NGFS Long-term Climate Scenarios & Data Tutorial

An introduction to the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) and its Phase IV long-term climate scenarios

Global Credit Data Webinar

17 April 2024

NGFS
Central Banks and Supervisors Network for Greening the Financial System

EUROPEAN CENTRAL BANK
EUROSYSTEM

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Introduction into NGFS Scenarios

What are climate scenarios?

NGFS scenarios have been developed to provide a common starting point for analysing climate risks to the economy and financial system

They help answering the questions:

What can happen? If climate change is not mitigated

What should happen? To shed light on long-term benefits from green transition

The NGFS Scenarios…

…**have been created as a tool to shed light on potential future risks**, and to prepare the financial system for the shocks that may arise

…**explore a range of plausible outcomes** by employing different models and examining a wide range of scenarios across regions and sectors

…**present unique features that make them suitable for a wide range of applications**, with results freely accessible through an online platform

…**are not forecasts** as they are intended to explore the bookends of plausible futures (neither the most probable nor the most desirable)

Widespread usage

NGFS scenarios are not only used by Central Banks and Supervisors, but also by academia, consulting, and diverse financial institutions

The scenarios are used by a wide variety of users

The usage of NGFS scenarios among (private) financial institutions (FIs) is widespread:

Banks | Insurers | Asset Managers | Development Banks | Investment Funds | Other FIs

Different institution, different use case

NGFS scenarios serve different use cases across different types of institutions

Central banks and supervisors are mostly interested in climate scenarios for:

1. Climate stress tests for micro-prudential purposes (safety and soundness of banks)
2. Climate stress tests for macro-prudential purposes (financial stability)
3. Monetary policy climate impact analysis (price stability)

Private financial and non-financial organizations are mostly interested in climate scenarios for:

1. Risk management
2. Opportunity identification
3. Target setting

For strategic, business operations, and portfolio resilience purposes

Policy makers and standard setting bodies are mostly interested in climate scenarios for:

1. Cost-benefit analysis (transition vs non-transition; speed of transition; type of transition)
2. Policy design analysis (choice of policy instrument)
3. Policy targeting (geographical area; sector)

*Less applicable to NGFS scenarios due to known limitations**

*Climate policy modelled as single "shadow" carbon price, limited sectoral granularity

Scenario framework

NGFS scenarios explore impacts of climate change and climate policy with the aim of providing a common reference framework

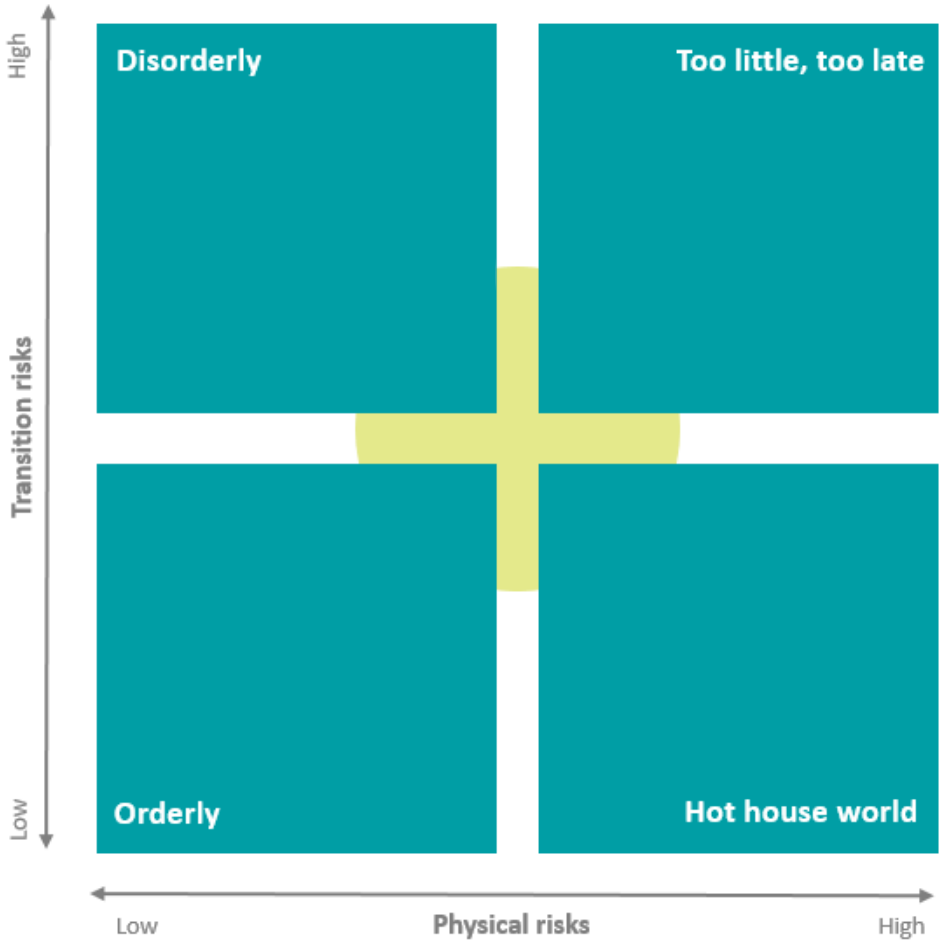
We analyze the impact of climate change and climate policy based on their implied level of:

physical risks (x-axis)

and transition risks (y-axis)

Which identify 4 quadrants of potential futures for economies and financial systems:

- **Orderly** scenarios assume climate policies are introduced early and become gradually more stringent
- **Disorderly** scenarios explore higher transition risks due to policies being delayed or divergent across countries and sectors
- **Hot house world** scenarios assume that globally efforts are insufficient to halt significant global warming
- **Too little, too late** scenarios assume that a late and uncoordinated transition fails to limit physical risks



Scenarios at a glance

7 scenarios are currently available, each of them exploring a different set of assumptions

Low Demand assumes that reduced energy demand mitigates the pressure on the economic system to reach global net zero CO_2 emissions around 2050.

Net Zero 2050 limits global warming to 1.5°C through stringent climate policies and innovation, reaching global net zero CO_2 emissions around 2050.

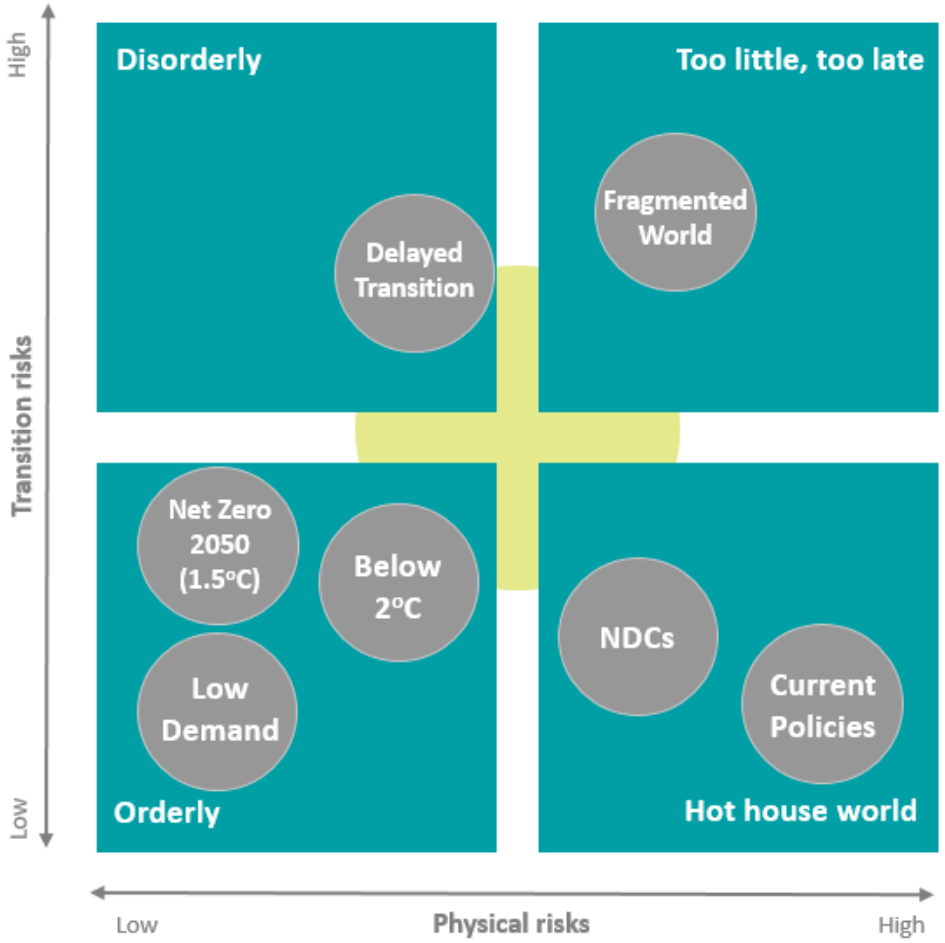
Below 2°C gradually increases the stringency of climate policies, giving a 67% chance of limiting global warming to below 2°C.

Delayed Transition assumes annual emissions do not decrease until 2030. Strong policies are needed to limit warming to below 2°C. Negative emissions are limited.

Nationally Determined Contributions (NDCs) includes all pledged targets even if not yet backed up by implemented effective policies.

Current Policies assumes that only currently implemented policies are preserved, leading to high physical risks.

Fragmented World assumes a delayed and divergent climate policy response among countries globally, leading to high physical and transition risks.



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Phase IV Update

Phase IV update overview

NGFS scenarios and their narratives have been updated in Phase IV

4 key changes compared to Phase III:

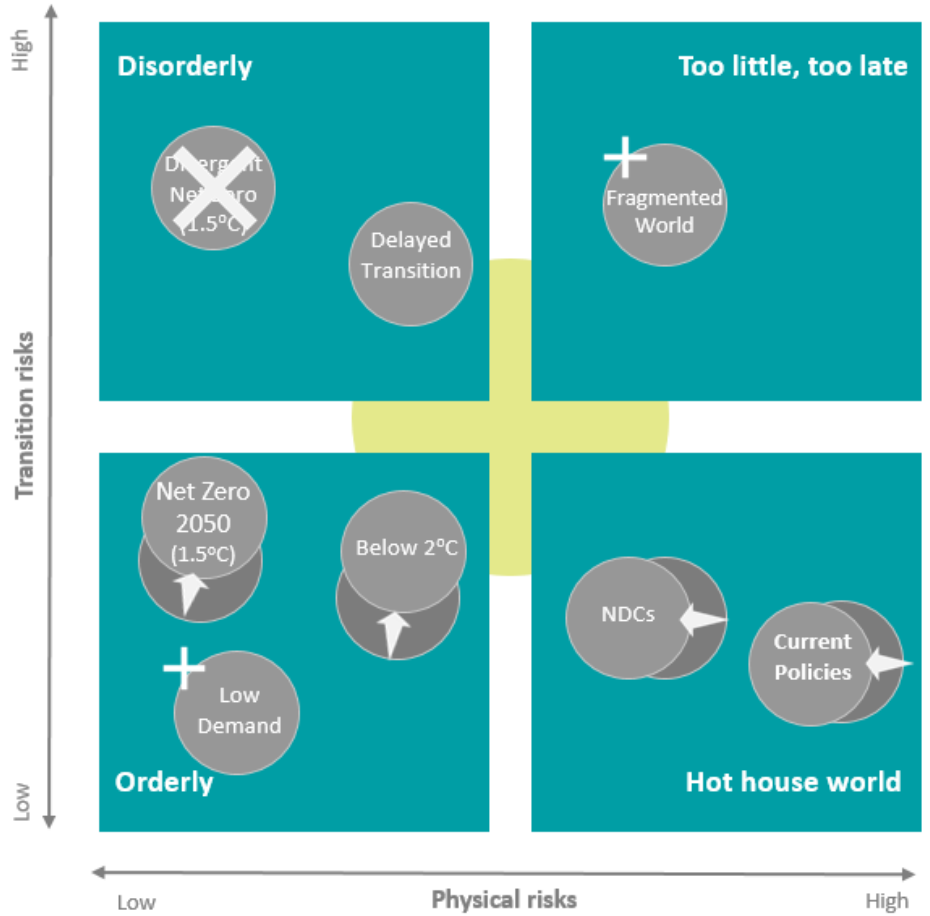
1. The NGFS scenarios have been **brought up to date** with new economic and climate data, and policy commitments.

2. **Acute physical risk modelling** has been enriched by including more hazards and greater geographical granularity.

3. The NGFS **orderly scenarios are now more disorderly**, reflecting climate policy delays and the current geopolitical context.

4. The NGFS scenario **framework has been expanded** to capture more and less adverse futures.

NGFS scenario framework: from Phase III to Phase IV



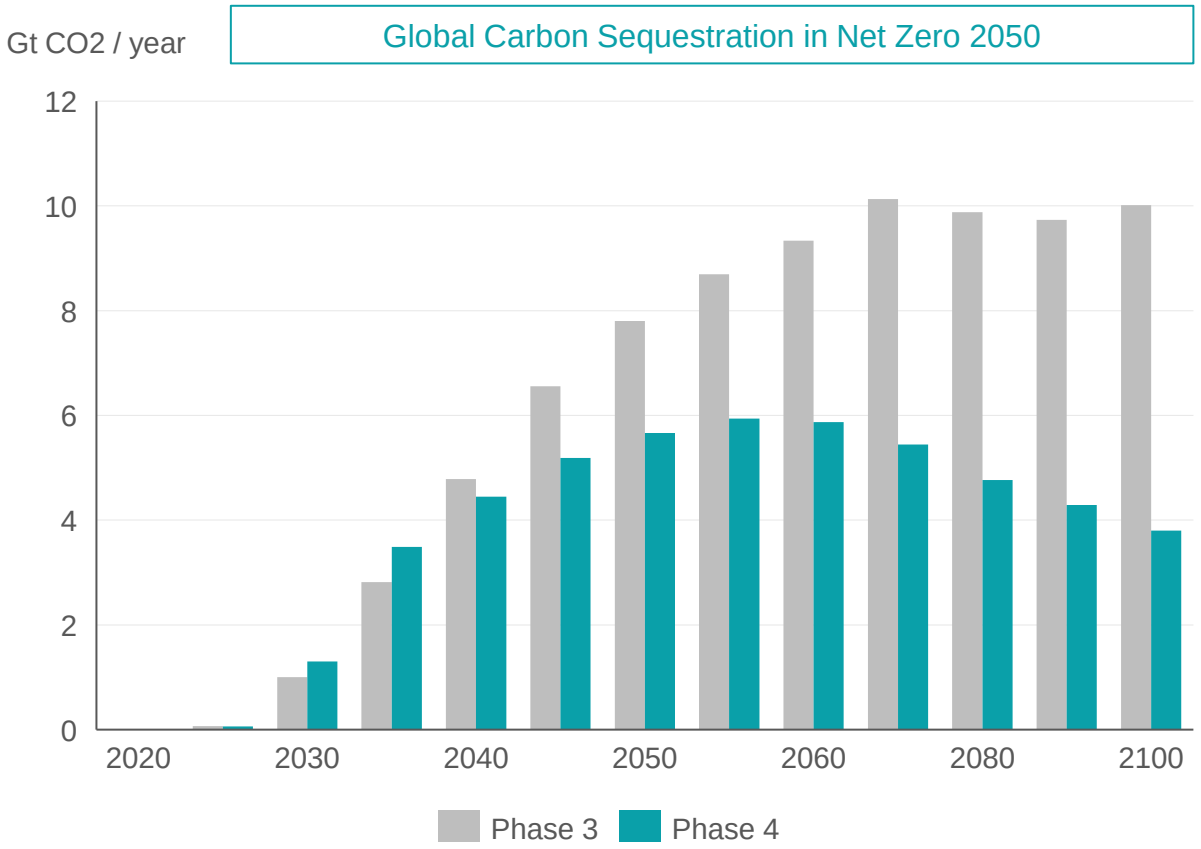
Positioning of scenarios is approximate, based on an assessment of physical and transition risks out to 2100.

1. Updated economic and climate data, incl. CCS limits

NGFS scenarios have been brought up to date with the latest economic and climate data, and policy commitments

- **Scenarios data** have been updated to reflect:
  - **new country-level policies** to reach net-zero emissions (e.g., EU Fit-for-55);
  - **latest GDP and population data** using IMF World Economic Outlook 2022;
  - **current geopolitical context**, incl. effects of the war in Ukraine on energy prices;
  - **latest trends** in renewable energy and key mitigation technologies.

- **Limits on the availability of Carbon Capture and Storage (CCS) technologies** have been introduced (see graph on the right).



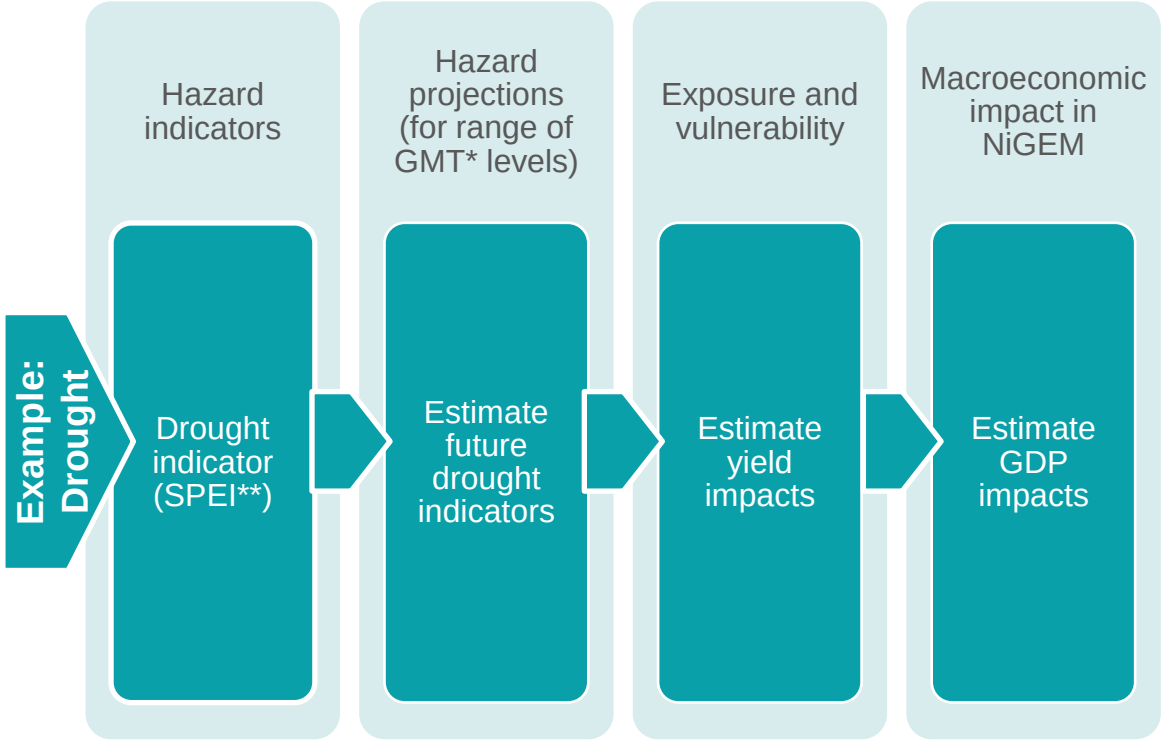
Source: REMIND-MAgPIE 3.2-4.6

2. Improved modelling of acute physical risks

Acute physical risk modelling has been improved to include more hazards and greater geographical granularity, among others

The modelling has been **enhanced** to include:

- **Four acute physical risk hazards**: heatwaves, droughts, tropical cyclones and riverine floods.
- **Additional channels of transmission** to the real economy.
- **Country level projections** of GDP losses for all hazards.

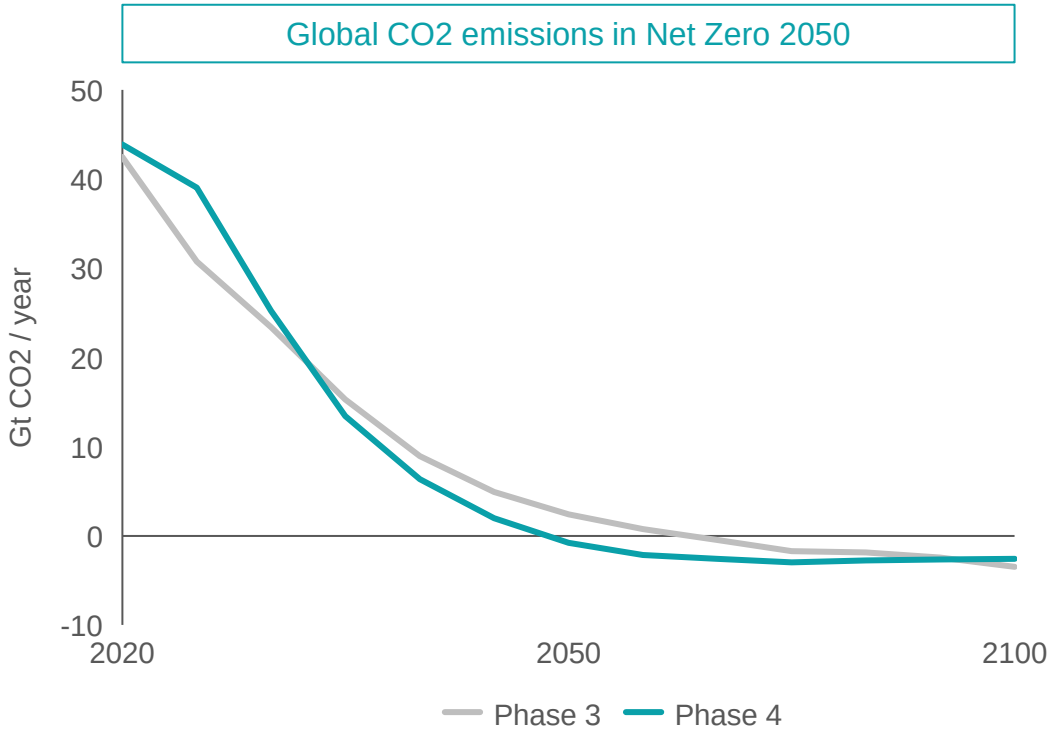


*GMT (Global Mean Temperature): increase in average earth surface temperature
**SPEI (Standardised Precipitation Evapotranspiration Index): drought indicator that account for multiple drought elements such as onset, duration and magnitude versus normal levels

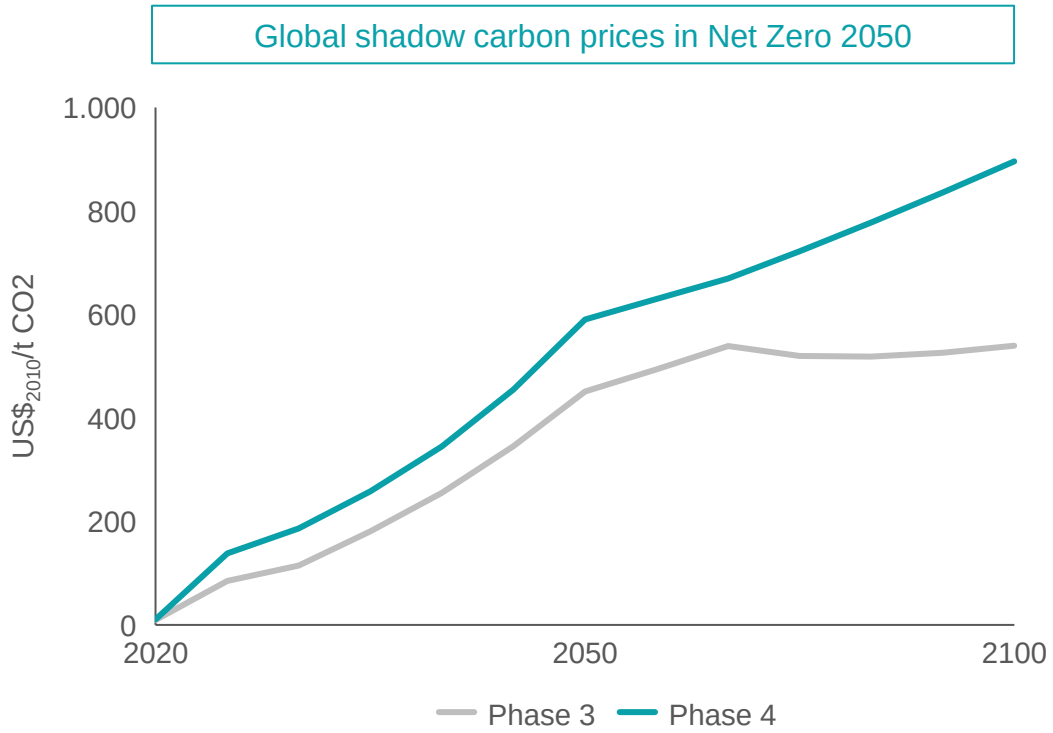
3. Towards a ‘more disorderly’ orderly transition

NGFS orderly scenarios are more disorderly, reflecting climate policy delays and recent developments in energy markets

Persistently high emission levels require more rapid and intense emission reductions to reach Paris-aligned goals.



Reaching the same climate goal in less time is reflected in higher shadow carbon prices (i.e., more stringent policies)



Source: REMIND-MAgPIE 3.2-4.6

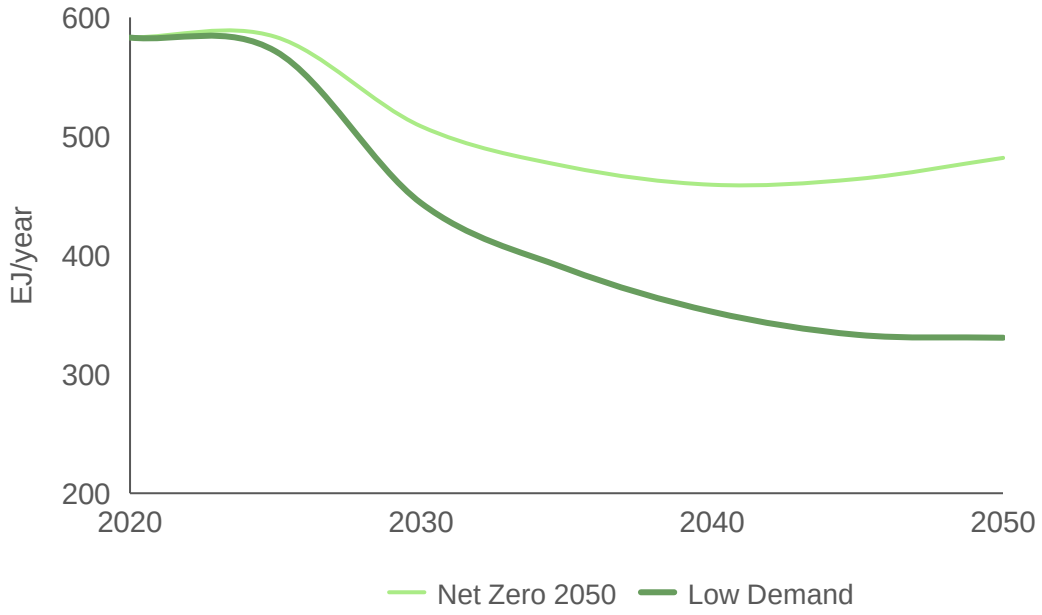
4. New scenario | Low Demand

Low Demand: a scenario in which strong energy demand reductions help to limit global warming to below 1.5°C in an orderly fashion

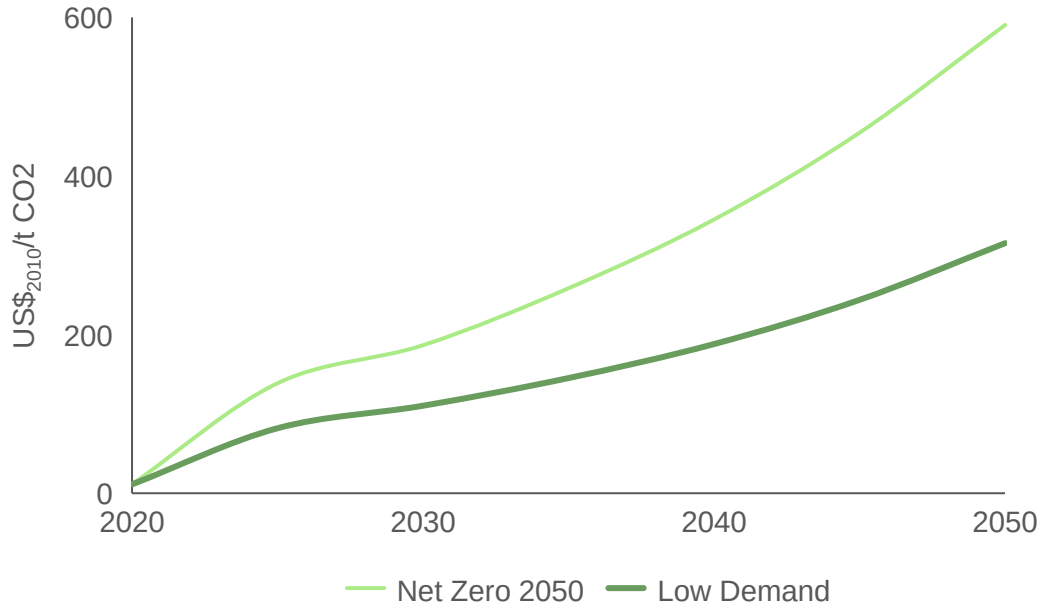
Low Demand stresses the importance of demand-side measures through more ambitious mitigation efforts, i.e., behavioral changes reflected in lower energy demand

Consequently, in this scenario, temperature increases are limited (similar to Net Zero 2050) in the nearer future amid less disruptive carbon prices (lower than Net Zero 2050)

Primary Energy Demand (World)



Shadow Carbon Prices (World)



Source: REMIND-MAgPIE 3.2-4.6

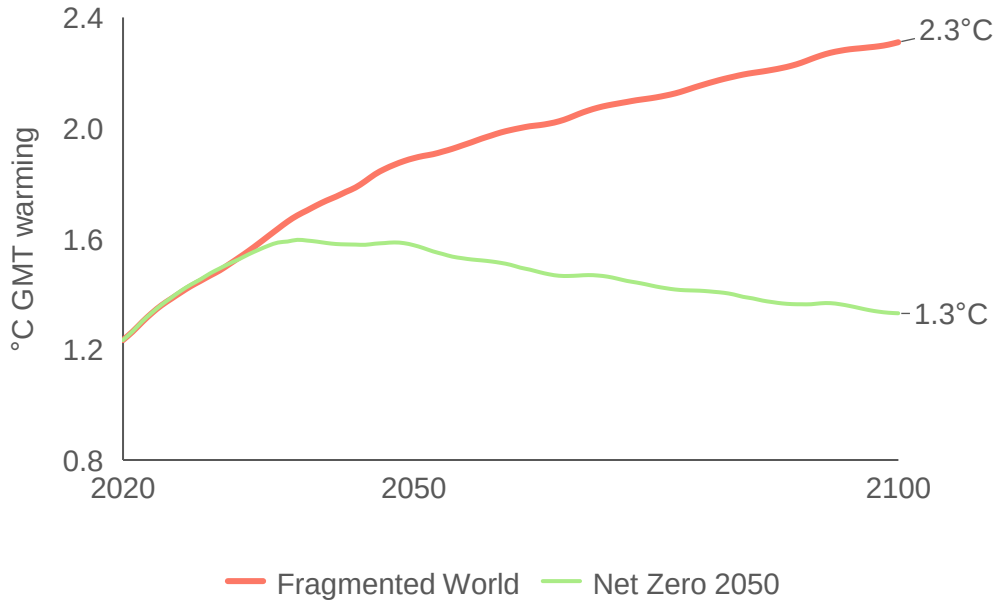
4. New scenario | Fragmented World

Fragmented World: a scenario that assumes delayed and divergent policy ambition globally, leading to high physical and transition risks

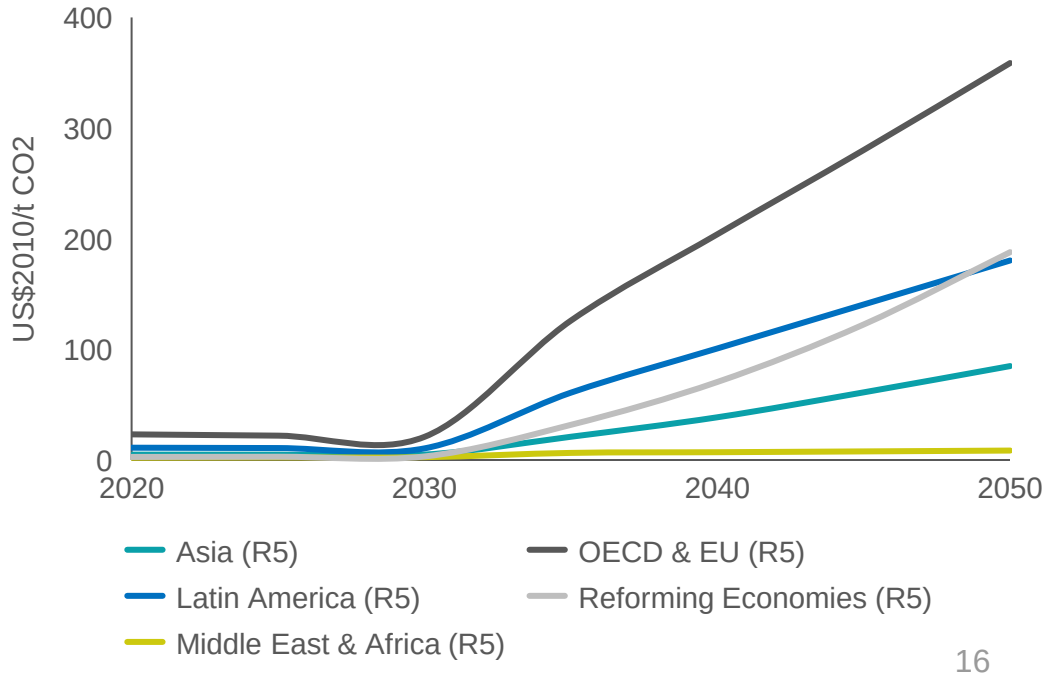
Fragmented World scenario explores adverse impacts if we fail to timely implement globally coordinated climate mitigation policies, with temperature rising by >2°C

Climate policies and corresponding carbon prices vary wildly across geographies and sectors, resulting in high transition risks on top of high physical risk

Global Mean Surface Temperature Warming



Regional Shadow Carbon Prices



Source: REMIND-MAgPIE 3.2-4.6

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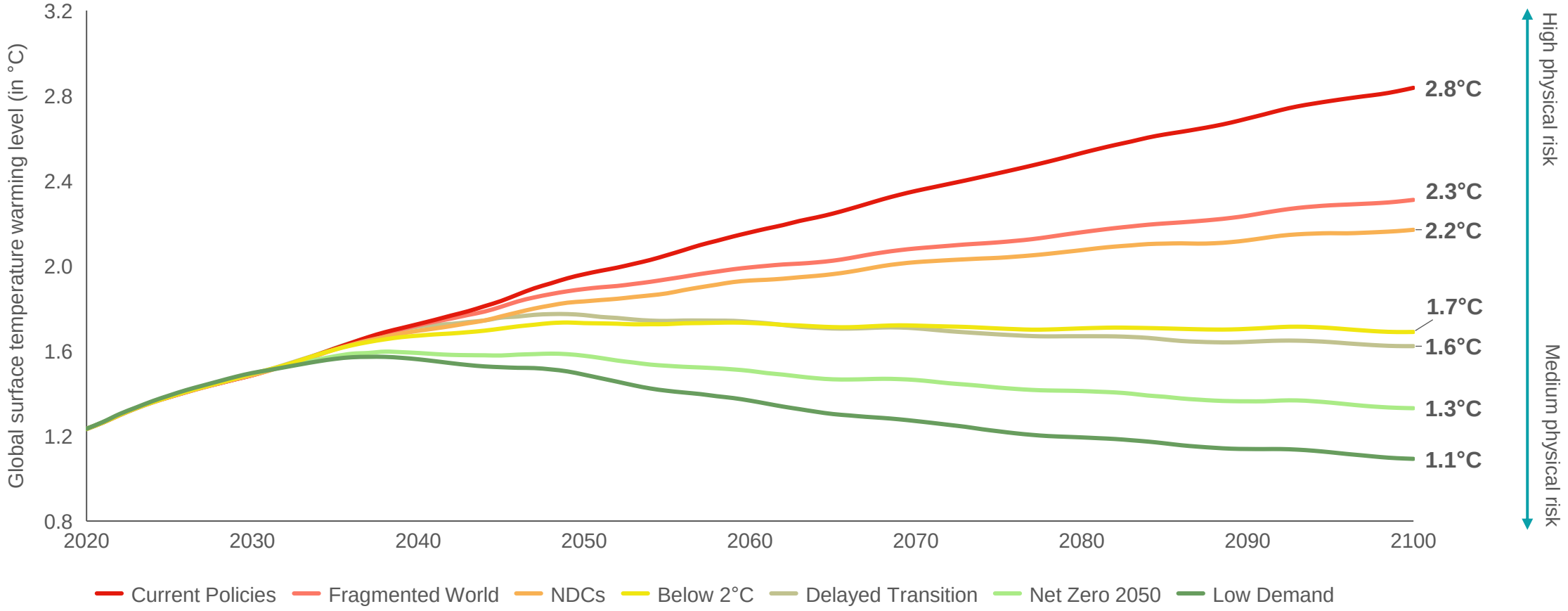
Key Results from Phase IV

Temperature pathways

Orderly and Delayed Transition scenarios reach peak temperatures around mid century; in other scenarios, temperatures keep rising



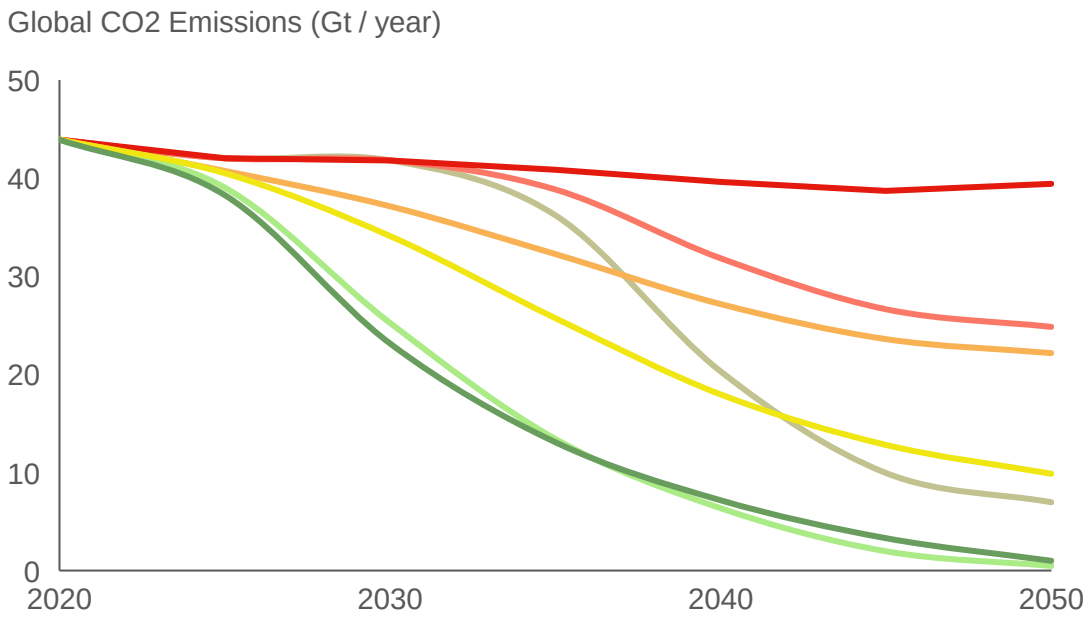
Source: REMIND-MAgPIE 3.2-4.6

Carbon emissions & shadow carbon prices

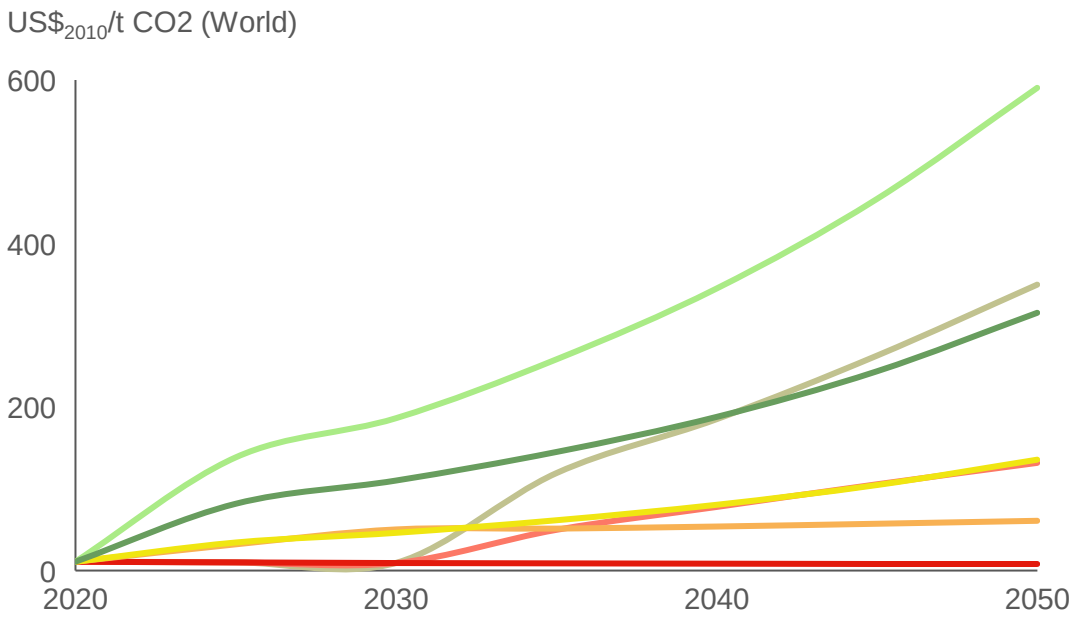
Orderly scenarios require more significant carbon reductions, which calls for higher shadow carbon prices

⚠ ***Carbon prices in NGFS scenarios are 'shadow' carbon prices, reflecting overall climate policy stringency (i.e., they are not just a carbon tax)**

Emissions barely decrease in Current Policies, while they are reduced to (near) zero in NZ2050



Carbon prices remain at current levels in Current Policies, while reaching almost $600/t in NZ2050



Delayed Transition · Fragmented World · Current Policies · NDCs · Net Zero 2050 · Below 2°C · Low Demand

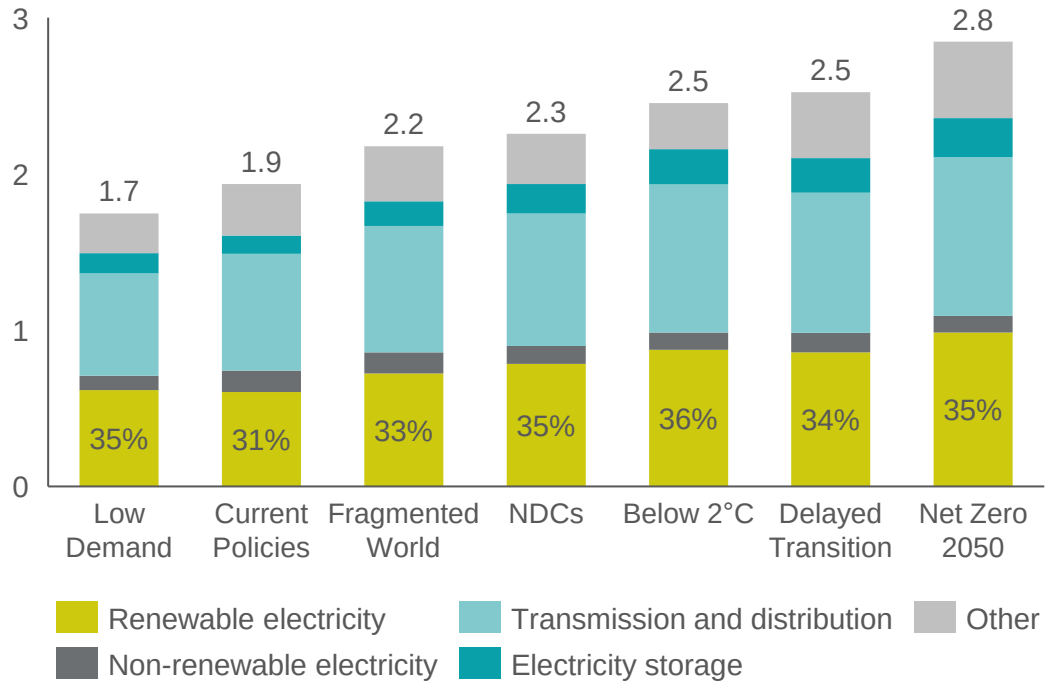
Source: REMIND-MAgPIE 3.2-4.6

Energy investments & prices

In most scenarios, global supply energy investments need to be above 2 trillion USD annually, while oil prices increase most in Net Zero 2050

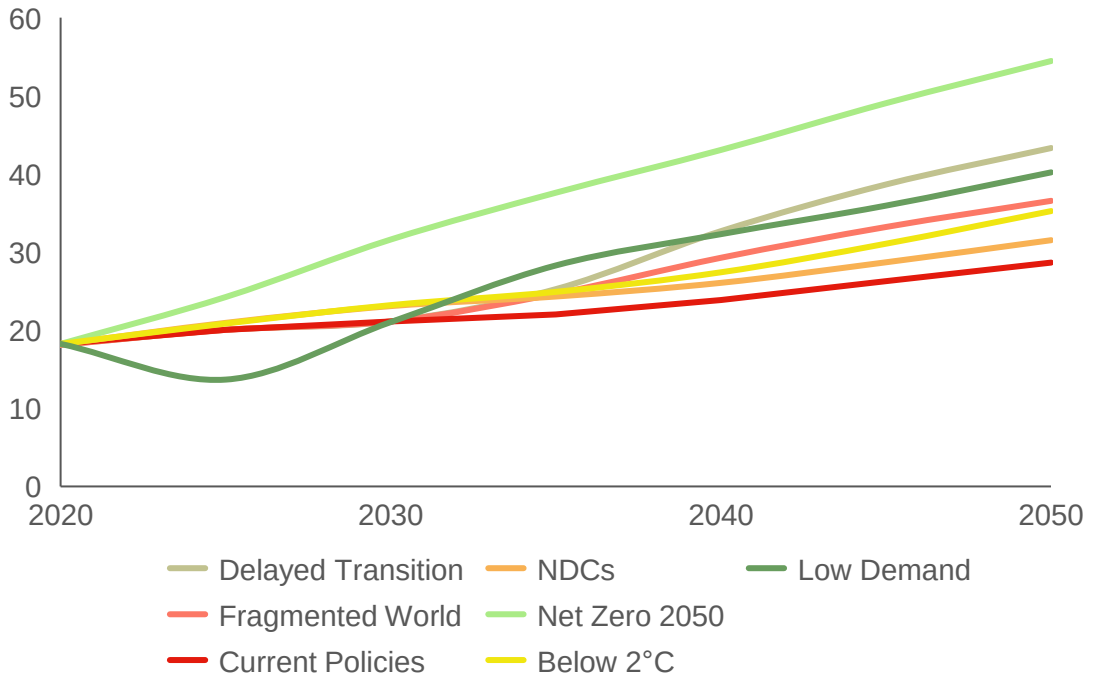
NZ2050 requires highest investment, while Low Demand reaches similar warming levels with lowest investments

Average yearly global energy supply investment: 2020 - 2050 (in trillion US$$_{2010}$$)



Residential oil price will increase most significantly in Net Zero 2050 scenario due to high carbon prices

Oil price in US$$_{2010}$$/GJ (Final energy - Residential - World)

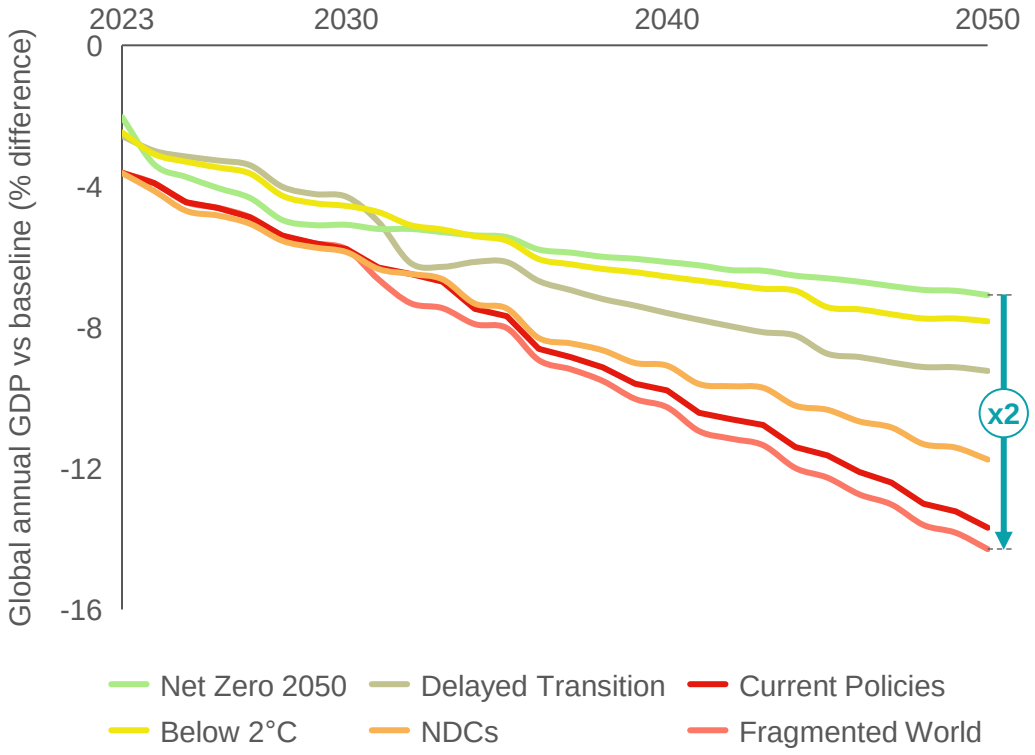


Other includes CO2 Transport and storage, Heat, Hydrogen, Liquids, and Other energy supply

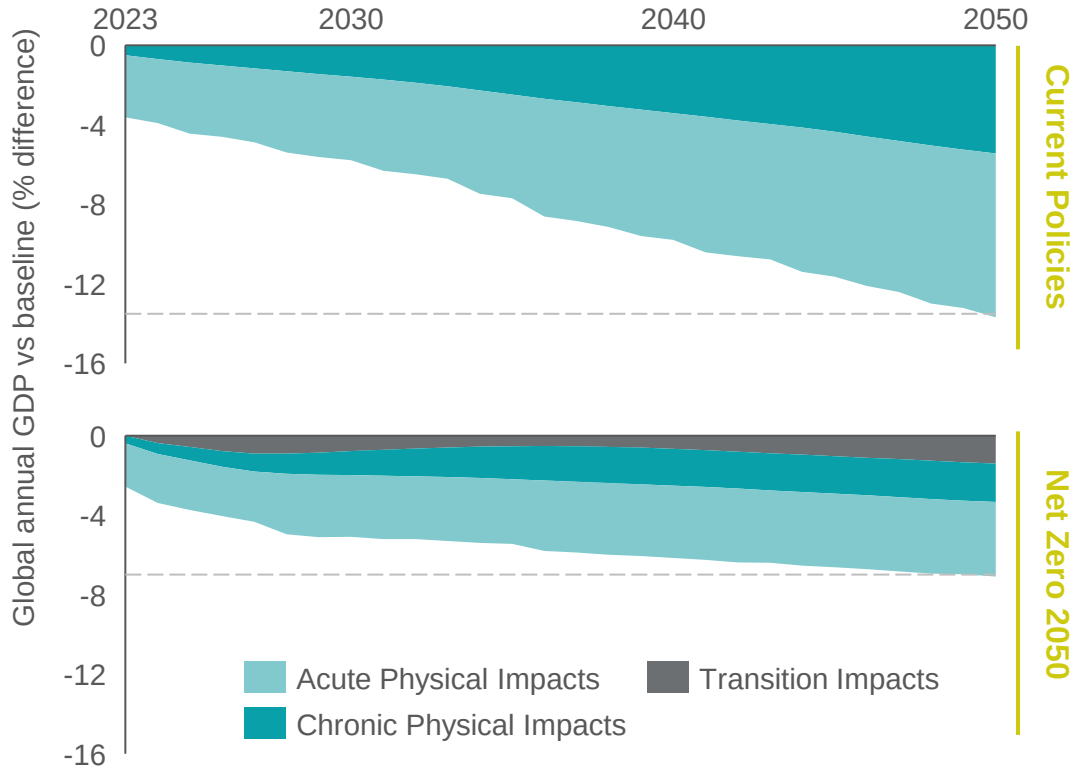
GDP impacts

Climate change reduces global GDP across all scenarios(*), but physical damages deepen losses in Hot House & Fragmented World scenarios

By 2050, annual global GDP losses would be 2 times higher in Fragmented World than in Net Zero 2050



Transition losses are dwarfed by physical losses, which hurt global GDP by 13.5% in Current Policies in 2050



(*) Compared to a baseline scenario without climate change.
Baseline constitutes a fictional scenario in which climate change does not occur, i.e., there are no physical or transition risks

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Data Access and Usage

NGFS scenario portal

If you like to learn more about the scenarios, check out the NGFS scenario portal

The portal provides a quick overview of key information about the scenarios

Purposes for scenario usage are described, as well as high-level info on how to use them

Assumptions and key indicators for each of the seven scenarios can be explored

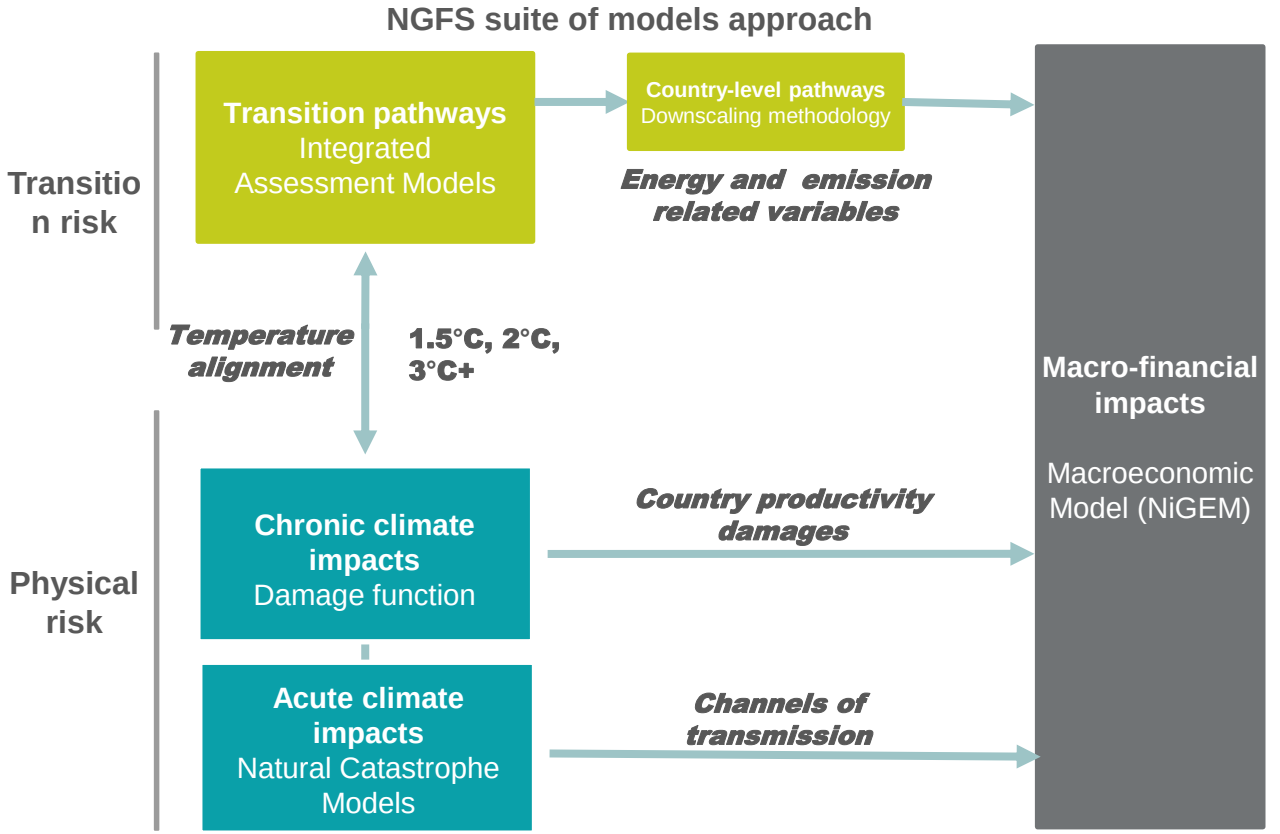
Links to various NGFS data sources and publications can be found here

Source: https://www.ngfs.net/ngfs-scenarios-portal/

Overview: Modelling and scope

The NGFS scenarios provide a range of data on climate-related transition risk, physical risk and economic impacts. This is produced by a suite of models aligned in a coherent way.

- **Transition variables** are separately produced by the three **Integrated Assessment Models** (IAMs): GCAM, MESSAGE and REMIND. These flow into the economic modelling.
- **Climate and physical risk variables** are produced by **separate modelling**. They provide chronic and acute physical risk indicators, that likewise flow into the economic modelling.
- **Macro-financial variables** are produced by the **econometric model NiGEM**, based on respective IAM and physical risk inputs.



Overview: Key dimensions of data

NGFS scenarios have several key model outputs that are distributed across several dimensions.

Models

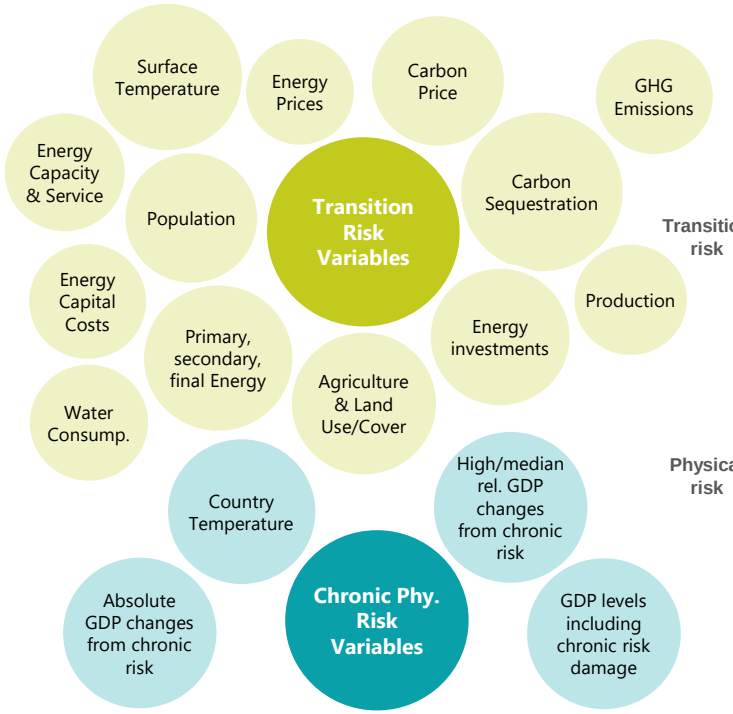
3 IAMs
1 Econometric model (NiGEM)
1 Damage function

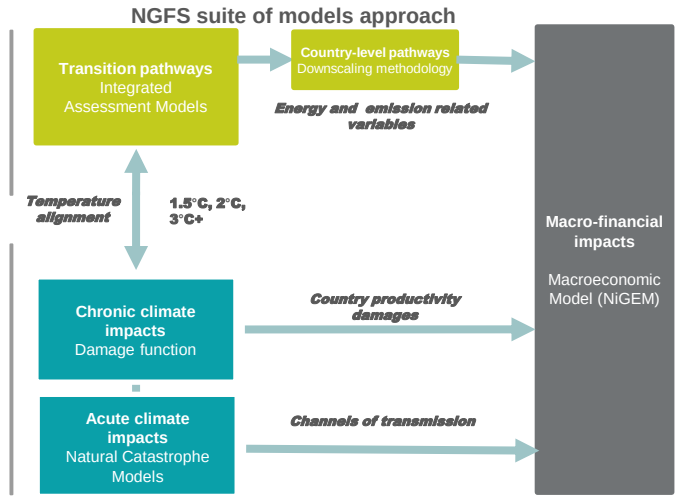
Time

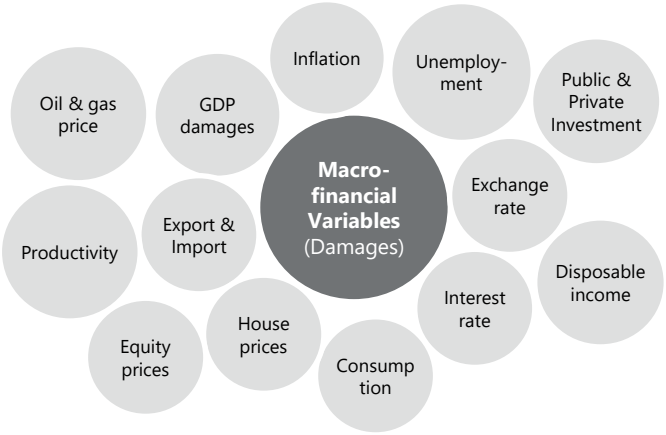
IAM data until 2100 in 5-year steps
NiGEM data until 2050 in yearly steps

Regions

Regional granularity differing by model.
Scope from **world** over **regional aggregate** to **country-level downscaling**



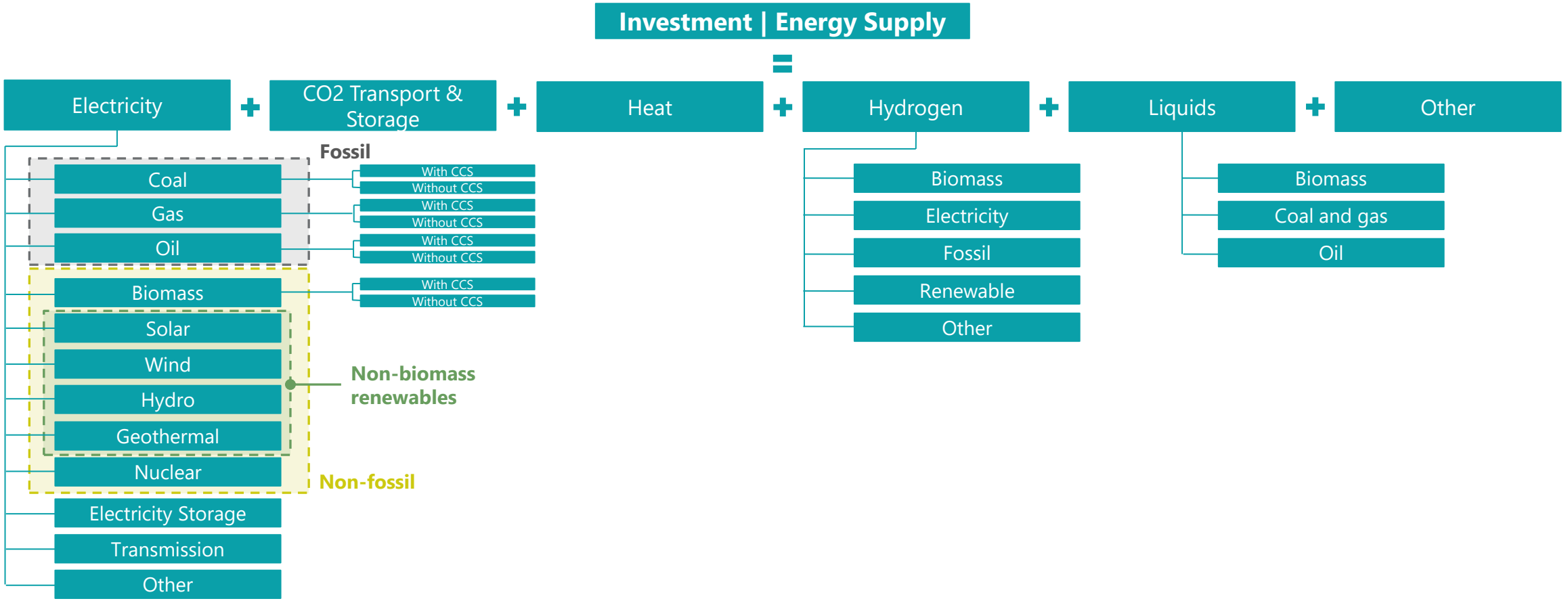




For an overview, we recommend using the IIASA Scenario Explorer as well as the EnTry Parameter Guide to identify available dimensions and parameters as well as combinations thereof.

Transition Variables: Granularity

Transition variables can be accessed in very granular or more aggregated form. Example of transition variable 'Investment in Energy (Supply)':



Physical Variables: Statistical Moments

Physical risk variables are reported based on underlying assumption on different percentiles in their stochastic modelling.

Relative GDP losses from chronic physical risk

Model producing GDP loss estimate	Percentile loss estimate	Percentile temperature	Currency
Chronic damage function (Kalkuhl & Wenz 2020)	Median (50th percentile)	5th percentile 50th percentile 95th percentile	USD
	High (95th percentile)**	5th percentile 50th percentile 95th percentile	USD
IAM (REMIND Integrated Run)	Median (50th pct.) High (95th pct.)**	50th percentile?	USD
NiGEM*	High (95th pct.)**	**Cur. Pol. & Fragm. Wrld: 95th pct.** **Other: 50th pct.**	USD Local

Relative GDP losses from acute physical risk

Floods are represented by a single variable (single shock), while for each other hazard, 9 variables exist (stochastic trial)

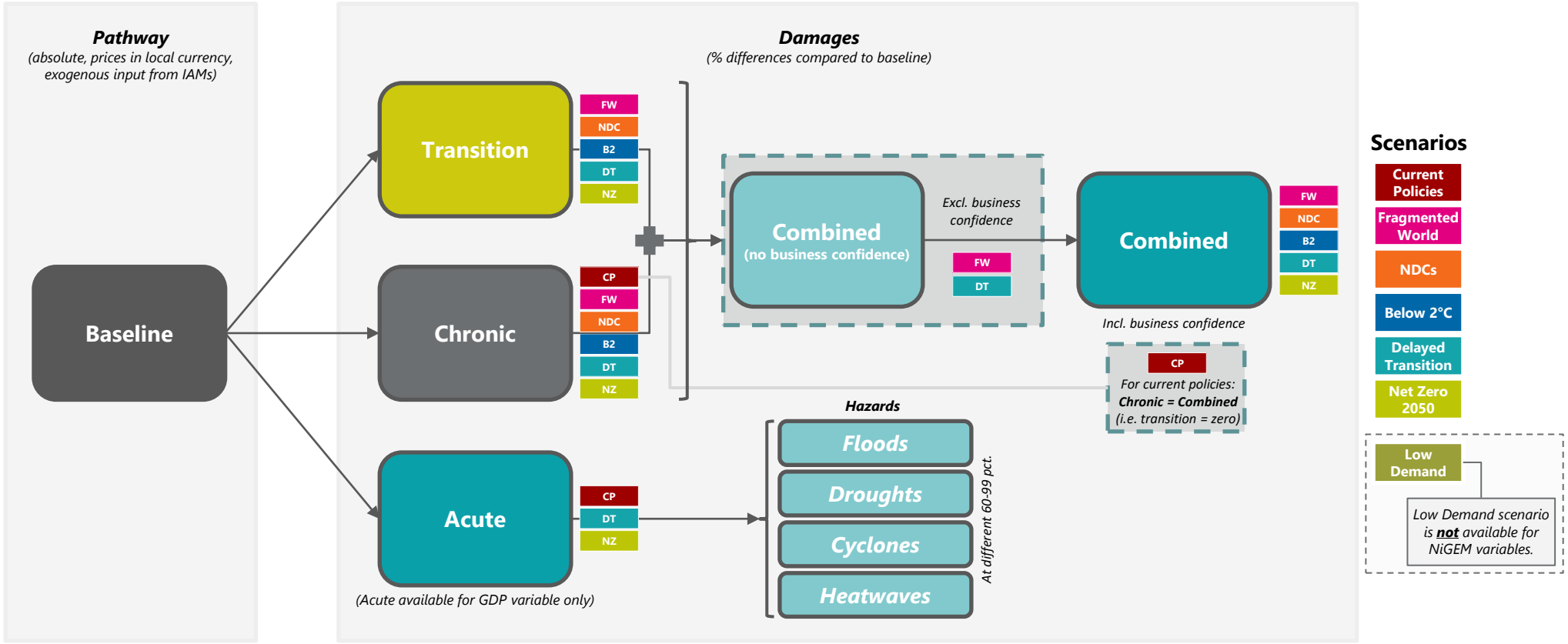
Droughts	60th pct. 85th pct. 65th pct. **90th pct.** 70th pct. 95th pct. 75th pct. 99th pct. 80th pct.	
Heatwaves		
Cyclones		
Floods	Single value	

90th percentile used as default value for acute physical risk

*NiGEM uses GDP loss data from damage function, downscaled to country-level as input (not the integrated run data)
**High loss estimate is used for chronic physical risk to reflect the absence of some chronic physical risk sources in the damage function, which estimates losses based on global mean temperature increases only

Macro-financial Variables: Climate risk types

Macroeconomic and financial variables come as damages for different climate-related risks, being transition as well as chronic and acute physical climate risks, for a baseline specific to input IAM- and region.



Overview: Data access and navigation methods

NGFS climate scenario data is published on two native platforms. There are several ways to access the data, based on users' analytical processing needs.

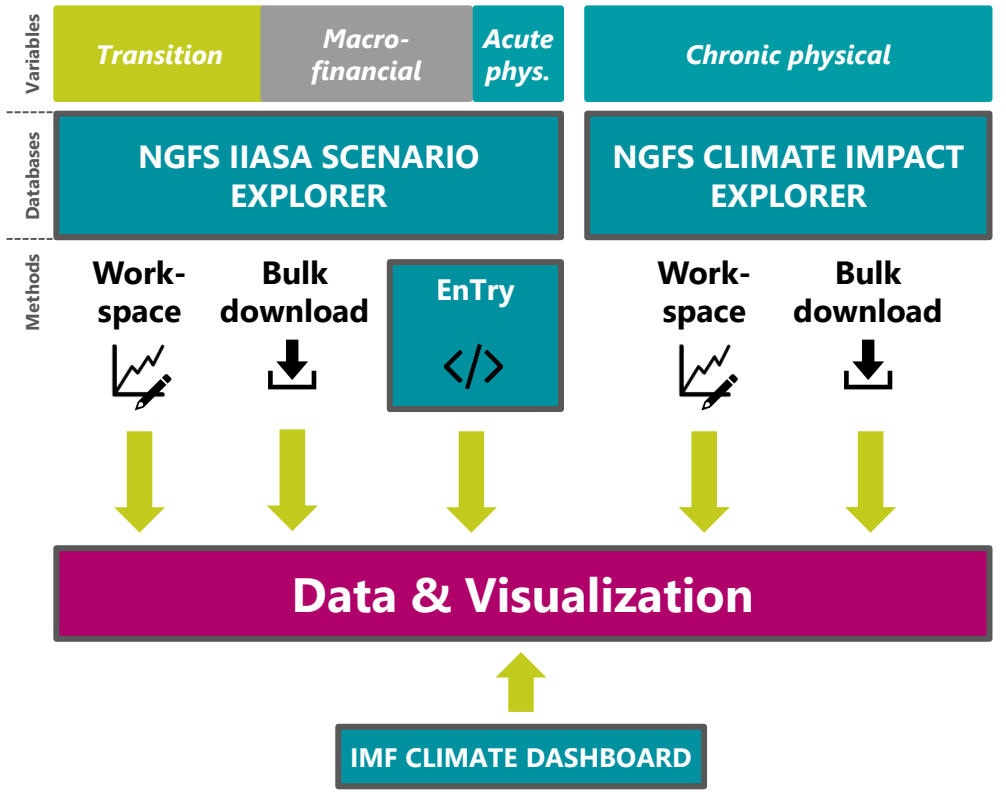
There are three main access methods to NGFS climate scenario data:

Workspaces: Both native data explorers, **NGFS IIASA Scenario Explorer** and **Climate Impact Explorer,** provide online interfaces to visualise and explore the data. Users can explore and compare variables over scenario, region and model.

Downloads: The full data can be downloaded in bulk or filtered as .csv or .xlsx data frames from the **NGFS IIASA Scenario Explorer** or **Climate Impact Explorer**.

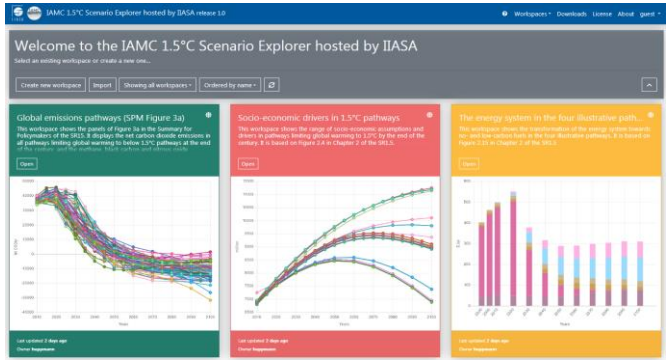
Code-based access: Both data explorers provide APIs to access the data in coding scripts directly. To facilitate users' access to this method, we provide the **NGFS EnTry Tool** (see slide 32).

Additionally, the **IMF Climate Dashboard** offers a user-friendly exploration tool for key NGFS scenario data variables and respective visualization.



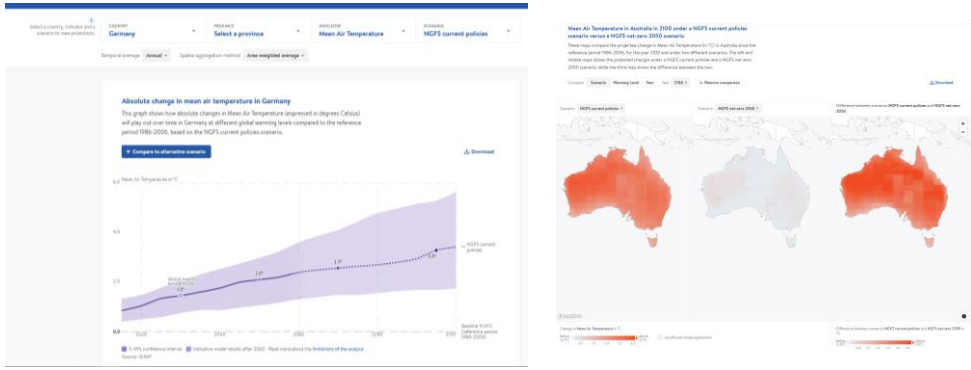
Overview: Two native databases

The IIASA Scenario Explorer provides access to all NGFS scenario data.



- The **NGFS IIASA Scenario Explorer** provides intuitive visualisations and display of the transition scenarios time series data. This database also includes macro-economic data from NiGEM as well as data on acute physical risk impacts.

The NGFS Climate Impact Explorer provides access to additional climate data in line with NGFS scenarios.



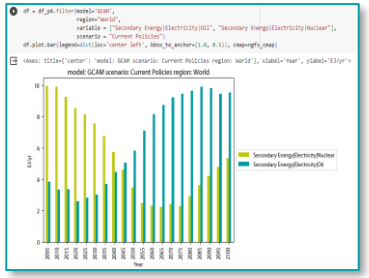
- The **NGFS Climate Impact Explorer** provides intuitive visualisations and display of the physical scenarios time series data, not limited to input used for the NGFS scenarios.

Overview: NGFS EnTry Toolkit

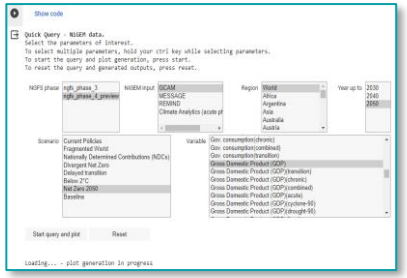
The NGFS Data EnTry Tool allows users to use or build their own code-based scripts to analyse the scenario data starting from templates.

The tool includes several scripts with examples to showcase its features and easy ways to attain and present the data of interest.

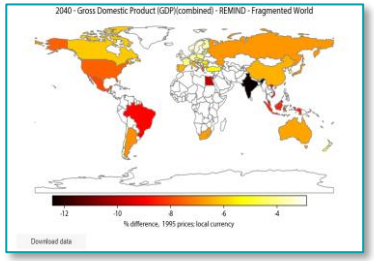
1. Demo of all basic functionalities
   → Gives a tour through the functionalities of the tool.



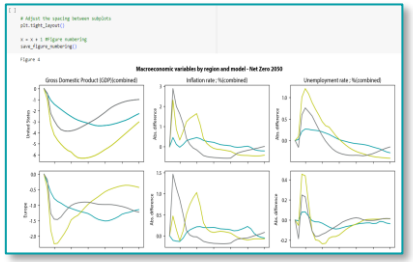
2. Quick Query Tool & Parameter Guide
   → Provides an easy ad hoc way to query and download data across models, scenarios and phases, as well as plot in NGFS style



3. Quick Map Tool
   → Provides an easy ad hoc way to produce maps based on available country-level data across models, scenarios and phases.



4. Report Template
   → Template to create NGFS-themed reports with plots and descriptions.

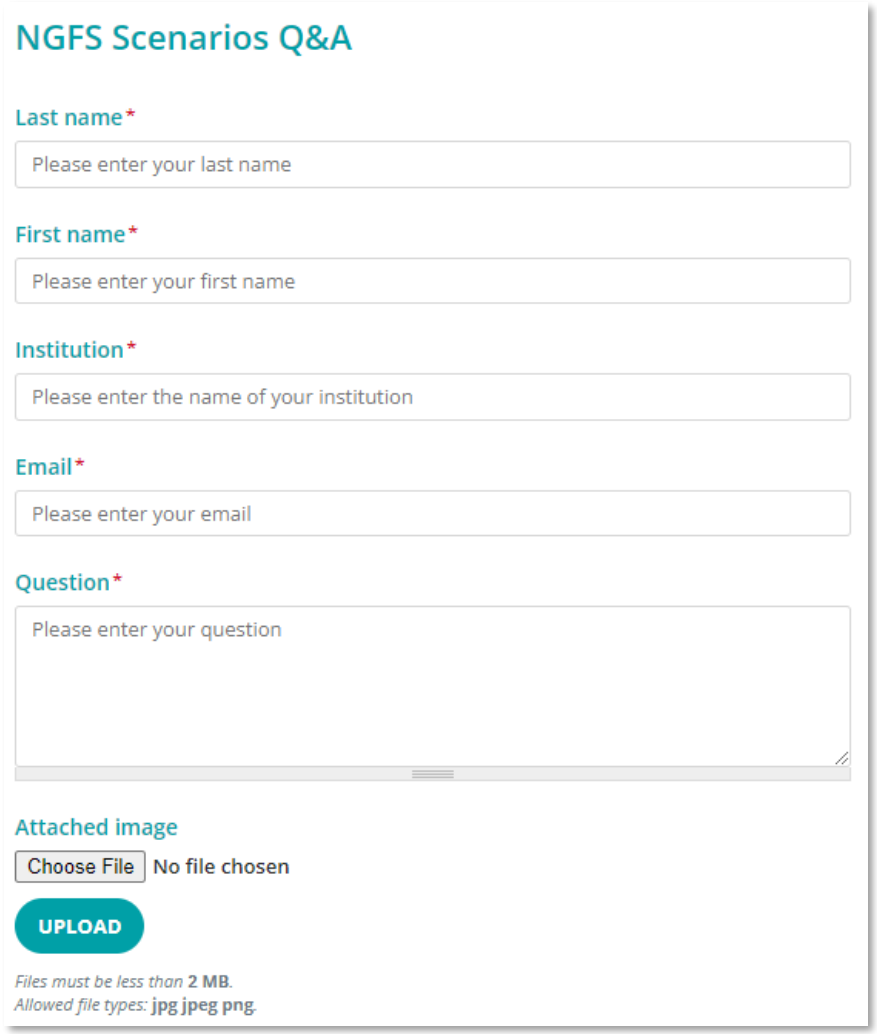


The **NGFS Data EnTry Tool** is available on the NGFS scenario portal under Data & Resources. Additional scripts are provided within publication documents to provide full transparency of the presented visuals and the underlying data.

Additional Resources – Understanding the data

Any questions about the NGFS scenarios?

- Understanding the large number of assumptions and context underlying the data is tricky.
- For answers to your questions, you can check out our **FAQ page.**
- If your questions are not answered there already, you can submit them to our **NGFS Q&A portal** and we will do our best to answer them.
- Additionally, refer to the revamped Phase IV **Technical Documentation** for data explanations.
- For the data access, refer to the **Data Access User Guide**.



4

Future Development

Next steps

We will explore further avenues to improve the long-term scenarios

- Enhance the **physical risk modelling** (e.g. improve the chronic risk damage function, explore how to reflect tipping points & compound risk)
- Expand the **sectoral granularity**, disaggregation methodology to be released with updated long-term scenarios.

We will develop short-term climate scenarios

- Looking into short-term **tail risk** scenarios
- Assuming very **severe transition risks** due to disorderly transition and/or **severe natural disasters**
- Accounting also for **compound effects** and second round effects of climate change

Timeline

Phase V update of LT scenarios: October 2024	First release of ST scenarios: early 2025