BANCO DE ESPAÑA
Eurosistema

25.03.2026

Opening remarks

High Level Conference. Climate risks and sustainable finance: Bridging policy, research and practice

Madrid

Soledad Núñez
Deputy Governor

Good morning, distinguished guests,

It is a pleasure to **welcome you to the Banco de España for this High-Level Conference on "Climate Risk and Sustainable Finance: Bridging Policy, Research and Practice".** A joint conference with the Network for Greening the Financial System (NGFS), the Centre for Economic Transition Expertise (CETEx), and the TPI Global Climate Transition Centre, both at London School of Economics. We sincerely thank these institutions for their valuable collaboration and contribution.

And I would like to thank all participants, in person and online from central banks, supervisors, academics, policy-makers and practitioners, for joining us today. Your commitment and expertise make gatherings like this not only possible, but truly meaningful. **We meet at a time when the global context makes our work more urgent than ever.** Climate change is no longer a distant or theoretical threat—it is a present and accelerating force shaping global economic and financial conditions. We are witnessing a sharp increase in physical risks with remarkable consequences from extreme weather events. At the same time, transition risks are becoming more complex, driven by rapidly evolving regulation, technological shifts, and rising expectations on transparency and accountability.

In today's increasingly complex geopolitical landscape, we are reminded of how deeply interconnected our world has become. These challenges underscore an urgent truth: the climate crisis does not pause political tensions, nor does it respect borders. More than ever, we must remain committed to advancing climate action, strengthening international cooperation, and accelerating the transition to a resilient, sustainable future. This requires embracing a long-term vision, as Mark Carney, former Governor of the Bank of England, reminded us with his idea of the 'tragedy of the horizon,' ensuring that today's decisions reflect the risks and opportunities that will unfold over the coming decades.

Extreme weather events are generating mounting economic and financial costs. These impacts translate into growing financial-sector vulnerabilities: higher credit risk in affected industries, increased insurance liabilities, and fiscal pressures that can weaken sovereign creditworthiness—all of which heighten systemic risk and challenge financial stability frameworks.

At the same time **extreme weather events do not affect all regions or countries in the same way,** and their economic and financial consequences vary widely depending on geographic exposure, structural vulnerabilities, and levels of development.

Moreover, the distinction between local and national impacts is crucial: while a flood or storm may devastate a specific region's productive capacity, employment, or credit conditions, the aggregate national effect may appear smaller—masking deep localized damage and financial-sector stress concentrated in the affected areas. For example, the October 2024 DANA in Valencia Spain, caused economically severe local losses for households and firms in the affected areas, though its overall impact on Spain's broader economy remained limited. From a financial stability perspective, the Banco de España concludes that, despite causing severe local damage and some deterioration in credit quality in the affected areas, had a non-systemic impact thanks to the relatively small share of exposed credit and the mitigating measures implemented by public authorities.

Recognizing this heterogeneity is essential for designing targeted adaptation policies and financial-stability frameworks that account for regional disparities and country-specific vulnerabilities.

In this context, strengthening our climate agenda is essential for boosting competitiveness and building greater resilience across our economies. Competitiveness and resilience are mutually reinforcing: the more resilient we become to environmental, energy, and geopolitical disruptions, the more competitive we are; and the more competitive we are, the better equipped we become to sustain long-term climate roadmap.

And **for central banks and supervisors, this reality poses a fundamental challenge:** we must ensure that the financial system remains resilient in the face of climate-related shocks. And to do so, we must deepen our understanding of how these risks propagate, how they interact with macroeconomic trends, and how they can impact financial stability. In this sense, advancing the knowledge, data, and analytical tools needed to assess climate risk is not optional—it is essential for fulfilling our mandates. And taking into account that today's challenges extend far beyond climate change alone, encompassing the accelerating loss of nature and biodiversity—crises that are deeply interconnected and must be addressed together.

Today's agenda reflects this imperative. Throughout the day, we will hear several presentations addressing both climate change mitigation and adaptation. While mitigation remains essential to reducing future risks, today's discussions will place particular emphasis on adaptation. This is a dimension that has become crucial for strengthening resilience, protecting vulnerable communities, and ensuring the stability of our economic and financial systems in the face of increasingly frequent and severe climate-related events.

In this regard, reliable, comparable, and sufficiently granular climate data is the foundation of any rigorous climate assessment. Without it, neither policy-makers nor supervisors can fully anticipate the risks ahead or design credible, effective responses. Strengthening our analytical capacity is therefore essential to improving the quality and precision of our decisions. For that reason, exploring how better data and methodologies can support more informed and forward-looking policymaking.

At the same time, a key part of this effort involves deepening our understanding of how physical climate risks will shape economic activity in the years to come and evaluating the credibility of transition plans. These dimensions are central to ensuring that financial institutions properly integrate climate-related risks into their strategies and operations.
And central banks themselves have an important role to play in the way we manage our own portfolios. Integrating climate considerations into portfolio management—while remaining fully aligned with our mandates—offers a concrete opportunity to lead by example.

Across all the sessions runs a common leitmotif: collaboration. No single institution, no single country, can address these challenges alone. We must strengthen the bridges between research and policy, between public and private sectors, and across jurisdictions. Only through coordinated efforts—rooted in sound science, rigorous analysis, and a

long-term perspective—can we ensure that the financial system supports a sustainable and orderly transition. As the Network for Greening the Financial System has stressed, the cost of inaction far exceeds the cost of an orderly transition: delaying climate measures not only raises transition costs but also amplifies the economic and financial risks posed by increasingly severe climate-related shocks.

Let me close by expressing my gratitude once again for your presence and engagement. I am confident that today's discussions will not only deepen our understanding but also inspire concrete progress in the months ahead.

Thank you very much.

Climate Risk and Sustainable Finance

Bridging Policy, Research and Practice

Banco De España, March 25th 2026

Professor Anil Markandya

BC3 BASQUE CENTRE FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

Outline

What is Sustainable Finance?

Flows of finance for climate risk and related planetary challenges

Estimates of finance needs to address climate risk and other planetary challenges of biodiversity and pollution

Ways in which more finance can be mobilized to fill financing gaps

Synergies and trade-offs between the planetary challenges

Areas for research and further development

What is Sustainable Finance?

Finance that meets requirements to manage climate risk in an efficient and equitable way

AND

Finance that recognizes the links between climate and other planetary challenges of biodiversity loss and pollution

Finance Discussed

- Finance for actions to mitigate climate impacts and to adapt to climate change
- Finance for action to reduce biodiversity loss
- Finance for actions to reduce pollution and the impacts of pollution
- Links between flows for these objectives

Planetary Crises: Synergies and Trade-offs

- Climate change on air pollution and biodiversity
  - Increase in local air pollutants from fossil fuel combustion
  - Climate change could overtake land-use change as the leading cause of biodiversity loss by 2070
  - Wildfires are increasing cause of loss of forests
  - Climate change is affecting, and will continue to affect all forests especially tropical forests.
  - Mean Species Abundance (MSA) is declining with temperature rise
  - Use of wood for energy is still an important source of deforestation in some hotspots
  - The changing climate is altering marine biomes, including systems such as coral reefs.
- Biodiversity on climate change and pollution
  - Biodiversity loss has huge implications for climate change: enormous amounts of carbon are locked within animal life and vegetation. The Amazon contains carbon equivalent to a decade of global human emissions
  - Biodiversity loss reduces the capacity of the biosphere to absorb wastes
- Pollution on climate change and biodiversity
  - The discharge of pollutants contributes to the depreciation of the biosphere. Acid rains damage forests, lakes, rivers, estuaries and coastal waters suffer from eutrophication when subjected to an overload of nutrients.
  - Emissions of sulphur reduce the impact of GHGs on temperature

FINANCE FOR CLIMATE MITIGATION/ADAPTATION

Global Figures

Climate finance seeks to reduce GHGs that determine climate change and to reduce impacts of such change through adaptation

At least $6.3 trillion in annual climate finance will be needed from 2024 through to 2030 to avoid the worst impacts of climate change.

Current finance for mitigation and adaptation is $1.9 trillion, made up of mitigation (93%) and adaptation (3%). Rest is mixed

Climate Finance Latest Data (CPI)

- Climate finance reached $1.9 trillion in 2023, up 134% since 2018 or a CAGR of 19%.
- This includes investment in mitigation (energy, transport, buildings, infrastructure) and adaptation.
- Almost 93% was for mitigation and 7% for adaptation and mixed programmes. One-third of mitigation was public, two-thirds private.
- Amounts are far short of needs. Between $4.4 and $8 trillion more a year will be needed from 2024 through to 2030 to avoid the worst impacts of climate. Equals 8-18% of all direct investment positions.

Increasing Mitigation Finance: Challenges

- Amounts going to fossil fuel production and distribution are still large ($1.2 trillion) in 2024
- At present low-carbon energy supply accounts for only 4% of global listed equity, compared to 10% for fossil fuel supply.
- Banks continue to finance fossil fuel supply heavily, with an estimated $1 trillion allocated in 2022, compared to USD$0.7 trillion for low-carbon energy.
- Fiscal incentives for switching to low carbon in the form of carbon pricing are low and regulations for net zero face some pushback. At present only 3.2% of emissions are priced at or above recommended level and only 28% of emissions are covered by any pricing.

Climate Finance: Mostly Positive Trends

- Costs for key clean technologies continue to fall rapidly making them competitive. The IEA's Clean Energy Equipment Price Index hit a record low in early 2024, a 60% fall compared to 10 years ago.
- Solar panel and wind turbine prices down 60% and 50% respectively since 2022 (but wind turbine prices in Europe rose).
- And costs of grid materials have doubled in last 5 years as a result of demand for cables and transformers raising infrastructure costs.
- Intermittency with renewables is an issue but costs of battery storage are declining fast (declined 93% since 2010). Also intermittency can be more addressed through better connected grids and variable electricity pricing.

Measures to Make Climate Finance for Mitigation More Effective

- Central banks to adopt climate-related prudential policies related to risk management and supervision (only 41 had done so by 2023).
- Prudential policies make finance institutions take account climate risks of fossil fuel investment and others through sectoral capital requirements, brown penalising factor, and climate related stress tests for loans.
- Government to mandate disclosures that relate to impacts on emissions and resilience of loans and introduce policies incentivising financial flows going to climate-misaligned activities.
- Collect and make public, to the extent possible, detailed data on finance exposed to activities contributing to or undermining climate goals.

Climate Finance for Adaptation

- Amounts are much smaller than for mitigation – 2024 figure was $123 billion compared to $1,780 billion for mitigation.
- Flows for adaptation in developing countries are around $26 billion, compared to estimated needs that are 10-12 times that figure.
- In Western Europe total investment for adaptation in 2023 was €13 billion (CPI). A study estimates needs for the EU at €70 billion/Yr. to 2050.
- Private sector finance accounts for ~5% of all adaption in high-income countries (67% of total mitigation is private) but in developing countries adaptation finance is predominantly international and public. In 2022 it was 100% for least developing countries and 97% for EMDEs.
- International public finance has declined since 2022 and further declines are expected.

Increasing Adaptation Finance

- More private sector investment is possible for agriculture, water use and infrastructure but projects often need public engagement. Estimates that 15-20% of adaptation can be met in this way.
- In developing countries public sector's role of de-risking investment and providing leverage is very important.
- Finance (where the funds come from) **versus** Funding (who pays for the investments) are linked. More finance can be raised by mobilising funding sources (e.g. charges for land value enhancement).
- Green bond issuances -- a growing source Public (75%) and Private (25%).
- A shift to dual purpose finance (mitigation and adaptation) is a fast growing channel for adaptation finance. AFOLU, water and waste are key sectors where complementarity exists.

FINANCE FOR BIODIVERSITY LOSS

The Global Diversity Framework aims to halt and reverse biodiversity loss by 2030. Restore 30% of degraded areas

Finance Target: Increase finance for biodiversity actions and strategies to $200 bn a year by 2030

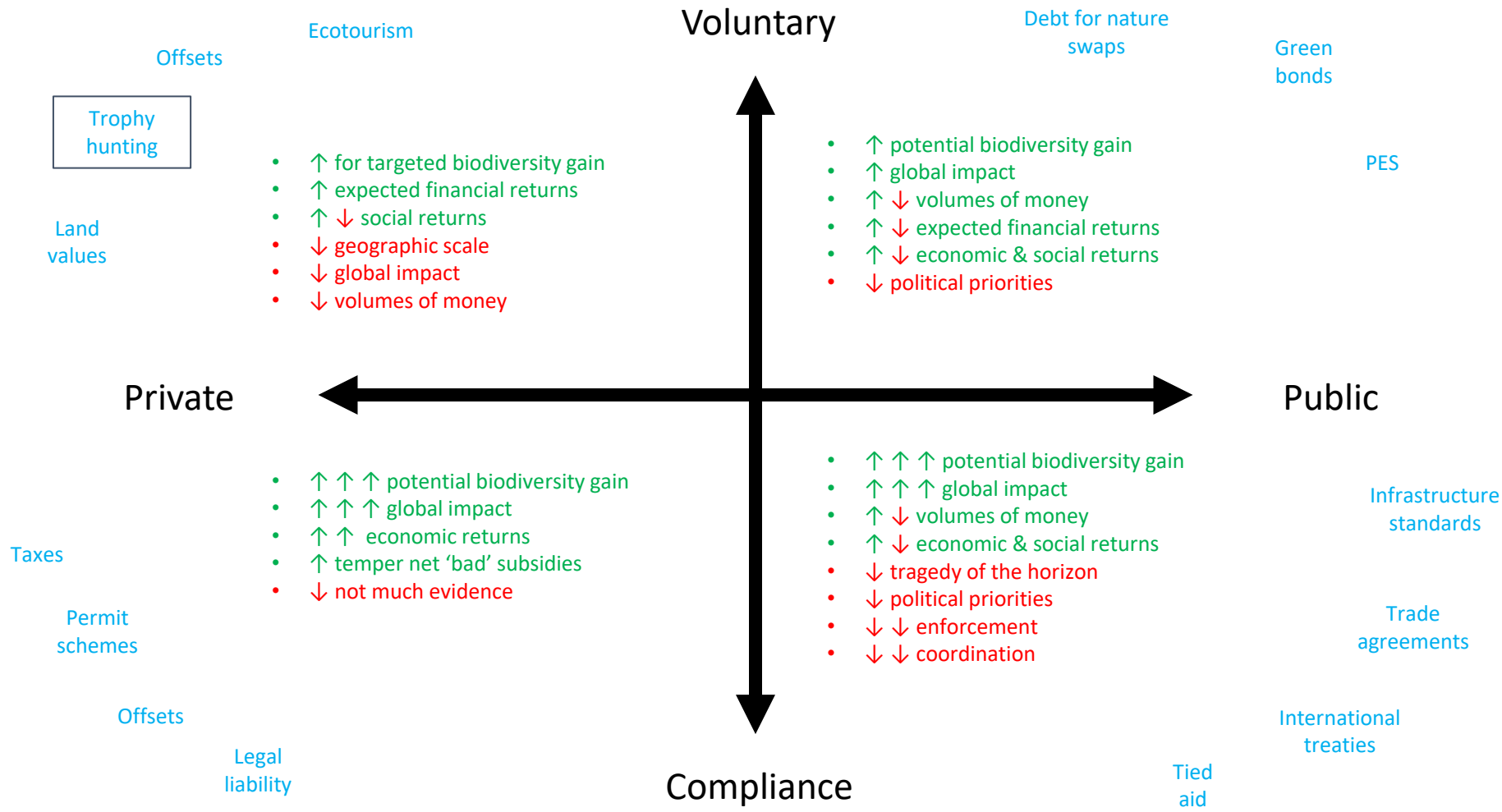
OECD Estimates current finance from all sources is $77-87 bn a year

Biodiversity is hard to finance because…

It is a public good

- Underprovided by the market
- Free-rider problem
- Global subsidy from the biodiversity rich to the financially rich
- Coordination problem

Monetizing biodiversity: What does the evidence tell us?


Voluntary
Compliance
Private
Public
Offsets
Ecotourism
Trophy hunting
Land values
↑ for targeted biodiversity gain
↑ expected financial returns
↑ ↓ social returns
↓ geographic scale
↓ global impact
↓ volumes of money
Debt for nature swaps
Green bonds
PES
↑ potential biodiversity gain
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Taxes
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↑ ↑ ↑ potential biodiversity gain
↑ ↑ ↑ global impact
↑ ↑ economic returns
↑ temper net 'bad' subsidies
↓ not much evidence
Infrastructure standards
Trade agreements
International treaties
Tied aid
↑ ↑ ↑ potential biodiversity gain
↑ ↑ ↑ global impact
↑ ↓ volumes of money
↑ ↓ economic & social returns
↓ tragedy of the horizon
↓ political priorities
↓ ↓ enforcement
↓ ↓ coordination

Private Sector Biodiversity Finance

- Biodiversity offsets and habitat banks.
  - Allow developers to offset any impacts by “buying” an equivalent habitat
  - Mostly developed in US and Western Europe but some examples of offsets in emerging markets (Colombia)
  - Issues arise over equivalency
- Biodiversity credits
  - Voluntary purchase of a credit that ensures biodiversity protection of a parcel of land or guarantees an increase in biodiversity through restoration.
  - Issues arise over metrics
- Biodiversity offset schemes are currently mobilizing jointly about US$6-9 billion annually. Biodiversity credits have very little trading and associated investment in biodiversity outcomes. One estimate suggests as little as US$8 million

Linking Biodiversity to Carbon Credits

- Biodiversity-positive carbon credits include additional actions linked to the enhancement, conservation, and or restoration of biodiversity in projects that generate carbon.
- With biodiversity co-benefits, the carbon credits can be sold at a premium (About $3-$4.00/tCO2e). Only a part of the voluntary carbon market (About $2 bn) involves biodiversity.
- Despite recent growth the supply of such credits is small. To increase the market will require further use of NCA to standardize biodiversity measures and adopt a common methodology for measuring biodiversity outcomes.
- In addition, REDD+ bundles bundle carbon reductions, human wellbeing and nature enhancement. REDD+ credits have mainly been linked to the VCM and represent the largest volume of nature-based credits, making up 24.5% of credits issued. But problems in acceptance remain. Credits issued have declined sharply from 2021 (150+ million issued) to 2024 (15 million issued) as criteria have been tightened.

Role of Public Sector In Biodiversity Finance

- Public sources are critical for biodiversity finance. Much is located in poor countries and is a global public good.
- Public finance can provide proof of concept and leverage private flows. Examples include:
  - Green, Social, Sustainability and Sustainability-linked (GSSS) bonds, a new asset class where use is tied to key performance indicators (KPIs) such as restoring wetlands, protecting forests, and reducing threats to wildlife and plant species, while still allowing for general use of proceeds. Amount raised was ~$980 bn in 2023 but only about $10 bn financed biodiversity.
  - Debt conversions or debt for nature swaps. Reduce debt obligations in exchange for committing freed-up financing toward domestic nature projects. Recent examples include Seychelles, Belize, Cabo Verde.

Other Sources of Biodiversity Finance

- Wildlife Conservation Bonds (Rhino Bond). Bond has World Bank rating. At the end of the life of the bond, investors get back the principal along with a variable pay out depending on the population growth rate of black rhino. $150mn.
- Blended finance where global public funds invest equity on a first loss basis to crowd in private investment. Example of the Global Fund for Coral Reefs use of $125 million on this basis to protect coral reefs. Investment is in sustainable ocean production, ecotourism, and sustainable infrastructure and waste management. Almost same amount raised from private sources.

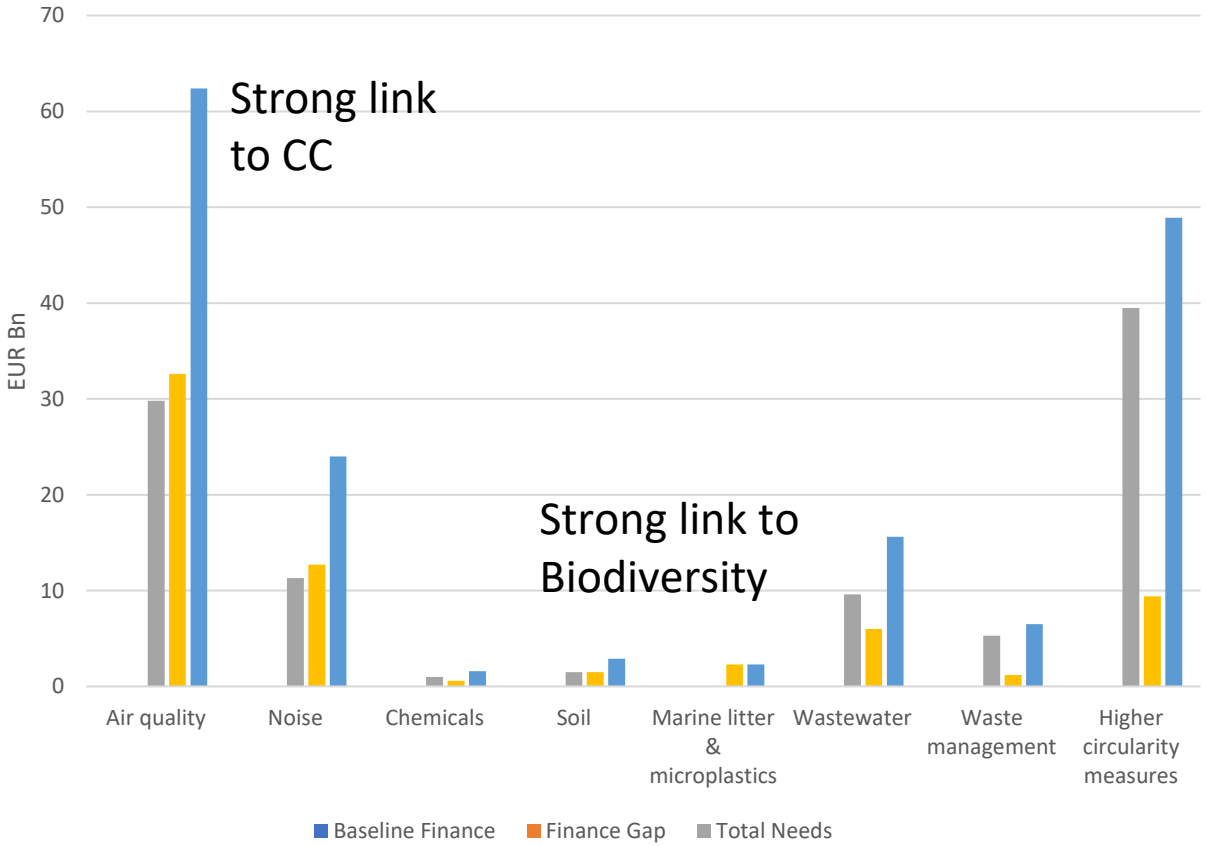
Pollution Prevention: Management and Finance

- Unlike climate and biodiversity there is no integrated planning and reporting framework for pollution.
- Instead, national pollution control and management policy is shaped by a set of disparate policies and plans developed in response to different priorities and multilateral environmental agreements targeting various environmental sinks (e.g. air) and pollutants (e.g. hazardous chemicals) across different lifecycle stages.
- OECD recommends developing national plans to tackle pollution comparable to those already available for climate change and biodiversity loss may be conducive to the identification of policy gaps, as well as opportunities for synergies and risks of trade-offs.
- There is also no comparison of financing of pollution reduction relative to needs covering all regions but there are some figures for the EU.

Pollution Prevention: Financial Needs in the EU

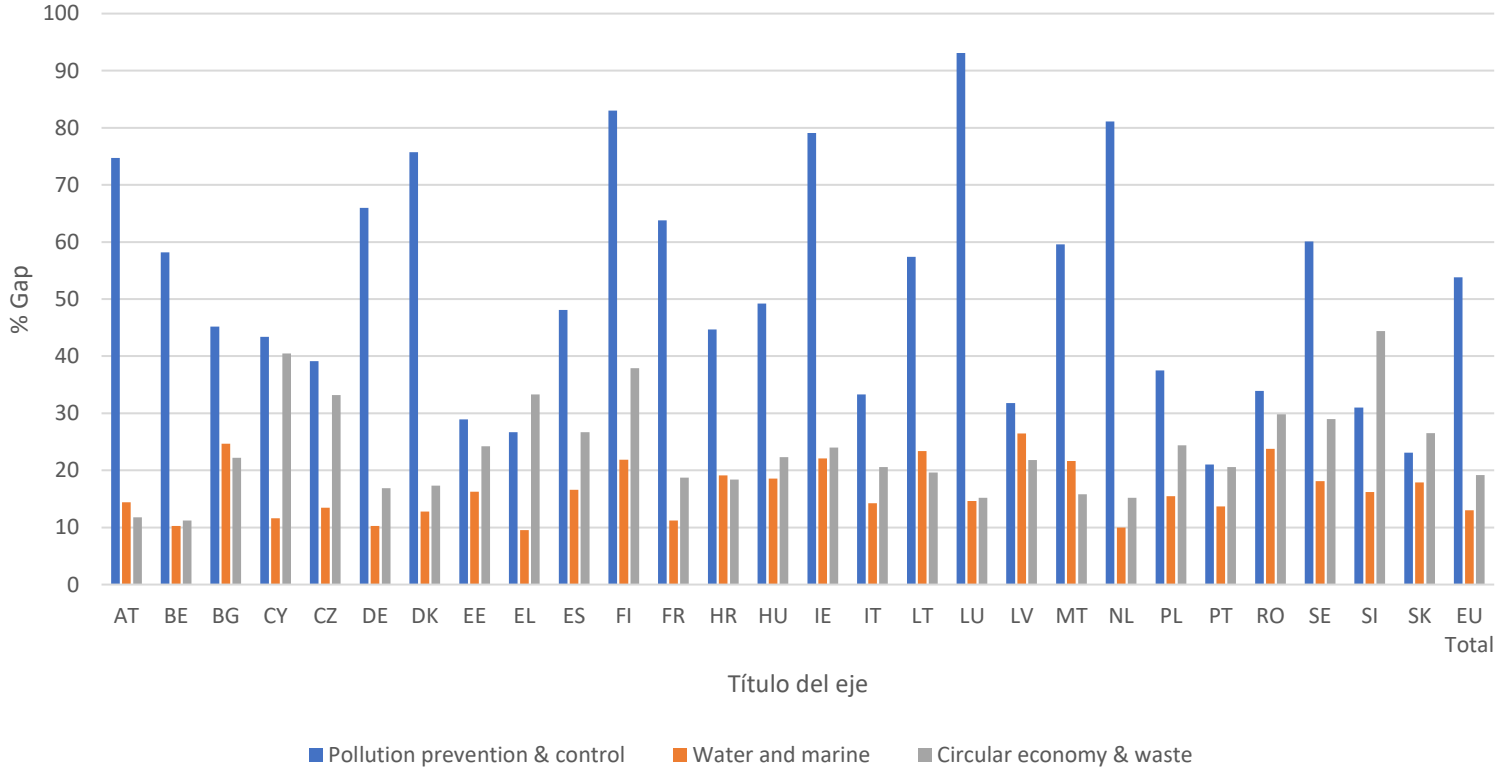
- The EU aims to meet its 2050 zero pollution goals, bringing down pollution to levels that are no longer harmful to the environment and human health.
- To achieve this goal by 2050, the EU needs to meet important milestones along the road. By 2030, this will require around EUR 76 billion in annual investments.
- The significant current investment gap of approximately EUR 40 billion is expected to be filled largely by private investments, and additional measures through national energy and climate plans (NECPs) (75-80%).

Pollution Prevention: Financing Gaps in the EU



By 2030 EU needs €63 bn more than baseline spending of €98 bn to be on track for zero pollution

Pollution Prevention: Financing Gaps in the EU



Finance for Zero Pollution Target in the EU

- Just 46% of the investment needs for pollution prevention and control across key thematic areas are currently met.
- Private funds are expected to account for a significant share of investments going forward, along with increased efforts by EU Member States — partly through in-country resources and partly through EU funding, such as through National Energy and Climate Plans.
- Easily understandable disclosures, well-introduced green bond standards and the incorporation of environmental, social and governance (ESG) elements into the ratings of corporations.
- Reduction of fossil fuel subsidies will help meet the zero pollution goal.

Summary of Financing Gaps for the EU

	Euros Billion in 2024				
	Needs	Current	Gap	Public Gap	Private Gap
Mitigation	718	325	393	118	275
Adaptation	83	13	70	67	4
Pollution Prevention	76	36	40	9	31
Biodiversity	39	23	16	14	2
Total	916	397	519	207	312
As % of:					
EU GDP	4.7%	2.0%	2.7%	1.1%	1.6%
EU Investment	20.9%	9.1%	11.8%	30.3%	8.4%
EU Public Expenditure				2.2%	

Key Messages

- The financing needs for meeting climate change, biodiversity and pollution prevention are significant across all countries.
- Climate change mitigation has the largest requirements and needs to go up at least 3-fold. Good news is that private investment in low carbon is increasing fast. Incentives to reflect risks for fossil fuel investment and support renewables can speed up the process.
- Adaptation to climate change has lower finance requirements but depends significantly on the public sector and gap is greater than for mitigation especially in developing countries. Increasing private sector role is possible to a limited extent but needs concerted action through blended finance and use of dual purpose programmes.

Key Messages

- Needs for biodiversity conservation are more than double actual flows. The expenditures are needed most in biodiversity countries which are mostly in the global south. Most finance needs to come from public sources. There is potential for private sector through various instruments but they need to be scaled up a lot and need support from the public sector.
- Pollution prevention finance is not tracked globally in an integrated manner across all sources and media (air, water, land). This gap needs to be addressed. For the EU current expenditure needs to double to meet zero pollution targets.
- Finance gaps for all 3 areas in the EU are significant and will place a burden on public sector especially. Scope for a shift of finance to the private sector is possible. Instruments for this are discussed.
- There is a gap in identifying the synergies and trade-offs when designing programs in these areas. This also is an area where action is needed.

NGFS scenarios: unveiling future climate risks

Banco de Espana Climate Conference
Session 1 on Climate Policy Data Challenges
25 March 2026

Agnieszka Trzcinska
Team Lead – Financial Stability, NGFS Workstream on Scenario Design and Analysis Chair's team;
Directorate General, Macroprudential Policy & Financial Stability, European Central Bank

** Disclaimer: This presentation should not be reported as representing the views of the European Central Bank (ECB). The views expressed are of the author.*

NGFS
Central Banks and Supervisors Network for Greening the Financial System

EUROPEAN CENTRAL BANK
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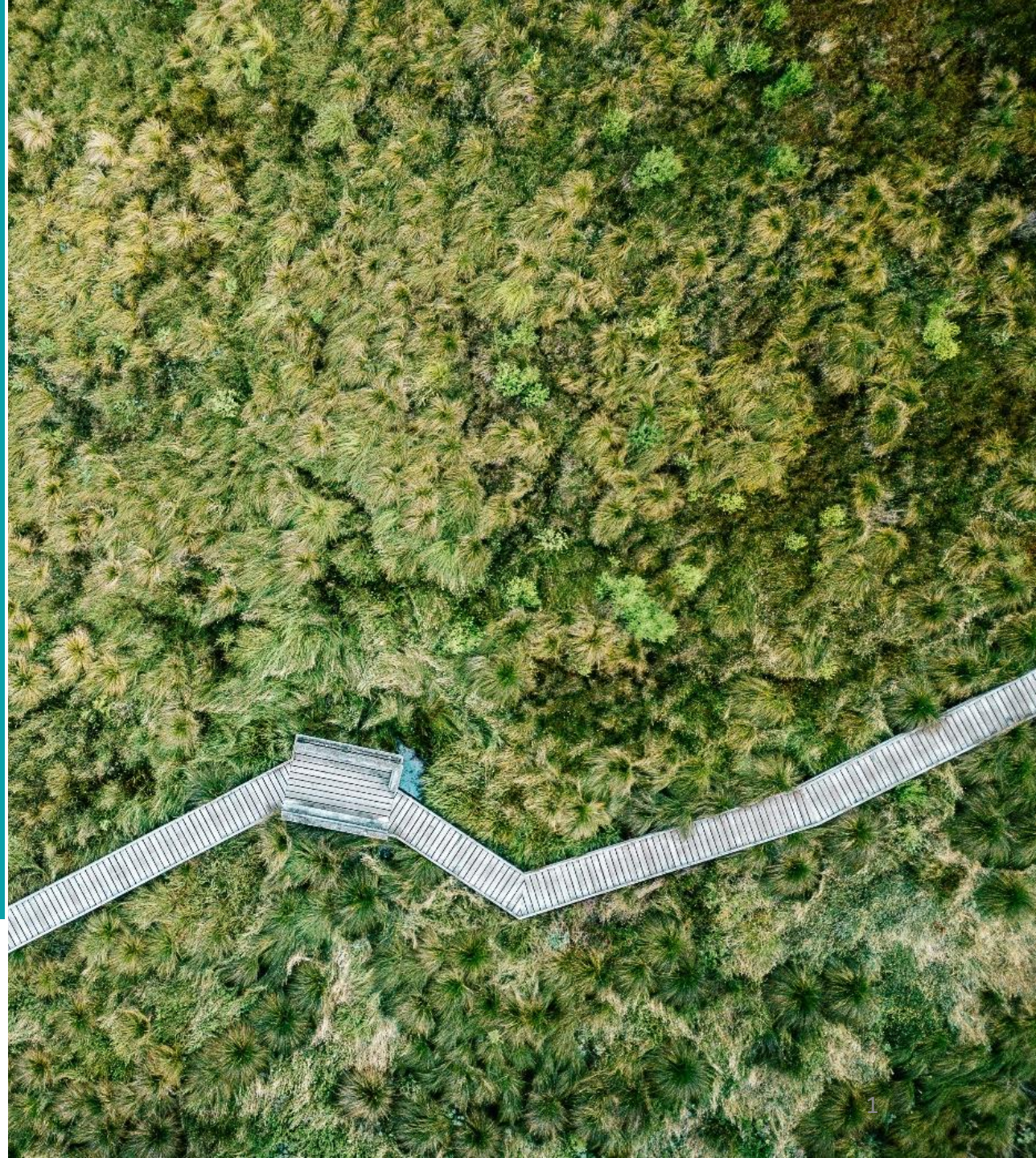


NGFS User Survey

Your feedback on your experience with NGFS scenarios is greatly appreciated!

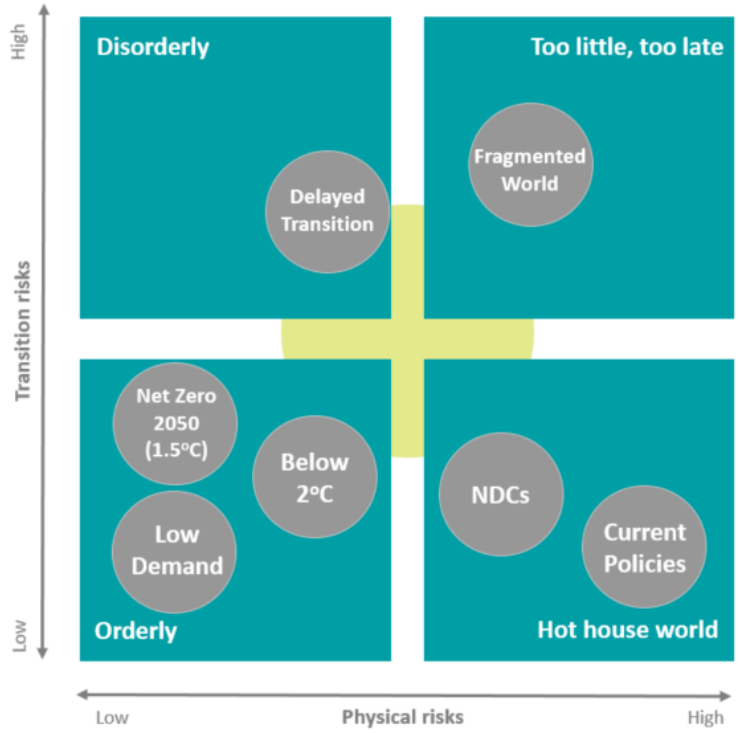
- In January 2026, the NGFS launched a user survey to collect **user feedback** and to better **understand application needs**.
- It is **publicly accessible**, and responses will be collected on an **ongoing basis.**
- The key findings will guide the development of the **NGFS scenario modelling framework** to ensure that NGFS scenarios remain relevant and comprehensive for a continuously growing user base.

QR-code to access the survey:

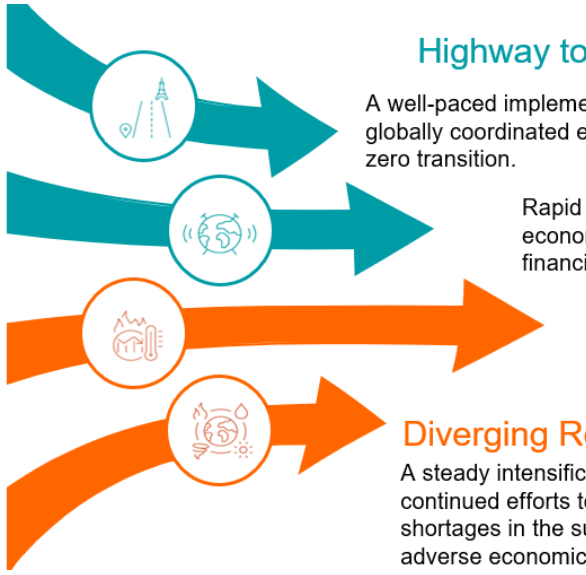
Link: https://forms.office.com/e/8Xr8LkayQq?origin=lprLink

NGFS scenarios at a glance

NGFS long-term scenarios (Phase V)



NGFS short-term scenarios (Phase I)



Highway to Paris

A well-paced implementation of effective climate policies, in a globally coordinated effort, limits the negative effects of a net-zero transition.

Sudden Wake-up Call

Rapid and unexpected policy shifts increase the economic costs of transitioning and cause additional financial stress.

Disasters and Policy Stagnation

A sequence of plausible but extreme weather events in one region causes substantial GDP losses, with effects on the global economy.

Diverging Realities

A steady intensification of climate hazards in some regions, the continued efforts to transition in other parts of the world and shortages in the supply of critical minerals cause lasting adverse economic effects.

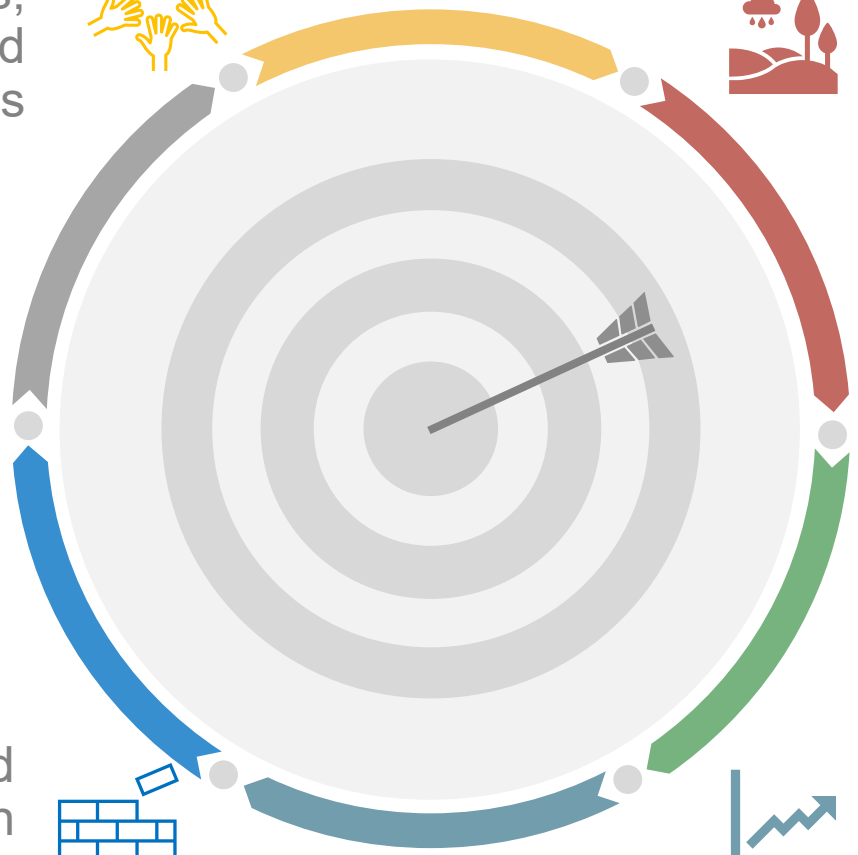
- Climate scenarios **are not forecasts** as they are intended to explore the bookends of plausible futures (neither the most probable nor the most desirable).
- The NGFS short- and long-term scenarios should be **compared with caution**. They differ in several aspects, such as in the **modelling framework, transmission channels, narratives, baseline scenarios, type and modelling of physical risks**.

NGFS **short-term scenarios** are a novel tool to assess the immediate impacts of climate risk

Integrate climate policy, extreme weather events, economic trends and sectoral dynamics

Impact of compound physical climate risks

Policy relevant timeframe



Novel risk transmission channels, including bottlenecks in the supply of critical minerals

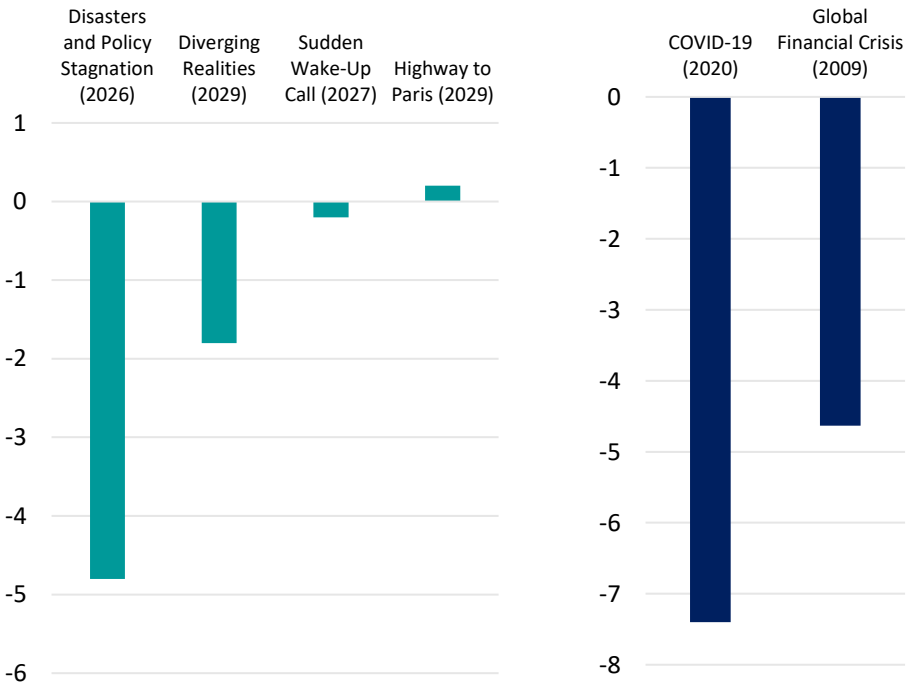
Detailed financial and sectoral modelling with broad geographic coverage

Plausible baseline scenario

Climate risks are no longer a “tragedy of the horizon”

Climate Disasters Could Rival Impact of Global Financial Crisis

(left chart: EU GDP, difference to baseline, %)
(right chart: EU GDP, difference to IMF WEO forecast, %)

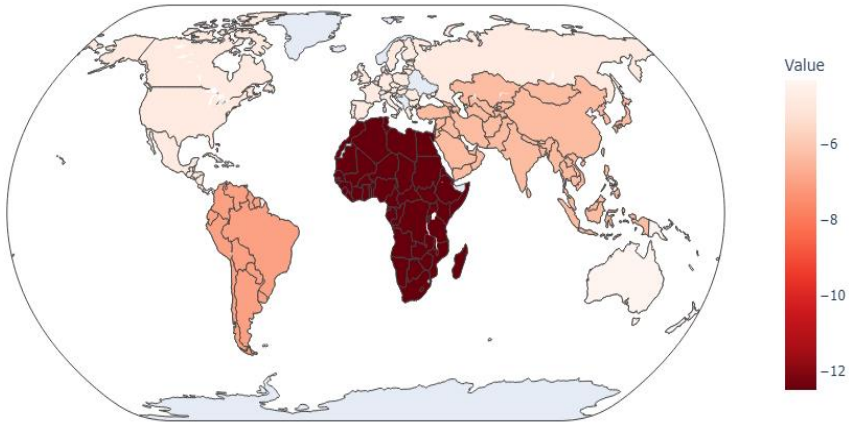


Notes: IMF WEO Forecast October 2019 was used for 2020 and IMF WEO Forecast October 2008 for 2009. Historical GDP values are sourced from IMF WEO database.

*A sequence of extreme climate events in Europe could **reduce its GDP by almost 5%.***

Compounding Weather Events Threaten All Economies

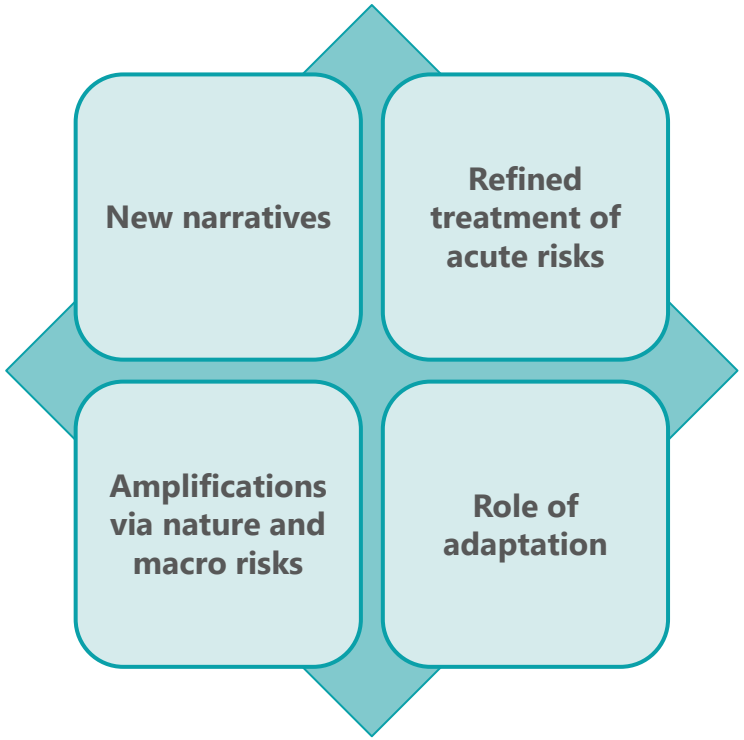
(GDP growth, Disasters and Policy Stagnation scenario, difference to baseline, %)



*The impact of compounding extreme weather events ranges between **5 and 12.5% of GDP** depending on the region.*

Future avenues for NGFS climate scenarios

Phase II of NGFS short-term scenarios



Current data and modelling challenges

Granularity and coverage of assessment

- Sector- and subnational-level projections
- Limited data availability for EMDE countries

Risk amplifications

- Tipping points and compounding effects

Modelling gaps

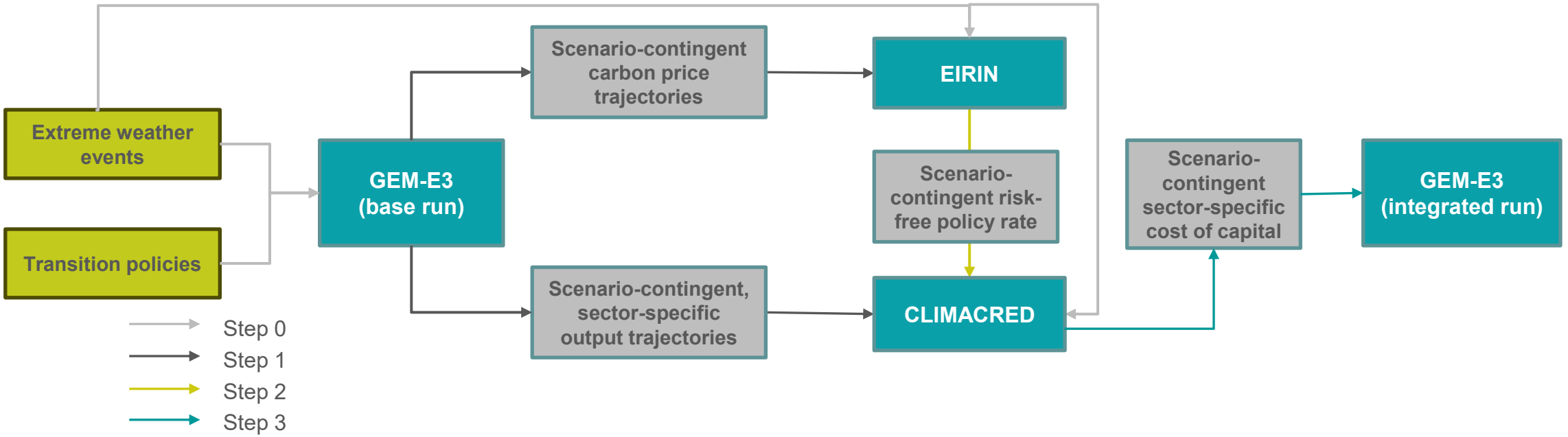
- Households and real estate sector less represented due to data and modelling gaps

Thank you!

Background

A coupled modelling infrastructure

The NGFS short-term scenarios are produced by a suite of integrated models.



- ✓ **GEM-E3** is a Computable General Equilibrium Model for Economy-Energy-Environment used to determine the dynamics of real macro variables and climate related variables at a high-level of granularity.
- ✓ **EIRIN** is a Stock-Flow Consistent behavioural model used to project inflation and monetary policy
- ✓ **CLIMACRED** is a climate credit risk model that allows for scenario-contingent valuation of bonds and equity and of the associated costs of capital

Comparison with NGFS long-term scenarios

- **NGFS short- and long-term scenarios should be compared with caution as they explore different narratives and employ different modelling frameworks.**

There are major differences between the two scenario sets, these include:

- **Narrative assumptions**
  - The two scenario sets contain unique narratives, associated policy storylines and applied shocks.
  - Transition narratives may partly align, but the timing of policy differs.

- **Modelling frameworks and transmission channels**
  - The short- and long-term scenarios are based on different suites of models, each with unique transmission channels.
  - The baseline for the short-term scenarios are calibrated based on the IMF's October 2023 World Economic Outlook, whilst the Phase V long-term scenarios are calibrated on the the SSP2 population and growth rate trend, IMF World Economic Outlook and NIESR baseline projections.

Physical risk and geographical locations

- In the short-term scenarios, physical risk is driven by specific acute compound events occurring in selected years and affecting each continent individually, while also accounting for trade and financial linkages.
- In contrast, the long-term scenarios model annual acute and chronic physical risks at the country level projecting them forward with a probabilistic approach to link them to changes in weather drivers over the longer time horizon.

Variables definitions

- While many variables are available in both scenario sets, definitions of these variables might differ.

The **carbon price** in both long- and short-term NGFS scenario frameworks represents **the marginal cost of abating the emissions until reaching the emission target**, after accounting for the explicitly modelled transition efforts (e.g. green investments, R&D). The two model frameworks however capture differently some of those important economic dynamics (e.g. R&D), leading to different levels in shadow carbon price. Additional differences come from varying timing and mixes of climate policies, modelling of technological progress and Baseline assumptions.

TPI Global Climate Transition Centre
Research and Data at **LSE**

Global School of Sustainability

Assessing the transition to a low-carbon economy

Climate risk and sustainability finance: Bridging policy, research and practice

Carmen Nuzzo, Professor in Practice, Executive Director, TPI Global Climate Transition Centre

Madrid, 25 March 2026

Agenda

1. TPI Centre's methods and entity assessments
2. Investor use cases of our climate data
3. Next steps to address evolving market needs

TPI Global Climate Transition Centre
Research and Data at LSE

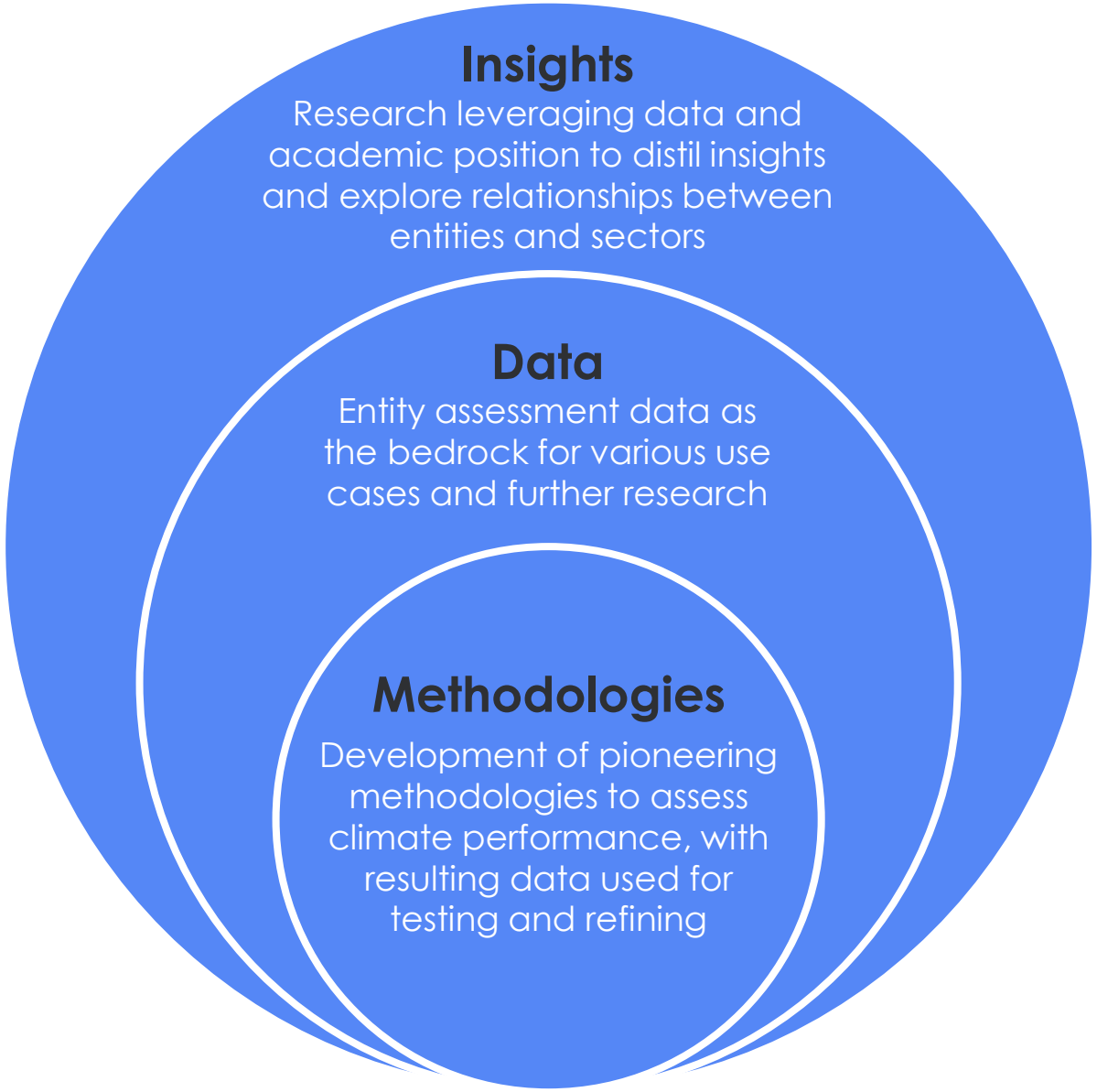
TPI Global Climate Transition Centre at LSE (TPI Centre)

An independent, rigorous source of research and data into the progress made by corporate and sovereign entities in the transition to a low-carbon economy.

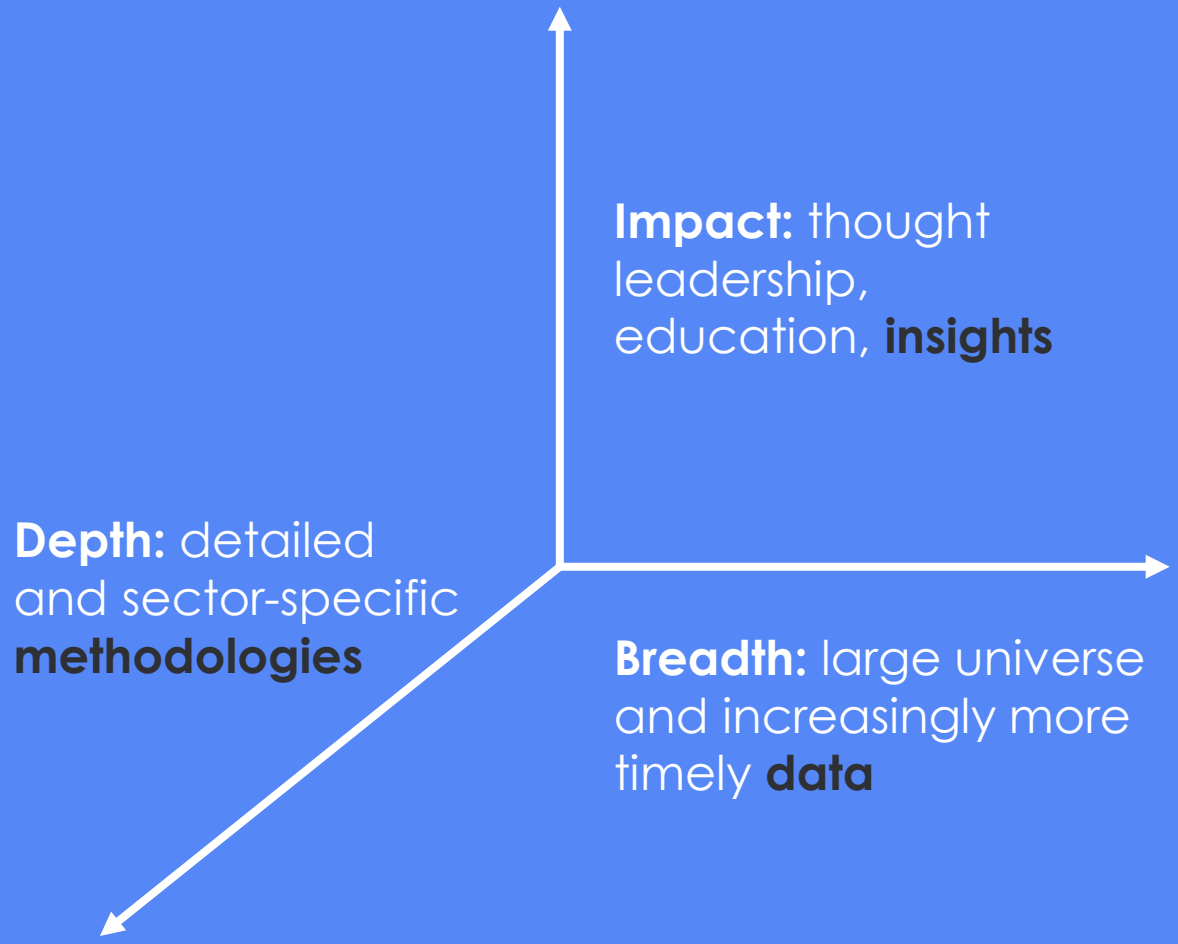
Research partner of Transition Pathway Initiative (TPI) - a global asset owner-led initiative supported by asset managers and service providers.

TPI Global Climate Transition Centre
Research and Data at LSE

The TPI Centre's integrated approach

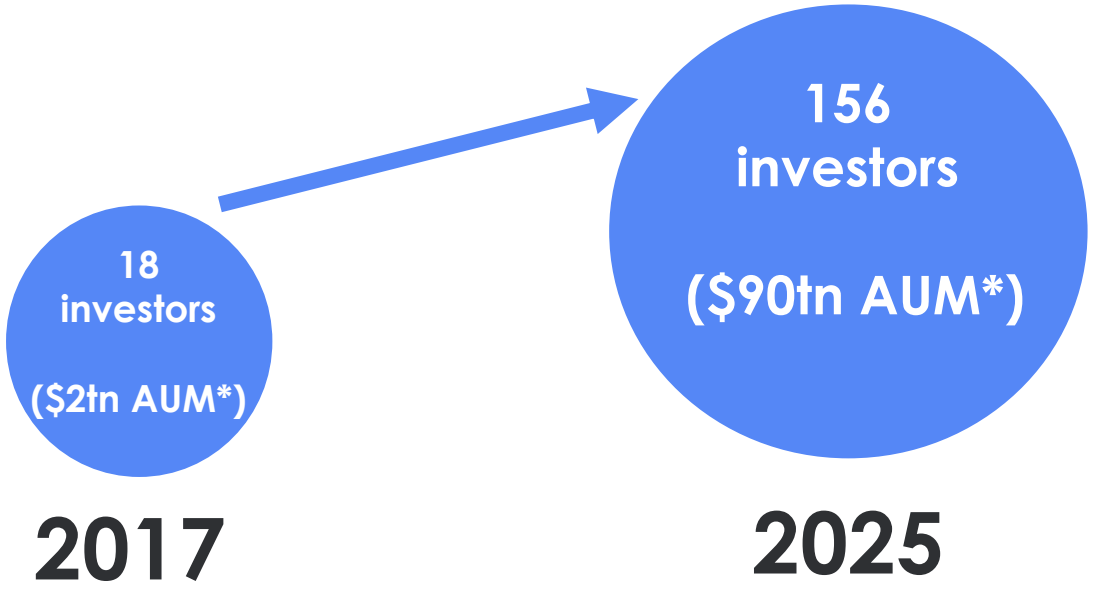


Complementary objectives



TPI Global Climate Transition Centre
Research and Data at LSE

TPI: a global investor initiative



*Assets Under Management (and Advice) are subject to market-price and foreign-exchange fluctuations. As the sum of self-reported data by TPI supporters, they may double-count assets. Data as of December 2025.

Toolbox users are increasing beyond investors

- Academic researchers and educators
- Policymakers and regulators
- Banks and stock exchanges
- Climate litigants

Key features of TPI Centre climate data

Disclosure-based

Only using publicly available information

Avoiding duplication

Works with existing frameworks and disclosure requirements

Forward-looking analysis

Evaluating alignment with future climate scenarios

Cross-sector comparability

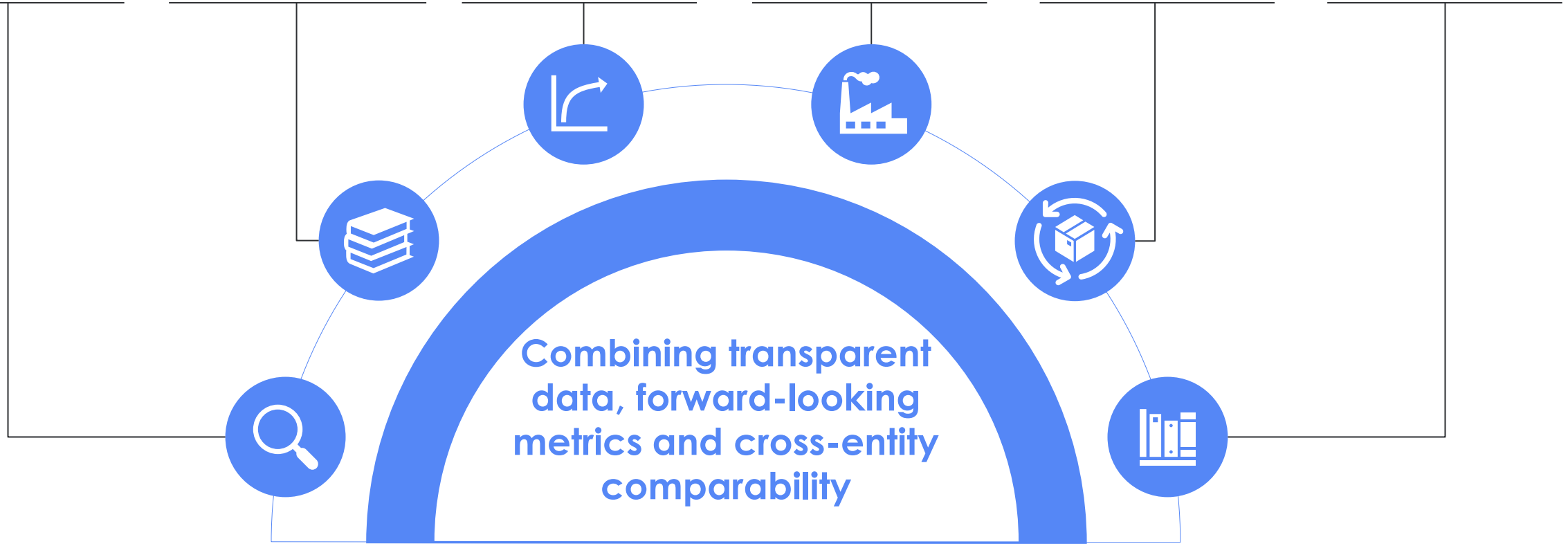
Consistent cross-sector or entity approaches

Holistic progress tracking

Measures the transition qualitatively and quantitatively

Methodological transparency

Open access data with transparent criteria



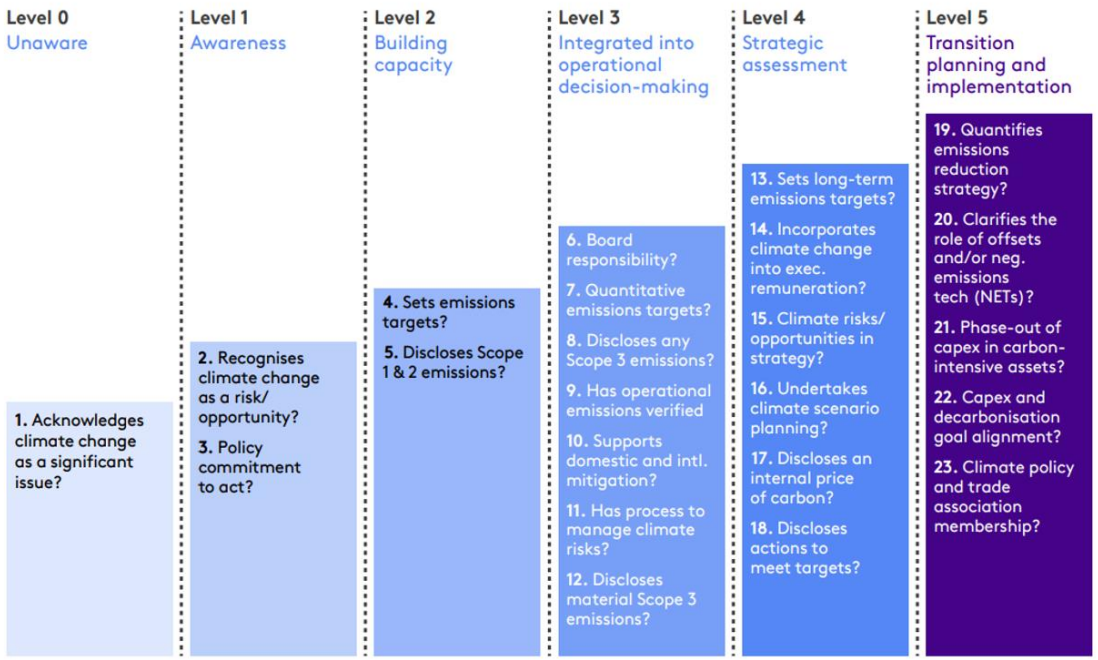
TPI Global Climate Transition Centre
Research and Data at LSE

The TPI corporate tool's two pillars

Management Quality

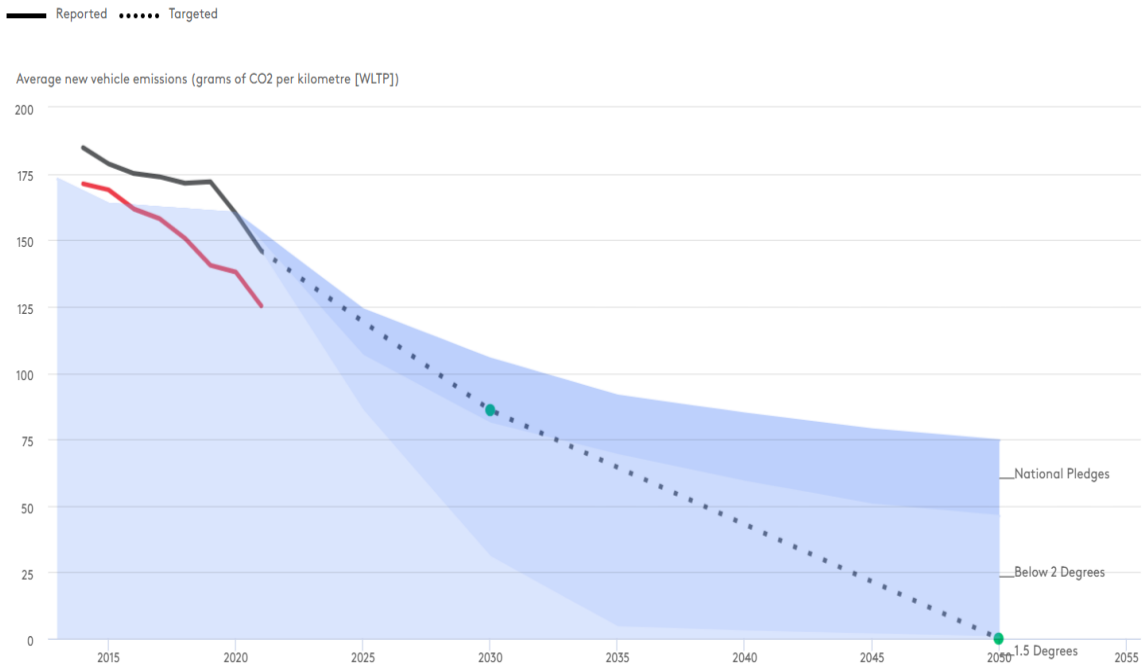
FTSE RUSSELL
An LSEG Business

Companies' governance/management of greenhouse gas emissions and the risks and opportunities from the low-carbon transition



Carbon Performance

Quantitative benchmarking of companies' emissions pathways against different climate scenarios



TPI Global Climate Transition Centre
Research and Data at LSE

2026 entity coverage

Corporates

Management Quality

FTSE RUSSELL
An LSEG Business

10,000 entities – 60 sectors

Carbon Performance

560 entities – 13 sectors

Net Zero Strategies

22 entities – 2 sectors

Banks

Net Zero Banking Assessment Framework

26 G-SIBs* – regional or thematic deep-dive

Carbon Performance

26 G-SIBs* – regional or thematic deep-dive

Sovereigns

ASCOR
Assessing Sovereign Climate-related Opportunities and Risks

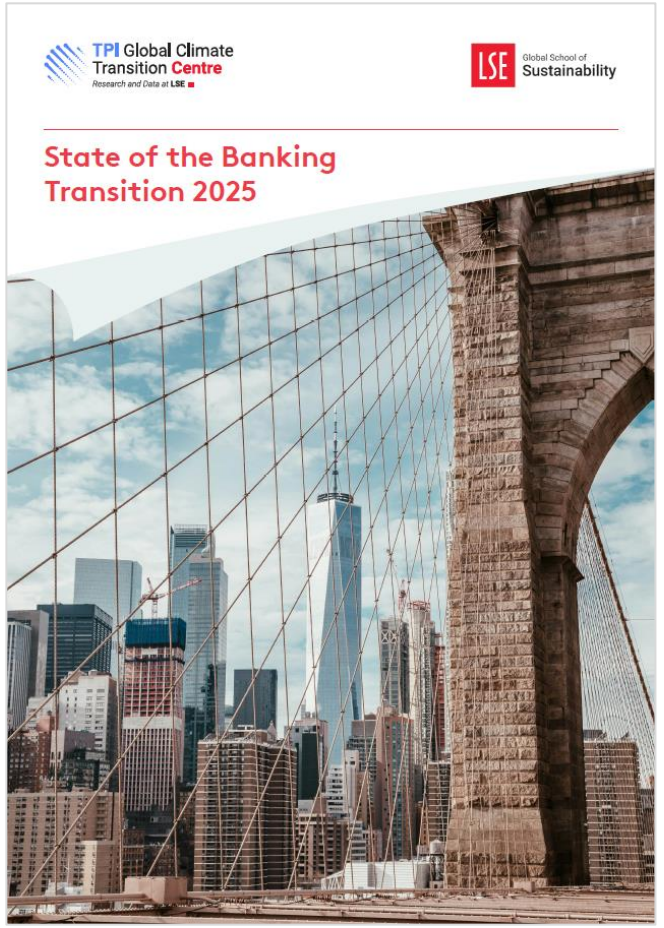
85 countries – 100% major index coverage

* Global-Systematically Important Banks

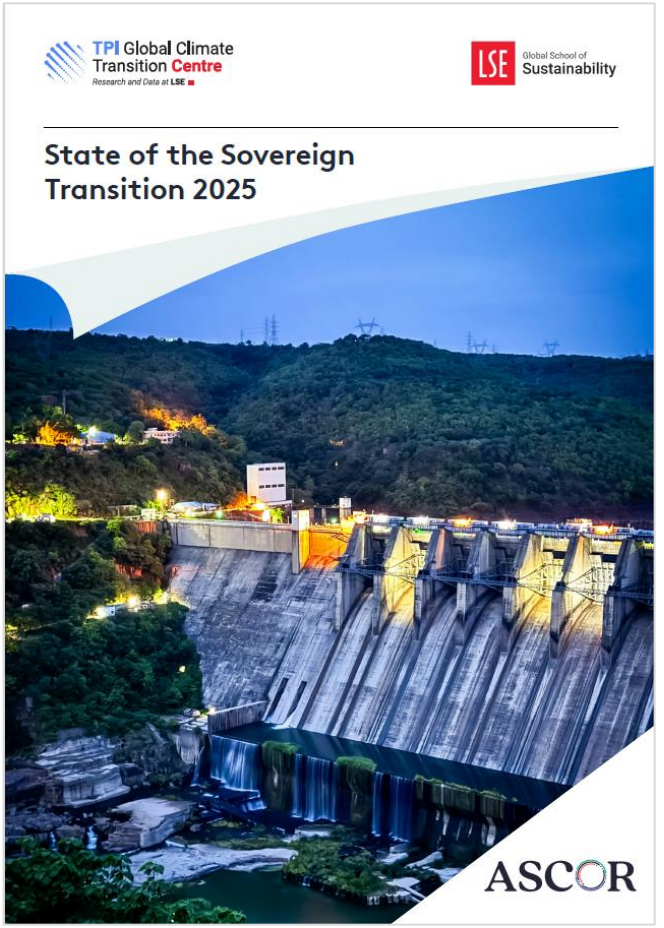
TPI Global Climate Transition Centre
Research and Data at LSE

The State of Transition Trilogy

September 2025



October 2025



November 2025

TPI Global Climate Transition Centre
Research and Data at LSE

Agenda

1. TPI Centre's methods and entity assessments
2. Investor use cases of our climate data
3. Next steps to address evolving market needs

Multiple investor use cases of climate data

Risk assessment

Exposing transition risk hotspots in portfolios

Investment decisions

Identify opportunities across sectors and geographies

Portfolio alignment

Reaching own climate targets

Active ownership

Engaging with investee entities & proxy voting

Product creation

Creating climate-sensitive financial products

Screening

Excluding/including investee entities

Reporting & compliance

Supporting voluntary and regulatory disclosures

Show of Commitment

Demonstrating commitment to the Paris Agreement

Enabling informed engagement

Accessible insights: format investors and companies can readily interpret

Common analytical framework: a shared, transparent basis for discussion

Convening and knowledge-sharing: LSE's academic platform supports public dialogue and expert workshops to enrich the analysis

Agenda

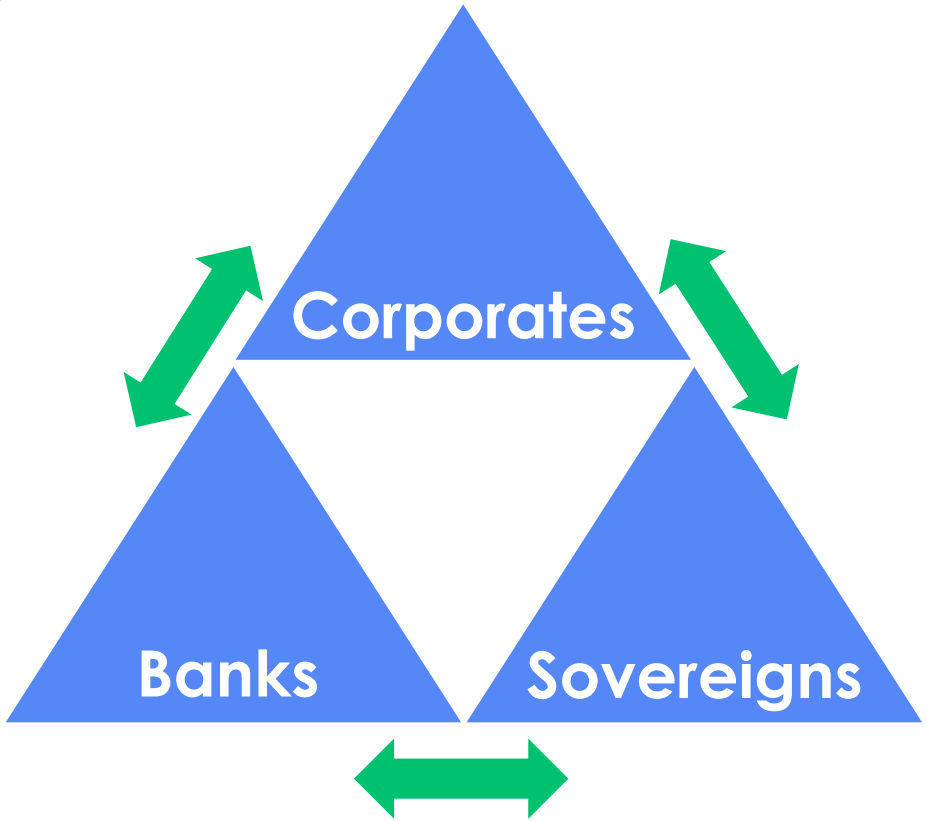
1. TPI Centre's methods and entity assessments
2. Investor use cases of our climate data
3. **Next steps to address evolving market needs**

Delivering a whole-of-system diagnostic of the transition

Combine three lenses: core corporate analysis, complemented by bank and sovereign insights

Amplify impact: a joined-up transition diagnostic pinpointing misalignments in policy, finance and real-economy outcomes

Support macroprudential analysis: a system-wide view of transition risks across firms, financial institutions, and sovereigns



Refining corporate analysis

1. Regionalisation

Aim: Integrate a regional lens by bringing local policy context into our methodologies, to sharpen the assessment of transition plans

2. Transition planning

Aim: Streamline analysis of target implementation and financing plans to assess credibility, identify dependencies and enable robust investment cases

Local policy shapes corporate action and creates regulatory transition risk

Tracking corporate pathways and dependencies can inform policymaking

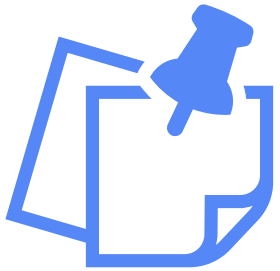
Need: coordinate **corporate and national transition planning** requires further research and data

Enhancing bottom-up evidence

Smart Carbon Performance methodology: algorithm-based to further expand TPI corporate universe.

CapEx focus: new research examining links of company ambition to investment decisions and if they differ by sector and region.

Asset level data analysis: tests whether stated transition plans align with underlying assets.



Two-way opportunity for impact

Investors: can use TPI Centre resources to understand transition and regulatory risks affecting the companies and the banks that finance them.

Supervisors: can use TPI Centre's evidence base to assess (sectoral and regional) risks in the real economy and their transmission to bank exposure.

Summary

1 Climate data must be decision-useful

Rigorous, independent, comparable and forward-looking data are essential to assess transition risks

2 A system-wide perspective is critical

Combined corporate, bank and sovereign analysis helps identify misalignments between policy, finance and real-economy

3 From ambition to action

Focus on implementation: new TPI Centre research on how transition plans are delivered and financed

Enhanced sectoral and regional analysis: strengthening dialogue and engagement

Informing policymakers: a growing, robust evidence base to underpin policy assessments

Disclaimer

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2. By accessing the data and information published in this report and on the website, you acknowledge that you understand and agree to the website terms and conditions. In particular, please read paragraphs 4 and 5 below which detail certain data use restrictions.
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Thank You

TPI Global Climate Transition Centre
London School of Economics and Political Science
Houghton Street
London WC2A 2AE, UK

E TPI.Centre@lse.ac.uk

www.transitionpathwayinitiative.org

TPI Global Climate Transition Centre
Research and Data at **LSE**

LSE Global School of Sustainability

CLIMATE RISK AND SUSTAINABLE FINANCE: BRIDGING POLICY, RESEARCH AND PRACTICE

INTEGRATING THE CLIMATE DIMENSION INTO ECONOMIC STATISTICS: THE EXPERIENCE OF THE BANCO DE ESPAÑA

Luis Ángel Maza

DIRECTOR OF STATISTICS DEPARTMENT

25 MARCH 2026

BANCO DE ESPAÑA
Eurosistema

THE BANCO DE ESPAÑA'S EXPERIENCE WITH CLIMATE STATISTICS

1

WHAT WE HAVE DONE SO FAR

1. IN-HOUSE WORK
2. JOINT PROJECTS

2

WHERE WE ARE NOW

1. WHAT IS ALREADY IN PLACE
2. WHAT WE ARE STILL BUILDING

3

LOOKING AHEAD

1. ACCESS TO DATA
2. TECHNOLOGY AND EFFICIENCY

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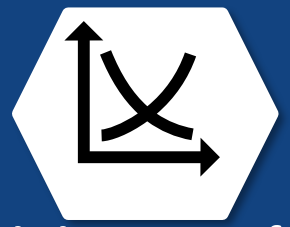
WHY CLIMATE STATISTICS ARE RELEVANT FOR CENTRAL BANKS



Economic impacts of climate change

Climate change is widely recognised as the **main global challenge facing humanity.** Its effects go well beyond the environmental sphere, with far-reaching implications for economic activity, price stability and long-term growth

The role of the financial sector

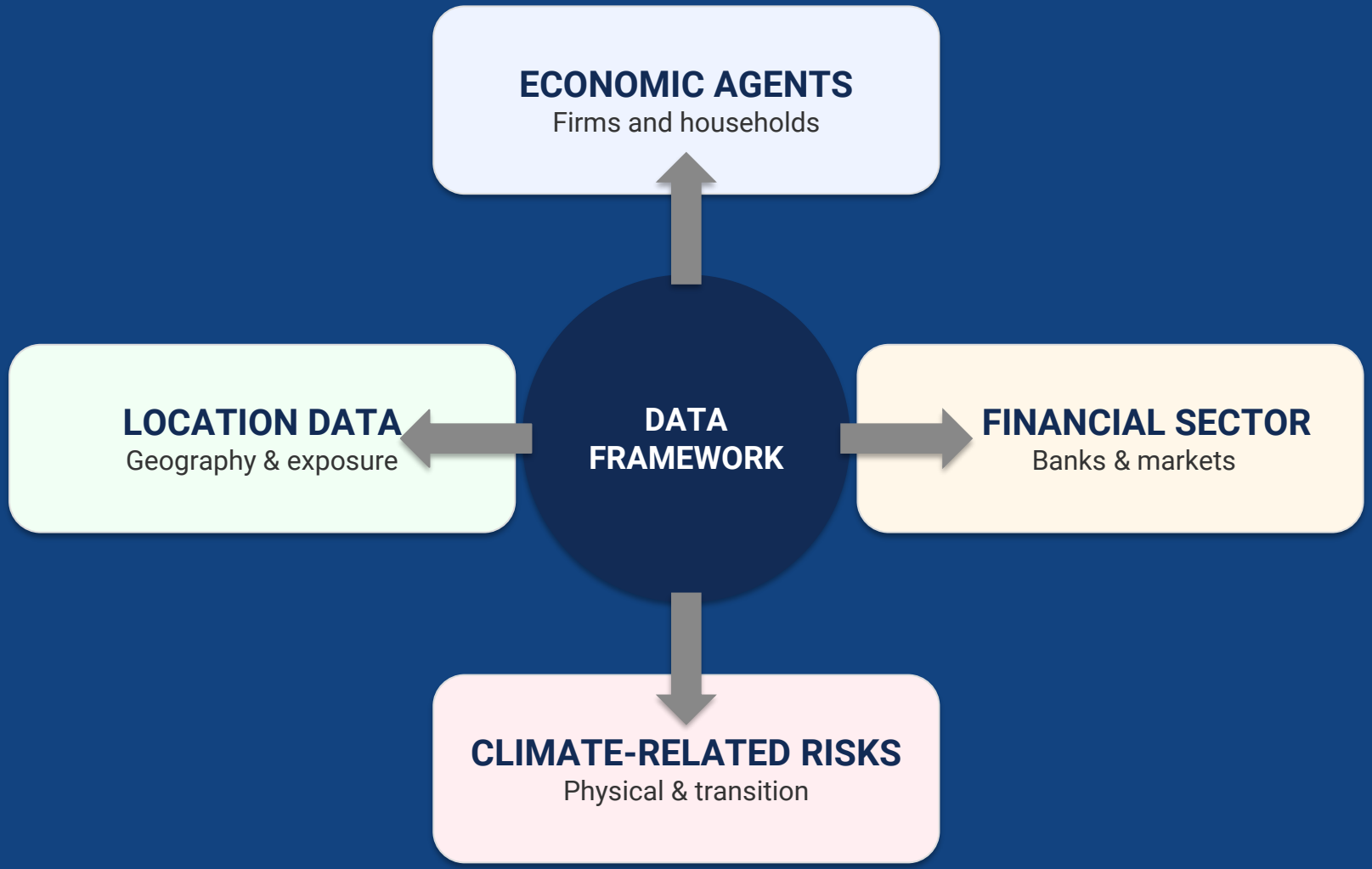
The financial sector is essential for **mobilising savings and financing the transition to a more sustainable economy**, while also being exposed to climate-related risks that need to be properly assessed

Why central banks need climate statistics

Central banks need reliable **climate-related data to properly fulfil their core functions**. Climate data are essential to assess the economic impacts of climate change, monitor financial risks and support sound policy analysis

BUILDING THE DATA FRAMEWORK

STARTING ~**8 YEARS AGO**: IDENTIFYING THE KEY DATA BUILDING BLOCKS – BANCO DE ESPAÑA



These datasets **were not part of the traditional statistical space** of central banks

They often relied on **unstructured data sources** and covered **emerging phenomena** for which there was little or no previous statistical experience

In addition, **methodologies were still evolving** – there were no fully settled, end-to-end frameworks

EARLY IN-HOUSE PROJECTS – BANCO DE ESPAÑA

TURNING NON-TRADITIONAL SOURCES INTO CLIMATE-RELEVANT **MICRODATA**

NEW SOURCES

- CSR / sustainability reports (NFCs)
- Bond prospectuses: sustainability info
- New admin sources (pollutant emissions)
- Risk layers (hazards, exposure)
- Commercial data providers (ESG and climate datasets)

FIRST DATA PRODUCTS

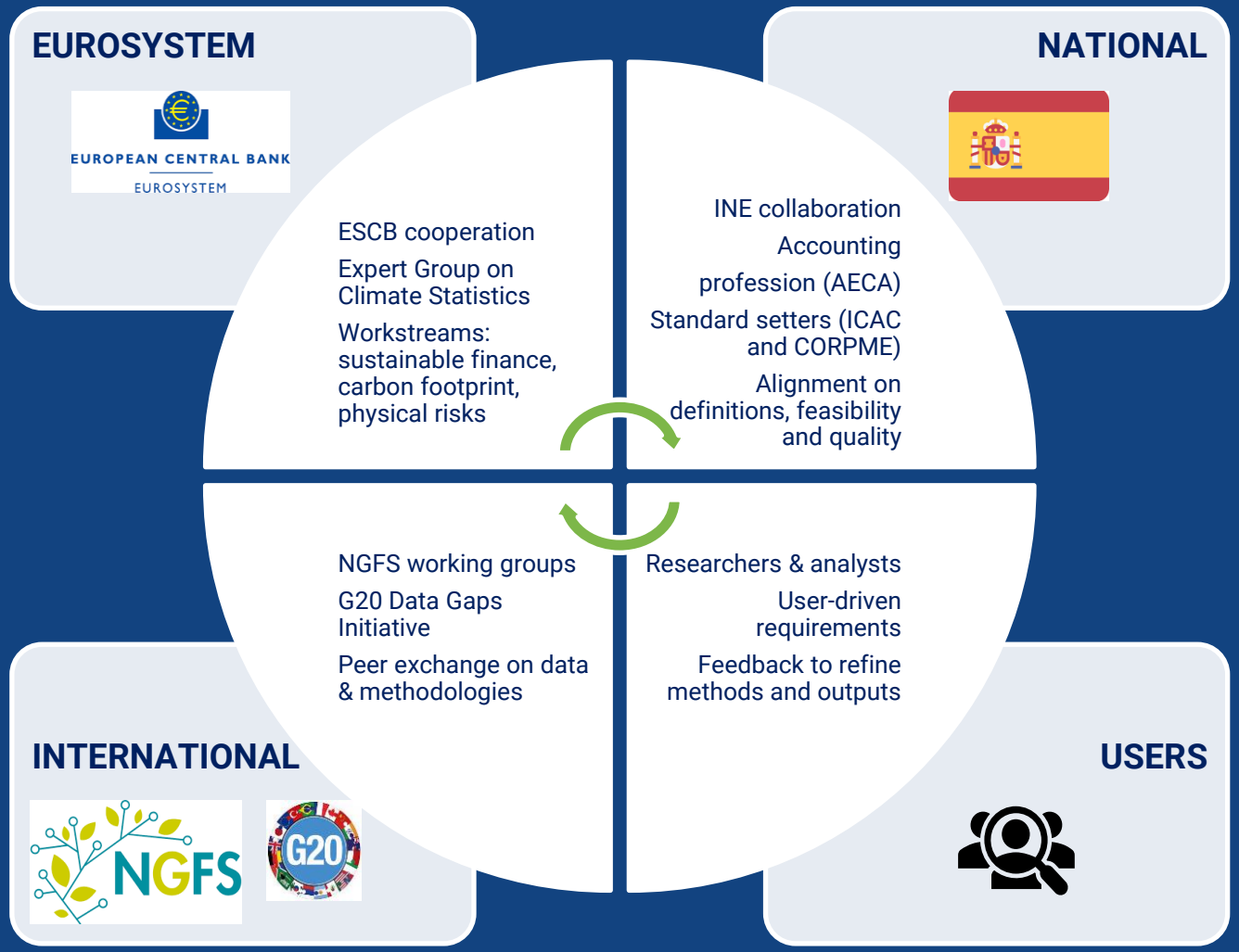
- ESG microdata for non-financial corporations
- Sustainable finance attributes for securities
- Better geo-location of firms & assets
- New indicators for climate risks
- Cross-links across datasets

NEW SKILLS

- Efficient microdata management
- Record linkage across databases
- Data science pipelines
- Text extraction from documents
- Machine learning for scale & quality

EARLY PILOTS COMBINED NEW SOURCES + MICRODATA + DATA SCIENCE TO DELIVER CLIMATE-RELEVANT STATISTICS

WE DID NOT WALK THIS PATH ALONE



This journey has shown that producing meaningful climate statistics requires **collective learning**: shared standards, joint methodological work and constant feedback from the research and user community.

CLIMATE STATISTICS: A GLOBAL CHALLENGE

- **A global phenomenon**
  Climate risks, emissions and transition dynamics transcend national borders
- **International cooperation**
  Joint work is essential to ensure consistency, credibility and analytical relevance
- **Replicable methodologies**
  Developing approaches that can be applied across countries, based on common data sources
- **Comparability and harmonization**
  Shared definitions, indicators and measurement frameworks are key to meaningful cross-country analysis

Meaningful climate statistics require internationally coordinated, replicable methodologies, built on common data sources to ensure comparability and harmonisation across countries

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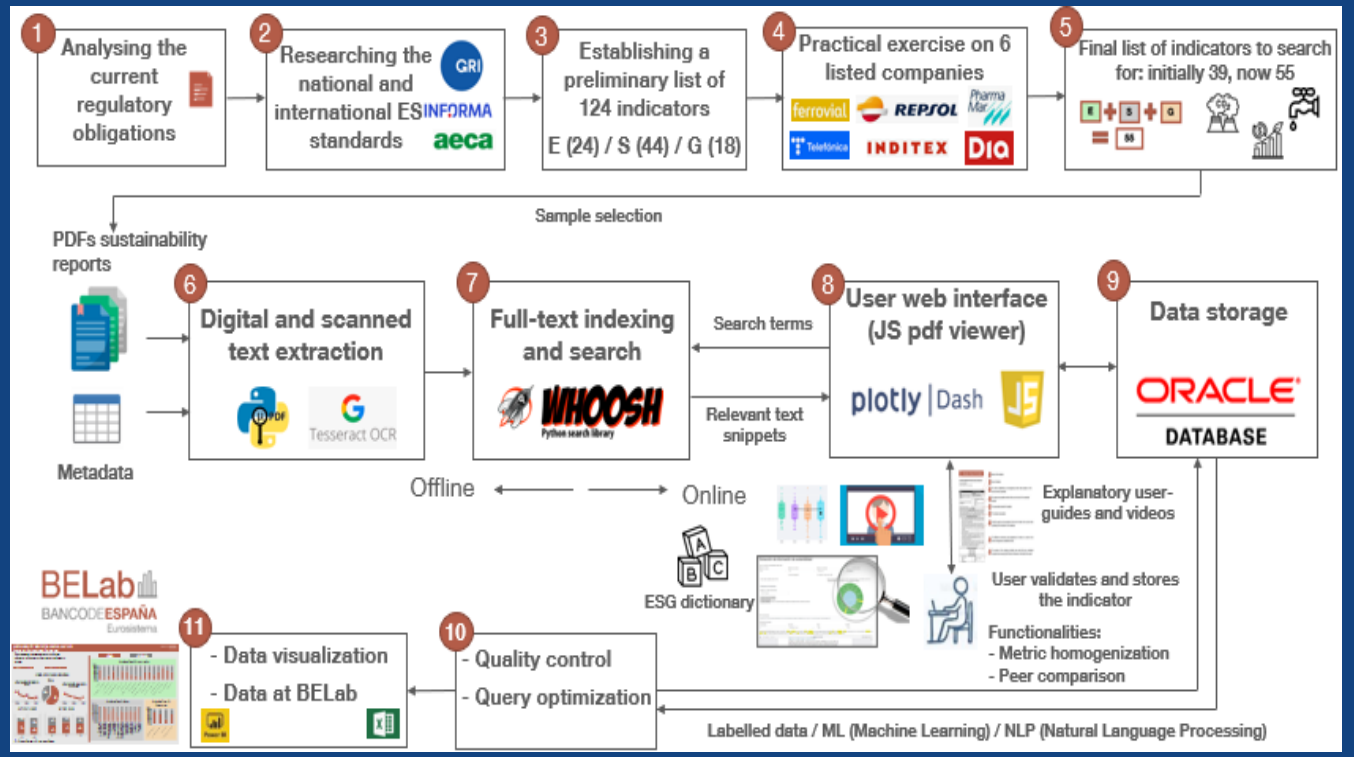
(I) CLIMATE DATASETS DEVELOPED AT BANCO DE ESPAÑA

Microdata on Sustainability Indicators (CBS) for Non-financial firms

By building an in-house database of ESG indicators extracted from the sustainability reports of major Spanish non-financial firms, leveraging the process on the use of new techniques (ML and NLP).

Project summary overview



How to monitor what companies are reporting in their sustainability reports?

(II) VIME – MULTI-LOCATION BUSINESS VISUALISER IN SPAIN

The Banco de España, in close collaboration with the **National Statistical Institute (INE)**, has developed the Multi-location Business Visualiser (VIME) to improve the spatial allocation of firms' economic activity by identifying productive establishments beyond corporate headquarters

Objective: Show how the distribution of Spanish firms changes based on their **headquarters** or **production centers**
Moving from headquarters-based geolocation to a multi-establishment approach is essential for accurate climate statistics and physical risk assessment.

Headquarters*

(*) postal code of the company´s headquarter

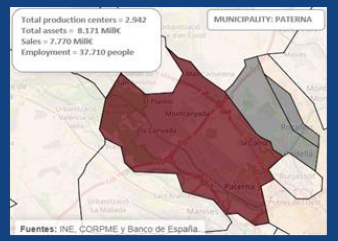
Nº of firms vs production centers

- Total assets
- Average nº of employees
- Turnover
- Gross Operating Profit (GOP)

❑ **Distribution of the four variables based on the % of employment** that the company has in each postal code according to INE data

Multilocalization**

(**) postal code associated with the multilocated company with 1 or more production centers in it



For example: in one municipality affected by DANA, the difference was +17% more impact in terms of sales, employment, and assets when analyzing the information by multilocation versus registered office

(III) ERICA DATABASE – A JOINT EUROPEAN ESG PROJECT

The ERICA database is developed under the umbrella of the **European Committee of Central Balance Sheet Data Offices** (ECCBSO).

Within this framework, the JECED Task Force as a joint European initiative. It compiles harmonised ESG indicators **for listed corporate groups**, bringing together **national central banks and national statistical institutes** to establish a reusable European database standard.

BANCO DE ESPAÑA – PROJECT LEADERSHIP (Database hosting)
Leadership and coordination of the JECED Task Force under the ECCBSO, methodological design and harmonisation, and promotion of a common European ESG database standard.

ECB + 9 COUNTRIES

EUROPEAN CENTRAL BANK
EUROSYSTEM

PERIOD COVERED

2005-2024(*):
- 3 Size Classes
- Business Sectors

SAMPLE

1,000 Groups yearly

Coverage is 95%, based on Turnover

Financial & Sustainability Data

(IV) JOINT CLIMATE INDICATORS IN THE EUROSYSTEM

The ECB, together with the national central banks of the Eurosystem, including the **Banco de España**, has developed and published analytical **climate-related statistical indicators**.These indicators aim to strengthen the financial sector's capacity to assess **sustainable financing**, as well as **transition** **and** **physical risks** associated with climate change

Sustainable finance	Carbon emissions	Physical risks
Indicators on issuances and holdings of sustainable debt securities.	Analytical indicators on carbon emissions financed by the financial sector loan and securities portfolios.	Analytical indicators on physical risks associated with financial sector loan and securities portfolios.

Banco de España – Key contributions:

- ❑ **Provision of national-level data and granular information**
- ❑ **Active contribution to methodological enhancements and refinements** (geopositioning and production center)

Provide consistent analytical tools for policy analysis and financial risk assessment

- Decarbonisation efforts
- Exposure of the financial system to climate risks
- The increasing relevance of climate-related factors in financial markets

Methodological advances

- Use of advanced statistical and analytical methodologies
- Integration of new and enhanced data sets

(V) METHODOLOGICAL CONTRIBUTIONS TO CLIMATE STATISTICS

In addition to data production, the Banco de España has contributed to the international methodological debate on climate-related statistics through analytical work and published research.

The link provides an overview of sustainability-related publications (2017–2026), including several methodological and statistical contributions.

CARBON FOOTPRINT OF CORPORATE LOANS

- Estimation of financed emissions in loan portfolios
- Methodological work on scope, coverage and imputations
- Contribution to international comparability

ENERGY EFFICIENCY OF MORTGAGE LOANS

- Use of energy performance information for housing collateral
- Linking mortgage loans to energy efficiency indicators
- Support analysis of transition risks in households

FORWARD-LOOKING CLIMATE INDICATORS

- Development and assessment of forward-looking indicators
- Alignment of climate pathways and economic trajectories
- Contributions to international fora (e.g. G20 DGI)

ONGOING WORK AND OPEN CHALLENGES

Key **priorities still under development** in climate and environmental statistics

G20 DATA GAPS INITIATIVE

- Carbon footprint of foreign direct investment
- Harmonised forward-looking indicators
- Public sector climate statistics (subsidies, public spending)

STATISTICAL MANUALS (2030)

- New national accounts and balance of payments manuals (SNA & BPM)
- Integration of sustainability-related concepts
- Methodological work ongoing, finalisation expected by 2030

SPATIAL HARMONISATION

- Harmonisation of geolocation-based projects
- Location of agents and activities
- Satellite and remote-sensing data

BIODIVERSITY & NATURE

- Water use and water stress indicators
- Conservation of species
- Protection of natural areas and ecosystems

Addressing open methodological recommendations DGI-3, integrating sustainability into core statistical manuals, strengthening the spatial dimension of data, and expanding the scope towards biodiversity are central priorities for ongoing works

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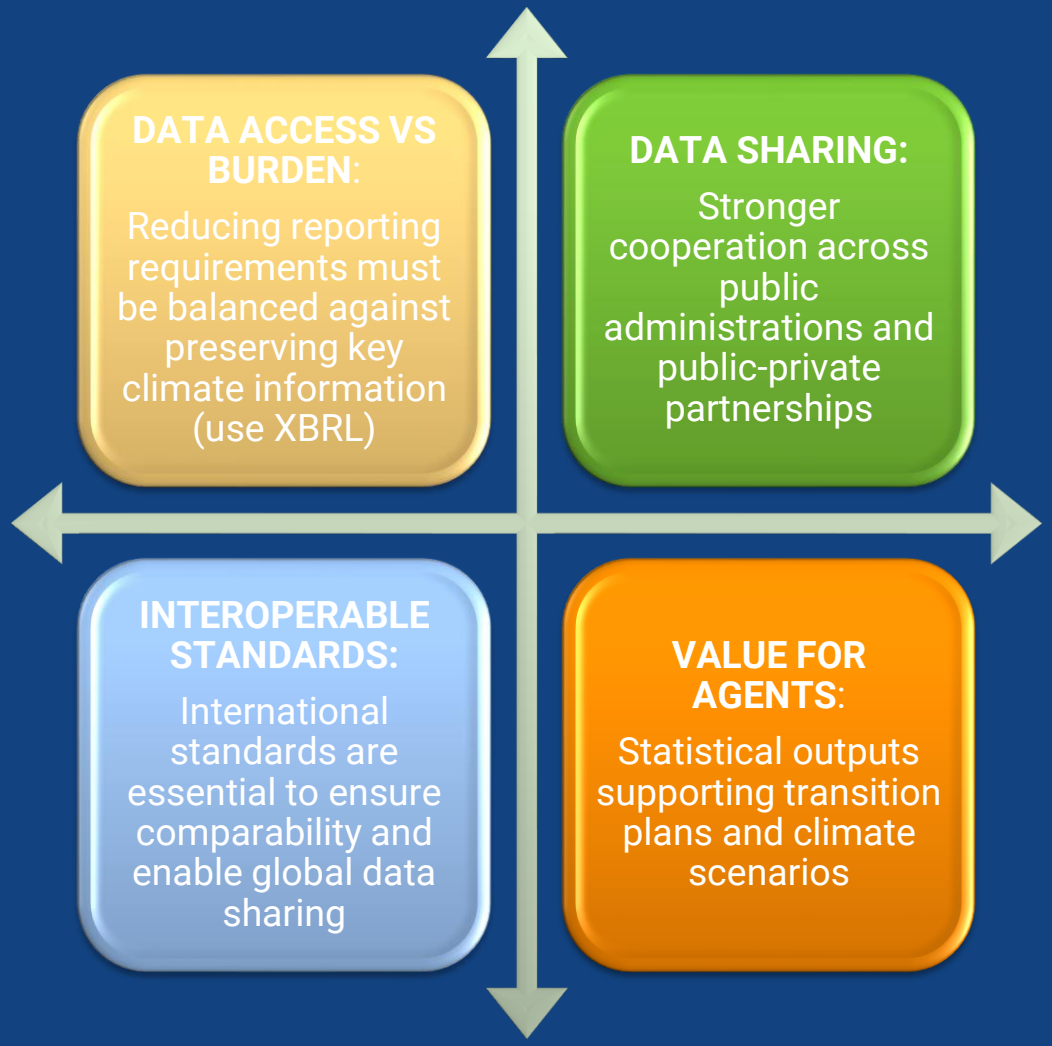
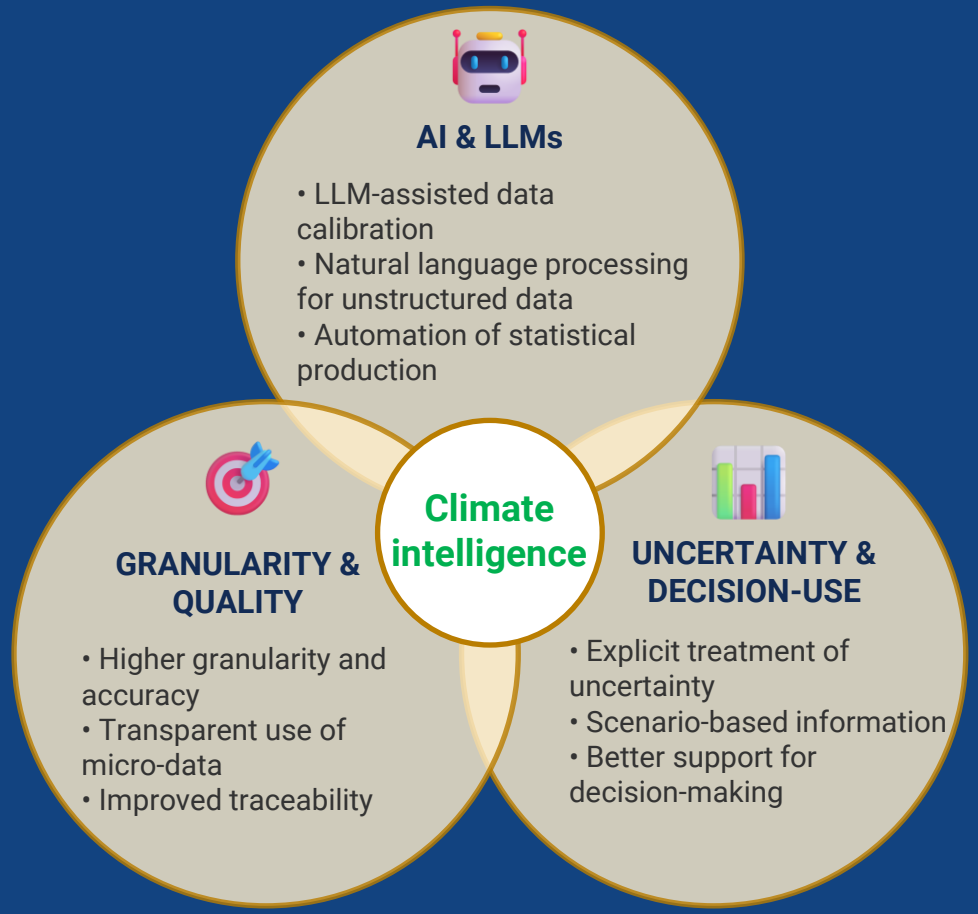
DATA ACCESS IN A CHANGING REPORTING LANDSCAPE



Reducing reporting burdens must go hand in hand with ensuring access to high-quality, comparable and decision-useful climate information

sustAInable: AI-enabled processes for climate and sustainability statistics



Maximising the potential of AI-enabled processes allows climate and sustainability statistics to become more granular, transparent and decision-useful, while ensuring efficiency and scalability

SUMMARY

KEY TAKEAWAYS

1. Relevance for Central Banking
Climate change is a systemic economic and financial challenge.
Central banks require climate-related statistics to assess macroeconomic impacts, financial stability risks and long-term growth.

2. Building New Statistical Capabilities
Climate statistics require expanding beyond traditional data.
Integration of non-traditional and emerging data sources.
Use of granular microdata and spatial information.

3. Cooperation and Harmonisation
International and cross-institutional cooperation is essential.
Shared definitions, methodologies and data standards ensure comparability and credibility.

4. Looking Ahead: Data, Technology and Use
Balancing data access and reporting burden
Strengthening the spatial and environmental dimensions.
Leveraging AI and advanced analytics to improve efficiency, granularity and decision-use.

Thank you very much for your attention

BANCO DE ESPAÑA
Eurosistema