

2022 ECB climate stress test exercise methodology



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MS^o Management Solutions
Making things happen

List of abbreviations

Abbreviation	Meaning
2DII	2 Degrees Investing Initiative
ACPR	Autorité de Contrôle Prudentiel et de Résolution
AQR	Asset Quality Analysis
BCBS	Basel Committee on Banking Supervision
BoE	Bank of England
COREP	Common Reporting Framework
CRE	Comercial Real State
DNB	Den Norske Bank
EAD	Exposure at Default
EBA	European Banking Authority
ECB	European Central Bank
EPC	Energy Performance Certificate
ESG	Environmental, Social, Governance
EU	European Union
FINREP	Financial Reporting
FVOCI	Fair Value in Other Comprehensive Income
FVPL	Fair Value Through Profit and Loss
ACPR	Greenhouse Gas
HFT	High Frequency Trading
ICAAP	Internal Capital Adequacy Assessment Process

Abbreviation	Meaning
IEA	International Energy Agency
IMI	Internal Model Investigations
IPCC	Intergovernmental Panel on Climate Change
LGD	Loss Given Default
LTV	Loan-To-Value
NACE	Nomenclature of Economic Activities
NGFS	Network for Greening the Financial System
NUTs	Nomenclature of Territorial Units for Statistics
OSI	Occupational Stress Index
P2R	Pillar 2 requirement
PCAF	Partnership for Carbon Accounting Financials
PD	Probability of Default
PIK	Potsdam Institute for Climate Impact Research
PMO	Project Management office
R&D	Research and Development
REA	Risk-weighted Exposure Amounts
SME	Small and Medium-Sized Enterprises
TR	Transition Rates
UK	United Kingdom
UN	United Nations

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1 | Context

Climate risk

The growing relevance of climate-related risks is giving rise to a context in which supervisory bodies are conducting exercises to assess the resiliency of the financial sector to these risks in the short and long term. In this context, the ECB has published the **Climate risk stress test methodology** which outlines the main characteristics of the **2022 climate risk stress test**



After the Paris Agreement in 2015, the concern about the climate-related risks has come to the forefront of the **industry and the regulators**. The exposure to transition and physical risks can have a **significant impact to the banking sector**, increasing the credit, market, operational, or liquidity risks, among others.



Therefore, **many regulatory and supervisory bodies** have begun to develop methodologies and conduct **scenario analysis and stress testing exercises**¹ (for example, the ACPR, in France, the BoE in UK, DNB in The Netherlands, the EBA pilot sensitivity analysis exercise). The objective is to understand the magnitude and the potential impact of these risks in the individual institutions and in the financial sector.



For the development of methodologies and the data used in the exercises, supervisors are **leveraging on the many global initiatives** working for the understanding of these risks, its measurement and management: the UN initiatives, the IPCC, working groups for development of methodologies (2DII, PCAF, etc.); many scientists, research groups, and public or private agencies for the collection of data, development of models and climate scenarios (IEA, NGFS, PIK, DDPP, etc.); publications and advice from regulatory bodies (BCBS², NGFS³).



In addition, **the EBA and the ECB have issued draft regulation and guidance** that includes this topic: the EBA Discussion paper on management and supervision of ESG risks for credit institutions and investment firms includes stress testing requirements, and the ECB Guide on climate-related and environmental risks incorporates a description on ECB expectations for institutions relative to climate-related and environmental risks.



Finally, the **ECB intends to conduct a full supervisory assessment** of all climate-related and environmental risk management practices and a **supervisory stress test on climate risk in the first half of 2022**. To this end, the ECB has already started a supervisory dialogue with the institutions and has published the methodology to carry out the exercise.

¹ For further details on supervisory declared intentions on stress testing, see [annex 1](#)

² BCBS: Climate-related financial risks – measurement methodologies. April 2021

³ NGFS: Guide to climate scenario analysis for central banks and supervisors. June 2020



[Access the entire Document](#)

2 Executive summary

The ECB has outlined the characteristics of the 2022 climate risk stress test exercise in order to provide banks with guidance on how to conduct the exercise. The main characteristics are: i) the quality assurance process and ii) the stress test modules.

The quality assurance process serves to enhance the supervisory understanding of what **climate-relevant data banks** have available and the **limitations when assessing climate-related risks**.



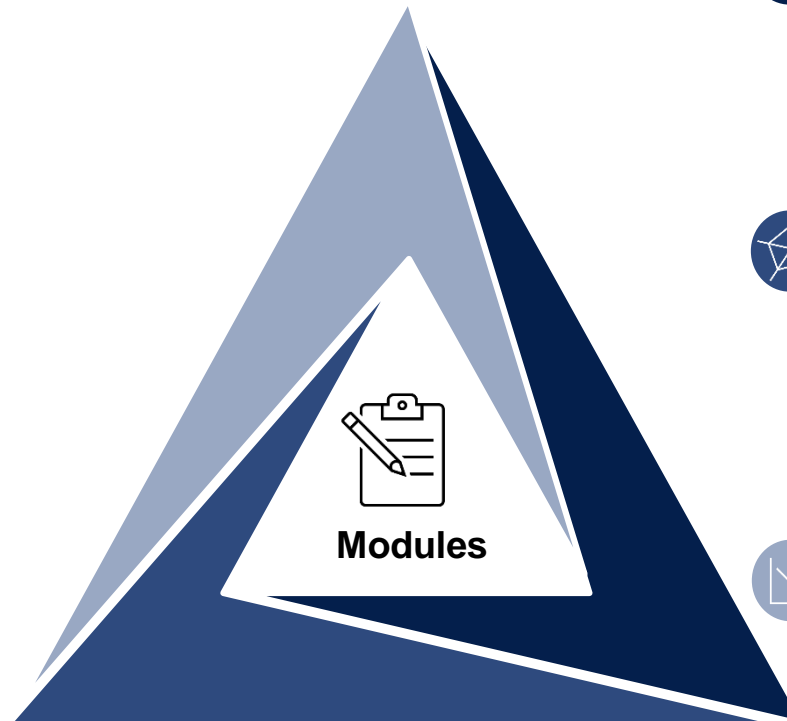
Phase 1: Data collection

- Banks are required to complete the template and produce results based on the instructions set out in the methodology¹.



Phase 2: Quality assurance

- The ECB will analyse the information submitted by banks to ensure that the submissions are i) of a **satisfactory quality**, ii) aligned with the **instructions** set out in the methodology, and iii) provide **comprehensive and reliable results** for the prescribed assumptions and scenarios.



Module 1: Questionnaire on the stress test framework

The purpose of this module is to gain an illustrative overview of the institution's internally available stress testing **capability and capacity** including its climate risk **stress testing framework, management and modelling** practices.



Module 2: Climate risk metrics

The purpose of this module is to shed light on banks' **analytical and data capabilities** regarding climate risk. More specifically it provides insights into the **sensitivity of banks' income to transition risk**, their exposure to carbon-intensive industries and, in that sense, the sustainability of the banks' business mode.



Module 3: Bottom-up stress test projections.

The purpose of this module is to describe the methodology for the **starting point data and projections** that banks must provide for the bottom-up stress test exercises targeting **transition risk and physical risk**.

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2022 ECB climate stress test exercise

Structure of the exercise

The stress test exercise covers three modules (questionnaire on the stress test framework, stock-take on emissions, and bottom-up exercise)

	Module 1: Framework questionnaire	Module 2: Stock-take on emissions	Module 3: Bottom-up climate ST
Description	<p>Qualitative questionnaire on 11 sections:</p> <ol style="list-style-type: none"> Existence and use of ST exercises Governance and inclusion in Risk Appetite Integration into strategy Methodology used Scenarios Data and sources of information Inclusion on the ICAAP Future development plan Role of Internal Audit EU subsidiaries of non-EU institutions Methodological assumptions and choices 	<p>Estimation of two metrics:</p> <ol style="list-style-type: none"> <u>Exposure to transition risks</u>: Income (interest income, fees, commissions) from GHG intensive industries per sectors <u>Financed carbon intensity</u>, separating Scope¹ 1, 2 and 3 <p><u>Scope:</u></p> <ul style="list-style-type: none"> Non-financial corporate (non SME) Metric 1: 80% gross interest income, max 5 countries. Reference date: from Jan-21 to Dec-21 Metric 2: 15 counterparties per 22 sectors. Reference date: average revenues for 2018,2019 and 2020, emissions data as of December 2020 	<p>Risk projections:</p> <ol style="list-style-type: none"> <u>Credit</u>² (impact on impairment; static balance sheet in s/t, dynamic in l/t): <ul style="list-style-type: none"> Transition: baseline and disorderly (3y), orderly, disorderly and hot house³ (10-30y) Physical (EU Corporates & SMEs and real state and mortgages): drought and heatwave, flood (1y from 1Jan22) <u>Market</u>: <ul style="list-style-type: none"> Bonds, equity and directly connected derivatives in the HFT Shock on valuation <u>Operational</u>: Qualitative questionnaire regarding operational and reputational risk
Requirements	<ul style="list-style-type: none"> Completion of the questionnaire No additional documentation requirement 	<ul style="list-style-type: none"> Aligned with FINREP Groups of sectors: NACE – level 2 Documentation: <ul style="list-style-type: none"> Actions carried out by the bank Emission calculation approach 	<ul style="list-style-type: none"> Some banks don't submit projections Groups of sectors: NACE – level 2 For mortgages, by EPC groups Documentation: <ul style="list-style-type: none"> Assumptions and methodology Consistency w/ public commitments

¹ Scope 1 directly emissions; Scope 2: indirectly from energy consumption; Scope 3: other indirect emissions along organisation's value chain.

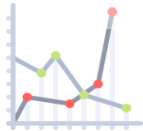
² Includes both [transition and physical risks](#).

³ NGFS scenarios, published on 7-june-2021

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2022 ECB climate stress test exercise Structure of the exercise | Module 3: scenarios

The climate stress test methodology considers different scenarios with different methodologies and time horizons



Scenarios

- **Transition risks¹**: short term (3 years) under baseline and stress and long term (30Y scenarios) under orderly, disorderly and hot-house scenarios
- **Physical risk²**: short term (1 year) under baseline and stress scenarios for drought and heatwave and flood scenarios

	Exposures	Scenario	Projections	Horizon	Segment	Balance sheet
Transition risk	Global (Cover at least 80% EAD, max. countries 5 in short term, 1 country in long term)	Short term stress	Baseline	3 years (2022 – 2024)	Corporate Loans Incl. SME, CRE + mortgages	Static balance sheet
			Stress (disorderly)			
		Long term paths	Orderly	30 years (2030, 2040, 2050)	Corporate Loans Incl. SME, CRE + mortgages	Dynamic balance sheet
Disorderly						
Hot-house						
Physical risk	EU Countries (Cover at least 80% EU EAD, max. 5 countries)	Drought & heat risk	Baseline	1 year (2022)	Corporate Loans (Incl. SME)	Static balance sheet
			Stress			
		Flood risk	Baseline	1 year (2022)	Mortgages + CRE loans	
			Stress			

¹ Transition risk refers to financial losses that an institution may incur, directly or indirectly, as a result of the process of adjustment towards a lower carbon and more environmentally sustainable economy.

² Physical risk refers to financial losses that an institution may incur, directly or indirectly, as a result of the process of adjustment towards a lower carbon and more environmentally sustainable economy.

2 | 2022 ECB climate stress test exercise

Templates

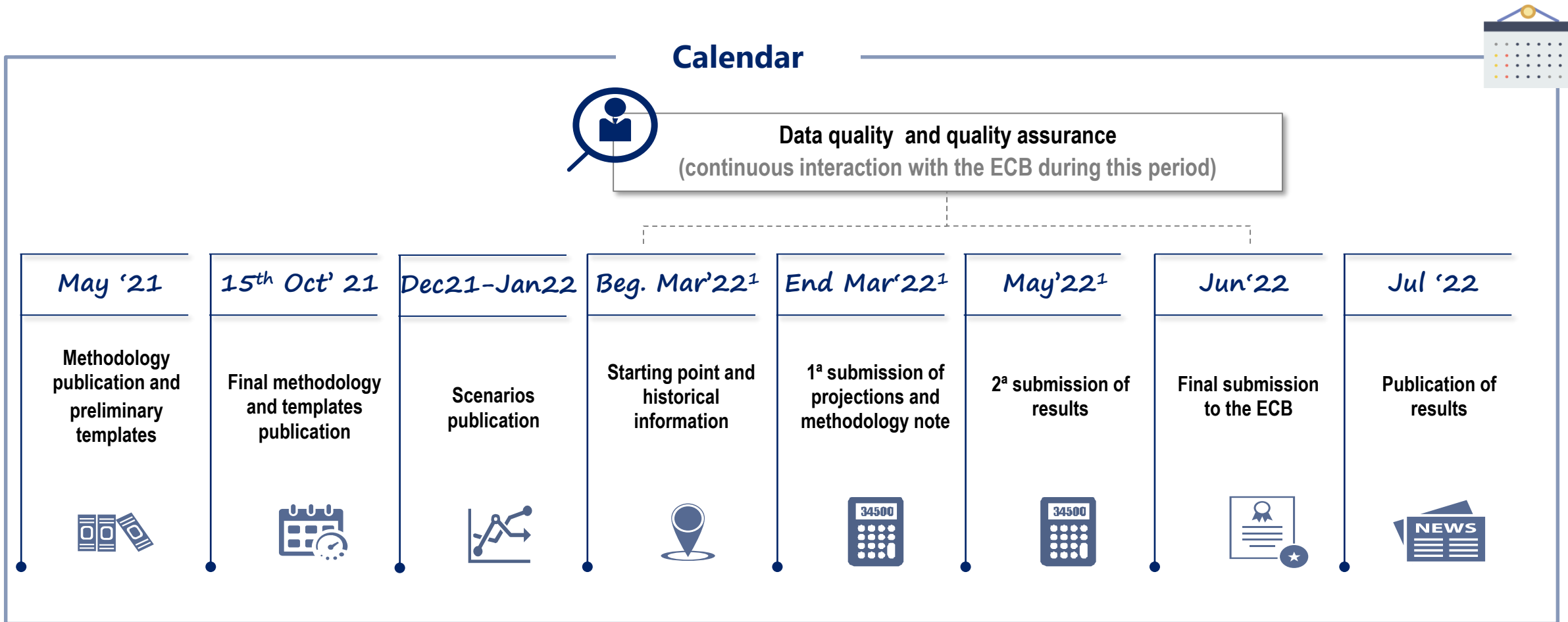
The stress test exercise covers three modules with their corresponding templates to be completed

Module	Template name	Topic	Description
	<i>Input</i>	<i>Input</i>	Countries of bank's main exposures and NACE sectors of bank's main exposures
Module 1	M1 Questionnaire	<i>Qualitative assessment</i>	Questionnaire on climate stress test framework
Module 2	M2_Metric 1	<i>Metric 1</i>	Information for Income, Fee & Commissions, Exposures
	M2_Metric 2	<i>Metric 2</i>	Information for counterparties' emissions - Calculation of GHG metric by scope, amount of scope 1, 2 and 3 emissions and counterparties' revenues for the last 3 years
Module 3	M3_TR_ST_CR	<i>Short-term Transition risk Credit risk</i>	Historical data and projections on credit risk parameters, REA, exposures and provisions for the main 5 countries detailed by NACE sector (corp) and EPC (real estate) and under the baseline and short term disorderly scenario (2021 – 2024)
	M3_TR_ST_MR	<i>Short-term Transition risk Market risk</i>	Historical data and projections on market risk parameters divided into short and long positions
	M3_TR_LT_CR	<i>Long-term Transition risk scenarios credit risk</i>	Historical data and projections on credit risk parameters, REA, exposures and provisions for the primary country of loan activity detailed by NACE sector (corp) and EPC (real estate) under the long term scenarios (2030, 2040 and 2050)
	M3_TR_LT_CR_inputs	<i>Dynamic balance sheet qualitative assessment</i>	Questionnaire on dynamic balance sheet approach
	M3_PR_DH_CR	<i>Physical risk Drought & Heat Credit risk</i>	Historical data and projections on credit risk parameters, REA, exposures and provisions for the main 5 countries detailed by NACE sector and under baseline and drought and heat scenario (1Y projections)
	M3_PR_FL_CR	<i>Physical risk Flood risk Credit risk</i>	Historical data and projections on credit risk parameters, REA, exposures and provisions for the main 5 countries detailed by probability of flood area and under baseline and flood scenario (1Y projections)
	M3_op_rep_assessment	<i>Operational /Reputational Risk qualitative assessment</i>	Questionnaire on operational/reputational risk approach

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2022 ECB climate stress test exercise Calendar

Tight calendar to comply with all the requirements to be completed during the preparation of the exercise phase

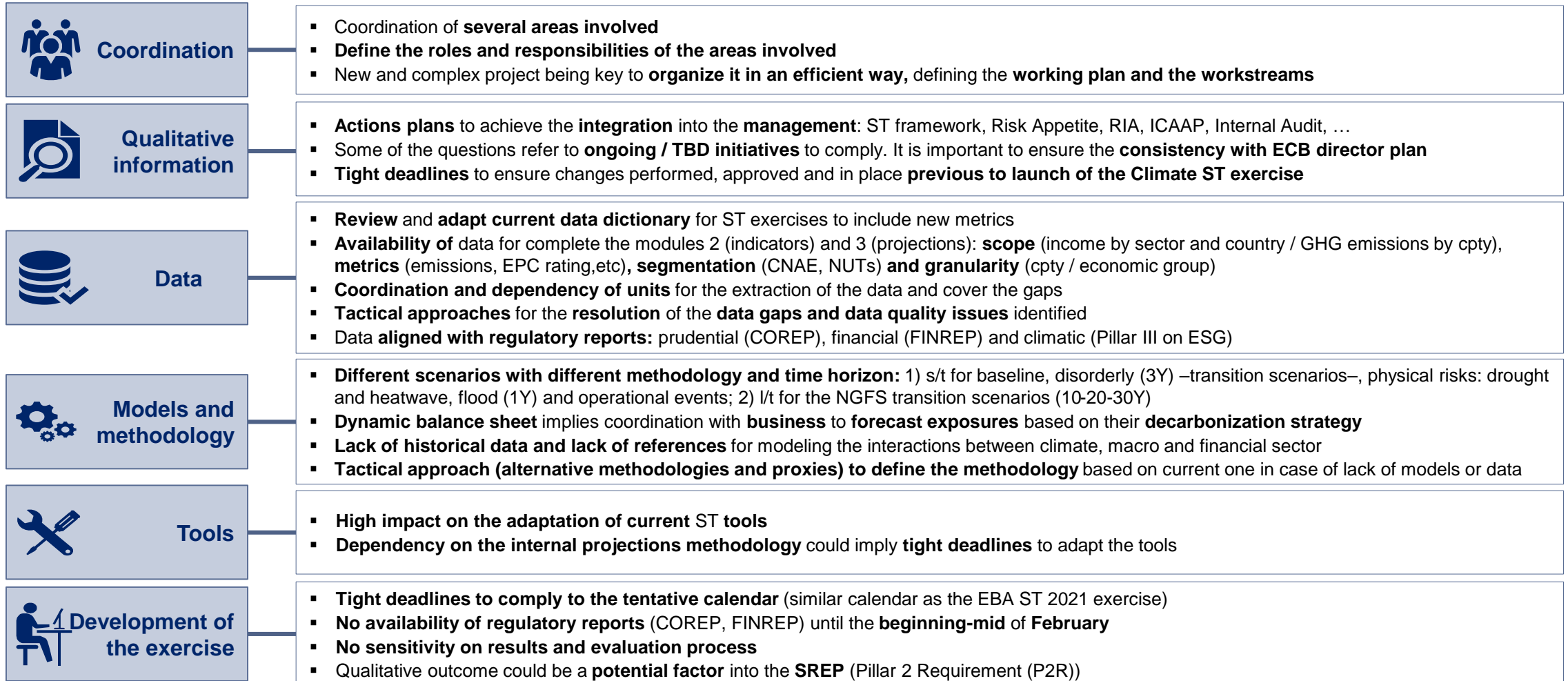


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2022 ECB climate stress test exercise

Main challenges

The 2022 ECB climate stress test exercise implies several challenges for the entities related to the coordination of the exercise, qualitative information requested, data, models and methodologies, tools and the development of the exercise



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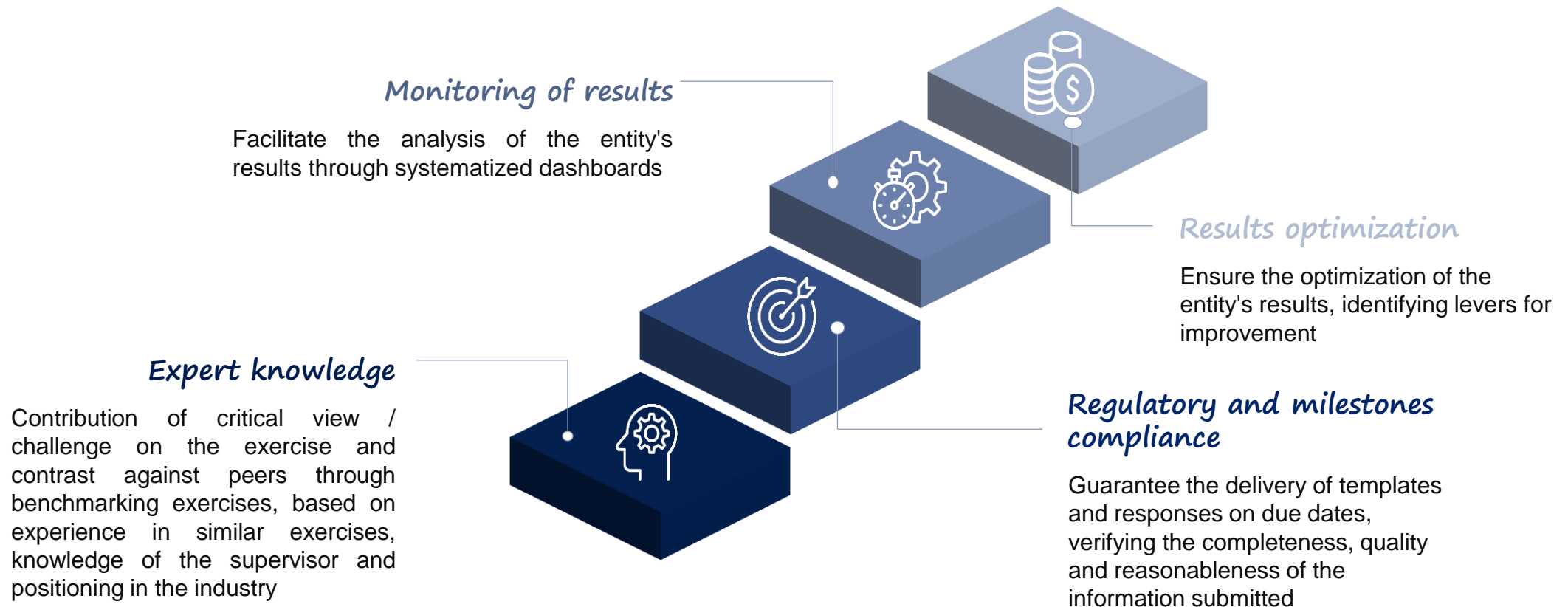


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Why MS?

Expected benefit

MS can support institutions to ensure compliance with the milestones established by the ECB, provide expert knowledge and alignment with best practices, guarantee the robustness of the process and help optimize the entity's results



3

Why MS?

Experience in Climate Risks and Stress Testing

MS has a unique expertise, team and value proposition in the areas of climate risk and stress testing to maximize the value contribution to the company

MS capabilities in the field of climate risks and stress testing

- 1 Extensive experience in the field of **sustainability and climate and environmental risk management** in major peers as well as in non-financial sector companies
- 2 Team specialized in **climate risk measurement methodologies and scenario analysis** (physical and transition risks in banking, energy sector and others) and portfolio alignment, supported by the **R&D area**
- 3 Extensive **participation in the various stress test exercises conducted in the industry** since 2012. **Ongoing collaborations** to support the **2022 ECB climate stress test exercise**
- 4 **Qualified and approved provider of capital models** by the main European supervisors. **6 framework agreements with the ECB** (internal models, stress test, AQR, PMO, OSI/IMI and on-site missions support), +60 missions, being the best rated consultant in the capital area
- 5 **Extensive experience** in the field of capital, ICAAP and stress testing **in more than 60 financial institutions**, both for G-SIBs and local entities worldwide
- 6 Team of more than **300 experts in capital and stress testing** (modeling, regulatory, impacts, information and systems, ...) based on a **multidisciplinary team** with quantitative, functional and technical profiles and strong regulatory knowledge
- 7 “*One Firm*”: **global partnership**, present in **more than 40 countries** through its **31 offices**
- 8 **Independent Firm**, with a clear **service vocation** and a proven track record of **successful projects**

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Annex I

Supervisory declared intentions for stress testing exercises

Many regulators and supervisors are focusing on the development of climate stress testing methodologies, for its incorporation as a supervisory tool

OBJECTIVE OF STRESS TESTS

- Multiple central banks and banking regulators aim to add climate-related risk scenarios to their Stress Test frameworks, with the objective of **understanding the impact of these risks on the financial system as a whole**, or financial institutions and the impact on balance sheets¹:

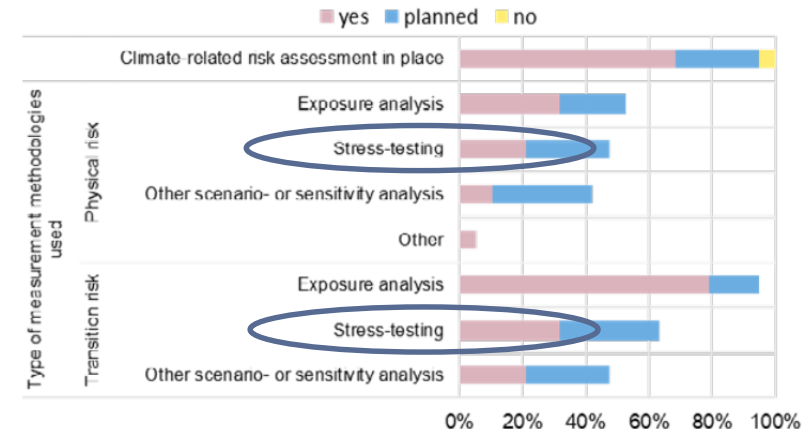
Examples of how central banks and supervisors assess different risks

Objective	Types of risk assessment
A Assess financial firm-specific risks	Stress testing, challenging firm capital adequacy assessments
B Assess financial system-wide risks	Stress testing, research on individual transmission channels
C Assess macroeconomic impacts	Macroeconomic forecasting, research on structural changes
D Assess risks to own balance sheet	Credit and market risk analysis, stress testing

DECLARED INTENTION FROM SUPERVISORS

- Supervisors have expressed their intention of develop climate stress testing methodologies in the near term².
- Banks' transition risk scenario analysis tends to focus on impacts to credit parameters for counterparties belonging to specific sectors.
- Banks' physical risk analysis tends to focus on corporate and household (particularly mortgage).

Types of measurement methodologies planned or in use:



¹ NGFS: Guide to climate scenario analysis for central banks and supervisors. June 2020

² BCBS: Climate-related financial risks – measurement methodologies. April 2021



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Annex II

Risks associated with climate change

Climate-related risks are usually classified into two categories: transition risks and physical risks

The risks related to climate change are recognized by supervisors as a source of risk for the financial system, and are therefore under their mandate to ensure the resilience of the sector. Climate change is recognized by supervisors as one of the most structural sources of change in the financial system because of its globalism, its impact, its irreversibility; its predictability and its dependence on short-term actions¹.

Risks typology	 Transition risks	 Physical risks
Risks subtypes	<p>The transition to a low-carbon economy as a source of extensive policy, legal, technological and market changes.</p> <ul style="list-style-type: none"> • Political and legal risks: Derived from political actions that limit the adverse actions of climate change. E.g. rising prices of greenhouse gas emissions, exposure to litigation. • Technological risks: Derived from technological improvements or innovations that support the transition. E.g. Unsuccessful investments in new technologies. • Market risks: Arising from changes in supply and demand for certain commodities, products/services as climate issues are considered. E.g. changes in customer behavior, increase in cost of raw materials. • Reputational risks: Arising from perceived contribution of an organization to the transition to a low carbon economy. E.g. Change in consumer preferences, stigmatization of a sector. 	<p>Derived from increased damage and losses from physical phenomena associated with climate trends (changing weather patterns, sea level rise) and associated events (natural disasters, extreme weather).</p> <ul style="list-style-type: none"> • Acute risks: Refer to the physical risks derived from the increase in frequency or severity of extreme weather events. E.g. Cyclones, hurricanes, floods. • Chronic risks: Refer to long-term changes in weather patterns. E.g. higher and sustained temperatures that can cause sea level rise; chronic heat waves or desertification of territories.
Impact on banks	<p>Climate change risk impacts financial entities:</p> <ol style="list-style-type: none"> 1. Indirectly: Mainly exposed to the direct impact suffered by their obligors. 2. Directly: Reputational and legal risks. 	<p>Climate change risk impacts financial entities:</p> <ol style="list-style-type: none"> 1. Indirectly: Mainly exposed to the direct impact suffered by their obligors and their collaterals. 2. Directly: Reputational and legal risks, and direct impact on their property (such as buildings and facilities).



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Annex III

2022 ECB climate stress test exercise | Modules 1 and 2

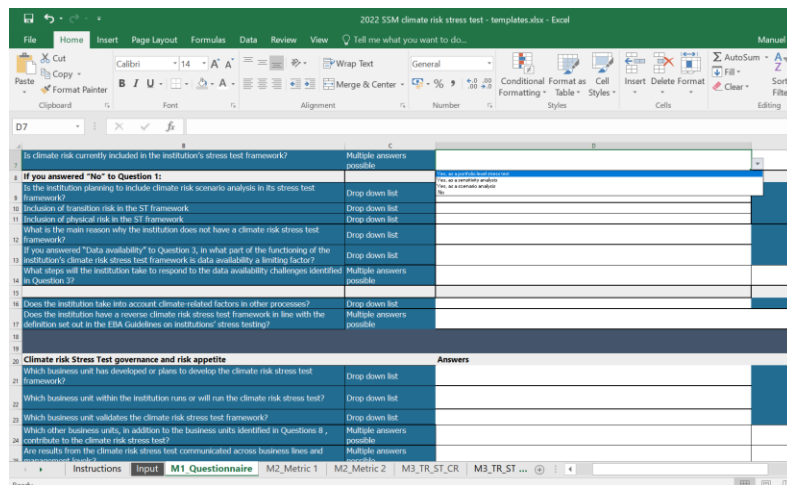


Modules 1 and 2 are requested to all participant institutions, and are based on Excel templates, that need to be filled in with both qualitative and quantitative information

Module 1: Questionnaire on Climate ST Framework

Purpose: gain an illustrative overview of the institution's climate risk stress test framework, management and modelling practices

- A total of **77 questions** classified in 11 blocks
- The questions in the **first ten blocks** of the survey are **mandatory** for all participating banks, while block 11 is mandatory for all banks that provide projections in the bottom-up stress test of Module 3.
- **Drill-down** answers, and some questions allow further clarification
- There is **no need to provide any additional document**, unless required by the ECB in the QA process.



Module 2: Climate risk metrics

Purpose: shed light on the analytical and data capabilities of the banks regarding climate risk

- **Map the corporate counterparties to various sectors**, based on NACE Rev. 2 according to its principle activity
- **Consolidated view** of the corporate counterparty and map it to one single sector
- **Need for an accompanying explanatory note** on climate-related actions the bank has taken in the past (e.g. de-risking high climate risk portfolios or selling green products) and details on metrics calculation

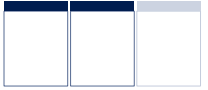
Metric 1

- Interest, fee and commission income from non-financial corporations **domiciled in both EU and non-EU countries**
- Include as many countries as needed to **cover at least 80%** of gross interest income and gross fee and commission income, max 5 countries
- Reference period: 1-jan-21 to 31-dec-21

Metric 2

- Weighted average **GHG intensity metric¹** (scopes 1, 2 and 3) non-SME non-financial obligors.
- Exposure to **top 20 largest counterparties** per NACE with scope 1 / 2 emissions reported or available from counterparty reporting or data provider.
- If scope 3 emission data are not available, banks can use **proxies to estimate the Scope 3 emissions**.
- Reference date: 31-dec-2021.





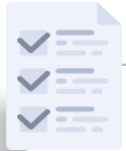
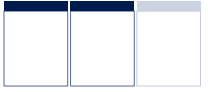
Module 1 Qualitative questionnaire

1. Existence and use of ST exercises
2. Governance and inclusion in risk appetite
3. Integration into strategy
4. Methodology used
5. Scenarios
6. Data and sources of information
7. Inclusion on the ICAAP
8. Future development plan
9. Role of Internal Audit
10. EU subsidiaries of non-EU institutions
11. Methodological assumptions and choices



1. **Existence and use of ST exercises (7 questions):** Inclusion of climate stress test, inclusion of transition and physical risk in the ST framework and availability of a reverse climate risk stress test framework
2. **Governance and inclusion in risk appetite (8 questions):** Business units that have developed and validated a climate risk ST framework and units that run climate risk ST. Intention to disclose results of the climate risk ST under Pillar III
3. **Integration into strategy (3 questions):** Integration of climate risk ST into institution's strategy
4. **Methodology used (6 questions):** Risk types that represent a transmission channel for climate risk, portfolios included in the ST framework, mitigation actions, balance sheet approach (static or dynamic) used for modelling
5. **Scenarios (8 questions):** kind of scenarios (public, internal or third-party scen.), type of scenarios (base, medium, adverse), type of risks (transition, physical, liabilities or reputational), weather events included in physical scenarios, forecast horizon, sources of external risk included for transition risk, type of variable modelled (CO2 emissions, GHG emissions, energy certificate labels...)
6. **Data and sources of information (6 questions):** availability of counterparties' information (emissions data, climate strategies, energy label classification, likelihood of potential physical risk events...), data needed from external providers, use of specific external data providers for ST models development, data sources used to calibrate ST models (internal data, third-parties data...), identification of green exposures based on the EU taxonomy
7. **Inclusion on the ICAAP (2 questions):** inclusion of the climate ST in the ICAAP (in a specific section or within a specific risk – credit, operational, market, strategy..), inclusion in the normative or economic perspective





Module 1 Qualitative questionnaire

1. Existence and use of ST exercises
2. Governance and inclusion in risk appetite
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8. **Future development plan (5 questions):** steps to enhance the ST framework, COVID's implications in ST strategy, COVID's implications in the development of a ST framework, influence of climate regulatory developments in the ST framework (ECB guide, EBA report on ESG risks, EU green taxonomy...), challenges to applying the new climate regulations...
9. **Role of Internal Audit (6 questions):** involvement in review the climate ST framework, involvement in the implementation of climate ST framework, opinion of the climate ST framework, revision of the selected transmission risks of the climate risk ST risks map included in the framework, scenarios revision, methodology revision, data infrastructure revision, plan to enhance the resources of IA with specialized teams
10. **EU subsidiaries of non-EU institutions (2 questions):** availability of bank's ST framework, consideration of parent company of all material aspects of the climate risks
11. **Methodological assumptions and choices (24 questions):**
 - **Vulnerabilities in a disorderly transition:** % of mortgages and corporate secured by real estate that can be allocated to an EPC based on internal info, % of the portfolio that can be classified based on the NACE, biggest challenge projecting the effects of a disorderly transition
 - **Transition risk strategy:** main factor responsible for a balance sheet adjustment in an orderly and disorderly transition scenario
 - **Reputational risk concerns:** main factor in the hot house world scenario, biggest challenge projecting credit risk parameters for 2030, 2040 and 2050...
 - **Heat and drought risk:** incorporation of private insurance and public insurance schemes coverage in projections, biggest challenge projecting the effects of drought and heat
 - **Flood risk:** incorporation of private insurance and public insurance schemes coverage in projections, biggest challenge projecting the effects of flood...





The module 3 consists of the bottom-up stress test exercise, including the reporting of the starting point, and for some Banks the execution of projections for transition risks...

All banks subject to Modules 1 and 2 need to **provide starting point information** for Module 3. Some banks will not have to submit their own bottom-up projections (ECB will calculate them). Bottom-up ST **methodology is anchored** as much as possible to the (simplified) **EBA EU wide stress test templates**

	Risk type	Time horizon	Scenario	Scope	Projection
Transition risk	Credit risk	Short term (3 years)	<ul style="list-style-type: none"> • Baseline • Disorderly: carbon prices increase by about USD 100 during 2022-24 	<ul style="list-style-type: none"> • Mortgage and corporate exposure (in short term: 80% of the exposure, max 5 countries, in long term: primary country) • Consistency with COREP 	<ul style="list-style-type: none"> • Credit impairments • Direct impact on counterparties and through changes in macro variables • Static Balance Sheet • Parameters projection by stages¹
		Long term (2030, 2040 and 2050)	<ul style="list-style-type: none"> • Orderly • Disorderly • Hot House Based on June'21 NGFS scenarios 	<ul style="list-style-type: none"> • Split by NACE or EPC (if within EPC scope) • All positions except FVPL and FVOCI • Starting point: 31-dec-21 	<ul style="list-style-type: none"> • Credit impairments • Dynamic Balance Sheet, split by general growth of the BS and realloc. between sectors/EPC • PIT PD, PIT LGD and ECL
	Market	Short term (instant shock)	<ul style="list-style-type: none"> • Price shock • FX rates remain fixed at 31-dec-2021 values 	<ul style="list-style-type: none"> • Corporate bonds and stocks in the TB (FVPL). Classification by NACE • Hedges directly connected • Starting point: 31-dec-21 	<ul style="list-style-type: none"> • Fair Value revaluation, excluding and including hedges.

¹ TR S1-S2, TR S1-S3, TR S2-S1, TR S2-S3, LGD S1-S3, LGD S2-S3, LRLT S1-S2, LRLT S2-S2, LRLT S3-S3, Cure rate S1-S3 and Cure rate S2-S3)



... as well as the impact of physical risks on credit risk, and the impact of climate-related risks on operational (conduct and own physical risk) and reputational risk

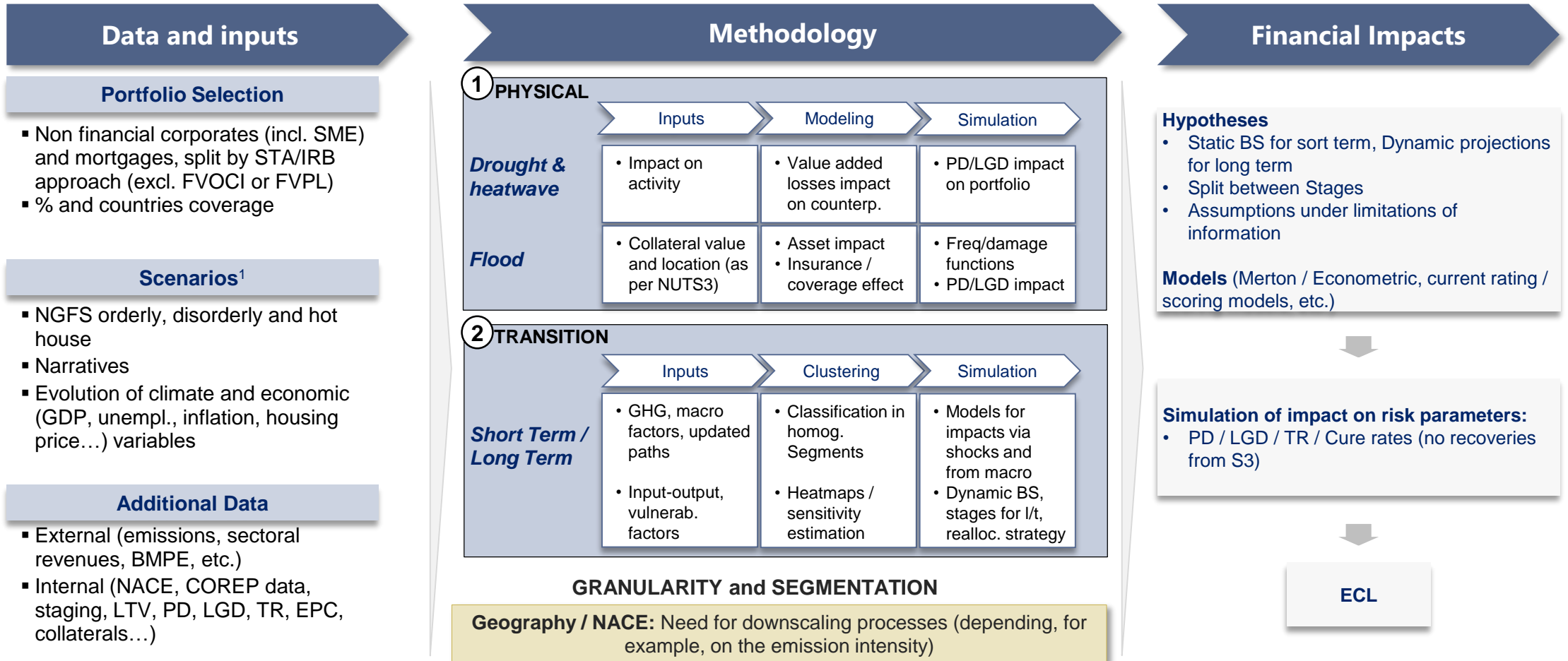
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	Risk type	Time horizon	Scenario	Scope	Projection
Physical risk	Credit risk	Short term (1 year)	<ul style="list-style-type: none"> • Baseline • Drought and heatwave 	<ul style="list-style-type: none"> • EU Corporates not secured by RE (80% EU exposure, max 5 countries) 	<ul style="list-style-type: none"> • Credit Impairments • Static Balance Sheet • Insurance schemes can be included as of 31-dic-21 • Parameters projection by stages¹
			<ul style="list-style-type: none"> • Baseline • Large flood 	<ul style="list-style-type: none"> • EU Corp. sec. by EU RE & mortg.² (80% EU exposure, max 5 countries) 	

¹ TR S1-S2, TR S1-S3, TR S2-S1, TR S2-S3, LGD S1-S3, LGD S2-S3, LRLT S1-S2, LRLT S2-S2, LRLT S3-S3, Cure rate S1-S3 and Cure rate S2-S3)



The climate stress test methodology has to be enriched with external scenarios, and the transmission channels need to be considered to get a consistent financial impact

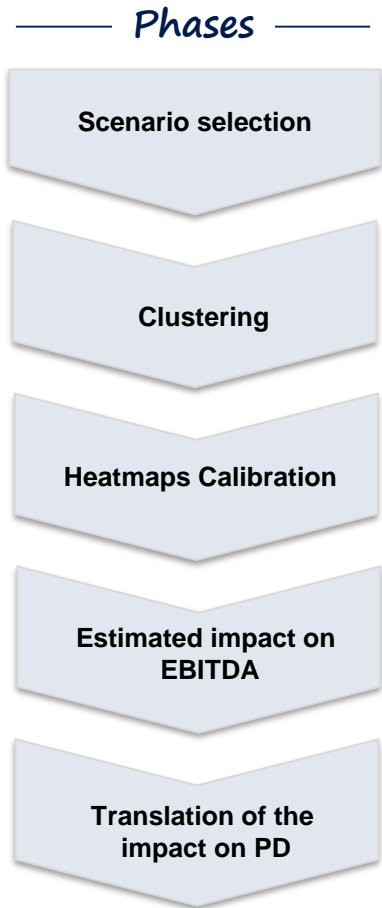


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Annex IV

Methodological approach: transition risk | Illustrative example

The methodology and associated transition risk tool uses external and internal data to translate a climate scenario into a PD impact at the individual level.



- Description**
- Selection of a **climate scenario**, to obtain paths of macro and economic variables, and **estimation of emissions**.
 - Generation of clusters (**homogeneous segments**) that have a similar impact in relation to transition risk (e.g. for energy: extraction, refining, transport...).
 - Estimation of the **level of impact** on different financial metrics (revenues, direct and indirect costs, capex) for each cluster, and calibration on the paths of financial variables.
 - Application of the estimated financial metrics to obtain the **impact of the scenario on EBITDA for each customer**.
 - Based on the impact on EBITDA (and possibly other financial variables), application of models (internal or economic) to estimate the **impact on PD**.

Example ILLUSTRATIVE EXAMPLE

Variable	Unit	2020	2025	2030	2040	2050
Price Primary Energy Oil	US\$2010/GJ	12,27	12,24	13,98	15,55	19,38
Primary Energy Oil	EJ/yr	24,01	22,73	21,51	20,74	19,77
Price Carbon	US\$2010/t CO2	5,54	12,26	12,54	13,07	13,51
Revenues	tn\$ 2010 / year	439.773	422.952	406.130	307.909	265.976

13533800.0 thousand tonnes CO2 for sector 1920 Oil refinery

Clusters	CNAE	Clusters	CNAE
Extracción de gas	610	Generación térmica gas, carbón u oil	3516
Refino.	1920	Generación power convencional nuclear	3517
Trading Oil, Transporte Oil (shipping), Distribución Oil (red de logística de productos refinados) y Comercialización de Oil (red de gasolineras, etc.)	4671	Trading Gas y comercialización de gas	3523
Servicios Oil & Gas, power convencional y power renovables		Trading power convencional y renovable. Comercialización power convencional y renovable	3514
Acuñación, regasificación de gas, transporte de gas y distribución de gas	3521, 3522	Transporte y distribución de power convencional y renovable	3512, 3513

RFP	Year	Oil Refineries	Sensitivity
Revenues	2025	Low	0,88
	2030	Mod. Low	0,88
	2040	High	1,29
	2050	Mod. High	1,00

$$\Delta Revenue(2030) = 1 + \left(\frac{422,952}{406,130} - 1 \right) * 0,88 = 93,28\%$$

$$\varepsilon(i, k, t) = \frac{EBITDA(i, k = 0, t = 0) + \Delta Revenues(i, k, t) + \Delta Opex(i, k, t) + \Delta Capex}{EBITDA(i, k = 0, t = 0)}$$

	2020	Impacto	2030	e(i, k, t)
Revenues	28.544	93%	26.627	
Costes emisiones	67	1173%	787	
Resto costes	6.669	106%	7.059	
Ebitda	21.808		18.781	0,861198

$$DD(i, k, t) = \left(\frac{\ln \left(\frac{\varepsilon(i, k, t) * V(i)}{D(i)} \right) + \left(r + \frac{1}{2} (\sigma_v(i))^2 \right) T}{\sigma_v(i) \sqrt{T}} \right)$$

	2020	2030
PD Crédito	10,4%	
DD Merton	24,94	6,28
DD Cto	1,26	0,32
PD Final		37,5%

$$PD(i, k, t) = \Phi(-DD(i, k, t))$$

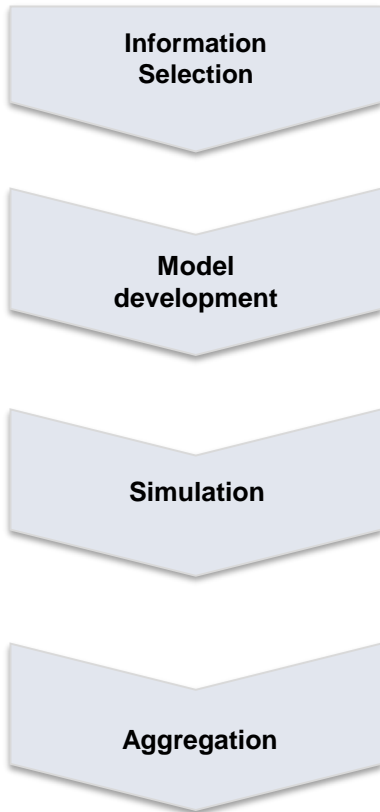
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Annex IV

Methodological approach: physical risk | Illustrative example

The methodology and associated tool for physical risks allow estimating the potential impact of physical risks on the value of the underlying physical assets of the portfolio and, in turn, on the valuation of collateral and the solvency of counterparties

Phases



Description

- Selection of information, from **external sources** depending on the scenario, and from **data on the physical assets** in the portfolio. Selection of events.
- **Clustering of the physical map** based on the above information for the assignment of event probabilities and severities.
- **Generation of impact functions** (estimation of the value of the asset after the event).
- Simulation of the impact on the distribution of physical assets in the portfolio, and implementation.
- Simulation of impact, depending on the counterparty's industry and its dependence on the physical asset on financial ratios.
- Aggregation of the impacts at each point in time, and obtaining the total impact for each asset (impact on LTV and PD).

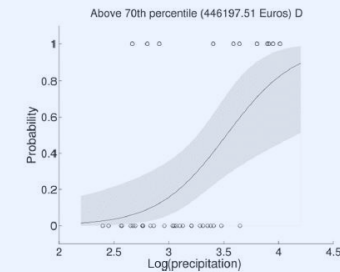
Example

ILLUSTRATIVE EXAMPLE

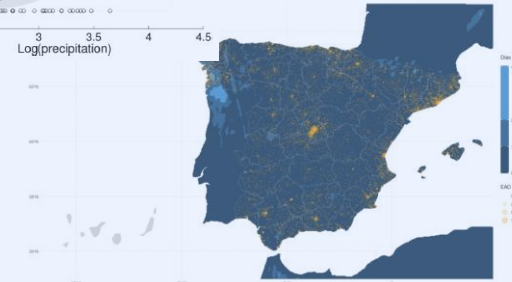
- Climatic (frequencies, events...)
- Impact functions
- Geolocation (latitude, longitude)
- Portfolio variables (EAD, LTV)

- Wildfire
- Rainfall
- Sea level Rise

$$D(P > Threshold) = A[m^2] \cdot p \cdot c_d$$



$$\log\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 \cdot P_i$$



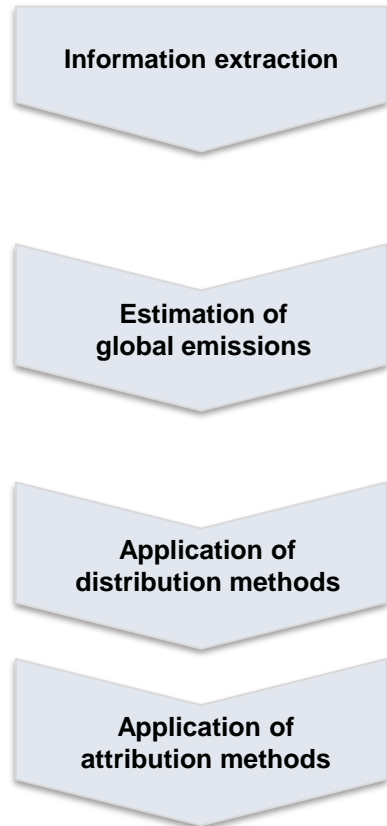
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Annex IV

Methodological approach: portfolio alignment | Illustrative example

Portfolio alignment methodologies are aimed at measuring the investment portfolio's financed emissions, and they support and guide the establishment of targets and pathways in order for the financial entity to align with the Paris Agreement

Phases



Description

- **Sectorial external information** is needed (for example, more or less sophisticated):
 1. Emissions published by counterparties
 2. Sectorial statistics about technological factors
 3. Aggregated values (e.g. revenues)
- The investment portfolio is divided based on relevant **segments** and sub segments (based on industry and additional external information)
- An **emission distribution** process is applied per segment, based on external information about technological factors.
- Individual client's emissions are estimated based on turnover.
- Emissions which should be **attributed to the financial entity** are estimated based on financing given to each counterparty (based on the company's total value – EVIC, or equity and debt value).

Example



CNAE 2	CNAE 4	Sector description	Emissions (M t)
32	-	Otras industrias manufactureras	40.7
33	-	Reparación e instalación de maquinaria y equipo	1113
35	-	Suministro de energía eléctrica	4880.5
36	-	Captura y distribución de agua	64

Subsector	Cifra de Negocio (Miles €)	Emissiones por turnover (ton)	Mix	Mwh	Intensidad Emissiones (tCo2/MWh)	Emissiones atribuidas (tCo2)	EAD (Mn€)
3515	n.d.		0,12	31.320.000	0	0	450,1
3516	10.680.698	5.111.102	0,28	73.080.000	0,47	34.347.600	136,4
3517	n.d.		0,22	57.420.000	0	0	4,0
3518	4.239.734	2.028.867	0,20	52.200.000	0	0	1.592,5
3519	6.035.440	2.888.177	0,18	46.980.000	0,22	10.335.600	2.634,2
Total	93.787.030	44.880.500		261.000.000			4.817,1

$$Emissions_{cnae} = Energy_{total} \frac{\% mix_{cnae}}{100} Intensity_{cnae}$$

$$Emissiones\ Cliente = \frac{facturación\ cliente}{total\ facturación} * Emissiones_{cnae}$$

$$FinancedEmissions_{client} = Emissiones_{client} \frac{EAD_{client}}{EVIC_{client}}$$



Management Solutions

Making things happen



International
One Firm



Multiscope
Team



Best practice
know-how



Proven
Experience



Maximum
Commitment

