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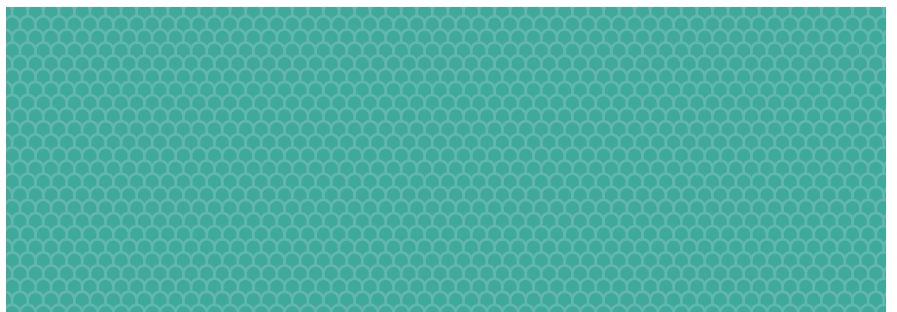
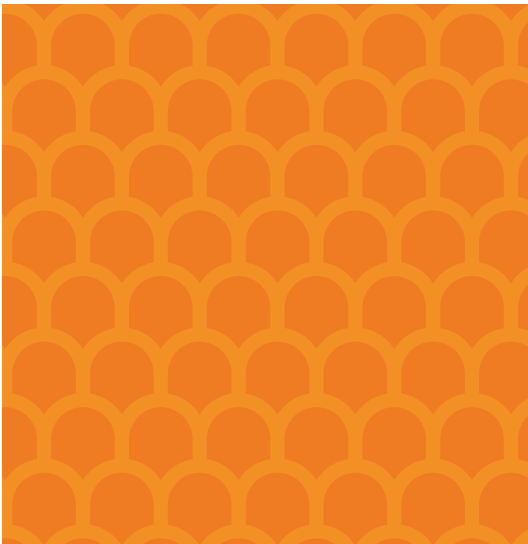
Financial Policy Committee  
Prudential Regulation Committee



Discussion Paper

# The 2021 biennial exploratory scenario on the financial risks from climate change

December 2019





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Responses are requested by Wednesday 18 March 2020.

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# Executive summary

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Climate change creates risks to both the safety and soundness of individual firms and to the stability of the financial system. These risks are already starting to crystallise, and have the potential to increase substantially in the future. There is a pressing need for central banks, regulators and financial firms to accelerate their capacity to assess and manage these risks. To facilitate this, the Bank's [April 2019 Supervisory Statement](#) set out expectations for UK banks<sup>(1)</sup> and insurers to develop and embed climate risk management practices, including by undertaking scenario analysis. To develop this field, the Bank will use its 2021 biennial exploratory scenario (BES) to explore the financial risks posed by climate change. The BES is the part of the Bank's stress testing framework used to explore less well-understood risks that are not neatly linked to the financial cycle.

The objective of the 2021 BES is to test the resilience of the current business models of the largest banks, insurers and the financial system to the physical and transition risks from climate change. The exercise will provide a comprehensive assessment of the UK financial system's exposure to climate-related risks and therefore the scale of adjustment that will need to be undertaken in coming decades for the system to remain resilient. To this end, the BES will focus on sizing risks, rather than testing firms' capital adequacy or setting capital requirements. It will also allow the Bank to examine how major financial firms expect to adjust their business models, and what the collective impact of these responses on the wider economy might be. Finally, the BES will provide a vehicle for financial firms to identify and address data gaps and to develop cutting-edge risk management approaches.

This discussion paper sets out the Bank's proposed framework for conducting the 2021 BES. Given the unique nature of climate-related risks, the 2021 BES will be a novel exercise for the Bank and for participating firms. As a result, the proposal differs from traditional stress tests in several areas:

- **Multiple scenarios:** the BES will test the resilience of individual firms and the financial system to three climate scenarios. These will include scenarios that embody the risks of earlier and later policy action to reach the Paris Agreement target, and a 'no additional policy action' scenario where the Paris Agreement target is not met and more severe physical risks crystallise as a result.
- **Broader participation:** the BES will test the resilience of both the UK's largest banks and insurers to climate-related risks. Insurers will participate via a BES-aligned Insurance Stress Test in 2021. This broader participation aims to test climate-driven financial risks across the system, and to gather insights on spillovers within the financial system.
- **Extended modelling horizon:** the BES will use a 30-year modelling horizon. This is because climate change, and the policies to mitigate it, will occur over a much longer timeframe than the normal horizon for stress testing. To make these scenarios credible and tractable, the Bank proposes that the BES examine firms' resilience using fixed balance sheets, focusing on sizing the risks and the scale of business model adjustment required to respond to these risks, rather than testing the adequacy of firms' capital to absorb those risks.
- **Integrated climate and macrofinancial variables:** the Bank will provide pathways for temperature, emissions, and climate policies to capture the underlying physical and transition risks in each scenario. The Bank will also provide a consistent set of macrofinancial variables to enable firms to model the impact of the scenarios.
- **Counterparty-level modelling expectations:** firms will assess the vulnerability of individual counterparties' business models to the underlying climate-related risks in each scenario.

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(1) References to banks in this paper also includes building societies.

There are many challenges involved in designing such an exercise and this proposal seeks to balance various trade-offs. These include providing a comprehensive description of the potential risks while also creating a tractable exercise for firms, and providing sufficient detail in the scenarios to allow results to be aggregated consistently while also providing scope for firms to assess the risks in a granular way.

The financial sector, including central banks, is still building capacity to model the financial risks from climate change. While the BES will build on the Bank's existing policy response to these risks, including the exploratory climate scenarios included within the 2019 Insurance Stress Test, its scope and breadth mean that it is a pioneering exercise. This discussion paper seeks feedback from external parties on the robustness and feasibility of the proposed framework, including whether the scenarios align with external expectations of climate-related risks and the related changes in the real economy. The Bank wishes to engage with a wide range of stakeholders, including financial firms, their customers, scenario modellers, and climate scientists to ensure that the BES is as informative as possible for both participants and regulators.

The Bank welcomes feedback on any aspect of this proposal for the 2021 BES. Responses should be submitted to [ClimateBES@bankofengland.co.uk](mailto:ClimateBES@bankofengland.co.uk) by Wednesday 18 March 2020. The Bank anticipates launching the BES in the second half of 2020, and publishing results in 2021.

# 1 Overview

## Background on climate-related financial risks

1.1 Climate change presents financial risks for banks, insurers and the wider financial system. It is therefore relevant to the Bank's objectives for financial stability and the safety and soundness of regulated firms. (See Box 1 for a summary of the Bank's response.) Climate change presents financial risks via two main channels:

- **Physical risks** arise from increasing severity and frequency of climate and weather-related events. These events severely damage property and other infrastructure, disrupt business supply chains, impact agricultural output and more broadly can lead to loss of life and migration. This reduces asset values, results in lower profitability for companies, damages public finances, and increases the cost of settling underwriting losses for insurers. Indirect effects on the macroeconomic environment, such as lower output and productivity, exacerbate these direct impacts.

The physical risks from climate change are already affecting UK financial firms. For example, around 10% of the value of mortgage exposures in England is on properties in flood-risk zones<sup>(2)</sup> and some UK banks have large direct exposures to regions particularly vulnerable to climate change, such as South-East Asia.<sup>(3)</sup>

- **Transition risks** arise from the adjustment towards a carbon-neutral economy, which will require significant structural changes to the economy. These changes will prompt a reassessment of a wide range of asset values, a change in energy prices, and a fall in income and creditworthiness of some borrowers. In turn, this entails credit losses for lenders and market losses for investors. The transition to a carbon-neutral economy also presents some opportunities for the financial sector, for example, financing investments in building energy efficiency, renewable energy and carbon-neutral transportation.

The United Nations Environment Programme Finance Initiative estimates that up to 15% of the value of a representative global market portfolio could be at risk in the transition to a low-carbon economy.<sup>(4)</sup> In the UK, loan exposures to fossil fuel producers, energy utilities and emission-intensive sectors amount to around 70% of the largest UK banks' common equity Tier 1 (CET1) capital. For UK insurers, around 12% of equity and 8% of corporate bond portfolio exposures are in 'high carbon' technologies.<sup>(5)</sup>

1.2 The window for an orderly transition to a carbon-neutral economy is finite and closing. The Intergovernmental Panel on Climate Change has warned that rises in global average temperatures since pre-industrial times have reached 1°C, and could exceed 1.5°C as early as 2030, absent material action. Internationally, over 190 countries have committed to put measures in place to limit the global temperature rise to 'well below 2°C'.<sup>(6)</sup> To support this, the UK Government is targeting a reduction in emissions to net zero by 2050.

1.3 Measuring the financial risks from climate change is complex. It involves assessing the effect of multiple climate pathways, with different physical and transition effects, over several decades. This requires new tools and approaches to measure and understand the risks.

(2) In particular, according to the Met Office (2018), by 2100, sea levels in parts of the UK could rise by up to 70cm in a 'low emissions scenario', and by up to 115cm in a 'high emissions scenario', relative to 1981–2000 levels.

(3) See Cambridge Institute for Sustainability Leadership 'Physical risk framework: Understanding the impact of climate change on real estate lending and investment portfolios'.

(4) At the portfolio level, transition opportunities may offset about two thirds of these losses. UNEP Finance Initiative (2019), 'Changing course'.

(5) According to research by Bank staff based on end-2018 data.

(6) The Paris Agreement falls within the United Nations Framework Convention on Climate Change. It was agreed in 2015 at the 21st Conference of the Parties. Each signatory must make financial flows consistent with a path to low greenhouse gas emissions.

## Box 1

### The Bank of England's response to the financial risks from climate change

The Bank's response to climate-related financial risks has two core elements, each motivated by its statutory objectives in its respective functions as Prudential Regulation Authority (PRA) and Financial Policy Committee (FPC). The first involves the PRA's objective of promoting the safety and soundness of the firms it regulates by enhancing their approach to managing climate-related risks. To that end, in April 2019 the PRA set out its expectations of banks and insurers in a [supervisory statement](#). The PRA also established the Climate Financial Risk Forum, co-chaired with the Financial Conduct Authority, to build capacity and share best practice across industry to advance financial sector responses to these risks. To promote further discussion of how business models and balance sheets may need to adapt, the [2019 Insurance Stress Test](#) included an exploratory section to capture information about insurers' financial exposures to climate-related risks, as well as risk management tools and data currently available for such risk assessment. The second element of the Bank's response concerns the FPC's aim to ensure that the UK financial system serves UK households and businesses in bad times as well as good. Thus, the FPC considers the system-wide financial risks from climate change.

The Bank's international engagement has supported this work. For example: it is a founding member of the Network for Greening the Financial System, a coalition of central banks and supervisors; it co-founded the International Association of Insurance Supervisors' Sustainable Insurance Forum; and it is an active supporter of the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD). In 2017, the TCFD released recommendations that provided a framework for companies and other organisations to develop consistent climate-related financial disclosures that would be useful to investors, lenders, and insurance underwriters in understanding material risks. [The Bank will disclose an assessment of how it manages its own climate-related financial risks](#) in its 2019/20 Annual Report in line with the TCFD's recommendations.

## Purpose of the 2021 biennial exploratory scenario

1.4 The Bank complements its annual cyclical stress tests by using exploratory scenarios to explore a range of risks that may not neatly link to prevailing economic or financial conditions. The Bank aims to run these exercises every other year. These BES exercises help the Bank and financial institutions prepare for possible future risks.

1.5 The 2021 BES will test the resilience of the UK financial system to the physical and transition risks associated with different climate pathways. The Bank decided to undertake this exploratory exercise following the publication of the Van Steenis [Future of Finance report](#).

1.6 The desired outcomes of the 2021 BES are to:

- size the financial exposures of participating firms and the financial system more broadly to climate-related risks;
- understand the challenges to participants' business models from these risks, gauge their likely responses and the implications this carries for the provision of financial services. This includes investigating the interdependency between insurers and banks, namely the impact of potential changes in insurance provision on banks' credit risk exposures; and
- assist participants in enhancing their management of climate-related financial risks. This includes embedding these risks in business-as-usual risk management, engaging counterparties to understand their vulnerability to climate change, and encouraging boards to take a strategic, long-term approach to managing these risks.<sup>(7)</sup>

1.7 The 2021 BES will draw upon lessons learnt from the climate scenarios in the 2019 Insurance Stress Test (see Box 1) and help the Bank develop its approach to climate-focused scenario analysis, both domestically and

(7) Counterparty refers to a firm whose liabilities are held by participants (these include loans, bonds, equity). This does not refer to an insurer's reinsurer.

through international groups like the Network for Greening the Financial System and the International Association of Insurance Supervisors' Sustainable Insurance Forum. The results will enhance the Bank's understanding of the financial stability implications of climate change and supplement supervisors' knowledge of firms' governance and climate-related risk management. The exercise will not be used to set capital requirements.<sup>(8)</sup>

1.8 The Bank intends the 2021 BES to be a learning exercise. Expertise in modelling these risks is in its infancy, so this exercise will develop the capabilities of both the Bank and firms.

## Purpose and structure of this discussion paper

1.9 Conducting a climate stress test poses distinct challenges compared to conventional macrofinancial or insurance stress tests. The 2021 BES is therefore a novel and complex exercise. To ensure it is effective in light of these challenges, the Bank is using this discussion paper to consult relevant stakeholders on the design of the exercise. This includes financial firms, their customers, climate scientists, economists, other industry experts, and informed stakeholder groups.

1.10 This discussion paper sets out the Bank's proposal for the 2021 BES as follows:

- (a) Chapter 2 outlines the key features, including: participation; the nature of the scenarios; the two parts of the exercise; the modelling horizon; treatment of balance sheets; and the reporting frequency.
- (b) Chapter 3 describes the scenario narratives.
- (c) Chapter 4 details the scenario specification.
- (d) Chapter 5 sets out the modelling approaches.
- (e) Chapter 6 sets out the approach to participants' submissions. This includes the reporting of risk exposures, as well as the management actions participants may take within the scenario.

1.11 To facilitate feedback on specific elements of the scenario design, there are targeted questions at the end of each chapter (a full list can be found in Annex 1). The Bank also welcomes feedback on the package as a whole, including whether respondents think the exercise will deliver the intended aims set out above. In particular, the Bank is seeking views on whether the exercise is:

- **feasible:** whether participants will be able to develop the proper staffing and information to run the BES as proposed. This includes consideration of the unique features of the exercise, and whether the proposed scenarios provide sufficient information for rigorous bottom-up analysis of individual exposures; and
- **robust:** whether the proposal for the BES, including the range of scenarios and the proposed modelling framework, will generate a reliable understanding of the financial risks from climate change.

## Discussion paper responses and next steps

1.12 The period for responses to this discussion paper closes on Wednesday 18 March 2020. The Bank invites feedback on the proposals set out in this paper. Please address any comments or enquiries to [ClimateBES@bankofengland.co.uk](mailto:ClimateBES@bankofengland.co.uk).

1.13 After considering the feedback, the Bank intends to consult on and publish the final BES scenarios in the second half of 2020. Participants would have around three to four months to run the exercise to avoid overlapping with the annual cyclical scenario. The Bank would then analyse the submissions and consider requesting a follow-up round of submissions to explore system-wide impacts in greater depth. It would aim to publish the results of the BES in 2021. The Bank welcomes feedback on this proposed timeline for the exercise.

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(8) Unlike in the annual cyclical scenario, individual banks' quantitative results are not tied directly to actions they are required to take. Instead, banks' submissions may inform the FPC's approach to system-wide policy issues, the PRA's approach to supervisory policy and guide further work between participants and supervisors to address any issues highlighted.



1.14 The Bank does not intend to disclose the results of individual firms. This reflects the exploratory nature of the exercise. Instead, the Bank anticipates disclosing system-level results of the financial sector's resilience to climate change, including highlighting the main sources of loss by sector and geography. It may also publish ranges of results across participants.

## 2 Key features of the 2021 BES

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2.1 This chapter sets out the Bank's proposal for the key features of the 2021 BES. The distinct characteristics of climate-related financial risks mean the 2021 BES will differ from traditional stress-testing methodologies.<sup>(9)</sup> Key differences include: the wide-ranging impact of climate-related financial risks, requiring broader participation; the range of possible pathways and climate outcomes, requiring multiple scenarios; the interaction with the real economy, requiring counterparty-level analysis; and the longer timeframe over which risks materialise, requiring multi-decade analysis. Given the difficulties of making long-term projections, the BES would have two parts. It would first test the vulnerability of today's balance sheets to climate change, and then ask firms how they might adapt their business models over the scenario. This would allow firms' responses to be aggregated to improve our understanding of the resilience of the overall system. See **Figure 2.1** for an overview of the exercise.

### Participation

2.2 Climate change affects all parts of the financial system, and the potential for spillovers between different sectors is substantial. The Bank would therefore test the resilience of both the UK banking and insurance sectors to these risks.<sup>(10)</sup> Bank participants would be those participating in the 2021 annual cyclical scenario.

2.3 Large insurers would participate in the 2021 BES via a set of BES-aligned climate scenarios added to the 2021 Insurance Stress Test.<sup>(11)</sup> The aim is to ensure that the Bank captures the impact of the BES on large insurers, while avoiding the added burden of asking some insurers to complete two separate stress-testing exercises. The PRA will still consult on any additional scenarios for the 2021 Insurance Stress Test via the standard process, however, it would seek alignment with the 2021 BES as much as possible. Given this alignment, insurers are asked to respond to this discussion paper with their views of the feasibility and robustness of the framework.

2.4 Only large firms will participate in the BES in order to balance the need to capture system-wide impacts of climate change against the costs of smaller firms developing the necessary modelling capabilities. However, the Bank welcomes responses to this discussion paper from financial firms outside the proposed scope of the BES. In addition, the Bank intends to make enough information available in the published scenarios to allow other firms to complete the exercise as part of their own scenario analysis work, in line with [the PRA's supervisory expectations on climate-related financial risks](#). Firms not regulated by the PRA are also welcome to make use of the scenarios set out in this exercise where helpful for their own management of climate-related risks.

### Nature of the scenarios

2.5 Physical and transition risks affect financial firms in distinct ways. In any single scenario there is a trade-off across both risks given their interrelated nature. For example, continued emissions will lead to rising temperatures that increase physical risks, but limiting these impacts requires substantial emissions reductions that increase transition risks.

2.6 To capture the range of different combinations of transition and physical risks, the 2021 BES would test the resilience of the UK financial system against three distinct scenarios:

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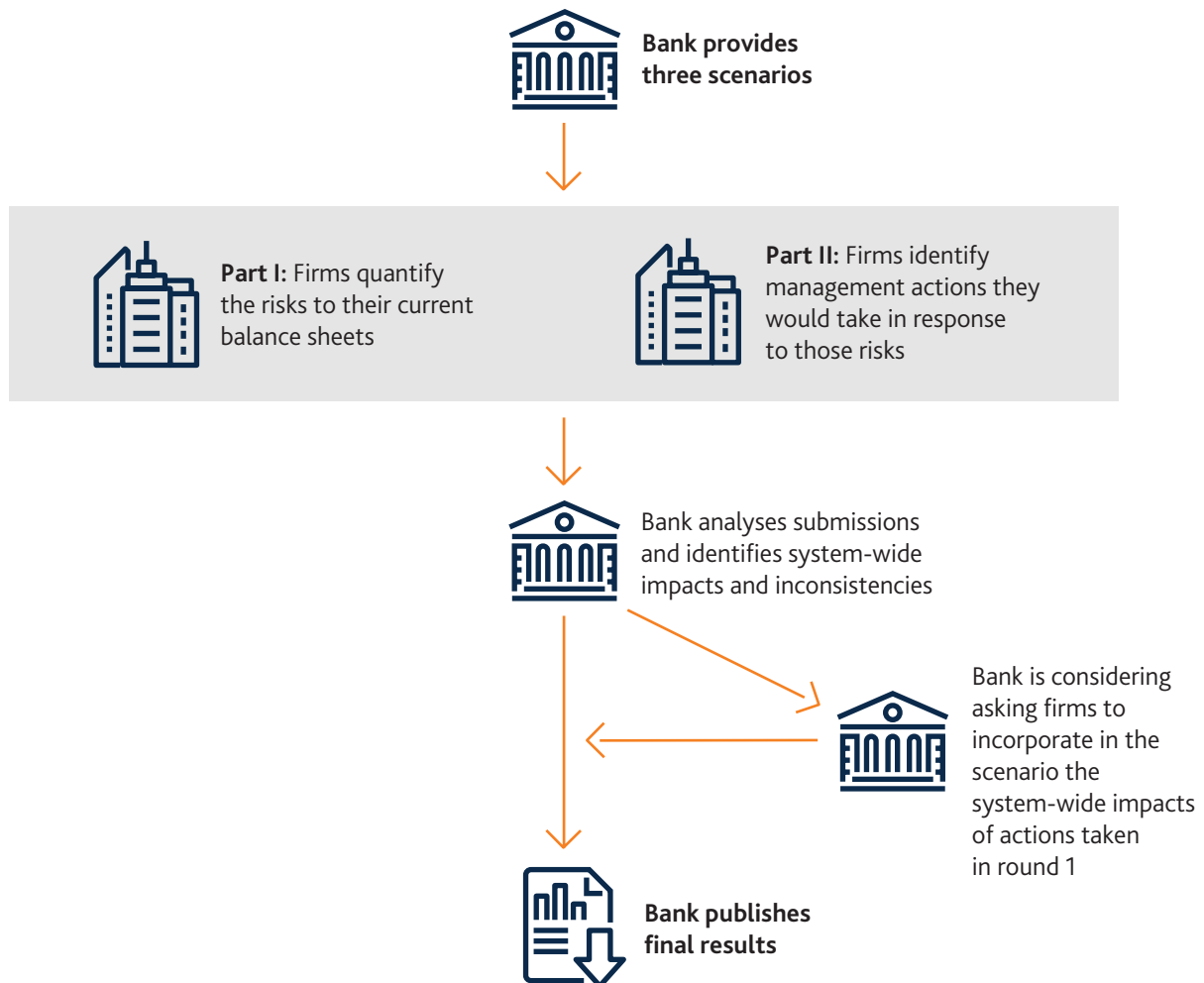
(9) The 2021 BES builds on the climate scenario in the 2019 Insurance Stress Test and exercises by other central banks. The 2021 BES is the first climate stress test in which participants in both the banking and insurance sectors would do bottom-up counterparty-level modelling of climate-related financial risks.

(10) All firms would submit at the UK group consolidated level.

(11) The PRA runs its own stress tests on a periodic basis for a number of insurance firms. It does this regularly for specific high-impact firms and others as the need arises. Not all 2021 Insurance Stress Test firms will be asked to complete these additional climate scenarios. To align with the BES, only the insurers with material commercial and personal property portfolios, material volumes of annuity business, or large asset portfolios would be asked to participate on a voluntary basis.

- **Early policy action scenario** where the transition to a carbon-neutral economy starts early and the increase in global temperature stays below 2°C, in line with the Paris Agreement.
- **Late policy action scenario** where the global climate goal is met but the transition is delayed and must be more severe to compensate for the late start.
- **No additional policy action scenario** where no policy action beyond that which has already been announced is delivered. Therefore, the transition is insufficient for the world to meet its climate goal.

Figure 2.1 Overview of the 2021 BES exercise



2.7 Each scenario would be a prudent estimate of underlying climate and transition pathways. For example, the scenarios would assume limited development in carbon capture and storage technologies and would take a conservative approach to the sensitivity of temperature to increases in emissions. As a result, the scenarios would not be forecasts of future paths for climate and macrofinancial variables. Rather, they would be possible scenarios about what could happen under certain assumptions. In conjunction with climate scientists, the Bank will develop a high-level view on the probability that impacts aligned with each scenario will crystallise. Firms will also be asked to set out their own expectations for future climate change driven scenarios.

### A two-part exercise: splitting out risks and responses to those risks

2.8 The BES would first test the resilience of financial firms' current business models to climate change, then explore how these might change in response. To do so, the first round of the BES would have two parts:

- **Part I: Sizing the risks.** To understand the vulnerability of current business models to climate change, participants would quantify the change in the value of their assets and (for insurers) liabilities at different points in each scenario. It would assume the nominal size and composition of balance sheets do not change. The results would account for both the direct and indirect impacts of climate-related financial risks, as well as the mitigation and adaptation plans of counterparties (see Chapters 5 and 6).
- **Part II: Sizing the responses.** Participants would then assess how they would change their business models in response to the risks in each scenario. This includes reducing exposures to at-risk sectors and redirecting capital to capture the opportunities in each scenario. The Bank would assess the plausibility of these actions in the aggregate. This includes the potential for spillovers across sectors, for behaviours to amplify the impact of the underlying climate shocks, and for material disruption to the provision of financial services to UK households and businesses.

2.9 The Bank is considering requesting a follow-up round of submissions to explore system-wide impacts. These include inconsistencies across the first round submissions, such as banks' assumption of high levels of flood insurance coverage where insurers indicate provision could be reduced. BES participants would respond to the aggregated results from the first round, and potentially revise parts of their submissions in response to Bank feedback. This approach is described in more detail in Chapter 6.

## Modelling horizon, treatment of balance sheets and reporting frequency

2.10 Climate change, and the policies to mitigate it, will occur over many decades. The resulting financial risks therefore crystallise over a timeframe much longer than the normal horizon for stress testing. To ensure the 2021 BES captures these risks to a meaningful degree, this exercise would use a 30-year modelling horizon (ie from 2020 to 2050).

2.11 The following design choices reduce the difficulties of projecting balance sheets over such a long period:

- **Fixed balance sheets in the first part of the exercise:** BES participants would assume the nominal size and composition of their balance sheets do not change over the time horizon of the scenario. In effect, the BES would test the resilience of 30 June 2020 balance sheets to climate-related financial risks at different points in each scenario.<sup>(12)</sup> By assuming away participants' ability to take management actions to reduce exposures,<sup>(13)</sup> the BES would quantify current underlying vulnerability to climate-related risks and shed light on the scale of adjustment required by the financial system over the coming years/decades.
- **Reporting frequency:** participants would submit projections at every five-year point in the test horizon, a lower frequency than in traditional stress tests. This allows firms to model long-term climate-related risks in a proportionate way. More detail on these design choices is described in Chapter 5.

2.12 Absent a rapid transition, some physical risks will crystallise in the period to 2050, but the most material shocks would occur later in the century. To ensure the no additional policy action scenario captures these severe risks but avoid lengthening the modelling period, the Bank proposes to calibrate the 30-year scenario assuming the more material risks anticipated in the period from 2050 to 2080 occur by 2050. As with the other scenarios above, participants would test the resilience of their current balance sheets to this scenario.

## Questions on the proposed key features of the 2021 BES

Q1 Are there areas of the financial system that should be represented in the 2021 BES that are not captured by the proposed participation?

Q2 Do firms envisage any challenges with modelling the no additional policy action scenario spanning 2050–80?

(12) The timing implications of the use of 30 June 2020 balance sheets is explored further in Chapter 5.

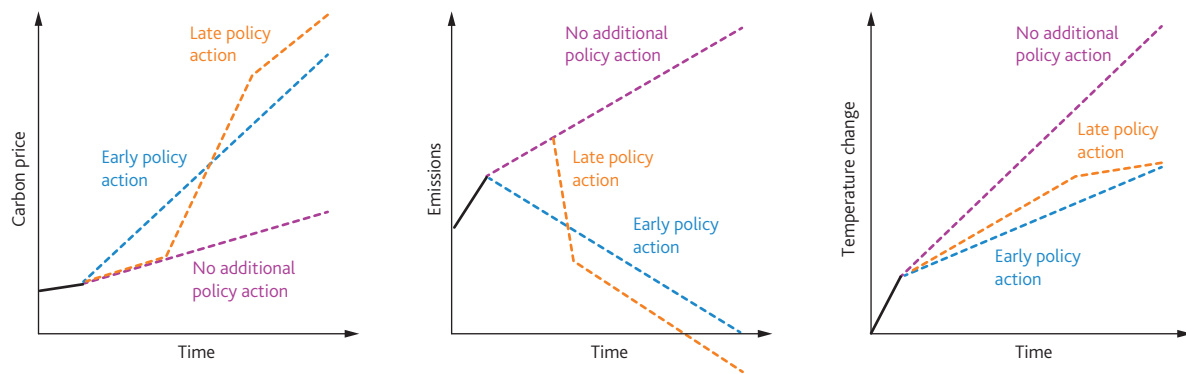
(13) This includes active changes (eg due to management actions) and passive changes (eg maturing assets) that alter the size or composition of balance sheets. The Bank will consider exceptions where this constraint impedes rather than clarifies our understanding of the underlying vulnerability to climate-related risks (eg rebalancing matching adjustment portfolios for life insurers).

## 3 Scenario narratives

3.1 The Bank proposes that the 2021 BES will include three scenarios that capture a range of prudent estimates for transition pathways and climate outcomes. This chapter outlines the proposed scenario narratives in more detail.

3.2 The scenarios build on the reference scenarios currently being developed by the Network for Greening the Financial System (see Box 2). They would provide a coherent set of climate pathways and key macroeconomic variables. **Figure 3.1** sets out key variable pathways in each scenario. Chapter 4 describes the macroeconomic and financial variables specified under each scenario.

**Figure 3.1** Illustrative variable pathways in each scenario



### Early policy action scenario

3.3 In this scenario, there is early and decisive action to reduce global emissions in a gradual way, with clearly signposted government policies implemented relatively smoothly. Companies and consumers align their behaviour with a carbon-neutral economy gradually over the scenario. Financial markets price in the transition in an orderly fashion and take advantage of the opportunities that the transition provides. In this scenario, there is a structural reallocation but no other macroeconomic shock. These actions are sufficient to limit global average temperature increases to below 2°C. But even this moderate increase in global temperatures leads to higher physical risks.

### Late policy action scenario

3.4 Under this scenario, action to address climate change is delayed by ten years. To compensate for the delayed start a deeper adjustment is required, as evidenced in a steeper increase in global carbon prices in a late attempt to meet the climate target. Companies and consumers change their behaviour in response to these dramatic shifts, and asset prices see a sharp repricing as a result, leading to a macroeconomic shock. The climate target is still met and global average temperature increases are limited to below 2°C; however achieving this brings a significant degree of disruption to the economy. Under this scenario, physical risks rise more quickly than in the early policy action scenario and transition risks are severe.

### No additional policy action scenario

3.5 Under this scenario, governments fail to introduce policies to address climate change other than those already announced. Companies and consumers do not change their behaviour to reduce emissions compared to current trends. There is also limited technological transition. As a result, the climate target is not met and the global average temperature increases substantially by 2080. This scenario tests financial firms’ resilience to both chronic changes in weather (eg rising sea levels), as well as more frequent and extreme weather events (eg flash floods). Therefore, under this scenario, there are limited transition risks, but physical risks are significant.

3.6 To ensure this scenario captures severe physical risks without lengthening the modelling period, the Bank proposes to calibrate the 30-year scenario assuming the more material risks anticipated in the period from 2050 to 2080 occur by 2050. As with the other scenarios above, participants would test the resilience of their current balance sheets to this scenario.

### Box 2

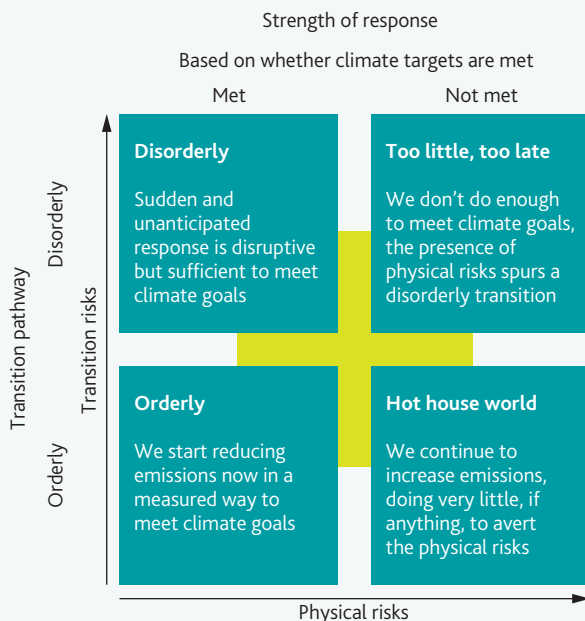
#### Adapting the Network for Greening the Financial System’s scenario framework

The Network for Greening the Financial System is developing an analytical framework for assessing climate-related risks in order to size the impact on the economy and financial stability. This includes looking at the different possible outcomes for climate change and the policies to mitigate it, assessing the financial impact and determining the timeframes during which risks could materialise. Based on a literature review of existing scenarios, the Network concluded that there are two important dimensions (see Figure 3.2):

- The total level of mitigation or, in other words, how much action is taken to reduce greenhouse gas emissions (leading to a particular climate outcome).
- Whether the transition occurs in an orderly or disorderly way, ie are the actions sudden and unanticipated.

The 2021 BES would build on this framework and leverage the reference scenarios that the Network is planning to publish in 2020.

Figure 3.2 Framework of representative scenarios



Source: NGFS Comprehensive Report 'A call for action: Climate change as a source of financial risk'.

## Questions on the proposed scenario narratives

Q3 Are there any other scenarios that the Bank should be testing as part of the 2021 BES?

Q4 Do the scenario timeframes strike the right balance between allowing a full assessment of these risks while also being tractable for firms' modelling?

## 4 Scenario specification

4.1 This section sets out the types of variables that the Bank proposes to provide in the 2021 BES to enable firms to model the financial impacts of the three scenarios. The specification would build on the Network for Greening the Financial System's reference scenarios due to be published in April 2020. The Bank will consult on the draft scenarios, including the calibrated pathways for scenario variables, which are not set out in this discussion paper.

4.2 The BES would provide variables for the underlying physical and transition risks for each scenario, and then map these risks onto macroeconomic and financial variables. These variables would reflect the macroeconomic and financial impact of the combination of climate-related risks in each scenario; they would not layer on an additional macroeconomic shock that is unrelated to climate change. They are not intended to be substitutes for individual counterparty analysis, but rather are designed to provide common background assumptions for participants' modelling (eg imposing common discount rates). The BES would not explicitly incorporate social and political feedback effects from the climate scenarios, such as migration or political upheaval, in its specification or calibration.

4.3 For banks, the BES would use a similar approach to specifying scenario variables as the annual cyclical scenario, where the widest range of variables are specified for the UK and the most important global economies. For insurers, the BES would use a similar approach to specifying scenario variables to that used in the 2019 Insurance Stress Test. **Table 4.A** provides specific examples of the climate and macrofinancial variables that the Bank would expect to provide in each BES scenario.

**Table 4.A** Indicative scenario variables for the proposed BES scenarios<sup>(a)(b)</sup>

Climate risk variables		Macrofinancial variables	
Physical variables	Transition variables	Macroeconomic variables	Financial market variables
<ul style="list-style-type: none"> <li>Global and regional temperature pathways.</li> <li>Frequency and severity of specific climate-related perils in regions with material exposure (including UK flood, subsidence and freeze).</li> <li>Longevity.</li> <li>Agricultural productivity.</li> </ul>	<ul style="list-style-type: none"> <li>Carbon price pathways.</li> <li>Emissions pathways (aggregate, and decomposed into world regions and sectors).</li> <li>Commodity and energy prices (including renewables), by fuel type.</li> <li>Energy mix.</li> </ul>	<ul style="list-style-type: none"> <li>Real GDP (aggregate and decomposed by sector).</li> <li>Unemployment.</li> <li>Inflation.</li> <li>Central bank rates.</li> <li>Corporate profits (aggregate and decomposed by sector).</li> <li>Household income</li> <li>Residential and commercial property prices.</li> </ul>	<ul style="list-style-type: none"> <li>Government bond yields for major economies.</li> <li>Corporate bond yields for major economies (investment grade and high yield).</li> <li>Equity indices.</li> <li>Exchange rates.</li> <li>Bank Rate.</li> </ul>

(a) The BES would specify a consistent set of variables across all three scenarios. Calibration would depend on the combination of physical and transition risks in each scenario.

(b) The Bank would also use a subset of these variables to understand the interaction between banks' and insurers' responses to the different scenarios — for example, these variables could include more granular detail around UK climate-related perils, adaptability cost, impacts on household income and impacts on property prices. The aim is to improve the Bank's understanding of how climate-related risks impact banks and insurers differently.



4.4 The approach to specification of variables in the 2021 BES would be as follows:

- **Physical and transition variables:** The BES would provide pathways for climate variables to represent the impact of climate risks and opportunities at the global and regional level. For example, physical variables would include information about regional sea level increases and changes in storm patterns, and transition variables would include a pathway for the carbon price. The test would recognise that physical risk and transition risk are interdependent, and so the ultimate financial impacts would be a combination of both.

For more detail on the approach to specifying and calibrating physical and transition risk variables, please see the paragraphs 4.7 to 4.11 below.

- **Macroeconomic and financial market variables:** The BES would provide macroeconomic and financial market variables. These would be designed to represent the impact of climate-related risks and opportunities at a global level, and at the level of key countries, regions, and sectors. These variables would be calibrated to reflect the impacts of physical and transition variables in each scenario. They would not layer on an additional macroeconomic shock, unrelated to the climate scenarios, and the financial market variables would reflect the direct financial market consequences of the paths of the macroeconomic variables. This would enable banks and insurers to model the financial impact of the scenarios on the value of their assets, as well as the impact on insurers' liabilities, but would not act as a substitute for firms performing their own analysis of individual assets and counterparties. Firms should also consider if their analysis might, in aggregate, imply different market-wide shocks.

The BES would ask firms to use the physical and transition variables, in combination with the macroeconomic and financial market variables, to quantify the combined impact of the overall climate-related risk in each scenario. Chapter 5 provides more detail on modelling approaches.

- **Participants to undertake scenario expansion:** The BES would not provide every variable that participating firms would need to model the scenarios. In line with other Bank stress tests, participating firms would have to undertake scenario expansion to extrapolate additional scenario variables needed to estimate impacts on individual counterparties.<sup>(14)</sup>

4.5 The Bank is considering its approach to calibrating these scenario variables. The Network for Greening the Financial System scenarios will provide coherent sets of physical and transition pathways. The Bank will then use macroeconomic models to generate paths for the macroeconomic and financial market variables. The Bank will seek to calibrate the climate and macroeconomic variables in a consistent manner, and to provide these variables at the required sectoral and geographic granularity. It is important to reiterate that the 2021 BES will be a test of resilience against climate shocks, so there will be no additional macroeconomic shocks in the scenario that are independent of the climate shocks.

4.6 The sections below provide more detail on the Bank's approach to specifying and calibrating physical and transition risk variables in the 2021 BES.

## Physical variables

4.7 The BES would specify physical variables, expressed as a change in frequency and severity of weather events, both in terms of mean outcomes and outcomes in the tail of the distribution. This would incorporate both the acute and chronic impacts of physical risks. The scenarios would be based on external research that specifies these variables with a high degree of geographic granularity and at the level of the individual peril to reflect their regional impacts (eg granular flood risk projections). Particular focus would be given to physical risk variables that have direct impacts on banks' and insurers' assets, as well as on insurers' broader underwriting portfolios. Banks would also be asked to consider the impact of changes in the provision of insurance for certain physical risks as part of the proposed second round exercise to examine interactions between banks and insurers (see paragraphs 6.18–6.19).

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(14) For insurance participants, this excludes reinsurance counterparties.

4.8 The macroeconomic and financial variables specified would reflect the impact of physical variables in each scenario. For example, the path of GDP would reflect estimates of the impact of temperature increases on labour productivity. Similarly, the paths of commercial and residential property prices would reflect, for example, the costs of climate-related damage to the housing stock. Household income and corporate profits metrics would be adjusted to reflect, for example, the cost of repairs to property and disruption to corporate supply chains. As part of its aggregation of the results of the BES, the Bank would consider whether these estimates should be revised. It would ask firms to update modelled outputs in the proposed second round (see paragraphs 6.18–6.19).

4.9 The BES would also specify variables to enable insurers to model the scenarios on the liability side of their balance sheets (eg for life insurers changes in longevity).

## Transition variables

4.10 The BES would test the impact of a range of transition risks and opportunities on participants, including:

- **Policies to reduce greenhouse gas emissions:** these measures could include increasing carbon prices for producers, redirecting government subsidies and the introduction of new regulations.
- **Technological change:** these measures could include the deployment of emissions-reducing technologies (eg renewable energy), improving end-user energy efficiency, or preventing release of carbon into the atmosphere.
- **Consumer preferences for lower-emission products:** these measures could include changes in price, consumer behaviour, availability of substitutes and perceptions of environmental impact.

4.11 The variables set out in **Table 4.A** would be calibrated to reflect the range of transition factors set out above. For example, corporate profitability would reflect impacts on costs (eg due to a carbon price and changes in supply costs) and on revenue (eg from reduced demand for fossil fuels or from increased demand for green products). To quantify the impact of transition risks on household sector exposures, the BES would specify profiles for household income and residential property prices. These profiles would reflect the impact of consumer costs (eg from changes to energy, transport or food prices), and of upgrading the energy efficiency of properties. The BES would also specify assumptions around the technological change (such as the deployment of key energy-related technologies) associated with the transition in each scenario. Again, the Bank would consider whether these estimates should be revised as part of its aggregation of system-wide results and would ask firms to updated modelled outputs in the proposed second round (see paragraphs 6.18–6.19). Modelling approaches to physical and transition risks are described in more detail in the next chapter.

## Questions on the proposed scenario specification

Q5 Does the scenario specification adequately capture the risks in each scenario? Are there additional risk channels or scenario variables that should be considered as part of the BES?

Q6 Are there alternative approaches to capturing the interactions between physical and transition risks, including capturing the impact of stranded assets?

Q7 Are there particular external sources to calibrate physical and transition risk impacts that the Bank should consider when calibrating the scenario variables?

Q8 Are there particular external sources or approaches that the Bank should consider when relating long-term macrofinancial variables to climate variables?

Q9 For life insurer liabilities, are there further risks beyond longevity that should be specified as part of the BES?

# 5 Modelling approaches

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5.1 This chapter sets out how participants might assess the impact of the scenarios — both the risks and the opportunities — on their balance sheets in Part I of the exercise. The proposed approach seeks to balance (i) imposing a common set of comparable assumptions with (ii) encouraging participants to judge the vulnerability of individual exposures.

5.2 To achieve this balance, the scenario variables would specify a Bank view of the aggregate impact of climate-related risks on the economy, financial markets and sectors. Participants would then assess their individual counterparties relative to these aggregate impacts. Box 3 sets out a practical example of how firms could approach this.

5.3 This approach would place new modelling demands on participants, requiring the development of new methodologies, the sourcing of new data sets, the interpretation of research and using expert judgement. Annex 2 sets out an initial list of relevant tools to support this.

## Bank and insurer assets

### Approach to different sectors

5.4 Participants would model the impact on their assets at the following level of granularity:

- **Corporate exposures** (eg loans, equities, bonds, commercial real estate): Participants would perform financial analysis of individual companies. This would include modelling cash flows and collateral values, and should reflect judgements about how companies would be positioned in light of both their underlying risks and opportunities, including an assessment of their current mitigation and adaptation plans. To do so, participants are encouraged to use climate disclosures, such as the Task Force on Climate-related Financial Disclosures, and directly engage with counterparties. This counterparty-level assessment should aim to cover 80% of participants' nominal exposure to corporates and be focused on their assets exposed to the risks.

Such analysis is resource intensive and relies on data that may be unavailable for some companies. So for the remaining 20% of exposures, participants may use simpler, less granular approaches, such as inputting the macroeconomic/financial variables (eg GDP, sectoral corporate profits) into existing stress-testing methodologies. Participants would indicate the share of their corporate portfolio modelled in this way. This would be compared to that of their peers.

- **Household exposures** (eg mortgages, unsecured lending): The scenario variables would specify country-level economic impacts such as changes in household income and property prices. Their calibration would account for some adaptation by households over the scenario. Participants would assess the impact on their household exposures based on their vulnerability to transition risks (eg energy efficiency of mortgaged properties) and physical risks (eg perils to borrowers in a particular location). For UK exposures, participants would analyse their physical risk exposures at a regional granularity of no less than four digit postcode.
- **Government exposures** (eg sovereign and municipal securities): The scenario would specify bond yields for major countries (eg UK, US, Germany) in order to impose common background assumptions for participants' modelling (eg on discount rates). Participants would perform sovereign risk analysis on countries not specified in the scenario. These are likely to include countries most impacted by climate change, such as those in emerging markets. For the handful of major sovereigns where paths for yields are specified, participants would also perform sovereign risk analysis to indicate whether they agree with the scenario's assessment. Any differences in views could be explored in the potential second round of submissions.

### Box 3

## Practical example of modelling financial impacts

This example sets out how participants could assess the impact of the scenarios on the valuation of a hypothetical corporate bond issued by an energy utility company. The issuer owns and operates large coal and gas-fired power stations in the UK and Poland. **Figure 5.1** illustrates how participants could revalue this security.

**Figure 5.1** Steps for counterparty-level analysis



### Step 1: Map the scenario to counterparty

Participants would first need to **understand the business model and material operating locations** of the utility. Participants would then **identify the relevant scenario variables** for performing a granular credit assessment of the bond, including analysis of the utility's revenues and costs over time. Relevant scenario variables would include: pathways for energy supply prices and capital expenditure (for revenue); and EU carbon prices, sectoral-level emissions, and the impact of extreme weather on operations (for costs). Participants would also need to consider the broader macroeconomic environment, such as the pathway of GDP. Participants may have to make assumptions to extrapolate the scenario into risk factors relevant to their specific exposures. For example, participants would assume a GDP pathway in Poland given EU GDP and estimate company-level emissions and stranded assets from sectoral emission and technology pathways.

### Step 2: Assess counterparty-level financial impacts

Next, participants would revalue the corporate bond. To do so, participants could use a number of existing frameworks and adapt existing models (such as natural catastrophe models) to assess impacts.<sup>(1)</sup> Participants would need to first quantify the **current vulnerability** of the utility given the impact of the scenario variables on the utility's profitability and assets over time. Participants would also need to consider the current **mitigation and adaptation strategies** of the company (eg emissions reductions targets, infrastructure investment) where credible information is available.<sup>(2)</sup> Participants would engage directly with the utility, use climate disclosures and relevant data. They may also need to use other scenario variables such as the government bond yields provided.

### Step 3: Check coherence against the scenario

Finally, participants would **aggregate the impact on individual counterparties across sectors** in their portfolio. They would then **compare these results to the average impacts** the Bank has specified. For example, participants could check how the change in emissions and corporate profitability compare to the sectoral pathways provided for these variables. Where there are big gaps, participants would do further analysis to understand how using different assumptions would affect the results.

(1) See for example the UNEP FI TCFD pilot approaches for banks, insurers and investors and the PRA Framework for quantifying physical climate change risk for general insurers.

(2) Credible information may include projects under way and those committed to in Task Force on Climate-related Financial Disclosures reports.

## Approaches to assets in different geographies

5.5 As set out in Chapter 4, the scenario variables would specify the impact of climate change for the UK and key economies, but would not specify the impact on all world regions. When 'expanding'<sup>(15)</sup> the scenario variables to other regions, participants should have regard to the variables provided including the overall exposure of those regions to physical and transition risks.

## Constraints

5.6 The scenario variables would specify average impacts by sector or region. In general, the results of more granular analysis should be distributed around these averages. Participants would justify material divergences between their portfolios and the average (eg if the participant only holds small, niche, unrepresentative exposures).

5.7 For example, in their financial analysis of individual corporate counterparties, a participant would project emissions and profitability of these counterparties over the scenario. When these variables are aggregated across that participant's portfolio, they should be broadly consistent with the emission and profitability pathways specified at the sector and economy level in the scenario.

5.8 The speed of technological innovation will be a key driver of outcomes. The Bank would specify how key transition technologies evolve in each scenario, such as the deployment of renewable energy and carbon capture and storage in the energy system. Participants would not assume material technological innovation beyond these areas when assessing the risks and opportunities for individual counterparties. This is to ensure the Bank obtains a prudent estimate of the underlying climate-related risks and the results can be compared across participants.

5.9 Participants should consider whether the scenario variables specified, such as technological innovation, corporate profitability or government bond yields, under or overestimate the potential risks. Where participants believe this to be the case, they should quantify the sensitivity of their results to adjusted assumptions.

## Approach to time

5.10 The BES would explore participants' resilience to climate-related risks over the course of each scenario. This includes identifying points at which material financial losses appear in each scenario. Specifically, the BES would test the sensitivity of participants' 30 June 2020 balance sheets at five-yearly points in each scenario. This balances the exploration of climate-related risk dynamics with feasibility. Multiple reporting points are required to test the financial system's sensitivity to varying levels of stress over a scenario but it is not feasible for participants to project cumulative losses (and management actions) over a 30-year scenario.<sup>(16)</sup> Under the proposed approach, the resulting estimates would be:

- **Snapshots of risks.** At every reporting point, participants would assess the impact on their 30 June 2020 balance sheets. Each reporting point is a snapshot of risks; losses (and any assumed management actions) from previous reporting points are irrelevant. For example, participants would test the impact of the scenario at Year 20 on their Year 0 (ie 30 June 2020) balance sheet, rather than on their end-Year 19 balance sheet.<sup>(17)</sup>
- **Forward looking.** Participants would adjust the value of their assets and liabilities from the shocks in the scenario that occur over the maturity of these exposures. Modelling of both credit and traded risk can therefore assume foresight of the variables provided for the later years in the scenario to the extent that it is relevant to the residual maturity of exposures.<sup>(18)</sup> For example, at Year 20 in a scenario, when revaluing a corporate loan with residual maturity of three years, a participant would take account of GDP growth being 2 percentage points lower at Year 20 than assumed in its current valuation, and that growth would decelerate a further

(15) Scenario expansion refers to the process of annual cyclical scenario firms extrapolating the scenario variables provided for major economies (such as the UK, US and China) and global indicators to smaller economies they are exposed to.

(16) In order to project balance sheets over 30 years, participants would need detailed modelling of both the income statement and management actions to avoid unrealistically large portions of their books becoming impaired. This would significantly complicate the exercise.

(17) By contrast, in the annual cyclical scenario, participants assess the cumulative impact of losses and management actions over the five-year scenario. The climate scenarios of the Insurance Stress Test assessed the initial balance sheet at a single reporting point where the set of shocks is calibrated to reflect all future physical and transition risks.

(18) For banks' modelling of credit impairments, this is similar to the perfect foresight approach in the annual cyclical scenario under IFRS 9.

0.5 percentage points between Years 20 to 23. However, one exception is that participants do not have foresight of the shock that occurs in 2030 in the late policy scenario, consistent with the narrative.

## Questions on the proposed modelling approaches

Q10 Are there data gaps or modelling deficiencies that would impede participants' ability to model the scenarios? How would participants reflect judgements about companies' current mitigation and adaptation plans in their quantitative assessment?

Q11 Would participants be able to assess 80% of their corporate counterparties at counterparty level, leveraging the tools set out in Annex 2 and expert judgement?

Q12 Does the proposed approach to modelling future risks at each reporting point work for both the modelling of credit and market risk? Does the reporting framework, in particular the frequency of five-yearly reporting points, adequately capture the evolution of risks over time? Might more frequent reporting be useful for some parts of the scenarios, for example, during the transition in the late policy action scenario?

Q13 What are insurers' views on how to assess underwriting portfolio liabilities to key territories/perils? The Bank welcomes insurers' views on key territories/perils to be explored.

## 6 Firm submissions

6.1 This chapter sets out the proposed submissions required to meet the BES objectives set out earlier in this paper.

6.2 This exercise is exploratory in nature and would not be used to set capital requirements. Therefore, it would not ask for detailed changes in regulatory metrics (such as capital ratios or the solvency capital requirement for insurers), make use of traditional hurdle rates, or be a pass/fail exercise. But the Bank would request indicative estimates for impacts on some regulatory measures such as capital requirements.<sup>(19)</sup> For insurers, the template would be more detailed than that for the climate scenarios in the 2019 Insurance Stress Test. For banks, it is anticipated that the data requirement will be lower than that of the annual cyclical scenario.

6.3 Published results would set out system-level metrics detailing the financial sector's exposure to climate change, including the main sources of loss by sector and geography. The Bank does not propose to publish firm-level results. Instead, it would publish some indicative ranges of responses. The results would supplement supervisors' knowledge of individual firms' vulnerability to climate-related risks, as well as their governance and management of these risks.

### Sizing financial impacts of climate change

6.4 Part I of the BES would size the financial risks to participants' 30 June 2020 balance sheets to shocks at different points in each scenario. The BES would assess the impact on the value of banks' assets and insurers' assets *and* liabilities. The Bank would ask firms to submit projections at reporting intervals of five years.

#### Key metrics for banks

6.5 For banks, the BES would use the same key metrics as the annual cyclical scenario to measure the change in the value of assets (the templates would *not* ask for detailed modelling of liabilities or the income statement):

- **Banking book:** the high-level results metric would be the *impairment charge*.<sup>(20)</sup> At each reporting year, firms would submit the impairment charges in that year and cumulative five-year impairment charges from that year. To identify the change in impairments driven by climate-related risks in the scenarios, impairment charges would be compared to those in the baseline scenario of the 2020 annual cyclical scenario stress test.
- **Trading book:** the high-level results metric would be the *change in fair value of the assets*. So the BES would measure the impact of climate-related risks above those already priced in by firms and markets.<sup>(21)</sup>

#### Key metrics for insurers

6.6 For insurers, the key result metrics would quantify the impact of climate-related risks on both liabilities and assets:

- **Liabilities:** the high-level result metrics for non-life insurers would be the *annual average loss* and *1:100 year Return Period Aggregate Exceedance Probability (AEP)*. Life insurers would show best estimate liabilities, *risk margin, transitional measures on technical provisions (TMTP) and other liabilities*.

(19) For example, 'Do you expect capital requirements on your trading book to increase by <10%, 10–50%, 50–100% or >100% in this scenario?'

(20) This metric captures increases to provisions and write-offs within a period of time. The simplified definition is: (provisions at period end) — (provisions at period start) + (write-offs during period). Given the BES would test the sensitivity of current balance sheets to different points in the scenario, provisions at period start would always be the provisions as of 30 June 2020 irrespective of the reporting date.

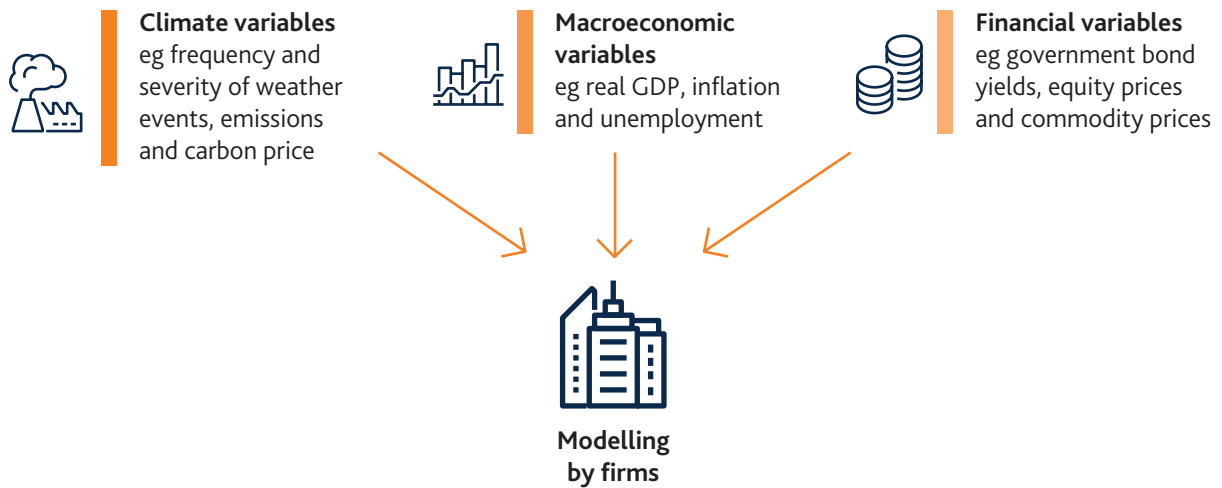
(21) It is unclear to what extent climate-related risks are already priced in by markets. Some valuations, such as those for coal companies, clearly already reflect some climate-related risks. This is likely to be most relevant for traded risk because forward-looking investors account for future profitability. By contrast for credit risk, firms' models are typically backward looking (so they incorporate few climate-related risks). The Bank would attempt to account for this in the calibration of the traded risk shock.



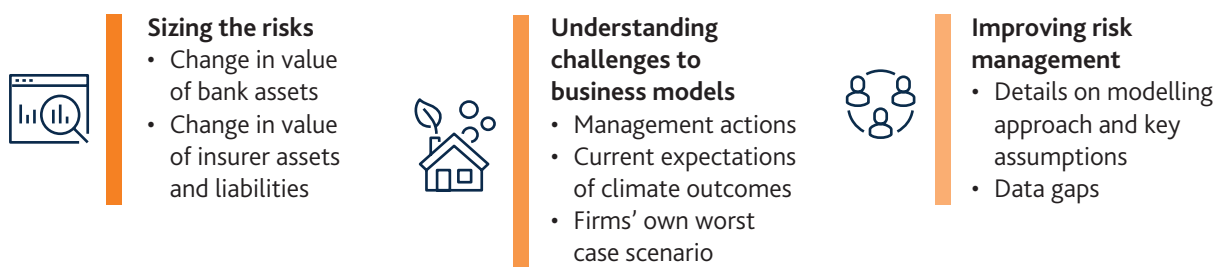
- **Assets:** key metrics would include change in the market value of investments/total investment returns, surplus change and change in eligible own funds.
- **Other:** insurers would also need to quantify where relevant the approximate effects on Matching Adjustment Portfolios (MAPs), with-profits funds (WPFs) and Solvency II transitionals such as TMTP. To calculate these numbers, insurers would need to consider results in subcategories reflecting the key risks affecting their business (such as equity risk, commercial property risk, longevity risk as relevant).

Figure 6.1 Firm inputs and outputs for the 2021 BES

**Input variables**



**Output variables**



**Temperature alignment**

6.7 To keep global temperature increases below 2°C, the business models of many companies and the structure of the overall economy need to change significantly. The financial system has exposures to many counterparties and sectors that are not currently aligned with the Paris Agreement target. Participants would assess their counterparties' current activities — and therefore their contribution to climate change — to estimate the increase in global temperature implicit in their exposures. By aggregating these, participants would estimate the overall 'temperature alignment' of their current portfolio.

6.8 The BES would not be prescriptive about how to calculate this temperature alignment metric. But existing approaches typically include estimating global temperature increases given the emissions intensity and technology pathways of counterparty activities.<sup>(22)</sup>

(22) Existing methodologies include Carbon Delta's Warming Potential metric and 2°ii's Paris Agreement Capital Transition Assessment (PACTA) Project.



### Breakdown of results

6.9 Climate-financial risk analysis requires more granular geographic and sectoral information than in traditional stress tests. For many exposures, the Bank would request high-level geographic and sector breakdowns similar to those in standard regulatory reporting (eg FINREP for banks or Solvency II reporting for insurers). But for exposures to the most at-risk sectors and regions, the Bank would ask for greater detail:

- **Geographic:** exposures in key countries would be broken down at the sub-national level (eg impacts on mortgages in flood-prone UK regions);
- **Sectoral:** for sectors that are likely to be more vulnerable to climate-related risks, the Bank may ask firms to report at a higher resolution than in most regulatory returns such as FINREP (eg at NACE level 2 rather than level 1 as is requested in FINREP).<sup>(23)</sup>
- **Perils/territories:** insurance firms would break down changes in the value of their asset and liabilities by the perils/territories set out in each scenario.
- **Key exposures:** for their top 50 counterparties by size and risk exposure, participants would submit detailed breakdowns of their modelling and assumptions. Participants would set out the judgements underpinning their results. This would include the level of adaptability that they have assumed of their counterparties/material exposures.

### Understanding challenges to business models

6.10 Part II explores how, if the constraint of a fixed balance sheet is relaxed, participants might change their business models in response to the scenarios. In particular, it probes participants' management actions, the impact of risks that were not covered in Part I, and their own expectations for climate-related risks. Each of these is detailed further below. Firms would submit one set of qualitative responses by scenario.

#### Management actions

6.11 The BES would ask participants to set out the actions they would take to mitigate risks and respond to new business opportunities in each scenario. Participants would choose from a menu of possible actions, including adjusting the size and pricing of different exposures (Table 6.A provides an illustrative list of example questions). Firms would quantify the magnitude of each action. To identify systemic risks, firms would also indicate at which reporting point in the scenario they would take the action and the underlying motivation. To illustrate the required level of detail, Table 6.B provides example narratives that submissions might support.

6.12 The Bank would then 'add up' these management actions to identify system-level impacts, including:

- **Changes in the provision or pricing of key services to the real economy:** For example, banks collectively stepping back from lending to high-carbon sectors or insurers sharply increasing the price of flood insurance to at-risk areas (leading to a larger insurance 'gap' between economic and insured losses).
- **Inconsistencies in assumptions:** For example, insurers no longer expect to provide services, such as flood insurance or legal liability cover, assumed by banks in their credit analysis.
- **Potential fire sales of at-risk assets:** For example, if many firms expect to sharply reduce their exposure to certain asset classes in a scenario.
- **Capacity to support the transition:** The transition to a carbon-neutral economy, as well the mitigation of physical risks, requires a substantial reallocation of capital. Participants would outline how they expect to rebalance their portfolios in response to the structural economic change in each scenario.

(23) In the NACE classification, 'Mining and Quarrying' is a level 1 classification. But level 2 is required to identify fossil-fuel mining such as coal, crude petroleum and natural gas.

6.13 A key system-level impact is the interaction of bank and insurer behaviour. To understand this, the Bank would request data to support further analysis of firm results (including considering the second round described below). For example, in order to quantify the impact on banks' mortgage books of the potential withdrawal of flood insurance in high-risk areas, the Bank would ask insurers to submit projections for their pricing/provision of flood insurance in these areas (as set out in **Table 6.A**) and for banks to submit detailed projections for mortgage assets in these areas (eg loan to value ratios, share of mortgages affected by flooding in the scenario).

### Firm expectations

6.14 The BES would also ask participants about their own expectations for climate change over the coming years. Aggregating firms' expectations would shed light on the level of climate-related financial risks priced into current valuations, as well as the potential for each scenario (if realised) to lead to a sharp repricing of assets. To do so, the BES would ask participants about:

- Their view on the most likely climate-related outcomes, and how resilient they believe their business model would be to these outcomes.
- The set of climate-related risks they judge could materially undermine the resilience of their own business. In other words, participants would outline climate scenarios that they judge most severe.

### Other risks

6.15 Participants would be asked to provide a qualitative outline of the risks not tested in Part I that are relevant to their business models. These include operational and reputational risks, as well as additional risks from bank-insurer interactions such as a reduction in the coverage of legal liability cover.

## Improving risk management

6.16 To support the Bank's understanding of firms' climate risk management, the BES would ask for detail on the modelling approaches, assumptions and data used in Part I.<sup>(24)</sup> This would allow the Bank to identify best practice and identify gaps in firms' risk management. For banks, this would be similar to the qualitative review of modelling practices in the annual cyclical scenario. It would include:

- **Modelling approaches:** Participants would explain how they modelled the financial impact of each scenario on their balance sheet. This includes both their approach to estimating the impact on their credit exposures across their *whole* balance sheet and the in-depth modelling of their key counterparties/material exposures. For the latter, firms would explain the selection criteria and any barriers to expanding this modelling. Participants would also detail their expansion<sup>(25)</sup> of the scenario to sectors or regions not quantified in the BES scenario.
- **Insurance cover:** banks would report their assumptions about insurance coverage of climate-related risks, such as the share of economic losses that they assume are insured (ie borne by the insurer) in their credit analysis.
- **Data gaps:** Firms would identify data that could have improved their financial analysis, the obstacles to attaining this data and their approach to filling any gaps.

6.17 The public results of the BES would identify examples of best practice and discuss the overall quality of climate risk management across banks and insurers.

(24) This would include climate-relevant assumptions embedded in these models. For example, banks may be asked to report the coverage of flood and other insurance assumed in their credit analysis.

(25) Scenario expansion refers to the process of annual cyclical scenario firms extrapolating the scenario variables provided for major economies (such as the UK, US and China) and global indicators to smaller economies they are exposed to.

Table 6.A Example questions for Part II

Impact	Example questions
<b>Management actions</b>	
Provision of key services to the real economy	Do you expect to materially decrease product provision in this scenario? Or to reprice to an extent that may lead to a substantial reduction in that exposure/product? If so, by when and for what reason? Do you expect to change the terms on which you provide credit, for example, to require minimum energy efficiency standards or other environmental or technical standards?
Bank-insurer interactions	<b>Insurers:</b> Do you expect to change the pricing or provision of flood insurance in this scenario? <b>Banks:</b> How would material reductions in the coverage of different insurance products affect your lending decisions?
Potential fire sales of at-risk assets	Do you expect to materially reduce any exposures in this scenario? Over what timeframe? What would be the trigger/motivation?
Supporting the transition	Do you expect to materially increase any exposures in this scenario? Would you have a target for exposures to 'green' assets? What are the barriers to you taking advantage of the opportunities from the transition?
Maintaining resilience	What actions would you take to maintain your firm's resilience in this scenario, eg cost reduction or capital management actions?
<b>Expectations</b>	
Central expectations	Given your information today, which climate outcomes do you view as most likely by the second half of this century (one of the BES scenarios or another)? Which climate outcomes do you think other financial firms view as most likely? Which climate outcomes do you think financial markets are currently pricing in?
Identifying climate-related risks	Which climate-related risks do you judge the biggest threat to your business? Which climate-related risks do you judge the biggest threat to the broader UK financial system?
<b>Other risks</b>	
Legal liability	<b>Banks:</b> To what extent do you judge legal liability to be a material risk in this scenario to you or your counterparties? Would this change if the coverage of liability insurance ceased? <b>Insurers:</b> In this scenario, would you be likely to materially re-price or reduce the provision of legal liabilities policies? What would trigger such actions?
Operational/reputational	Does this scenario present new operational or reputational risks to your business? If so, how will these risks evolve over the scenario?

Table 6.B Illustrative results for Part II

Themes	Illustrative metrics and narratives
Management actions in response to the scenario	<b>Banks:</b> The majority of banks expect to reduce their exposures to fossil fuel producers by more than 50% within the first five years of the late policy action scenario. This is primarily driven by reputational concerns.
Timing of management actions	<b>Insurers:</b> In the no additional policy action scenario, general insurers expect to increase the price of property insurance to at-risk parts of the UK by up to 150%. One insurer said that, absent further government support, it would likely cease providing this product altogether in these regions.
Motivation for management action	<b>Opportunities:</b> In the early policy action scenario, firms expect to significantly increase their exposures to green sectors such as renewables. But several firms highlighted the lack of liquid green assets as significant barrier to this rebalancing.
Other risks from climate change	In no additional policy action, only a third of banks and insurers expected operational risks to represent material risks to the sustainability of their business models.
Expectations of climate change and the transition	Participants judged the most likely outcome to be both high physical and high transition risks. No firm judged an orderly transition to be a likely outcome.

## Second submission

6.18 To explore system-wide impacts in more depth, the Bank would consider a follow-up round of submissions. BES participants would respond to the aggregated results from the first round, and potentially revise parts of their submissions in response to Bank feedback, including:

- **Management actions** of participants, such as fire sales of carbon-intensive exposures.
- **Interaction between banks and insurers**, where assumptions made are incompatible. For example, assumptions on the level of insurance coverage for banks' mortgage portfolios where household insurance coverage could be retracted as a result of increased flood, subsidence and/or freeze risk (ie climate-related risks become uninsurable).
- **Other assumptions and judgements** that differ across firms. Firms could be asked to reconsider assumptions that are significantly different from those made by their peers, such as the impact of the scenario on corporate counterparties/material exposures.
- **Challenge scenario assumptions.** The BES is a pioneering exercise. So in light of their own analysis, firms may disagree with the calibration of the scenarios. In addition, the analysis undertaken by firms might suggest that the scenario assumptions should be recalibrated. The follow-up round is an opportunity for the Bank and for firms to test the sensitivity of their results to different scenario assumptions.

6.19 The Bank is considering different approaches to this second round. This ranges from an extensive second submission (as in the 2020 Liquidity BES) to targeted requests to firms to reconsider specific results that appear infeasible in light of the aggregate results (as in the annual cyclical scenario).

## Timing of submissions and modelling

6.20 The Bank expects to publish the final BES scenarios in the second half of 2020, giving participants three to four months to run the exercise. The Bank would then analyse the submissions and aim to publish the results of the BES exercise in 2021. This timetable means that:

- Participants would use their 30 June 2020 balance sheets for the BES.
- Participants would have three to four months to run the scenario.

## Questions on the proposed firm submissions

Q14 Given the suggested timetable for the BES, is 30 June 2020 the latest cut of balance sheet data that firms can submit? Is three to four months sufficient time for participants to run the BES?

Q15 Would the proposed outputs accurately capture the climate-related financial risks faced by participants and achieve the objectives of the BES?

Q16 Do participants have access to data and tools to enable them to estimate the temperature alignment of their current asset holdings? Which asset classes should be included in this calculation?

Q17 Do five-year reporting intervals pose challenges to participants that are not reflected in this discussion paper?

Q18 Are there additional changes that should be modelled in the second round that would allow the Bank to better understand systemic climate-related risks?

Q19 Would life insurers prefer to provide Solvency Capital Requirement and percentage capital coverage as part of the scenario outputs?

# Annex 1: Full list of discussion questions

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The Bank would welcome feedback on the proposal as a whole, including whether respondents think it will deliver the intended aims of the 2021 BES.

## Questions on Chapter 2: The key features of the 2021 BES

Are there areas of the financial system that should be represented in the 2021 BES that are not captured by the proposed participation?

Do firms envisage any challenges with modelling the no additional policy action scenario spanning 2050–80?

## Questions on Chapter 3: Scenario narratives

Are there any other scenarios that the Bank should be testing as part of the 2021 BES?

Do the scenario timeframes strike the right balance between allowing a full assessment of these risks while also being tractable for firms' modelling?

## Questions on Chapter 4: Scenario specification

Does the scenario specification adequately capture the risks in each scenario? Are there additional risk channels or scenario variables that should be considered as part of the BES?

Are there alternative approaches to capturing the interactions between physical and transition risks, including capturing the impact of stranded assets?

Are there particular external sources to calibrate physical and transition risk impacts that the Bank should consider when calibrating the scenario variables?

Are there particular external sources or approaches that the Bank should consider when relating long-term macrofinancial variables to climate variables?

For life insurer liabilities, are there further risks beyond longevity that should be specified as part of the BES?

## Questions on Chapter 5: Modelling approaches

Are there data gaps or modelling deficiencies that would impede participants' ability to model the scenarios? How would participants reflect judgements about companies' current mitigation and adaptation plans in their quantitative assessment?

Would participants be able to assess 80% of their corporate counterparties at counterparty level, leveraging the tools set out in Annex 2 and expert judgement?

Does the proposed approach to modelling future risks at each reporting point work for both the modelling of credit and market risk? Does the reporting framework, in particular the frequency of five-yearly reporting points, adequately capture the evolution of risks over time? Might more frequent reporting be useful for some parts of the scenarios, for example, during the transition in the late policy action scenario?

What are insurers' views on how to assess underwriting portfolio liabilities to key territories/perils? The Bank welcomes insurers' views on key territories/perils to be explored.

#### **Questions on Chapter 6: Firm submissions**

Given the suggested timetable for the BES, is 30 June 2020 the latest cut of balance sheet data that firms can submit? Is three to four months sufficient time for participants to the run the BES?

Would the proposed outputs accurately capture the climate-related financial risks faced by participants and achieve the objectives of the BES?

Do participants have access to data and tools to enable them to estimate the temperature alignment of their current asset holdings? Which asset classes should be included in this calculation?

Do five-year reporting intervals pose challenges to participants that are not reflected in this discussion paper?

Are there additional changes that should be modelled in the second round that would allow the Bank to better understand systemic climate-related risks?

Would life insurers prefer to provide Solvency Capital Requirement and percentage capital coverage as part of the scenario outputs?

## Annex 2: Additional information on the climate variables

The Bank recognises that the subject area of assessing the financial impacts from climate change is rapidly developing and understanding what material is readily available for firms to leverage is not straight forward. This annex provides some indicative sources of data, methodologies and research that the Bank will use to specify the scenarios and that may prove useful to participants in undertaking granular financial analysis. This list is not intended to be exhaustive and will be enhanced based on the feedback the Bank will receive as part of this discussion paper and during the calibration of the scenarios.

**Table A2.A** Sources of information on transition risks

Information	Sources
Framework for using catastrophe models to assess impacts from physical climate change shocks.	<a href="#">PRA (2019)</a>
IPCC reports collating and summarising research for policymakers on physical risks in different scenarios.	<a href="#">IPCC Fifth Assessment Report (2014)</a> <a href="#">IPCC Special Report Global Warming of 1.5°C</a>
Industry data on the economic losses/insured losses from physical risk events.	<a href="#">SwissRe Sigma</a> <a href="#">Munich Re Nat Cat</a>
Research on the frequency and severity of individual hazards.	<a href="#">Refer to Appendix II, IST (2019)</a> <a href="#">Risky Business (2014)</a>
Information on UK government projection of physical climate impacts.	<a href="#">CCRA DEFRA</a> <a href="#">GOC 2017</a>
Macroeconomic and financial system impacts from physical risks.	<a href="#">TCFD Framework</a> <a href="#">UNEP FI: Pilot project on implementing the TCFD recommendations for Banks (physical risks) (2018)</a> <a href="#">UNEP FI: Pilot project on implementing the TCFD recommendations for investors (2019)</a> <a href="#">CISL (2015)</a> <a href="#">CRO Forum (2019)</a> <a href="#">Ralite and Thoma (2019)</a> <a href="#">Climate Impact Lab</a> <a href="#">DWS (2018)</a>



**Table A2.B** Source of information on transition risk

Information	Sources
Current emissions data.	<u>CDP</u> and a range of other commercial data providers
Classification of Economic Activities.	<u>Statistical Classification of Economic Activities in the European Community</u>
Research and analysis on transition pathways.	<u>IEA World Energy Outlook (2019)</u> <u>IRENA REMap Transition Pathway (2019)</u>
Information on UK government response to transition risks.	<u>Committee on Climate Change advisory report on Net Zero (2019)</u> <u>HM Government Clean Growth Strategy (2017)</u> <u>EU Emissions Trading Scheme</u> <u>UK Carbon Pricing</u>
Macroeconomic and financial system impacts from transition risks.	<u>TCFD framework</u> <u>UNEP FI: Pilot project on implementing the TCFD recommendations for investors (2019)</u> <u>UNEP FI: Pilot project on implementing the TCFD recommendations for Banks (transition risks) (2018)</u>