



EUROPEAN CENTRAL BANK  
BANKING SUPERVISION

## 2022 climate risk stress test

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# Executive summary

As a competent authority, the European Central Bank (ECB) is required to carry out annual stress tests on supervised entities in the context of its Supervisory Review and Evaluation Process (SREP) as set out in Article 100 of the Capital Requirements Directive IV (CRD IV)<sup>1</sup>. In 2022, the ECB has carried out a climate risk stress test among the significant institutions as its annual stress test.

Climate change and the transition to net zero carbon emissions pose risks to households and firms, and therefore to the financial sector. Accordingly, exposure to climate-related and environmental risks is among ECB Banking Supervision's [strategic priorities for 2022-24](#).

The 2022 climate risk stress test should be seen in the context of a broader set of activities that ECB Banking Supervision is undertaking in 2022 to assess supervised institutions' level of preparedness for properly managing climate risk.

In particular, the stress test is complemented by an ongoing supervisory thematic review of banks' climate-related and environmental risk management practices, which will seek to comprehensively assess how banks have incorporated these risks into their strategy, governance and risk management frameworks and processes. Taken together, the thematic review and the climate risk stress test will indicate the extent to which banks are aligned with the ECB's supervisory expectations as outlined in its [Guide on climate-related and environmental risks](#).

In addition, banks' level of preparedness for managing climate risk is being assessed in the context of the ongoing deep dive into commercial real estate risk practices. Supervisors will also conduct on-site inspections, engage with institutions showing material deficiencies in their management of climate-related and environmental risk to ensure they implement sound remedial action plans, and monitor compliance with upcoming regulatory requirements.

The 2022 ECB climate risk stress test should be seen as a joint learning exercise with pioneering characteristics aimed at enhancing both banks' and supervisors' capacity to assess climate risk. The exercise should thus help create awareness of climate risk among the supervised institutions and make it easier to ascertain banks' vulnerabilities to, and resilience against, the materialisation of climate-related risks.

The exercise was carried out to assess the internally built climate risk stress-testing capabilities of the banks in scope. Specifically, it explored:

- the progress banks have already made in developing climate risk stress-testing frameworks;

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<sup>1</sup> Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms, amending Directive 2002/87/EC and repealing Directives 2006/48/EC and 2006/49/EC (OJ L 176, 27.6.2013, p. 338).

- the capacity of banks to produce climate risk factors, an intermediate step towards developing climate risk stress test estimates;
- the capacity of banks to produce climate risk stress test projections;
- the risks banks are facing in the form of transition risks (both short-term and long-term) and acute physical risk events.

To assess these points, the ECB analysed a wide set of qualitative and quantitative information such as governance-related aspects, data availability, adequacy of transmission channels, scenario development capacity, asset class coverage, concentrations of sectoral income, financed greenhouse gas emissions and hypothetical stress test projections. The 2022 CST exercise therefore addresses wider, and to a large extent qualitative, aspects of stress testing rather than simply looking at quantitative results.

Focusing on the climate risk stress test projections, it was a constrained bottom-up stress test, with participating banks asked to provide data and projections under different climate risk scenarios following a common methodology. The [methodology](#) underlying the 2022 climate risk stress test was published in October 2021, and the [scenarios](#) were published in January 2022.

The ECB has carried out thorough quality assurance on the banks' stress test submissions, and during the process there has been an ongoing dialogue between banks and the ECB on the quality assurance findings.

At the time the 2022 climate risk stress test was conducted, several external challenges were present. For instance, the lack of harmonised legislation on energy performance certificates and on the disclosure of greenhouse gas emissions, in particular Scope 3 emissions, hampered banks' ability to collect hard data. In addition, a first delegated act on sustainable activities for climate change adaptation and mitigation objectives<sup>2</sup> had only just been published.

Given that this stress test was essentially a learning exercise, the ECB took into account the challenges and limitations banks were facing at the time of the exercise by following a somewhat less intrusive quality assurance process than with the regular solvency stress tests and by applying the proportionality principle to banks' participation in the various modules of the climate risk stress test.

Importantly, given the exploratory nature of the exercise, the 2022 ECB climate risk stress test will not have any direct capital implications for the supervised institutions. Any supervisory findings will feed into the annual SREP assessment in an indirect and qualitative way only.

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<sup>2</sup> Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives (OJ L 442, 9.12.2021, p. 1).

The key findings were as follows.

- The 2022 climate risk stress test was a useful learning exercise for banks and supervisors, acting as a catalyst to strengthen banks' efforts to develop climate risk stress-testing frameworks in accordance with the expectations laid out in the ECB [Guide on climate-related and environmental risks](#).
- The exercise showed that banks have made considerable progress with respect to their climate stress-testing capabilities. At the same time, the exercise also revealed many deficiencies, data gaps and inconsistencies across institutions. Against this background, the ECB expects banks to make substantial further progress in the coming years.
- Climate risks are relevant for the large majority of significant institutions directly supervised by the ECB. These significant institutions generate non-negligible income from activities related to greenhouse gas (GHG)-emitting industries. The share of interest income related to the 22 most GHG-emitting industries amounts to more than 60% of total non-financial corporate interest income on average for the banks in the sample (median of 65.2%). The extent to which this could give rise to climate risk will depend on the transition plans of the counterparties in these high-emitting sectors. For banks to be able to gauge their exposure to climate risks in the future, it will therefore be important for them to enhance their customer engagement to gain insights into their clients' transition plans.
- The significant institutions are, to varying degrees, exposed to the materialisation of acute physical risks in Europe, namely drought and heat events and flood risk. The risks banks are facing in this regard are closely linked to the geographical location of their lending activities and could in some cases lead to non-negligible losses.
- Taken together, under a short-term, three-year disorderly transition risk scenario and the two physical risk scenarios (flood risk and drought and heat risk), the combined credit and market risk losses for the 41 banks providing projections would amount to around €70 billion. For a number of reasons this estimate significantly understates the actual risk. First, the scenarios considered in this exercise are not adverse, as they are in regular stress tests. Specifically, there is no economic downturn accompanying the negative climate effects. Second, the data and modelling underlying the banks' projections are still at a preliminary stage, with climate factors only captured to a rudimentary degree. Third, given that this is essentially a learning exercise, no supervisory overlays have been applied. Fourth, the exposures in the scope of this exercise only account for around one-third of the total exposures of the 41 banks.

- Under the 30-year transition scenarios, losses that may occur in the context of the transition to a more sustainable environment are projected to be notably lower under a scenario of orderly phasing-in of sustainable climate policies than in the case of delayed and disorderly transition paths. However, it should be borne in mind that the 30-year projections are exploratory and subject to significant uncertainty. Therefore, these long-term loss projections should be interpreted as a qualitative yardstick for the direction of travel rather than as a robust quantitative measure.
- Many banks appear to lack clearly defined long-term strategies for credit allocation policies that reflect the various transition paths. In view of the non-negligible income generated from the financing of carbon-intensive industries, banks need to step up their long-term strategic planning, e.g. green transition plans and targets.
- Overall, banks have started to integrate climate risk into their stress-testing frameworks. Nevertheless, the majority of supervised institutions are still at a very early stage in the development and implementation of such frameworks. Around 60% of banks do not yet have a well-integrated climate risk stress-testing framework, and most of those banks envisage a medium to long-term time frame for incorporating physical and/or transition climate risk into their framework.
- Most banks with a climate stress-testing framework already in place also include climate-related and environmental events in their operational risk stress-testing or scenario analysis framework. It is less common for banks to include reputational risk derived from these events in their stress-testing framework.
- The exercise also revealed that many banks are still at an early stage in terms of factoring climate risk into their credit risk models. In many cases, credit risk parameters projected by banks were found to be fairly insensitive to the climate risk shocks depicted in the scenarios.
- While banks evidently made considerable efforts to provide relevant stress test data submissions, the exercise clearly illustrated that further work is needed on the part of many institutions to gather and manage data with climate-relevant breakdowns.
- Most banks are making extensive use of proxies instead of actual counterparty data (i.e. data directly available in the disclosure documentation of counterparties) to measure climate-related aspects, such as Scope 1, 2 and (more often) 3 emissions and energy performance certificates for housing collateral. While proxies are considered a first step towards closing the data gaps, banks need to invest further in the methodological assumptions that are used to

calculate the proxies and implement procedures to proactively address them.

- Regarding GHG emissions, while the ECB acknowledges and appreciates the challenges related to data availability and corporate disclosure requirements, the findings from this exercise clearly illustrate that enhanced customer engagement to obtain the relevant counterparty information is very much needed in order for banks to align with supervisory expectations regarding climate risk management practices. Different practices followed by institutions to approximate GHG emissions and/or recourse to different data providers with diverse modelling practices to fill data gaps led banks to report heterogeneous emissions estimates, even for the same counterparties.
- Considering the above-mentioned deficiencies affecting banks' projections, the quantitative results should be interpreted with caution.
- Pending the expected standardisation of non-financial reporting requirements, supervisors may need to provide additional guidance to address deviations observed in risk measurements, stemming from different proxy modelling approaches or data providers' modelling practices.<sup>3</sup>
- Finally, while acknowledging the many challenges banks are facing with regard to climate risk stress testing, the exercise showed that in each of the assessed areas, at least some of the banks were able to address the challenges in a satisfactory manner, suggesting that it is possible for the industry to raise the bar across all of the areas assessed. In this light, the ECB plans to follow up on the findings with bank-specific recommendations and guidance on best practices in climate stress testing. The main focus will be on helping banks to build their internal climate risk stress-testing frameworks and overcome the current challenges.

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<sup>3</sup> In this regard, the [ECB Guide on climate-related and environmental risks](#) highlights that banks are expected to assess the quality of any data sourced and the plausibility of any proxies. In addition, they should provide transparency on methodologies, criteria and assumptions, both in their internal reporting and in their public disclosures, and regularly reassess the quality and appropriateness of their data sources (see Expectations 6.2, 7.7 and 13.3 in the Guide).



# 1 Introduction

As a competent authority, the European Central Bank (ECB) is required to carry out annual stress tests on supervised entities in the context of its Supervisory Review and Evaluation Process (SREP) as set out in Article 100 of the Capital Requirements Directive IV (CRD IV). In 2022, the ECB has carried out a climate risk stress test of the significant institutions as its annual stress test.

The 2022 CST should also be viewed in the context of ECB Banking Supervision's [strategic priorities for 2022-24](#), which include tackling exposures to climate-related and environmental risks.

The 2022 CST complements other ECB Banking Supervision activities related to climate and environmental risks. Together with the ongoing supervisory thematic review of banks' climate-related and environmental risk management practices, the 2022 CST will help in assessing supervised institutions' preparedness for meeting the supervisory expectations regarding climate risk management and practices. These expectations are outlined in the ECB [Guide on climate-related and environmental risks](#). Likewise, targeted deep-dive reviews of climate risk in relation to commercial real estate exposures, together with on-site missions, will contribute to providing supervisors with a comprehensive assessment of risk management practices.

## 1.1 Objectives

The 2022 CST has several mutually reinforcing objectives. It differs from the regular stress-testing exercise in that it does not provide any information on capital depletion and includes several parts aimed at exploring from different angles the level of banks' preparedness for tackling and managing climate risk, taking both qualitative and quantitative elements into consideration.

The 2022 CST should be seen as a joint learning exercise with pioneering characteristics aimed at enhancing both banks' and supervisors' capacity to assess climate risk.

The 2022 CST is aimed at gaining an understanding of banks' climate risk stress-testing frameworks and their level of preparedness. This should be seen in the context of the ECB [Guide on climate-related and environmental risks](#). Specifically, on climate risk stress testing, the Guide states that the ECB expects institutions with material climate-related and environmental exposures to incorporate climate risks, in the form of both physical and transition risks, into their capital planning process (including the internal capital adequacy assessment process, ICAAP) and recovery planning process. In this regard, the 2022 CST complements ECB Banking Supervision's thematic review, which focuses on the other supervisory expectations not related to stress testing, as outlined in the ECB Guide. These expectations are also underpinned by the European Banking Authority's (EBA's) [Report on](#)

In addition, the exercise should help create awareness of climate risk among the supervised institutions and make it easier to ascertain banks' vulnerabilities to, and resilience against, the materialisation of climate-related risks.

The ECB acknowledges that the discipline of measuring and stress testing climate risks in the banking sector is still at an early stage of development. Therefore, the exercise also serves the purpose of providing guidance to banks and helping them enhance climate risk-related data availability. As a follow-up to the 2022 CST and based on lessons learnt from the exercise, the ECB will work on identifying best practices to help banks overcome the limitations they face in compiling climate-relevant data and carrying out climate risk stress testing.

In terms of immediate supervisory follow-up actions, the participating significant institutions have been provided with institution-specific assessments of their climate risk stress-testing capabilities and have received benchmarked results in relation to relevant peers. This report provides an aggregate overview of the bank-level outcomes, summarising the main conclusions from this analysis. Banks are expected to draw on their bank-specific reports and further improve their climate risk stress-testing capabilities, even in those areas where they have received positive feedback. As banks and supervisors are still at an early stage of understanding how climate risks may affect the banks, there will be no direct capital impact from the 2022 CST: it is not a "capital exercise", and there will be no quantitative effect on banks' Pillar 2 Guidance<sup>4</sup>. The outcomes of the exercise will instead be incorporated into the annual SREP assessment in a qualitative manner, alongside the findings of the parallel thematic review on climate-related and environmental risks.

## 1.2 Structure of the report

This report presents the main findings of the ECB's 2022 climate risk stress test. It is structured as follows.

In Section 3, a high-level overview of the applied methodology and scenarios is provided. Section 4 summarises the qualitative findings on banks' climate risk stress-testing capabilities and the extent to which climate risk is incorporated into their business strategies. In Section 5, the quantitative findings are summarised, covering (i) banks' exposures at a specific point in time to, and income generated from, more carbon-intensive industries and (ii) the various scenario analyses focusing on transition and physical risks. Section 6 looks at banks' future plans for financing the green transition, while Section 7 discusses supervisory follow-ups. Section 8 concludes the report.

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<sup>4</sup> The Pillar 2 Guidance is a bank-specific recommendation that indicates the level of capital that the ECB expects banks to maintain in addition to their binding capital requirements. It serves as a buffer for banks to withstand stress.

## 2 Methodology, scenarios and quality assurance

The 2022 CST was conducted as a constrained bottom-up stress test. This meant that banks provided the qualitative and quantitative input while complying with a common methodology and applying a common set of scenarios. In order to ensure consistency of outcomes, a level playing field and adequate data quality, the ECB carried out a thorough quality assurance process.

The ECB limited the scope of the 2022 CST to a selection of climate-related risk transmission channels, asset classes and scenarios to keep the bottom-up exercise manageable at operational level. Accordingly, the 2022 CST does not cover all interlinkages between climate risk and banks' balance sheets. The 2022 CST bottom-up methodology and scenarios are to be viewed in the context of this selective approach.

### 2.1 Methodology and scenarios

The 2022 CST was a constrained bottom-up exercise, meaning that participating banks provided their own data submissions and stress test projections subject to a common methodology and common scenarios.

The [methodology](#) underlying the 2022 CST was published in October 2021, while the [scenarios](#) were published in January 2022.<sup>5</sup>

Three distinct modules formed the basis of the methodology (see Chart 1).

Module 1 consisted of a qualitative questionnaire aiming at providing a uniform and standardised assessment of banks' climate risk stress-testing capabilities. This module assessed banks' internal climate risk stress-testing frameworks in line with Expectation 11 (on scenario analysis and stress testing) set out in the ECB [Guide on climate-related and environmental risks](#). Apart from including general questions regarding the existence and use of climate risk stress testing within the institution, the Module 1 questionnaire covered areas such as governance and risk appetite, integration into the institutions' business strategy, methodology and scenario design, data availability and sources, ICAAP and future plans. The aim of this was to understand interlinkages between the banks' stress-testing frameworks and other internal business processes.

Module 2 consisted of two climate risk metrics providing insights into the sensitivity of banks' income to transition risk and their exposure to carbon emission-intensive industries as of the reference date (31 December 2021). Banks were asked to split their corporate volumes and income among 22 industries (see Annex A.2 for the full

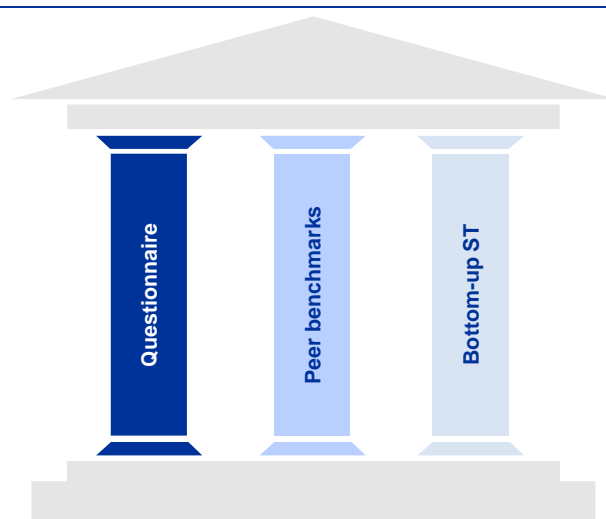
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<sup>5</sup> The detailed numbers underlying the scenarios applied in the 2022 CST can be found on the [ECB Banking Supervision website](#).

list) at the NACE<sup>6</sup> two-digit level. The sectors selected covered all of the high climate impact sectors defined by the Technical Expert Group on Sustainable Finance (EC TEG)<sup>7</sup> and represent around 90% of total GHG Scope 1 emissions in Europe. To measure the carbon intensity underlying their corporate portfolios, banks were also asked to report the top 15 largest non-SME (non-small and medium-sized enterprise) corporate exposures for each of these high climate impact sectors, along with the counterparties' Scope 1, 2 and 3 emission data<sup>8</sup> and revenue data.

### Chart 1

#### The three modules of the 2022 CST methodology



Source: ECB, climate risk stress test 2022, methodology, October 2021.

Note: ST stands for stress test.

Module 3 constituted the bottom-up stress test component where banks were asked to provide projections for a number of different scenarios and risk areas. Chart 2 provides an overview of the dimensions covered by this module. A high-level description of the scenarios is provided in Box 1. The bottom-up stress test projections covered both physical and transition risks. For physical risks, banks were asked to provide credit risk projections under both a drought and heat scenario and a flood risk scenario. For transition risks, the 2022 CST covered two time horizons. The first was a long-term 30-year horizon for which three different climate policy paths were depicted: (i) an orderly transition; (ii) a delayed, disorderly transition; and (iii) a “hot house world” with unchanged policies (see Box 1 for details). The second was a short-term three-year horizon.

Banks were asked to provide credit risk projections under the three long-term scenarios. Importantly, in the long-term transition scenarios, banks were allowed to adjust their balance sheets dynamically. By contrast, under the short-term (three-year

<sup>6</sup> NACE (for the French term “nomenclature statistique des activités économiques dans la Communauté européenne”) refers to the Statistical Classification of Economic Activities in the European Community, the industry standard classification system used in the European Union.

<sup>7</sup> See “[Taxonomy: Final report of the Technical Expert Group on Sustainable Finance](#)”, *Technical report*, EU Technical Expert Group on Sustainable Finance, March 2020.

<sup>8</sup> Scope 1: direct emissions from activities under the control of the company; Scope 2: indirect emissions from the purchase and use of electricity, steam, heating and cooling; Scope 3: other indirect emissions coming from sources not under the control of the company.

horizon) transition risk scenario the balance sheet was assumed to remain static. In this short-term transition scenario, a frontloaded disorderly transition policy was depicted, against which banks were asked to provide projections for credit and market risks. Operational and reputational risks derived in general from climate-related and environmental risks were also covered in Module 3, though only in a qualitative way (via a questionnaire).

While the bottom-up stress test part of the 2022 CST included less comprehensive risk coverage than the regular EU-wide EBA stress tests, it did contain some innovative elements. In particular, banks were asked to provide projections with a breakdown by the 22 carbon-intensive non-financial corporate industries (at NACE two-digit level) on the basis of sector-specific scenarios. Similarly, they were required to break down mortgages by EPC ratings. In addition, in the context of the physical risk scenarios, a within-country geographical disaggregation of exposures was requested at the NUTS3<sup>9</sup> level of granularity. For these reasons, the ECB decided to apply proportionality in the sense that only the more advanced significant institutions were required to participate in Module 3. The ECB believes that the innovative elements of the 2022 CST will assist the banks in their future preparations for further developing their climate risk stress-testing frameworks.

## Chart 2

### Module 3 scenarios and risk dimensions

	Exposures	Scenario	Projections <sup>1</sup>	Horizon	Credit risk	Market risk	Operational risk
Transition risk	Global	Short-term stress	Baseline	3 years (2022-2024)	Corporate loans (incl. SME, CRE) + mortgages	Bonds + stocks issued by NFCs <sup>2</sup>  (incl. accounting and economic hedges)	Operational and reputational risks to be assessed via a qualitative questionnaire
			Stress				
		Long-term paths	Orderly	30 years (2030, 2040, 2050)	Corporate loans (incl. SME, CRE) + mortgages		
			Disorderly				
			Hot house				
Physical risk	EU countries	Drought & heat risk	Baseline	1 year (2022)	Corporate loans (incl. SME)	1.All projections with the exception of the long-term paths will be based on a static balance sheet. 2.The parent company needs to be an NFC, e.g. bonds issued by car financing company X are in scope.	
			Stress				
		Flood risk	Baseline	1 year (2022)	Mortgages + CRE loans		
			Stress				

Source: ECB, climate risk stress test 2022, methodology, October 2021.

Notes: CRE stands for commercial real estate; NFC stands for non-financial corporation; SMEs stands for small and medium-sized enterprises.

## Box 1

### Exploratory climate risk scenarios

The ECB 2022 CST considered a broad range of exploratory scenarios covering both transition and physical risk as well as short-term and long-term perspectives. Crucially, these are to be considered hypothetical and do not reflect the ECB's/ECB Banking Supervision's or the Eurosystem's expectations about future realised outcomes.

<sup>9</sup> For more detailed information on the regional classification system NUTS (nomenclature of territorial units for statistics), see [NUTS MAPS](#) on Eurostat's website.

The scenarios are largely based on the Phase II Network for Greening the Financial System (NGFS) models output (released in June 2021). The overlays and additional calibrations have been performed to tailor the scenarios to the specific needs of this exercise. Transition risk is modelled in long-term and short-term scenarios, whereas physical risk scenarios are designed as instantaneous shocks.

### Long-term transition risk scenarios

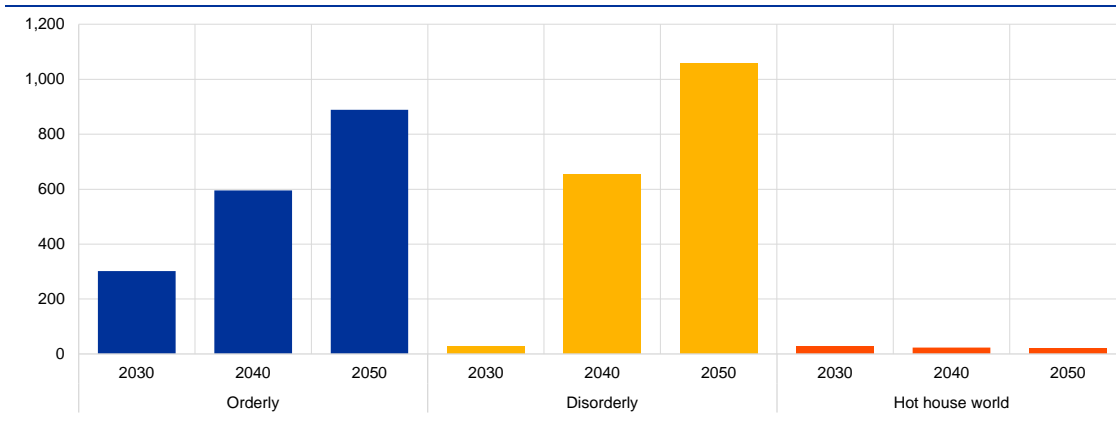
The narratives **underlying** the **three** long-term transition risk scenarios are based on the NGFS Phase II scenarios released in June 2021.

First, the **orderly scenario** assumes that climate policies are introduced early and gradually become more stringent. It is based on the NGFS net zero 2050 scenario, in which global warming is limited to 1.5°C through stringent climate policies and innovation, with net zero carbon emissions reached in around 2050 thereby mitigating increases in physical risk. Both physical and transition risks are relatively subdued: the smooth and gradual nature of the transition ensures that the costs resulting from the energy transition are minimised, while restricting global warming to only 1.5°C helps mitigate increases in physical risk.

Second, the **disorderly scenario** explores higher transition risk due to delays in the implementation of policies. It is based on the NGFS delayed transition scenario, which assumes new climate policies are not introduced until 2030. Strong policy actions are then needed to limit warming to below 2°C and to compensate for lost time: for instance, carbon prices must be set at higher levels to achieve an outcome that is aligned with the Paris Agreement. This leads to higher transition risks than in the orderly transition scenario. Compared with an orderly transition, physical risks are also higher, as the delay in implementing policies leads to a greater increase in temperature, subsequently leading to a rise in the frequency and magnitude of extreme weather events.

Third, the **Hot house world scenario** assumes that no new climate policies are implemented. The scenario calibration is based on the NGFS current policies scenario. Even though European emissions gradually decline in this scenario, global emissions grow until 2080, leading to about 3°C of warming. In this scenario, the transition to a carbon-neutral economy is assumed never to take place, so transition risks are negligible. However, the absence of transition costs is more than offset by the adverse impact of extreme physical risk on the economy. Even though many of these effects take place after 2050, to limit the scenario horizon to 2050 while still including relevant physical risks, the physical damages arising during 2050-2080 have been frontloaded to 2040 and 2050.

**The carbon price is a key distinctive feature in the different scenarios (see Chart A).** In the orderly scenario, the carbon price is already relatively high in 2030 and increases further until 2050 so that the carbon emissions targets consistent with 1.5°C of warming can be met. This increase in the carbon price is delayed in the disorderly scenario, and the 2040 and 2050 numbers show that a higher carbon price is needed when the transition is delayed. In the Hot house world scenario, carbon prices do not increase over the scenario horizon. However, this comes at a cost, as physical damage is higher owing to extreme global warming in this scenario.

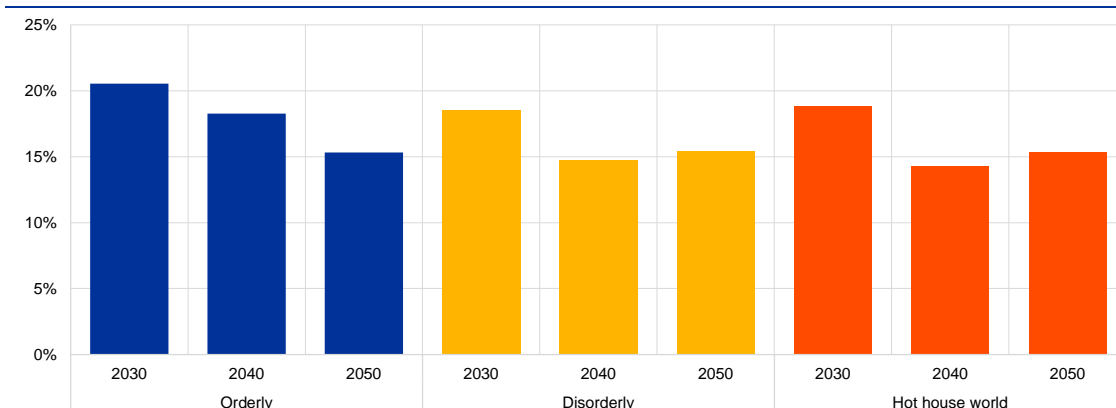
**Chart A**Carbon price (USD/tCO<sub>2</sub>)

Sources: NGFS phase II and ECB calculations.

**Chart B shows that European gross domestic product (GDP) in the orderly scenario is highest** in all years from 2030-2050. GDP in the disorderly and Hot house world scenarios is already lower in 2030, and in 2050 the difference relative to the orderly scenarios worsens to -7% for the disorderly scenario and -8% for the Hot house world scenario. However, in all three scenarios the long-term projections indicate a growing economy (65%, 58% and 57% cumulative growth versus 2021 respectively for the three decades in the orderly, disorderly and Hot house world). This is driven by long-term model assumptions about population growth, increasing labour productivity and technological progress in general. The overall GDP developments reflect very different pathways at the corporate sector level, with projected gross value added growth differing significantly depending on the carbon intensity of specific industries.

**Chart B**

European GDP growth (% compared with previous decade)



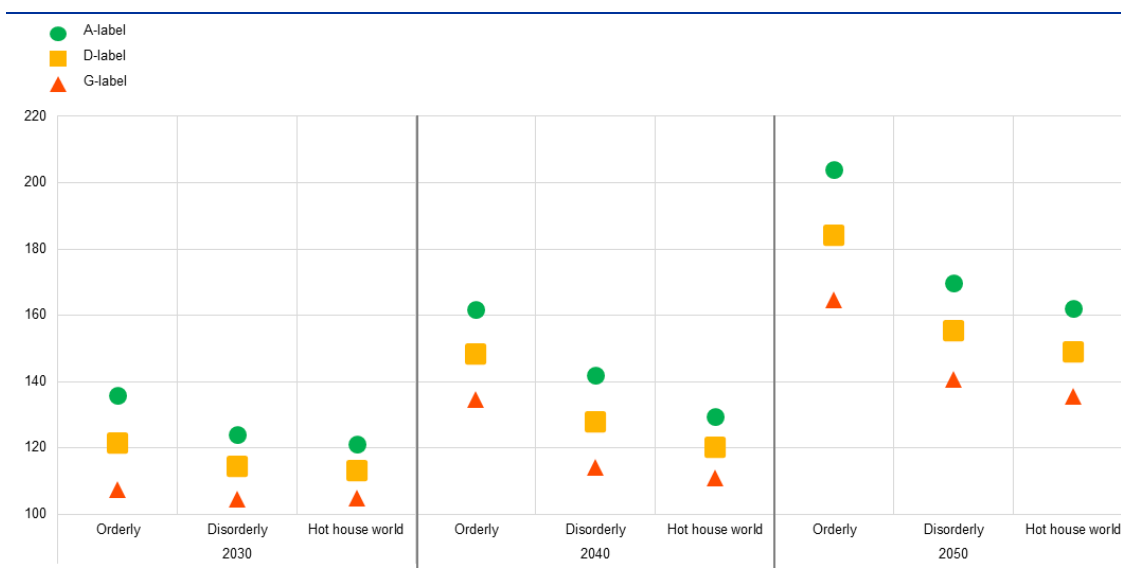
Sources: NGFS phase II and ECB calculations.

The equity price developments and credit spread shocks are broadly in line with the impact of the increase in carbon prices on the gross value added of the respective industries. In addition, the credit spreads of carbon-intensive companies are heavily affected. The rise in the carbon price increases costs, which these companies can pass on to consumers to a limited extent only. Therefore, the profit margin is eroded and the credit risk of these companies increases.

In general, real estate prices show an increasing trend from 2022 until 2050. However, the average increase is significantly larger in the orderly scenario compared with the disorderly and Hot house world scenarios. This general trend is driven by an increase in physical risks in the Hot house world scenario that decreases the value of real estate. In both the long and short-term transition risk scenarios, the price increases in the most energy-efficient class (A-label) outperform those in the worst class (G-label) (Chart C). This is due to increasing electricity costs, which make energy-efficient properties more attractive than energy-inefficient properties.<sup>10</sup>

### Chart C

Real estate price projections disaggregated by energy performance certificates in the three long-term scenarios



Sources: NGFS phase II and ECB calculations.

### Short-term transition risk scenario

The short-term disorderly transition risk scenario assesses banks' short-term vulnerabilities triggered by a sharp, abrupt increase in the price of carbon emissions. The scenario aims to capture tail risks in a situation suitable for stress testing and should thus be considered as a severe but plausible representation of a disorderly transition.

The calibration of the scenario is based on the NGFS delayed transition scenario. To focus on a short(er)-term horizon, the carbon price increase is frontloaded to 2022, 2023 and 2024. The baseline scenario is based on the Eurosystem December 2021 Broad Macroeconomic Projections Exercise (BMPE).<sup>11</sup>

<sup>10</sup> Note that the calibration does not consider possible minimum energy efficiency standards that could be set by governments, such as the minimum energy performance standards for existing buildings as proposed in the European Commission's [revision of the Energy Performance of Buildings Directive \(EPBD\)](#). Such measures would lead to more significant differences in prices.

<sup>11</sup> See "Eurosystem staff macroeconomic projections for the euro area, December 2021", ECB, Frankfurt am Main, December 2021.



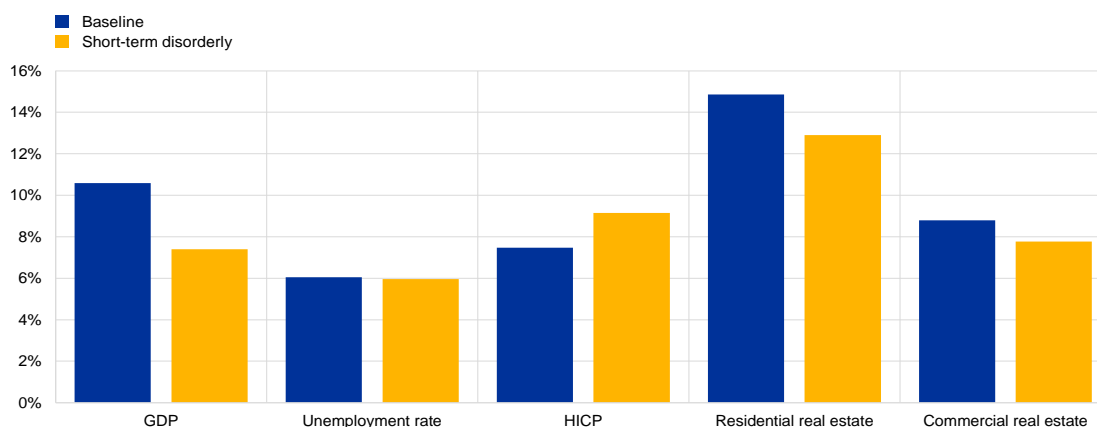
For market risk projections, only the figures for 2022 were used as banks were asked to forecast how selected trading book exposures would be affected by an instantaneous shock to asset valuations (as a one-off impact).

Contrary to the long-term scenarios, the short-term scenario does not reflect an economic recovery as the horizon is not long enough to capture the benefits stemming from the green transition. Chart D shows the various macroeconomic variables for the baseline and the short-term disorderly scenario. EU GDP grows cumulatively by around 7.4% in the period 2021-2024, compared with 10.5% in a baseline scenario. In terms of magnitude, this is not as adverse as a typical EU-wide EBA stress test scenario, and it is important to note that a disorderly transition is different from a severe economic crisis. It is the result of a push to reallocate resources in the economy resulting in temporary shocks, which can be relatively large in sectors strongly linked to fossil fuels. For example, the mining and quarrying sector shrinks by more than 12% in 2022 and by around 30% over the full scenario horizon relative to the baseline scenario (Chart E).

### Chart D

#### Developments in main macroeconomic variables

(EU averages %, cumulative growth 2022-2024)



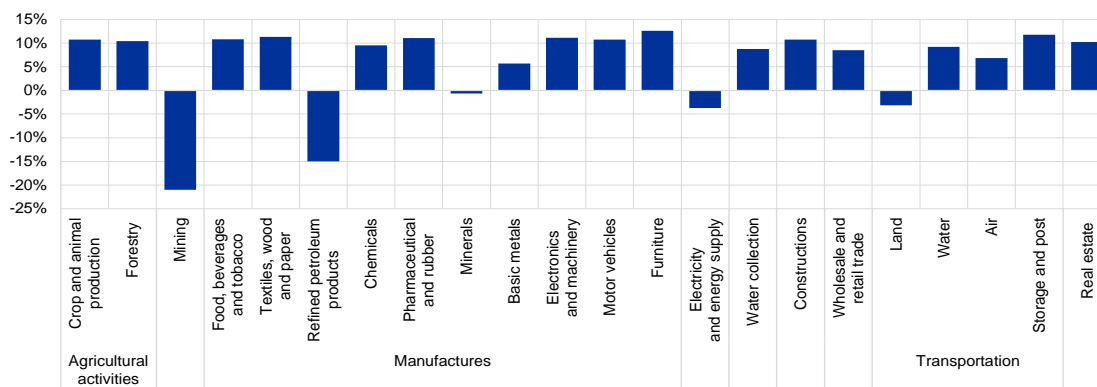
Source: ECB calculations.

Note: Unemployment rate refers to percentage of labour force at the end of the scenario.

### Chart E

#### Sectoral impact of short-term disorderly scenario

(gross value added (EU average %, 2022-2024))



Sources: NGFS and ECB calculations.

## Drought and heat scenario

This scenario models the economic effects of a severe drought and heatwave, which is assumed to hit Europe on 1 January 2022. While this is arguably not a realistic date for a heatwave to occur, it has the advantage that end-of-year data can be used as a starting point and the projection horizon can be limited to one year ahead.

The calibration is based on NGFS estimates for labour productivity shocks due to heat stress across relevant countries until 2050. To limit the scope of the exercise, the scenario only models the shocks to sectoral gross value added growth. Given the one-year time horizon, a 100% pass-through of a labour productivity shock to GDP is assumed.

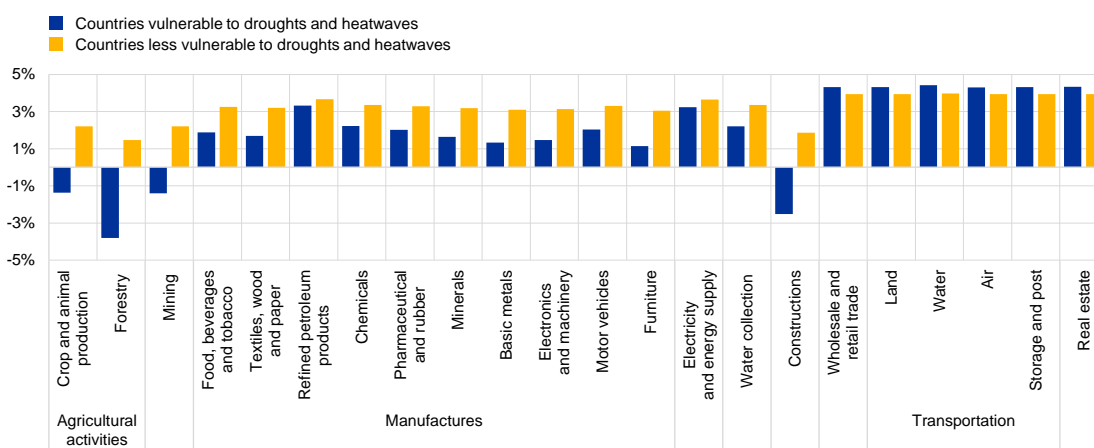
The sensitivity to drought and heat risk is heterogeneous across Europe, with southern European countries in general being affected most. This is in line with scientific evidence and the findings of the Intergovernmental Panel on Climate Change (IPCC), which concludes that countries in the Mediterranean basin are more prone to stress from climate change and are expected to see an increase in the number of extreme heat days.

Chart F shows that the hardest-hit sectors are agriculture and construction, with limited effects on manufacturing and small effects on services. Agriculture and construction are most affected as they are both activities that take place outdoors and require a high degree of physical exertion.

### Chart F

#### Annual gross value added growth rates

(gross value added impact (%), 2021-22)



Sources: NGFS and ECB calculations.

## Flood risk scenario

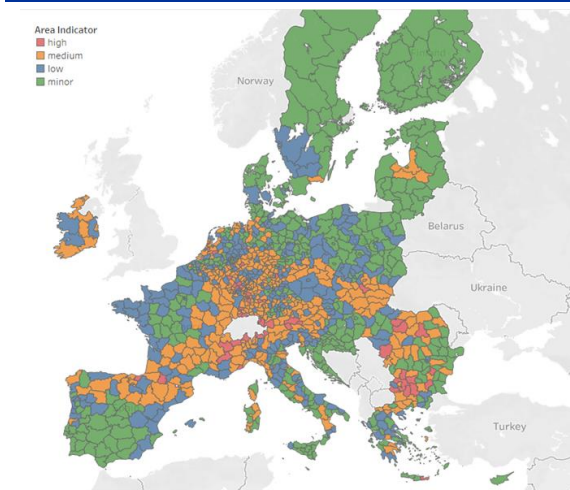
River flooding has historically been a major source of physical risk in Europe and, with a rise in extreme levels of precipitation being associated with climate change, this risk is expected to increase, leading to banks making losses as real estate is destroyed or severely damaged.

In this scenario, it is assumed that severe floods take place across Europe on 1 January 2022. While the probability of such an event is low, it allows the creation of relevant flood risk scenario across the European Union. Flood risk is heterogeneous across Europe and can differ significantly even within a few kilometres. Therefore, the flood risk scenario accounts for within-country variation in risks. As

such, a flood risk map at the NUTS3 level is constructed as shown in Chart G. The map splits regions into four buckets according to their level of flood risk: minor, low, medium or high. It clearly shows the heterogeneity of the flood risk within countries and across the European Union.

## Chart G

### Flood risk map



Sources: The flood risk map was constructed using insights from the European Commission Joint Research Centre's work on flood risk, complemented by granular geospatial flood risk data from the Four Twenty Seven dataset.

Table A shows the corresponding commercial and residential real estate price shocks across the geospatial flood risk areas.

## Table A

### Commercial and residential real estate price shocks (%)

Area indicator	Commercial real estate price shock	Residential real estate price shock
Minor	-3%	-4%
Low	-8%	-10%
Medium	-16%	-19%
High	-43%	-45%

Source: ECB calculations.

## 2.2 Quality assurance process

In the quality assurance phase (from March 2022 to the end of June 2022), the ECB analysed the information submitted by banks to ensure that the submissions (i) were of a satisfactory quality, (ii) complied with the methodological requirements and (iii) provided comprehensive and reliable results for the prescribed assumptions and scenarios.

This analysis included checks to ensure adherence to the instructions and compared individual bank submissions with peer benchmark data and challenger views as appropriate. Centralised calculations were performed for the banks subject to the proportionality requirements.

Banks were requested to address quality assurance queries raised in relation to the information provided. In this process, the ECB required banks in selected cases to adjust their inputs, perform further analysis or provide supporting evidence to substantiate their results. Three cycles of interactions with the banks were generated to address the quality assurance findings. During these cycles, the ECB interacted closely with the banks to clarify and discuss issues identified in the banks' submissions.

In contrast to the EU-wide solvency stress tests, and because the 2022 CST was essentially a learning exercise for banks and supervisors, no quantitative supervisory overlays were applied.

## 3 Findings on banks' climate risk stress-testing capabilities

A substantial part of the 2022 CST focused on gathering information to better understand banks' progress on integrating climate risk into their internal stress-testing frameworks. This information was collected primarily via a qualitative questionnaire (Module 1) but also through other explanatory material provided by the banks, as well as an assessment of the quantitative information submitted by banks in the exercise (Modules 2 and 3).

This section provides an overview of the main findings with respect to banks' climate stress-testing capabilities.

### 3.1 Framework for the qualitative assessment

The ECB asked banks to provide detailed information on their climate stress-testing framework via a comprehensive qualitative questionnaire (for details see Annex A.1 of the 2022 CST [methodology](#)).

The questionnaire consisted of a range of questions covering general descriptions of banks' frameworks, governance, the integration of climate risk stress test results into business strategy decisions, methodology and scenario design, data availability and usage, ICAAP, future plans and internal audit.<sup>12</sup> The range of questions allowed the ECB to assess the extent to which banks are aligned with Expectation 11 (on scenario analysis and stress testing) of the ECB [Guide on climate-related and environmental risks](#).<sup>13</sup>

The analysis of the qualitative questionnaires allowed the ECB to gain an overview of the banks' climate risk stress-testing capabilities, including their framework, governance and modelling practices.

Apart from the qualitative findings, the approach also allowed the ECB to score banks in relative terms. To this end, it used a scoring system to indicate the level of preparedness of individual banks in comparison with their peers.

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<sup>12</sup> The questionnaire asked for information as of the reference date of end-December 2021.

<sup>13</sup> Expectation 11 stipulates that "[i]nstitutions with material climate-related and environmental risks are expected to evaluate the appropriateness of their stress testing with a view to incorporating these risks into their baseline and adverse scenarios".

## 3.2 Assessment of banks' current climate risk stress-testing capabilities

Significant institutions appear to have made meaningful progress over the last year in terms of setting up climate risk stress-testing frameworks.

The ECB [report on the state of climate risk management in the banking sector](#), published in November 2021, showed that only about 25% of institutions had performed an ad hoc climate risk-related stress test, scenario analysis or sensitivity analysis. At the same time, only 13% of institutions had started integrating climate risks into their regular stress-testing frameworks.

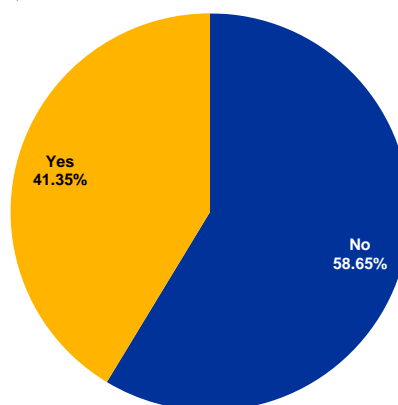
Based on the findings of the 2022 CST, the percentage of banks reporting that they had a climate risk stress-testing framework in place (as of the reference date of 31 December 2021) stood at around 40%.<sup>14</sup> It is possible that participation in the 2022 CST has acted as a catalyst for many institutions and contributed to a more widespread integration of climate risk into stress-testing frameworks. Notwithstanding the progress made and the likely variations in the soundness and comprehensiveness of banks' stress testing practices, most of the institutions have not yet implemented a climate risk stress-testing framework that is integrated into their ICAAP and broader stress-testing frameworks (Chart 3).

**Chart 3**

Preparedness of climate risk stress-testing frameworks implemented

Is climate risk currently included in the institution's stress test framework?

(percentage share of participating banks)



Sources: Bank submissions and ECB calculations.

Chart 4 provides a detailed indication of institutions' preparedness across the different dimensions of climate risk stress testing by showing the individual scores assigned to them (ranging from 1 to 4, with 1 being the best and 4 being the worst). Climate-related data availability is a challenging factor for many institutions, and it reportedly represents the key driver for the lack of a climate risk stress-testing framework (for 23% of the banks with no framework). More than half of the banks with a climate risk

<sup>14</sup> One-to-one mapping between the questions asked for the November 2021 self-assessment report and the 2022 CST Module 1 questionnaire is not possible, since the Module 1 questionnaire is more comprehensive. Hence, a direct comparison can only be indicative.

stress-testing framework in place report that climate strategies/targets for corporate counterparties and/or granular location data (e.g. location of headquarters/main manufacturing facilities) are not internally available to their relevant business areas. Box 2 provides a more detailed assessment of banks' data challenges for climate risk measurement and stress testing. These findings are indicative of broader shortcomings in the banks' climate and environmental risk data governance, which the latest thematic review addresses.<sup>15</sup>

Around 40% of the banks with a climate risk stress-testing framework in place do not consider climate stress test outcomes when implementing their business strategy, while only 19% of the banks with a CST framework in place use it to inform their loan granting process.

In total, 60% of the banks with a climate risk stress-testing framework in place do not currently disclose or intend to disclose any results of the climate risk stress test under Pillar III.

Although the majority of the banks with a climate risk stress-testing framework in place have developed a validation process (93%), 75% of them do not ensure independence between the development and validation processes, since the same business area is responsible for both developing and validating the climate risk stress-testing framework.

Many banks with a climate risk stress-testing framework already in place do not currently involve the internal audit function in reviewing the framework (40%).

In terms of risk types, the majority of the banks with a climate stress-testing framework include at least physical or transition risk in the scenarios they consider (71% for physical and 81% for transition), but only 24% include liability and reputational risk.

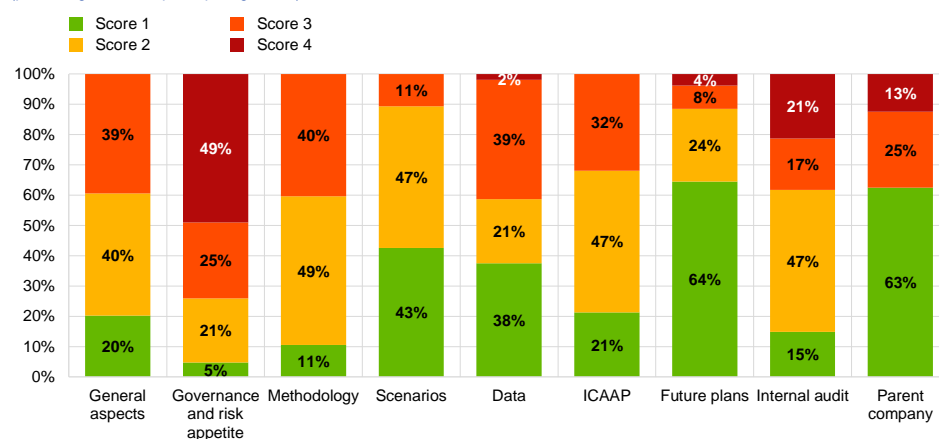
Many banks with a climate risk stress-testing framework in place include only between one and two balance sheet climate risk transmission channels (e.g. credit and counterparty risks, market risk) in their credit risk stress-testing framework (37% of banks) and include only between one and three portfolios (e.g. corporate loans, retail household loans, retail SME loans) in their methodology (35% of banks). Half of the banks that have implemented a framework have not included any mitigating actions (e.g. hedging of positions with financial derivatives). For the modelling of climate risk, only 22% of the banks apply or are considering applying a dynamic balance sheet approach for both transition and physical risk.

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<sup>15</sup> The statistics referred to in this report cannot be combined on a one-to-one basis with the outcomes of the thematic review given the different approaches used in the two exercises.

**Chart 4****Preparedness across key components of climate risk stress-testing frameworks****Banks' scores in Module 1 per block**

(percentage share of participating banks)



Sources: Bank submissions and ECB calculations.

Of the 40% of banks that have a climate risk stress-testing framework in place, around three-quarters state that climate-related and environmental events are included in their operational risk stress testing or scenario analysis. For reputational risk, less than 40% of the banks indicate that climate-related and environmental events are included. Several banks indicate that they do not consider reputational risk independently, but rather as part of the bank's business risk.

Heavy rainfall, storms and flooding were reported by banks to have affected their operational risk in the last five years. A few banks indicated that this caused damage to their branch premises or ATM machines. Total damage was relatively low and covered by insurance. Only one bank reported that income has been negatively affected by reputational risk events derived from climate-related and environmental events in the last five years.

**Box 2****Data gaps identified**

One of the objectives of the 2022 CST was to act as a catalyst for banks to enhance their data infrastructure and collection of climate-relevant data breakdowns of exposures and key income items. Having good, reliable data is a first – and instrumental – step towards developing proper stress-testing frameworks and strengthening risk management more broadly.

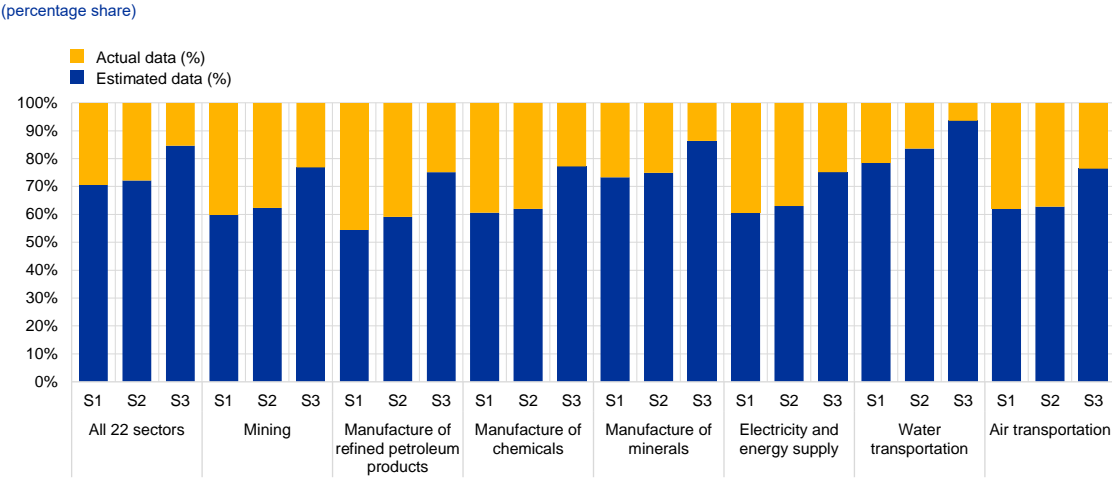
The 2022 CST has therefore been useful as a practical stock-take of how far banks have advanced in terms of climate-relevant data handling. The 2022 CST methodology acknowledged the data challenges that banks are facing and therefore allowed for the use of proxies to collect Scope emissions and EPC data.

Overall, banks have made widespread use of proxy data to compile key data points for Scope 1, 2 and 3 emissions and EPCs.



For all Scope emissions, banks depend to a great extent on estimates using proxies, as many firms do not disclose this information at present (Chart A). In this respect, future regulatory requirements, including EU disclosure rules currently under discussion, could increase the availability of actual client data to replace proxies.

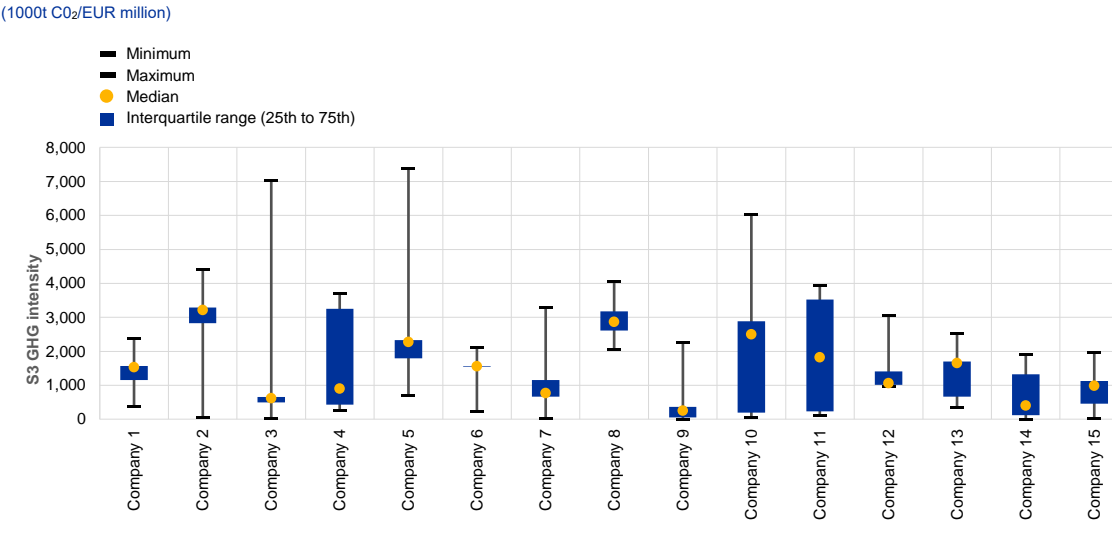
**Chart A**  
Relative use of actual counterparty data vs proxies for reporting of Scope 1, 2 and 3 emission data



Sources: Bank submissions and ECB calculations.

For Scope 3 in particular, there is a high degree of complexity underlying the compilation of data on associated emissions (encompassing 15 different elements, with both upstream and downstream data needed). In this regard, estimating Scope 3 emissions using various proxy techniques leads to a high dispersion of the data reported (see Chart B). This dispersion is also observed when comparing the Scope emissions data from various data providers for the same corporate counterparties.

**Chart B**  
Dispersion of reported Scope 3 GHG intensity per counterparty



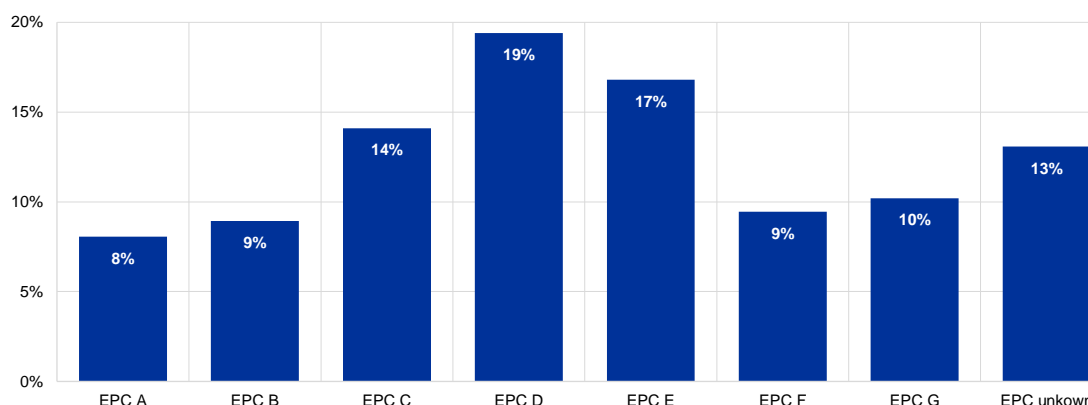
Sources: Bank submissions and ECB calculations.

Regarding EPCs, banks were unable to allocate 13% of their reported collateral to an EPC bucket (see Chart C). To report exposures with an EPC rating, 65% of the banks had to use proxies, which in some cases are not adequately described or not sufficiently robust given the nature and number of assumptions banks need to make. The main input factors for these proxies are often the construction year or energy costs of the building, either in combination or used as a single factor.

### Chart C

#### Mortgage and real estate-secured exposures per EPC rating

(% of total exposures)



Sources: Bank submissions and ECB calculations.

Banks need to invest more in climate-relevant data collection and become less dependent on the use of proxies, particularly in view of possible developments in climate risk disclosure regulations. The ECB expects banks to step up their customer engagement and make significant progress in developing data infrastructures that allow for proper counterparty assessments.

## 3.3 Summary of banks' future plans to enhance their climate risk stress-testing frameworks

Most banks have a medium to long-term perspective for the inclusion of climate risk in their stress-testing framework. More than 50% of all banks that currently do not have a climate stress-testing framework in place indicate that they need at least one to three years to incorporate physical and/or transition climate risk into their stress-testing framework (Chart 5).

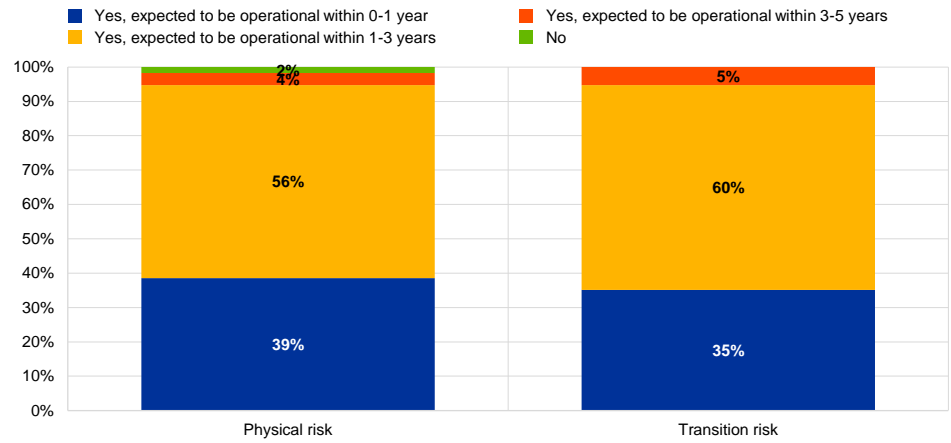
Almost all banks mention the need for data to enhance their climate risk stress-testing framework by either improving data collection from counterparties and/or engaging with data providers, indicating that they plan to improve these two aspects.

Most banks indicate they will invest in staff recruitment to enhance their climate risk stress-testing capabilities. At the same time, more than 30% of all the banks state that the coronavirus (COVID-19) pandemic has made the development of a climate risk stress-testing framework less of a priority.

**Chart 5**

**Time frame envisaged for implementing climate risk stress-testing frameworks**

(percentage share of participating banks)



Sources: Bank submissions and ECB calculations.

## 4 Banks' exposure to climate risks

The CST 2022 included a comprehensive and granular collection of income (interest income and fee and commission income) and exposure data broken down by GHG-emitting sectors, which are sensitive to transition. Banks were also requested to provide GHG emission figures and revenues for their largest counterparties within those sectors.

This rich data collection made it possible to assess the degree to which institutions' income relies on the financing of GHG-emitting corporate sectors. Likewise, thanks to this innovative approach, it was possible to ascertain the magnitude of exposures to those sectors.

### 4.1 Reliance on income from carbon-emitting sectors

Overall, institutions participating in the 2022 CST reported that on average, as of the reference date<sup>16</sup> (31 December 2021), more than 60% (median 65.2%) of their interest income<sup>17</sup> was derived from business with non-financial corporate customers belonging to the 22 carbon-intensive sectors (Chart 6). The relative shares differed somewhat across business models. Custodians and asset managers, along with global systemically important banks (G-SIBs), were rather less reliant on income from GHG-emitting sectors, while development banks/promotional lenders and small domestic retail lenders were the most reliant.

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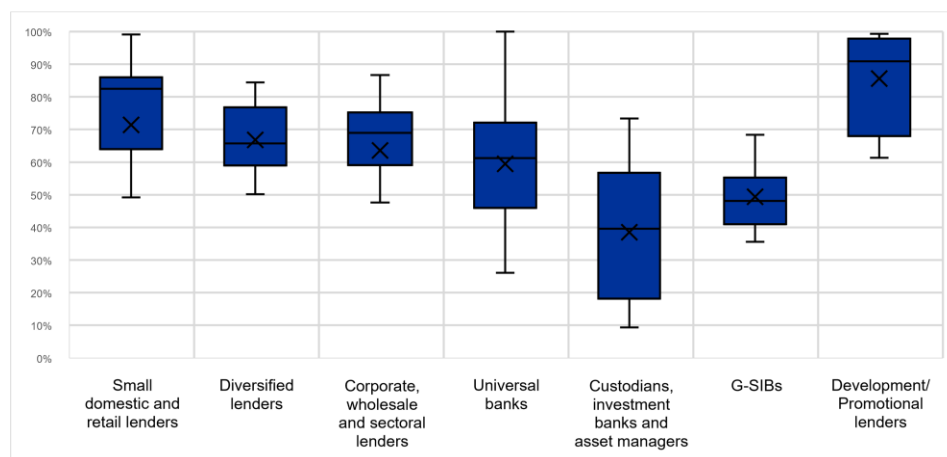
<sup>16</sup> The scope of the data collection encompassed the five main jurisdictions in which banks operate. Banks were able to bundle non-EU jurisdictions into a single entry ("non-EU"). In some instances, banks reported more than five individual jurisdictions in total as they counted the individual countries grouped under the "non-EU" heading.

<sup>17</sup> "Reliance on income" refers to interest income only, as FINREP does not include a breakdown of fee and commission income per type of counterparty.

## Chart 6

### Interest income from 22 carbon-intensive industries as a share of total non-financial corporate interest income

(percentage share)



Sources: Bank submissions and ECB calculations.

Together, the 22 industries selected represent around 54% of the EU economy in terms of gross value added.<sup>18</sup> This implies that the income banks are generating from the most GHG-emitting sectors exceeds these industries' relative weight in the EU economy.

It should be noted, however, that while the relative shares of income derived from GHG-emitting sectors is high overall, the largest shares of income are attributable to sectors with relatively lower intensity such as construction, wholesale and retail trade as well as real estate activities (Chart 7).<sup>19</sup> At the same time, highly GHG-intensive industries (i.e. sectors with GHG emission intensity exceeding 1,000 tCO<sub>2</sub> per EUR million of revenues) account for a lower but still significant share of reported income (21%), confirming the potentially non-negligible impact of transition risk on bank income – especially for institutions with relatively large concentrations of exposures to these sectors. The extent to which such exposures are associated with climate risk will depend on whether these counterparties have credible green transition plans in line with the Paris Agreement. To properly gauge the climate risk embedded in those exposures, it will therefore be crucial for banks to obtain knowledge of the counterparties' transition plans.

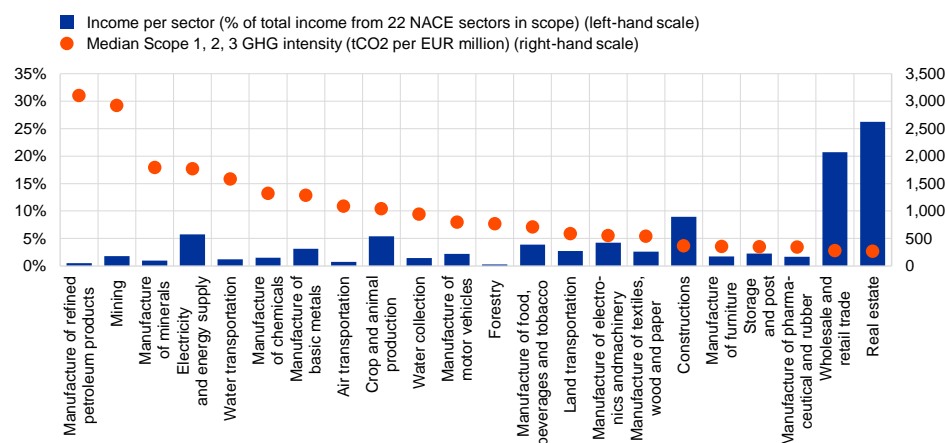
<sup>18</sup> Source: Eurostat.

<sup>19</sup> Based on median GHG emission intensity (sum of Scope 1, 2 and 3 GHG emissions) of the companies reported in the sectors.

**Chart 7**

Interest income and fee and commission income per sector from 22 carbon-intensive industries and median of the Scope 1, 2 and 3 GHG intensity

(percentage share; tCO<sub>2</sub> per EUR million of revenue)



Sources: Bank submissions and ECB calculations.

## 4.2 Exposures to carbon-emitting sectors

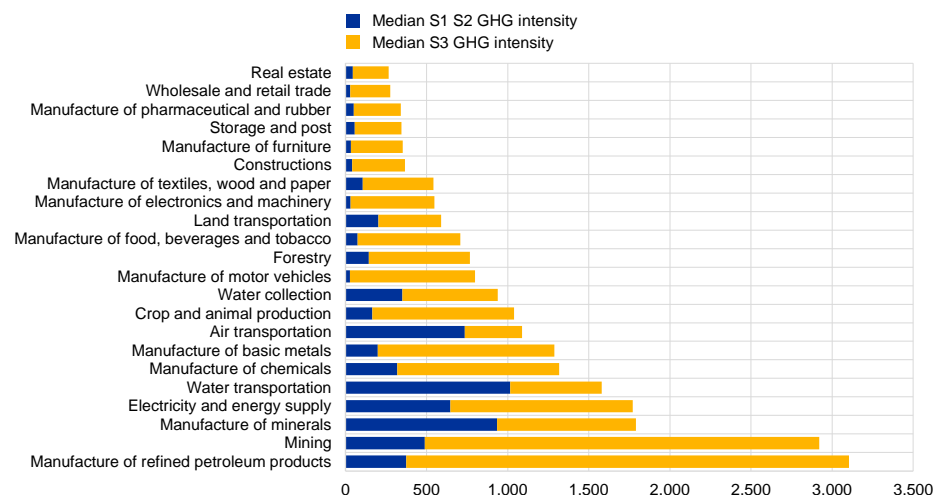
To account for the heterogeneity of emission intensities across the companies operating within the selected industries (i.e. either because they operate in diverse sub-activities or because of different technologies of production), institutions were asked to provide the GHG emissions and revenues (i.e. the gross annual sales) for the top 15 counterparties in the 22 selected sectors.

Chart 8 presents the reported median carbon intensity (measured in tonnes of CO<sub>2</sub> per EUR million of revenue) across counterparties of the different sectors. The top seven GHG-emitting sectors (i.e. the top one-third) are mining and quarrying (B05-B09) and manufacture of coke and refined petroleum products (C19), followed by manufacture of non-metallic products (C23, e.g. cement), electricity, gas, steam and air conditioning supply (D35), water transportation (H50), manufacture of chemical products (C20), and manufacture of metal products (C24-C25). It is notable that for most sectors the Scope 3 emissions appear to be the dominant driver of carbon intensity. This underlines how important it is for institutions to collect actual Scope 3 emission data or develop robust estimation approaches, as proxied data are largely used at present (see Box 2).

**Chart 8**

**Median Scope 1+2 and 3 emission intensity per sector**

(tCO<sub>2</sub> per EUR million)



Sources: Bank submissions and ECB calculations.

Note: The figures represent the median GHG emission intensity (Scope 1+2 and Scope 3 respectively) of companies reported by all participating banks across the 22 sectors.

Meanwhile, the carbon content of banks' corporate portfolios can be assessed by computing the (exposure)-weighted average of the GHG emission intensity (based on Scope 1, 2 and 3 emissions) to assess banks' exposures to carbon-intensive sectors. The results show quite notable differences across business models. Chart 9 shows that G-SIBs and universal banks (as well as custodians and asset managers) hold the largest share of exposures to the seven most carbon-intensive industries and thus have the highest corporate portfolio carbon intensity.

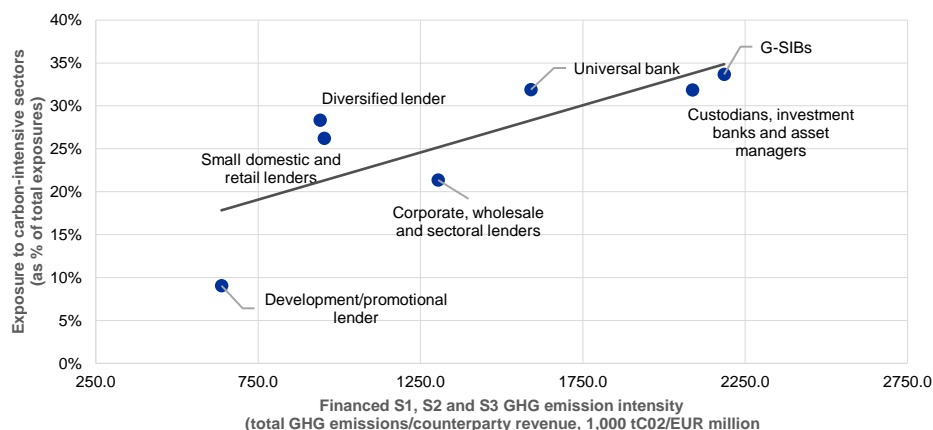
The overall carbon intensity of exposures at bank level is influenced by the share of reported exposures to the most emitting sectors ("exposure effect"). The combined weight of the seven most GHG-emitting sectors represents 28.8% (median of participating banks) of non-financial corporate exposures related to the 22 NACE sectors considered in this exercise. Owing to the high emission intensities of these seven sectors, they account for more than 50% (median of 53.8%) of observed levels of carbon intensity of banks' corporate portfolios.

The most emitting sectors, in particular mining and quarrying and manufacture of coke, tend to be dominated by large companies (proxied by the size of revenues) which may be more likely to enter into relationships with larger banks (including via syndicates) or specialised lenders. This could explain why G-SIBs, universal banks and investment banks have more significant exposures to GHG-emitting sectors (Chart 9).

## Chart 9

Business model differentiation by carbon intensity of the corporate portfolio (x-axis) and exposures to seven most carbon-intensive sectors (y-axis)

(Module 2 metric 2; tCO<sub>2</sub> per EUR million)



Sources: Bank submissions and ECB calculations.

Notes: The x-axis describes the median exposure-weighted average of the GHG emission intensity (Scope 1, 2 and 3) of counterparties reported by banks per business model. The y-axis describes the median share of exposures to the top seven most GHG-intensive sectors in the total exposures reported by banks per business model. The top seven most GHG-emitting sectors are mining and quarrying (B05-B09) and manufacture of coke and refined petroleum products (C19), followed by manufacture of non-metallic products (C23, e.g. cement), electricity, gas, steam and air conditioning supply (D35), water transportation (H50), manufacture of chemical products (C20) and manufacture of metal products (C24-C25).

Two additional factors can explain bank-level outcomes. The first is the “concentration effect”, meaning that a concentration of exposures to certain production technologies used in sub-activities within sectors may mitigate or amplify the “exposure effect”. For instance, some development banks have a high share of exposures to electricity, gas, steam and air conditioning supply (D35) while displaying low carbon intensity overall. The underlying reason is a significant concentration of exposures towards projects linked to the development of renewable energies. Second, given that availability of GHG emissions data is still limited, banks rely heavily on approximation techniques and/or on external providers, which may affect the accuracy and conservativeness of banks’ estimates regarding carbon intensity (see Box 2 for more details).

## 4.3 Scenario analysis

The 2022 CST examined a comprehensive set of hypothetical but plausible climate change-related scenarios, including short and long-term transition risk scenarios as well as two physical risk scenarios (see Box 1 for a description).

The multitude of scenarios reflects the multi-faceted and complex nature of the climate risk facing the banking sector, providing insights into a variety of climate-related vulnerabilities and how these might affect the banks should the depicted risks materialise.

When interpreting the results of the scenario analysis, it is important to keep in mind that the nature and severity of the scenarios employed in the 2022 CST are not comparable to adverse scenarios used in regular solvency stress tests (such as the EU-wide EBA stress tests and SREP stress tests). The regular solvency stress tests



typically consider a broad-based and long-lasting macro-financial downturn scenario. The 2022 CST scenarios instead depict more targeted, climate-related shocks to an otherwise baseline scenario while still assuming a growing economy. In other words, the losses projected under the 2022 CST scenarios are not comparable to (and are generally smaller than) those resulting from the standard solvency stress tests. Furthermore, the portfolios in the scope of the 2022 CST are limited, while in the regular stress tests all credit risk exposures are covered.

Banks are vulnerable to an increase in transition risk in the short term, which is projected to cause a non-negligible increase in credit risk impairments. Losses that may occur in the context of the long-term transition to a more sustainable environment are projected to be notably lower under a scenario of orderly phasing-in of sustainable climate policies than in the delayed and disorderly transition paths.

The practice of modelling climate risk and integrating it into existing models is still in its infancy. Data gaps and limitations identified in banks' climate stress-testing capabilities affect the accuracy of quantitative results, in particular for the long-term projections. Overall, banks are in a better position to incorporate the short-term scenarios into their models and projections than the long-term ones. In addition, the underlying uncertainty of the results also has to be considered in the context of the climate scenarios applied, which are mild overall, and the relatively narrow set of portfolios considered in the exercise.

#### 4.3.1 Long-term transition risk projections

As an innovative feature of the 2022 CST, banks were asked to declare their long-term strategies towards the 22 most emitting sectors in the next three decades and to project the losses they expect in these time frames in three different scenarios (orderly, disorderly and Hot house world).

The most notable conclusion is that the losses projected are lower in the orderly transition scenario than in scenarios where transition policies are phased in late or not at all, showing the importance of early policy action (Chart 10). This finding is in line with ECB's own recent [economy-wide climate risk stress test analysis](#).

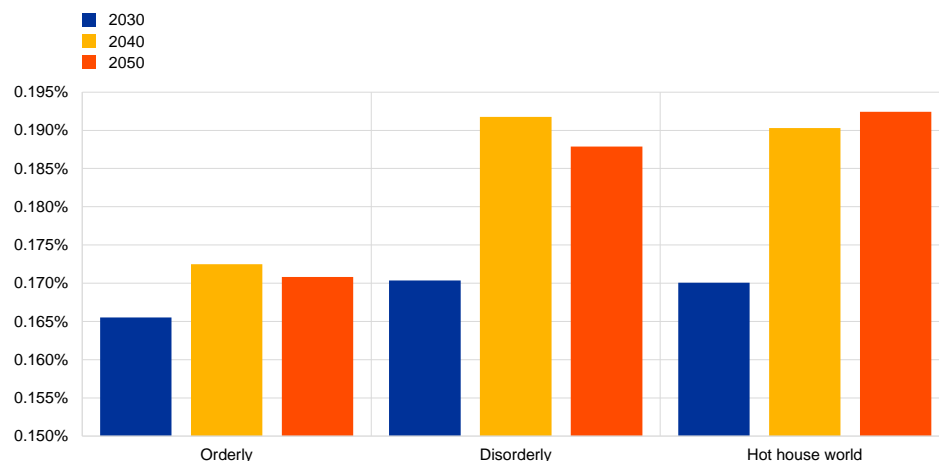
The aggregate pattern of loan loss projections over time is masked by notable differences across banks with respect to projected losses in the long term: some institutions project increasing loan losses over the three decades, distinguishing between scenarios, while other institutions project considerable loan losses in the first decade, which are then either reversed or remain broadly constant in the following decades, without any significant distinction between scenarios.

**Chart 10**

Projected loan losses under the orderly scenario are lower than those both under a disorderly transition scenario and under a scenario with no transition policies (Hot house world)

**Projected loan losses per decade in the long-term scenarios**

(% of performing exposures in each decade)



Sources: Bank submissions and ECB calculations.

An orderly transition would lead to lower loan losses by 2050 relative to the disorderly and Hot house world scenarios, particularly for sectors with high carbon intensity, such as mining and minerals. A disorderly scenario with delayed but abrupt phasing-in of climate-related transition policies tends to produce the highest cumulated losses for the most polluting sectors, since these sectors are most affected by negative gross value added developments owing to (i) a decrease in demand and changes in the energy mix (macroeconomic channel) and (ii) the negative cost impact on the corporate counterparties themselves, leading to a deterioration in their credit quality (microeconomic channel).

The picture is similar when it comes to banks incorporating portfolio allocation strategies into their long-term projections. Certain banks already have a sustainability strategy in place that takes into consideration future emissions paths in line with different scenario narratives. However, most banks do not report significantly different balance sheet projections across the three long-term transition scenarios. Overall, banks most actively reduced their exposure to the most polluting sectors in the Hot house world scenario, partly because the forecast for GDP growth in this scenario is lower than in both other long-term scenarios.

Focusing on loan losses on exposures to the seven most GHG-emitting sectors, Chart 11 illustrates the mitigating effects of allowing for dynamic balance sheet projections in the long-term transition scenarios. In both the disorderly and the Hot house world scenarios, banks project a non-negligible reduction of exposures to those carbon-intensive sectors, which – all else being equal – lessens the cumulated loan loss impact under these two scenarios compared with the orderly scenario. The assumed exposure reduction is particularly pronounced under the Hot house world scenario (e.g. a 50% decline compared with the orderly scenario for the electricity and

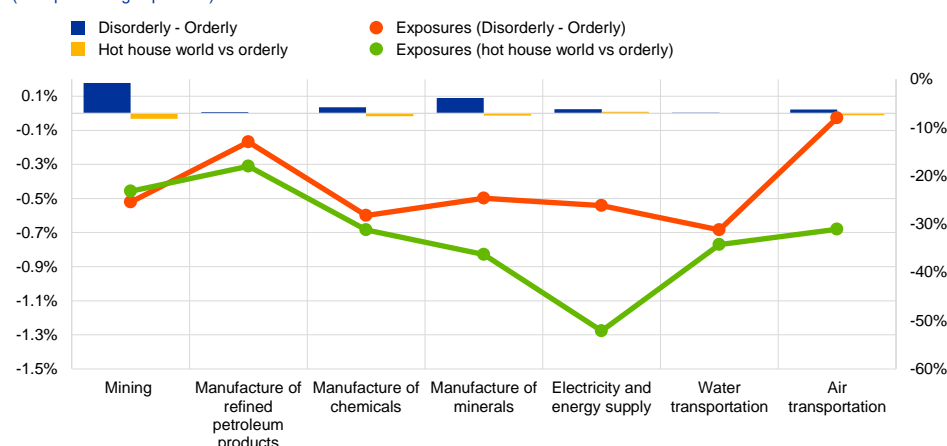
energy sector), which for the seven most GHG-emitting sectors results in lower cumulated loan losses than under the disorderly scenario (and in some cases also the orderly scenario).

### Chart 11

Banks project decreasing exposures to most carbon-emitting sectors, which mitigates to some extent the cumulated loan losses under the disorderly and hothouse world scenarios

Cumulative loan losses in the period 2030-2050 (LHS) and exposure changes (RHS) in the long-term scenarios to 2050

(% of performing exposures)



Sources: Bank submissions and ECB calculations.

Overall, however, banks show little differentiation between the disorderly and Hot house world scenarios in their loan loss projections. In addition, the losses coming from these particular scenarios (e.g. due to chronic physical risk), which are a function of the challenges banks face when adjusting their models and forecasts to such a long-term horizon, appear to be underestimated to some extent. More specifically, banks mentioned the following challenges: i) how to model loss projections over a 30-year time horizon and how to connect scenario assumptions to credit risk parameters (i.e. probability of default, PD and loss given default, LGD); ii) how to characterise extreme weather events (incorporation of physical risks); and iii) how to anticipate changes in customers' behaviour, which is one of the main triggers of transition risk.

Focusing on the behaviour of some of the underlying credit risk parameters in the long-term transition scenarios can help shed light on banks' credit risk modelling capacity when it comes to climate risk. Chart 12 plots the differences between projected risk parameters at sectoral level in two different scenarios against the sectoral gross value added (GVA) growth assumed under these different scenarios. In the upper panel of Chart 12, it is observed that banks' projected PDs appear relatively insensitive to the differences in scenarios (orderly and disorderly). Except in the case of mining, no major differences between sectoral PD projections are observed, despite differences in assumed GVA growth between the sectors. The lower panel focuses on projected LGD parameters, distinguishing between the orderly and Hot house world scenarios. The Hot house world scenario depicts an increase in chronic physical

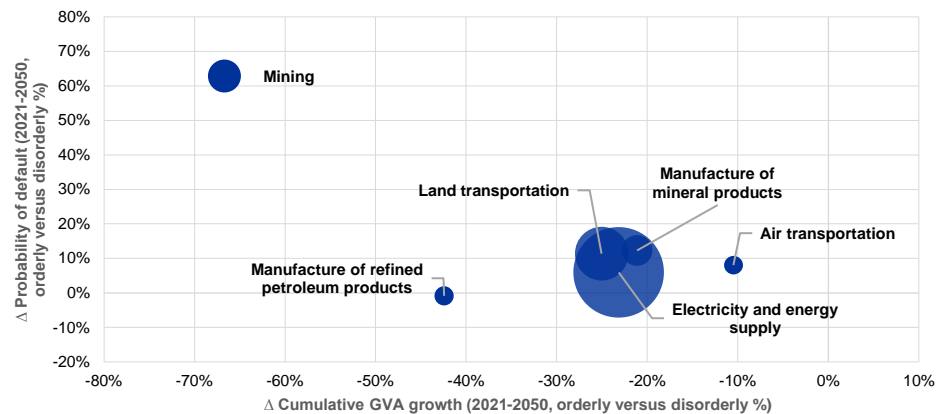
risk, which leads to lower GVA at sectoral level. However, this is not matched by observed changes in banks' projected LGDs. Overall, these findings suggest that many banks are not yet accurately accounting for climate risk in their credit risk modelling; see Box 3 for more details.

### Chart 12

Banks' long-term projections for climate-related credit risk show inconsistencies with the scenarios

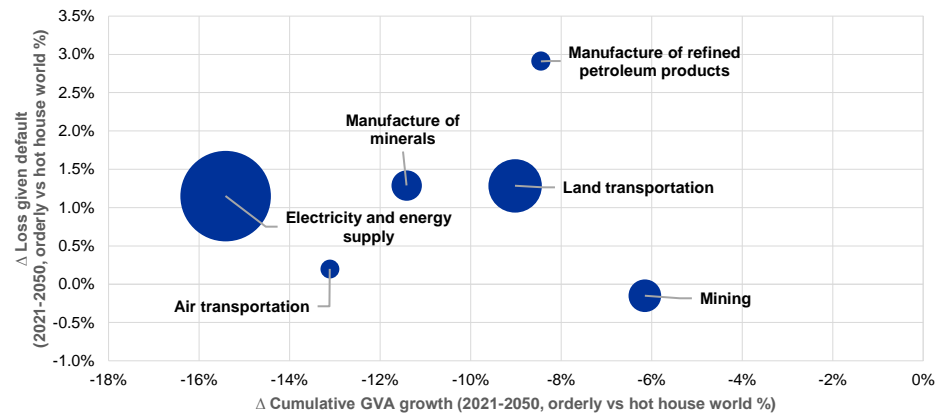
#### a) Sectoral PD and GVA growth orderly vs disorderly

(x-axis: GVA growth 2021-2050; y-axis: PD increase 2021-2050)



#### b) sectoral LGD and GVA growth orderly vs hot house world

(x-axis: GVA growth 2021-2050; y-axis: LGD increase 2021-2050)



Sources: Bank submissions and ECB calculations.

### Box 3

#### Insights into banks' climate risk-related credit risk modelling

The 2022 CST exercise has provided the ECB with initial insights into banks' climate-related credit risk modelling capabilities. Overall, it appears that climate risk factors have not yet been fully considered in banks' internal credit risk stress-testing models. This may explain the limited differentiation with respect to institutions' projected credit risk parameters across the different climate risk scenarios. This box summarises qualitatively some of the ECB's main observations when scrutinising banks' credit risk projections in the 2022 CST.

At a more general level, banks seem to have mainly used existing credit risk models as a starting point, with targeted adjustments to incorporate climate risk factors. With regard to the latter, carbon prices have often been used as the key (and often the only) explanatory variable, followed by energy prices and emissions data. Most banks also include counterparty-specific variables to model the impact of transition risk transmission.

Unsurprisingly, the sensitivity of banks' exposures to transition risk seems better reflected in projected credit risk impairments in the short-term disorderly scenario than in the long-term transition scenario. This may reflect banks' preference, as mentioned above, for adapting existing models to capture the impact of climate risk instead of developing new models. Considering that the horizon of the short-term scenario is also in line with regular stress-testing exercises, banks appeared to be able to implement the scenario shocks in a more standardised way within existing models.

Overall, banks' projections show some sensitivity to negative GVA shocks in carbon-intensive sectors. However, the full impact of the transition scenarios might not have been fully captured in the exercise. Specifically, the ECB found that: (i) the sectoral dimension is often not properly reflected in banks' credit risk models, as shown by the fact that the asymmetric shocks across industry sectors assumed in the scenarios did not result in notable differences in projected sectoral risk parameters (see also Chart 12); (ii) climate risk variables were mostly captured using proxies (e.g. with respect to emissions and EPCs), the quality of which seems highly variable across institutions; and (iii) with carbon prices often being the only climate-related explanatory variable, existing credit risk models do not seem to incorporate all relevant climate risk channels – i.e. both direct channels (e.g. carbon price shock, emissions pathways, etc.) and indirect channels (e.g. macroeconomic variables) – that could affect the credit quality of each counterparty.

Broadly speaking, regarding the level of advancement in terms of climate-related credit risk modelling, around 10% of the banks which provided projections can be viewed as more advanced because they (i) took into consideration both direct and indirect transmission channels (e.g. carbon price shocks, GHG emissions pathways) and (ii) carried out analysis at counterparty level, with actual data for large counterparties and with good extrapolation techniques for SMEs (using proxies). Meanwhile, around 10% of the banks can be classified as less advanced because they did not consider climate risk factors at all, and their credit loss projections were driven entirely by standard macro-financial explanatory variables. The remaining banks can be classified somewhere between the above-mentioned groups in terms of their advancement in climate-related credit risk modelling, with some of them (i) taking indirect transmission channels into consideration, for instance using sectoral GVA growth as an indirect indicator of the carbon price increases; (ii) showing different capabilities in terms of data collection or proxy methodologies; and (iii) considering climate-related variables in addition to the carbon price, etc.

To conclude, banks' efforts to incorporate climate risk into their credit risk modelling are still at a preliminary stage, which is due in part to the challenges banks are facing. Banks will need to step up their efforts to ensure more climate-sensitive credit risk modelling in their stress-testing frameworks.

### 4.3.2 Short-term transition risk projections

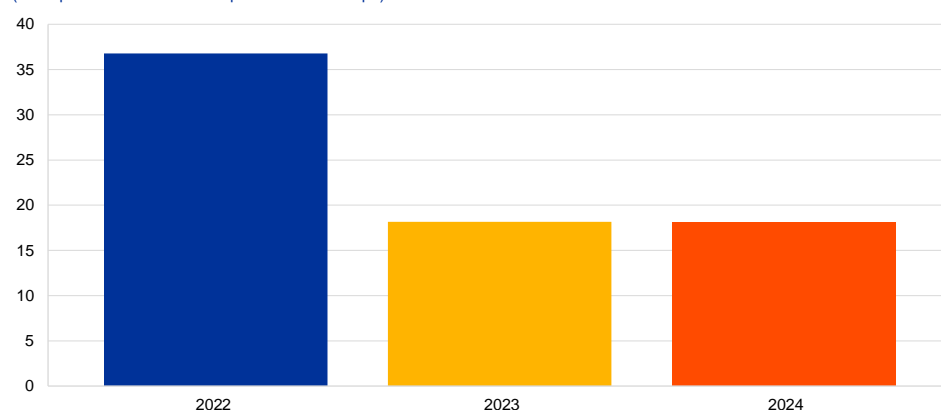
Banks are vulnerable to an abrupt and large increase in transition risk shock in the short term, which is projected to cause a non-negligible increase in credit risk impairments (Chart 13).

**Chart 13**

Frontloaded materialisation of transition risk projected to increase credit impairments

#### Loan losses in the short-term disorderly scenario vs baseline

(basis points of total REA of exposures within scope)



Sources: Bank submissions and ECB calculations.

Note: REA stands for risk exposure amount.

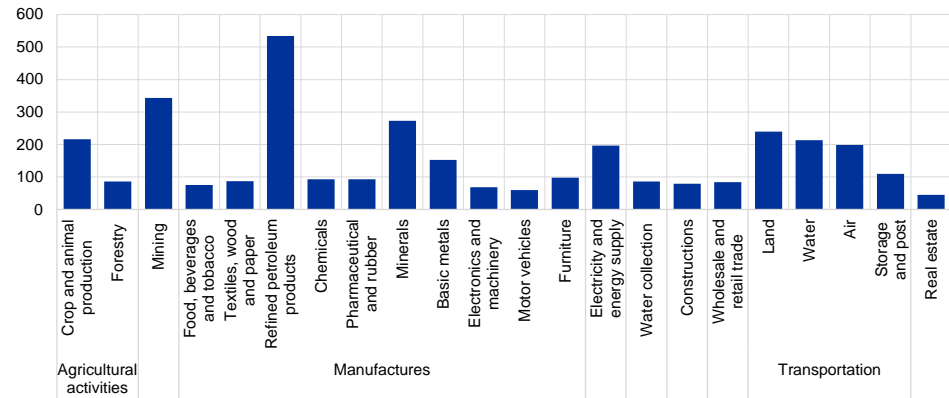
Under the short-term disorderly transition scenario, banks show an increase in cumulated impairments of around 73 basis points compared with the baseline over the scenario horizon. At the same time, the impact must be viewed in the context of the relatively benign features of the scenario from a macroeconomic perspective. The increase is mainly driven by the most carbon-emitting sectors, such as refined petroleum products, mining, minerals and land transportation, which experience cumulated loan losses of more than 200 basis points, reflecting the steep increase in carbon prices required to reach a net zero economy within a short time horizon (Chart 14).

**Chart 14**

Losses from 22 GHG-intensive sectors increase significantly in a short-term disorderly transition scenario

**Cumulative loan losses in the short-term disorderly vs baseline scenario by 2024**

(basis points of the REA of exposures in scope)



Sources: Bank submissions and ECB calculations.  
Note: REA stands for risk exposure amount.

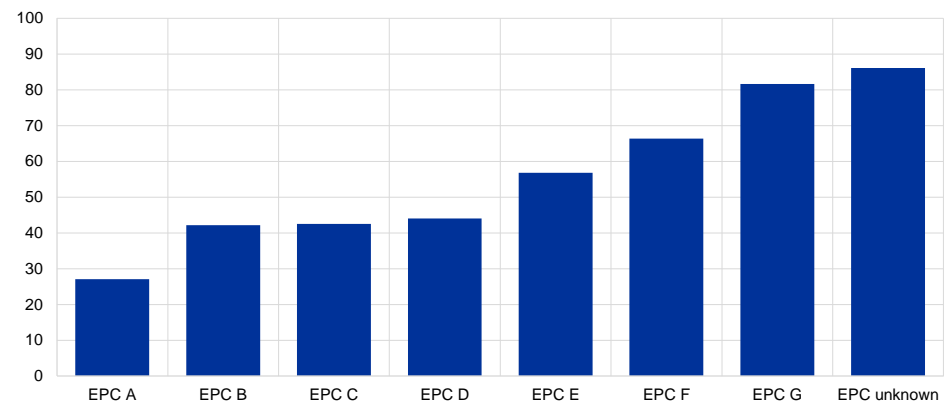
While the overall exposure allocation to various EPC categories does not show significant concentration in any of them, as expected the increase in loan losses is most pronounced for the lower-rated and unknown categories (Chart 15).

**Chart 15**

Impairment losses for each EPC rating class higher in the short-term disorderly scenario than in the baseline

**Cumulative loan losses in the short-term disorderly vs baseline scenario by 2024**

(basis points of the REA of exposures in scope)



Source: Bank submissions and ECB calculations.  
Note: REA stands for risk exposure amount.

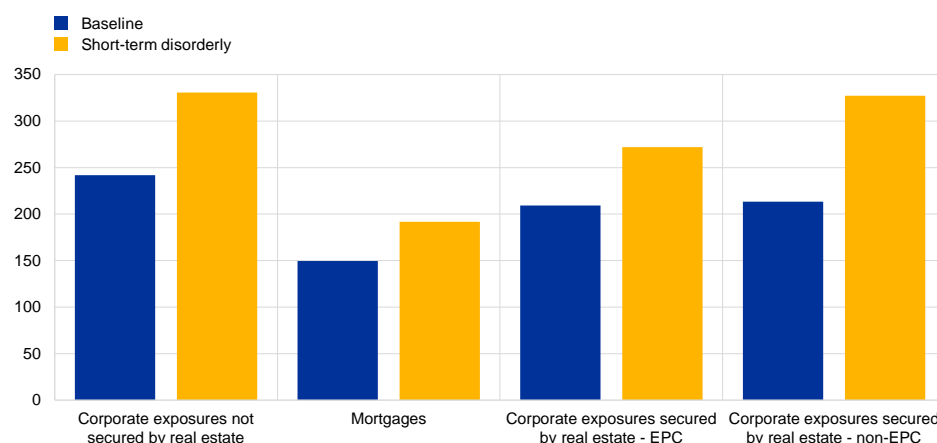
Results at asset class level show that the increase in loan losses is driven by sectoral dynamics. The highest impact is observed for corporate exposures not secured by real estate and those secured by real estate but not within the scope of the EPC. At the same time, the energy efficiency of the underlying collateral (secured by real estate – EPC) appears to play a somewhat less pronounced role (Chart 16).

## Chart 16

Impairment losses are highest for corporate exposures not secured by real estate in the short-term disorderly scenario

### Cumulative loan losses in the short-term disorderly vs baseline scenario by 2024

(basis points of the REA of exposures in scope)



Sources: Bank submissions and ECB calculations.  
Note: REA stands for risk exposure amount.

As regards market risk, banks report a very small drop in the net fair value of their trading portfolios from a one-year materialisation of an instantaneous transition risk shock (Chart 17).

However, in this exercise there is no widespread market-specific stress scenario comparable to those usually included in the EU-wide solvency stress tests (i.e. no volatility shocks such as an increase in the Chicago Board Options Exchange's Volatility Index, VIX). In other words, the market risk-related shocks considered in the 2022 CST are both less comprehensive and less severe than in the adverse scenarios of the regular EU-wide EBA stress tests, which focus on the solvency of institutions. In addition, the market risk methodology adopted was admittedly simplified, in keeping with the concept of a learning exercise. More work is needed in the future to account fully for climate-related market risk, both in banks' internal stress-testing frameworks and in future supervisory exercises.

It is also notable that banks' hedging strategies are compensating for the losses in equity positions, even leading to an increase in the net fair value of the trading portfolio. As regards corporate bonds, the overall change is negative, showing less effective hedging positions. However, even without considering the effect of hedges, the market risk impact reported by banks is fairly benign.

As regards sectoral decomposition, in general terms, there is no clear pattern in the sensitivity of the different sectors, and the aggregated impact on the most polluting sectors is broadly similar to that on the less polluting ones.

Overall, while acknowledging the relatively benign market risk shocks assumed in this exercise and the potential mitigating role of hedges, the mild market risk impact projected by banks combined with the apparent insensitivity to sectoral shocks seems



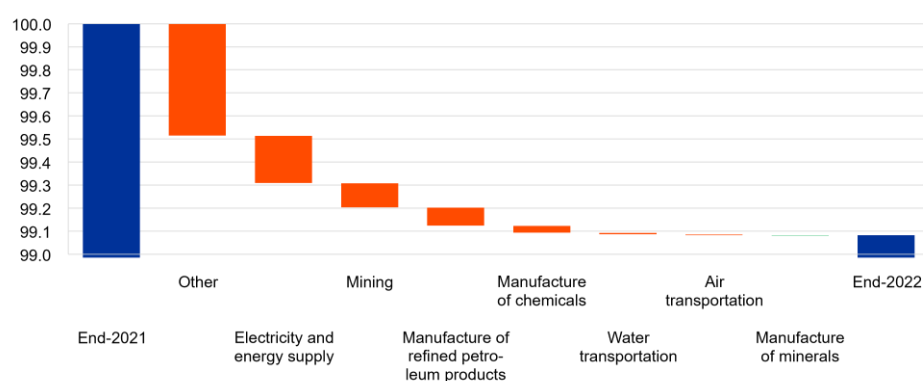
to suggest that climate risk is not yet properly integrated into banks' market risk stress-testing models.

### Chart 17

#### Market risk: change in net fair value positions

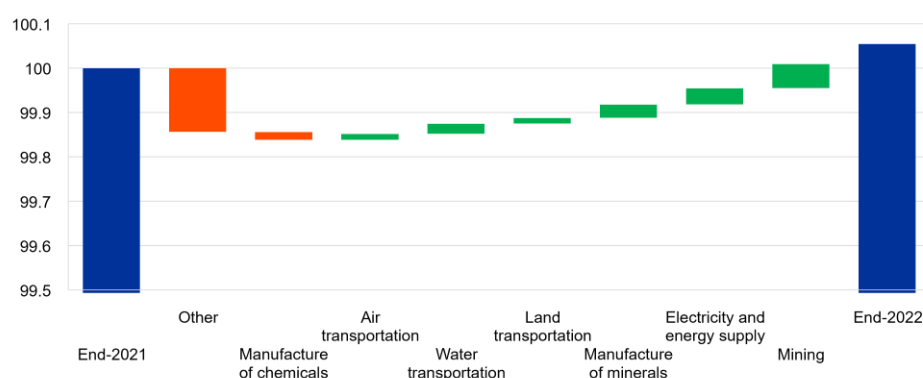
##### a) Sectoral change in fair value: net corporate bond positions

(index: fair value of net positions in 2021 =100)



##### b) Sectoral change in fair value: net equity positions

(index: fair value of net positions in 2021 =100))



Sources: Bank submissions and ECB calculations

## Box 4

### 2022 CST climate risk shocks in the light of prevailing geopolitical tensions

Recent developments related to the COVID-19 pandemic and the geopolitical situation have resulted in sharp increases in energy and commodity prices (including carbon prices). This raises the question of whether the climate risk scenarios considered in the 2022 CST exercise are still up to date, especially as regards the assumed shocks to energy prices. This box compares the energy price shocks and overall GDP effects with those in the ECB's recent [vulnerability analysis on the impact of the Russia-Ukraine war](#).

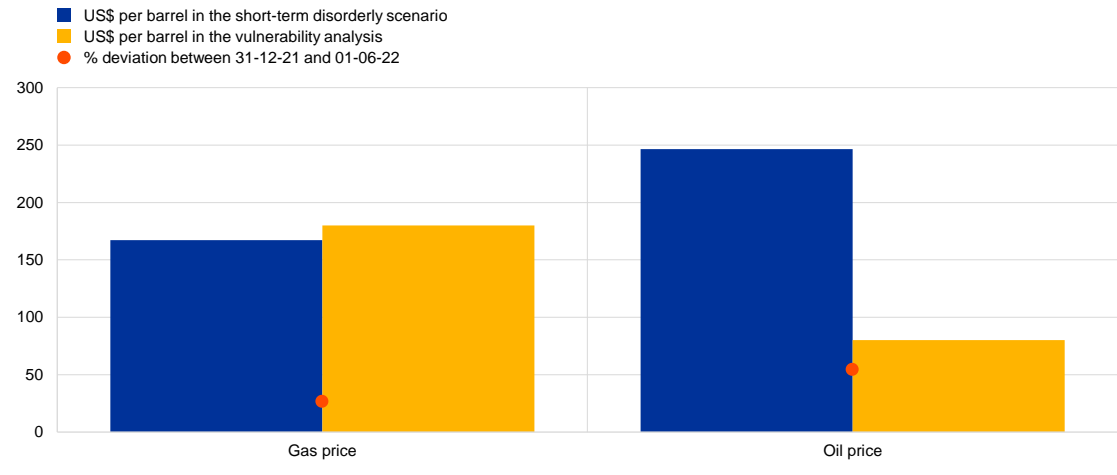
Energy prices are the driving force both in the 2022 CST adverse scenarios – with carbon prices driving the transition to a carbon-neutral economy – and in the ECB vulnerability analysis (2022 VA), which shows oil and gas prices negatively affecting banks' counterparties.

Comparing the 2022 CST short-term disorderly scenario with the severely adverse scenario in the 2022 VA, it can be observed that the direction and magnitude of the shocks to energy prices are broadly similar. Gas price shocks are of almost the same size in the two exercises, whereas oil price shocks are notably higher in the 2022 CST (see Chart A). In addition, comparing the 2022 CST energy price shocks with realised outcomes to date in 2022, the energy price shocks are clearly on the adverse side despite the prevailing geopolitical tensions and supply-side shocks to energy and commodity markets experienced in recent months.

At the same time, it is important to emphasise that the implications of increasing energy prices are not the same in the two exercises. In the context of the 2022 CST, the increase in carbon prices is the main negative factor affecting the economy.<sup>20</sup> By contrast, in the 2022 VA, the energy price shocks occur against the background of a strong macroeconomic contraction with persistently high uncertainty and negative confidence effects. This leads to diverging GDP projections, with the CST scenarios projecting a growing economy while the vulnerability analysis models project a protracted economic downturn (see Chart B).

**Chart A**  
Energy price development in CST short-term disorderly scenario

(projected price in the short-term disorderly scenario and vulnerability analysis)

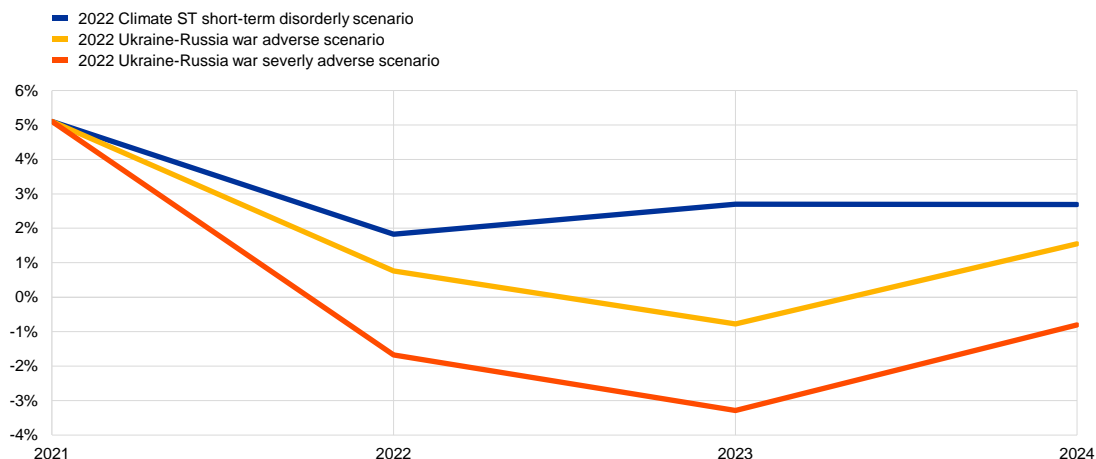


Source: ECB calculations.

<sup>20</sup> At the same time, while the carbon price increase has negative short-term effects on the costs of banks' counterparties and hence their creditworthiness, in the long-term it should speed up investments in green technologies and foster green transition.

**Chart B****Comparison of GDP projections in CST and VA exercises**

(GDP growth (EU average compared with previous year, %))



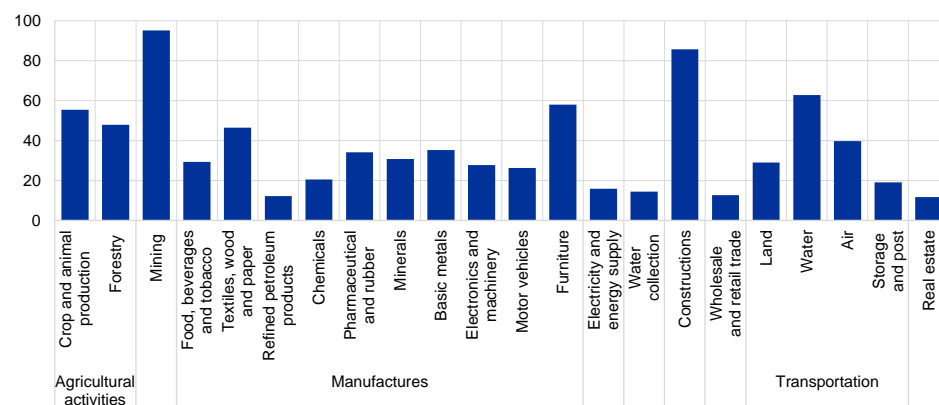
Sources: NGFS and ECB calculations.

**4.3.3 Drought and heat risk projections**

In the drought and heat scenario, sectors and countries are affected differently by extreme temperatures. The impact materialises via a decrease in sectoral productivity, mostly affecting outdoor sectors such as agricultural activities, construction or mining (Chart 18).

**Chart 18****Accumulated loan losses under the drought and heat scenario****Loan losses in the drought and heat vs baseline scenario**

(basis points of the REA of exposures within scope per sector)



Sources: Bank submissions and ECB calculations.

Note: REA stands for risk exposure amount.

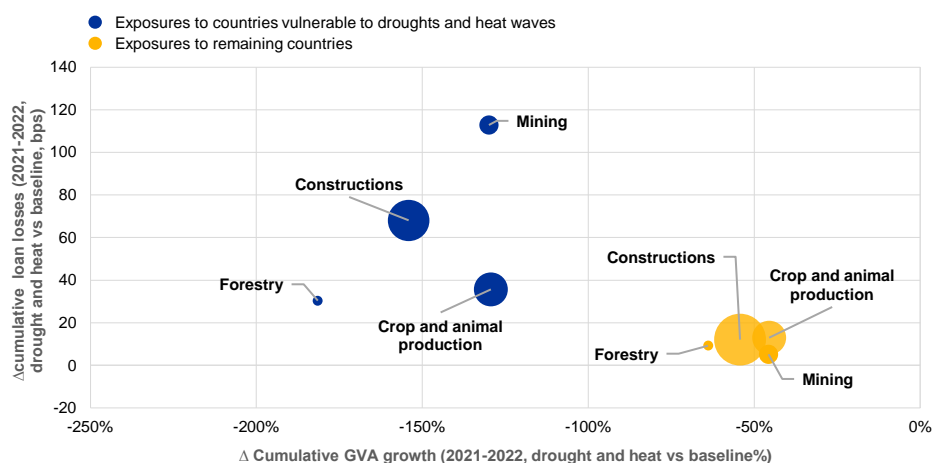
While the vulnerability of each sector to such climate events is a factor driving reported loan loss projections, the geographical location of banks' exposures also plays a key role. The increase in loan losses is concentrated in areas vulnerable to heat and drought, which leads to a strongly heterogeneous impact across banks (Chart 19).

## Chart 19

Drought and heat would decrease productivity in vulnerable sectors such as agriculture, construction and mining and lead to an increase in loan losses in those sectors

### Cumulative loan losses in the drought and heat vs baseline scenario

(basis points of the REA of exposures in scope (y-axis) vs cumulative GVA growth (x-axis))



Sources: Bank submissions and ECB calculations.

Note: GVA stands for gross value added; REA stands for risk exposure amount.

Most banks did not incorporate insurance coverage and public natural disaster relief schemes into their projections, as such information is not broadly available. Overall, not accounting fully for insurance coverage and relief schemes is likely to lead to an overestimation of the effective losses that would occur under the drought and heat scenario.

## 4.3.4 Flood risk projections

In the flood risk scenario, real estate collateral in high(er) flood risk areas is assumed to experience severe damage. This affects the value of the collateral underlying mortgages and corporate loans secured by real estate. The main driving factor for credit risk materialisation under the flood risk scenario stems from the assumed negative shock to real estate prices in areas hit by floods. This in turn pushes up loan-to-value (LTV) ratios, which ultimately leads to an increase in LGDs and hence expected losses.

High and medium flood risk exposures bear half of the losses with share of just 31% of overall exposures. While the impact at asset class level is of similar magnitude for high risk areas, it seems that for other risk areas mortgages are more vulnerable to the materialisation of such a climate event (Chart 20).

In line with the assumed transmission channel through which collateral is destroyed under a flood scenario, LTV ratios show an increase within the one-year projection horizon, which represents a deterioration in the indicator. However, banks' projections do not seem to differentiate clearly between the different flood risk areas when

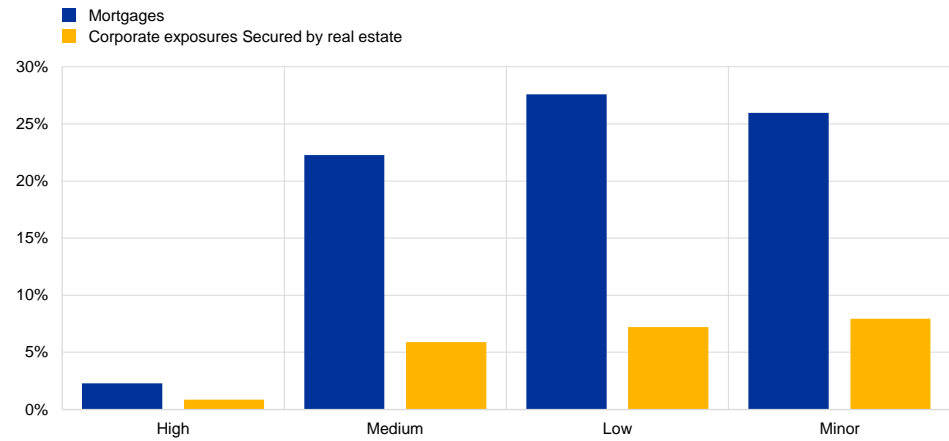
applying the credit risk shocks. The changes in the LTV ratios do not always show a clear distinction between medium and high flood risk areas, for instance.

## Chart 20

### Exposures and loan losses under the flood risk scenario

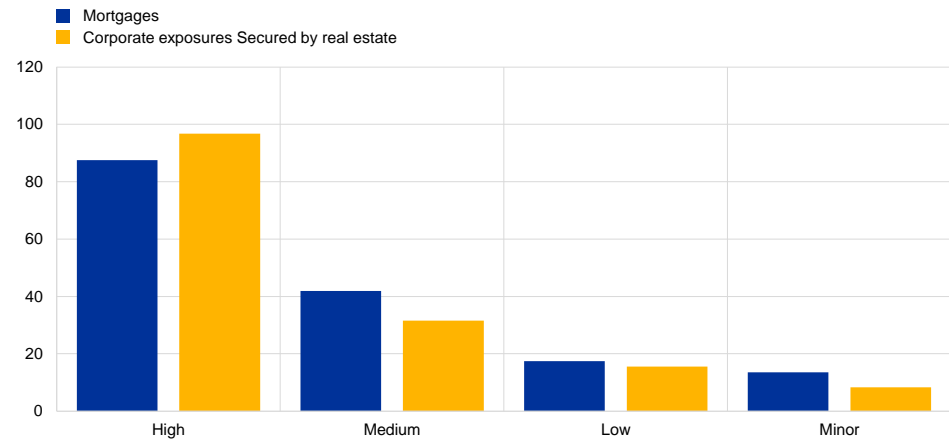
#### a) Allocation of exposures by flood region

(% of total exposures)



#### b) Cumulative loan losses under the flood scenario

(basis points of REA of exposures within scope per region)

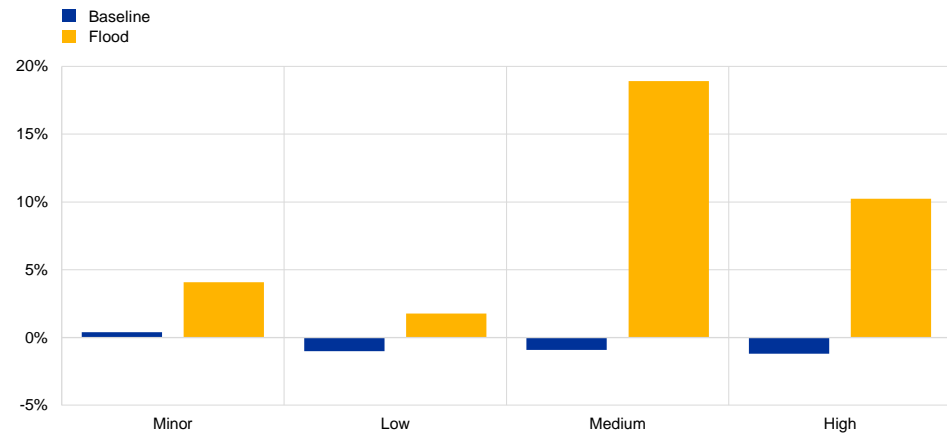


Sources: Bank submissions and ECB calculations.

Note: REA stands for risk exposure amount.

**Chart 21****Development of mortgage loan-to-value ratios**

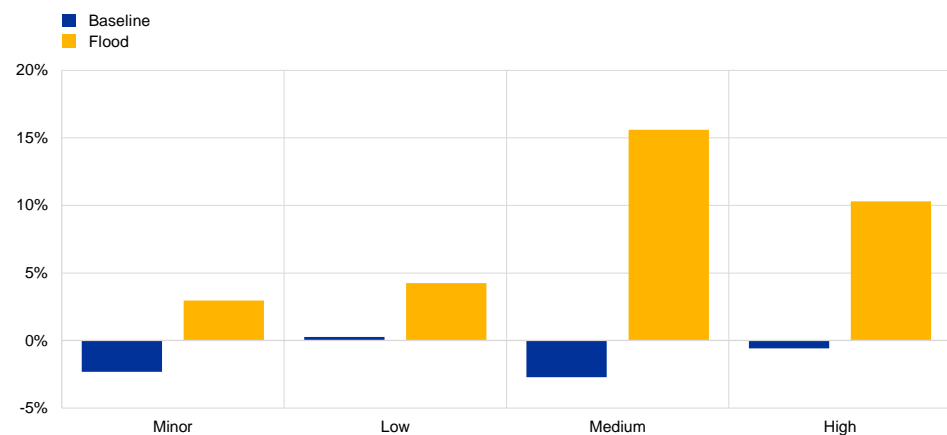
(difference between the end-of-year and beginning-of-year median LTV ratios)



Sources: Bank submissions and ECB calculations.

**Chart 22****Development of loan-to-value ratios for corporates secured by real estate**

(difference between the end-of-year and beginning-of-year median LTV ratios)



Sources: Bank submissions and ECB calculations.

While losses stemming from physical risk may be mitigated through physical protection and insurance instruments, less than 25% of the banks applied private insurance coverage in their projections. For half of those banks, this insurance covers a large amount (over 50%) of the collateral loss. In addition, public natural disaster relief schemes are mentioned by a few banks but not considered in the projections.

### 4.3.5 Overall assessment of the scenario-based projections

Taken together, under a short-term, three-year disorderly transition risk scenario and the two physical risk scenarios (flood risk and drought and heat risk, respectively), the combined credit and market risk losses for the 41 banks that provided projections would amount to around €70 billion. For a number of reasons, this estimate

significantly understates the actual risk. First, the scenarios considered in this exercise are not adverse, as they are in the regular stress tests. Specifically, there is no economic downturn accompanying the negative climate effects. Second, the data and modelling underlying the banks' projections are still at a preliminary stage, with climate factors only captured to a rudimentary degree. Third, given that this is essentially a learning exercise, no supervisory overlays have been applied. Fourth, the exposures within the scope of this exercise only account for around one-third of total exposures of the 41 banks.

Under the 30-year transition scenarios, losses that may occur in the context of the transition to a more sustainable environment are projected to be notably lower under the scenario of an orderly phasing-in of sustainable climate policies than in the case of delayed and disorderly transition paths. However, it should be borne in mind that the 30-year projections are exploratory and subject to significant uncertainty. Therefore, these long-term loss projections should be interpreted as a qualitative yardstick for the direction of travel rather than as a robust quantitative measure.

## 5 Banks' plans for financing the green transition

To gain insights into their current and future plans for financing the green transition, participating institutions were asked to provide both qualitative and quantitative information about their strategies.

### 5.1 Qualitative insights into banks' current and future plans

In the context of the 2022 CST, banks were invited to provide additional background information on past and planned actions to support the green transition in the selected GHG-intensive industries and the portfolio in the scope of the 2022 CST. The objective was to capture the possibility that some banks might have a significant share of income from, or business volumes with, GHG-emitting sectors but might be gradually de-risking their portfolio by supporting existing clients in their transition process or by selecting clients which contribute to transition within this sector or which are already aligned with the transition objectives. Accordingly, for each sector, banks were asked to provide information on (i) their quantitative criteria for selecting counterparties to support in the transition, (ii) the outstanding amounts related to the provision of green finance instruments and (iii) the key performance or key risk indicators developed to monitor progress towards the alignment on the required transition.

While the information provided by banks was fairly heterogeneous, some observations can be drawn.

Whereas most banks (67%) provided quantitative information about the acquisition of green bonds, only a few (15%) provided such information at sector level (mostly in relation to energy-related project finance). It was a similar picture for information provided on other instruments (green loans, project finance, etc.).

Regarding details provided on key indicators of climate change-related risk, only one-third of banks provided information at global level, while just a handful of banks (5%) provided information at sector level. This suggests that current actions undertaken are mostly driven by high-level objectives (e.g. an overall amount of green finance products).

Institutions also had the opportunity to describe the actions they planned to take to mitigate transition risk and support the transition in relation to the corporate portfolio studied in the 2022 CST. The majority of banks (59%) described actions which cover a significant part of their corporate balance sheet, i.e. a significant number of economic activities (Chart 23). Nevertheless, for most of them (61%), information on future actions are not yet associated with concrete targets (Chart 24). For instance, some banks refer to overarching objectives (e.g. the Net Zero Banking Alliance) but associated key performance indicators (KPIs), while planned, are still to be established and connected in concrete terms with alignment on the required transition.



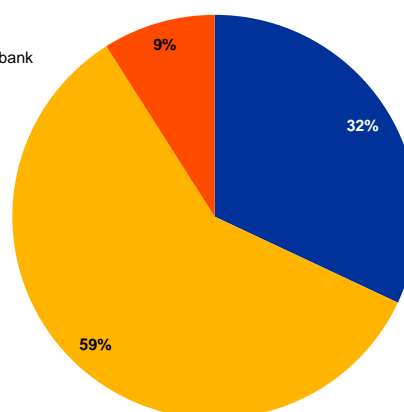
Note that, in its thematic review, the ECB is comprehensively assessing the incorporation of climate-related and environmental risks into the institutions' strategy and their governance and risk management frameworks. This follows the feedback provided in 2021 in the context of the self-assessment.

### Chart 23

Magnitude of past and planned actions to mitigate transition risk and support transition in relation to the sectors studied in the CST 2022

(percentage share)

- Cover a niche activity/portfolio
- Cover a significant part of the balance sheet/activity of the bank
- No actions/plans



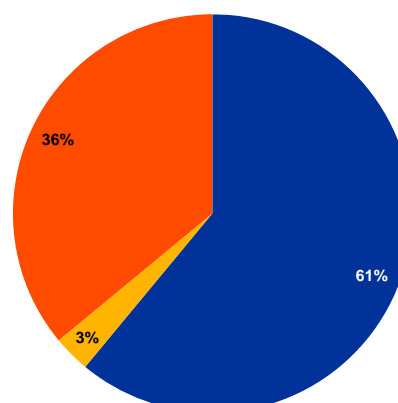
Sources: Bank submissions and ECB calculations.

### Chart 24

Information on green asset ratios or other KPIs for actions to mitigate transition risk and support transition in relation to the sectors studied in the CST 2022

(percentage share)

- No
- Yes at sector level
- Yes, at global level



Sources: Bank submissions and ECB calculations.

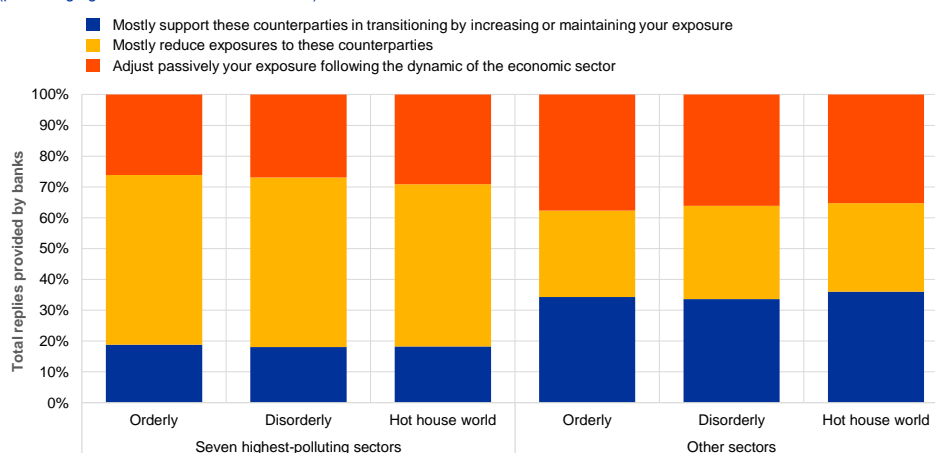
## 5.2 Long-term balance sheet projections under the different climate risk scenarios

In the 2022 CST exercise, banks were asked to provide information about their long-term strategic plans under the three different scenarios, i.e. orderly, disorderly and Hot house world.

While many banks indicated that they would tend to reduce exposures to the most GHG-emitting sectors and counterparties, banks showed little sensitivity when it came to elaborating strategies for the different scenarios (Chart 25). Banks consistently reported the same strategic options regardless of the scenario analysed: the most polluting sectors were mainly reported as “mostly reduce”, while the less polluting among the sectors in scope were reported as “mostly support” or “adjust passively”. This lack of elaboration on the different paths signals the need for further efforts to formulate strategic options for the long-term transition scenarios.

**Chart 25**  
Institutions’ long-term strategies

(percentage growth between 2021 and 2050)



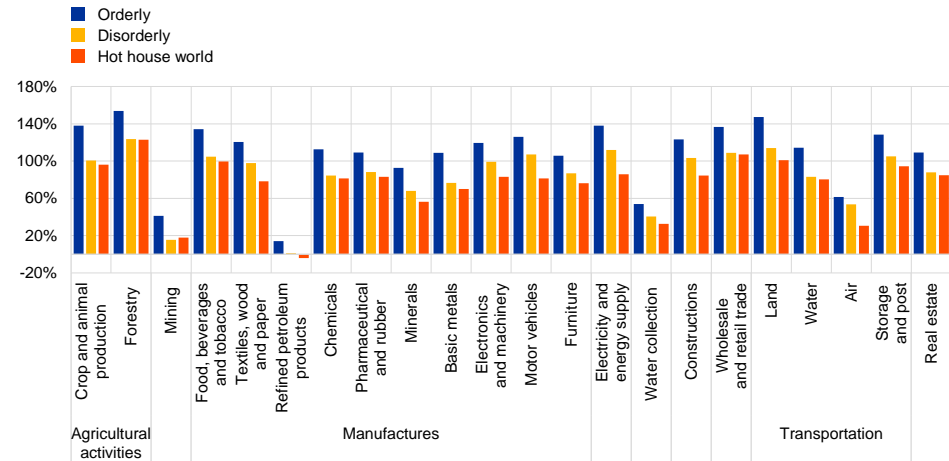
Sources: Bank submissions and ECB calculations.

The long-term transition risk scenarios allowed for dynamic balance sheet adjustments over the 30-year horizon. In line with the positive overall growth in GDP assumed in the long-term scenarios, banks projected that exposures to the 22 NACE sectors considered in the exercise would increase. In line with the scenarios, Balance sheet growth was projected to be highest in the orderly transition scenario and least strong in the Hot house world scenario (Chart 26). At sectoral level, exposure growth was projected to be relatively less pronounced for refined petroleum products, mining, water collection and air transportation.

**Chart 26**

Growth in exposure by NACE sectors for all banks (% growth 2021-2050)

(percentage growth between 2021 and 2050)



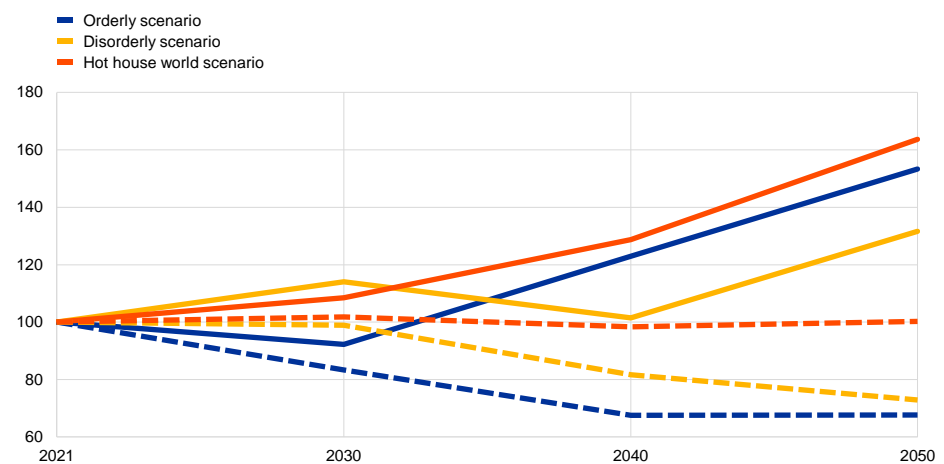
Sources: Bank submissions and ECB calculations.

Focusing on the projected growth in exposures to the most GHG-emitting sectors over the 30-year transition scenarios, Chart 27 shows divergent patterns across the banks. While some banks project that they would reduce exposures to these high-polluting sectors (dotted lines in the chart), others assume continued lending to the same sectors, which could reflect an ambition to continue support those counterparties with their green transition (as also indicated by the blue bars in Chart 25).

**Chart 27**

Projected exposures to the most carbon-emitting sectors

(index: 2021=100)



Sources: Bank submissions and ECB calculations.

Note: The continuous line represents the first quartile; the dashed line represents the fourth quartile.

## 6 Supervisory follow-up

The ECB's 2022 climate stress test (2022 CST) will have no direct capital implications. Instead, any supervisory findings may feed qualitatively into the broader annual SREP assessment, complementing findings from the thematic review of climate-related and environmental risks.

At the end of the 2022 CST exercise, the ECB communicated to the banks a detailed assessment of their performance and level of preparedness for climate risk stress testing. The ECB will continue monitoring the banks' progress on climate risk stress testing with the clear expectation that all institutions under its direct supervision will improve their stress-testing capabilities in the coming years.

Apart from the immediate takeaways and input into this year's SREP, in the coming months the ECB will further analyse the insights from the 2022 CST to identify good practices in climate risk stress testing that could be used to guide institutions currently at a less advanced stage.

### 6.1 Integration into the SREP

Given that the 2022 CST is essentially a learning exercise, stress test findings will be integrated into the SREP in a qualitative and non-mechanistic way.

The SREP will jointly integrate the findings from the 2022 CST and the thematic review on climate-related and environmental risk.

When assessing the different SREP areas, Joint Supervisory Teams (JSTs) consider climate risk in conjunction with all other risk drivers assessed in those areas. In other words, climate risk is not assessed separately or given an individual score.

### 6.2 Guidance on “best practices”

While the 2022 ECB CST has been instrumental in helping banks to make progress with their stress-testing frameworks, the exercise has clearly illustrated that considerable efforts are still needed on the part of many significant institutions.

It is also clear that many institutions face challenges across several dimensions of climate risk stress testing. This is especially true with regard to compiling appropriate data, but there is still work to do in other areas too, such as governance, modelling and integration into ICAAP.

To help banks make further progress, the ECB will carry out follow-up work to provide guidance on best practices and suggestions on how to overcome the obstacles and challenges that some institutions are currently facing. This work is planned to be completed towards the end of 2022. A high-level description of the good practices identified is provided in Box 5.

## Box 5

### Some examples of good practices

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While the ECB will carry out follow-up work to identify best practices after the 2022 CST, the current assessment already provides some high-level examples of good climate stress testing practices. Not one bank is currently carrying out all its climate risk stress testing activities in a perfect way.

However, across different dimensions of climate risk stress testing, some banks are already demonstrating relatively advanced approaches, suggesting that despite the significant challenges that have been acknowledged, developing sound climate risk stress-testing capabilities is not an unsurmountable task. This box highlights some of the good practices observed across different banks during the 2022 CST. It is notable that those good practices are not concentrated in specific business models or countries.

Good practices were observed in the following dimensions, including:

1. Banks that were able to engage with customers to retrieve climate-relevant counterparty-level data breakdowns.
2. Banks that have already integrated climate risk into their ICAAP supported by a good governance framework.
3. Banks that demonstrate proper climate risk credit modelling capabilities (e.g. displaying the relevant sensitivity to risk parameters at sectoral level). Such banks have developed climate-sensitive credit risk models (i) operating at sector level or even firm level to take better account of the heterogeneity in corporate sector vulnerability to climate-related risks, (ii) allowing for the joint integration of transition and physical risks and (iii) making use of actual data with respect to emissions, investments in energy efficiency and transition plans at counterparty level.
4. Banks that appropriately allocated their income and exposures by sector/country and by emission intensity (with Scope 1 to 3 emissions included) using counterparty-level data. While the large majority of banks used proxies for deriving Scope 3 emissions data in particular, some banks also made additional efforts to use proper, actual modelled data to account for the full Scope 3 emissions.
5. While the general finding is that most banks still do not have clearly specified long-term strategies for dealing with the green transition, some banks have more elaborate plans which include concrete green transition targets and KPIs.

The above-mentioned findings, along with banks' ability to provide the complete set of information requested for the 2022 CST – even though the information provided was of variable quality – indicate that banks can draw on their internal capacity and advance further in the domain of climate risk stress testing.

The ECB plans to conduct more in-depth analysis of the good practices and key obstacles encountered in the 2022 CST so as to provide the industry with more specific guidance and recommendations, thus helping institutions to make progress in setting up their climate risk stress-testing frameworks. This work will be completed during the second half of 2022.

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## 7 Conclusion

Although some progress has been made since 2020, the results of the European Central Bank (ECB) 2022 climate risk stress test show that banks do not yet sufficiently incorporate climate risk into their stress-testing frameworks and internal models.

The test, which is part of the ECB's wider climate roadmap, was a learning exercise for both banks and supervisors to assess the sector's preparedness for managing climate risk. It was also aimed at identifying best practices for dealing with this risk effectively.

The findings of this exercise will complement the results of other ongoing supervisory activities, such as the 2022 thematic review of how banks are incorporating climate and environmental risks into their processes.

# Annexes

## Annex A.1: List of abbreviations

List of abbreviations	
<b>BMPE</b>	Broad Macroeconomic Projections Exercise
<b>CRD</b>	Capital Requirements Directive
<b>CST</b>	climate risk stress test
<b>EBA</b>	European Banking Authority
<b>EU</b>	European Union
<b>ECB</b>	European Central Bank
<b>EC TEG</b>	Technical Expert Group on Sustainable Finance
<b>EPBD</b>	Energy Performance of Buildings Directive
<b>EPC</b>	energy performance certificate
<b>ESG</b>	environmental, social and governance
<b>GDP</b>	gross domestic product
<b>GHG</b>	greenhouse gas
<b>G-SIB</b>	global systemically important bank
<b>GVA</b>	gross value added
<b>ICAAP</b>	internal capital adequacy assessment process
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>JRC</b>	Joint Research Centre (of the European Commission)
<b>JST</b>	Joint Supervisory Team
<b>KPI</b>	key performance indicator
<b>LGD</b>	loss given default
<b>LTV</b>	loan-to-value
<b>NACE</b>	nomenclature statistique des activités économiques dans la Communauté européenne (Statistical Classification of Economic Activities in the European Community)
<b>NFC</b>	non-financial corporate
<b>NGFS</b>	Network for Greening the Financial System
<b>NUTS</b>	nomenclature of territorial units for statistics
<b>PD</b>	probability of default
<b>REA</b>	risk exposure amount
<b>SREP</b>	Supervisory Review and Evaluation Process
<b>SMEs</b>	small and medium-sized enterprises
<b>ST</b>	stress test
<b>VA</b>	vulnerability analysis
<b>VIX</b>	Chicago Board Options Exchange's Volatility Index

## Annex A.2: List of 22 industries

NACE industrial sector	NACE industrial sector description
A01	Crop and animal production, hunting and related service activities
A02-A03	Forestry and logging; Fishing and aquaculture
B	Mining and quarrying
C10-C12	Manufacture of food products, beverages and tobacco products
C13-C18	Manufacture of textiles; Manufacture of wearing apparel; Manufacture of leather and related products; Manufacture of wood and of products of wood and cork, except furniture; Manufacture of articles of straw and plaiting materials; Manufacture of paper and paper products; Printing and reproduction of recorded media
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21-C22	Manufacture of basic pharmaceutical products and pharmaceutical preparations; Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products
C24-C25	Manufacture of basic metals; Manufacture of fabricated metal products, except machinery and equipment
C26-C28	Manufacture of computer, electronic and optical products; Manufacture of electrical equipment; Manufacture of machinery and equipment not elsewhere classified
C29-C30	Manufacture of motor vehicles, trailers and semi-trailers; Manufacture of other transport equipment
C31-C33	Manufacture of furniture; Other manufacturing; Repair and installation of machinery and equipment
D	Electricity, gas, steam and air conditioning supply
E36-E39	Water collection, treatment and supply; Sewerage; Waste collection, treatment and disposal activities; Materials recovery; Remediation activities and other waste management services
F	Construction
G45-47	Wholesale and retail trade and repair of motor vehicles and motorcycles; Wholesale trade, except of motor vehicles and motorcycles; Retail trade, except of motor vehicles and motorcycles
H49	Land transport and transport via pipelines
H50	Water transport
H51	Air transport
H52-H53	Warehousing and support activities for transportation; Postal and courier activities
L	Real estate activities



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For specific terminology please refer to the [ECB glossary](#) (available in English only).

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