Scotiabank™

Impacts of climate risk on corporate lending

07 JULY 2022

Agenda

01 Regulatory landscape

02 Climate risk modelling

03 Integration of climate scenario modelling

01

Regulatory landscape

Increasing attention on climate change from regulators and banks

Disclosure of climate risks becoming standardized through overlapping global initiatives:

- Task force on Climate-related Financial Disclosures (TCFD)
- United Nations Environment Programme Finance Initiative (UNEP FI)
- Carbon Disclosure Project (CDP)
- Partnership for Carbon Accounting Financials (PCAF)

Financial Stability Board (Basel Committee):

- Actively investigating the extent to which climate-related financial risks can be addressed within the existing Basel Framework

Bank of Canada + Office of the Superintendent of Financial Institutions (OSFI):

- Issued several papers ran pilot in 2021 with 2 peer banks related to impacts from climate change
- OSFI announcement of B15 guideline yesterday

Scenario analysis to support climate change risk management needed for:

- Bank commitment for full TCFD reporting by end of 2022
- Support of the BNS commitment to mobilize $100Bn to reduce impacts of climate change
- Support of the analysis for pathways to lower the carbon intensity of Scotiabank's lending profile

Bank of England's Climate Biennial Exploratory Scenario (CBES)

Pilot project completed in Q4 2021

- Examining the risk to climate change through different climate pathways

1) Early Policy Action Pathway:

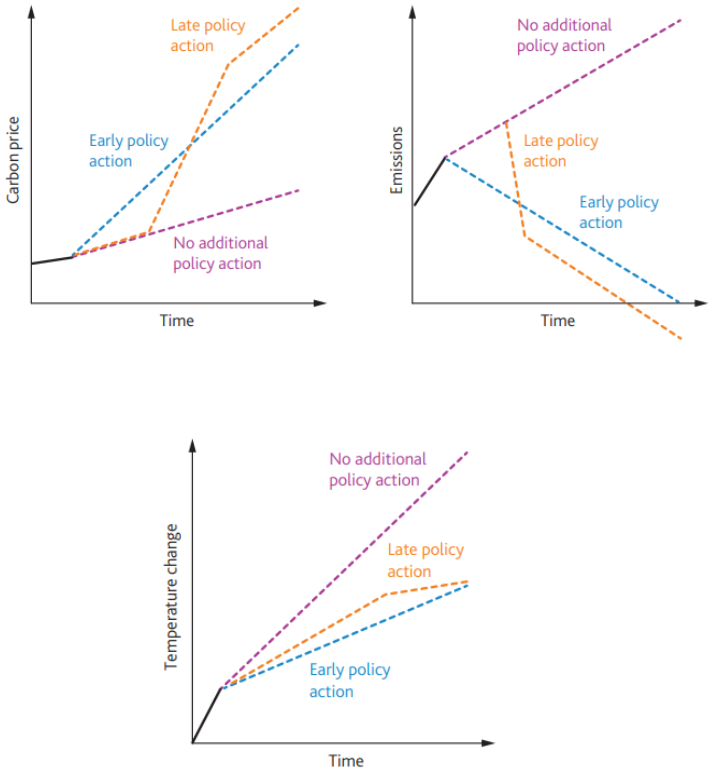
- Carbon prices and other policies are introduced slowly and the increase in global temperature stays below 2°C, in line with the Paris Agreement.
- Overall level of physical risk remains subdued.

2) Late Policy Action Pathway:

- The global climate goal is also met but the transition is delayed until 2030 and must be more sudden and substantial to compensate.
- The Bank expects this to result in a material short-term macro disruption.

3) No Additional Policy Action Pathway:

- No policy action beyond that which has already been enacted is delivered.
- Thus, the transition is insufficient for the world to meet its climate goal, leading to severe physical risks.



Source: Bank of England 2020

02

Climate risk modelling

Financial risks from climate change

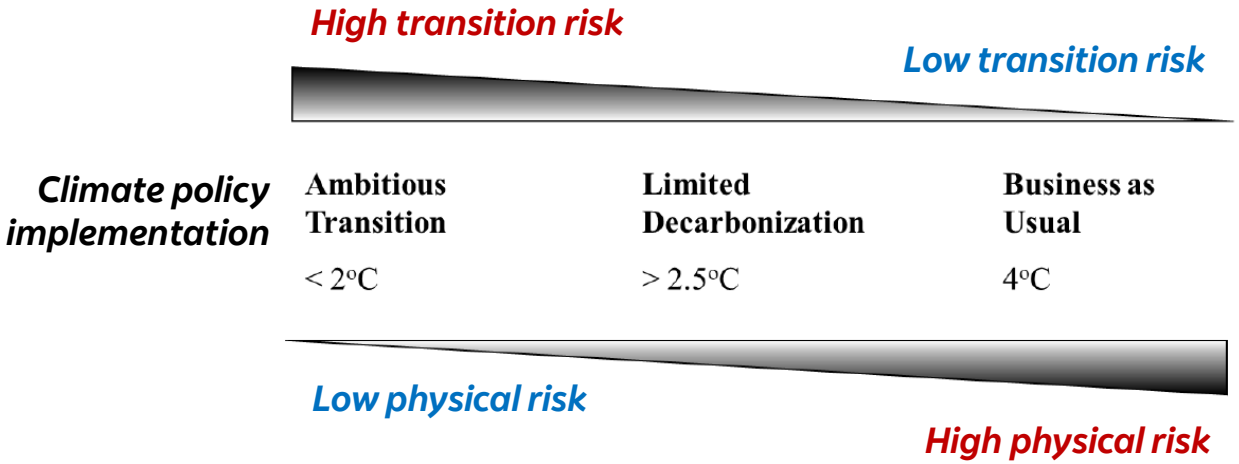
Transition risk

- Shifts in global markets towards low-carbon processes
- Emission pricing

Physical risk

- Shifts in climate patterns and impacts on assets

Pathways have coupled physical and transition risks linked to the assumptions for climate policy implementation



Source: Kastner 2020

Modelling climate change

2 Major Scientific Fields

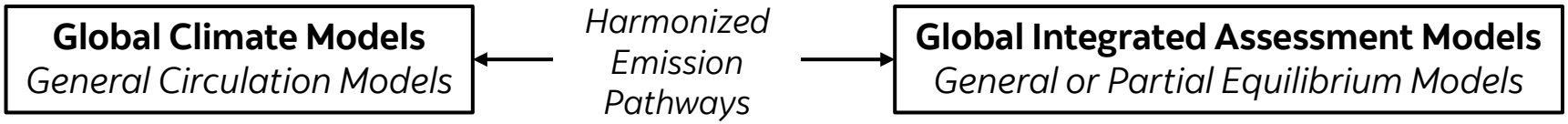
1) Global integrated assessment models (IAM)

- Economic models of societal responses to climate policies
- Modellers are usually economists and engineers

2) Global climate models:

- Physical models of climate outcomes under prescribed emissions and land-use
- Modellers are usually earth system scientists (global fluid dynamics, hydrology, biochemistry, etc.)

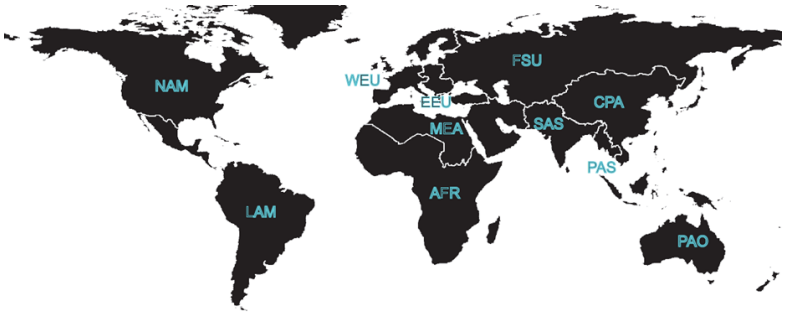
The (2) fields need to be integrated to model climate scenarios



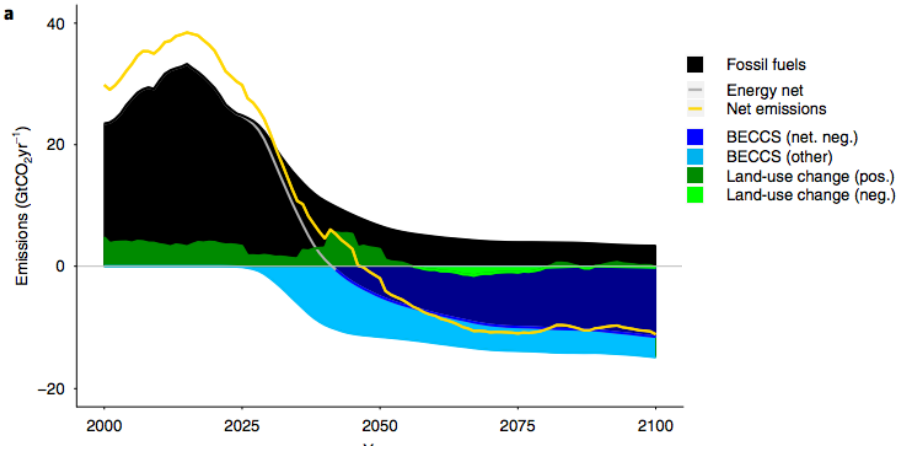
Integrated Assessment Models (IAMs)

- Finds a *pathway* i.e., a combination of energy and land use processes that minimize the total cost of meeting the future demands under policy constraints
- 11-18 macro-regions; domestic, commercial, industrial and transport demand sectors
- 5-year / 10-year future timesteps: 2020, 2025, 2030, 2040, …, 2100
- Policy constraints define limits on emissions or certain technologies
- Certain combinations of policy constraints and final outcomes are incompatible and no solution exists

Macro-regions



Example emissions pathway to 2100 consistent with 1.5C



BECCS = Bioenergy with carbon capture and storage

Source: van Vuuren et al 2018

Summary: creating a climate pathway

Pathway 1
Cumulative Emissions

Pathway 2
Cumulative Emissions

Integrated Assessment Model

Pathway 1
Emissions and land-use path

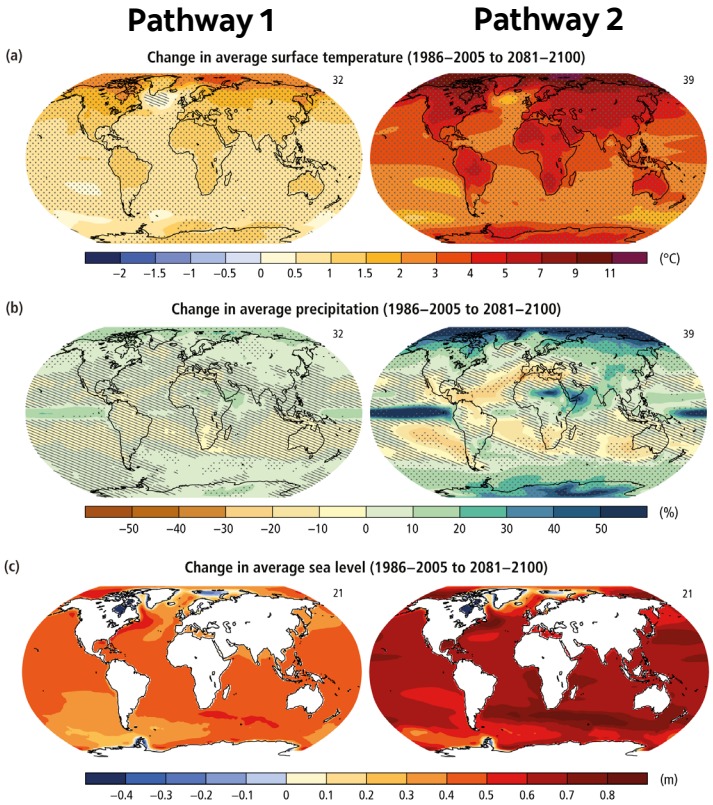
Pathway 2
Emissions and land-use path

Global Climate Model

Pathway 1
Physical climate path

Pathway 2
Physical climate path

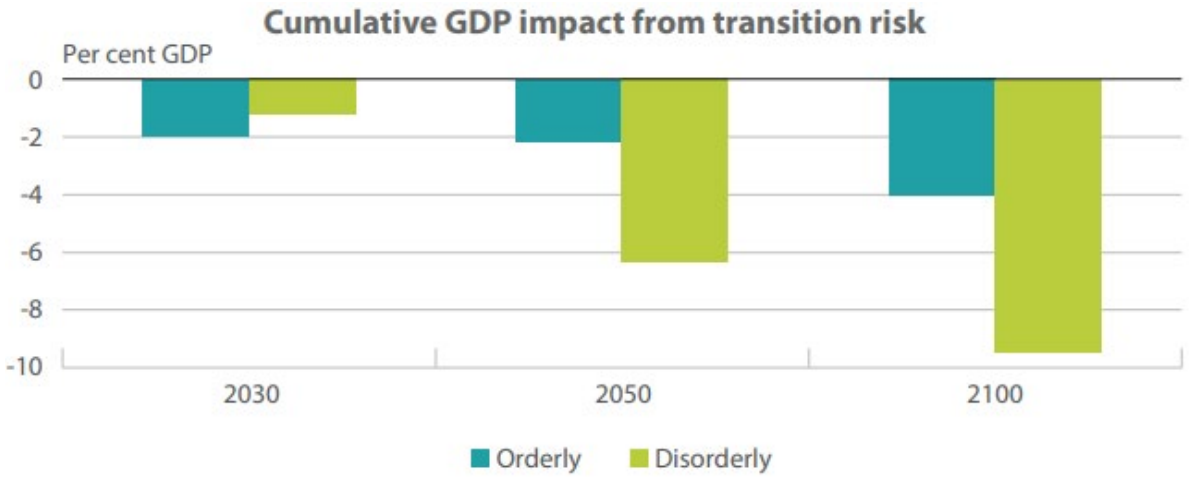
Comparison between physical climate outcomes



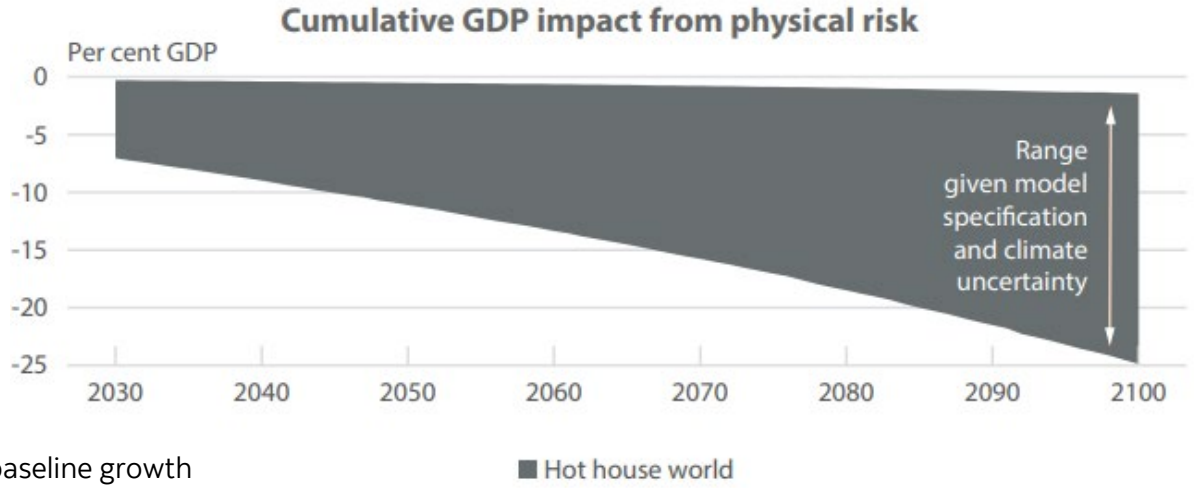
Source: IPCC 2018

Impact of Climate Risk on Economy is Large

- Estimates on the future impact to GDP[1] have significant uncertainty
- Impacts from transition risk are small or even positive depending on timeline for action



Source: IIASA NGFS Climate Scenarios Portal, marker models.



[1]GDP impact measured as deviations from the baseline growth assumptions specified by a Shared-Socioeconomic Pathway (SSP)

Source:NGFS

Investment required to decouple growth and emissions

Investments in all sectors needed to decarbonize the economy. Energy, Transportation, Industry, Real Estate, Agriculture and Land use are Key sectors for decarbonization.

Potential impact of 1.5C policy on average annual renewable energy investments *(2016-2050):*

Current renewables investment

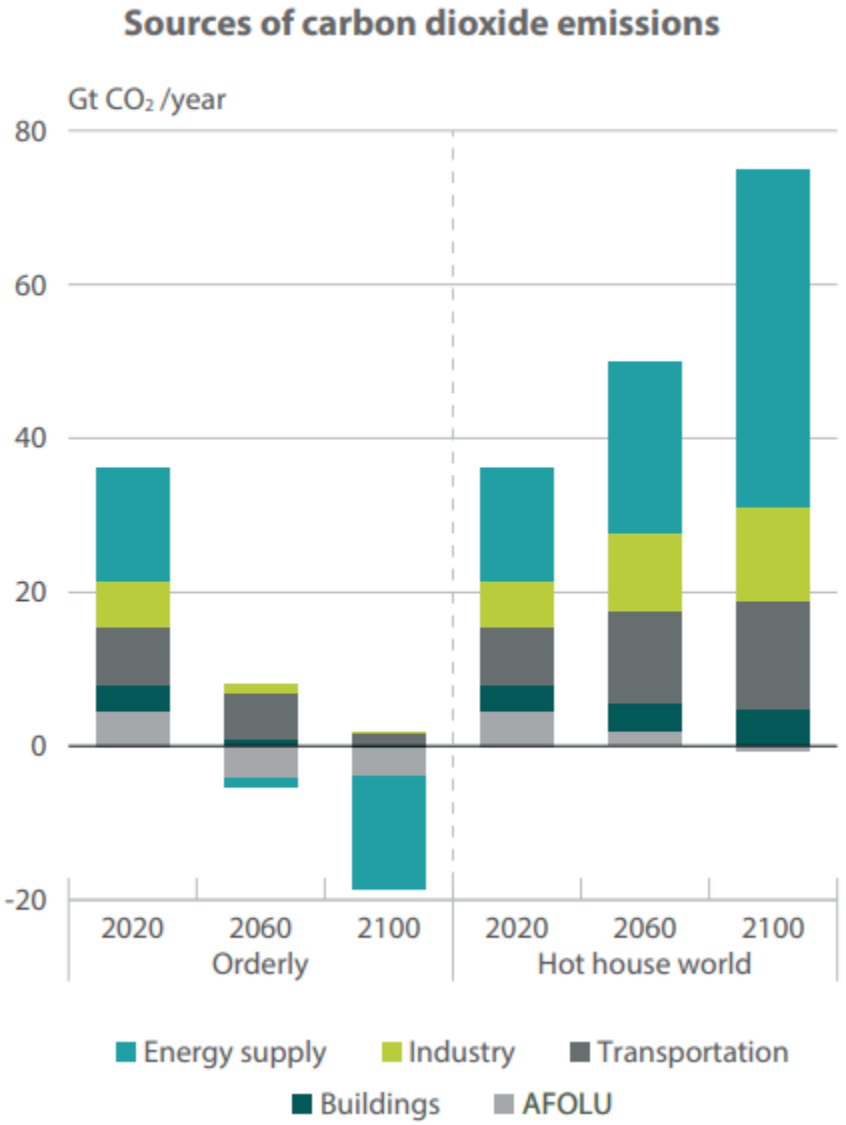
- 0.25 Trillion US$/yr

1.5 C renewables investment

- 0.83 Trillion US$/yr

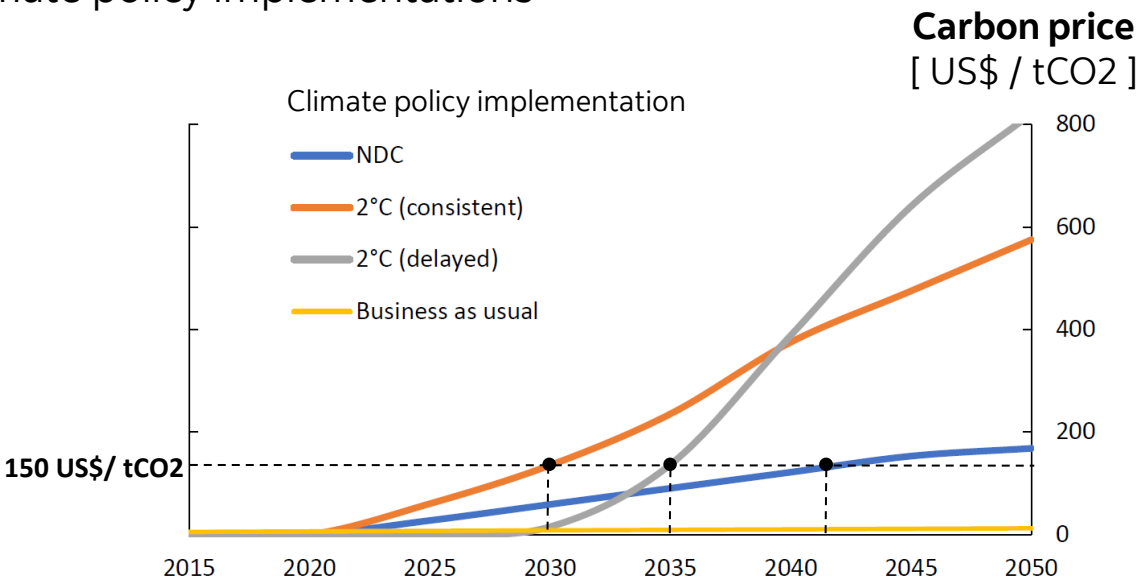
INCREMENTAL investments :

- +0.58 Trillion US$/yr



Use outputs from IAMs to forecast transition risk

Integrated assessment models (IAMs) project future carbon prices under alternative climate policy implementations



NDC =
Nationally Determined Contribution
The pledges each country made in response to the Paris Agreement to reduce national emissions and adapt to the impacts of climate change.

Potential impact of carbon pricing at a company-level

Example: Company A

- Reported Emissions for 2020: **339,000 tCO2**
- Under 2C consistent scenario: **150 US$ / tCO2** carbon tax in 2030 (see graph above)
- Impact on operating cost: **50.85 million US$/year [2.38 % of reported operating profit in 2020]**

Source: Bank of Canada, 2020; Company A, 2021

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Integration of climate scenario modelling

Scenario Narratives and Overview

Nationally Determined Contributions

Scenario includes all pledged polices, regardless of implementation status. CO_2 emissions decline and lead to warming of about 2.5ºC by 2100.

Physical Risk – Moderate to High

Transition Risk - Low

Net Zero 2050

Scenario limiting global warming to 1.5ºC with strong climate policy action. CO_2 emissions reach zero near 2050, giving a 50% chance of limiting warming to 1.5ºC by 2100.

Ambitious policies introduced immediately. Moderate reliance on carbon dioxide removal technology to accelerate the transition.

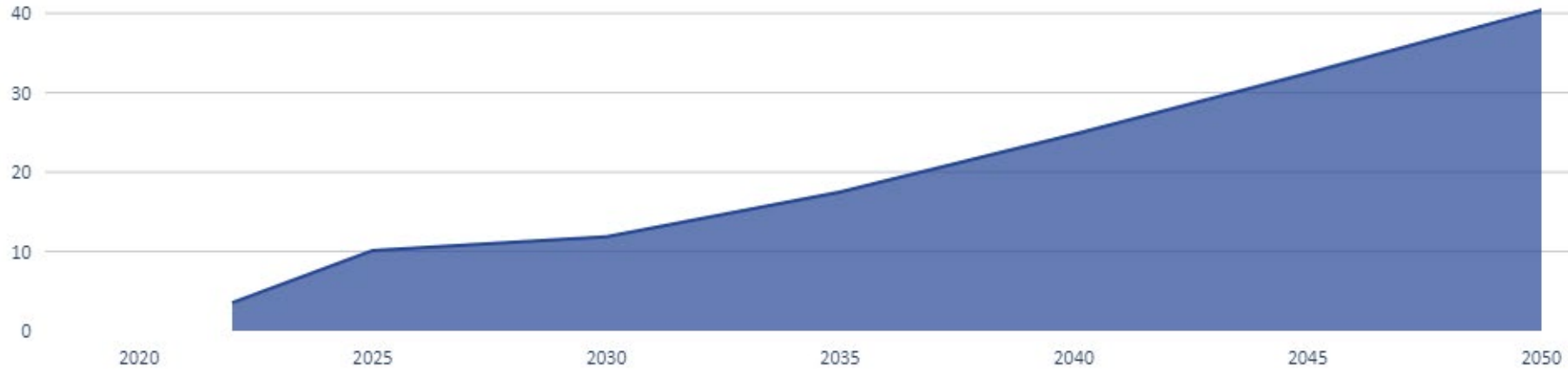
Physical Risk – Low

Transition Risk – Moderate to High

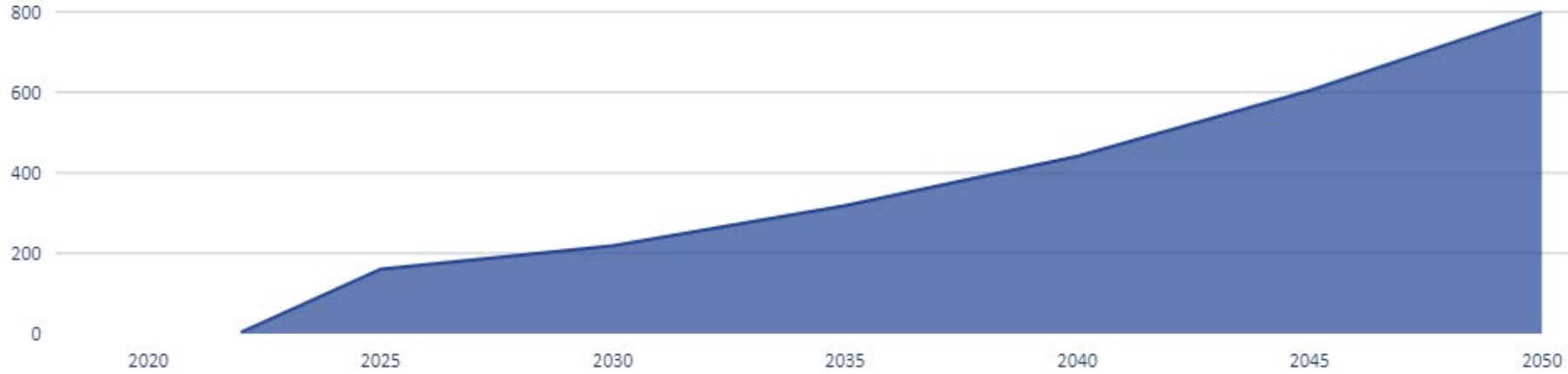
Source: NGFS

Scenario Variables – Net Zero 2050

Carbon Price, NDC Scenario (2020 USD/tonne CO_2)



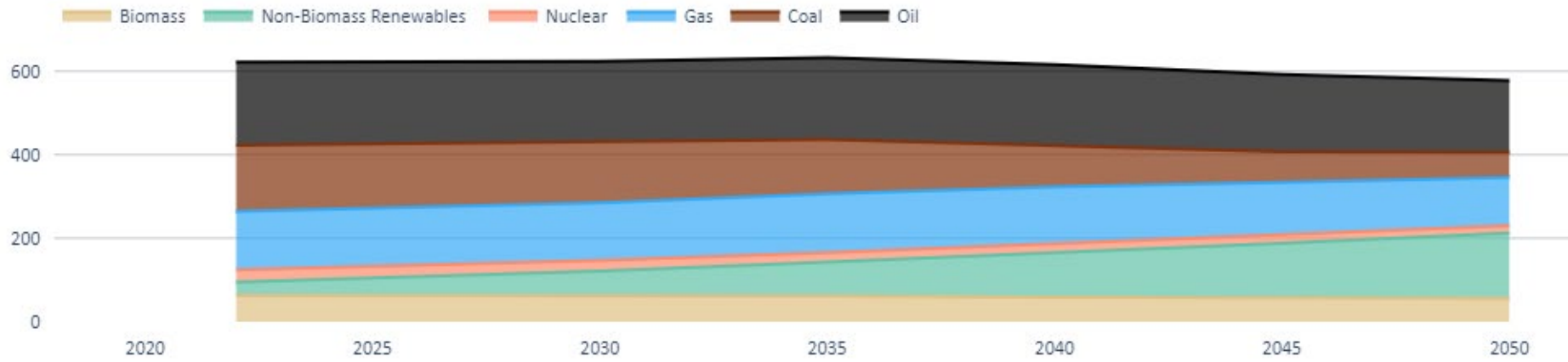
Carbon Price, Net Zero 2050 Scenario (2020 USD/tonne CO_2)



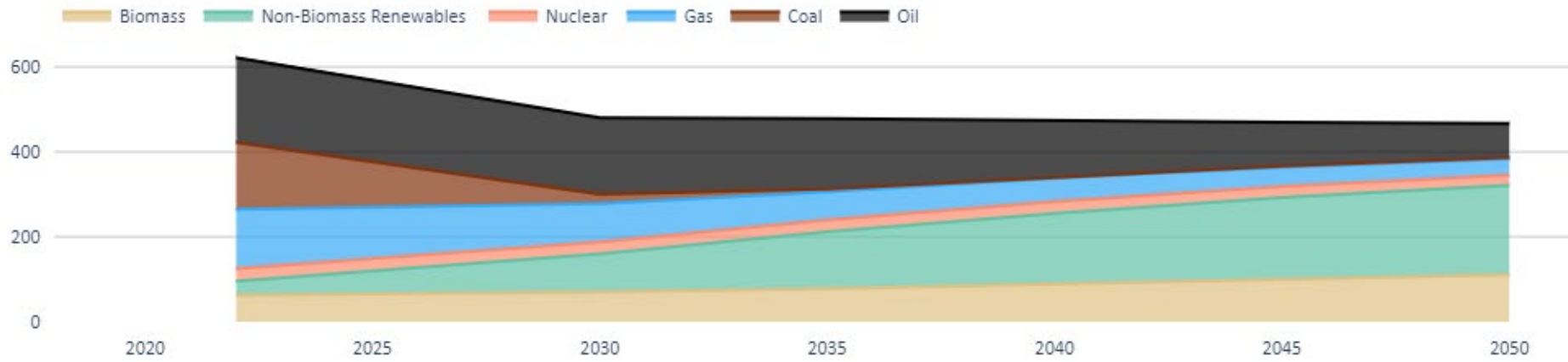
Source: NGFS

Scenario Variables - NDCs

Energy Mix, NDC Scenario (EJ/y)



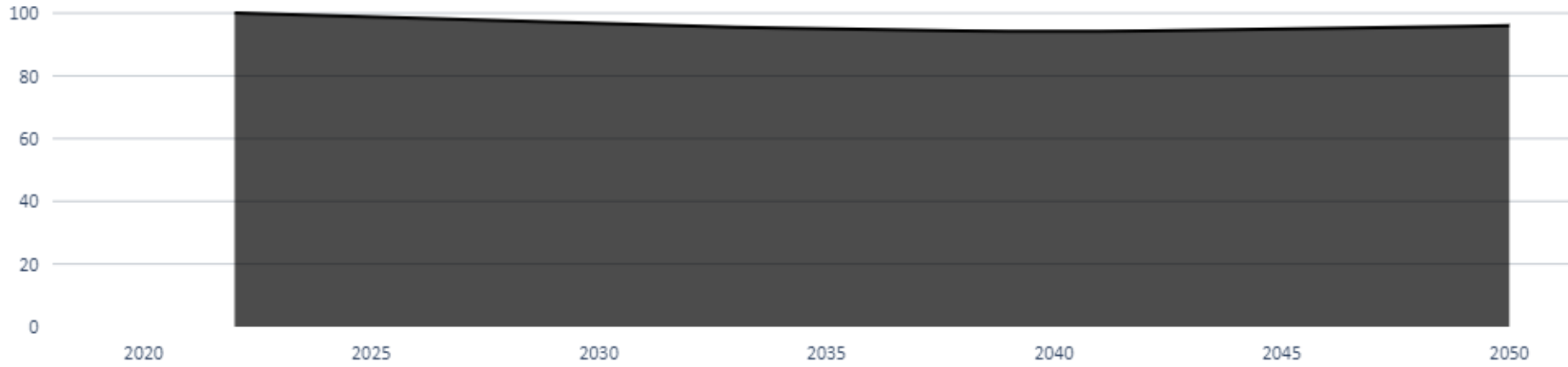
Energy Mix, Net Zero 2050 Scenario (EJ/y)



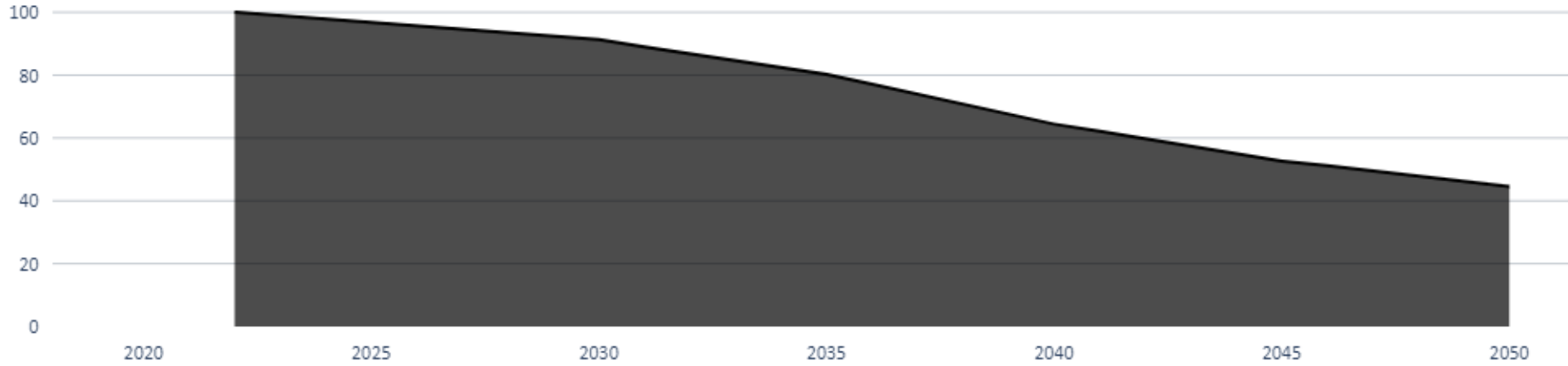
Source: NGFS

Scenario Variables – Net Zero 2050

Oil price NDC Scenario (Indexed, 100 = baseline)



Oil price Net Zero 2050 Scenario (Indexed, 100 = baseline)



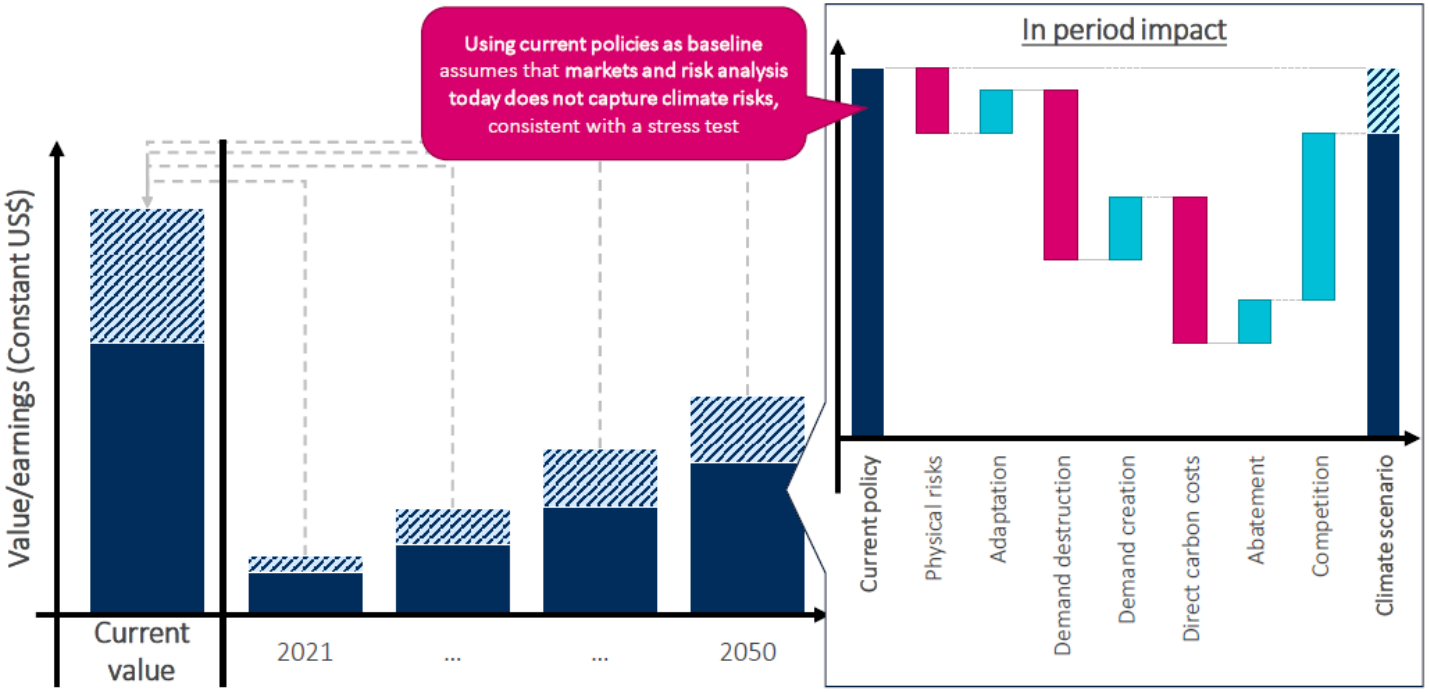
Source: NGFS

Planetrics engagement for Bank of England 2021 scenarios

Climate Scenarios → **Change in company valuation** → **Change in probability of default**

Climate scenarios use transition and physical risk from IAM and GCM

PD changes derived from Altman-Z model



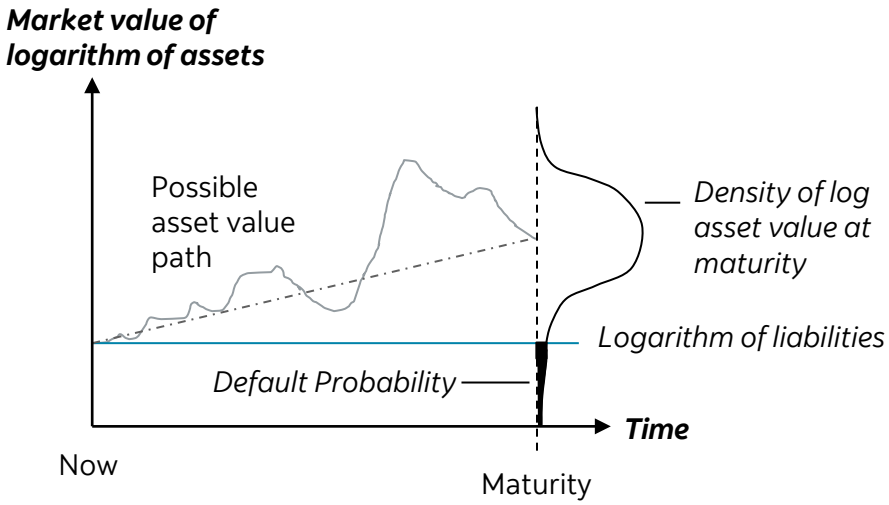
Source: Planetrics, 2021

Framework for calculating Climate-adjusted Probability of Default

Structural credit risk modeling with independent shocks to company asset valuation:

$$assets \times (\ \ 1 + shock_1 + shock_2 + \cdots shock_n\ \ ) < liabilities$$

Merton default probability



distance-to-default

$$DD = \frac{log[(1-\varepsilon)\,V/D] + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

ε = shock to asset value
V = asset value
D = liabilities (debt)
r = risk free rate
σ = asset volatility*
T = Maturity

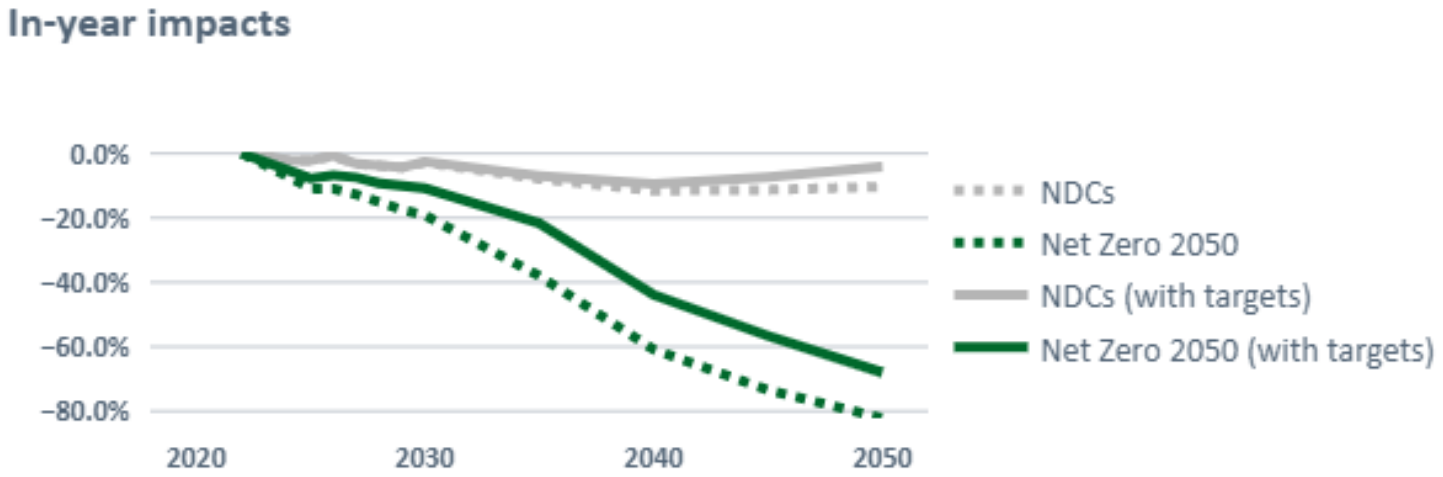
* Solved for using iterative solution of Black-Scholes pricing equation

Carbon pricing shock $\longrightarrow$ $\varepsilon = asset\_elasticity \times \frac{\Delta\ carbon\_price\ \times carbon\_intensity}{assets\ - liabilities}$

Bouchet and Le Guenedal, 2020

Example company level Impacts

Company A



	PD Impact (Altman Z)	PD Impact[1] (Merton)	PD Impact[1] (Merton w targets)
2030 (NDC)	0.28%	0.63%	0.63%
2050 (NDC)	0.41%	0.87%	0.66%
2030 (Net Zero)	1.90%	1.27%	0.89%
2050 (Net Zero)	3.69%	29.23%	13.10%

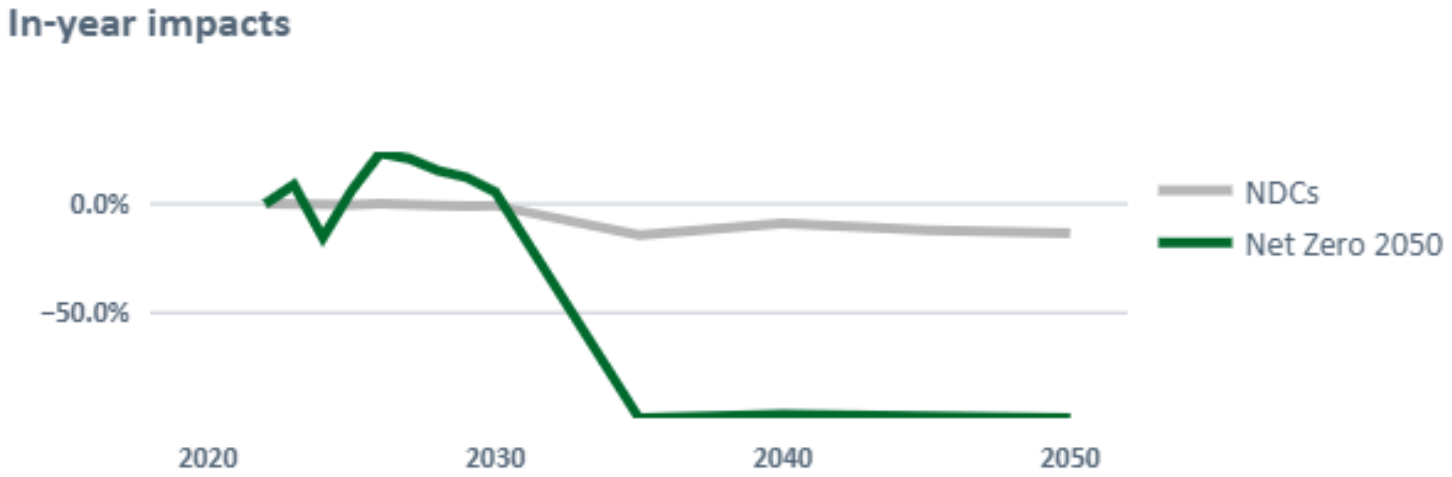
Reflecting company targets improves modelled PD outcomes

Source: Planetrics Model, In house Calculations

[1]Model still under development

Example company level Impacts

Company B



	PD Impact (Altman Z)	PD Impact[1] (Merton)	PD Impact (Merton w targets)
2030 (NDC)	1.61%	0.00%	N/A
2050 (NDC)	1.62%	0.001%	N/A
2030 (Net Zero)	7.96%	0.00%	N/A
2050 (Net Zero)	7.96%	61.26%	N/A

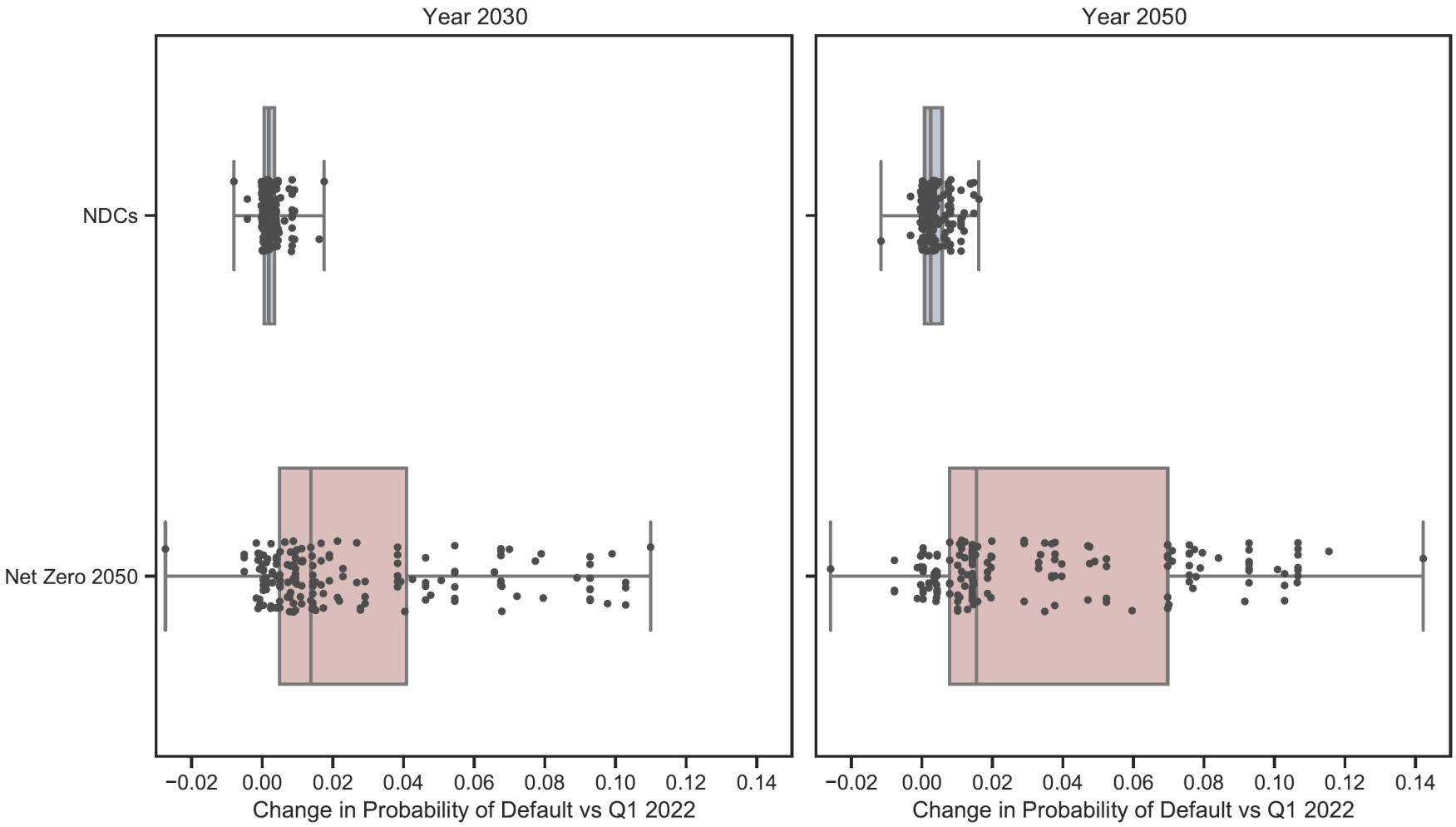
Difference between Net Zero and NDC scenarios highlights impacts of transition risk for some customers

Source: Planetrics Model, In house Calculations

[1]Model still under development

Selection of 61 customers: Probability of Default (PD)

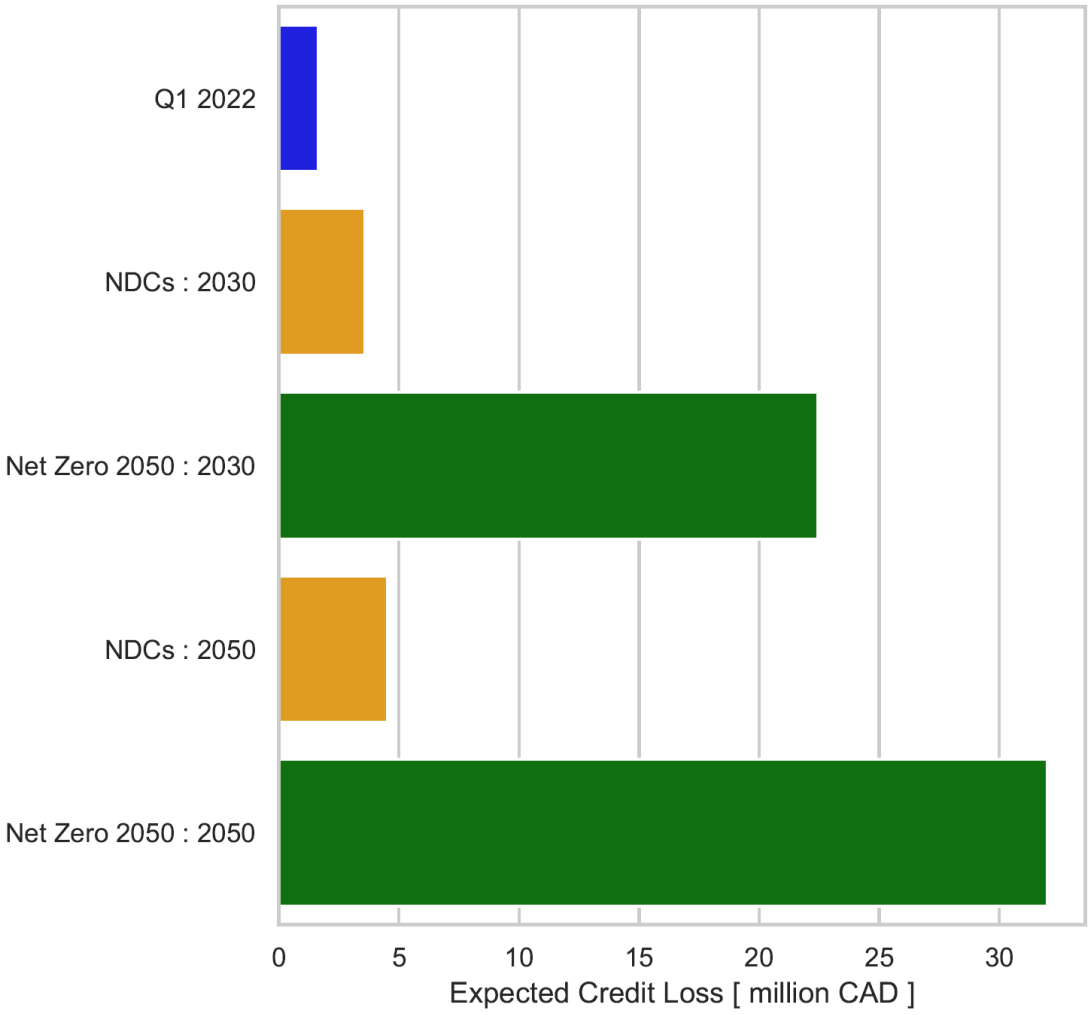
Total Outstanding Q1 2022 ~ 4 billion CAD



Boxes show the middle 50% of the dataset

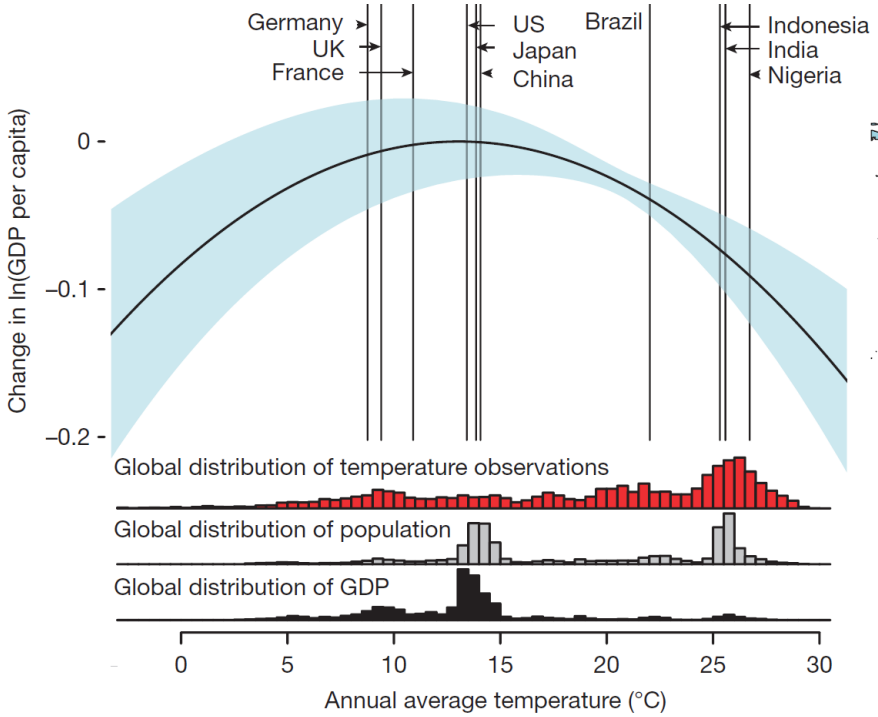
Selection of 61 customers: Aggregate performance

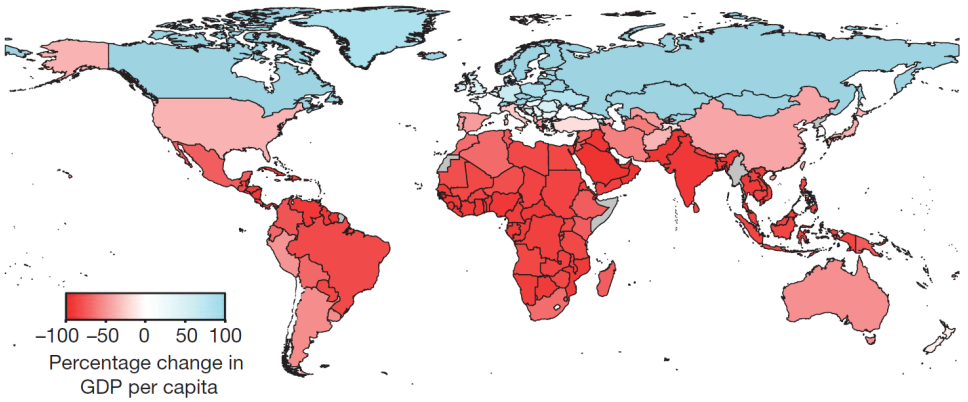
Total Outstanding Q1 2022 ~ 4 billion CAD



Use outputs from global climate models to forecast physical risk

Temperature changes projected by global climate models can be translated to country-specific changes in GDP





Source: Burke et al. (2015)