 1: Climate-related reporting practices* - under 'Strategy' section) of its various investment strategies. The report also shows the net climate cost impact on allocated assets (i.e. revenues minus costs of climate). AXA also considers the potential impact of flooding and windstorms on the value of its real estate portfolio. The monetised overviews are in effect primarily based on sensitivity analysis tests that consider specific impacts.

Quantification and monetisation of scenario outputs

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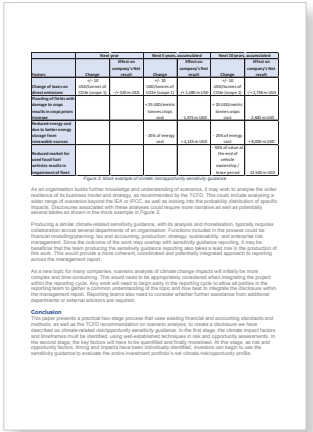
Mock-up example illustrating impacts

Jagd, J.T. (2018) How to make TCFD scenarios useful for investors – a short guide, Center for ESG Research & CDSB, pages 3, 5

Why this example is selected

Because good practice examples are typically from a limited range of companies – often related to oil and gas – the PTF-CRR wants to show how other preparers could provide useful TCFD scenarios. To do so, reference is made to the model from the short guide on TCFD scenario reporting prepared by the Center for ESG Research and CDSB. By using a relatively simple two-step model, the guide shows how companies can work with scenarios in a stress-test model, using this to provide useful TCFD reporting that is both quantified and monetised.

It should be pointed out that this kind of scenario analysis would require consideration of the likelihood of the risks. Companies would also need to assess whether the monetised impacts from the scenario analysis should be considered when making impairment assessments of assets, provisions, contingent liabilities. Risks that are unlikely to occur should not be reflected in balance sheet line items. See also IAS 36, IAS 37, and CDSB (2018).



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APPENDIX 1:

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APPENDIX 2:

ACRONYMS AND ABBREVIATIONS

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Acronyms and abbreviations

2°C	2° Celsius
ADEME	French Environment & Energy Management Agency
BNEF	Bloomberg New Energy Finance
IIRC	International Integrated Reporting Council
Cap (large-cap, mid-cap or small-cap)	Market capitalisation (large, medium or small)
C2ES	Centre for Climate and Energy Solutions
CDP	Formerly Carbon Disclosure Project
CDSB	Climate Disclosure Standards Board
COP21	21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC). See also *Paris Agreement* below.
CRR	Climate-related Reporting
EBRD	European Bank for Reconstruction and Development
E P&L	Environmental profit and loss account
ESG	Environmental, social and governance
European Lab	European Corporate Reporting Lab @EFRAG
European Lab SG	European Lab Steering Group
FSB	Financial Stability Board
G20	Group of Twenty nations
GeSI	Global e-Sustainability Initiative
GHG	Greenhouse gas
GICS	Global Industry Classification Standard
GRI	Global Reporting Initiative
I4CE	Institute for Climate Economics
IAMs	Integrated Assessment Models
IAS/IFRS	International Accounting Standards/International Financial Reporting Standards
IEA	International Energy Agency
IIGCC	Institutional Investors Group on Climate Change
IPCC	Intergovernmental Panel on Climate Change
KPI	Key Performance Indicator
MIT	Massachusetts Institute of Technology
NBGs	European Commission's non-binding guidelines on non-financial reporting
NFRD	Directive 2014/95/EU – the EU Non-Financial Reporting Directive
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
Paris Agreement	Paris Agreement under the United Nations Framework Convention on Climate Change (also called Paris Climate Agreement or COP21)
PRI	Principles for Responsible Investment (PRI)
PTF-CRR	European Lab Project Task Force on Climate-related Reporting
RCP	Representative Concentration Pathway
SASB	Sustainability Accounting Standards Board
SBT; SBTI	Science Based Targets; Science Based Targets Initiative
SDGs/UN SDGs	Sustainable Development Goals of the United Nations General Assembly
SDS	Sustainable Development Scenario
TCFD	Task Force on Climate-related Financial Disclosures
TRE	Thomson Reuters Eikon
UN	United Nations
UNGC	United Nations Global Compact
UNEP	United Nations Environment Programme
VaR	Value at Risk
WEM	World Energy Model

EXAMPLES

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Examples

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This section is included in the optimised for printing version of Supplement 2.

The interactive electronic version of Supplement 2 includes examples which can be viewed on-screen using the zoom out feature. This section includes a printable version of those same examples. The index below links the examples presented in printable format on the subsequent pages, to the respective sections of Supplement 2 where the specific examples are analysed.

Supplement 2 section	Company	Source document	Corresponding analysis found on Supplement 2:	Printable version found on Supplement 2:
GOVERNANCE/STRATEGY ON SCENARIOS				
Governance/strategy on scenarios	**Unilever**	*Unilever company presentation, page 9*	Page 10	Page 59
	BP	*BP (2018) Sustainability Report 2018, page 64*	Page 10	Page 60
		Annual report and Form 20-F 2018, page 9	Page 10	Page 61
	Eni	*Eni (2018) Path to Decarbonization report, page 4*	Page 10	Page 62
PARAMETERS AND ANALYTICAL CHOICES				
Quantitative vs. qualitative scenarios	**Société Générale**	*Société Générale (2019) Climate Disclosure – Société Générale's Task Force on Climate-related Financial Disclosures Report, page 23*	Page 14	Page 63
		Société Générale (2019) Climate Disclosure – Société Générale's Task Force on Climate-related Financial Disclosures Report, page 24	Page 14	Page 64
	Oil Search	*Oil Search (2017) Climate Change Resilience Report, page 20*	Page 14	Page 65
	Lendlease	*Lendlease (2019) Lendlease Annual Report 2019, page 54*	Page 14	Page 66

Examples

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Supplement 2 section	Company	Source document	Corresponding analysis found on Supplement 2:	Printable version found on Supplement 2:
PARAMETERS AND ANALYTICAL CHOICES (continued)				
Assumptions	**Citibank**	*Citigroup (2018) Finance for a Climate-Resilient Future – Citi's TCFD Report, page 16*	Page 17	Page 67
		Citigroup (2018) Finance for a Climate-Resilient Future – Citi's TCFD Report, page 13	Page 17	Page 68
		Citigroup (2018) Finance for a Climate-Resilient Future – Citi's TCFD Report, page 12	Page 17	Page 69
	Oil Search	*Oil Search (2017) Climate Change Resilience Report 2017, page 24*	Page 17	Page 70
		Oil Search (2017) Climate Change Resilience Report 2017, page 25	Page 17	Page 71
		Oil Search (2017) Climate Change Resilience Report 2017, page 34	Page 17	Page 72
	Arcelor Mittal	*Arcelor Mittal (2019) Climate Action Report 1, page 18*	Page 18	Page 73
		Arcelor Mittal (2019) Climate Action Report 1, page 19	Page 18	Page 74
	ATP	*ATP (2018) Responsibility Statement, page 78*	Page 18	Page 75
		ATP (2018) Responsibility Statement, page 79	Page 18	Page 76
Time horizon		*Cicero-Climate Finance, Climate Scenarios Demystified 2018, page 9*	Page 20	Page 77
	Rio Tinto	*Rio Tinto (2018) Our approach to climate change 2018, page 18*	Page 21	Page 78
		Rio Tinto (2018) Our approach to climate change 2018, page 23	Page 21	Page 79
	Société Générale	*Société Générale (2019) Climate Disclosure – Société Générale's Task Force on Climate-related Financial Disclosures Report, page 10*	Page 21	Page 80
		Société Générale (2019) Climate Disclosure – Société Générale's Task Force on Climate-related Financial Disclosures Report, page 11	Page 21	Page 81
		Société Générale (2019) Climate Disclosure – Société Générale's Task Force on Climate-related Financial Disclosures Report, page 20	Page 21	Page 82
	South32	*South32 (2018) Our Approach to Climate Change 2018, page 17*	Page 22	Page 83
	Aviva	*Aviva (2018) Aviva's Climate-Related Financial Disclosure 2018, page 17*	Page 22	Page 84
		Aviva (2018) Aviva's Climate-Related Financial Disclosure 2018, page 18	Page 22	Page 85

Examples

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Supplement 2 section	Company	Source document	Corresponding analysis found on Supplement 2:	Printable version found on Supplement 2:
PARAMETERS AND ANALYTICAL CHOICES (continued)				
Maturity assessment and scope	Citibank	*Citigroup (2018) Finance for a Climate-Resilient Future – Citi's TCFD Report, page 29*	Page 24	Page 86
	South32	*South32 (2018) Our Approach to Climate Change 2018, page 29*	Page 25	Page 87
	Rio Tinto	*Rio Tinto (2018) Our approach to climate change 2018, page 35*	Page 25	Page 88
	Oil Search	*Oil Search (2017) Climate Change Resilience Report 2017, page 21*	Page 25	Page 89
	Equinor	*Equinor (2018) 2018 Sustainability Report, page 18*	Page 26	Page 90
	CNP Assurances	*CNP (2018) 2018 Sustainable Investment Report, page 30*	Page 26	Page 91
SCENARIOS AND MODELS				
Scenario selection	EDP	*EDP (2018) Sustainability Report 2018, page 108*	Page 30	Page 92
	Galp	*Galp (2018). Galp Integrated Report 2018, page 34*	Page 30	Page 93
	Iberdrola	*Iberdrola (2018) Statement of Non-Financial Information. Sustainability Report 2018, page 61*	Page 30	Page 94
	Rio Tinto	*Rio Tinto (2018) Our approach to climate change 2018, pages 18-19*	Page 31	Page 95
	South32	*South32 (2018) Our Approach to Climate Change 2018, pages 23*	Page 31	Page 96
		South32 (2018) Our Approach to Climate Change 2018, page 29	Page 31	Page 97
		South32 (2018) Our Approach to Climate Change 2018, pages 36	Page 31	Page 98
Physical risk scenarios	South32	*South32 (2018) Our Approach to Climate Change 2018, page 37*	Page 33	Page 99
	Landsec	*Landsec (2019) Sustainability Performance and Data 2019, page 25*	Page 34	Page 100
		Landsec (2019) Sustainability Performance and Data 2019, page 28	Page 34	Page 101
		Landsec (2019) Sustainability Performance and Data 2019, page 29	Page 34	Page 102
		Landsec (2019) Sustainability Performance and Data 2019, page 29	Page 34	Page 103
	Commonwealth Bank of Australia	*Commonwealth Bank of Australia (2019) 2019 Annual Report, page 56*	Page 35	Page 104
		Commonwealth Bank of Australia (2019) 2019 Annual Report, page 59	Page 35	Page 105
		Commonwealth Bank of Australia (2019) 2019 Annual Report, page 60	Page 35	Page 106
		Commonwealth Bank of Australia (2018) Annual Report 2018, page 53	Page 35	Page 107
		Commonwealth Bank of Australia (2018) Annual Report 2018, page 54	Page 35	Page 108

Examples

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Supplement 2 section	Company	Source document	Corresponding analysis found on Supplement 2:	Printable version found on Supplement 2:
SCENARIOS AND MODELS (continued)				
Models and data	**Aviva**	*Aviva (2018) Aviva's Climate-Related Financial Disclosure 2018, page 17*	Page 38	Page 109
		Aviva (2018) Aviva's Climate-Related Financial Disclosure 2018, pages 18	Page 38	Page 110
		Aviva (2018) Aviva's Climate-Related Financial Disclosure 2018, page 20	Page 38	Page 111
		Aviva (2018) Aviva's Climate-Related Financial Disclosure 2018, page 21	Page 38	Page 112
	Citibank	*Citigroup (2018) Finance for a Climate-Resilient Future – Citi's TCFD Report, page 11*	Page 39	Page 113
	Unilever	*Unilever (2018) Annual Report and Accounts 2018, page 34*	Page 39	Page 114
	CNP Assurances	*CNP (2018) Sustainable Investment Report, page 31*	Page 39	Page 115
	ATP	*ATP (2018) Responsibility Statement, page 29*	Page 40	Page 116
INTEGRATION INTO BUSINESS DECISIONS				
Scenario outputs and business decisions	**Eni**	*Eni (2018) Path to Decarbonization report, page 23*	Page 44	Page 117
	AXA	*AXA (2019) 2019 Climate Report, page 19*	Page 44	Page 118
Quantification and monetisation of scenario outputs	**BHP Billiton**	*BHP Billiton (2015) Climate Change: Portfolio Analysis, page 13*	Page 47	Page 119
		BHP Billiton (2015) Climate Change: Portfolio Analysis, page 14	Page 47	Page 120
	Equinor	*Equinor (2018) 2018 Sustainability Report, page 18*	Page 48	Page 121
		Equinor (2018) 2018 Annual Report and Form 20-F, page 84	Page 48	Page 122
	AXA	*AXA (2019) 2019 Climate Report, page 17*	Page 48	Page 123
		AXA (2019) 2019 Climate Report, page 19	Page 48	Page 124
		AXA (2019) 2019 Climate Report, page 24	Page 48	Page 125
	Mock-up example illustrating impacts	*Jagd, J.T. (2018) How to make TCFD scenarios useful for investors – a short guide, Center for ESG Research & CDSB, page 3*	Page 49	Page 126
		Jagd, J.T. (2018) How to make TCFD scenarios useful for investors – a short guide, Center for ESG Research & CDSB, page 5	Page 49	Page 127

USING THE RESULTS OF OUR SCENARIO ANALYSIS

Presenting the financial impact of long-term risks, such as climate change, draws attention to it as a priority. This has allowed senior management to assess materiality, compare to other issues and determine how much resource to use in addressing the issue, i.e. it contributes to the overall business case and confirmed we are doing the right thing. Our analysis showed that, without action, both scenarios present financial risks to Unilever by 2030, predominantly due to increased costs in our supply chain where costs of raw materials and packaging would rise.

We also found that the development of climate models and scientific research around climate change is still evolving and progressing, therefore we need to continue to update our models as the science progresses to make them as decision-useful as possible.

PHASE TWO – DEEP DIVE ON SOY

The results of our scenario analysis confirmed the importance of doing further work to ensure that we have action plans in place to help mitigate the risks of climate change and to prepare the business for the future environment in which we will operate.

We knew that the biggest impacts would be in our supply chain so we decided to focus on our largest ingredients. We piloted an analysis for soy first, as it is one of our most important ingredients, it is a high-profile crop in the countries where it is grown and has good availability of historical price data and suitable climate models.

HOW

We performed thorough data availability and robustness scans before starting the work, to ensure we were minimizing uncertainty in the data, whilst simplifying the process as much as possible. Once we had collated the external and internal data sets we wanted to use, we had visibility over our data gaps and we agreed assumptions that would help to cover these.

The pilot model we developed used the direct risks from climate change to the price of soybean oil, such as change in yield and change in supply. Three steps were performed:

1. We estimated future yields by analysing external agricultural and climate models in key growing regions.
2. We estimated the impact on future prices of soy as a result of climate-related yield changes.
3. The future yields and price impacts were then used to calculate the estimated financial impact from climate change for our business, based on our forecast purchasing volumes.

The model was built in such a way that it could be used to analyse other ingredients.

NEXT STEPS

At the time of writing, we have completed our business level analysis and our deep dive on soy and incorporated it into our disclosures in our Annual Report and Accounts 2018. The next step is for us to model the impacts of climate change against two of our other key ingredients, tea and palm oil.

We will continue to refine the approach, with a focus on delivering insight for the decision makers throughout our organization. As we refine the work, we expect to find it easier to complete the analyses and have more fluency with internal resources.

We will continue to work on how best to facilitate discussions on TCFD and scenario analysis within the business to get the full value from this approach.

Board oversight

Our board is responsible for the overall conduct of the group's business.

BP's board of directors reviews and monitors performance against our long-term strategy and confirms that the processes for identifying and managing key risks – both financial and non-financial – are in place.

We identify risks for particular oversight by the board and its committees each year. In 2018 these were financial liquidity; geopolitical risk; cyber security; process safety, personal safety and environmental risks; security; ethical misconduct; legal and regulatory non-compliance; and trading non-compliance.

The oversight and management of other risks, for example technological change, is undertaken in the normal course of business and in the executive team, the board and relevant committees.

The safety, ethics and environment assurance committee, one of our six board committees, looks at the processes that BP's executive team use to identify and mitigate operational and non-financial risk.

Climate governance

BP's governance framework applies equally to the management of the various aspects of climate change and the transition to a lower carbon economy. In addition to the oversight provided by the executive team, the board and relevant committees, various groups and committees in BP bring together cross-segment and cross-functional expertise of relevance to this area, including those set out below.

BP governance framework
See *bp.com/annualreport*.

↑

Renewal committee
Reviews strategic, commercial and investment decisions outside of core activity and related to new lines of business. Chaired by our deputy chief executive.

New energy frontiers steering committee
Oversees strategy and development of growth opportunities in low carbon business models that can be scaled up to create new businesses for BP. Chaired by our deputy chief executive.

Carbon steering group
Focuses on strategy, policy, performance oversight and collaboration relating to carbon management activities across the group. Chaired by our vice president of carbon management.

Upstream carbon steering committee
Focuses on the delivery of lower carbon plans in the Upstream. Chaired by our chief operating officer of production, transformation and carbon, Upstream.

Downstream advancing the energy transition committee
Develops and drives the implementation of advancing the energy transition in the Downstream. Chaired by our head of technology, Downstream and BP chief scientist.

Executive-level committee Cross-functional committee Business and segment committee

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The changing energy mix

The *BP Energy Outlook* explores the forces shaping the global energy transition out to 2040 and the key uncertainties surrounding that transition. We use the scenarios in the Outlook together with a range of other analysis and information when forming our long-term strategy.

The demand for energy is set to increase significantly – growing economies need energy to support their industry and infrastructure. In all the scenarios considered, world GDP more than doubles by 2040 driven by increasing prosperity in fast-growing developing economies.

In the evolving transition scenario, this improvement in living standards causes energy demand to increase by a third by 2040, driven mainly by India, China and other developing Asian economies. The rate of growth however is slower than in the previous 20 years, as the world increasingly learns to produce more with less energy. Despite this, a substantial proportion of the world's population in 2040 could live in countries where the average energy consumption per person is relatively low.

At the same time, the energy mix is changing as technology advances, consumer preferences shift and policy measures evolve. Renewables are now the fastest-growing energy source in the world today and in our evolving transition scenario we estimate that they could account for 15% of all energy consumption in 2040 – and in other scenarios more.

Energy consumption – 2040 projections

1 Evolving transition

- World energy demand increases by one third from 2017 to 2040.
- CO_2 emissions from energy use increase by 7% by 2040.
- Oil and gas account for more than half of global energy in 2040.

2 Rapid transition

- Oil demand in 2040 decreases by 14Mb/d. Biofuels grow by 4Mb/d.
- CO_2 emissions from energy use decline by around 45% by 2040.
- Global energy consumption grows by around one fifth.

That said, oil and gas could meet at least 50% of the world's energy needs in 2040 – even in a scenario consistent with the Paris goals, with the share of gas growing aided by increasing use of carbon capture, use and storage.

Gas offers a cleaner alternative to coal for power generation and can lower emissions at scale. It also provides a valuable partner for renewables intermittency, delivers heating at the high temperatures required by industry and is increasingly used in transportation. Across our scenarios, gas grows robustly, overtaking coal as the second-largest source of energy by 2030.

Oil demand grows for the next 10 years in our evolving transition scenario, before gradually leveling out due to factors such as accelerating gains in vehicle efficiency and greater use of biofuels, natural gas and electricity. The largest source of oil demand growth is the non-combusted use of oil, for example as a feedstock for petrochemicals.

1 Evolving transition
This scenario assumes that government policies, technology and social preferences continue to evolve in a manner and speed seen over the recent past.

2 Rapid transition
This scenario is consistent with the Paris goals, and is broadly similar to the reduction in carbon emissions in the IEA's Sustainable Development Scenario.

More information

BP Energy Outlook
See bp.com/energyoutlook for more information on our projections of future energy trends and factors that could affect them out to 2040.

BP Technology Outlook
See bp.com/technologyoutlook for information on how technology could influence the way we meet the energy challenge into the future.

CLIMATE GOVERNANCE

ROLE OF THE BOARD OF DIRECTORS AND BOARD'S COMMITTEES

ON THE SUBJECT OF CLIMATE CHANGE, THE BOARD OF DIRECTORS IS SUPPORTED MAINLY BY THREE COMMITTEES OF DIRECTORS: SUSTAINABILITY AND SCENARIOS COMMITTEE, CONTROL AND RISK COMMITTEE AND REMUNERATION COMMITTEE

The **Board of Directors**[1] (BoD) **plays a central role in managing the main aspects linked to climate change**. In particular, on the proposal of the Chief Executive Officer (CEO), the Board of Directors examines and/or approves:

- → Objectives related to climate change and energy transition, as an integral part of business strategies;
- → The "**GHG Action Plan**" with investments to meet emission reduction targets by 2025;
- → The portfolio of **Eni's top risk**, including climate change;
- → The **Short Term Incentive Plan** with targets related to the reduction of GHG emissions for CEO and managers with strategic responsibilities[2];
- → **Annual sustainability results**, including the sustainability report (**Eni for**) and the **HSE review**, including climate change performances;
- → **Institutional reporting**, including the Interim Consolidated Report and the Annual Financial Report (including the Consolidated Disclosure of Non-Financial information);
- → The relevant projects and their progress, on a half-year basis, **with sensitivity to Eni and IEA SDS carbon pricing**[3];
- → **Resilience test** on all upstream Cash Generating Units (CGUs) applying the IEA SDS scenario;
- → **Strategic agreements**, including climate change-related initiatives.

SUSTAINABILITY AND SCENARIOS COMMITTEE (SSC) (SET UP IN 2014)	It addresses the integration among strategy, evolution scenarios and business sustainability over the medium to long term and examines the scenario for preparing the Strategic Plan. During 2018, the SSC discussed in detail climate change issues at all meetings, including the decarbonization strategy, energy scenarios, renewable energies, research and development to support the energy transition, climate partnerships and water resources and biodiversity issues[4].
CONTROL AND RISK COMMITTEE (CRC)	It supports the BoD in the quarterly review of the main risks, including climate change.
REMUNERATION COMMITTEE	It proposes to the BoD the general criteria for the annual incentive of the CEO and managers with strategic responsibilities, which include specific objectives associated with the reduction of GHG emissions.

ADVISORY BOARD ESTABLISHED IN 2017

Since the second half of 2017, for an even broader view of the factors affecting value creation in the long term, the BoD has set up an **Advisory Board** to support it and Eni's CEO. Composed of international experts[5], it further strengthens the monitoring of long-term trends in energy markets, geopolitics, innovation, energy transition and the decarbonization process.

The Board has assigned a **central role in the internal control system to the Chairman**, in particular with regard to presiding over the Internal Audit function. The chosen model establishes a clear separation between the functions of Chairman and Chief Executive Officer. In 2018, Eni also contributed to the "Climate Governance"[6] initiative of the World Economic Forum (WEF), with the involvement of the Eni BoD through its Chairman. During 2018, following up on the **training initiatives for the Board of Directors** on these issues in recent years, ongoing training sessions were held through visits to laboratories of upstream and renewables operational areas and to the Zohr plant in Egypt on the occasion of the Board meeting held abroad. In addition, the meetings of the Sustainability and Scenarios Committee include regular in-depth training sessions by external experts on climate change.

FOR MORE DETAILS ON ENI'S GOVERNANCE SEE PP. 10-11 OF "ENI FOR 2018 - SUSTAINABILITY REPORT"

1) Board of Directors: https://www.eni.com/en_IT/company/governance/board-of-directors.page To learn more about Eni's organisational structure, please refer to the section "Company" of the corporate website (www.eni.com) and to the Corporate Governance Report.
2) Managers with strategic responsibilities: Managers reporting directly to Eni's Chief Executive Officer and Chairman of the Board.
3) Sustainable Development Scenario (SDS) from the World Energy Outlook 2017 of the International Energy Agency (IEA).
4) For more information, please refer to the section "Sustainability and Scenarios Committee" in the 2018 Corporate Governance Report.
5) Chair: Fabrizio Pagani. Members: Christiana Figueres; Ian Bremmer; Phillip Lambert and Davide Tabarelli.
6) The initiative aims to raise the Boards' level of awareness of climate-related issues, also following the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD).

4.2. Focus: climate-related transition risk methodology

The approach adopted to measure the additional credit risk due to the transition risk corresponds to a "climate vulnerability" indicator defined during the annual renewal of internal ratings. The quantification method is inspired by that developed by the United Nations Environment Programme Finance Initiative (UNEP-FI)[18], to which Societe Generale has contributed alongside 15 international banks.

4.2.1 Approach

The diagram below offers an overview of the approach Societe Generale will adopt for measuring transition risks. In a nutshell, this approach aims to assess transition risks by quantifying the marginal impact of a 2°C scenario on the credit rating of a representative sample of borrowers for a set of priority sectors, under the assumption that the borrower does not adapt to this 2°C scenario. Results from the sample are extended to the sector which allows to quantify the Expected Loss.

Figure 1: Approach for assessing transition risks on the credit portfolio

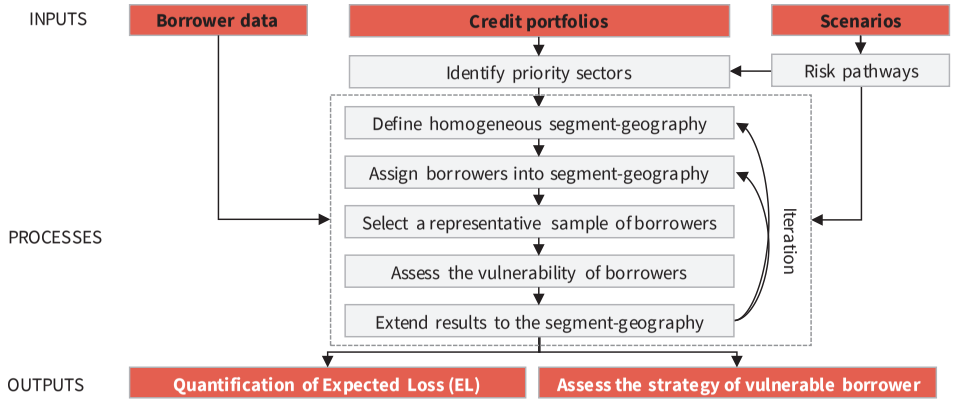
	Define climate scenarios	Assess borrower impact	Assess portolio impact
Objectives	**Define relevant and plausible climate scenarios and identify key risk drivers**	**Assess the marginal impact of the scenario's variables on the credit rating of a representative sample of borrowers**	**The vulnerability of borrowers can be translated into the quantified impact of expected losses on the credit portfolio**
Activities	-Identify priority sectors -Review and understand the range of published scenarios that exist -Define scenarios appropriate to our portfolio -Identify quantifiable risk factor pathways showing how scenarios affect sector performance	-Define homogeneous segments/geography within the sectors -Allocate borrowers into each segment/geography -Identify representative borrowers -Assess the marginal impact of the scenario's variables on the financial and PD TTC of these borrowers	-Extend the results of the sample to the sector or segment/geography -Quantify the Expected Loss on the portfolio for the priority sectors -For vulnerable borrowers, formalize an opinion on adaptation strategy

[18] UNEP-FI (2018) Extending our horizons: http://www.unepfi.org/news/themes/climate-change/extending-our-horizons/

4.2.2 Methodology

The diagram below offers an illustrative summary of the methodology, with each step detailed below.

Figure 5: Methodology for assessing transition risks on the credit portfolio



1. **Identify priority sectors**: Given Societe Generale's exposure, the sectors affected by the transition risk identified as priorities include: Oil & Gas, Power Utilities, Metals & Mining, Transportation (including Automotive, Shipping, Airlines). This selection was limited to sectors for which climate scenarios data was available.
2. **Choice of climate scenarios**: Climate scenarios are selected and provide a coherent framework for formalizing the reasoning on possible futures reflecting the effects of policy measures to limit global warming below a certain threshold. The scenario focuses on clarifying the evolution of certain variables (e.g. carbon tax, investments in new technologies, changes in energy prices) which are detailed at the level of each activity sector in an associated geographical area.
3. **Risk factor pathways**: In a second stage, Societe Generale identifies quantifiable risk factor pathways showing how scenarios affect sector performance. These risks factors pathways offer a view on how a given sector's revenue, cost and capital expenditure could be impact:
    - Incremental emissions costs: impact of carbon price on the sector's direct and indirect emissions relative to baseline.
    - Incremental revenue: impact of changes in prices and demand for goods and services relative to baseline.
    - Incremental capital expenditure: Additional capital expenditure borne by the sector to transition to a low carbon economy.
4. **Define homogeneous segments-geographies**: The sectors are then segmented into homogeneous groups. Homogeneity is defined by experts in relation to the main transition risk factors given by the scenario based on objective sectoral and regional criteria (e.g. energy mix for electricity producers, US and EU utility regulatory differences). For that step, complementary corporate and sector data is necessary.
5. **Assign borrowers into segments-geographies**: Most borrowers in the most exposed sectors are then assigned into a segment-geography. Here again, corporate data is necessary to conduct this allocation.
6. **Select a representative sample of borrowers**: Key representative borrower, based on size, business model, or simply corporates for which data is easily available are sampled from each segment-geography.

CLIMATE SCENARIO ANALYSIS

Climate scenario analysis forms an important part of Oil Search's risk assessment, strategy development and decision-making processes.

Scenario analysis is not forecasting. Scenarios are hypothetical constructs that examine different climate scenarios and help us to test the financial resilience of our assets against a range of possible outcomes. Analysing factors that are different to our reference case, such as aggressive technology or regulatory changes, contributes a range of different insights for the Company to consider.

CLIMATE SCENARIO ANALYSIS METHODOLOGY

Using a robust scenario analysis approach, Oil Search chose an external third party, Wood Mackenzie, to provide the necessary supply data and price forecasts, building on the demand projections from the published scenarios (Figure 3). Independent published climate scenarios were selected so that underlying assumptions and data are accessible, transparent and comparable. As recommended by the TCFD[6], the scenarios selected reflect a wide range of possible climate change outcomes:

- **IEA New Policies Scenario (IEA NP):** Reflects announced government policies (including 2015 Paris pledges)[7].
- **IEA 450 Scenario (IEA 2°C):** IEA's 2-degree Celsius scenario[8].
- **Greenpeace Advance Energy [R]evolution Scenario (GP AER):** Complete decarbonisation scenario (~1.5°C)[9].

Using the oil and gas demand projections provided by these scenarios, Wood Mackenzie developed oil and gas supply projections and used them to calculate oil and gas price forecasts for each climate change scenario.

Oil Search then applied these price forecasts to generate LNG contract price forecasts as inputs into our economic models to evaluate the potential impact on asset Net Present Value (NPV) (Figure 4). The NPV impact for each scenario was then compared with the current base and low economic models that Oil Search uses to evaluate the resilience of Oil Search investments and expansion projects. Resilience was further assessed by evaluating our LNG Expansion Project

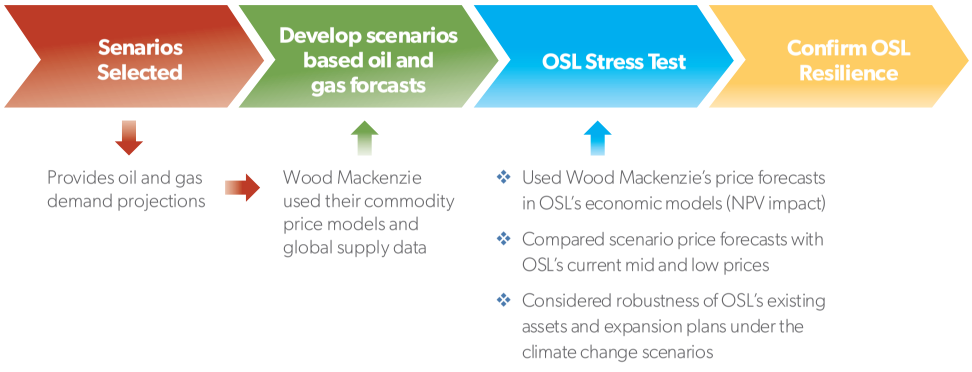


Figure 3: Climate scenario analysis methodology applied by Oil Search in 2017

6 www.fsb-tcfd.org/publications/final-implementing-tcfd-recommendations/
7 www.iea.org/bookshop/720-World_Energy_Outlook_2016
8 www.iea.org/bookshop/720-World_Energy_Outlook_2016
9 www.greenpeace.org/archive-international/en/publications/Campaign-reports/Climate-Reports/Energy-Revolution-2015/

Sustainability

Climate-related risk

- Task Force on Climate-related Financial Disclosure (TCFD) aligned summary of our current and future climate-related disclosures.

	Where we are today	Priorities to 2021
Governance	• Board oversight: engagement through Sustainability Committee three times per year • Management's role: engagement through Quarterly Business Review (QBR) processes • Working committees: TCFD Steering Committee and Global Sustainability Leadership Team updates	• Continue to strengthen and improve climate risk governance
Strategy	• Updated Sustainability Framework • Four Lendlease climate scenarios created for scenario planning (see below)	• Stress test business strategies using four climate scenarios • Identify risks and opportunities for each scenario • Set metrics and targets relevant to business outcomes • Engage with stakeholders across our value chain
Risk management	• Climate-related risks integrated into Risk Committee • Climate-related risks integrated into Group Risk Appetite Framework • Acute physical risk analysis undertaken across portfolios • Shadow price on carbon integrated into Investment Committee investment decisions – $20USD/Tonne in 2020, rising to $100USD/Tonne in 2030 and $140USD/Tonne by 2040	• Continue to integrate climate-related risks into our Risk Management Framework • Continue analysis of physical and transitional supply chain and market risks • Disclosure of climate-related financial impacts
Metrics and targets	• In 2014, we set 20% by 2020 targets for energy, water and waste on an intensity basis. We disclose our annual scope 1 and 2 carbon emissions on our website In FY20, we will embark on a process to co-design the new beyond 2020 metrics and targets with each of our businesses. The targets will be related to our new Sustainability Framework and informed by our TCFD scenario planning activities. **15%**[1] Reduction in emissions intensity in FY18 from FY14 — Our investment management business has reduced gross carbon emissions over the last five years whilst increasing floor area. The result is a 15 per cent reduction in emissions intensity on emissions per floor area.	**27%**[2] Increase in gross emissions in FY18 from FY14 — Our construction business has seen an increase in gross carbon emissions in FY18. The increase in emissions can be attributed to increased construction activity in general as well as an increase in tunnelling activities.
Lendlease climate scenarios	Our climate scenarios have been created to test our business strategies, align with our Sustainability Framework, respond to key trends and our vision to create the best places. Details of the references and models that were used to create our scenarios will be made available on our website together with how we see each scenario playing out over the coming decades. >4°C **Resignation** — Resources and efforts solely focused on adaptation and survival 3-4°C **Polarisation** — National self-interest prioritises local adaptation over multi-lateral action 2-3°C **Paris alignment** — Multi-lateral government climate regulation from the Paris Agreement <2°C **Transformation** — Collective self-limitation and sharing of resources enable a just zero transition	

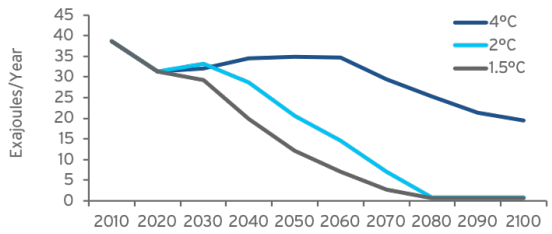
1. Overall reported reduction in intensity for all Assets undermanagement globally. **2.** Gross increase in reported emissions for all Construction Projects and auxiliary offices globally.

Key Scenario Assumptions

Citi's oil & gas transition scenario analysis also relied on the assumptions and outputs of the REMIND model's CD-LINKS 1.5°C and 2°C scenarios, which we described earlier. However, the scenario assumptions that are important to consider when evaluating the results of a portfolio-level risk analysis for the oil & gas sector are different than those for the utilities sector or have different implications for the oil & gas sector:

1. In the scenarios, oil & gas serve as short-term substitute fuels as the world quickly transitions away from coal. In addition, demand for transportation grows rapidly and oil is assumed to remain an important transport fuel that is not easily substituted in the short-term. Consequently, under the 2°C scenario, U.S. oil demand increases between 2020 and 2030 and first starts to fall between 2030 and 2040. Even in a 1.5°C scenario, oil demand remains relatively robust and does not fall sharply until after 2030.

U.S. Oil Demand



Source: Potsdam Institute for Climate Impact Research

2. The scenarios assume that carbon capture and storage (CCS) technologies become commercially viable, available and in use after 2030 to mitigate fossil fuel emissions. One consequence of this assumption is that demand for fossil fuels declines more slowly than would be the case without the successful development of such technologies. As we noted earlier, this assumption requires rapid acceleration in CCS technology development, beyond what is feasible today.

3. The scenarios assume that the spot price of oil & gas remains robust and even increases in 2030 and 2040 in most of the scenarios analyzed, with the exception of natural gas in the 2030 timeframe under a 1.5°C scenario as compared to the possible price in 2020.

Oil historical and scenario projected U.S. spot price (2010 USD / BBOE)

	2010	2020	2030	2040
4°C (baseline)	$60.60	$71.56	$84.74	$93.06
2°C	$60.60	$71.56	$83.87	$88.86
1.5°C	$60.60	$71.56	$77.82	$79.40

Natural gas historical and scenario projected U.S. spot price (2010 USD / MMBTU)

	2010	2020	2030	2040
4°C (baseline)	$6.56	$7.16	$7.77	$8.39
2°C	$6.56	$7.16	$7.32	$7.39
1.5°C	$6.56	$7.16	$7.11	$7.22

Source: Potsdam Institute for Climate Impact Research

Citi did not independently analyze the potential viability of the assumptions under the REMIND model's scenarios. We note only that the projected futures in these scenarios are a limited set of the countless possibilities of how the future of energy demand and prices may evolve.

Findings

In applying the REMIND CD-LINKS 2°C scenario and the UNEP FI pilot methodology to calculate the change in scenario-implied probability of default from transition risk, Citi estimates that the impacts to our North American E&P portfolio would be limited in 2030 and 2040. These results are driven by the model scenario assumptions. Climate transition scenarios, such as the ones we used for our analysis, generally assume an orderly low-carbon transition to minimize disruptions to the economy.

Utilities Transition Scenario Analysis

Citi's pilot transition risk analysis for the utilities sector included 39 companies in the U.S. covered by the U.S. Power Sector team. These companies included both regulated utilities and independent power producers, representing approximately $10 billion in exposure as of December 2017 and 30% of our global exposure to the power sector.

Consistent with the approach recommended in the UNEP FI pilot, we divided our U.S. utilities portfolio into four segments based on whether they are regulated or not and the carbon intensity of their generation assets:

- **Regulated Heavy Carbon**: primarily regulated utilities with significant generation assets for whom fossil fuel generation represents greater than half of their generation portfolio
- **Regulated Low Carbon**: primarily transmission & distribution companies with low fossil fuel generation
- **Unregulated Heavy Carbon**: primarily independent power generation companies with significant fossil fuel generation, including significant coal-fired generation or peak gas-fired assets
- **Unregulated Low Carbon**: primarily independent power generation companies with significant renewable energy or efficient gas-fired assets

Approximately 75% of Citi's exposure in the U.S. utilities portfolio is to regulated utilities, and approximately 60% of Citi's exposure in this portfolio is to heavy carbon companies.

As explained in more detail below, the scenario analysis suggests greater impacts on the utility sector than on the oil & gas sector. The REMIND model's CD-LINKS scenarios use a global carbon price, which is assumed to be paid by the companies that use fossil fuels and emit greenhouse gases. Accordingly, under the scenarios, utilities are directly impacted by the price of carbon, whereas oil & gas producers are indirectly impacted through the reduction in fossil fuel demand caused by carbon prices. Utilities would face the choice of making capital expenditures to generate less carbon or absorb losses from carbon pricing, which increases over time. These impacts are likely to have the most significant negative effect on utilities in the Unregulated Heavy Carbon segment, with higher carbon intensity and less ability to pass along the new costs to customers.

Key Scenario Assumptions

Citi's scenario analyses relied on the assumptions and outputs of the REMIND model's CD-LINKS 1.5°C and 2°C scenarios. There are a few assumptions in the REMIND CD-LINKS 1.5°C and 2°C scenarios that were key drivers of results in our portfolio-level risk analysis for the utilities sector:

1. The scenarios assume a global carbon price will be implemented to reduce carbon emissions. In the 2°C scenario, there is a global carbon price per ton of carbon dioxide of $68 (2010 USD) in 2030 that increases to $111 in 2040. In the 1.5°C scenario, the global carbon price is even higher, at $117 in 2030 and $190 in 2040. This assumption adds to the operating costs of utilities, particularly in the Heavy Carbon segments. Utilities can reduce some of the costs from a carbon price by investing in capital expenditures for renewable generation and other low-carbon technologies.

2. The scenarios assume that carbon capture and storage (CCS) technologies will become commercially viable, available and in use after 2030 to mitigate fossil fuel emissions. For utilities that continue to be reliant on fossil fuel generation, are able to withstand the net income erosion until such technologies become available and have the financial strength or regulatory support to afford the acquisition of such technologies, this assumption helps to lower direct emissions costs due to a carbon price. Citi recognizes that this assumption requires rapid acceleration in CCS technology development, beyond what is feasible today.

3. The scenarios assume that electricity prices will increase due to growing adoption of electric vehicles and greater electrification of the transport sector, which drive up demand for electricity. This assumption benefits utilities in both the Regulated and Unregulated segments by increasing revenues.

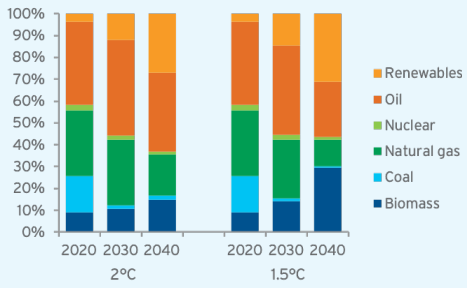
Socio-economics

- Population peaks at 9.5 billion people in 2070
- GDP continues to grow, with average global income increasing by a factor of 6 by 2100
- Developing countries achieve significant economic growth, reaching current OECD average income levels in the second half of the century

Energy

- Use of fossil fuels continues throughout the century, although at declining rates, with the exception of coal, which rapidly declines to under 2% of the total energy mix by 2030
- Oil demand remains steady through 2030 due to growing demand for liquid fuels in the transport sector, whose growth does not peak until 2035 in the 2°C scenario and 2030 in the 1.5°C scenario
- Reverse emissions technologies and carbon sequestration through land use are critical in mitigating the cost of carbon and reducing emissions
- Use of renewable energy increases, accelerating rapidly after 2030 through transmission, distribution and storage investments
- Biofuels see demand increases, particularly in the second half of the century

U.S. Primary Energy Mix

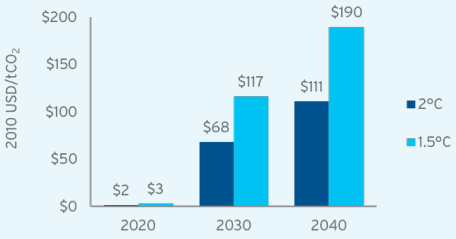


Source: Potsdam Institute for Climate Impact Research

Policy

- A global carbon price implemented after 2020 is the sole policy instrument for transition risk in the energy end-use sectors
- The given carbon price is assumed to be the same across all regions, though regions have differing economic responses to prices

Global Carbon Price



Source: Potsdam Institute for Climate Impact Research

SCENARIO INSIGHTS

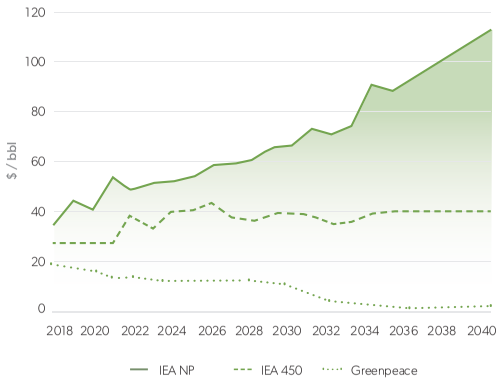
- LNG demand grows under all three scenarios.
- Oil demand remains robust enough to encourage development of new supplies under the IEA scenarios.
- There is a large range and variability across the scenarios in terms of possible oil prices (US$5/bbl - US$115/bbl).
- Peak oil and gas demand does not occur before 2040 under IEA NP.

Across the three scenarios, gas is less impacted than oil, particularly in non-OECD driven Asian markets. This outcome is driven by the role of gas as a transition fuel for a low-carbon future. Based on Wood Mackenzie's analysis, gas prices are positioned for growth under all three scenarios and the oil price increases under the IEA NP scenario. Oil prices remain robust enough to encourage development of new supplies under both IEA scenarios. In the IEA NP scenario, despite limited oil demand growth, 40 mmb/d of new supply is still needed to offset declines from producing fields. Higher-cost sources of both discovered and yet-to-find supply will be needed to fill this gap, pushing oil prices to US$70/bbl (real) by 2030 and above US$100/bbl post-2035. In the IEA 450 (2°C) scenario, despite declining oil demand, 20 mmb/d of new supply is still needed to compensate for declines from on-stream fields. In the IEA NP scenario, strong gas demand growth, combined with declines from producing fields, mean ~2,500 bcm per annum of new gas supply will be required to meet demand by 2040. LNG demand will double, accounting for 20% of demand by 2040 versus 11% today. However, continued near-term oversupply means prices remain depressed until post-2025, when demand picks up, driving a more than 4x increase in Asian and European gas prices.

In the IEA 450 (2°C) scenario, ~2,000 bcm per annum of new gas supply is needed by 2040 to meet demand.

LNG demand grows 75% through the forecast period. The period of near-term oversupply is extended until the mid-2020s, delaying an uptick in prices, which also plateau at lower levels due to weaker long-term demand. Gas prices are still expected to increase from today's lows, particularly in Asian and European markets, where prices triple by 2030. In the Greenpeace (1.5°C) scenario, gas demand is largely maintained until 2030, such that 1,000 bcm per annum of new supply is still needed. LNG demand grows 30% to 2030 before declining. Gas prices still increase post-2020, peaking in the early 2030s before also entering a decline (Wood Mackenzie 2017).

BRENT OIL PRICE, 2018 - 2040



SPOT GAS PRICE, 2018 - 2040

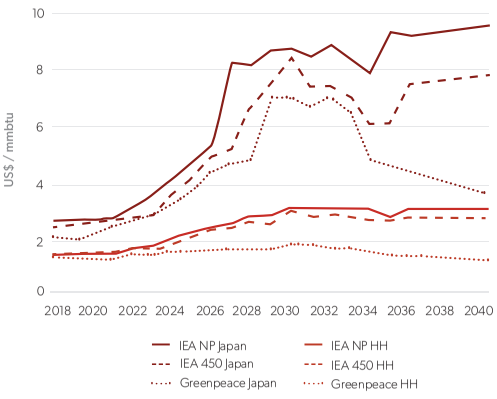


Figure 7: Oil and spot gas price forecasts under the IEA New Policies, IEA 450 and Greenpeace Advanced Energy Revolution scenario. Source: Wood Mackenzie (2017).

	Scenario Characteristic	IEA New Policies (NP)	IEA 450 (2°C)	Greenpeace Advanced Energy [R]evolution
	Overview	Scenario reflecting announced government climate policies	De-carbonisation scenario	Complete de-carbonisation scenario
	Target	N/A	50% chance of limiting global warming to a 2°C temperature rise in 2100	100% renewable energy supply by 2050
	2040 CO_2 emissions (Mt)	36,290	18,427	8,086
2040 share of renewables	Primary energy demand	19% of 18,000 Mtoe	31% of 15,000 Mtoe	66% of 482,000 PJa
	Power demand	37% of 39,000 TWh	58% of 34,000 TWh	87% of 52,000 TWh
	Transport demand	7% of 3,400 Mtoe	20% of 2,700 Mtoe	61% of 68,000 PJa
	Transport / Electric Vehicles (EVs)	10% EVs reaching total 150M; some rise in biofuels to 4.2 mboed	Almost 50% EVs reaching total 710M; bigger rise in biofuels to 9 mboed	Electricity contributes 37% of transport demand; biofuels consumption at 7,436 PJa
	Technology change (Generation & storage)	No major step-changes	Significant cost reductions in renewable technologies and broader deployment of CCS	Improvements in smart grids, renewables system integration, and storage/batteries— based on latest technologies at an assumed reasonable rate of replacement
	Regulatory change	As per announced global and government targets	Greater policy initiatives (e.g. energy intensity targets, efficiency initiatives, fuel-switching, carbon pricing, CCS, system-wide measures)	Active policy and technical support for energy efficiency measures; supportive government climate policy
	Others	Fossil fuel subsidies phased out	Fossil fuel subsidies phased out; major capital inflow to clean energy tech	Includes phasing out of nuclear along with fossil fuels

Figure 8: Summary assumptions and key characteristics of each of the published scenarios used to test Oil Search climate resilience. Compiled by Wood Mackenzie.

The assumptions applied by Wood Mackenzie and Oil Search in assessing the impacts of the scenarios are outlined in the Basis of Preparation section at the end of this document.

BASIS OF PREPARATION

A NOTE ON THE 2017 UPDATE TO THE IEA SCENARIOS AND IEA WORLD ENERGY OUTLOOK (WEO) 2017

The IEA NP and 450 scenarios relied on by Wood Mackenzie and Oil Search for this analysis were published in the 2016 version of the WEO. The IEA released an update to these scenarios in November 2017 after Oil Search's scenario analysis work was substantially advanced. A tabular comparison of the 2017 data with the 2016 version is presented on the next page.

In summary, the 2017 NP scenario is only marginally different in terms of oil and gas demand from the 2016 version, with higher growth for non-bioenergy renewables and lower growth for coal and nuclear. There is also an increased projection of EV fleet growth from 150 million by 2040 to 280 million under the 2017 NP scenario. The 2017 publication includes a Sustainable Development scenario (SDS) instead of a 450 scenario. However, the 450 scenario has not disappeared. The SDS incorporates the 450 scenario and also considers the Sustainable Development Goals (SDGs) of universal energy access and improving air quality. The 2040 emissions figure of the SDS are broadly in line (18,310 vs. 18,427) with the 450 scenario. However, assumptions on how the energy mix evolves have changed more significantly, with higher demand for gas and a more significant increase in non-bioenergy renewables. Though oil and gas demand in each scenario is higher than in the 2016 versions, the differences are not great enough to have a significant impact on the conclusions of this analysis in terms of longer-term implications for Oil Search (Wood Mackenzie, 2017).

OIL SEARCH'S ECONOMIC ANALYSIS ASSUMPTIONS

- The scenario NPV impact analysis for PNG LNG includes Oil Search's PNG oil assets. The interdependency of these projects – both technically and financially - makes separation inappropriate.
- The scenario NPV impact analysis was undertaken using the most recent understanding of the commercial structure for the LNG Expansion Project (drawing on Elk-Antelope, P'nyang and foundation field gas).
- Nanushuk scenario NPV analysis is based on a conservative acquisition case development concept.
  - The acquisition case is based on a resource of 500 million barrels, compared to the existing JV partners' estimate of at least 1.2 billion barrels.
  - Our entry price using a 500-million-barrel resource is just over US$3 per barrel; this will decrease to approximately US$1.30 per barrel if the 1.2 billion upside is proven.
  - The NPV analysis has not considered potential cost savings and opportunities to improve efficiencies, optimise the design, and realise synergies with existing infrastructure.
  - The NPV analysis does not include the value of our option to double our interest in the asset by mid-2019.
  - The NPV analysis includes the lower USA corporate tax rate, which became law in December 2017.
  - The IEA450 and Greenpeace scenario analyses include additional cost deflation consistent with a low oil price environment.
- IEA NP, IEA 450 and Greenpeace AER oil and gas price scenario forecasts are provided by Wood Mackenzie.
- Wood Mackenzie has modelled the pricing scenarios firstly through their Oil Price Model and subsequently through their Global Gas Model.
- Wood Mackenzie does not provide contract LNG pricing levels required to underpin FIDs. Oil Search has inferred contract pricing levels based on oil, spot LNG and US Henry Hub pricing levels.
- Analysis does not account for potential changes to project timing, cost structures or geopolitical impacts derived from the climate scenarios.

Low-emissions technology pathways and policy scenarios

We have developed four policy scenarios to assess the implications of different levels of policy commitment for the steel industry's ability to meet the carbon challenge. We have used this analysis to inform our policy recommendations presented in chapter 6.

Policy scenarios: driving the transition to low-emissions steel

A concerted public and private investment effort is essential to accelerate the pace of development and roll out of commercial low-emissions technologies and advance the timeline to make the steel industry 'technology ready' to meet the objectives of the Paris Agreement.

Steel is a global material traded directly across countries and continents in the form of sheets and bars for steel products, equipment, buildings and infrastructure. It is also embedded in the imported goods consumers buy, such as cars, appliances, etc.

Countries and regions that introduce a cost of CO_2 emissions, but with neither supportive energy policies nor effective mechanisms to maintain the competitiveness of low-emissions versus higher-emissions steel, will fail to decarbonise their steel. What is more, it may in fact disadvantage their steel industry as production will migrate to other countries and regions that do not support decarbonisation, thereby exacerbating the carbon challenge globally **(Stagnate scenario).**

Even in jurisdictions actively providing financial support to develop and roll out low-emissions technologies, the steel industry will need further support. Without effective mechanisms to offset the structurally higher operating costs of deploying these technologies, and affordable access to the clean energy they need, the steel industry will be unable to make the necessary shift needed to meet the goals of the Paris Agreement **(Wait scenario).**

Countries and regions developing supportive energy policies, and establishing a fair mechanism to offset the structurally higher costs of low-emissions steel producers, will succeed in transitioning to low-emissions steelmaking **(Accelerate scenarios).** They will reap the benefits of a positive steel industry that contributes to their economies and to the carbon challenge. But only if such mechanisms are applied globally can this acceleration take place on a global scale and the steel industry become a successful partner in meeting the objectives of the Paris Agreement.

STAGNATE

- Lack of access to sufficient and affordable clean energy
- No mechanism to address high risk that steel production is made structurally uncompetitive across countries/regions
- Slow development of low-emissions steelmaking technologies
- No meaningful reduction in global steel CO_2 emissions as production shifts to less carbon-regulated jurisdictions
- Insignificant global progress to goals of Paris Agreement

WAIT

- Technology makes encouraging progress and is potentially ready for significant deployment within 10-20 years
- But only fragmented access to affordable clean energy
- No mechanism to address high risk of steel production being structurally uncompetitive in affected countries/regions
- Marginal steel CO_2 reductions globally as production shifts to less carbon-regulated jurisdictions
- Limited progress towards goals of Paris Agreement

ACCELERATE regionally

- Technology makes encouraging progress and is potentially ready for significant deployment within 10-20 years
- Access to sufficient and affordable clean energy in supportive countries/regions
- Regions with more active climate legislation ensure mechanisms are in place to enable steel production to remain competitive, e.g. green border adjustment
- Significant reductions in steel CO_2 in supportive countries/regions
- Partial global progress to goals of Paris Agreement

ACCELERATE globally

- Technology makes encouraging progress and is potentially ready for significant deployment within 10-20 years
- Access to sufficient and affordable clean energy globally
- Low-carbon legislation in place in the majority of countries, ideally with a common global framework or mechanism to ensure steel production remains competitive globally
- Significant global reductions in steel CO_2
- Global industry alignment with goals of Paris Agreement

Box 6: policy scenarios and their effectiveness in driving de-carbonisation of the steel industry

Figure 3

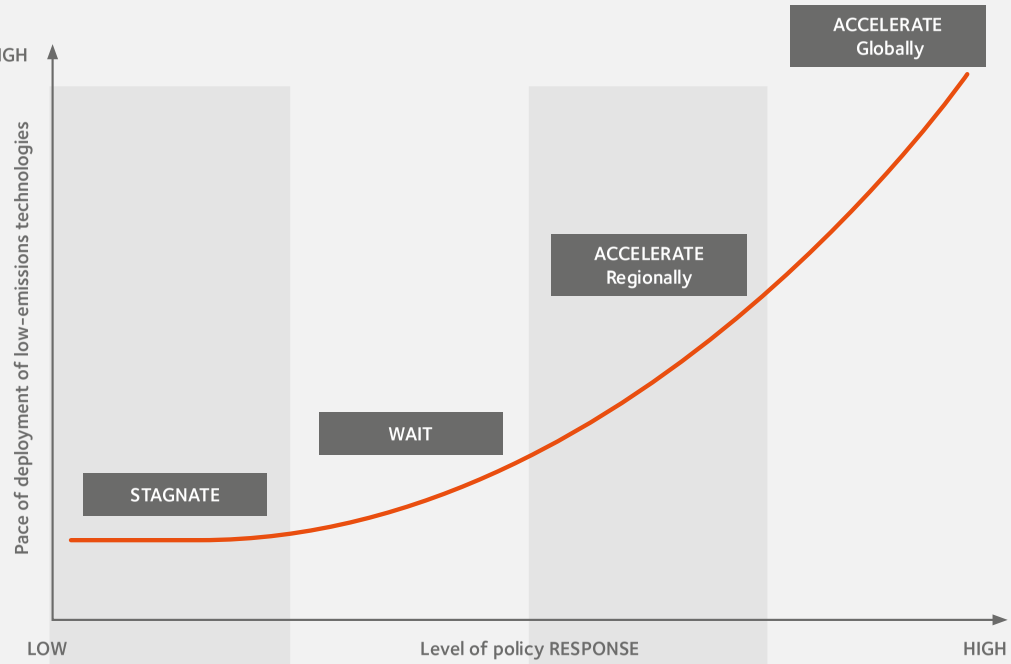


Table 2

Policy challenge				
Structurally higher operating costs of low-emissions steelmaking	Ineffective mechanism in place to offset structurally higher operating costs of low-emissions steelmakers versus higher-emissions steelmakers	Ineffective mechanism in place to offset structurally higher operating costs of low-emissions steelmakers versus higher-emissions steelmakers	Mechanisms to maintain competitive market by offsetting structurally higher operating costs of low-emissions steelmakers versus higher-emissions steelmakers and imports set in some countries and regions, e.g. green border adjustment	Common global framework is implemented to maintain competitive market to offset structurally higher operating costs of low-emissions steelmakers versus higher-emissions steelmakers
Clean energy infrastructure and allocation by sector	No concerted policy in any market to incentivise and allocate clean energy to steel sector	No concerted policy in any market to incentivise and allocate clean energy to steel sector	Support for clean energy to steelmaking industry from clean power, circular carbon and carbon capture and storage infrastructure provided in only some countries and regions	Support for clean energy to steelmaking industry from clean power, circular carbon and carbon capture and storage infrastructure provided globally
Investment in low-emissions steelmaking technologies (development and roll out)	Limited public support for R&D to bring technologies to commercialisation maturity	Accelerated public support for R&D to bring technologies to commercialisation maturity; some investment support for roll out of technologies	Accelerated public support for R&D to bring technologies to commercialisation maturity; high levels of investment support for roll out of technologies	Accelerated public support for R&D to bring technologies to commercialisation maturity; high levels of investment support for roll out of technologies

Appendix 3:

Scenarios, climate models and climate model data

The UN Climate Panel (IPCC) has developed four scenarios for future greenhouse gas concentrations

ATP bases its climate analysis on the four scientifically recognised and developed scenarios for future greenhouse gas concentrations which were used by the UN Climate Panel in its recent Assessment Report (AR5).

Around every seven years, the Climate Panel publishes a report summarising major international research into climate change and its implications. The Climate Panel also describes the four possible Representative Concentration Pathways (RCP), which set out four different scenarios for greenhouse gas concentrations. The four selected scenarios represent the breadth of academic research into greenhouse gas concentrations and range from virtually no climate effort to highly ambitious global climate action. Three of these scenarios (RCP2.6, RCP4.5 and RCP6.0) describe a future with efforts to combat climate change with different levels of ambition, while the fourth scenario (RCP8.5) represents a future where no special measures are taken to further curb greenhouse gas emissions.

Many factors have to be taken into account in order to understand climate change. Greenhouse gas emissions are the main cause of climate change, which has many direct and indirect components. These include contributory factors such as energy consumption, population growth, land use, regional economic development, technological advances, lifestyle and many more. The four scenarios are based on socio-economic models and integrated assessment models, and have very different assumptions about economic growth, population growth etc.
It is important to emphasise that the four scenarios are not predictions, and that there are many different socio-economic pathways for a specific level of greenhouse gas concentrations. The RCP scenarios each represent one possible pathway for a specific concentration level. The four RCP scenarios represent the development in greenhouse gas concentrations among the scenarios that were described in research literature at the time of selection. This means that, unlike previous IPCC reports, they are not representative of various socio-economic developments. The IPCC scenarios have the advantage that they are based on research and that the socio-economic assumptions are logically consistent, which means that a scenario does not assume a major food crisis and notable population growth at the same time.

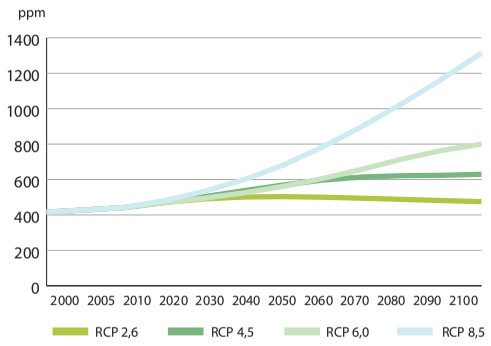
The development of internationally recognised standard scenarios ensures that researchers, decision-makers, companies and investors are able to use comparable data for climate modelling, among other things.

Climate literature uses the term 'radiative forcing' and the scenarios have indeed been named after their radiative forcing. In simple terms, this is a measure of the total impact of the greenhouse effect in the scenario. Technically, radiative forcing describes how the balance between incoming solar energy and outgoing energy from Earth is altered. If radiative forcing is positive, it will lead to surplus energy on Earth and cause warming. In the RPC scenarios, the value is calculated as the change in Watts per square metre (W/m2) from 1750 to 2100.

Development in greenhouse gas concentrations in the four scenarios

The development in greenhouse gas concentrations in the four scenarios is shown below The greenhouse gas concentration is calculated as CO_2 equivalents (CO_2e). These concentration levels are some of the most significant inputs in a climate model calculation to estimate future changes in temperature, sea levels etc.

CO_2-equivalent concentration in the four RCP scenarios



Assumptions in the four scenarios

RCP2.6
The RCP2.6 scenario is the most optimistic scenario of the four IPCC scenarios with the most dramatic reduction in greenhouse gas concentrations and the smallest change in the greenhouse effect. In the scenario, scientists assume that the global population will grow to 9 billion by 2100, a global income development in the median range, a growing demand for energy in developing countries, but also a small increase in the demand for energy in industrialised countries. The scenario also assumes the adoption of many new climate regulations. Achieving RCP 2.6 requires that all countries participate and a very rapid reduction in greenhouse gas emissions. Therefore, new solutions are needed to ensure energy efficiency, more renewable energy, more nuclear power and more biofuel. At the same time, a technological solution must be developed that can capture and store carbon. In fact, it is assumed that carbon capture will exceed carbon emissions in the last 20 years of the scenario, resulting in negative emissions. RCP2.6 was developed by a group of scientists from the Netherlands' Environmental Assessment Agency.

RCP4.5
IPCC scenario RCP4.5 is a so-called stabilisation scenario. Radiative forcing will increase towards 2080 and then stabilise. The scenario assumes that the global population will grow to 8.7 billion by 2100. The global economy – measured in terms of GDP – will grow about six-fold. Concurrently with this population growth and economic development, it is assumed that decision-makers will introduce a relatively large number of climate initiatives, resulting in the stabilisation of greenhouse gas concentrations and radiative forcing. Such initiatives include the introduction of a global GHG emission price (popularly referred to as a global carbon tax). In the scenario, scientists assume that the carbon tax will be implemented simultaneously and efficiently in all countries, so arbitrage is not possible. The price of greenhouse gas emissions will increase towards 2100 (without countries withdrawing or competing to lower the price). Global GDP will grow six-fold, global energy consumption will have tripled and an increasing share of energy consumption will be met by nuclear energy. The scenario also assumes an increase in consumption of renewable energy such as hydro, solar and wind energy. In order to stabilise radiation forcing, RCP4.5 also expects to see a rapid development in CSS technology. RCP4.5 was developed by a group of scientists from the Pacific Northwest National Laboratory's Joint Global Change Research Institute (JGCRI).

RCP6.0
RCP6.0 is a comparatively carbon-intensive scenario with fewer climate policy interventions. In this scenario, a steep drop in greenhouse gas emissions will not be seen until after 2060, while climate policy interventions will be picking up speed from around 2060. Among other things, it is assumed that a global carbon price will rise sharply from 2060 towards 2080. In the scenario, the world will remain dependent on fossil energy. This scenario assumes relatively high population growth, equivalent to 9 billion by 2100, but the lowest level of economic prosperity in 2100 of the four scenarios. The scenario was developed by a group of scientists from the National Institute for Environmental Studies (NIES) in Japan.

RCP8.5
RCP8.5 is the scenario with the greatest impact on the greenhouse effect. This scenario is the only scenario to assume that no new climate policy initiatives will be adopted and is thus a 'business as usual' scenario (BAU scenario) within climate research and policy. Due to a growing population, among other things, it is assumed that the total energy consumption will triple towards 2100. The growing demand for energy will be met by coal in particular, but renewable energy and nuclear energy consumption will increase, too. RCP8.5 assumes a global population of 12 billion by 2100. The scenario's assumptions about population growth thus come closest to the UN's latest 2017 forecast of a population of 11.2 billion by 2100. Due to an increased demand for food and resources, land use is expected to change to enable more land to be used for agriculture. Assumptions about the development in land use (e.g. in forestry, agriculture or cities) also has an impact on climate development. This scenario was developed by a group of Austrian

When is scenario stress-testing useful?

	Next 10-20 years	Mid-century
Physical Risk 	**Climate impacts independent of scenario** because of historical GHG emissions Consider probabilities of physical events	**Scenario choice matters** Use alternative scenarios spanning 2-4°C to explore range of physical risks
Transition Risk 	**Scenario choice matters** Use alternative scenarios spanning 2-4°C to explore range of transition risks	

The Task Force on Climate-Related Financial Disclosure (TCFD) established by the Financial Stability Board recommends scenario stress-testing for all companies and financial organizations.

Scenario stress testing is useful for some risks and time frames, but not all.

Stress testing against a range of scenarios can help prepare for transition risk, across all periods. A range of scenarios should be examined to understand the range of transition risk, including 2°C, 3°C, and even 4°C scenarios. **Given today's policy ambition, approximately 3°C global warming by 2100 is the most likely scenario**.

Physical climate impacts are independent of scenario in the near future. Changes such as extreme events and flooding are impacting all sectors and regions already. These impacts will become clearer over the next 10-20 years, as a result of historical emissions. By limiting current and future emissions we can limit additional and worse impacts. Regional assessments can be used to examine specific physical risks.

Using a higher temperature scenario e.g. 4°C can be useful for examining a possible worst-case scenario of potential physical impacts.

The period for stress testing should reflect the lifetime of the assets under consideration and how long it is exposed to climate risks.

For more details, see the next chapters on transition and physical risk.

CLIMATE SCENARIOS

Our analysis indicates that Rio Tinto's business is relatively robust to scenarios mapping the policy and technology pathways necessary to limit global temperature rises:

- **Financial impact at a manageable level:** Rio Tinto has the financial and institutional capacity to manage the long-term impacts of a scenario limiting a rise in global temperature to below 2°C, while continuing to be profitable;
- **Portfolio naturally hedged:** diversification of our portfolio across multiple commodities provides a natural hedge against climate change policy; our aluminium and copper assets will be needed in the transition to a low-carbon future and could provide an offset in an environment where our iron ore assets are less attractive from a climate change perspective;
- **Many abatement options available to us to reduce direct emissions:** the significant number of internal abatement options available, coupled with a more gradual evolution of downstream industries, will give us time to anticipate and adapt to changes in policy.

Rio Tinto considers the impact of climate change over two time horizons given the long-term nature of our business and the potential for unpredictability in regulatory response.

1. **Short to medium term** (0-20 years): while there is limited scope to react immediately to regulatory changes, we do have the ability to mitigate (or potentially take advantage of) shifts in technology and the policy environment. In this timeframe, physical changes are largely pre-determined since they are largely the result of carbon levels already accumulated in the atmosphere over past decades.
2. **Long term** (20-50 years): the physical impact of climate change to the world could potentially become more severe, depending on the success or failure of policy. Technology development is highly uncertain.

Across these time horizons, the Group assesses three climate change scenarios, which consider:

- **The policy environment** – for example, the level and coordination of carbon pricing internationally; and
- **The rate of technological development** – for example, the costs of low-carbon electricity generation and batteries.

Our approach recognises that there is an interplay between these two factors: technology that leapfrogs what is available today, for example, could succeed in dramatically reducing climate change and its impacts even in an environment where government mandates do not exist.

NEW FRONTIERS

Energy Transitions Commission: hard-to-abate sectors

Rio Tinto has joined the Energy Transitions Commission (ETC), a group of leaders from public, private and social sectors with the goal of accelerating change towards low-carbon energy systems. The ETC is tackling the challenge of how we reduce emissions from the "hard-to-abate" industrial and transport sectors of the economy, including steel – the customer for our iron ore and the source of most of our scope 3 emissions.

These sectors will account for an increasing percentage of the total global emissions and without action will make it impossible for the world to meet the goals of the Paris Agreement and net zero emissions by 2050 to 2070.

The recent ETC report, *Mission possible: Reaching zero carbon emissions from hard to abate sectors by mid-century*, concludes that it is technically possible to decarbonise these hard-to-abate sectors at an affordable cost to consumers and to the overall economy, but there are important issues relating to the feasible pace of change and the optimal process of transition, including the pace of innovation and the importance of strong policy actions. As an important part of the value chain, we believe we can contribute and benefit from this cross-business and multi-stakeholder collaboration.

Commodity impacts

The table gives a high-level summary of the potential risks and opportunities for Rio Tinto's portfolio across different time horizons within the IEA SDS relative to the Limited Action case. Coordinated Action, which lies between Limited Action and the IEA SDS, would have directionally similar, albeit smaller, implications.

The methodology used to consider implications of the IEA SDS on the outlook of our key commodities accounts for impacts of regulations and technologies on demand, the cost structure of supply and the knock-on effect on price.

Commodity impacts of a 2°C scenario

Commodity	Outlook	Short to medium term	Long term
Pilbara iron ore	↓	Pilbara iron ore becomes less attractive due to the effect of increased use of scrap, however, the business continues to be highly profitable. Demand for lump and pellet is robust. There is scope to significantly decarbonise our iron ore mining operations in order to maintain cost-competitiveness (see Reducing our footprint).	There is large uncertainty around how the steel production sector will decarbonise in the long run, which could materially affect the value of Rio Tinto's iron ore business. In addition to an escalation of the severity of the medium-term impacts, there is a need to plan for greater frequency and intensity of cyclones on the Pilbara coast.
Copper (and battery materials such as lithium)	↑	Increased demand for copper as well as other battery materials due to greater focus on electrification. Supply investment expected to lag demand due to long mine development lead times, resulting in extended periods of high prices.	Structural increase in demand due to faster electric vehicle take-up and investment in power and the grid, requiring significant new supply, partially offset by an increase in scrap collection rates.
Aluminium (including bauxite mining and alumina refining)	↑	Emission-reduction policies likely to increase aluminium prices, benefiting low-cost, low-carbon producers but putting greater pressure on coal-based smelters as well as the refineries supporting them.	Structurally steeper global aluminium cost curve and potential for decarbonising aluminium smelting direct emissions using inert anode technology.

Portfolio resilience

The factors described above could have a material impact on our business, but on balance we believe that Rio Tinto is likely to be resilient to these issues, given:

- Factors will affect different commodities in different ways and as a diversified miner we will benefit from this. For example, climate change policies placing a carbon price on emissions will result in downside impacts on lower-grade iron ore. However, these same policies will benefit tier one copper and aluminium assets;
- The relative cost position of most of our assets is expected to remain robust within their respective industry cost curves. Our hydro-based aluminium assets in Canada will consolidate their position at the bottom of a steeper aluminium cost curve. The overall cost position of our iron ore and copper businesses will be relatively unchanged, with suppliers of low-grade iron ore expected to face much stronger margin compression;
- Impacts are likely to materialise over the long term and we have a range of options, and the financial and operational capacity to execute these, to (i) mitigate risks; (ii) reduce direct emissions through a range of abatement projects and (iii) to offset remaining emissions where commercially justified.

Rio Tinto's internal use of a carbon price

One of the ways we mitigate the potential impact of climate change policies on our business is through the use of an internal price on carbon. Rio Tinto has tested the resilience of its investments against a carbon price since 1998. We have developed separate price forecasts for the regions and main markets in which we operate and sell our products, and modelled how these might change over time.

Our process to develop and update carbon prices includes short-term market data, price forecasts and scenarios, and input from experts within and outside our business. The forecasts will be impacted by variables such as the progress of international climate agreements and commitments on national energy and climate policy, and the evolution of low-emission technology costs and deployment.

The climate scenarios described contribute to the maintenance and update of our carbon cost forecasts. They also impact the forecasts we use for the price of our commodities.

3. STRATEGY

Societe Generale identifies that physical and transition risks do not represent a major risk on a 5-year horizon. However, such risks could impact materially in the long-term. Likewise, the Group has identified a range of climate-related opportunities for a variety of sectors, financial products and geographies. Over the years, this has led the Group to define a climate strategy articulated around three axes:

- Managing climate-related risks (transition and physical);
- Seizing climate-related opportunities and supporting Societe Generale's clients; and
- Managing the bank's impact on climate (via its own activities and that of the clients it finances).

To deliver this strategy, the Group has developed in-depth environmental expertise across the whole value chain: from research and advisory, to financing and capital markets, as well as investor solutions and services. Finally, the Bank has started shifting its capital allocation towards greener sources of energy and away from the most emission-intensive ones; i.e. more renewables and less coal.

3.1. Climate-related risks identified

3.1.1 Risk terminology used

Financial risks from climate change arise from three primary channels or 'risk factors': transition, physical and liability risks

- **Transition risks:** Transitioning to a lower-carbon economy may entail extensive policy, legal, technology, and market changes to address mitigation and adaptation requirements related to climate change. Depending on the nature, speed, and focus of these changes, transition risks may pose varying levels of financial and reputational risk to organizations.[6]
- **Physical risks:** 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.
- **Liability risks**: These risks can arise if parties who have suffered losses from physical and transition risk factors seek to recover these losses from those they view as responsible. Specific mechanisms include a failure to disclose financial risks, a failure to adapt to their foreseeable nature, and a failure to take the short-term action required to mitigate future financial risks[7].

3.1.2 Time horizons being considered

Societe Generale considers short- and medium-term for credit horizons that range between 1 and 5 years. Longer term horizon Societe Generale considers extend to 2040 typically, sometimes 2050 when assessing climate-related risks and opportunity. Even if these horizons do not match Societe Generale's immediate decision-making, they may have an influence on Societe Generale's long-term strategy.

6 TCFD (2017) Recommendations of the Task Force on Climate-related Financial Disclosure https://www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-TCFD-Report-062817.pdf

7 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

Table 2: Time horizon considered for credit analysis

	From (years)	To (years)
Short-term	0	1
Medium-term	1	5
Long-term	5	Up to 2050

3.1.3 Climate-related credit risks identified

Risks associated with climate change, both physical (increased frequency of extreme weather events) and transition-related (new carbon regulations, technological and market changes), have been identified as factors that could aggravate the Group's existing risks.

Societe Generale has identified a variety of physical and transition risks that could result in financial impact on the Group. A description of the processes used to determine which risks could have a material financial impact on Societe Generale is provided in Section 4.

- In the short term, reputational risks (e.g. increased stakeholder concern or negative stakeholder feedback) could have a financial impact on Societe Generale's direct operation and through its clients. This could materialize through a shift in consumer preference and decreased demand for goods/services leading to a reduction in revenue for Societe Generale and/or its clients.
- Other transition risks are expected to emerge in the long term: Increased policy and regulatory costs, risks associated with technological changes and changing market equilibriums. This is likely to affect mostly Societe Generale's customers in the most carbon intensive sectors financed by the bank: energy, transport, building, metals & mining.
- Societe Generale also sees physical risks materializing in the long-term through increased frequency and severity of extreme weather events, or gradual changes in weather patterns. Societe Generale's own operation either on its sites and its supply chain, or on Societe Generale clients' activities and their supply chain could be impacted. This would affect operations and clients across the globe.
- As for liability risks, the Group has not conducted analysis of the climate-related legal risks of its clients and its impact on portfolio in the long-term.

Table 3: Climate-related credit risks identified

Risk driver	Financial impact identified	Horizon
Policy and regulation Increased pricing of GHG emissions Enhanced emissions-reporting obligations Mandates on and regulation of existing products and services	• Higher operating costs for most carbon intensive customers • Article 173 of the French Energy Transition for Green Growth Act requires greenhouse gas emissions generated by the company's businesses, particularly using the goods and services that it produces, to be reported via significant balance sheet items. This is expected to impact Societe Generale's customers & direct operations in the transport, metals & mining, power generation and oil & gas globally.	MT-LT
Technology Substitution of existing products and services with lower GHG options Unsuccessful investment in new technologies	• Capital investments in technology development: Power generators customers with a high share of fossil fuel generation are expected to experience high capital expenditure requirements to decarbonize their mixes.	MT-LT

3.6.3 Climate scenario and time horizons used

In order to measure the alignment with a 2°C scenario for its coal portfolios, Societe Generale relied on the IEA's 2DS scenario.

Within its Energy Technology Perspectives annual publication, IEA defines the 2°C Scenario (2DS) as follows: "The 2DS lays out an energy system deployment pathway and an emissions trajectory consistent with at least a 50% chance of limiting the average global temperature increase to 2°C. The 2DS limits the total remaining cumulative energy-related CO_2 emissions between 2015 and 2100 to 1 000 $GtCO_2$. The 2DS reduces CO_2 emissions (including emissions from fuel combustion and process and feedstock emissions in industry) by almost 60% by 2050 (compared with 2013), with carbon emissions being projected to decline after 2050 until carbon neutrality is reached."[16] This scenario is also consistent with the 450 Scenario declined in the IEA World Energy Outlook and defined as "an energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentration of greenhouse gases in the atmosphere to around 450 parts per million of CO_2." [17] As a consequence, Societe Generale's alignment on IEA 2 degrees scenario refers to both the 2DS and the 450 Scenario.

For its coal portfolio, Societe Generale decided to exclude the Chinese contribution from the considered scenarios to take into account the fact that China is currently representing 51% of the world's coal demand for primary energy and 42% of the world's coal power capacity, whereas Societe Generale is not significantly active in financing Chinese coal extraction and power generation assets.

Additionally, IEA scenarios provide a 2050 timeframe but considering the average transaction profile timeline, a shorter timeframe had to be considered when defining operational targets for the Bank. This timeframe should be short enough to allow the monitoring of the Bank portfolio and long enough to absorb short term evolutions. This timeframe should also allow readapting the Bank's targets to updated or new IEA scenarios to come.

For its assessment of transition risks, Societe Generale has used in depth output data of the REMIND and MESSAGE models, respectively developed by the Potsdam Institut für Klimafolgenforschung (PIK) and Applied Systems Analysis (IIASA). These are integrated assessment model (IAMs) for medium- to long-term energy system planning, energy policy analysis, and scenario development. Societe Generale also uses the IEA detailed output data for analyses. Societe Generale also relies on ad-hoc studies (with both qualitative and quantitative projections) for specific pieces of analysis.

Table 5: Complementary information on the climate scenarios used

Strategic exercise	Scenario	Geographical coverage	Horizon
Coal exposure target	Consistent with IEA 2DS and IEA 450 scenarios	excludes China's contribution	timeframe limited to 2020
Transition risks	REMIND SSP2 (2°C)	global coverage	timeframe up to 2050

[16] *IEA (undated) ETP 2017 data visualization https://www.iea.org/etp/explore/*

[17] IEA (undated) ETP 2017 data visualization *https://www.iea.org/etp/explore/*

South32 climate-related risks, mitigation options and opportunities

Table 1 summarises the most significant climate-related risks, mitigation options and opportunities relevant to our business today, both in a future that exceeds, and in a future that avoids, more than two degrees of warming.

Where internal or external progress has been made since last year's assessment, we have reflected these changes in the table. Our three scenarios have been used to identify likely risks and opportunities relevant to that scenario. Further information on our scenarios is provided from page 22.

Table 1 Climate-related risks and opportunities

Topic	Time horizon[4]	Most relevant scenario	Risks	Mitigation and opportunities
Policy	Short, medium and long term	GC	Carbon pricing policies including carbon taxes, cap and trade systems and any other regulatory carbon pricing mechanisms may increase costs for companies with liable carbon emissions.	We include a short-run regional and long-run global carbon price in our capital allocation and investment evaluations. This contributes to effective and well-informed decisions to manage risks beyond current pricing policies. Further detail is provided on page 19. In addition, our voluntary carbon emission reduction targets drive internal processes to identify, evaluate and implement a range of operational emissions reduction projects on an ongoing basis.
	Medium and long term	RCC		
	Short, medium and long term	GC	As our stakeholders, including customers and suppliers, are likely to be subject to similar changes in policy, we may face changing commercial requirements to meet regulatory changes in jurisdictions outside of our own operating environments.	Our scenario analysis incorporates potential policy-based impacts on our supply chain to test resilience of our portfolio to these risks. Insights gained from this process are used as an input into our ongoing strategic plans. We have also calculated and disclosed our annual Scope 3 emissions to ensure that we are aware of the scale and sources of our supply chain emissions. Further detail is provided on page 10.
	Medium and long term	RCC		
	Short, medium and long term	GC	Water and biodiversity regulation may become more stringent as pollution concerns or scarcity pressures increase.	Through our focus on innovation and technology, we are working to reduce our land requirements, biodiversity impacts, waste, carbon and water usage over time. As our internal voluntary performance standards drive resource efficient operations, we aim to be ahead of policy change and avoid the risk that more stringent future policies could pose.
	Medium and long term	RCC		
Legal	Medium and long term	GC and RCC	Increased litigation against governments and companies, either seeking compensation for damages caused to them because of climate change impacts or to force greater action on climate change.[5]	We consider that our proactive approach to climate-related risk assessment, risk management and disclosure, along with our diversified portfolio, assist in minimising our relative exposure to climate change-related litigation. However, we monitor legal developments in this space and seek advice on major developments when required.

GC: Global Co-operation (two degrees) **PP**: Patchy Progress (three degrees and base case) **RCC**: Runaway Climate Change (four degrees)

(4) In this context, we consider a short-term, medium term and long term as the next 3-5 years, 6-10 years and 11-50 years respectively.

(5) Please see https://www.law360.com/articles/766214/emerging-trends-in-climate-change-litigation for a list of recent climate change litigation cases.

Appendix: Climate VaR Modelling Approach

Climate scenarios considered

Aviva is developing a Climate VaR measure that enables the potential business impacts of future climate-related risks and opportunities to be assessed in each of the IPCC scenarios and in aggregate. The IPCC scenarios aim to measure the effect on the energy balance of the global climate system due to changes in the composition of the atmosphere from sources like Greenhouse gas emissions, other air pollutants[19] and changes in land use. The four IPCC scenarios represent different Representative Concentration Pathways (RCPs) which describe the composition of the atmosphere at the end of the 21st century. Table 2 summarises the link between the RCPs, potential temperature rises by 2100 and the level of mitigation required, which we will use to describe the scenarios in this report.

Table 2: Mapping for RCPs, potential temperature rises and levels of mitigations. *Source: TCFD.*

RCP	Temperature rise	Description	Notes
RCP2.6	1.5°C	Aggressive mitigation	emissions halved by 2050
RCP4.5	2°C	Strong mitigation	emissions stabilise at half today's levels by 2080
RCP6.0	3°C	Some mitigation	emissions rise to 2080 then fall
RCP8.5	4°C	Business as usual (BAU)	emissions continue rising at current rates

Figure 12 also sets out implications for Greenhouse gas emissions and potential temperature rise by 2100 for each scenario. Aggressive mitigation is the only scenario where it is more likely than not that the temperature change in 2100 will be less than 2°C.

Aviva is developing this Climate VaR measure in conjunction with the UNEP FI investor pilot project, which is developing models and scenario analysis tools to assess the potential impact on corporate assets and real estate of the four IPCC scenarios in conjunction with Carbon Delta.

CARBON DELTA
the environmental fintech

Carbon Delta is using the REMIND model[XVIII] from the Potsdam Institute for Climate Impact Research (PIK)[XIX]. Scenario outputs from the REMIND model include financial metrics such as direct/indirect emissions costs, additional capital expenditure, and revenue implications broken down by sector and geography. Whilst these scenarios reflect current scientific research and the Paris agreement, there clearly remains significant uncertainty regarding future climate trajectories as well as political risk with respect to implementation of the Paris agreement and Nationally Determined Contributions (NDCs)[XX].

It is important to note that the four scenarios all assume a gradual path, in which temperatures slowly rise but climate policy is ramped up at varying speeds with a fairly high degree of global coordination. They do not consider the transition risk in a more chaotic policy environment, where there is lack of global coordination and policy action is taken too late and too suddenly. This may result in an understatement of transition risk.

The Carbon Delta model and scenario analysis tools also allow consideration of the five Shared Socioeconomic Pathways (SSPs)[20]. These consider socio-economic characteristics including things such as population, economic growth, education, urbanisation and the rate of technological development.

Time horizon considered for each scenario

In conjunction with the UNEP FI investor pilot project, it was agreed to use a single 15-year time horizon for the Climate VaR measure to analyse the impact of the different scenarios on our business but with the capability to consider transition effects over shorter time horizons depending on the business decision being considered. Consideration was given as to whether a longer time horizon was needed to capture the worst physical impacts of climate change, as these are not likely to manifest themselves until the second half of the century (See Figure 15).

To address this point in a decision-useful way and ensure consistency with the 15-year time horizon for transition risk, it was agreed to look at a higher, 95th percentile of physical risks as well as the expected outcome in the BAU scenario over the 15-year horizon. Figure 16 shows large dispersion around the mean from the impact of climate change on Coastal flooding over the next 15 years.

XVIII REMIND is a global multi-regional model incorporating the economy, the climate system and a detailed representation of the energy sector. It allows for the analysis of technology options and policy proposals for climate mitigation.

XIX The Potsdam Institute for Climate Impact Research (PIK) is a German government-funded research institute addressing crucial scientific questions in the fields of global change, climate impacts, and sustainable development.

XX Intended Nationally Determined Contributions is a term used under the United Nations Framework Convention on Climate Change for reductions in greenhouse gas emissions that all countries that signed the UNFCCC were asked to publish in the lead-up to COP21.

Figure 15: Global average surface temperature change. Source: IPCC.

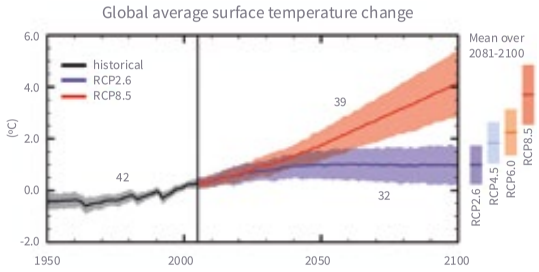
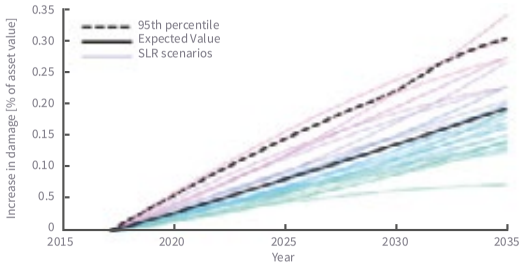


Figure 16: Example of Coastal Flooding . Source: Carbon Delta.



Risks and opportunities covered

The modelling of transition and physical risks and opportunities specifically covers the projected costs of policy action related to limiting Greenhouse gas emissions as well as projected profits from green revenues arising from developing new technologies and patents. In addition, it captures acute abrupt weather impacts such as more frequent and severe storms, extreme heat and cold, heavy precipitation and snowfall, wind gust, and tropical cyclones, as well as chronic gradual impacts such as higher than average temperatures and rises in sea level. It is important to note that the changes in acute and chronic weather can also have a positive as well as negative impact on individual companies or instruments (see figure 17), as this is measured against current conditions and in some regions these impacts will reduce even though the overall the impact will be negative.

Figure 17: Risks and opportunities covered. Source: Carbon Delta.

Building Block Approach

To assess these risks and opportunities, a building block approach has been adopted (see Figure 18).

Figure 18: Building Block Approach. Source: Carbon Delta.

SECTION 4:

Looking Forward

Our experience with the UNEP FI pilot gave us important insights that will help to inform our strategy going forward into 2019 and beyond. Citi acknowledges the risks highlighted by the IPCC's recent Special Report, *Global Warming of 1.5°C*, and recognizes the urgent need to keep warming below 2°C with a goal to limiting it to 1.5°C.

Given this imperative, Citi understands that even though our pilot scenario analysis exercise did not indicate that climate change will pose material financial risks to our business in 2030 and 2040, this was not an exhaustive or conclusive analysis. Regardless, we must take action today to do our part to avoid the worst potential impacts of climate change. To enable this transition, we must work closely with our clients in climate-exposed sectors to help them transition and become more resilient through enhanced climate adaptation and mitigation measures.

This pilot analysis highlighted several difficult challenges associated with conducting climate scenario analysis and understanding climate-related risks that we will need to address:

- Long-term climate projections tend to be inaccurate. This is made even more challenging by the fact that climate risks and impacts are expected to accelerate and get worse over time. Non-linearity is hard to capture and forecast with the currently-available tools for climate risk assessment.
- There are significant data gaps, including data on the linkage between climate risk and credit quality and asset-level data on asset utilization and climate mitigation factors at a facility.
- Climate impacts can be very local and affect different geographies and sectors differently. This will require more granular data at the local and asset level.
- Climate-related losses may be due to indirect, second-order impacts, such as impacts on critical infrastructure or the supply chain, not just direct impacts. This is hard to measure and estimate at this time and will require additional data.

It will take time and collaboration with stakeholders for us to find solutions to these challenges, but we are committed to building upon the pilot project and further implementing the TCFD recommendations. Some potential next steps we are exploring include:

- Conducting climate scenario analysis on other sectors and/or geographies
- Exploring and potentially testing other methodologies, models, tools and scenarios that have been developed by third parties
- Continuing to collaborate with UNEP FI and the pilot group to refine the transition risk and physical risk methodologies that we have developed
- Engaging with clients and other stakeholders to further our collective understanding of climate risks and opportunities, particularly in the supply chain
- Engaging with clients to support investments in climate change solutions for climate adaptation and/or mitigation
- Working with stakeholders to improve data availability and fill data gaps
- Working with climate modelers to adapt climate scenarios for financial analysis

In FY17, we completed a detailed assessment of our portfolio resilience to transition risks that may arise from climate change. Transition risks are defined as non-physical risks arising from the structural shift toward a low-carbon energy system, most significantly policy, technology, legal and market change. This analysis used the Global Cooperation scenario to compare commodity performance against our base case (Patchy Progress scenario).

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Our portfolio resilience to transition risks

Our portfolio composition will depend on future prices and the opportunities that emerge over time. This scenario analysis and modelling provides us, and our stakeholders, with a view on the outlook for each commodity in our current portfolio under the Global Cooperation scenario.

SCENARIOS USED: GLOBAL COOPERATION SCENARIO[12]

Our methodology is built around the existing valuation models and scenario-based analysis used in our strategic planning process. This considers major variables such as the outlook for commodities, the development of technology, the needs of societies, consumer behaviour and the ability of the environment to continue providing the natural resources and ecosystem services that we and the world need to continue to thrive.

As a first step in evaluating comparative portfolio resilience, we applied the main supply and demand drivers to our existing global commodity models to determine whether the commodity would be advantaged or disadvantaged by the rapid transition involved, relative to the base case. This was a qualitative step to frame the subsequent company-specific assessment. We then undertook a quantitative analysis to assess the scale of this directional impact on South32's specific products and operations. This included factoring in relative demand for our products compared to competitors (e.g. based on chemical composition and supply location) and our position on the cost curve for each of our unique value chains.

When comparing outcomes between the base case and the Global Cooperation scenario drivers, we found that comparisons of net present value or earnings forecasts did not provide us with meaningful insights on broader portfolio resilience. This was largely due to the variability of other underlying factors (particularly commodity price forecasts) overshadowing the impacts of the climate-scenario related inputs. We instead took the decision to use a fit-for-purpose resilience metric (Figure 4), which focused on the demand for each commodity from each operation in our portfolio. Resilience was determined by a quantitative assessment of whether the supply and demand balance increased or decreased (ten per cent either way) or materially increased or decreased (20 per cent either way), relative to our base case forecasts out to 2040.

(12) This section refers to South32's resilience under the Global Cooperation scenario. As such, the descriptions of resilience here are not South32 forecasts, but describe what we have assessed could happen if the world's development progressed in line with the Global Cooperation scenario.

A summary of the guidance against our exposure assessment highlights areas of alignment and gaps:

EBRD/GCECA guidance	Rio Tinto 2018 exposure assessment
Assess value chain	✗ Supply chain ✓ Operations ✗ Markets
Assess first order impacts	✓ Heat stress ✓ Drought ✓ Extreme rainfall ✓ Cyclones ✓ Sea level rise ✗ Wildfire
Assess second order impacts	✗ Assess impacts of climate change on economics, humans and ecosystems beyond the boundaries of the organisation. Includes changes in availability of natural resources such as water, disruption to transport, changes to global trade routes and migration.
Assess physical climate risk over asset life	✓ Projections for 5-20 year timeframe ↗ Scenario analysis for 20+ year timeframe ✗ Assessment of historical impact of extreme weather events

✓ Completed
↗ Work in progress or partial achievement
✗ Not part of our current scope

against Wood Mackenzie's IEA450 LNG new project cost curve (Figure 5).

The outcomes of this testing were then applied in a number of ways internally, as described earlier in this Report.

We have identified signposts for each selected scenario that reflect the underpinning assumptions and market indicators they indicate as necessary for each scenario to materialise. These help to inform our judgment on the probability of that scenario occurring with the passage of time.

The corresponding narrative reflects information provided by the IEA and Greenpeace for the relevant scenarios, integrated with Wood Mackenzie and Oil Search's views. Some signposts are used by Oil Search as indicators to monitor trends and changes in the external environment.

LIMITATIONS OF OUR ANALYSIS

The selected scenarios use the IEA 2016 information, which reports data from 2015 (and 2014/15 in the case of Greenpeace AER). As a result, the short-term price forecasts from 2017-2020 do not reflect the prices currently being realised in the market. This has a disproportionately negative impact on PNG LNG, where more than 30% of the project's value is realised over the five-year period from 2018-2022.

Our current climate scenario analysis does not include detailed consideration of geopolitical tensions or Gross Domestic Product (GDP) implications that are likely to escalate in cases where decarbonisation is accelerated.

Detailed analysis of physical climate risk scenarios is ongoing and will be reported in subsequent years.

Figure 4: Scope of Oil Search's climate NPV impact assessment.

Our strategic response to climate-related risks

Our strategy and Climate roadmap forms the basis for how we respond to climate-related risks and opportunities. As part of this we have embedded climate considerations into our incentives, reporting and decision-making, and have targets in place to measure progress and incentivise performance across the entire company – starting at the top. CO_2 intensity (upstream) is a key performance indicator and influences executive pay.

Investment principles – Our investment principles take climate into account. We require all potential projects to be assessed for carbon intensity and emission reduction opportunities, at every decision phase – from exploration and business development to project development and operations. We apply an internal carbon price of at least USD 55 (real 2018) per tonne of CO_2 in investment analysis. In countries where the actual or predicted carbon price is higher than USD 55, we apply the actual or expected cost, such as in Norway where both a CO_2 tax and the EU Emission Trading System (EU ETS) apply.

Energy scenarios – Our energy scenarios inform the economic planning assumptions used in our investment decisions and the formulation of our strategy. Our Energy Perspectives 2018 report illustrates that there is significant uncertainty around the future energy mix and the exact pace and scale of the energy transition. In that report we also assess sensitivities to our Renewal scenario related to potential disruptive technologies, CCS and climate policy action.

Portfolio stress test – Equinor annually conducts a price sensitivity analysis for our project and asset portfolio against the assumptions regarding commodity and carbon prices in the range of energy scenarios of the International Energy Agency (IEA), as presented in their World Energy Outlook report. This analysis is used to assess energy transition-related risks. The practice is in accordance with a shareholder resolution passed in 2015, suggesting that stress testing should be done against third-party scenarios to allow for comparability.

The "project and asset portfolio" entails equity production, excluding exploration activities[1]. However, our investment decision criteria, including the internal carbon price and discount rates, apply also to exploration projects.

In 2018 we tested our portfolio against the IEA's Current Policies, New Policies and Sustainable Development scenarios. The scenarios and assumptions are presented in the World Energy Outlook 2018 report (IEA). Equinor has not tested our portfolio against a 1.5°C scenario, as the IEA has so far not published such a scenario with corresponding oil, gas and carbon price assumptions. The four illustrative model pathways presented in the International Panel on Climate Change's special report on the impacts of global warming of 1.5°C[2] indicate that oil and gas demand would have to be significantly lower than in a 2°C scenario, and as such the potential downside for Equinor in a sensitivity analysis could be expected to be more significant. However, our sensitivity analysis does not take into account the fact that our portfolio would change to be more robust as the different scenarios unfold and materialise.

1. Exploration activities are not included due to significant uncertainty regarding discoveries and development solutions. This is a change from previous years' analysis, which have included exploration activities.
2. IPCC (2018): Special Report: Global Warming of 1.5ºC.

Net present value of portfolio

NPV impact on base case

The sensitivity analysis in 2018 demonstrated that our portfolio continued to be robust in the various IEA scenarios (World Economic Outlook 2018). The chart illustrates changes in the net present value (NPV) of Equinor's asset and project portfolio when replacing our own assumptions regarding oil, gas and carbon prices with those of the IEA scenarios.

Capex per maturity

Equinor has significant capex flexibility to shape our future portfolio. The share of non-sanctioned projects is significant already in 2021 and rapidly increasing towards 2028. Producing and unconventional assets are also to a large extent flexible.

Oil and gas production in 2025

A major part of our forecasted production in 2025 is within conventional oil and gas, and shale gas, which have a relatively low carbon intensity compared to heavier oil segments. These production segments represent around 90% of our forecasted production in 2025.

3.1.1 Physical risk

CNP Assurances has mainly focused on analysing the physical risk exposure of its property and woodland assets. CNP Assurances also carried out further study on the physical risk of its property assets in 2017. It was completed in 2018 with an analysis of the physical risk on its directly-held equities and corporate and sovereign bond portfolio to get a better picture of the climate risk it may be exposed to.

At 31 December 2018, 72% of assets were subject to a physical risk analysis.

Property assets

CNP Assurances has commissioned EcoAct, a consulting firm specialised in guiding companies and regions through the climate transition, to carry out an assessment of the physical risks related to climate change on its French property assets held directly or through wholly-owned companies in order to analyse the exposure to physical risk of its property assets.

Analysis of the physical and operational risks inherent in CNP Assurances' property portfolio was carried out for six climate hazards that could potentially impact buildings and their occupants. Two types of climate hazards were studied.

Trend hazards:
- Annual change in average temperature
- Change in sea level

Extreme hazards:
- Heatwaves
- Drought
- Heavy rains and floods
- Violent winds

Changes in these climate hazards were analysed for the near term (2021-2050) and compared to a period-of-reference climate (1971-2000) based on two scenarios using different levels of greenhouse gas emissions established by the International Panel on Climate Change (IPCC):

- RCP4.5 (most likely pathway in view of the current state of commitments to the COP21);
- RCP8.5 (current pathway if no measures are implemented).

In order to determine the current and future levels of exposure for each property asset, a list of climate change indicators to evaluate over the period of reference and in the future was defined for each climate hazard listed above. These climate indicators were used to run the climate models for each geographic location in the CNP Assurances property portfolio.

The study provided CNP Assurances with a clear picture at end-2017 of the assets with high physical risks in the event of the climate hazards examined.

The following formula is applied to calculate the risk score by risk type and by asset:

$$\text{Risk score} = \underbrace{\text{Exposure to climate hazard} \times \text{Change in climate indicator over time}}_{\text{Probability of occurrence}} \times \underbrace{\text{Severity of impact} \times \text{Category of security}}_{\text{Sensitivity to risk}}$$

Results

For most of the risks, CNP Assurances' exposure is weak or non-existent. Only buildings located around the Mediterranean and in cities that are prone to urban heat islands have a higher risk of heatwave or higher average temperatures by 2050.

Use of results

CNP Assurances will aim to reduce this exposure by encouraging its asset managers to propose mitigating measures.

evolution of schemes to support renewable generation; CO_2 price and projections; climate change trends, including frequency of extreme weather events.

Climate change explicitly influences the following priorities of the EDP strategic agenda for 2020:

- Organic growth focused on low carbon technologies, especially wind, hydro and solar, with a view to reaching about 76% of renewable capacity by 2020;
- Low CO_2 exposure and other environmental risks through renewable generation, CO_2 portfolio management and sustainability leadership, with a view to reducing specific emissions by 75% in 2030 compared to 2005 levels.

RISK AND OPPORTUNITIES MANAGEMENT

A detailed assessment of emerging climate risks and opportunities according to the taxonomy proposed by the TCFD was carried out: physical risks (these may have financial implications for organizations, such as direct damage to assets or disruption in the supply chain), transition risks (may involve major business changes to respond to the need for climate change mitigation and adaptation, with potential financial and reputational impact on organizations) and opportunities (potential gains from the mitigation strategy) – for more details, see the table below.

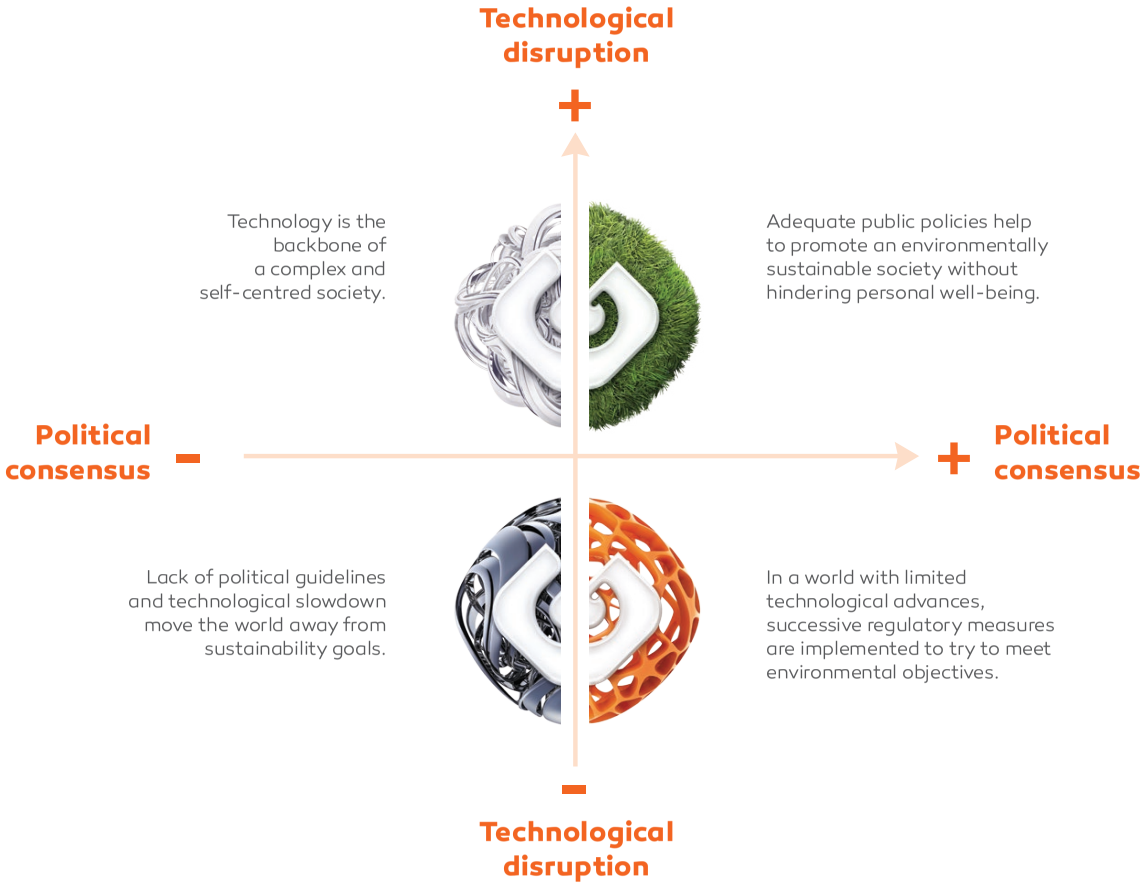
One of the key recommendations of the TCFD, in order to assess the resilience of the strategies of organization, is the use of long-term climate scenarios, including the 2ºC scenario. EDP used 4 IPCC Representative Concentration Pathway (RCP) scenarios: 8.5 (business-as-usual), 6.0, 4.5 and 2.6 (the most aggressive in terms of mitigation), for the analysis of physical risks, and used two scenarios from the IEA (International Energy Agency), IEA450 and 2DS, for the analysis of transition risks:

RISK	RISK TYPE	MAIN IMPACTS AND MITIGATION
PHYSICAL RISKS	**Acute**, with an impact on the increasing frequency and severity of extreme events, such as heat waves, droughts, floods, storms, forest fires.	Increasing the frequency and severity of extreme events, according to the IPCC scenarios, could disrupt production and distribution activities, as well as increase the operational and capital cost of recovering from damage to distribution and generation network assets. As mitigation strategies, EDP has a comprehensive insurance plan and has been reinforcing business continuity and crisis management plans, thereby minimizing impact to business and third parties.
	Chronic, related to longer-term changes in climate patterns, for example, increase in mean temperature and average level of oceans, and changes in precipitation patterns.	A structural decrease in precipitation, compounded by a potential increase in competitive uses of water, will affect hydroelectric production. IPCC scenario 8.5 is particularly worrisome for the Iberian Peninsula business, and may represent a decrease of 10% in average annual precipitation levels, directly impacting hydro productivity. To mitigate this risk, EDP has a strategy of diversification by technology, geographical area and by business area. Years such as 2017, representing a very dry year (HPI = 0.47), where the impact of the hydrological risk in the Iberian Peninsula was around €300M, may be more common, with the structural reduction of precipitation levels.
TRANSITION RISKS	**Regulatory** actions on concerted government actions for the adoption of climate mitigation and adaptation strategies, e.g. changes in schemes supporting renewable energies	One of the potential climate regulatory risks identified is related to the change in the regulatory framework regarding generation from renewable sources, with a potential financial impact for EDP. Risk is mitigated through an active strategy of diversification across technologies and geographical areas (see opportunities), asset maturity, as well as through rigorous monitoring of government policy and regulation.
	Technological, regarding the adoption of new technologies requiring greater investment by organizations.	In a fast-paced sector where the current system will be disrupted, the emergence of new, more efficient technologies will require higher levels of investment. The risk of failure to monitor or delay the adoption of new technologies may jeopardize the future. EDP tracks market trends, the study of still-maturing technologies throughout the value chain and has a clear innovation policy focused on the main trends in the sector (page 42).

2.1.

We challenge our strategy against multiple futures

In a world marked by increasing complexity, significant volatility and uncertainty, we are working to ensure Galp's sustainability by testing the resilience of our strategy in different scenarios. We present below four contrasting scenarios, with different levels of technological and regulatory disruption, which we believe reflect the critical uncertainties facing the energy sector.



Strategy

Climate change is a key element for defining the company's strategy. Iberdrola treats it not only as a risk factor, but also as an opportunity for growth through mitigation and adjustment activities during the transition towards a low-carbon economy.

Iberdrola's strategy is aligned with the objectives of the Paris Agreement, given that the company has been integrating the fight against climate change into its strategy since the early 2000s, clearly committing to decarbonisation of the energy model through renewable energy, storage and smart grids, together with the commitment to achieve the SDGs.

In 2018 ScottishPower sold its 2,566 MW of thermal generation, making it the first vertically integrated company in the United Kingdom with 100 % renewable wind power generation facilities.

Iberdrola has chosen four climate scenarios on which it is performing the analysis of potential impacts on its business model:

- **Two transition scenarios** that for Iberdrola represent potential paths towards a low-carbon economy. They are based on plausible projects prepared by a third party, the International Energy Agency:
  - *Sustainable Development Scenario* (*SDS*): this scenario assumes achievement of the climate change goals agreed to in Paris (<2°C), improvement in air quality and universal access to electricity in accordance with the UN SDGs.
  - *New Policies Scenario* (*NPS*): a scenario based on the World Energy Outlook, which includes current and announced energy policies (e.g. nationally determined commitments, or NDCs, from the Paris Agreement).

  There has been a comparative analysis of these two scenarios allowing for conclusions to be extracted by business and geographic area regarding the level of resiliency of Iberdrola's strategy with respect to climate change in the short and medium term. Continuity of the Outlook 2018-2022 has been assumed, with a qualitative transfer thereof through 2030.

  The result of the analysis indicates that, thanks to the company's strategy and positioning in renewable energy, divestment from oil and coal plants, and smart grids, its business model is sufficient to face both scenarios.

  It is important to note that, over the long term, Iberdrola's goal to achieve carbon neutrality by 2050 (which the company already set in 2009) is more ambitious than the goals sought under the NPS scenario and is aligned with the SDS.
- **Two physical scenarios**, based on the IPCC Fifth Assessment Report, to diagnose the range of impacts:
  - *Representative Concentration Pathway 8.5* (*RCP 8.5*) of the Intergovernmental Panel on Climate Change (IPCC): the most unfavourable case of the physical risks that the company might face corresponds to a 3.7° C increase in average global temperature during the 2081-2100 period.
  - *Representative Concentration Pathway 4.5* (*RCP 4.5*) of the Intergovernmental Panel on Climate Change (IPCC): stabilisation scenario, taking account of the efforts being made and to be made at the international level to reduce greenhouse gas emissions.

Taking into account that adjustment to the physical risks arising from climate change is a major issue for a sector as strategic as electricity, Iberdrola has analysed the principal climate threats to which the electricity sector might be exposed under these two scenarios in the various jurisdictions and for the different technologies in the short, medium and long term.

CLIMATE SCENARIOS

Our analysis indicates that Rio Tinto's business is relatively robust to scenarios mapping the policy and technology pathways necessary to limit global temperature rises:

- **Financial impact at a manageable level:** Rio Tinto has the financial and institutional capacity to manage the long-term impacts of a scenario limiting a rise in global temperature to below 2°C, while continuing to be profitable;
- **Portfolio naturally hedged:** diversification of our portfolio across multiple commodities provides a natural hedge against climate change policy; our aluminium and copper assets will be needed in the transition to a low-carbon future and could provide an offset in an environment where our iron ore assets are less attractive from a climate change perspective;
- **Many abatement options available to us to reduce direct emissions:** the significant number of internal abatement options available, coupled with a more gradual evolution of downstream industries, will give us time to anticipate and adapt to changes in policy.

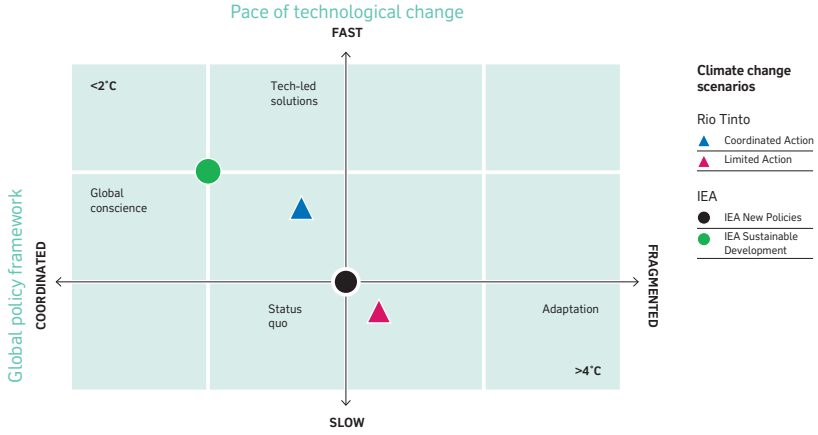
Rio Tinto considers the impact of climate change over two time horizons given the long-term nature of our business and the potential for unpredictability in regulatory response.

1. **Short to medium term** (0-20 years): while there is limited scope to react immediately to regulatory changes, we do have the ability to mitigate (or potentially take advantage of) shifts in technology and the policy environment. In this timeframe, physical changes are largely pre-determined since they are largely the result of carbon levels already accumulated in the atmosphere over past decades.
2. **Long term** (20-50 years): the physical impact of climate change to the world could potentially become more severe, depending on the success or failure of policy. Technology development is highly uncertain.

Across these time horizons, the Group assesses three climate change scenarios, which consider:

- **The policy environment** – for example, the level and coordination of carbon pricing internationally; and
- **The rate of technological development** – for example, the costs of low-carbon electricity generation and batteries.

Our approach recognises that there is an interplay between these two factors: technology that leapfrogs what is available today, for example, could succeed in dramatically reducing climate change and its impacts even in an environment where government mandates do not exist.



We have identified three scenarios that attempt to assess plausible combinations of these factors to better understand the resilience of the business across all time periods.

1. **Limited Action:** currently forms the baseline for our financial assessments and assumes that carbon prices (or other financial incentives to reduce carbon emissions) remain similar to today's levels throughout the planning period. It describes a conservative assumption against which to measure more proactive scenarios.
2. **Coordinated Action:** describes a central case view of policy pathways to 2050, taking into account both climate change objectives and a view on the feasibility of policies being adopted. We believe it is likely that climate change ambition will gradually increase over time, resulting in an increase of nationally determined contributions. However, we anticipate that the pace and degree of ambition will be insufficient to meet the Paris Agreement. This scenario lies in-between the International Energy Agency's (IEA) New Policies and Sustainable Development scenarios, resulting in a climate change outcome in the 2.5 -3.5°C warming range by 2100.
3. **IEA Sustainable Development Scenario:** developed by the IEA to describe a plausible path to meet the key global goals of the Paris Agreement and hold the rise in the global average temperature to well below 2°C above pre-industrial levels. This scenario assumes relatively high-carbon prices (up to US$140/tCO$_2$e by 2040 in developed countries) as well as a widespread deployment of low-carbon technologies such as carbon capture and storage. Where possible we use IEA's assumptions directly, but it is also necessary to make additional reasonable assumptions regarding how these will pass through to the mining and processing industries.

The IEA Sustainable Development Scenario (SDS)

In the SDS, global CO_2 emissions peak before 2020 and decline swiftly. By 2040, emissions are at the lower end of a range of publicly available decarbonisation scenarios, all of which estimate a temperature increase of around 1.7-1.8°C in 2100.

Developed world carbon prices reach US$140/tCO$_2$e in 2040 (US$100/tCO$_2$e in the developing world). This increases the cost of carbon-intensive power used for mining, processing, and transporting ores to customers. The total economic cost of implementing low-carbon technology is not expected to be a significant drag on economic growth, given the multiple co-benefits, including higher productivity from lower levels of air pollution. Thus, the main impact on commodity prices is from the cost side, and the dominant factor influencing our margins is our carbon intensity (or that of using Rio Tinto's products) relative to that of our peers.

We have made commodity-specific assumptions to flesh out the Scenario in a plausible fashion:

- Iron ore and steel: we assume full pass-through of carbon costs to mines and smelters even though a degree of transitional assistance is possible. High carbon prices provide an incentive to increase the use of high-grade ores, lump, and pellets. High carbon prices are assumed to cause significant substitution towards scrap, reducing demand for ore.
- Copper and aluminium: we consider the impact on the cost of acquiring raw materials, such as alumina, and assume that transitional assistance for aluminium is phased out quickly. In the short to medium term, carbon-related cost inflation is likely to be lower for copper than aluminium, leading to limited substitution towards copper.
- Battery materials (incl. lithium): we use a high-case electric vehicle penetration forecast, consistent with the IEA SDS, but with additional detail on the types of vehicles, size of batteries and implications of these for commodity demand.

Using the TCFD voluntary guidelines, we have followed a staged process (Figure 2) to stress test our portfolio and our operations against plausible, evidence-based but divergent scenarios.

In collaboration with subject matter experts and stakeholders we developed three scenarios:

(1) Global Cooperation

(2) Patchy Progress (South32 base case)

(3) Runaway Climate Change

These scenarios combine elements from distinct scenarios set out by international agencies including IPCC, IEA and WEO (see Glossary for more detail).

Building these customised scenarios gave us a comprehensive view of the various climate change-driven impacts which may affect our business, including social dynamics, market behaviours and physical impacts.

These scenarios are both qualitative and quantitative in approach and intentionally extreme to provide a sharp contrast between potential futures.

The real future may deliver on a combination of the different scenarios or none, but the scenarios are designed to gain insight, recognise trends, identify possibilities and enable us to act quickly on the opportunities we see. The drivers within the scenarios will be revisited and updated every two years (next in FY19) to incorporate progress against signposts and triggers.

In stress testing against these scenarios, we have focused on indicators that can be used to support internal decision-making while also informing stakeholders of South32's position. We will continue reviewing and refining our resilience measures as our analysis evolves over time, including options to incorporate more quantitative information.

Figure 2 Our approach to stress testing our portfolio and operations

What is a scenario?

A scenario describes a path of development leading to a particular outcome. Scenarios are not intended to represent a full description of the future, but rather to highlight central elements of a possible future and to draw attention to the key factors that will drive future developments. It is important to remember that scenarios are hypothetical constructs; they are not forecasts or predictions nor are they sensitivity analyses. Scenario analysis is a tool to enhance critical strategic thinking.[7]

(7) TCFD Technical Supplement: The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities (June 2017).

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Our resilience to the physical impact of climate change[13]

SCENARIO USED: RUNAWAY CLIMATE CHANGE SCENARIO[14]

Nearly every sector of the economy faces risks from the short and long-term physical effects of climate change. Physical impacts are classified as chronic or acute. Chronic are those that incrementally develop over time, such as air temperature, or decreasing rainfall trend. Acute are the sudden shock events such as flooding, bushfire and cyclones.

The resilience of our business to the physical impacts of climate change will depend on the scale and pace of global temperature rise and associated climatic trends including (for example) precipitation, sea level rise, humidity, temperature and frequency and intensity of extreme weather events.

We used the Runaway Climate Change scenario to test our strategic risks and opportunities for physical impact, as this presents the most chronic and acute modelled physical impacts.

This analysis provides us, and our stakeholders, with insights on where our operations may experience material impacts due to physical climate change beyond those incorporated into our base case. Importantly, it also provides drivers, or signposts, for timely adaptation.

We commenced with the Australian operations in FY18 and plan to complete similar assessments for the Southern African and Colombian operations, as well as our greenfield or acquired sites, over the course of FY19 and FY20.

Our methodology is built around Australian climate data projections that are aligned with the Runaway Climate Change scenario, and were largely sourced from the Mining Climate Assessment (MiCA) tool available through the International Council on Mining and Metals (ICMM) database (using 2035 as a proxy for 2040) and CSIRO (using 2030 and 2050 projections to cross-check MiCA data).

Based on these resources, projections were developed for several key measures (for example temperature increase, precipitation etc.) at the locations of each operation, which will plausibly be operated/ managed by South32 through to 2040, based on their reserve lives and post-closure rehabilitation activities. We used a variety of technical resources and methodologies to develop a fit-for-purpose approach to this analysis. A worked example is provided on page 37.

Each operation was considered separately, and resilience was assessed across three key impact categories: asset integrity and production continuity, maintaining supply chain and logistics, and worker health. A total of 14 drivers were considered to give a range of possible outcomes to 2040, considering:

Exposure: A rating of exposure to acute and chronic physical climate change projected for an operation's location

Sensitivity: A rating to reflect financial or other critical impacts that consider existing operational design, infrastructure and supply chain factors

Adaptive Capacity: A rating to reflect an operation's capacity to adapt to avoid the critical impacts, based on an understanding of availability, current technology or other adaptation options

The results indicate where we may need to reprioritise our attention on designing and planning for resilience, and will form an input into our ongoing planning process as we assess signposts for realising this or other scenarios. This includes timely and pragmatic decisions on future infrastructure investments required to preserve the value of our operations, as well as to assist in avoiding maladaptive investments.

(13) This section refers to South32 operational resilience under the Climate Change scenario. As such, the descriptions of resilience here are not South32 forecasts, but describe what we have assessed could happen if the world's climate progressed in line with the Runaway Climate Change scenario, as described on page 24.

(14) Projected change in global mean surface temperature for the late 21st century, relative to the 1986–2005 period – IPCC 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

ASSESSMENT EXAMPLE: WORSLEY ALUMINA RUNAWAY CLIMATE CHANGE SCENARIO AT 2040

Climate stressor	Examples of impacts considered for all South32 operations	Relative assessment of resilience in 2040 Runaway Climate Change scenario – Worsley Alumina
Changes in extreme weather patterns	Containment failure in dams following intense rainfall	Moderate resilience
	Containment failure in facilities following intense rainfall	High resilience
	River flooding affects mine and processing operations	High resilience
	Cyclones or storms affect port and rail operations	Moderate resilience
Warmer temperatures and lower rainfall	Bushfires affect operations	Moderate resilience
	More dust created by our mining and processing activities	Low resilience
	Droughts affect water supply to operations	Low resilience
	Droughts affect hydroelectric power supply to operations	Not applicable
Warmer temperatures and more frequent heatwaves	Hotter weather affects how we manage gas levels in underground mines and in processing facilities	Very high resilience
	Heat interrupts flight operations	Not applicable
	Heat interrupts rail operations	High resilience
	Power supply to operations interrupted	Moderate resilience
	Heat affects worker health and safety	High resilience
Warmer temperatures and more rainfall	Conditions affect where and when our locations are receptive to malaria	Very high resilience

Impact category key

- **Asset integrity and production continuity:** Impacts which could directly affect the operation's capacity to operate safely and maintain planned production levels (e.g. direct damage from severe storms, flooding from intense rainfall events, productivity decline from increasing dust creation).
- **Maintaining supply chain and logistics:** Impacts which could materially affect access to critical inputs and delivery of products to key locations (e.g. storms affecting port and rail integrity, drought affecting hydroelectric power supply, heat interrupting flight operations).
- **Worker health:** Impacts on the health and safety of our employees (e.g. heat-related illness, increased malaria risk due to regional climate changes).

Resilience key

- **Very high resilience** has been attributed where, under this scenario, our operations have been assessed as highly unlikely to be impacted in 2040 for this driver.
- **High resilience** has been attributed where, under this scenario, our operations have been assessed as unlikely to be impacted in 2040 for this driver.
- **Moderate resilience** has been attributed where, under this scenario, our operations have been assessed as may be impacted in 2040 for this driver.
- **Low resilience** has been attributed where, under this scenario, our operations have been assessed as likely to be impacted in 2040 for this driver.
- **Very low resilience** has been attributed where, under this scenario, our operations have been assessed as highly likely to be impacted in 2040 for this driver.

Task Force on Climate-Related Financial Disclosures (TCFD)

Our approach to climate risk and opportunity
This section of our Performance and Data report responds to the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD). Here you can find a comprehensive account of our approach to climate risk and opportunity.

Our position on TCFD
We are committed to implementing the recommendations of the TCFD, providing our stakeholders and investors accurate data and insight about the climate-related risks and opportunities which are relevant to our business. We've made a public commitment to assessing and mitigating climate change risks across our portfolio and are one of 580 organisations publicly listed by the TCFD as supporters.

Our approach to climate risk and opportunity is discussed in our Annual Report on pages 40-41, and as part of our principal risks and uncertainties section on page 59. For further disclosures you can access our CDP response at https://www.cdp.net/en.

Governance
Our Chief Executive has overall responsibility for climate-related risks and opportunities. The Board receive an annual briefing on our sustainability programme which includes discussion of risks and opportunities. Ongoing oversight of climate-related issues is carried out by our Sustainability Committee, chaired by the Chief Executive. Our Sustainability Committee is comprised of our Director of Corporate Affairs and Sustainability and our Group HR Director – both members of our Executive Committee – together with our Head of Sustainability, Public Affairs and Health, Safety & Security and senior representation from our portfolio management, development and finance functions.

The committee meets quarterly and is the senior forum for determining our sustainability strategy and reviewing performance. This includes responding to climate-related opportunities such as investment in renewables, improvements in energy efficiency and investment in low-carbon technologies. The committee has oversight for climate-related risks including policy, regulatory and legal risks, as well as the physical risks to our assets. The committee also approves and reviews research and analysis to determine our response to climate-related risks and opportunities.

Our Sustainability Committee is supported by our Investment Committee, London Executive Committee and Retail Executive Committee. Each committee reviews the risks opportunities as described above. This can include reviewing and approving investment in energy efficiency projects and renewables, as well as approving development or refurbishment plans which include climate-related aspects of design.

Our commitment to address climate-related risks is embedded across the business, through an energy reduction Group KPI. The performance against this KPI is linked to executive and management remuneration, aiming to incentivise progress against our science-based carbon reduction target and energy efficiency commitment.

Identifying risks and opportunities
As an owner and operator of property, our business is exposed to both risk and opportunity from climate change. The nature and level of risk is dependent on government, business and society's response in the short and long term. In the event of a strong response to climate change in the short term up to 2030, our business will be affected in positive and negative ways by the transition. With a limited response to climate change, our business will be affected in the long term past 2030 by physical effects such as extreme weather and higher temperatures. Accordingly, our analysis focuses on both transitional risks up to 2030 and physical risks past 2030.

To determine how our business may be affected by the physical risk, we conducted research and modelling. This research was carried out in 2017 and 2019. The modelling has enabled us to determine the likelihood of potential future weather patterns and natural hazards. The risks occurring due to these weather and climate patterns include chronic factors such as energy costs from overheating, and acute factors such as windstorm, and coastal, inland and flash flooding. Our exposure to these risks is derived through analysis of our property portfolio, using climate and natural hazard databases such as SwissRe CatNet™ and MunichRe NATHAN™, and is further adjusted based on expert judgement. The research and analysis carried out in 2019 incorporated the Met Office Climate Projections 2018 (UKCP18), which are widely accepted as the most accurate forecasts for how climate change will affect the climate and weather in the UK.

The modelling of all chronic and acute physical risks was based on the four Representative Concentration Pathways (RCPs), which are used by the Intergovernmental Panel on Climate Change (IPCC) to illustrate future concentrations of greenhouse gases in the atmosphere. Although our modelling analysed all four RCPs, we simplified our approach by focusing on two distinct scenarios, a best-case scenario where global average temperature increases by less than two degrees in line with the 2015 Paris Climate Agreement, and a worst-case scenario, where temperatures increase by up to four degrees.

To determine how our business will be affected by a transition to the low-carbon economy, we conducted quantitative and qualitative scenario analysis, using the TCFD recommendations as a guide. The process of scenario analysis was designed to allow us to assess our resilience in two alternate futures, transition to the low-carbon economy or failure to transition. This process relied on a variety of data sources and a panel of experts including insurance, strategy, finance, insight and treasury functions from our business, alongside weather, natural catastrophe, enterprise risk management and academic research representatives from Willis Towers Watson and the Willis Research Network.

Four degrees scenario

This scenario is aligned with the IPCC's RCP 8.5, where climate change will increase by up to four degrees by 2100. In the lead up to 2030, limited actions are taken to mitigate climate change, current levels of investment in low-carbon technology continue, and emissions continue to rise along their current trajectory. In the period between 2030 and 2100, the physical effects of climate change begin to intensify rapidly, and government, business and society will need to adapt to the effects.

Beyond 2030, widespread disruption to markets could begin to occur, and investment in climate change resilient technologies and infrastructure is likely to be required for organisations with physical assets. The policy, regulatory and legal response, although limited in the short term, could begin to force organisations in control of physical assets to adapt to climate change. In this scenario, businesses with high levels of carbon emissions could experience a backlash in consumer, customer and investor sentiment.

Physical risks and their impacts

What could happen in this scenario by 2070?

- **5.4°C** hotter in summer
- **50%** increase in heatwaves
- **35%** more rain in winter
- **9%** increase in electricity use
- **32%** decrease in gas use

In this scenario it is likely we will experience an increase in flash flooding, river floods, coastal flooding and storm surges. These weather events are applicable to a small proportion of assets in our portfolio, noted in the Metrics and Targets section of this report. Increases in year-round temperature are predicted, with summer temperatures at 5.4°C higher and winter temperatures at 4.2°C higher than the current climate. Higher levels of precipitation are predicted in winter at up to +35%, and lower levels of summer precipitation are predicted at down to -47%.

These physical effects could have several effects on our business due to changes in markets, policy, regulation and technology. Accordingly, we do not consider the consequences of these physical risks to be 'transition' risks, as under the four-degree scenario there will be very little transitional activity. We consider these risks and associated impacts to be costs of adapting to the new climate and weather patterns.

In this scenario, the physical risks to our portfolio could pose several market challenges, including potential lower asset values, higher operational costs, higher costs of insurance premiums, and reduced attractiveness to our customers and consumers. Specifically, asset values could fall where they are proven to have poor resilience to windstorm and flooding. Where we own assets in cities, particularly London, we could experience reduced demand for our properties affected by extreme heat and air pollution.

Due to the extreme temperature and weather patterns associated with this scenario, it is likely that poorly designed, operated and maintained assets will experience more frequent building system and envelope failures. This is likely to lead to higher operational costs, but also reputation risks, where customers begin to rely more on property companies to maintain safe and comfortable spaces for their staff and consumers. More extreme weather could also lead to increasing numbers of building failures and natural catastrophes, leading to rising insurance premiums.

In this scenario our business could also be affected by higher raw material costs due to increasing fossil fuel and water costs, disruption to logistics and higher cost of production from taxes and levies. Similarly, we will experience higher construction costs arising from climate change resilient facades and building services with increased capacity.

In the long-term under this scenario, a widespread decrease in combustion-engine vehicle use could lead to assets without good public transport links becoming less attractive to consumers. Consumers and our direct customers could develop greater awareness and expectations of property businesses, pressurising them to act on climate-related issues, and creating greater favour for destinations which are sustainable.

Opportunities

Owing to the nature of this scenario, there are only limited opportunities as the impacts are predominantly negative for most business types. We could experience higher levels of customer and investor demand for resilient assets which can withstand the increasing frequency of windstorm and flooding. In addition, falling asset values and business failures could lead to opportunity for more resilient businesses to gain increasing market share.

How we'll need to respond

In this scenario, our analysis demonstrates that changes to our strategy and financial planning will be required. This will include divestment of assets which are less resilient to extreme heat and rainfall, or investment into infrastructure to limit the impact of flooding and coastal surge. We believe our strategy for investing in high-quality assets in primary locations will continue to be resilient in this scenario. However, to maintain an effective strategy we will need to increase our prioritisation of climate change factors in investment, development and divestment decisions.

This scenario could also result in changes to our customers' and supply chain partners' businesses, as well as consumer preferences. To continue to be resilient in this scenario, we will need to constantly reassess the risks posed by climate change to ensure we are not exposed to risk of default from business failures or supply chain disruption. Increased due-diligence in supply chain selection will be required, particularly considering the sourcing of construction materials which may be processed or manufactured in countries where the effects of climate change are more extreme.

TCFD Metrics and targets Table 29

Financial category	Climate related category	Metric	Unit of measure	Landsec 2017/18	2018/19
Revenues	Risk Adaptation & Mitigation	Revenues/savings from investments in low-carbon alternatives (e.g., R&D, equipment, products, services)	£	1,538,662.58	1,918,389.31
Revenues	Risk Adaptation & Mitigation	Avoided energy consumption costs benefitting customers in year, measured against 2013/14 baseline	£	–	£4.0m[1]
Revenues	Risk Adaptation & Mitigation	Percentage of revenues derived from BREEAM certified assets	£	56%	57%
Expenditures	Risk Adaptation & Mitigation	Expenditures (OpEx) for low-carbon alternatives (e.g., R&D, technology, products, services)	£	1,716,526,526.10	1,457,997.84
	Energy/Fuel	Total energy consumption	kWh	265,723,992.15	265,571,273.86
	Energy/Fuel	Proportion of energy consumption from renewable sources	%	64%	66%
	Energy/Fuel	Total electricity consumption	kWh	167,507,064.49	167,590,019.79
	Energy/Fuel	Proportion of electricity consumption from renewable sources	%	93%	96%
	Energy/Fuel	Total fuel consumption (i.e. gas)	kWh	86,337,790.66	81,310,160.07
	Energy/Fuel	Proportion of fuel consumption from renewable sources (i.e. green gas)	%	17%	16%
	Energy/Fuel	Total building energy intensity by floor area	kWh/m^2	144	142
	Energy/Fuel	Forecast change in energy cost by 2100, four-degree scenario	£	–	£0.9m[2]
	Water	Percent of fresh water withdrawn in regions with high or extremely high baseline water stress	m^3	0	0
	Water	Total building water intensity by floor area	m^3/m^2	0.57	0.56
	GHG Emissions	Total GHG emissions intensity by floor area	tCO_2e/m^2	0.052[3]	0.043
Assets	Location	Percentage floor area of portfolio exposed a 10-20% risk of inland, coastal and flash flooding in a ten-year period	% floor area	0.4%	0.3%
	Location	Percentage value of portfolio exposed to a 10-20% risk of inland, coastal and flash flooding in a ten-year period[4]	% Value	1.5%	1.4%
	Location	Insured value of assets exposed to possible significant increase in river flood risk due to climate change	£	£5.7m	£7.0m[5]
	Location	Insured value of assets exposed to possible significant increase in coastal flood risk due to climate change	£	£281m	£257.3m[6]
	Risk Adaptation & Mitigation	Percentage of portfolio which is BREEAM certified	% floor area	40.1%	40.2%
	Risk Adaptation & Mitigation	Percentage of portfolio which is BREEAM certified	% portfolio value	61%	60%
	Risk Adaptation & Mitigation	Investment (CapEx) in low-carbon alternatives (e.g., capital equipment or assets)	£	4,402,019.00	2,377,136.00
	Risk Adaptation & Mitigation	Costs of obtaining Energy Performance Certificates for assets which are not currently certified[7]	£	–	£0.3m

1 Consumption costs measured in 2018/19, based on comparable floor area from 2013/14 portfolio.
2 Increase in cooling costs offset by decrease in gas costs.
3 This figure is based on absolute energy across scopes 1,2 and 3.
4 Based on a return period of 50-100 years meaning there is a 1-2% chance every year or 10-20% in the next 10 years that flooding would occur.
5 Acquired one new asset in river flood risk zone.
6 Divested two assets in coastal flood risk zone.
7 30% of our assets must obtain an EPC before 2023.

TCFD: Data sources Table 30

Projections	Analysis	2017 analysis	2019 analysis	Source
Energy Consumption	Modelling	Now out of date	Updated	UKCP18 previously CMIP5
Flood Risk	Exposure & Scoring	Now out of date	Updated	Swiss Re CatNet; Munich Re NATHAN
	Probabilistic Modelling	Current	No update minimal impact	CCRA Report 2017; (Next update 2022)
Sea Level Rise	Exposure & Scoring	Now out of date	Updated	UKCP18 previously CCRA 2017 after UKCP09
Windstorm	Probabilistic Modelling	Current	No update minimal impact	ABI Report 2017
Temperature	Review	Now out of date	Updated	UKCP18 previously CMIP5
Precipitation	Review	Now out of date	Updated	UKCP18 previously CMIP5

Addressing climate change (continued)

	Phase 1-2 Policy, due diligence, governance, analysis of portfolio risks and opportunities	Phase 3 Extending scenario analysis, strategic responses, capability building	Phase 4 Embedding climate considerations into strategy, business and risk management processes
	Pre-FY19	**FY19**	**FY20-21**
Governance	• Climate Policy Position Statement[1] • Group Environment Policy[1] • Equator Principles III Report[1] • ESG Lending Commitments[1] • Responsible Investing Framework[1] • The Board governs climate risks and opportunities through the Risk Management Framework[2]	• Developed a Group Environmental and Social Policy with updated climate commitments, including: – continuing to reduce our exposures to thermal coal mining and coal fired power generation, with a view to exiting the sectors by 2030, subject to Australia having a secure energy platform – supporting the development of existing and emerging technologies that enable an accelerated transition to a low carbon future	• Review the Group Environmental and Social Policy to ensure alignment with the rapidly evolving nature of environmental and social issues • Review the Group Risk Appetite Statement • Review of climate-related roles and responsibilities
Strategy	• Commitment to support the objectives of the Paris Agreement • Climate scenario analysis: – Business lending: transition risks – FirstChoice Australian Share Fund: transition risks – Retail (home lending) and insurance: physical risks • Portfolio-level strategic responses	• Climate scenario analysis: – Agribusiness lending: physical risks • Portfolio-level strategic responses • Client engagement	• Climate scenario analysis: – Business lending: physical risks for other key portfolios – Retail (home lending) and insurance: transition risks – Investment portfolios: transition and physical risks • Further develop strategic responses • Client and customer engagement
Risk management	• Elevated climate as a strategic risk and a long-term driver of both financial and non-financial risks • Introduced an ESG Risk Assessment Tool, including climate and energy considerations, for business lending • Training on ESG risks, including climate, for business lenders • Established Energy Value Chain analysis	• Physical climate risk added to the ESG Risk Assessment Tool process for business lending • Reviewed clients within carbon sensitive sectors, based on FY18 scenario analysis, to better understand their management of climate risk • Updated Energy Value Chain Analysis	• Continue to update the ESG Risk Assessment Tool and build capabilities as stakeholder expectations and global developments evolve • Work with clients as they progress their transition strategies
Metrics and targets	• Emissions reduction target (Scope 1 and 2) • Assessed emissions in business lending portfolio • Low carbon project funding target of $15 billion by 2025	• Joined the global RE100 initiative and committed to sourcing 100% of our electricity needs from renewable energy by 2030 • Assessed emissions in business lending portfolio[3] • Progress on low carbon project funding target	• Continue to make progress on our RE100 commitment • Science-based emissions reduction target (Scope 1 and 2) • Assess emissions in business and retail lending and investment portfolios • Emissions reduction target (Scope 3) • Progress on low carbon project funding target

1 All policies are found at commbank.com.au/policies.
2 Further information on the Group's Risk Management Framework is provided on page 201.
3 Our assessed emissions reporting is available at commbank.com.au/CRreporting.

What we found

Grains

Current grain growing regions face the risk of potential farmer profitability declines by 2060, due to falls in productivity in many areas of up to 50% below the 2018 baseline levels, primarily due to changes in predicted rainfall (Figure 01). Adaptive measures can preserve current productivity levels in most regions, and even improve profitability up to 65% above the baseline in some regions (Figure 02). However, the trend of declining rainfall could result in some regions becoming significantly less viable for crop production in the long term.

Adaptive measures including breeding for improved tolerance to drought and heat could improve crop yields by up to 20% by 2060 for certain crops. Genetic modification can markedly increase crops' climate resilience, with the potential to improve the yield of some crops by up to 40% over the next 40 years. However, the use of genetically modified organisms (GMOs) is a controversial solution and is currently banned in parts of Australia.

Further developments in crop monitoring and management technology to maximise water efficiency and optimise activities are expected to boost productivity. Farmers can also shift the sowing window to optimise the growing season, and there is potential for further improvements.

Livestock

Livestock regions face significant farmer profitability declines by 2060, with falls of up to 40% due to a deterioration in pasture growth and quality (Figure 03). However, adaptive measures can significantly improve livestock production, with most regions able to convert an absolute decline in profitability to an improvement above the baseline by 2060. There is a cost to these adaptive measures, which may outweigh the benefits for some regions (Figure 04).

Potential adaptive measures include breeding for increased tolerance to heat and humidity, improving pasture quality in harsher conditions and cooling livestock by providing shade and water sprays. Developments in monitoring and management technology can maximise resource efficiency. An example is rotational grazing using virtual fencing technology. This maintains soil and pasture quality by reducing overgrazing. Genetic modification of pasture species has most potential in the south where pastures are typically not native.

Dairy

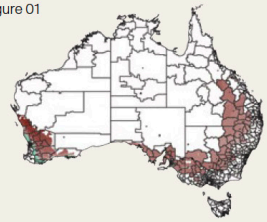
Dairy regions also face the risk of farmer profitability declines by 2060, with falls in most regions of up to 40% from baseline levels (Figure 05). A key risk for declining dairy profitability is the incidence of consecutive days of significant heat stress, measured using the Temperature Humidity Index (THI). After five such days in a row dairy cows can stop lactating, ceasing production.

Adaptive measures can significantly improve the situation for dairy production, with most regions projected to at least maintain baseline levels of profitability. As Figure 06 shows, in some regions a farmer profitability decline could be converted to an improvement of up to 40% above the baseline.

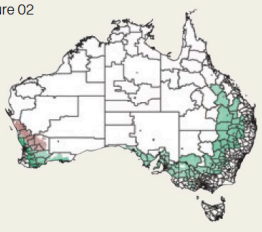
Breeding in *Bos indicus* genetics could increase tolerance to heat and humidity but may also lower milk yield, so uptake of this measure is likely to be delayed. Improved monitoring technology has the potential to maximise output, by optimising supplemental feed and the cooling of cows using shade and water sprays. Genetic modification of pasture or supplemental feed species can also potentially increase yield.

Climate simulation: impact on farm profitability by 2060

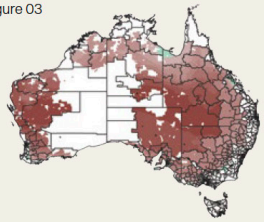
Grains
Worst case without adaptation
Figure 01



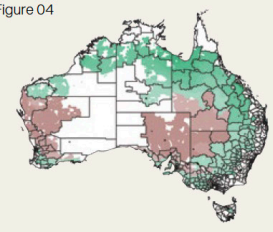
Worst case with adaptation (ex GMOs)
Figure 02



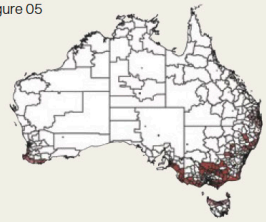
Livestock
Worst case without adaptation
Figure 03



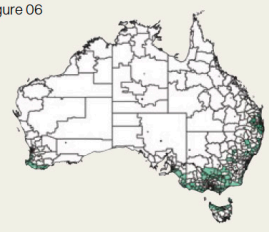
Worst case with adaptation (ex GMOs)
Figure 04



Dairy
Worst case without adaptation
Figure 05



Worst case with adaptation (ex GMOs)
Figure 06



% change in farm profitability -50% +110%

Addressing climate change (continued)

How we are responding

We have estimated the impacts of the above potential changes on the credit quality of our portfolio. We found that while many customers are likely to be impacted by potential productivity falls due to climate change, in aggregate the impacts are not significant for our portfolio. Through our credit assessment, we have observed that our farmers are largely able to manage climate events within their financials, due to the buffers present in their current and future interest coverage ratios. With the right adaptive measures, and the right timing of their uptake, these impacts can be successfully mitigated by adaptation improving yields for farmers.

As a Group, we are using the findings of our analysis to inform the future management of our agriculture portfolio, including building better tools to manage and monitor our risks. We will focus on supporting our customers operating in those areas of Australia that, according to our modelling, will be significantly impacted by climate change. We are also engaging and upskilling our agribusiness teams through training, policies and toolkits, so that they are able to incorporate considerations of climate resilience and adaptation into conversations with our farming customers.

Methodology for agriculture portfolio physical risk scenario analysis

Climate change scenarios

Climate change impacts to each agriculture sector were assessed in response to multiple emissions pathways, climate scenarios and adaptation responses to capture a wide range of potential impacts. The Intergovernmental Panel on Climate Change's (IPCC) low (Representative Concentration Pathway 4.5) and high (RCP 8.5) global emissions pathways were considered as well as two climate models to provide a range of potential outcomes. Outcomes were then considered with and without the uptake of cost-effective adaptive measures. Altogether, 12 scenarios were considered, book-ended by a best case (low emissions pathway, climate model showing least change, full adaptation uptake, inclusive of GMO developments) and worst case (high emissions pathway, climate model showing most change and no adaptation uptake).

Impact models

Climate impact models were sourced for grains, dairy cattle and livestock based on a survey of Australian literature. The impact models are:

- Grains: a statistical relationship between productivity, seasonal rainfall and seasonal temperature was applied to historical and future climate data on a five kilometre grid.
- Livestock: a statistical relationship between productivity, seasonal rainfall and seasonal temperature was applied to historical and future climate data on a five kilometre grid.
- Dairy: a statistical relationship between productivity and seasonal rainfall, temperature and the Temperature-Humidity Index modelled at three sites by Dairy Australia was applied to the other five dairy regions.

Climate variables

The climate variables are:

- seasonal rainfall and temperature
- daily average temperature and humidity.

Additional climate variables and related environmental stressors are known to affect production but were assessed more broadly due to data and evidence limitations. These parameters include fire, cyclones, sea level rise, pests and diseases. As a result, our modelling of physical climate risk may understate the potential impact of climate change.

Outputs

Bounds were placed on the results of the statistical models to ensure that outputs were plausible. Results were filtered, using Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) land use data, to remove unused land such as deserts and waterways. The effects of climate change were expressed as percentage changes in productivity from a 2018 adjusted baseline to ensure relevance to the current day. Commodity prices were assumed to remain steady. In adaptation scenarios the change in profitability is the change in output post adaptation less the cost of adaptive measures.

Adaptation

Potential adaptive measures were researched for each agricultural sector. These include measures already taken up by some farmers but with potential for increased uptake, as well as measures not yet implemented but well researched. Additionally, an allowance was included for future technology not yet developed, projected to be available from around 2035. Adaptation uptake curves were developed for each representative commodity type based on the selected measures, their expected crop yield improvements, and costs to implement and uptake rates.

Credit risk

Using the profitability and productivity impacts, we were able to estimate how climate change could effect the credit risk metrics of our existing agribusiness customers. Using a driver based approach and our existing credit risk models we were able to assess the impact on the portfolio's probability of default. A number of simplifying assumptions were made for example, land values and commodity prices were held constant. As a consequence, the actual impacts may be greater or less than those calculated.

Data sources

Farm location information was obtained from the Australian Bureau of Statistics (ABS) Agricultural Census 2015-16. Other geographical information was obtained from the ABS, ABARES and other Australian Government agencies. Climate impact models were drawn from research by CSIRO, ABARES and Dairy Australia.

Limitations and uncertainties

This analysis is based on best available information. However, it is unable to overcome some important limitations and uncertainties. For example, climate change simulations currently have minimal ability to model extreme weather events. Similarly, agricultural impact models need to be further developed to test the bounds at which statistical relationships change.

Estimated annual average losses to customers from physical risks

Impact	Customers facing increasing repair and replacement costs for physical damage to their properties.
Findings	Under the high emissions (RCP 8.5) scenario, if we were to continue to lend in these areas, the estimated annual average losses to customers across our home lending portfolio are expected to increase by 27% by 2060 – this is less than 1% per annum. The largest contributor to these losses currently arises from soil contraction, but the modeling shows that coastal inundation losses could increase by 71% by 2060, primarily due to sea level rises.

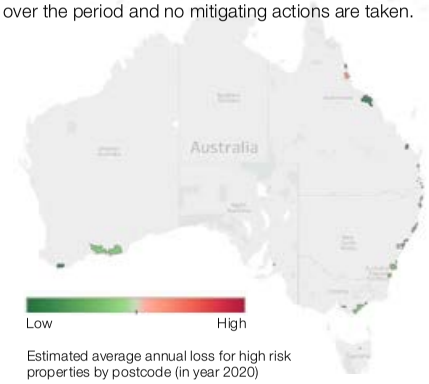
Estimated annual average loss by postcode in year 2060

Estimated annual average loss by peril

High risk properties

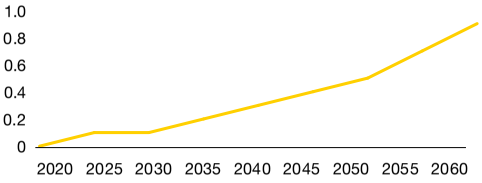
To better understand our potential credit risk, we have estimated the part of our current portfolio which may be high risk, where this is located and how it could change over time. We have considered high risk to be properties where the increase in insurance costs from 2018 as a result of climate change have the potential to create financial strain for customers and their property values.

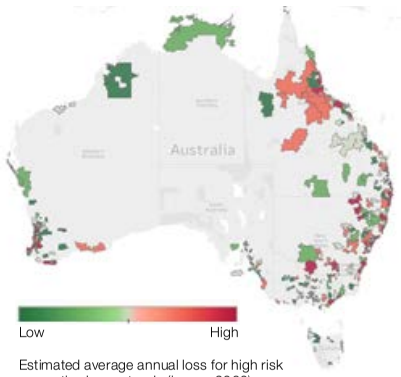
High risk properties make up only 0.01% of our portfolio (by outstanding balance) in 2020 and rises to be around 1% in 2060 if there are no changes in the way we lend in these areas. This assumes no change in the portfolio over the period and no mitigating actions are taken.



Estimated average annual loss for high risk properties by postcode (in year 2020)

Estimated % of portfolio (outstanding balance) considered high risk





Estimated average annual loss for high risk properties by postcode (in year 2060)

How we are responding
It is important for the Bank to consider the impacts and risks of physical climate changes on our customers as well as our insurance and residential lending portfolios. We will continue to develop our understanding of physical climate change and the locations and types of properties most affected by climate risk. Based on these learnings, we will build our capability to effectively respond, develop and implement business rules (such as maximum loan to valuation ratios or loan conditions) to protect both our customers and the Bank from risks associated with climate change.

The expected impact of climate change may compound the existing issue of insurance affordability in areas with high risk of severe weather events. To counter this threat, we will consider the most effective approaches to mitigating against physical climate change risks. This will include consideration of our products and services through which there may be opportunities to assist or incentivise customers to make home resilience improvements, and advocating on their behalf for governments to invest in mitigation measures to respond to community level risks.

Minimising climate risk for property, both residential and commercial, is an issue that goes beyond the banking and insurance sectors. Appropriate planning regulation is essential to building climate resilience in the sector going forward and both a private and public response is needed. Where we don't have the ability to help our customers directly, we will engage and advocate on their behalf across government, insurance and banking to find solutions to these problems before they become acute.

To this end, we have been actively involved in the development of the National Risk Reduction Framework, as a priority of the National Resilience Taskforce, which is being led by the Department of Home Affairs. This is a collective effort involving public, private and community sectors in the development of a framework to identify, address and mitigate disaster risk.

Transition risks and opportunities

We have undertaken scenario analysis to assess the transition risks and opportunities in our business lending portfolio, covering Commonwealth Bank, Bankwest and ASB. The climate scenarios (outlined on page 50) were assessed to identify the impacts for the Australian economy at a sectoral level, and these were analysed in relation to the Bank's debt exposure and one of our domestic equity portfolios, to 2050.

The scenarios align to reference scenarios and industry-specific research. There were a number of out-of-model adjustments, based on industry-specific research, made in order to ensure that the model reflected our view of different climate futures. These adjustments were on:

- carbon pricing and offset markets
- international energy demand
- materials efficiency
- domestic energy use
- new business models

This project was supported by EY and ClimateWorks Australia.

Transition risks and opportunities in our business lending portfolio

What we found
Emissions fall under all three of our scenarios. However, Australia only meets its existing international emissions commitments under the Global Co-ordination and Disruptive Decarbonisation scenarios.

The analysis provided economic growth, by sector, for the Australian economy under the three scenarios through to 2050.

The analysis found that the overall economy grows across all scenarios and timeframes through to 2050. However, the rate of growth, sectors impacted and degree of impact, vary by scenario.

The variation is illustrated in the transition risk heatmap which represents the growth and contraction at a sectoral level across the three scenarios over the medium term (2035).

Scenario characteristics – transition analysis

Scenario characteristics	Global Coordination	Disruptive Decarbonisation	Policy Inertia
Reference scenarios	Deep Decarbonisation Pathways Project IEA 2DS	Deep Decarbonisation Pathways Project Review of disruptive technologies and business models	Deep Decarbonisation Pathways Project IEA 4DS
Target	66% likelihood of limiting global warming to 2°C	66% likelihood of limiting global warming to 2°C	66% likelihood of limiting global warming to 3°C
Proportion of renewables of total generation in 2050 (from baseline of 15% in 2017)	73%	94% Distributed generation increases from 4% of total generation in 2017 to 39% in 2050	58%

Appendix: Climate VaR Modelling Approach

Climate scenarios considered

Aviva is developing a Climate VaR measure that enables the potential business impacts of future climate-related risks and opportunities to be assessed in each of the IPCC scenarios and in aggregate. The IPCC scenarios aim to measure the effect on the energy balance of the global climate system due to changes in the composition of the atmosphere from sources like Greenhouse gas emissions, other air pollutants[19] and changes in land use. The four IPCC scenarios represent different Representative Concentration Pathways (RCPs) which describe the composition of the atmosphere at the end of the 21st century. Table 2 summarises the link between the RCPs, potential temperature rises by 2100 and the level of mitigation required, which we will use to describe the scenarios in this report.

Table 2: Mapping for RCPs, potential temperature rises and levels of mitigations. *Source: TCFD.*

RCP	Temperature rise	Description	Notes
RCP2.6	1.5°C	Aggressive mitigation	emissions halved by 2050
RCP4.5	2°C	Strong mitigation	emissions stabilise at half today's levels by 2080
RCP6.0	3°C	Some mitigation	emissions rise to 2080 then fail
RCP8.5	4°C	Business as usual (BAU)	emissions continue rising at current rates

Figure 12 also sets out implications for Greenhouse gas emissions and potential temperature rise by 2100 for each scenario. Aggressive mitigation is the only scenario where it is more likely than not that the temperature change in 2100 will be less than 2°C.

Aviva is developing this Climate VaR measure in conjunction with the UNEP FI investor pilot project, which is developing models and scenario analysis tools to assess the potential impact on corporate assets and real estate of the four IPCC scenarios in conjunction with Carbon Delta.

CARBON DELTA
the environmental fintech

Carbon Delta is using the REMIND model[XVIII] from the Potsdam Institute for Climate Impact Research (PIK)[XIX]. Scenario outputs from the REMIND model include financial metrics such as direct/indirect emissions costs, additional capital expenditure, and revenue implications broken down by sector and geography. Whilst these scenarios reflect current scientific research and the Paris agreement, there clearly remains significant uncertainty regarding future climate trajectories as well as political risk with respect to implementation of the Paris agreement and Nationally Determined Contributions (NDCs)[XX].

It is important to note that the four scenarios all assume a gradual path, in which temperatures slowly rise but climate policy is ramped up at varying speeds with a fairly high degree of global coordination. They do not consider the transition risk in a more chaotic policy environment, where there is lack of global coordination and policy action is taken too late and too suddenly. This may result in an understatement of transition risk.

The Carbon Delta model and scenario analysis tools also allow consideration of the five Shared Socioeconomic Pathways (SSPs)[20]. These consider socio-economic characteristics including things such as population, economic growth, education, urbanisation and the rate of technological development.

Time horizon considered for each scenario

In conjunction with the UNEP FI investor pilot project, it was agreed to use a single 15-year time horizon for the Climate VaR measure to analyse the impact of the different scenarios on our business but with the capability to consider transition effects over shorter time horizons depending on the business decision being considered. Consideration was given as to whether a longer time horizon was needed to capture the worst physical impacts of climate change, as these are not likely to manifest themselves until the second half of the century (See Figure 15).

To address this point in a decision-useful way and ensure consistency with the 15-year time horizon for transition risk, it was agreed to look at a higher, 95th percentile of physical risks as well as the expected outcome in the BAU scenario over the 15-year horizon. Figure 16 shows large dispersion around the mean from the impact of climate change on Coastal flooding over the next 15 years.

XVIII REMIND is a global multi-regional model incorporating the economy, the climate system and a detailed representation of the energy sector. It allows for the analysis of technology options and policy proposals for climate mitigation.

XIX The Potsdam Institute for Climate Impact Research (PIK) is a German government-funded research institute addressing crucial scientific questions in the fields of global change, climate impacts, and sustainable development.

XX Intended Nationally Determined Contributions is a term used under the United Nations Framework Convention on Climate Change for reductions in greenhouse gas emissions that all countries that signed the UNFCCC were asked to publish in the lead-up to COP21.

Figure 15: Global average surface temperature change. Source: IPCC.

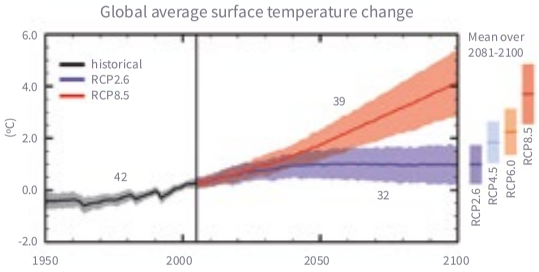
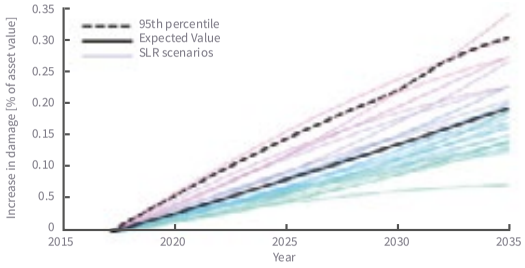


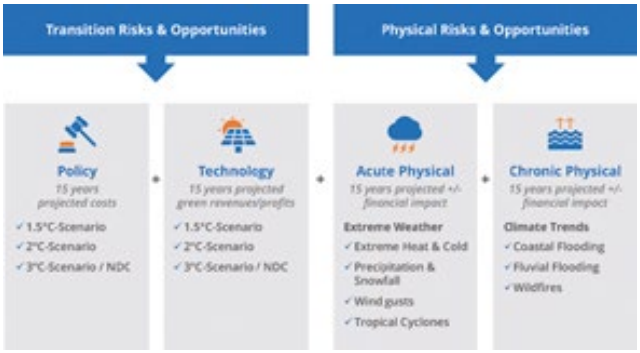
Figure 16: Example of Coastal Flooding . Source: Carbon Delta.



Risks and opportunities covered

The modelling of transition and physical risks and opportunities specifically covers the projected costs of policy action related to limiting Greenhouse gas emissions as well as projected profits from green revenues arising from developing new technologies and patents. In addition, it captures acute abrupt weather impacts such as more frequent and severe storms, extreme heat and cold, heavy precipitation and snowfall, wind gust, and tropical cyclones, as well as chronic gradual impacts such as higher than average temperatures and rises in sea level. It is important to note that the changes in acute and chronic weather can also have a positive as well as negative impact on individual companies or instruments (see figure 17), as this is measured against current conditions and in some regions these impacts will reduce even though the overall the impact will be negative.

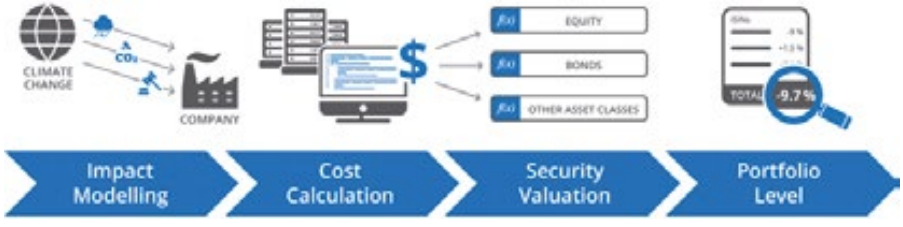
Figure 17: Risks and opportunities covered. Source: Carbon Delta.



Building Block Approach

To assess these risks and opportunities, a building block approach has been adopted (see Figure 18).

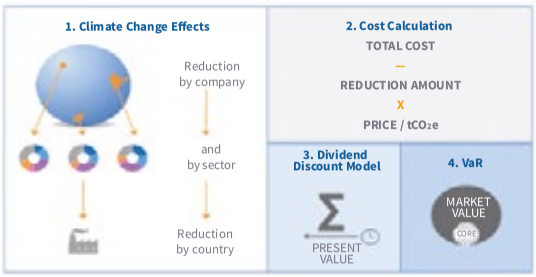
Figure 18: Building Block Approach. Source: Carbon Delta.

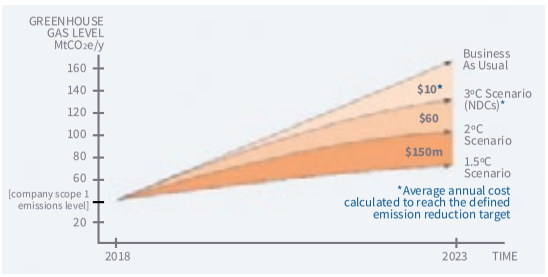


Investments

The following high-level methodology is used to assess the potential downside risk from different transition scenarios on our investments (see figure 21).

Figure 21: High level methodology overview. Source: Carbon Delta.





For both corporate bonds and equity shares the difference between the market value and the adjusted value after factoring in future climate change costs and/or revenues is measured (i.e. the impact relative to current climate conditions and emissions trajectory). To estimate the impact in a consistent way when a company has issued both shares and bonds, the Merton model[XXI] is used. This model enables the impact on a business as a whole to be translated into a change in value of its corporate bonds and equity shares. As both costs and opportunities are covered, the Climate VaR can be either negative or positive depending on the balance of future anticipated carbon-related costs and revenues for individual companies or instruments.

Carbon Delta has also developed a methodology for estimating the transition exposure of property assets which we have used for both direct real estate and real-estate-linked debt holdings. For infrastructure assets, Aviva plans to use the ClimateWise Transition Risk Framework to identify the key risk exposures across our portfolio of assets, taking into account how transition risk and opportunities vary by geography, sector and sub-sector to assess the potential impact in different climate scenarios. For example, a recent review of transport infrastructure highlighted strong potential opportunities.

Insurance liabilities

Aviva has assessed the impact on life insurance reserves from the potential reduction in mortality rates resulting from less air pollution in the aggressive and strong mitigation scenarios. This reflects an anticipated reduction in carbon emissions and an increase in electric vehicles replacing vehicles with internal combustion engines. For each transition scenario, there is potential for fewer deaths relating to air pollution. Although we note that this is very much dependent on the fuel mix generating electrical power for the grid. Whilst waste-to-energy plants have similar particulate outputs to gas-fired power stations, biomass plants such as wood pellet fired facilities, for their many positives, produce significantly more particulates than gas-fired power stations for example[21].

On the general insurance side, transition risks and opportunities may also arise. For example, the wider adoption of electric vehicles and the rise of car-sharing and automated cars might decrease the pool of vehicles to be insured leading to a decrease in claims frequencies but also premiums. However, these affects have not been included to date. We plan to extend our modelling to cover general insurance transition risks and opportunities over time.

Physical risks and opportunities

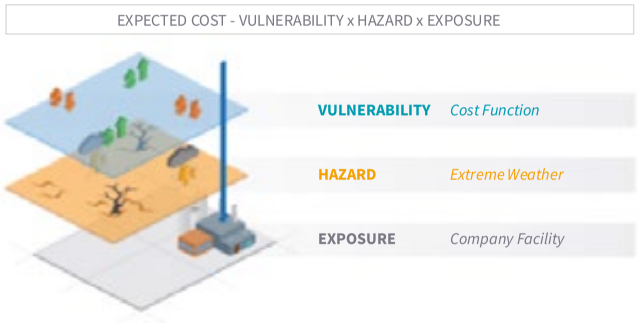
The financial impact of physical risks and opportunities is based on an assessment of both the expected costs in the BAU scenario and the costs at a higher 95th percentile arising from hazards such as: Extreme heat and cold, Heavy precipitation and snow, Coastal flooding, Wind gusts and Tropical cyclones. We use the expected costs and the costs at a higher percentile to define a distribution of physical risk outcomes for each scenario and thus capture some of the more extreme potential physical effects of climate change whilst using a consistent 15-year time horizon as that used for transition risk.

Investments

The physical risks on investments are generally going to be driven by the exposure of the facilities (buildings, plant, infrastructure) owned or used by the company who has issued the financial instrument, their "facilities", and the supply chain they rely on for producing their end product. We use the following high-level methodology to assess the potential physical risk from different scenarios on our investments in this regard.

XXI Analysts and investors utilise the Merton model to understand how capable a company is at meeting financial obligations, servicing its debt, and weighing the general possibility that it will go into credit default.

Figure 22: Impact modelling and expected cost estimate. Source: Carbon Delta.



The cost (in figure 22) is built up by mapping the facilities onto a world map, with measures that define the facility's exposure to different extreme weather hazards, and then combining this with a vulnerability function that converts the exposure and an assessment of the physical hazard impact in each scenario into an estimated monetary cost, per facility.

For both corporate bonds and equity shares, the difference between the market value and the adjusted value after factoring in aggregated facility costs and/or revenues is measured. The costs and/or revenues to a business are measured relative to an assessment of physical risks under current conditions as these are assumed to be already factored in to the market value. This business impact is then translated into a change in the value of its corporate bonds and equity shares using the Merton model.

Aviva recognises that the current approach does not capture the impact on companies' supply chains nor necessarily demand for its products and services or potential mitigating impact of insurance. For example, in the case of a major car manufacturer their real assets will mainly include their factories and machinery and possibly their dealerships. Their supply chain will be broad, complex and potentially geographically diverse and if disrupted it could adversely impact companies' costs and/or revenues. We will continue to work internally and with external partners to develop best practice in this area. For directly held real estate assets, real estate loans and infrastructure assets, we use the same approach described above. For directly held real estate the impact is carried directly against the property valuation. For real estate loans, we assess the physical climate change risk impact by running the stressed property value through our debt valuation models.

For sovereign bonds, the impact on the market value of a security is measured by assessing how a sovereign's rating could change as a result of the occurrence of different extreme weather hazards in each scenario. The following climate-related factors may impact sovereign debt: exposure and vulnerability to climate change; readiness and adaptation; ability to raise money for mitigation and post-disaster repair; ability to raise money via taxation and debt; reliance on foreign aid and support of the International Monetary Fund and other supra-national bodies. To assess a sovereign's vulnerability to climate change and readiness, the Notre-Dame University's Notre Dame-Global Adaptation Index (ND-GAIN)[XXII] measure for country climate change risk has been used. We note that the assessment of sovereign debt is difficult because sovereigns are exposed to climate change via several vectors: government buildings and government owned infrastructure, cost of emergency relief to areas effected by climate-related disasters, aid and rebuilding costs and the cost of acting as insurer of last resort. So, the ND-GAIN data has been used to help support expert judgements about the appropriate stresses to apply to different sovereign bonds in our modelling at this stage. We will continue to work internally and with external partners to develop best practice in this area.

Insurance liabilities

The Climate VaR for life insurance risks calculates the impact on reserves of a change in mortality rates as a result of the occurrence of different extreme weather hazards in each scenario based on a review of academic literature linking climate change to potential changes in mortality rates[22-25]. For higher temperature scenarios, where climate change has dramatically taken hold, the picture is complicated. For example, it is possible that both summers and winters will be warmer or that seasons will in fact be more extreme. The latter is more likely to have an adverse impact and for the UK could plausibly result from the Gulf Stream changing its path and missing the UK.

On the general insurance side, the Climate VaR calculates the impact on premiums as a result of the occurrence of different extreme weather hazards in each scenario. The impact on premiums is then used to determine the impact on our business, considering the impact on pricing, sales volumes and our reinsurance strategy. Initially, we have focussed our efforts on UK Flood. We have worked with internal and external experts to consider how climate change could change the frequency and severity of UK Flood and leveraged our existing catastrophe modelling capability to assess the impact of this on premiums. We plan to further refine this approach and to extend our modelling to other extreme weather hazards over time.

XXII https://gain.nd.edu/our-work/country-index/

TRANSITION SCENARIOS

There are numerous pathways to reach a particular temperature warming scenario, such as a 2°C scenario, and different climate models have different assumptions, drivers and levels of granularity. While the methodology developed by the UNEP FI pilot group and Oliver Wyman is compatible with different climate scenario sources, the group decided to pilot the methodology using specific scenarios. In order to conduct climate scenario analysis, the pilot group needed climate transition scenarios that were appropriate for financial analysis and that met the requirements we had established for the project, including a number of different macroeconomic, energy-related and sector specific variables. To identify the most appropriate climate scenarios, we undertook a thorough review of a number of different climate models and scenarios and assessed their usefulness for financial analysis based on the requirements we had established and the following criteria:

- The availability of scenario data for the three temperature warming scenarios of interest
- The coverage of the sectors and subsectors where we expect transition risk to be most material
- The coverage of different regions of the world where the banks in the UNEP FI pilot group operate

Our review encompassed the landscape of climate models, including integrated assessment models (IAMS) and models from the International Energy Agency (IEA), International Renewable Energy Agency (IRENA), and the Deep Decarbonization Pathways Project (DDPP). Given the pilot group's requirements, which included the availability of a 1.5°C scenario and coverage of the agricultural sector, we selected two IAMs that most closely met the project's criteria and requirements – REMIND-MAgPIE (REMIND) from PIK and MESSAGE-Globiom (MESSAGE) from IIASA – for use in the pilot. The scenarios derived from these climate models are widely used around the world for policy and other analyses, including by the IPCC in its recent special report, Global Warming of 1.5°C. As the vast majority of climate models, including these models, were not originally developed for use in financial analysis, the pilot group further collaborated with the developers of these two models at PIK and IIASA to get access to additional variables and increase data availability.

THE REMIND MODEL

In conducting the transition scenario analysis as part of the UNEP FI pilot project, Citi used the 1.5°C, 2°C and 4°C scenarios from the REMIND model developed within the CD-LINKS project. The CD-LINKS project explores the complex interplay between climate actions and development at the global and national levels. We will consider using the MESSAGE model along with other models and scenarios in future analyses as the methodology the pilot group has developed is compatible with other climate scenario sources.

The REMIND model uses the Shared Socioeconomic Pathways, Representative Concentration Pathways ("SSP-RCP") scenario framework, which was developed for analysis in the IPCC and provides a combination of socioeconomic and emissions pathway assumptions to develop different climate scenarios. Researchers have developed five Shared Socioeconomic Pathways (SSPs) that narrate different socioeconomic futures that have implications for the challenge of climate change mitigation and adaptation.

The REMIND CD-LINKS scenarios used for this report represent SSP2, which describes a "middle of the road" world where social, economic and technological trends do not shift markedly from historical patterns and there is a medium level of challenges to climate mitigation and adaptation. It combines the socioeconomic assumptions from SSP2 with different representative concentration pathways (RCPs), which are based on varying levels of greenhouse gas emissions concentrations, to develop scenarios for different temperature warming targets. A summary of the assumptions is provided below.

REMIND Model Assumptions

Description

Transition risk occurs in a "middle-of-the-road" world where social, economic, and technological trends do not significantly vary from historical patterns. Current policies are continued until 2020, at which point a carbon price begins to be implemented at a level that ensures the world does not exceed 1.5°C or 2°C warming depending on the scenario.

RISKS CONTINUED

We identified the material impacts on Unilever's business arising from each of these scenarios based on existing internal and external data. The impacts were assessed without considering any actions that Unilever might take to mitigate or adapt to the adverse impacts or to introduce new products which might offer new sources of revenue as consumers adjust to the new circumstances.

The main impacts of the 2°C scenario were as follows:

- Carbon pricing is introduced in key countries and hence there are increases in both manufacturing costs and the costs of raw materials such as dairy ingredients and the metals used in packaging.
- Zero net deforestation requirements are introduced and a shift to sustainable agriculture puts pressure on agricultural production, raising the price of certain raw materials.

The main impacts of the 4°C scenario were as follows:

- Chronic and acute water stress reduces agricultural productivity in some regions, raising prices of raw materials.
- Increased frequency of extreme weather (storms and floods) causes increased incidence of disruption to our manufacturing and distribution networks.
- Temperature increase and extreme weather events reduce economic activity, GDP growth and hence sales levels fall.

Our analysis shows that, without action, both scenarios present financial risks to Unilever by 2030, predominantly due to increased costs. However, while there are financial risks which would need to be managed, we would not have to materially change our business model. The most significant impacts of both scenarios are on our supply chain where costs of raw materials and packaging rise, due to carbon pricing and rapid shift to sustainable agriculture in a 2°C scenario and due to chronic water stress and extreme weather in a 4°C scenario. The impacts on sales and our own manufacturing operations are relatively small.

The results of this analysis confirm the importance of doing further work to ensure that we understand the critical dependencies of climate change on our business and to ensure we have action plans in place to help mitigate these risks and thus prepare the business for the future environment in which we will operate.

During 2018 we developed and piloted an approach to assess the impact of climate change on our key commodities. We selected soy for this pilot based on its importance to Unilever (large purchased volume), it being a high-profile crop in the countries where it is grown and the availability of good historical price data and suitable climate models.

We developed a methodology which combined forecasting future yields and quantifying the impact on commodity prices of soybean oil. Climate change was the only price factor accounted for in the model used to calculate the impact. Other factors which impact price, such as technology and acreage, were excluded. The model considered the direct risks from climate change to the price of soybean oil, such as change in yield and change in supply. Three modelling steps were performed:

- Yield estimation: We analysed multiple agriculture and climate models to provide a forecast range of expected yields in key growing regions.
- Price relationship: An econometric model was developed, based on an analysis of the soybean oil market and historical trends, to estimate the impact of climate-induced yield changes on future prices. This model considered the importance of co-products eg soybean meal, substitution potential eg with sunflower oil and industrial uses of soybean oil, as well as the impact of yield on price.
- Impact estimation: Future yields and price impacts were then translated into an estimated financial exposure from climate change for our business, using our forecast procurement volumes.

Our pilot analysis showed that soybean yields may increase over the 2030 and 2050-time horizon and that subsequent lower prices may then lead to small potential reductions in our procurement spend on soy. While the results may indicate a low financial risk to our business, we would need to consider a wider range of risk factors when determining our strategic response. Indirect risks from climate change, such as catastrophic events or external policy response and adaptation could also have an impact but were not included in our modelling. Furthermore, these pilot results are specific to soy and can't be applied to other crops. We have therefore decided to get broader understanding on the climate change risks to our agricultural sourcing and extend our analysis to two other important crops to Unilever: Palm Oil and Tea, for which suitable climate change models for yield predictions will be available in 2019.

RESPONDING TO RISKS AND OPPORTUNITIES

Unilever's vision is to grow our business whilst decoupling our growth from our environmental footprint and increasing positive social impact. This vision explicitly recognises that sustainable growth – including management of climate-related risks and opportunities – is the only way to create long-term value for all our stakeholders.

The Unilever Sustainable Living Plan (USLP) was developed to deliver our vision. It is fully integrated with our business strategy. Climate-related issues are integral to the USLP. Two of our GHG reduction targets included in the USLP are recognised as science-based:

- Halve the greenhouse gas impact of our products across the lifecycle by 2030 (this target covers all the phases across the lifecycle of our products: ingredients/raw materials, manufacturing, distribution, retail, packaging, consumer use and disposal)
- Reduce scope 1 and 2 greenhouse gas emissions by 100% from our own operations by 2030 (this is part of our ambition to be become carbon positive in our manufacturing by 2030)

We are taking action across our value chain to reduce our emissions, creating growth opportunities and minimising risk. Our commitment to source 100% of our palm oil from sustainable sources is helping to avoid emissions from deforestation (see pages 14 and 47). Our efforts to reduce energy and GHG emissions in manufacturing are helping us to save costs. For example, by using less energy, we have already avoided energy costs in our factories of over €600 million since our baseline year of 2008.

Our divisions are taking action to reduce emissions. In Home Care we are focusing on concentrated liquid laundry detergents such as Persil, Omo and Surf Small & Mighty which help consumers to wash clothes at lower temperatures, reducing GHG by up to 50% per load. We have removed phosphates from all laundry powders worldwide, resulting in lower greenhouse gas emissions of up to 50% per consumer use. Our Foods & Refreshment division has prioritised reducing greenhouse gas emissions from ice cream freezers since 2008. As the world's largest producer of ice cream, we have committed to accelerating the roll-out of freezer cabinets that use more climate-friendly natural (hydrocarbon) refrigerants. By 2018 our total purchase of these cabinets had increased to around 2.9 million.

Detailed Lifecycle Analysis has shown that our GHG contribution from animal-based agriculture, including fats and proteins, is relatively low: 7.5% for Foods & Refreshment and 2.5% for total Unilever. While emissions are comparatively low, the business opportunity is significant for natural and plant-based foods and beverages. We have a range of vegan and vegetarian variants such as Hellmann's vegan mayonnaise, Ben & Jerry's non-dairy ice creams, Magnum vegan and other options (see pages 11 to 12). We continue to actively promote vegetarian and vegan recipes, notably via our Knorr brand websites.

A number of our targets directly address risks and opportunities related to water scarcity caused by climate change. We estimate that the sale of products which address water scarcity issues could increase in our Home Care and Beauty & Personal Care divisions where a number of products are available which address water scarcity and/or have a lower GHG in use. For example, our Beauty & Personal Care division is investing in water smart product innovations such as dry shampoo and cleansing conditioner which help consumers use less water while also offering relevant benefits such as reduced colour loss and damage which can arise from frequent washing. Home Care is combining insights in consumer behaviour and water consumption with innovative technology to develop new market opportunities, launching products and formulations that address water scarcity and help our consumers save water. Day2, the world's first dry wash spray is made with only 0.02% of the water in a normal laundry load. Sunlight 2-in-1 Handwashing Laundry Powder and Rin (Radiant) detergent bar are also helping to reduce water consumption at point of use in water-stressed countries.

CNP Assurances' overall adaptation and resilience strategy will be based on:

- the transmission of information to our partners for appropriation and implication;
- the ordering of priorities and completion of more detailed studies;
- the integration of climate risk into work decisions.

Woodland

Société Forestière is committed to an approach aimed at mitigating risks related to climate change on the CNP Assurances portfolio. To this end, four analyses are monitored:

- **integration of viewpoints on climate change into management plans:** these plans lay down forward management of forests for ten to twenty years, on a forest-by-forest basis. They are approved by the forest administration, which guarantees compliance with the regulations in force;
- **analysis of the geographical spread of woodland assets:** CNP Assurances has implemented an investment policy that has allowed the purchase of woodland in a wide number of areas. The spread of woodland assets also reduces the risk to extreme events such as storms or drought;
- **analysis of tree and plant species diversity:** in addition to the interest in terms of biodiversity noted above, tree and plant species diversity is a genuine means of spreading the risks run with each species in respect of climate change, such as health problems related to the appearance of pathogens and drought that could impact each species differently;
- **insurance against the main climate risks:** namely fires, storms, natural disasters, weight of snow, frost, freezing temperatures and hail.

Results and their use

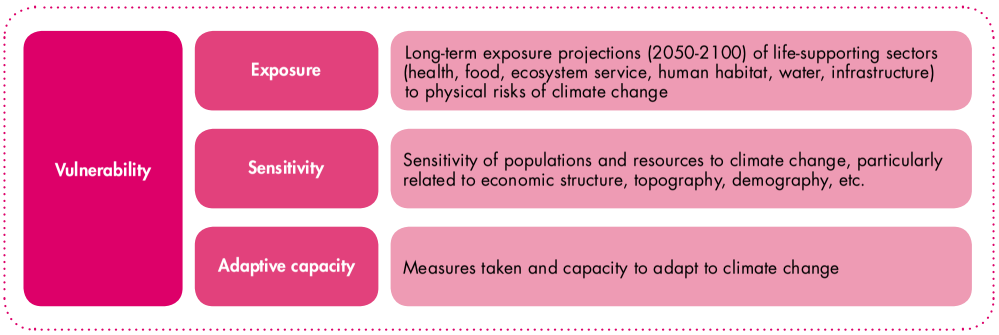
- Since 2008, the consideration of climate change in these plans has been reflected in the analysis of such items as the expected impact of local climate change, the adaptation of existing tree and plant species and production cycles. At 31 December 2018, 53% of the woodland portfolio was covered by a plan incorporating the consideration of climate change. This rate is intended to gradually rise to 100% as the various plans are renewed.
- Some areas subject to significant natural hazards have been avoided (South-East France, for instance, due to the fire risk). To round out this acquisition policy, which notably serves to spread the risks, woodland was purchased in Scotland in 2017 and 2018.
- The status of species diversity and the geographic spread of the CNP Assurances portfolio at 31 December 2018 are mapped on page 22.
- All the forests owned by CNP Assurances are covered by insurance policies covering the main climate risks.

Equities, corporate and sovereign bonds

Methodology

CNP Assurances has commissioned Indefi, a consultancy firm, to map issuers' geographical vulnerability to climate change in order to analyse the physical risk exposure of its directly-held listed securities, equities and bonds.

The physical risk analysis is based on ND-Gain's database and Country Index calculated according to the methodology developed by researchers at the University of Notre Dame in the United States. The "vulnerability to climate change" component measures the likelihood of States being negatively impacted by climate change, closely related to physical risk.



Exposure, sensitivity and the capacity to adapt to climate change are assessed in six areas: health, food, ecosystem service, human habitat, water and infrastructure. Exposure projection is attained from the changing greenhouse gas emission scenario established by the IPCC, where RCP4.5 corresponds to the most likely pathway in view of the current state of commitments to the COP21.

The study provided CNP Assurances with a clear picture of the assets at end-2018 according to seven levels of physical risks.

nomic pathways for a specific level of greenhouse gas concentrations. The RCP scenarios each represent one possible pathway for a specific concentration level.[4]

Structure of climate models

Modern climate models are highly complex and comprise an enormous variety of factors. This complexity is due to a desire to enable very accurate modelling of the Earth's climate and be able to describe geographical variations in many different scenarios. The greenhouse effect is one of the most important climate factors.

However, a climate model also has to include other impacts and factors to more accurately calculate changes in temperature. However, a climate model also has to include other impacts and factors such as cloudiness, snow and ice cover and a description of the global oceans to more accurately calculate changes in temperature. In addition, climate models also include descriptions of temperature, humidity, precipitation, atmospheric particles, ocean currents and many other factors. The various factors also interact, and these complex relationships must also be addressed in the climate model.

The most commonly used climate models, known as general circulation models, cover all these factors as accurately as possible.

The climate models can be used to examine the implications of external influences. These may be man-made changes in the atmospheric content of greenhouse gases. Different scenarios, for example the four RCP scenarios, can be used as input and serve as a starting point for greenhouse gas concentrations. It can also be examined how 'natural' impacts such as major volcanic eruptions may affect the climate. External influences, both man-made and natural, may give rise to positive or negative feedback mechanisms.

A more detailed description of the greenhouse effect and the modern climate models is provided in Appendix 3.

Future temperature increases in five of ATP's forest investments

Based on data from many of the climate models on which the Climate Panel has based its recent Assessment Report (AR5),[5] ATP has examined temperature increases in five forestry investments in the four different RCP scenarios.

The temperature increases were determined by calculating the average of all available data from the climate models via the CMIP5 database. Appendix 3 contains a complete list of the model data used in the calculations. The appendix also shows an example of the method used (specifically the forest in Queensland in RCP8.5).

The table shows the temperature increases in the four different RCP scenarios in the geographical locations of ATP's forest investments through ATP Timberland Invest K/S. Due to lack of historical data on forest temperatures, the temperature increase from 2006 to 2100 is shown and not for the period 1986-2005, which is the reference period commonly used in the Climate Panel's recent Assessment Report (AR5). The temperatures will rise in all four scenarios. The increase is most pronounced in RCP8.5, however.

The temperature increases show that the forests Northwoods, Wolf River and Upper Hudson are located in regions that are likely to see greater increases in temperature in the future and may even be more climate-sensitive regions than, say, the forest in Queensland, Australia. This confirms to ATP the relevance of including climate considerations when assessing forestry investment opportunities and our forest management.

4 The RCP scenarios are named after the level of radiative forcing that each scenario produces which is a measure of the total greenhouse effect in the scenario. Technically, radiative forcing describes how the balance between incoming solar energy and outgoing energy from Earth is altered. If radiative forcing is positive, it will lead to surplus energy on Earth and cause warming. In the RPC scenarios, the value is calculated as the change in Watts per square metre (W/m2) from 1750 to 2100. A more detailed review of the RCP scenarios is provided in Appendix 3.

5 Data from the international research programme 'Coupled Model Intercomparison Project Phase 5' (CMIP5) which was used by the UN Climate Panel in its Fifth Assessment Report (AR5).

LOW CARBON OIL & GAS PORTFOLIO

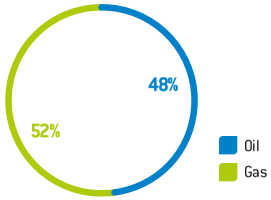
One of the drivers used by Eni to pursue its decarbonization strategy is the Oil & Gas portfolio characterized by **conventional projects developed in stages and with low CO_2 intensity**. The main upstream projects in progress, which account for about 45% of the total development investments in the sector in the four-year period 2019-22, show an overall break-even at a Brent price of $25/barrel, which is therefore resilient even in the presence of a low-carbon scenario, and an internal rate of return (IRR) of 22%. Furthermore, these projects have a positive cumulative Free Cash Flow as early as 2019, due to the cash in from the application of the Dual Exploration Model, which is the early monetization of exploration successes through the sale of minority stakes. The **hydrocarbon equity resources**[13] at 31/12/2018 show that **natural gas**, a bridge solution towards a low carbon future, **accounts for over 50%**.
The flexibility and adaptability in the use of Eni's investments, amounting to about €33 billion in the period 2019-22, are confirmed by the non-committed share of 50% already in the two-years period 2021-22.

OIL & GAS PORTFOLIO

>50%

SHARE OF GAS ON EQUITY RESOURCES IN 2018

Oil & Gas portfolio
(%)



AVG. BREAK-EVEN

$25 A BARREL

AVERAGE BREAK-EVEN PRICE OF NEW UPSTREAM PROJECTS

PORTFOLIO RESILIENCE

Portfolio resilience is ensured by the **regular review of the assets portfolio and new investments** in order to identify and assess potential emerging risks associated with changes in emissions regulations and in the physical conditions of operations. The return on the main investment projects is tested using a **sensitivity to carbon pricing** when the Final Investment Decisions (FID) is made and later during the six-monthly monitoring of projects, based on the following assumptions:

- → **scenario of hydrocarbon prices and CO_2 cost of Eni**[14];
- → **IEA SDS low-carbon scenario of hydrocarbon prices and cost of CO_2**.

The results of the most recent monitoring have highlighted marginal impacts on internal return rates. In addition, the portfolio composition and decarbonization strategy minimises the risk of stranded assets in the upstream sector thanks to:

- → a progressive reduction of the break-even of Oil & Gas projects by optimising the asset portfolio with a significant share of conventional gas;
- → **near field exploration**;
- → **improved efficiency** in development.

In this regard, the management has subjected to a sensitivity analysis the book value of all CGUs (Cash Generating Units) in the upstream sector, adopting the IEA SDS scenario; this stress test highlighted the substantial retention of the asset book values and no impact on fair value.

MARGINAL IMPACT ON INTERNAL RATES OF RETURN FROM SENSITIVITY TO CARBON PRICING

NO IMPACT ON FAIR VALUE FROM SENSITIVITY ANALYSIS OF THE BOOK VALUE OF ALL UPSTREAM CGUS, ACCORDING TO THE IEA SDS SCENARIO

13) 3P+Contingent.
14) "Stress" scenario that considers the simultaneous and immediate adoption of a cost for CO_2 equal to $40 a ton in 2015 corrected for inflation.

These combined costs and opportunities are then translated into a "climate cost" indicator. As detailed in the table below, our exploratory analysis also shows that, on aggregate, the companies we invest in may lose 4.6% of their total revenues in transition costs, and 4.6% of revenues to physical costs, but this is partly offset by green revenues equivalent to 4.4% of total revenues, thanks to the results derived from forward-looking green patent investments. **Ultimately, and according to this methodology, AXA's "Company cost of climate" appears to be equivalent to an average 4.8% reduction of the turnover of the companies we invest in. This would translate into a 0.2% reduction in AXA's investment value, which could be described as a "Portfolio cost of climate".** However, this averaged figure necessarily smoothes out heterogenous impacts amongst market players: some will likely be far more impacted than others.

> *Transition costs and physical costs are partly offset by green revenues*

Methodology Box

Green patents: a proxy to identify the "winners" of the energy transition?

The model used links green revenues with the occurrence of specific green patents. While certainly not the only factor to be taken into account to estimate future green revenues, a statistically relevant correlation has been established by Carbon Delta. The high share of green patent filings in the energy and transport sectors demonstrate companies' responsiveness to reduction efforts needed in the most relevant sectors, hopefully facilitating the low-carbon transition on a macroeconomic level. The greatest green investments are being made in transport (48%), renewable energy (22%), and energy efficiency (19%)[1]. This allocation is a positive development given that the energy sector contains the highest sectoral emission reduction potential to reach targets for 2030, followed by transport. Moreover, given these are the sectors most immediately concerned, this is a positive sign of reactivity within our portfolio to address transition risks. For AXA, green patent filing represents a promising area to monitor and a possible lever of shareholder engagement.

(1) Carbon Delta analysis.

Overview of company-level climate-related "cost" metrics

Asset class	Transition cost *(% of total revenues)*	Physical Risks Cost *(% of total revenues)*	Green Revenues *(% of total revenues)*	"Company" cost of climate *(% of total revenues)*
Fixed Income	**-5.2**	**-4.7**	**4.1**	**-5.8**
Relevant benchmark: Bank of America Merril Lynch (BofAML)	*-4.7*	*-4.9*	*3.8*	*-5.8*
Equity	**-2.2**	**-4.0**	**6.6**	**0.4**
Relevant benchmark: MSCI World ACWI	*-3.9*	*-4.5*	*5.3*	*-3.1*
AXA Total Corporate Assets	**-4.6**	**-4.6**	**4.4**	**-4.8**

Context Box

Is future regulation likely to impose emissions reductions with the help of carbon pricing?

Despite significant political and commercial obstacles, there is a growing consensus among economists, governments and businesses on the fundamental role of carbon pricing in the transition to a decarbonized economy. For governments, carbon pricing is one of the instruments of the climate policy package needed to reduce emissions. Some businesses already use internal carbon pricing to evaluate the impact of mandatory carbon prices on their operations and as a tool to identify potential climate risks and revenue opportunities. Some investors are also testing the use of carbon pricing to analyze the potential impact of climate-related policies on their investment portfolios. Carbon pricing can take different forms from carbon trading schemes to carbon taxes. In 2017 and 2018, carbon pricing initiatives have emerged in Asia and the Americas while the European ETS (CO_2 market) entered in its third phase. China's ETS was officially launched in December 2017 and work is underway to prepare for its implementation.

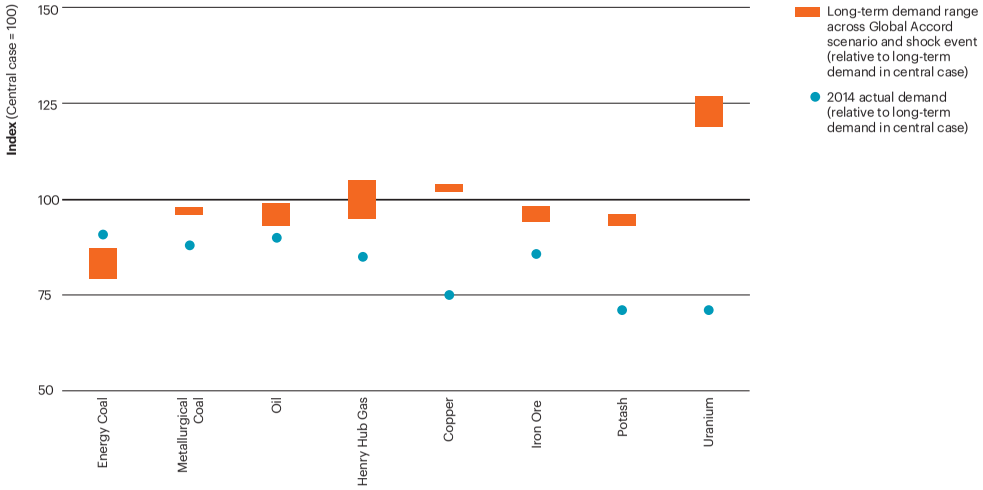
Figure 6 highlights the long-term demand with the range covering both the Global Accord scenario and the shock event. This long-term demand is shown relative to the central case forecast. The chart also shows actual demand in 2014, once again indexed to the long-term demand forecast in the central case. This highlights that even in an orderly or rapid shift to a 2°C world, we forecast growth in long-term demand for most of our commodities, although at a slower pace than in the central case.

The energy sector is most affected in a 2°C world as it is a key source of global emissions and likely to face a combination of strong environmental regulation leading to further efficiency improvements and increasing competition between fuels. For energy commodities, we forecast the share of renewable energy in the power mix to increase by almost 25 per cent in the Global Accord scenario compared with the central case. In the shock event, we also expect to see the rise of nuclear power to provide low emissions baseload power, increasing uranium demand by more than 50 per cent. In transport, several trends intensify in Global Accord compared to the central case, including improvements in the fuel economies of new vehicles and the rise in electric vehicles. Given the current low penetration of electric vehicles, combined with more efficient diesel and gasoline vehicles, it will take a decade before they become a material part of the global fleet.

As a result, energy coal and crude oil are likely to be the most affected in the Global Accord scenario and the shock event. We forecast lower long-term demand for energy coal than in the central case. However, as shown in Figure 6, demand is not substantially lower than today and so additional quantities of energy coal are likely to be required in order to meet the world's energy needs. BHP Billiton's high-quality, low-cost energy coal assets have strong margins and therefore remain attractive despite the reduced demand. Natural gas demand initially finds support given the fuel's lower emissions intensity compared with energy coal, however in the long run, emissions from the use of natural gas will also need to decline in the 2°C world.

For non-energy commodities, we expect increased recycling and the rise in environmental costs to be key drivers. Global copper consumption increases in a low-carbon environment due to rising demand for energy efficient technologies such as copper-intensive solutions in the power and machinery sectors. High levels of steel recycling reduce iron ore and metallurgical coal demand. In the Global Accord scenario and the shock event, both sectors are also impacted by tighter environmental constraints and emissions costs. Potash demand growth is hampered by improved fertiliser efficiency and higher crop nutrient recycling through higher and more effective return of crop residues in the Global Accord scenario.

Figure 6: Long-term commodity demand range in a 2°C world



2014 actual Business contribution to Group revenue

4 Portfolio impacts in a 2°C world continued

Our portfolio remains resilient

Our consideration of scenarios and shock events provides us with a divergent range of responses to reach the 2°C goal. This consideration of multiple pathways underlines the value of a scenario planning approach in that we do not consider a single view of a 2°C world, but rather a range of potential outcomes. This provides deeper, more valuable insights into the potential impacts on the portfolio and thereby improves our ability to respond where we see key signposts and triggers.

The analysis highlights that our uniquely diversified portfolio of high-quality assets is robust under both an orderly and a more rapid transition to a 2°C world.

In Global Accord, we believe there is a likelihood of upside for uranium and our high-quality metallurgical coal and iron ore. In addition, we expect copper to offer continued opportunity for growth. Gas may also provide significant opportunities during a transition to a lower emissions economy. Overall, we anticipate these commodities are robust and mitigate potential negative impacts on other commodities.

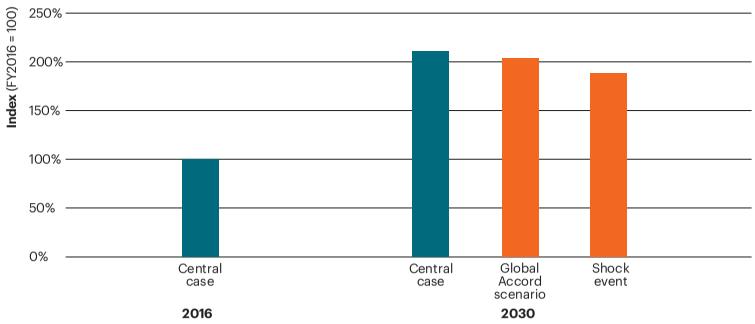
In the Global Accord scenario, we anticipate the impact on the current portfolio value will be minimal. This is due to portfolio diversification and diminishing contribution of fossil fuels as a proportion of portfolio value over time, in comparison with other commodities. We project the carbon price impact on the portfolio value would be less than two per cent. In the shock event, we predict there is likely to be more downside, but the portfolio will nonetheless be resilient in spite of the very fast change in market conditions this event would entail. Once again, the carbon price impact on the total portfolio value is relatively small (<5 per cent), and the fossil fuel contribution to the portfolio is lower.

Depending on the speed of transition and the energy choices made during the transition, we expect there will be opportunities to mitigate the impact on portfolio value through selectively investing in those commodities that are preferred or advantaged due to policy or technological breakthroughs that eventuate or due to their lower emissions intensity (e.g. gas, copper, iron ore, metallurgical coal or uranium).

Without any mitigation or action to adapt our portfolio, our overall portfolio value is lower in the Global Accord scenario and the shock event, however we still expect the Company to grow in absolute terms compared with today.

We have a strong project pipeline with many capital-efficient growth options that continue to generate high shareholder value in a 2°C world. The return on our organic projects remains high, with an overall project pipeline internal rate of return reducing slightly relative to the central case, but still averaging around 20 per cent in both the Global Accord scenario and the shock event. The resilience of our portfolio in a 2°C world is highlighted in Figure 7, which shows how earnings before interest, taxes, depreciation and amortisation (EBITDA) grow relative to FY2016 in the central case, the Global Accord scenario and the shock event.

Figure 7: EBITDA



Our strategic response to climate-related risks

Our strategy and Climate roadmap forms the basis for how we respond to climate-related risks and opportunities. As part of this we have embedded climate considerations into our incentives, reporting and decision-making, and have targets in place to measure progress and incentivise performance across the entire company – starting at the top. CO_2 intensity (upstream) is a key performance indicator and influences executive pay.

Investment principles – Our investment principles take climate into account. We require all potential projects to be assessed for carbon intensity and emission reduction opportunities, at every decision phase – from exploration and business development to project development and operations. We apply an internal carbon price of at least USD 55 (real 2018) per tonne of CO_2 in investment analysis. In countries where the actual or predicted carbon price is higher than USD 55, we apply the actual or expected cost, such as in Norway where both a CO_2 tax and the EU Emission Trading System (EU ETS) apply.

Energy scenarios – Our energy scenarios inform the economic planning assumptions used in our investment decisions and the formulation of our strategy. Our Energy Perspectives 2018 report illustrates that there is significant uncertainty around the future energy mix and the exact pace and scale of the energy transition. In that report we also assess sensitivities to our Renewal scenario related to potential disruptive technologies, CCS and climate policy action.

Portfolio stress test – Equinor annually conducts a price sensitivity analysis for our project and asset portfolio against the assumptions regarding commodity and carbon prices in the range of energy scenarios of the International Energy Agency (IEA), as presented in their World Energy Outlook report. This analysis is used to assess energy transition-related risks. The practice is in accordance with a shareholder resolution passed in 2015, suggesting that stress testing should be done against third-party scenarios to allow for comparability.

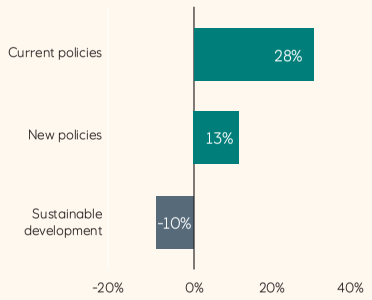
The "project and asset portfolio" entails equity production, excluding exploration activities[1]. However, our investment decision criteria, including the internal carbon price and discount rates, apply also to exploration projects.

In 2018 we tested our portfolio against the IEA's Current Policies, New Policies and Sustainable Development scenarios. The scenarios and assumptions are presented in the World Energy Outlook 2018 report (IEA). Equinor has not tested our portfolio against a 1.5°C scenario, as the IEA has so far not published such a scenario with corresponding oil, gas and carbon price assumptions. The four illustrative model pathways presented in the International Panel on Climate Change's special report on the impacts of global warming of 1.5°C[2] indicate that oil and gas demand would have to be significantly lower than in a 2°C scenario, and as such the potential downside for Equinor in a sensitivity analysis could be expected to be more significant. However, our sensitivity analysis does not take into account the fact that our portfolio would change to be more robust as the different scenarios unfold and materialise.

1. Exploration activities are not included due to significant uncertainty regarding discoveries and development solutions. This is a change from previous years' analysis, which have included exploration activities.
2. IPCC (2018) Special Report Global Warming of 1.5°C

Net present value of portfolio

NPV impact on base case



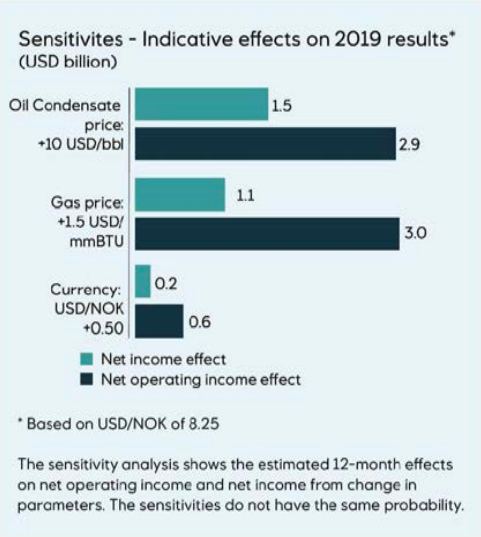
The sensitivity analysis in 2018 demonstrated that our portfolio continued to be robust in the various IEA scenarios (World Economic Outlook 2018). The chart illustrates changes in the net present value (NPV) of Equinor's asset and project portfolio when replacing our own assumptions regarding oil, gas and carbon prices with those of the IEA scenarios.

Capex per maturity

Equinor has significant capex flexibility to shape our future portfolio. The share of non-sanctioned projects is significant already in 2021 and rapidly increasing towards 2028. Producing and unconventional assets are also to a large extent flexible.

Oil and gas production in 2025

A major part of our forecasted production in 2025 is within conventional oil and gas and shale gas, which have a relatively low carbon intensity compared to heavier oil segments. These production segments represent around 90% of our forecasted production in 2025.



The illustration shows the indicative full-year effect on the financial result for 2019 given certain changes in the oil/condensate price, natural gas contract prices and the USD/NOK exchange rate. The estimated price sensitivity of Equinor's financial results to each of the factors has been estimated based on the assumption that all other factors remain unchanged. The estimated indicative effects of the negative changes in these factors are not expected to be materially asymmetric to the effects shown in the illustration.

Significant downward adjustments of Equinor's commodity price assumptions could result in impairments on certain producing and development assets in the portfolio. See note 10 Property, plant and equipment to the Consolidated financial statements for sensitivity analysis related to impairments.

Fluctuating foreign exchange rates can also have a significant impact on the operating results.

Equinor's revenues and cash flows are mainly on denominated in or driven by USD, while a large portion of the operating expenses, capital expenditures and income taxes payable accrue in NOK. In general, an increase in the value of USD in relation to NOK can be expected to increase Equinor's reported earnings.

Historically, Equinor's revenues have largely been generated by the production of oil and natural gas on the NCS. Norway imposes a 78% marginal tax rate on income from offshore oil and natural gas activities (a symmetrical tax system). For further information, see section 2.7 Corporate Taxation of Equinor.

Equinor's earnings volatility is moderated as a result of the significant proportion of its Norwegian offshore income that is subject to 78% tax rate in profitable periods and the significant tax assets generated by its Norwegian offshore operations in any loss-making periods.

Dividends received in Norway are subject to the standard income tax rate (reduced from 23 % in 2018 to 22 % in 2019). The basis for taxation is 3 % of the dividends received giving an effective tax rate of 0.69 % in 2018. Dividends received from Norwegian companies and from similar companies resident in the EEA for tax purposes, in which the recipient holds more than 90% of the shares and votes, are fully exempt from tax. Dividends from companies resident in the EEA that are not similar to Norwegian companies, companies in low-tax countries and portfolio investments outside the EEA will, under certain circumstances, be subject to the standard income tax rate (reduced from 23% in 2018 to 22% in 2019 based on the full amounts received).

Disclosures about market risk

Equinor uses financial instruments to manage commodity price risks, interest rate risks, currency risks and liquidity risks. Significant amounts of assets and liabilities are accounted for as financial instruments.

See note 25 Financial instruments: fair value measurement and sensitivity analysis of market risk in the Consolidated financial statements for details of the nature and extent of such positions and for qualitative and quantitative disclosures of the risks associated with these instruments.

Inadequate insurance coverage risk

Equinor's insurance coverage may not provide adequate protection

Equinor maintains insurance coverage that includes coverage for physical damage to its oil and gas properties, third-party liability, workers' compensation and employers' liability, general liability, sudden pollution and other coverage. Equinor's insurance coverage includes deductibles that must be met prior to recovery. Equinor's external insurance is subject to caps, exclusions and limitations, and there is no assurance that such coverage will adequately protect Equinor against liability from all potential consequences and damages. Uninsured losses could have a material adverse effect on our financial position.

Inefficient operations and lack of new technology risks

Equinor's future performance depends on efficient operations and the ability to develop and deploy new technologies and new products

The ability to maintain efficient operations, to develop and adapt to innovative technologies and digital solutions, to seek profitable renewable energy and other low-carbon energy solutions, are key success factors for future business. There is a possibility that Equinor could be adversely affected if competitors move faster in the development or use of innovative cost-effective technologies (incl digitalisation) and low-carbon or renewable energy solutions.

Failure to secure capable and competent workforce risk

Equinor may fail to secure the right level of workforce competence and capacity over the short and medium term

The uncertainty of the future of the oil industry in light of reduced oil and natural gas prices and climate policy changes, creates a risk in ensuring a robust workforce through industry cycles. The oil industry is a long-term business and needs to take

A First Estimate of AXA's Corporate Investments Warming Potential

Based on the methodology described above, AXA's Corporate Securities (debt and equities combined) "Warming Potential" estimate stands in line with widely used market indices (BofAML Global Aggregate – Corporate and MSCI ACWI) of 3.3°C. It should come as no **surprise that these figures are above 2°C: this confirms that with today's public policies and business environment, and according to the "Warming Potential" approach tested here, AXA's operating investment universe is not aligned with the 2°C trajectory agreed during COP21**.

The graphs on this page show this analysis per sector and per asset class (corporate debt vs equities).

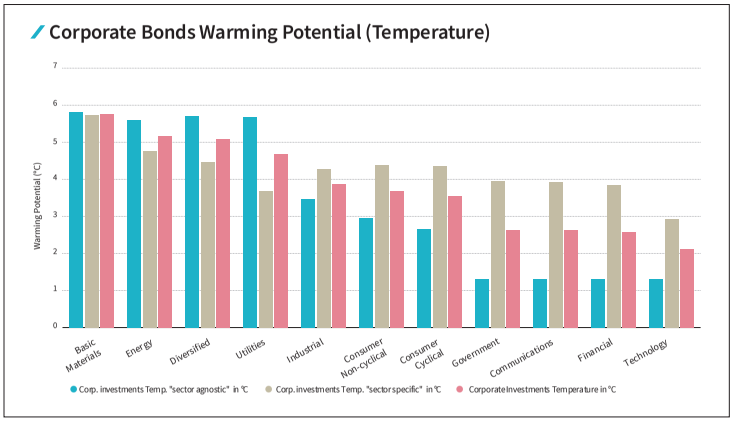
3.3°C

The "Warming Potential" of the main corporate market indices

4.6°C

The "Warming Potential" of AXA's divested coal and oil sands assets

AXA's Corporate Investments' Warming Potential Sector Breakdown



Source: Carbon Delta.

How can a large asset owner like AXA influence its Warming Potential, bearing in mind the numerous regulatory and fiduciary constraints to which an insurer's investments are subject? There is still room for action. For example, our analysis shows that AXA's climate-related divestments (coal, oil sands) have reduced our investments' carbon footprint (see section 4) as well as the Warming Potential of our corporate holdings, as the "warmest" sectors (Utilities, Materials, Energy) are now underweighted in terms of asset allocation. Indeed, the average Warming Potential of AXA's coal and oil sands exclusion list reaches 4.6°C (including the "smoothing" effect on temperature caused by combining sector "agnostic" and "specific" model(s). These divestments slightly reduced AXA's Warming Potential. Indeed this effect concerns only a small fraction of AXA's overall corporate investments, and it has a gradual impact as coal/oil sands debt assets are run off over the course of several years. This is why this decision alone is insufficient to bring AXA's Warming Potential significantly below its benchmark, and a more comprehensive approach, including all industry participants, is required.

These combined costs and opportunities are then translated into a "climate cost" indicator. As detailed in the table below, our exploratory analysis also shows that, on aggregate, the companies we invest in may lose 4.6% of their total revenues in transition costs, and 4.6% of revenues to physical costs, but this is partly offset by green revenues equivalent to 4.4% of total revenues, thanks to the results derived from forward-looking green patent investments. **Ultimately, and according to this methodology, AXA's "Company cost of climate" appears to be equivalent to an average 4.8% reduction of the turnover of the companies we invest in. This would translate into a 0.2% reduction in AXA's investment value, which could be described as a "Portfolio cost of climate".** However, this averaged figure necessarily smoothes out heterogenous impacts amongst market players: some will likely be far more impacted than others.

Transition costs and physical costs are partly offset by green revenues

Methodology Box

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(1) Carbon Delta analysis.

Overview of company-level climate-related "cost" metrics

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Relevant benchmark: Bank of America Merril Lynch (BofAML)	*-4.7*	*-4.9*	*3.8*	*-5.8*
Equity	**-2.2**	**-4.0**	**6.6**	**0.4**
Relevant benchmark: MSCI World ACWI	*-3.9*	*-4.5*	*5.3*	*-3.1*
AXA Total Corporate Assets	**-4.6**	**-4.6**	**4.4**	**-4.8**

Context Box

Is future regulation likely to impose emissions reductions with the help of carbon pricing?

Despite significant political and commercial obstacles, there is a growing consensus among economists, governments and businesses on the fundamental role of carbon pricing in the transition to a decarbonized economy. For governments, carbon pricing is one of the instruments of the climate policy package needed to reduce emissions. Some businesses already use internal carbon pricing to evaluate the impact of mandatory carbon prices on their operations and as a tool to identify potential climate risks and revenue opportunities. Some investors are also testing the use of carbon pricing to analyze the potential impact of climate-related policies on their investment portfolios. Carbon pricing can take different forms from carbon trading schemes to carbon taxes. In 2017 and 2018, carbon pricing initiatives have emerged in Asia and the Americas while the European ETS (CO_2 market) entered in its third phase. China's ETS was officially launched in December 2017 and work is underway to prepare for its implementation.

Our results, which are based on an internal exploratory methodology, show that both annual average losses, as well as losses generated by flood and storm events with a return period of 100 years, remain limited compared to the total asset value. This is consistent with findings we disclosed in our 2018 TCFD report, despite the increase in Real Estate exposure by 8% for the same country scope[1]. The results of our assessment are detailed on a country-level in the tables below.

Potential Average Annual Losses to AXA's Real Estate Portfolio Due to Floods and Windstorms

		Floods		Windstorm	
€Million	% of Exposure	2017	2018	2017	2018
Belgium	9.5%	-	-	0.2	0.2
France	31.9%	-	-	0.6	0.5
Germany	12.0%	0.4	0.4	0.2	0.2
Luxembourg	1.0%	-	-	0.0	0.0
Switzerland	35.9%	-	-	0.3	0.4
UK	4.6%	0.1	0.1	0.2	0.1
USA	3.7%	-	-	0.1	0.1
Japan	1.4%	-	-	-	0.1

Potential Losses to AXA's Real Estate Portfolio due to Floods and Windstorms Potentially Occurring Once Every 100 Years

		Floods*		Windstorm	
€Million	% of Exposure	2017	2018	2017	2018
Belgium	9.5%	-	-	2.6	2.0
France	31.9%	-	-	5.1	6.4
Germany	12.0%	7.0	7.8	1.9	1.4
Luxembourg	1.0%	-	-	0.0	0.1
Switzerland	35.9%	-	-	5.8	6.7
UK	4.6%	0.8	3.1	3.2	1.0
USA	3.7%	-	2.2	0.7	0.6
Japan	1.4%	-	-	-	0.7

* *As we base our analysis on a market CAT model, some countries, in particular for flood risk, are not covered as they are not in the scope of the model. We are working to improve coverage via internal developments.*

The evolution in our results is explained by both improved geocoded data used by our internal model as well as by the changing composition of our portfolio locations to either "riskier" or "safer" areas.

For instance, in France where about a third of AXA's real assets are located, although exposure has increased by 5%, average annual losses from windstorms has decreased by 9%. Mapping 2017 and 2018 asset exposure reveals that the decrease in overall windstorm risk for the France portfolio can be accounted for by the divestment of a number of buildings in higher risk locations in Paris in favor of new investments in areas with lower NatCat risks.

Significant reductions in average annual losses from windstorms in the UK and US portfolios are similarly explained by changes in the composition of asset locations. The increase in asset exposure in the UK has been accompanied by a simultaneous decrease in exposure to annual losses associated with windstorms and an increase to areas exposed to 100-year flood events. The decrease in US exposure is caused by a shift in asset locations to areas that are not as exposed to windstorms.

In conclusion, it is clear that, on the basis of our in-house risk modelling, the financial impacts of climate-related "physical risks" on our current Real Estate assets are very limited. Obviously, AXA is more exposed to such risks as an insurer – but this is the core of AXA's insurance business. Indeed, AXA's insurance risks (P&C claims) are fully modelled, as developed in AXA's 2018 Annual Report (Section 3.3, Insurance Risk Management).

(1) *This excludes the addition of Japan for 2018.*

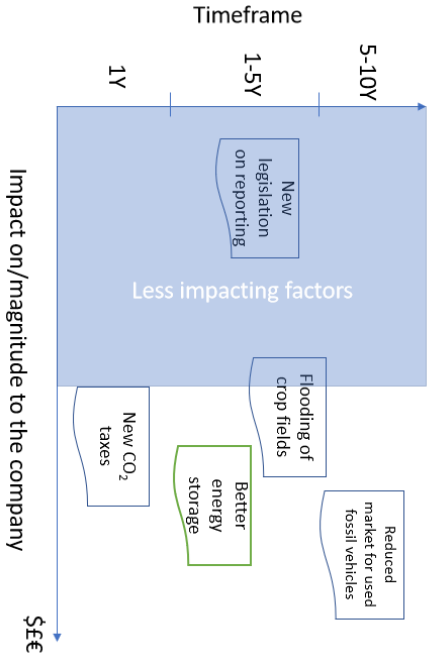

Figure 1: Risks and opportunities assessment of climate risk factors with a high likelihood defined by a 2°C scenario

A simple diagram such as *Figure 1* can allow organisations to determine the **magnitude** of the identified risks and opportunities, as well as the potential **timeframe** of their occurrence. The high **likelihood** would already be defined by the IEA, IPCC or other scenario provider which can be combined with the company-assessed timeframe of the impact. This can then be used to determine whether the risks (and this only concerns the risks) should also be considered for inclusion within the provisions, contingent liabilities or whether they should not be included in the balance sheet at all (IAS 37[11]). Alternatively, if the impact affects the value of assets, the risk/opportunity impacts should be included in the impairment assessments (IAS 36[12])[13].

As a first step, when identifying risk/opportunity factors, one does not need to overcomplicate scenarios by attempting to cover all possible outcomes, as **identifying specific factors that could influence a company's business is a more important first step**. For instance, a food company might identify the increased likelihood of flooding and damages to crops as one of their key risks, alongside a ban on the use of diesel vehicles in countries where their distribution is most dependent on road transport. Similarly, the company could identify its key opportunities to be found in innovative automation technologies. This allows a focused analysis on the key factors in the next stage of the process which looks to monetise the potential impacts and present it in a meaningful way to investors.

Stage 2: Monetising and presenting the risks/opportunities

Once the key risks and opportunities have been identified, organisations need to present it in a meaningful way to investors. This stage does not require new processes or practices, as there are lessons to be taken from conventional business risk analyses.

The current wording of an example of forward-looking sensitivity guidance in the mainstream report to investors could be used by companies to understand what "meaningful" investor climate-related information could look like, as shown in *Figure 2*[14].

	Next year		Next 5 years, accumulated		Next 10 years, accumulated	
Factors	Change	Effect on company's Net result	Change	Effect on company's Net result	Change	Effect on company's Net result
Change of taxes on direct emissions	+/- 10 USD/tonnes of CO2e (scope 1)	-/+ 320 m USD	+/- 10 USD/tonnes of CO2e (scope 1)	-/+ 1,480 m USD	+/- 10 USD/tonnes of CO2e (scope 1)	-/+ 2,738 m USD
Flooding of fields with damage to crops results in crops prices increase			+ 25 USD/metric tonnes crops cost	- 1,375 m USD	+ 25 USD/metric tonnes crops cost	- 2,600 m USD
Reduced energy cost due to better energy storage from renewable sources			- 25% of energy cost	+ 4,125 m USD	- 25% of energy cost	+ 8,000 m USD
Reduced market for used fossil fuel vehicles results in impairment of fleet					- 50% of value at the end of vehicle ownership / lease period	- 12.500 m USD

Figure 3: Mock example of climate risk/opportunity sensitivity guidance

As an organisation builds further knowledge and understanding of scenarios, it may wish to analyse the wider resilience of its business model and strategy, as recommended by the TCFD. This could include analysing a wider range of scenarios beyond the IEA or IPCC, as well as looking into the probability distribution of specific impacts. Disclosures associated with these analyses could require more narrative as well as potentially several tables as shown in the mock example in *Figure 3*.

Producing a similar climate-related sensitivity guidance, with its analysis and monetisation, typically requires collaboration across several departments of an organisation. Functions included in the process could be: financial modelling/planning; tax and accounting; production; strategy; sustainability; and enterprise risk management. Since the outcome of the work may overlap with sensitivity guidance reporting, it may be beneficial that the team producing the sensitivity guidance reporting also takes a lead role in the production of this work. This would provide a more coherent, coordinated and potentially integrated approach to reporting across the management report.

As a new topic for many companies, scenario analysis of climate change impacts will initially be more complex and time-consuming. This would need to be appropriately considered when integrating the project within the reporting cycle. Any work will need to begin early in the reporting cycle to allow all parties in the reporting team to gather a common understanding of the topic and how best to integrate the disclosure within the management report. Reporting teams also need to consider whether further assistance from additional departments or external advisors are required.

Conclusion

This paper presents a practical two-stage process that uses existing financial and accounting standards and methods, as well as the TCFD recommendation on scenario analysis, to create a disclosure we have described as *climate-related risk/opportunity sensitivity guidance*. In the first stage, the climate impact factors and timeframes must be identified, using well-established techniques in risk and opportunity assessments. In the second stage, the key factors will have to be quantified and finally monetised. At this stage, as risk and opportunity factors, timing and impacts have been individually identified, investors can begin to use the sensitivity guidance to evaluate the entire investment portfolio's net climate risk/opportunity profile.