NZGBC

TE KAUNIHERA HANGANGA TAUTAIAO

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Climate Scenarios for the Construction and Property Sector

Ngā Horopaki Āhuarangi mō te Rāngai Hanganga me ngā Whare

Contents

He puāwai putiputi te Māoritanga, ko āna taketake ko te reo. Ko tēnei reo nei kua pihia, kua tipua, ā, kua puāwaitia hei reo o mihi mai i te kākano kua whakatōngia mai e ō tātou tūpuna. I runga anō I tēnei āhuatanga, nei rā ā mātou mihi atu ki a koutou.

Maoridom is but a blossoming flower, of which the roots are its language. From the seeds planted by our ancestors, it is this language that has blossomed and flourished that greets us with its beauty. It is also the language which we send to you our greetings and acknowledgements.

We continually have an opportunity and responsibility firstly to acknowledge and secondly harmonise with a relationship with Māori as a co-signing people to Te Tiriti o Waitangi.

Within that, we recognise all the iwi of Aotearoa as kaitiaki across the motu.

The way we build and manage construction and property can greatly improve our health, air, land and waterways.

The vision of Te Kaunihera Hanganga Tautaiao | New Zealand Green Building Council (NZGBC) is ngā wāhi katoa i Aotearoa, ka ora, ka matomato, ka toitū, mō ngā tāngata o te motu nei - all homes and buildings in Aotearoa green and sustainable, making healthier, happier New Zealanders.

In setting out sector climate scenarios this document encourages those in the construction and property sector to consider the risks and opportunities they face from a changing climate.

Whiria te tangata. There has been a weaving together of the wide range of people on their views of the risk and opportunities for the sector and what the right scenarios and drivers are for us in property and construction. We are grateful for all those that contributed.

- Andrew Eagles, CEO, Te Kaunihera Hanganga Tautaiao | New Zealand Green Building Council

Executive Summary

This report presents the climate change scenarios for the Construction and Property sector, developed by Beca Limited (Beca) for Te Kaunihera Hanganga Tautaiao | New Zealand Green Building Council (NZGBC).

Sector participants will be able to use these to apply a consistent method when conducting scenario analysis for climate-related disclosures, in line with External Reporting Board (XRB's) reporting standards NZ CS 1, 2 and 3.

The XRB requires that Climate Reporting Entities (CREs) conduct scenario analysis for Climate-related disclosures using three scenarios, including:

(i) at least one 1.5°C, Paris Agreement-aligned scenario,
(ii) a greater than 3°C-aligned high warming scenario, and
(iii) a third scenario.

The three sector-specific scenarios the NZGBC have developed align with these XRB requirements.

Scenario development

The NZGBC created a Leadership Group (LG) and Technical Working Group (TWG) to oversee this work. Beca have facilitated the collaborative development by the NZGBC of three climate scenarios for the Construction and Property sector, using the working draft of the XRB's guidance for **Scenario analysis: Getting started at the sector level (2022)**. The Beca team have consolidated all outputs from this process to develop the final sector scenarios presented in this report.

Table 1: Summary of the three Construction and Property sector scenarios

SCENARIO 1	
	An 'Orderly' 1.5°C scenario where decarbonisation policies are enacted immediately and smoothly (globally, in Aotearoa New Zealand, and within the sector). Whole of life carbon emissions reduction requirements for buildings is at 90% by 2050.
SCENARIO 2	
	A 'Disorderly' scenario where significant decarbonisation is delayed until 2030 (globally, within New Zealand, and within the sector). This leads to global warming being limited to <2°C by 2100. The sector faces high transition risk after 2030 as entities rush to decarbonise.
SCENARIO 3	
	A 'Hot House World' scenario where global warming reaches >3°C above pre-industrial levels by 2100. No further decarbonisation policies are enacted (globally, within New Zealand, or within the sector). Emissions continue to rise. The sector faces limited transition risks but extreme physical climate risks, particularly towards the end of the century.

The short (1-page) version of each draft Construction and Property sector scenario is presented on pages 11-13. A detailed version of each scenario is provided in the **Full Climate Scenarios** section.

Full Climate Scenarios →

1. Project Background

There is growing recognition of the risks and opportunities posed by climate change. This has resulted in a demand for climate-related information in the context of economic decision making. Investors have an increased focus on the negative impact that weak corporate governance can have on shareholder value, resulting in increased demand for transparency from organisations on their risks and risk management practices. In response, the industry-led Task Force on Climate-related Financial Discloses (TCFD), published a set of recommendations for consistent disclosures that will help financial market participants understand their climate-related risks[1].

In October 2021, Aotearoa New Zealand became the first country to pass legislation making climate-related disclosures mandatory for banks, insurers, asset managers, and larger companies listed on the New Zealand Stock Exchange (NZX)[2]. Beginning in 2023, climate-related disclosures using the TCFD framework will be required annually. Reporting will be governed by climate standards set by New Zealand's independent accounting standard-setter, the External Reporting Board (XRB)[3].

Mandatory climate-related disclosures will help New Zealand meet its international obligations and achieve its target of net-zero carbon emissions by 2050. The idea is that through greater transparency and by revealing climate-related information within financial markets, our financial system will become more resilient[2].

Climate scenario analysis is the key strategic component of the climate-related disclosure process. Scenario analysis is a well-established method for developing strategic plans that are more flexible or robust to a range of plausible future states.

The XRB believes that a sectoral approach to climate scenario analysis will provide more cohesiveness. Although not a mandatory approach, sectoral collaboration is likely to provide greater comparability and lead to higher quality scenarios, while imposing fewer resource demands on CREs, compared to CREs undertaking scenario analysis independently.

To encourage comparability within the Construction and Property sector, the NZGBC created a LG and a TWG to oversee this work. The TWG and a team of specialists from Beca have collaboratively developed a set of climate scenarios for the sector to use when conducting scenario analysis for climate-related disclosures. The LG signed off on progress and the final report.

1 TCFD (2017). **Recommendations of the Task Force on Climate-related Financial Disclosures**
2 Ministry for the Environment (2022). **Mandatory climate-related disclosures**
3 External Reporting Board (2022). **Climate-related Disclosures**

2. Defining the Construction and Property Sector

For the purpose of these climate scenarios, the Construction and Property sector is defined as:

> **Entities whose primary activity is the development, ownership, or management of buildings, including upstream supporting entities that provide building products, raw materials, management, design, and construction services.**

A "building" is defined by the Building Act 2004 and includes any structure intended for occupation by *people, animals, machinery, or chattels*[4].

As per Building Code Clause A1 – Classified Uses, this broadly includes *housing, communal residential, communal non-residential, commercial, industrial, outbuildings, and ancillary*[5].

This group contributes 20% of New Zealand's total carbon emissions. This includes the carbon emissions created through the extraction and manufacture of building materials (referred to as embodied carbon emissions), and the emissions associated with the running of buildings (referred to as operational emissions)[6].

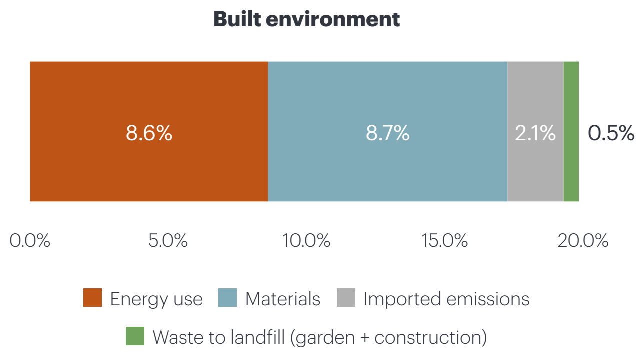


Figure 1: The Carbon Footprint of New Zealand's Built Environment[7]

Participants in this sector are typically capital intensive, with significant investments in long-lived real assets that are fixed in place and subject to the long-term physical impacts of climate change. They are dependent on carbon intensive raw materials and products, and the energy grid, with exposure to the financial impacts of greenhouse gas emissions.

Most NZ entities will have a relationship with the Construction and Property sector but are not direct participants. This includes banks, insurers, building tenants, local authorities etc. (see Table 2). It is recommended that these entities integrate the relevant elements of the Construction and Property sector scenarios into their own scenario analysis.

Many direct construction and property sector participants will also have relationships with other sectors, for example health and education. It is recommended that these entities integrate relevant elements from other sectors where they are not addressed within this document.

Table 2: Direct participants in the construction and property sector and its related entities

DIRECT PARTICIPANTS	RELATED ENTITIES
Portfolio owners	Banks
Building portfolio managers	Insurers
Property developers	Tenants
Construction companies	Local authorities
Building product and material manufacturers	Supporting infrastructure providers
Building design consultancies	Labour, skills and education providers
Industry bodies (e.g. NZGBC)	

4 Building Act 2004
5 Schedule 1 of the Building Regulations 1992
6 Thinkstep ANZ (2019). Under construction: Hidden emissions and untapped potential of buildings for New Zealand's 2050 zero carbon goal
7 ThinkStep, The Carbon Footprint of New Zealand's Built Environment, pg 19

3. What is Climate Scenario Analysis?

Climate scenario analysis is a methodology through which an entity can test their strategy against climate scenarios that represent extremes of physical and transition risk. The process helps organisations identify their most material climate-related risks and opportunities and develop a better understanding of the resilience of its business model and strategy in the face of the different challenges the scenarios present (Figure 2).

The XRB defines a climate scenario as **"A plausible, challenging description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships covering both physical and transition risks in an integrated manner" (NZ CS 1).**

Climate-related scenarios are not intended to be probabilistic or predictive, or to identify the 'most likely' outcome(s) of climate change. They are intended to provide an opportunity for entities to develop their internal capacity to better understand and prepare for the uncertain future impacts of climate change.

Climate scenario analysis is the key strategic component of climate-related disclosures process. Scenario analysis is a well-established method for developing strategic plans that are more flexible or robust to a range of plausible future states. Climate scenarios are based on a particular policy narrative coupled with a science-based analysis of corresponding physical risks. Scenario analysis can be qualitative, quantitative, or a combination of both.

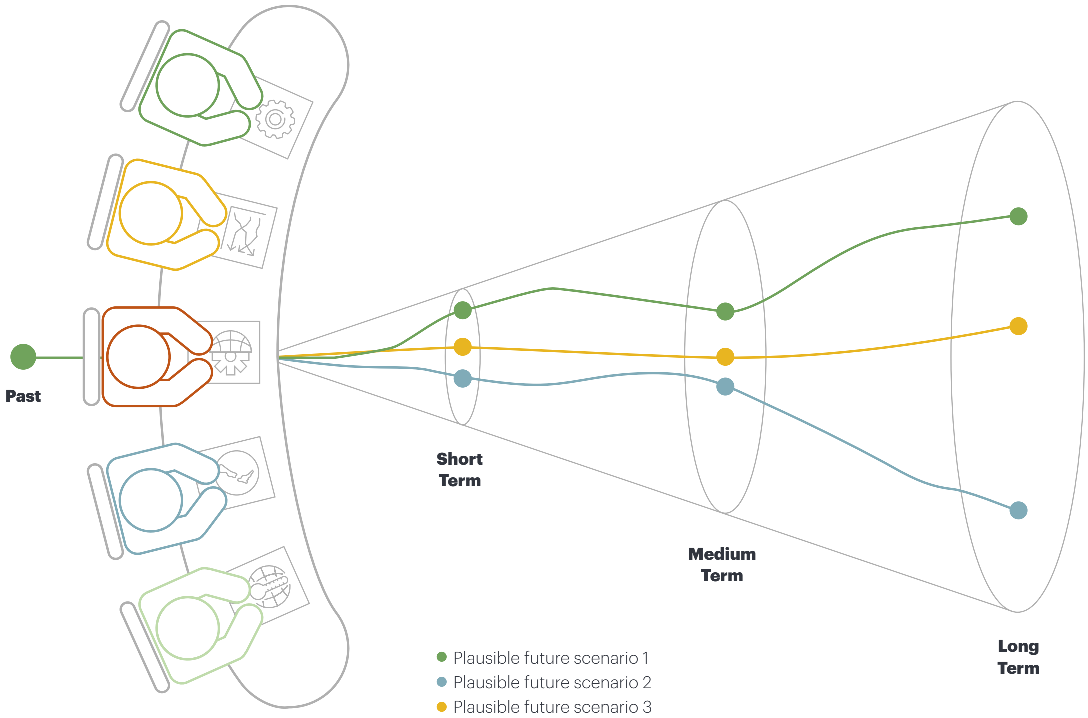


Figure 2: The XRB's visual description of the climate scenario analysis process

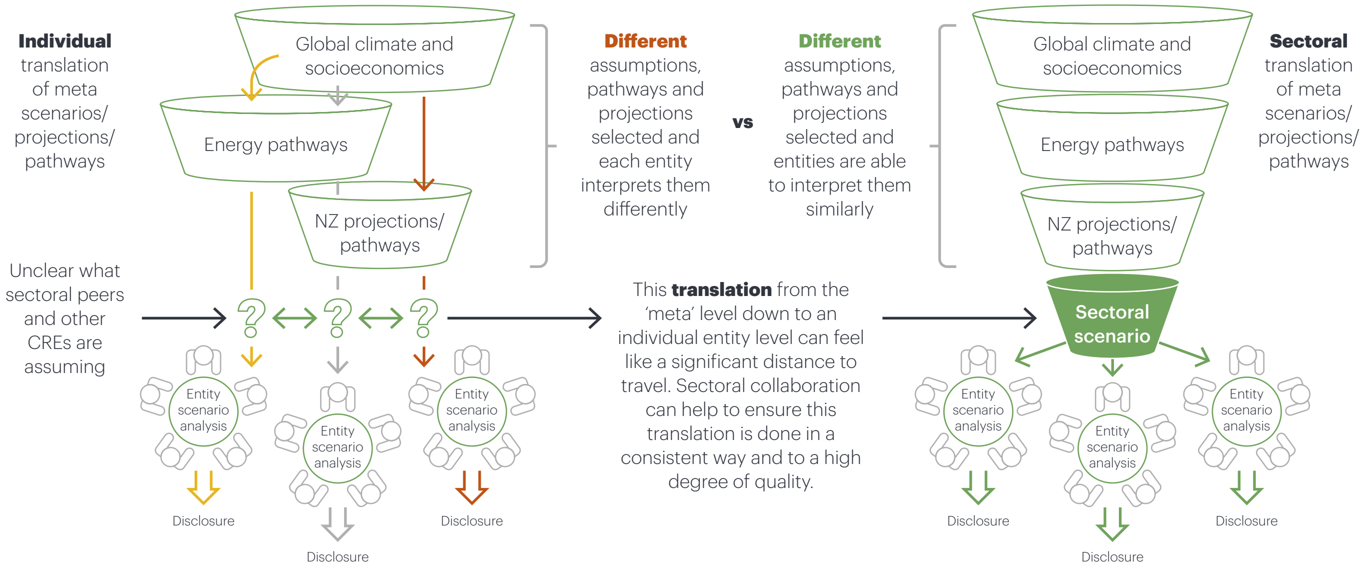


Figure 3: The role of sectoral scenarios in creating a shared scenario architecture for the use of Climate Reporting Entities in New Zealand from the XRB Scenario analysis and climate-related disclosures fact sheet

Organisations need to consider how their climate-related risks and opportunities may evolve and the potential implications under different conditions.

Final XRB Standard release

After 18 months of consultative iteration, the **Aotearoa New Zealand Climate Standards** were published in their final version on 15 December 2022. Around 200 of New Zealand's most economically significant entities will start reporting against the standards for accounting periods beginning on or after 1 January 2023.

Part of the final standards is a requirement for climate-related entities to undergo climate scenario analysis to test the climate resilience of their strategy. The XRB recommends sectoral alignment on the development of climate scenarios for use in New Zealand.

Sector Alignment

The XRB believe that a sectoral approach will provide more cohesiveness.

XRB guidance explains that CREs need to be able to bridge the divide between the scales of analysis available globally and nationally, and what is relevant to them as an individual entity. Sectoral scenarios offer the most practical and flexible means of doing so. Although not a mandatory approach, sectoral collaboration is likely to provide greater comparability and lead to higher quality scenarios, while imposing fewer resource demands on CREs, compared to CREs undertaking scenario analysis independently[8] (see Figure 3).

[8] External Reporting Board (2022). **Scenario analysis: Getting started at the sector level, XRB working draft, Version 2022.C.1**

4. Introduction to Sector Climate Scenarios

This section introduces the Construction and Property Sector Scenarios and provides critical explainer information.

Purpose of Scenarios

The Climate Scenarios presented here have been developed for use by the Construction and Property sector to undertake climate scenario analysis.

Climate-related scenarios for scenario analysis are not intended to be probabilistic or predictive, or to identify the 'most likely' outcome(s) of climate change. They are intended to provide a picture of multiple challenging, plausible future states to allow entities to develop their internal capacity to better understand and prepare for the uncertain future impacts of climate change.

Scenarios should not be used in isolation. They are intended to be used as a set of scenarios to test the extremes of plausible future transition and physical climate risk.

The data contained in these scenarios has been derived from various sources (see **Appendix D**). The data contained here should not be relied upon as predictive or probabilistic when making decisions. The data contained in these scenarios is reflective of the best possible data available at the time these scenarios were developed. Updates should be made to these scenarios as new data becomes available.

Time Horizons

Reference to short-, medium- and long-term time horizons in the Construction and Property Sector scenarios presented here are defined as:

Short-term	Present (2023) – 2030
Medium-term	2031 – 2050
Long-term	2050 – 2100

The Construction and Property Sector is associated with long-lived assets that will still be subject to the long-term impacts of climate change. For this reason, impacts beyond 2050 have been included in the scenarios and underlying data sources. However, the scenario narratives predominantly focus on short to medium term timeframes (i.e. present-2050) as these are the predominant focus for business strategy planning. Where long-term impacts are realised within these earlier timeframes (e.g. pricing of insurance retreat) they are included in the scenario narratives.

Physical Climate Data

Please note that physical climate data included in each scenario is relative to a baseline. Not all data baselines are the same since data has come from various sources.

The New Zealand physical climate data for rainfall intensity, number of hot days and wind extremes has been sourced from downscaled NIWA RCP projections (IPCC AR5). NIWA have not yet completed downscaling for global SSP projections (IPCC AR6). This has resulted in the need to align both Scenario One and Two with downscaled RCP2.6 data – as RCP2.6 data aligns with a range of global warming between ~1.5 to ~2°C (relative to pre-industrial levels).

Due to data availability the mean RCP2.6 data has been provided for both Scenario One and Two. However, once downscaled SSP projections are released, it may be possible to update the scenarios to indicate the nuance in physical climate variables between Scenario One (SSP1-1.9) and Scenario Two (SSP1-2.6).

The use of the same NZ climate data figures for both Scenario One and Two does **not** mean that the difference in global temperatures between these scenarios will not produce varying physical outcomes for New Zealand. Data constraints prevent the scenarios from providing this variance.

Carbon Price

Carbon price data and information in the scenarios refers to a shadow carbon price. Shadow carbon pricing is a method of investment analysis that adds a hypothetical price on carbon to affect a specific emission end point, such as a 1.5°C world. A higher shadow price is more likely to drive earlier and faster decarbonisation scenario, as the future cost impacts of higher carbon activities would be factored into the investment decision making. Conversely, in a scenario where little to no decarbonisation is occurring, it is likely a lower shadow would prevail and wouldn't drive the same level of decarbonisation.

Carbon prices presented here do not reflect unit pricing under the NZ ETS. It is not possible to project future ETS unit pricing, or how this would affect entities/activities outside the ETS scheme, as this figure is driven by a variety of real-world market factors.

Scenarios on a Page

Policy Ambition	Policy Reaction	Technology Change	Behaviour Change	Physical Risk Severity	Transition Risk Severity	Socio-political Instability
1.5°C	Immediate and smooth	Fast change	Fast change	Moderate	Moderate	Low - Moderate

Scenario One

'An "Orderly" scenario where' the world exceeds in limiting global temperature increase to 1.5°C above pre-industrial temperatures. Global emissions decline steadily to achieve net zero CO_2 emissions globally by 2050. New Zealand climate policies are ambitious and in line with the rest of the world's, with the building and construction sector adopting and prioritising decarbonisation policies. The energy grid shifts rapidly away from fossil fuel use, with the New Zealand grid reaching 100% renewable by 2050. Alternative fuels are used as a backup, and renewables are utilised onsite instead of fossil fuels.

The shadow price of carbon increases dramatically to align with a 1.5°C trajectory, steadily rising up to $250/$tCO_2$e by 2050 (an increase of ~614% from a 2023 baseline of $35/$tCO_2$e). As a result, the cost and lead-times for low carbon materials and products increase through the 2020s and 2030s, but they become more cost and time effective than traditional materials by 2040. The construction sector grows significantly as carbon-supporting infrastructure is replaced with greener, low carbon infrastructure.

Regulatory changes for the property and construction sector include government procurement policies targeting recycled materials and circular economy principles. Stringent energy and carbon caps for new buildings are phased in rapidly. Existing buildings must disclose energy and carbon performance, take steps to remove all reliance on fossil fuels for operation, and scale up energy efficiency.

Pressures on centralised infrastructure increase with the demand for electrification, closing of fossil fuel power stations and direct climate impacts on storm and wastewater networks. Modular, circular designs will take precedence, with existing building re-use and adaptive re-use being in demand rather than new builds. Rapid densification puts pressure on horizontal infrastructure, necessitating significant upgrades.

Significant behavioural change results in an increased demand for energy efficient buildings, increased pressures on public transport, the rise of circular business models and a higher consumer awareness regarding low carbon buildings.

	Increase in average global air temperature (relative to pre-industrial levels)		**Average sea level rise NZ** (from a 1995-2014 baseline)	**Increase in number of hot days in NZ** (from a 1986-2005 baseline)[1]	**Increase in rainfall intensity in NZ[2]** (from a 1986-2005 baseline)	**Increase in extreme wind speeds in NZ** (from a 1986-2005 baseline)
2041-2060	**1.6°C**	2031-2050	**0.19m**	**40%**	**6%**	**Up to 5%**
2081-2100	**1.4°C**	2081-2100	**0.39m**	**40%**	**6%**	**Up to 5%**

	Whole of life carbon emissions reduction requirements (for buildings)	**NZ Population**	**Percentage of NZ >65 y/o**	**Carbon price (NZD)** (percentage increase from a 2023 baseline)	**Electricity grid emissions**
2025	**20%**	**5.22M**	**17.5%**	**$84/$tCO_2$e (+140%)**	**0.07 $kgCO_2$/kWh**
2050	**90%**	**6.13M**	**23.3%**	**$250/$tCO_2$e (+614%)**	**0.00 $kgCO_2$/kWh**

[1] Baseline data for different regions is provided in Appendix D
[2] Calculated based on projected increased rainfall depth for a 12 hour, ARI 100 yr event

Policy Ambition	Policy Reaction	Technology Change	Behaviour Change	Physical Risk Severity	Transition Risk Severity	Socio-political Instability
~2.0°C	Delayed	Slow / fast change	Slow / fast change	Moderate	High	Moderate

Scenario Two

A 'Delayed Transition' where policy, technology and behaviour changes remain slow up until 2030. As global emissions continue to rise during the 2020s, concerns about meeting Paris Agreement Goals drives a sudden shift in global policy around 2030. Abrupt and stringent decarbonisation policies are enacted in the 2030s, succeeding in limiting global warming to below 2°C above pre-industrial levels by 2100.

New Zealand follows suit with the rest of the world, leading to abrupt policy and market changes for the property and construction sector post-2030. There is no initial increase in carbon price up to 2030, at which point price rapidly increases to reach $250/tCO_2e$ by 2050.

During the 2020s there is a slow increase in demand for electricity, followed by a surge in demand in the 2030s as New Zealand rushes to electrify our transport networks. The electricity sector is unprepared for the sudden shift in demand at 2030, which causes a delay in adequate expansion of the grid during the 2030s and leads to supply constraints. These constraints result in more frequent blackouts and fluctuations in electricity prices.

During the 2020s, increased regulation within the sector attempts to address the need to decarbonise, but regulation is uneven across local entities and conflicting regulations lead to uncertainty. At 2030 more stringent regulatory changes are introduced. During the 2020s there is less investment signalling for both new and retrofit low carbon buildings, which causes further uncertainty and lack of momentum until 2030. At 2030, significant regulatory changes demand an immediate step change in building energy and carbon requirements.

Limited investment during the 2020s means the spike in demand for low carbon materials, low energy technology and onsite generation in 2030 causes significant disruption for the sector. Competition for availability of products, materials, professional advice and competent installers impacts significantly on both new building and retrofit projects resulting in escalation in development costs.

Pressures on centralised infrastructure are compounded after 2030 due to increasing densification and the increasing impacts of physical climate risks. Spatial planning to prioritise decarbonisation and densification versus climate resilience and managed retreat is inconsistent across the country. This inconsistency leads to increasing uncertainty for the construction and property sector regarding which assets are most likely to become stranded.

Initially the construction and property sector is slow to decarbonise, but 'fast movers' get the opportunity to utilise materials, capital, and knowledge while late movers are disadvantaged when demands peak post-2030.

	Increase in average global air temperature (relative to pre-industrial levels)		**Average sea level rise NZ** (from a 1995-2014 baseline)	**Increase in number of hot days in NZ** (from a 1986-2005 baseline)[1]	**Increase in rainfall intensity in NZ**[2] (from a 1986-2005 baseline)	**Increase in extreme wind speeds in NZ** (from a 1986-2005 baseline)
2041-2060	**1.7°C**	2031-2050	**0.2m**	**40%**	**6%**	**Up to 5%**
2081-2100	**1.8°C**	2081-2100	**0.6m**	**40%**	**6%**	**Up to 5%**

	Whole of life carbon emissions reduction requirements (for buildings)	**NZ Population**	**Percentage of NZ >65 y/o**	**Carbon price (NZD)** (percentage increase from a 2023 baseline)	**Electricity grid emissions**
2025	**0%**	**5.22M**	**17.5%**	**$35/tCO_2e (no change)**	**0.08 kgCO_2/kWh**
2050	**80%**	**6.13M**	**23.3%**	**$250/tCO_2e (+614%)**	**0.02 kgCO_2/kWh**

1 Baseline data for different regions is provided in Appendix D
2 Calculated based on projected increased rainfall depth for a 12 hour, ARI 100 yr event

Policy Ambition	Policy Reaction	Technology Change	Behaviour Change	Physical Risk Severity	Transition Risk Severity	Socio-political Instability
3.0°C	None – current policies	Slow change	Slow change	Extreme	Low	High

Scenario Three

A 'Hot House World' where global emissions continue to grow. Global average temperature rises to greater than 3°C above pre-industrial levels by 2100.

New Zealand's climate change policy remains in keeping with the rest of the world's. No further policies are introduced to curb emissions, with the building and construction sector following suit. Regulatory changes are slow and focus on adaptation and managing climate-driven immigration/refugees. The price of carbon remains at $35/$tCO_2e$ to 2050. Mandates are introduced to conserve energy for critical functions, as asset and infrastructure damages due to climate change are realised.

New Zealand's electricity grid is gradually decarbonised further in line with current policies. Emission grid factors remain at 0.06 $kgCO_2$/kWh by 2050 which means buildings wishing to achieve net zero carbon emissions must invest in their own zero carbon generation.

Existing low carbon materials are readily available due to low demand but there is little innovation beyond technologies and materials currently available. Investment is prioritised towards adaptation and climate resilience. Some assets become stranded as building codes increasingly become more stringent regarding the need for buildings to withstand climate impacts (such as storm events, extreme rainfall, heatwaves, and floods).

Centralised infrastructure will show failures and stresses, with some assets becoming stranded due to the physical impacts of climate change. Consequently, local councils increase rates to invest in protection and restoration of certain assets.

There are no incentives for meaningful behavioural change. A significant breakdown of social cohesion occurs, with heat stress and mental health impacts from climate change at record levels. Food insecurity and growing populations drive retreat from cities. Spikes in demand for housing occur due to climate-driven immigration from other parts of the world and increasing numbers of climate refugees.

	Increase in average global air temperature (relative to pre-industrial levels)		**Average sea level rise NZ** (from a 1995-2014 baseline)	**Increase in number of hot days in NZ** (from a 1986-2005 baseline)[1]	**Increase in rainfall intensity in NZ**[2] (from a 1986-2005 baseline)	**Increase in extreme wind speeds in NZ** (from a 1986-2005 baseline)
2041-2060	**2.1°C**	2031-2050	**0.24m**	**100%**	**8.6%**	**5-10%**
2081-2100	**3.6°C**	2081-2100	**1.08m**	**300%**	**26.1%**	**Up to 10%**

	Whole of life carbon emissions reduction requirements (for buildings)	**NZ Population**	**Percentage of NZ >65 y/o**	**Carbon price (NZD)** (percentage increase from a 2023 baseline)	**Electricity grid emissions**
2025	**0%**	**5.25M**	**17.6%**	**$35/$tCO_2e$ (no change)**	**0.08 $kgCO_2$/kWh**
2050	**50%**	**6.93M**	**21.4%**	**$35/$tCO_2e$ (no change)**	**0.06 $kgCO_2$/kWh**

[1] Baseline data for different regions is provided in **Appendix D**
[2] Calculated based on projected increased rainfall depth for a 12 hour, ARI 100 yr event

6. How to use these scenarios

Using sector scenarios for your climate-related disclosures

When undertaking climate scenario analysis, entities in the Construction and Property sector will have to consider a number of elements to support a successful process. The following recommendations are drawn from **TCFD guidance**.

1

Inform, educate and engage

Engagement is necessary to mobilize the involvement of business units and management throughout the company.

A first step in the scenario process is often to inform and educate board members and senior management about the basics of climate change, its risk manifestations, and the potential business implications for the company.

2

Build the case

Closely aligned with informing and educating is making the case for scenarios and gaining internal support for conducting the scenario analysis process.

One way in which to do this is to prepare a project proposal that can be used by an executive sponsor to engage decision-makers and stakeholders.

3

Clear governance and executive-level leadership

The scenario process needs well-defined governance roles and clear reporting relationships to senior levels.

Many companies undertaking scenario analysis cite the critical importance of designating an executive-level sponsor. The CEO or the designated executive sponsor should ensure that the board is aware of key developments. The board can also take an active role by clearly assigning a committee to oversee the scenario process.

4

Establish a strong, dedicated scenario team

A dedicated scenario team comprised of business representatives is suggested for large and midsized companies. The team leader should ideally be a senior person from the strategic planning or sustainability areas.

Team members should possess multidisciplinary expertise across the company's value chain, and understand different aspects of its business model, assets, operations, organizational structure, mission, and strategy.

5

Secure internal and external resource requirements

The time commitments involved in a typical scenario process consist of initial meetings to discuss the scenario focus and scope, prepare briefing notes and readings; a series of workshops to discuss various scenario aspects and an assessment report and strategic options.

External expertise can support a sound climate-related scenario analysis process.

Climate scenario analysis aligned with the External Reporting Board's standards

The XRB's aim is to develop climate-related disclosure (CRD) standards[9] to ensure disclosures made by climate reporting entities (CREs) are of a high quality. The three standards are as follows:

- **NZ CS 1** is the core standard with detailed objectives and requirements under each disclosure area.
- **NZ CS 2** is relevant for CRE's adopting the requirements for the first time. The standards contain first-time adoption provisions from requirements in NZ CS 1 and NZ CS 3. The adoption provisions are optional. A CRE must disclose if an adoption provision has been used.
- **NZ CS 3** outlines the principles and general requirements for climate-related disclosures. NZ CS 3 is structured under the core concept of fair presentation, and then provides a set of information principles and presentation principles. It provides other important requirements such as materiality and the disclosure of methodologies and assumptions.

Climate-reporting entities in New Zealand will have to ensure that their climate scenario analysis process meets XRB standards by FY24 (for most entities). Below are the specific standard provisions from both NZ CS 1 and NZ CS 3 that CRE will need to meet.

Table 3 contains the general disclosures required for the "Strategy" section of NZ CS 1. Each line in the table has more detailed standard provisions attached to it. The more detailed provision for the process of climate scenario analysis (11(b)) is included below. The outcomes of climate scenario analysis, however, are likely to inform 11(c), 11(d) and 11(e) as well.

Table 3: Strategy disclosures

NZ CS 1	TO ACHIEVE THE DISCLOSURE OBJECTIVE, AN ENTITY MUST DISCLOSE:
11(a)	a description of its current climate-related impacts;
11(b)	a description of the scenario analysis it has undertaken;
11(c)	a description of the climate-related risks and opportunities it has identified over the short, medium, and long term;
11(d)	a description of the anticipated impacts of climate-related risks and opportunities;
11(e)	a description of how it will position itself as the global and domestic economy transitions towards a low-emissions, climate-resilient future state;

Table 4 outlines more specific requirements for climate scenario analysis. These are expanded in NZ CS 3.

Table 4: Scenario analysis

NZ CS 1	SCENARIO ANALYSIS UNDERTAKEN
13	An entity must describe the scenario analysis it has undertaken to help identify its climate-related risks and opportunities and better understand the resilience of its business model and strategy.

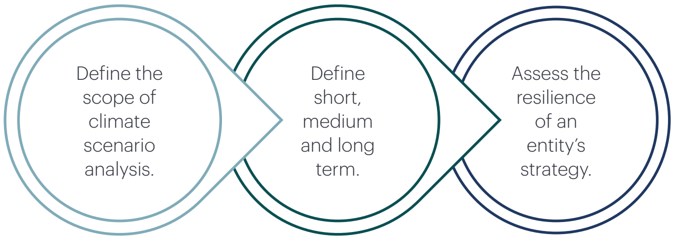
Table 5 includes the specific provisions outlined by NZ CS 3 relating to climate scenario analysis and the use of scenarios. These provisions can be a guide to a CRE when deciding what information to include in their disclosures.

[9] XRB (2022). Climate-related Disclosures

Table 5: NZ CS 3 requirements for climate scenario analysis

NZ CS 3	THE FOLLOWING INFORMATION MUST BE INCLUDED WHEN DESCRIBING THE METHODS AND ASSUMPTIONS UNDERLYING THE CLIMATE-RELATED SCENARIOS USED, AND THE SCENARIO ANALYSIS PROCESS EMPLOYED:
51 (a)	**The climate-related scenarios it has used, including:**
(i)	A brief description of each scenario narrative;
(ii)	The time horizons considered, including endpoints and whether the endpoints are determined by a year or a temperature target;
(iii)	A description of the various emissions reduction pathways in each scenario and the assumptions underlying pathway development over time, including the scope of operations covered, policy and socioeconomic assumptions, macroeconomic trends, energy pathways, carbon sequestration from afforestation and nature-based solutions and technology assumptions including negative emissions technology
(iv)	An explanation of why the entity believes the chosen scenarios are relevant and appropriate to assessing the resilience of the entity's business model and strategy to climate-related risks and opportunities; and
(v)	The sources of data used to construct each scenario;
51 (b)	**How the scenario analysis process has been conducted, including:**
(i)	Whether scenario analysis is a standalone analysis or integrated within the entity's strategy processes;
(ii)	The governance process used to oversee and manage the scenario analysis process, including the role of the governance body and management;
(iii)	If modelling has been undertaken, a clear description of what modelling was undertaken and why the model was chosen as the appropriate model; and
(iv)	Which external partners and stakeholders are involved.

Scenario analysis process



Define the scope

To conduct an effective scenario process, a company needs to define the scope of its analysis. Ideally, scenario analysis should encompass the company as a whole, including supply and distribution chains. Initially, however, a company may focus on a particular critical business unit, product line, geography, asset, or input(s) that may be highly impacted by climate-related risks or opportunities before expanding the scope of its scenario analysis.

Define the time horizons

In setting climate-related scenario time horizons, companies should challenge their thinking about traditional planning horizons, which are often too short. The scenarios developed in this work programme have time horizons associated with them, which a CRE can choose to use. CREs may decide to use alternate time horizons that align with their strategic planning processes. To meet XRB requirements, CREs will need to explain how its definitions of short, medium, and long term are linked to its strategic planning horizons and capital deployment plans (NZ CS 1 Ref. 14 (a)).

Assess the resilience of the entity's strategy

A CRE may start by identifying its climate-related risks and opportunities overall. The most significant of these can be used in the discussion of the climate scenarios. The climate scenario analysis team can examine how the company's strategy might unfold under each scenario, noting the key challenges or points of resilience. The process itself may be a workshop or a series of interviews with key leadership. The results can then be prepared as a report for circulation and integration into an entity's climate-related disclosures.

The following outlines key questions to ask during climate scenario analysis, drawn from **TCFD guidance.** The objective is to understand the potential implications of scenarios' hypothetical conditions for the company's strategy.

Guiding questions for conducting climate scenario analysis

Identifying the implications of various scenarios for a company's strategy is encapsulated in the basic question:

How would our company's existing (or proposed) strategy likely perform under each scenario if it were true?

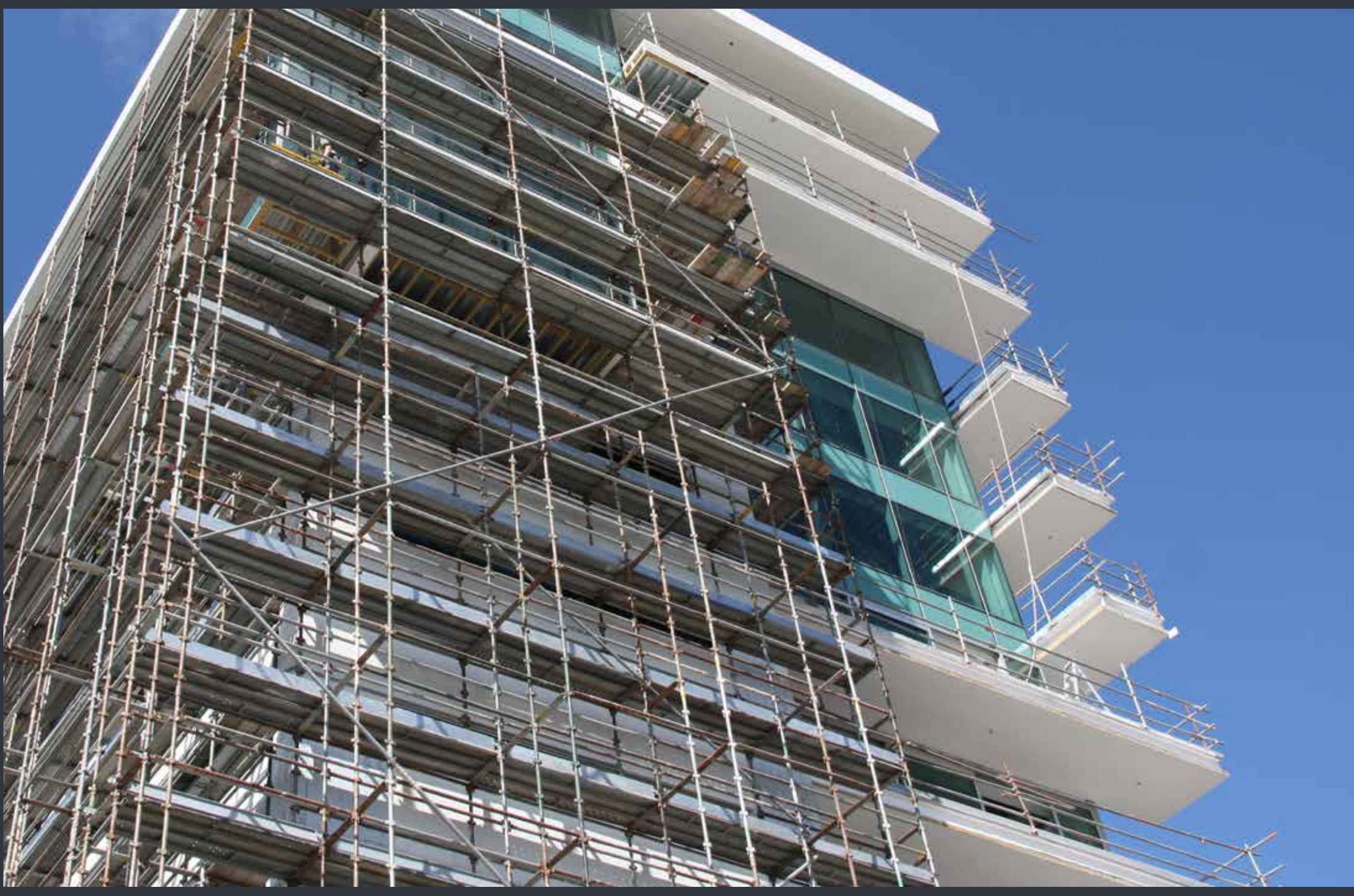
At the level of the company's external stakeholders:

- For each group of external stakeholders, what value changes are involved in each scenario? What are the associated business opportunities?
- What are the new bottlenecks in the market? Who is getting squeezed and what will they want to do about it?

At the level of the company:

- How does the company's current strategy, policies, and capabilities prepare it for the future described in each scenario?
- Does the company's current strategy and associated strategic posture look sound across only one or several scenarios?
- If you knew this scenario would occur, what opportunities and risks/threats would the company face based on the earlier identified vulnerability factors?
- What strategies could you implement to best take advantage of the opportunities and remove the risks/threats?
- What signposts or leading indicators might alert you that this scenario and associated dynamics are going to occur, or would signal that a particular strategy option should be implemented?

Full Scenarios



Scenario One – Orderly

Scenario One describes a world where globally we succeed in limiting global warming to 1.5°C. Ambitious decarbonisation goals are introduced immediately, and emissions decline rapidly and steadily towards net zero 2050 goals.

Scenario One at a glance

NGFS 'Net Zero 2050'

Ambitious global climate policies are introduced immediately. Emissions decline rapidly and steadily to achieve net zero by 2050. This results in at least a 50% change of limiting global warming to 1.5°C.

IPCC SSP 1-1.9

The world shifts toward a more sustaible path, emphasizing more inclusive development that respects perceived environmental boundaries. Consumption is oriented toward low material growth and lower resource and energy intensity.

IEA 'Net Zero Emissions'

The global energy grid shifts uniformly and quickly away from fossil fuel use and increased use of renewables.

Renewables make up 2/3 of the global energy grid by 2050.

CCC 'Tailwinds'

Aotearoa New Zealand's policy and markets move in line with the rest of the world's. Ambitious climate policies are enacted and prioritised across all sectors. Technology availability and adoption is widespread and coordinated. Behaviour change moves rapidly to reflect 1.5°C climate goals.

IPCC RCP 2.6

Physical climate change impacts for Aotearoa New Zealand align with downscaled NIWA projections for RCP2.6.

Policy Ambition	Policy Reaction	Technology Change	Behaviour Change	Physical Risk Severity	Transition Risk Severity	Socio-political Instability
1.5°C	Immediate and smooth	Fast change	Fast change	Moderate	Low - moderate	Low - moderate

Emissions Trajectory and Alignment of Global Action

The world succeeds in the Paris Agreement's goal of limiting global temperature increase to 1.5°C above pre-industrial levels. Beginning in the 2020s, and thanks partly to Aotearoa New Zealand exceeding the emissions reductions promised in its Nationally Determined Contribution under the Paris Agreement, emissions steadily decline. Direct carbon capture technology matures to a point where the world is on track to achieve net zero CO_2 emissions globally by 2050.

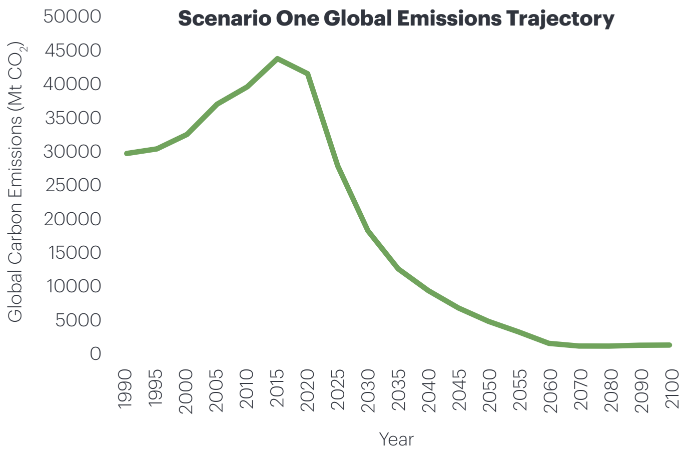


Figure 4: Scenario One emissions trajectory[10].

The global shift towards this more sustainable path stems from well-signalled and broadly supported regulatory changes. These align with market drivers to orientate our society towards growth that is decoupled from material consumption, with lower resource use, and higher levels of efficiency. Aotearoa New Zealand's policy and markets move in line with the rest of the world's. Ambitious climate policies are enacted with a shadow price on carbon steadily rising to $250/t$CO_2$e by 2050.

However, Aotearoa New Zealand still faces moderately severe physical impacts of climate change with an increase in extreme wind speeds (up to 5%), rainfall intensity (6%), and number of hot days (40%) by 2050.

2041-2060	2081-2100
1.6°C	1.4°C

Increase in average global air temperature
(relative to pre-industrial levels)

2031-2050	2081-2100
0.19m	0.39m

Average sea level rise in NZ
(from a 1995-2014 baseline)

Landscape of Fossil Fuel Use / Energy Transition

The pressure to achieve net-zero emissions by 2050 means the global energy grid shifts uniformly and quickly away from fossil fuel use to increased use of renewables, which make up 2/3rds of the global electricity grid by 2050. In New Zealand, due to the high pre-existing level of renewables, government investment, and the affordability of low carbon generation, the electricity grid reaches near 100% renewable by 2050. In the short to medium term, New Zealand's highly renewable grid becomes more attractive internationally, with energy intensive industries such as cloud-based data services seeking the lowest absolute grid emissions relocating here. Electricity prices, whilst being decoupled from fossil fuel volatility, increase in the 2020s and 2030s, as the decarbonisation of

[10] Emissions trajectory data has been sourced from NGFS emissions modelling available on the **NGFS IIASA Scenario Explorer**. The emissions trajectory for Scenario One aligns with the NGFS Net-Zero 2050 scenario.

2025		2050
0.07 $kgCO_2/kWh$		0.00 $kgCO_2/kWh$

NZ Electricity grid emissions

2025		2050
20%		90%

Whole of life carbon emission reduction (for buildings)

industrial processes and transportation sectors puts pressure on grid capacity.

The grid capacity rapidly expands in response to demand, but it cannot keep pace in the short to medium term. Shortfalls in generation capacity become more frequent increasing risk of blackouts. Building occupants are required to relinquish some performance outcomes (e.g. occupant comfort) to support energy, cost and carbon reduction measures. In the short-term, this drives demand for on-site electricity generation, and the expansion of alternative fuels (such as hydrogen and biofuels). Over the medium term, energy efficiency improvements, and greater use of demand control infrastructure such as energy storage and load shedding, are implemented to lower peak demands and support the transition to a renewable electrified economy.

Energy and carbon limits for new buildings are phased in rapidly in the 2020s. Existing buildings are initially required to disclose energy and carbon performance and over the medium-term are required to remove fossil fuels and undertake retrofits for energy efficiency. The scale of retrofit activities across both residential and non-residential property is significant with most properties constructed prior to 2020 needing major upgrade of building envelope or systems. This poses a risk to some entities resulting in increased operational expenses and the need for large capital expenditure. Meanwhile, there is significant demand for low carbon building products, materials, and technologies, which presents an opportunity to entities involved in the building product supply chain. Clear government signals, tightening procurement rules and direct incentives give supply chains certainty and capital to rapidly respond to demand. Government financial support is funded by increased taxes and fees levied on high carbon alternatives.

By 2030, new buildings are 50% more efficient than current code requirements for operational energy and fossil fuel free. Existing buildings that are still relying on fossil fuels are transitioning well in advance of equipment end of life and are fully decarbonised by 2050. Building embodied carbon emissions (from products and materials) are 30% lower by 2030 with changes in design solutions and supply chain decarbonisation both contributing.

New Zealand's Emissions Trading Scheme (ETS) is amended to make carbon capture and storage (CCS) a recognised removal activity. Carbon capture and storage systems are implemented in the medium term to accelerate the rate of decarbonisation and mitigate hard-to-abate fossil fuel use. The implementation of this technology increases pressure on technical and skilled labour supply. As this technology matures there is a reduction in focus on hard-to-abate emissions associated with some construction materials (e.g. concrete, steel, aluminium). This unlocks capital for more cost-effective decarbonisation strategies.

All entities that haven't yet set ambitious science-based emission reduction targets do so in the short-term as pressure from investors and customers to align with 1.5°C of warming grows. Failure to achieve targets results in direct financial penalties from lenders, by way of access to capital, government funding restrictions, and interest rate adjustments. Funding programmes designed to support emissions reduction and improve resilience are more accessible and commonly leveraged. Due to increasing market awareness of climate change risks and the need to decarbonise, entities that fail to set and meet ambitious science-based emission reduction targets also face reputational risks, loss of market share, and scrutiny from customers, shareholders, and competitors. These reputational and market risks affect the sector significantly in the short to medium term.

As the carbon price and waste levies increase, a shift to a more circular economy occurs, supported by government mandates for recycled content. These levies and mandates increase the cost and lead-times for low carbon products and materials in the 2020s and 2030s. They become more cost and time effective than traditional materials by the 2040s due to innovation in production, overall reduction in material handling/wastage, new construction systems, value extraction from circularity, and the rising price of carbon. Large product manufacturers shift to an "as a service" business model (e.g. building lighting as a service) that reduces capital expenditure and enables greater levels of end-of-life value capture. Whilst this increases building operating expenses there are net positive whole of life financial outcomes.

This shift to circular economy business models is also seen in other sectors, leading to lower levels of conspicuous consumption, which accelerates changes in the purchase and supply of physical goods. This impacts commercial building demands, especially retail, logistics, and warehousing. Building occupiers and purchasers also begin demanding more energy efficient, low carbon buildings as consumer awareness (and prices of higher carbon materials) increase. Demand is refocused towards existing building re-use and adaptive re-use over new construction. This is part of a rapid wider shift towards economic degrowth models, with rapid technology and system shifts also helping to curb inflation.

The construction sector grows significantly as carbon-supporting infrastructure is replaced with greener infrastructure. This includes the development of carbon capture and storage facilities which become operational in the medium-term to offset hard to abate carbon emissions and energy efficiency upgrades for existing assets. The shift in focus towards large publicly funded or subsidised adaptation, green infrastructure, and efficiency projects creates an end-market for construction companies and their supply chains with higher margins and greater certainty of forward workload. This becomes a preferred market and reduces capacity and contractor appetite for other types of construction work (e.g. new buildings, refurbishment, etc) leading to increased costs and reduced margins for developers.

Social Change

Social changes start to occur in the 2020s, due to changes in market behaviour, working habits, required knowledge/skills, purchasing and investment behaviours, and the changing focus of government funding. In the short term, those working in carbon-intensive industries or professions are required to change roles. This results in more significant social change and upheaval in places where other employment opportunities are limited, but the public and private sectors pivot to support this transition.

There aren't enough skilled employees to enable rapid decarbonisation, particularly in the first decade, so automation accelerates to help meet the talent availability gap. University and trades course offerings pivot to help meet demand for a workforce with high and widespread climate change, circular economy, and sustainable design skills. Globally aligned efforts to reduce warming results in manageable levels of climate-related refugees and modest net migration to New Zealand, which is home to 6.13 million people by 2050. An ageing population (23.3% of the population is over 65 by 2050) increases pressure on aged care funding and facilities and government funding is reduced as it is diverted towards decarbonisation.

Rates of people working from home increase for office-based jobs, as transport modes shift, and employers encourage their employees to reduce emissions by commuting less. This has less impact on site-based jobs, such as construction and manufacturing. The shift to working from home for some sectors means increased demand for residential dwellings and local shared working spaces with suitable facilities and a greater ownership of remote-working health and wellbeing outcomes from employers. The increase in levels of daytime residential use drives demand for air-conditioning and other amenities to boost space comfort levels.

Land Use Change and Infrastructure

The acute physical impacts of climate change are evident in the short and medium term and strongly influence public support and decisions on land-use and infrastructure business cases. As a result, there is broad support – across the political spectrum and at all levels of government – for investment in New Zealand's infrastructure and communities to both reduce carbon emissions and exposure and vulnerability to climate-related events.

2031-2050	2081-2100
6%	6%

Increase in rainfall intensity in NZ

(from a 1986-2005 baseline)

By 2050, New Zealand is still dealing with severe climate related events. But the outlook for 2100 is more positive. A combination of managed retreat and infrastructure investment has mitigated long-term physical risks, as warming plateaus and exposure and vulnerability are progressively reduced.

The primary driver of changes to land use and densification is GHG emissions reduction, with changes in transportation use and community connections being of primary importance out to 2050. Land use change due to increased forestry sequestration continues through to 2050 but the extent is limited and has marginal impacts on food production and biodiversity. However, the full impact of already baked-in sea level rise is yet to be experienced in 2050, which will present a second wave of retreat and adaptation towards 2100 for existing assets. This is being factored into decision-making well in advance and new, long-lived infrastructure is not being provided to areas at risk.

Decarbonisation policy at the central and local government level drives rapid densification of urban areas to reduce urban sprawl. Rapid densification puts pressure on legacy horizontal infrastructure (e.g. water networks) and necessitates significant upgrades. Although levels of working from home increase, public and active transport infrastructure also grows to accommodate those who still need to commute. Behaviour and policy change drives greater usage for active and public transport networks and creates demand for rapid upgrades and expansions. There is a shift in mode from trucks towards rail or sea freight for bulk products and materials distribution with greater investment in a lower carbon, diversified and more resilient transport network. This impacts on the design and retrofit of buildings with end of trip facilities prioritised over carparks which are rarely integrated into new build sites after 2030.

In response to continued high intensity rainfall events, properties in floodplains, or subject to unstable ground conditions (e.g. near cliffs/softer coastal soils), experience increasing insurance premiums above inflation and experience insurance retreat by 2050. The threat of late century sea-level rise is being priced into property valuations in the short term and premiums on some coastal properties increase to the point of permanent unprofitability, leading to them being stranded. Properties in denser areas (e.g. in a CBD) experience negligible increases in insurance premiums, as they benefit from surrounding publicly-funded adaptation defences.

Scenario Two – Disorderly

Scenario Two describes a world where globally we succeed in limiting global warming to less than 2.0°C. New decarbonisation policies are not introduced until 2030, at which point there is a rapid and stringent effort to decarbonise. This leads to high transition risk severity in the medium term (2030 – 2050) as Aotearoa New Zealand and the sector rush to meet net zero 2050 goals.

Scenario Two at a glance

NGFS 'Delayed Transition'

Global emissions do not decrease until 2030 Strong policies are then needed to limit warming to below 2°C. New climate policies are not introduced until 2030 and the level of action differs across countries and regions. Emissions pathway results in a 2/3rd chance of limiting global warming to below 2°C.

IPCC SSP 1-2.6

Minimal shift in social, economic, and technological trends from historical patterns development up until 2030. From 2030 onwards, trends shift abruptly towards a more sustainable path.

IEA 'Sustainable Development'

Up until 2030, the global energy grid remains at >80% fossil fuel based with free market trends and competing technologies dictating change. In 2030, stringent decarbonisation policies are enacted and renewable technologies rapidly adopted.

CCC 'Headwinds'

Aotearoa follows the rest of the world in delaying significant policy change until 2030. Technology and behavioural change is initially slow. After 2030, abrupt policy changes are enacted and technology and behaviour changes increase. Change is disjointed across sectors.

IPCC RCP 2.6

Physical climate change impacts for Aotearoa New Zealand align with downscaled NIWA projections for RCP2.6.

Policy Ambition	Policy Reaction	Technology Change	Behaviour Change	Physical Risk Severity	Transition Risk Severity	Socio-political Instability
<2.0°C	Delayed	Slow - fast change	Slow - fast change	Moderate	High	Moderate

Emissions Trajectory and Alignment of Global Action

The world fails to implement the changes required to limit warming to 1.5°C above pre-industrial levels by 2100. Global emissions continue to rise during the 2020s as historical social, economic, and technological trends continue. However, the increasing frequency of climate related physical events, and concerns about meeting Paris Agreement Goals drives a sudden shift in global policy around 2030, when abrupt and stringent decarbonisation policies are enacted. Although the level of action differs across countries and regions, globally we have a 2/3[rd] chance of limiting global warming to below 2°C above pre-industrial levels by 2100.

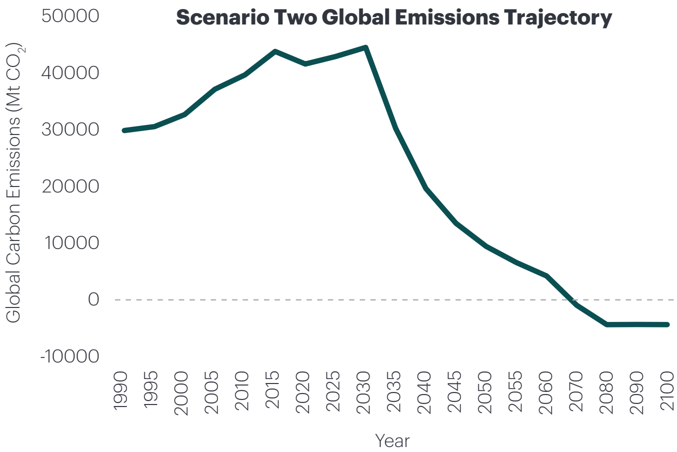


Figure 5: Scenario Two emissions trajectory[11].

New Zealand follows suit with the majority of the world, leading to abrupt policy and market changes for the property and construction sector post-2030. Whilst rapid policy, technology, and behaviour change does occur, it is disordered and inconsistent across sectors and sub-sectors. There is no initial increase in shadow carbon price up to 2030, but the price rapidly increases after this to reach $250/t$CO_2$e by 2050. This introduces new pricing tensions and previously stable organisations and relationships are disrupted with many entities and business ecosystems failing to adapt in line with the pace of change. This rapid change also leads to greater levels of political polarisation as people react to poorly supported changes that exacerbate wealth and income inequality. The pace of change also generates significant financial incentives for innovation, especially for carbon sequestration, capture and storage which must play a large role in carbon emissions reduction by 2050.

2041-2060
1.7°C

2081-2100
1.8°C

Increase in average global air temperature
(relative to pre-industrial levels)

New Zealand still faces moderately severe physical impacts of climate change with an increase in extreme wind speeds (up to 5%), rainfall intensity (6%), and number of hot days (40%) by 2050. A lack of action in addressing medium term physical risks in the 2020s results in a greater extent of vulnerable assets in the medium term (2030-2050). This significantly increases the impact of weather-related events as adaptation has not been well implemented, retreat has not been well managed, and the pace of insurance retreat is accelerating.

Landscape of Fossil Fuel Use & Energy Transition

Up until 2030, the global energy grid remains at >80% fossil fuel based. Governmental intervention is limited, with free market trends and competing technologies dictating change. At 2030, more stringent decarbonisation policies are enacted and renewable technologies become rapidly adopted. In New Zealand, the relative affordability of low carbon generation means the grid is already steadily decarbonising throughout the 2020s.

[11] Emissions trajectory data has been sourced from NGFS emissions modelling available on the **NGFS IIASA Scenario Explorer**. The emissions trajectory for Scenario Two aligns with the NGFS Disorderly scenario.

2025
0.08
$kgCO_2/kWh$

2050
0.02
$kgCO_2/kWh$

NZ Electricity grid emissions

2025
0%

2050
80%

Whole of life carbon emission reduction (for buildings)

In the short-term, there is limited-to-no change in fossil fuel use or energy transition for the sector. Stringent decarbonisation policies enacted in 2030 include the introduction of energy efficiency requirements for buildings. In 2030 all new buildings are 40% more efficient than current code requirements for operational energy efficiency. Whilst still legal, few new buildings utilise fossil fuels for heating, hot water or cooking. Many existing buildings still rely on fossil fuels but are transitioning over the medium-term (2030-2050) and become fully decarbonised by 2050. The pace of change and costs associated with upgrades leads some buildings to be abandoned.

Electricity prices increase in the 2020s and 2030s due to continuing reliance on fossil fuel peak demand generation. A slow increase in demand for electricity doesn't provide sufficient signals for the upgrades required for a fast transition in 2030, leading to supply constraints. Grid systems that provide both demand and supply side management (pumped hydro, large battery systems) are delayed, and this results in significant fluctuations in electricity prices as the grid remains exposed to fossil fuel costs and unreliable generation systems in the short to medium term. This increases the risk of price shocks, supply constraints and blackouts.

Aging infrastructure is overwhelmed by increased physical impacts in the medium term and there is less investment in replacement infrastructure with reprioritisation of spending towards decarbonisation impacting on the nature of construction activities. Heavy investment is made in carbon capture and storage systems in the medium term to accelerate the rate of decarbonisation and mitigate hard to abate fossil fuel use. Whilst this leads to construction activity growth, the need for rapid decarbonsiation from 2030 means that these carbon removals are insufficient to relieve pressure on the Construction and Property sector to reduce hard to abate emissions sources (e.g. cement, steel).

Policy, Regulation and Markets

As the likelihood of missing the 1.5°C trajectory increases through the 2020's, many organsations reduce their carbon reduction ambitions and unlock capital to focus on adaptation. Investors and customers increase pressure on entities to prioritise climate resilience as physical impacts accelerate and directly impact on the financial viability of some organisations.

Regulation based on current policy attempts to address the impacts of climate change and the need to decarbonise, but it is uneven across local government entities and conflicting regulations lead to uncertainty. These mixed investment signals cause uncertainty and a lack of momentum until 2030 at which point new policy is implemented which generates alignment and investment accelerates.

At 2030, the significant regulatory changes demand an immediate step change in building energy and carbon requirements. New technologies haven't been developed in time for the spike in demand in 2030, leading to disruption of building and materials market and competition for materials and products that impacts new buildings and retrofit development. This leads to significant price escalations and construction delays, with financially marginal market segments becoming unviable.

Assets developed prior to 2030 are at increased risk of stranding once new regulations are introduced in 2030. This is because they are wildly inconsistent with new building levels of performance and market demands for low carbon buildings. This rapid change in tenant and investor demands means some assets rapidly lose value. Early movers within the Construction and Property sector have the opportunity to utilise their future-proofed assets, established knowledge and material supply chains whilst late movers are disadvantaged by stranded assets and development and construction practices that are out of step when change accelerates post 2030. However, the slow rate of technology change up to

2030 means investing early is expensive, not well supported by government funding, and not differentiated by the market. The shadow price of carbon remains low until a rapid escalation at 2030. After 2030, the carbon price rises steadily to $250/t$CO_2$e by 2050. This reflects that sector entities are recognising a higher cost of carbon emissions and shadow pricing is utilised to drive decarbonisation decision making.

One reaction to the more stringent decarbonisation requirements after 2030 is a rapid shift towards economic degrowth models. This undermines demand for non-essential building typologies and makes new build development increasingly precarious financially. This coincides with commercial building demand reduction due to an increase in working from home, as transport modes shift, and employers encourage their employees to reduce emissions by commuting less. The shift to working from home/neighbourhood for some sectors means increased demand for residential dwellings and local shared working spaces with suitable facilities and a greater ownership of remote-working health and wellbeing outcomes from employers. The increase in levels of daytime residential use drives demand for air-conditioning and other amenities to boost space comfort levels.

Despite these changes in demand for new non-essential building typologies, the construction sector as a whole grows significantly from 2030 as the rapid transition requires greener infrastructure and a focus on refurbishment of existing buildings. This leads to a growth adjusted reduction in demand for other construction services such as new build construction.

Social Change

Minimal social changes occur prior to 2030, however the pace of change around 2030 is unprecedented. Carbon intensive industries are either rapidly decarbonised, divested from, or progressively regulated out of existence. Communities impacted by this rapid change are not well supported to adapt. This results in increasing wealth inequality, feelings of injustice and political polarisation. Mental health issues become more widespread and are most severe in communities where opportunities to adapt to a low carbon future are limited. Some parts of society feel increasingly left behind or marginalised and this leads to unrest, crime and an overall reduction in safety and security for both individuals and organisations.

The disorganised policy response in the 2020s results in a lack of support for retraining which drives a significant shortage of skilled workers required to enable a rapid transition. Automation and innovation accelerate to meet this gap, but NZ is falling behind countries that have undertaken a smoother transition during the 2020s and we increasingly rely on imported solutions.

This occurs over the backdrop of modest net migration to New Zealand and an ageing population (>20% of pop. over 65 in the medium-term). This means government spending for pensions and aged-care funding and facilities is severely curtailed from 2030 as it is diverted to decarbonisation efforts.

Over the following decades (out to 2050) New Zealand adjusts to the new normal, with government funding redirected over time to deal with the social issues created by the pursuit of rapid decarbonisation.

Land Use Change and Infrastructure

The physical impacts of climate change are evident in the short-term and strongly influences public support and decisions on land-use and infrastructure business cases. A focus on adaptation over mitigation until 2030 means that much of the investment in New Zealand's infrastructure and communities is used to reduce exposure and vulnerability to climate-related events. There is limited investment in infrastructure that supports emissions reduction which inhibits decarbonisation efforts post 2030.

2031-2050		2081-2100
6%		6%

Increase in rainfall intensity in NZ

(from a 1986-2005 baseline)

2031-2050		2081-2100
0.2m		0.6m

Average sea level rise in NZ

(from a 1995-2014 baseline)

After 2030, the primary driver of changes to land use and densification switches to GHG emissions reduction, with changes in transportation use and community connections being of primary importance. Land use change due to increased forestry sequestration takes place out to 2050 and there are moderate impacts on food production and biodiversity as rapid decarbonisation efforts significantly expand the extent of managed forests.

Continuing sprawl and investment in road-based transportation throughout the 2020s has created an infrastructure network that is more entrenched and difficult to transition to a low carbon alternative. This infrastructure (along with older infrastructure) requires significant upgrade to align with the decarbonisation policies enacted in 2030. This increases the costs of transition, although the delay means we can more readily adapt our infrastructure strategies to technology changes over the past decade. The need for a greater rate of decarbonisation in the medium term means some short-term transitional technologies (such as hydrogen) are leapfrogged, and not implemented at scale.

The impacts of climate change on coastal areas, floodplains and drought-prone regions combined with significant transition efforts around 2030 cause a change in population distribution as residents and businesses retreat to lower risk areas.

After 2030, public and active transport infrastructure grows as behaviour and policy change drive greater usage and necessitate rapid upgrades and expansions. There is a shift in mode from trucks towards rail or sea freight for bulk products and materials distribution with greater investment in a lower carbon, diversified and more resilient transport network. This increases supply chain lead times and reduces construction programme flexibility but gives greater certainty of delivery as the now diversified network is more resilient to physical events.

By 2050, New Zealand is dealing with severe climate related events, but the level of warming is stabilising to less than 2°C, with the outlook for 2100 being more of the same. However, the full impact of already baked-in sea level rise is yet to be experienced in 2050, which will present a second wave of retreat and adaptation towards 2100. An early focus on adaptation has meant long-lived infrastructure is not being provided to areas at risk.

Properties in floodplains experience increasing insurance premiums above inflation and experience insurance retreat by 2040. Premiums on some coastal commercial properties increase to the point of permanent unprofitability, leading to them being stranded by 2030. The threat of late century sea-level rise is priced into property valuations in the short term. Properties in denser areas (e.g. in a CBD) experience a slower increase in insurance premiums, as they benefit from surrounding publicly-funded adaptation defences.

Scenario Three – Hot House World

Scenario Three describes a world where no additional policies are introduced to curb greenhouse gas emissions. This results in emissions continuing to rise and global warming reaching >3°C above pre industrial levels by 2100.

Scenario Three at a glance

NGFS 'Current Policies'

Only current policies are preserved, causing emissions to grow until 2080. This leads to greater than 3°C of physical warming and severe physical risk.

IPCC SSP 3-7.0

Exploitation of fossil fuel resources and the adoption of resource and energy intensive lifestyles continues to increase around the world. As the physical impacts of climate change are increasingly realised, policies shift toward national and regional security and resource issues. Social cohesion degrades and conflict and unrest become increasingly common.

IEA 'Stated Policies'

No further action is taken to decarbonise the global energy grid beyond current policies that have already been declared. The global energy grid remains >80% fossil fuel based by 2050.

CCC 'Current Policies'

Aotearoa follows global trends in keeping with current climate policies. No additional policies are introduced. Both technology and behavioural change remain slow across all sectors.

IPCC RCP 8.5

Physical climate change impacts for Aotearoa New Zealand align with downscaled NIWA projections for RCP8.5.

Policy Ambition	Policy Reaction	Technology Change	Behaviour Change	Physical Risk Severity	Transition Risk Severity	Socio-political Instability
>3°C	None - current policies	Slow change	Slow change	Extreme	Low	High

Emissions Trajectory and Alignment of Global Action

Climate policy development stalls at the present day, with no further effective climate policy enacted. Global emissions continue to grow until 2080, which leads to greater than 3°C of physical warming above pre-industrial levels by 2100. Exploitation of fossil fuel resources and the adoption of resource and energy intensive lifestyles continues to increase around the world. The world sees increasingly severe physical risks and the surpassing of bioclimatic tipping points. Historical social, economic, and technological trends continue until the physical impacts of climate change disrupt our ability to maintain the status quo.

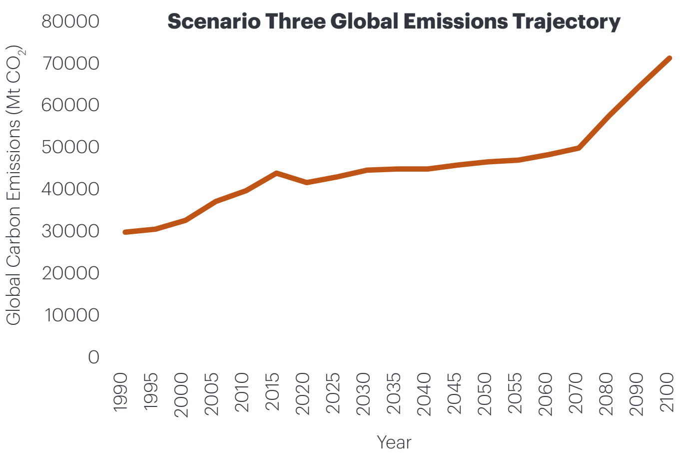


Figure 6: Scenario three emissions trajectory[12].

As with the rest of the world, New Zealand does not enact any additional climate policy, including for the building and construction sector. Regulatory changes are slow and focus on adaptation and managing climate-driven immigration/refugees. The shadow price of carbon remains at $35/t$CO_2$e to 2050 which reflects our current fossil fuel reliance, methods of raw material extraction and product manufacturing technologies. The lack of further policy action to decarbonise disincentivises carbon reduction strategies such as building energy efficiency improvements, fuel switching, carbon capture and storage, and electrification of transport unless they also improve the physical resilience of assets or communities. As physical climate impacts worsen beyond the medium term (2030 onwards) mandates are introduced to conserve energy and infrastructure access for critical functions. As the risk of asset loss and stranding increases, the focus of the property and construction sector becomes climate adaptation and supporting the resilience of communities as they are forced to either adapt or retreat.

Use of carbon capture and storage is minimal. Current policies are entrenched seeing New Zealand's reliance on carbon sequestration through forestry increase significantly out to 2050 in an attempt to offset continued increases in emissions.

New Zealand faces severe physical impacts of climate change with increased extreme wind speeds (5-10%), increase in rainfall intensity (8.6%), and an increase in the number of hot days (100%).

2041-2060	2081-2100
2.1°C	3.6°C

Increase in average global air temperature
(relative to pre-industrial levels)

2031-2050	2081-2100
0.24m	1.08m

Average sea level rise in NZ
(from a 1995-2014 baseline)

12 Emissions trajectory data has been sourced from NGFS emissions modelling available on the **NGFS IIASA Scenario Explorer**. The emissions trajectory for Scenario Three aligns with the NGFS Hot-House World scenario.

Landscape of Fossil Fuel Use / Energy Transition

The global energy grid remains >80% fossil fuel based by 2050. Aotearoa follows global trends in not introducing additional policies and both technology and behaviour change remain slow across all sectors. New Zealand's electricity grid is gradually decarbonised but does not achieve neutrality in the long term. This means buildings wishing to achieve net zero carbon emissions must invest in their own zero carbon generation. Without strategies to decommission fossil fuel plants, incentivise low carbon generation or create localised networks, there are limited benefits from these onsite systems to wider emissions reductions or community resilience.

Increasing frequency and severity of acute weather events (e.g. storms) result in more frequent and severe damage to electricity assets and more frequent and longer blackouts. Building energy efficiency improves in the medium term as passive design solutions, which are more resilient to electrical network failures, become more popular. This reduces the need for fossil fuels for heating in buildings and the financial performance of fully electric buildings (based on current technology) drives operational carbon reductions in the sector.

Policy, Regulation and Markets

National policy shifts towards addressing national and regional security and resource scarcity. Decarbonisation is not a priority and there is no significant behaviour change. Emissions reduction targets put in place by the property and construction sector are not met as they rely on adjacent sectors also decarbonising. Additionally, no governmental support, financial incentives or infrastructure to support the required extent of decarbonisation is provided.

Increasing frequency and severity of acute weather events, as well as longer term increases in baseline shifts (increasing temperatures and sea level rise), drive an increasing need for climate adaptation. For example, the need to retrofit buildings and infrastructure to be more heat and flood resilient. There is little investment in technology and innovation that does not serve these pressing adaptation needs. This increases our reliance on current extractive technologies, which become more expensive as material resources become scarcer (e.g. rare earth minerals for EVs and mobile phones).

2025	2050
0.08 kgCO_2/kWh	0.05 kgCO_2/kWh

NZ Electricity grid emissions

The shadow price of carbon stays stable at \$35/tCO_2e through to 2050 with limited financial incentives to improve efficiency or reduce resource consumption. However, there are strong measures to address resource scarcity, with access to energy and other resources being restricted for non-critical functions. For example, carless days, water restrictions, limits on air-conditioning or heating use, etc. There is more demand for buildings that are resilient to direct climate related physical events, infrastructure failures, and any resulting resource scarcity.

Whilst consumption is not impacted by behaviour changes, a greater proportion of private and government spending is directed to adaptation of physical assets and responding to climate related events. Local councils also increase rates to invest in protection and restoration of certain assets in locations where retreat is not an option. This increase in adaptation spending reduces the level of discretionary spending, which impacts on non-essential infrastructure and building activity related to retail premises.

Designing new infrastructure involves accounting for more frequent risk, but mandates to use low carbon materials in

2025	2050
0%	50%

Whole of life carbon emission reduction (for buildings)

buildings and construction are very slow to come into effect. Investment is prioritised towards adaptation and climate resilience.

Existing low carbon materials are readily available due to low demand but there is little innovation beyond technologies and materials currently available. The construction of physical defences accelerates in the medium-term and this increases demand for concrete and steel. These industries struggle to decarbonise in the face of soaring virgin product demand and a lack of government support.

Changes to building codes are focused on the response to physical impacts and tragic events. This increases the cost of development with limited whole of life cost benefits. Resilience requirements also capture existing buildings which need to be upgraded to be considered safe. This results in a significant capital works programme of building retrofits, but the opportunities to also improve energy efficiency and carbon emissions are not taken as capital is severely limited. The need to improve building resilience causes many assets (especially in smaller/remote/less resilient settlements) to be stranded/abandoned.

Socio-political landscape

Increasing severity and frequency of weather events causes disruptions to global food supplies in the medium-term (2031-2050). Social cohesion starts to degrade and conflict and unrest become increasingly common. The frequency of heat stress and mental health impacts from climate change are at record levels. Older people become more vulnerable and there's more demand for care and assisted living as physical risks increase (i.e. heat stress related illness). However, a large increase in net migration to New Zealand (6.93 million people by 2050) means that the growth rate of people aged over 65 slows considerably from 2040, with minimal change over the following decade (to 2050).

There are changes in population distribution and land use over the medium-term (that accelerates post 2050) as people begin to retreat from areas at risk from physical impacts (e.g. coastal areas at risk from sea level rise and storm surges, floodplains, regions vulnerable to drought). Food insecurity due to physical impacts, that effect growing areas as well as the ability to transport food, leads to large scale retreat out of cities and toward self-resilient lifestyles with less consumption. This combines with net migration to significantly changes the demographics of many locations in New Zealand. New wealth divisions are created based on the level of financial exposure to physical risks. This change in circumstances for individuals and communities gives rise to a feeling of injustice, with political polarisation and conflict undermining government policies and increasing regionalism.

For the Construction and Property sector this means significant changes in the location of construction activity, which does not match up with where skilled labour forces have relocated. The level of disruption, resulting political polarisation, and regionalism, reduces the extent of large centrally funded capital works, which reduces construction activity generally. There is an opportunity for construction sector participants to band together and create smaller regionalised supply chains that can adapt quickly to local changes in construction needs and respond to physical events.

Land Use and Infrastructure

More extreme weather puts significant strain on power infrastructure and the security of electricity supply is at risk. The sector must actively manage the risk of increasingly disrupted supply chain as extreme climate events occur across the world. This risk is moderate in the short term but becomes increasingly extreme in the medium and longer terms as increasing emissions drive more frequent and severe extreme weather events.

Investment is required to restore/protect infrastructure and design of new assets involves designing for more frequent risk. Some publicly funded services and infrastructure are unable to cope with the high degree of physical climate risks. Where there is a perception or a reality that public infrastructure or services are not resilient to climate risk, demand for private infrastructure and emergency management services increases.

There are changes in population distribution and land use post-2050. Food insecurity and growing populations drive retreat from cities. People begin to retreat from areas at risk from physical impacts and significant managed retreat from coastal areas moves populations inland to areas that are less vulnerable to climate hazards. Populations that live in floodplains and regions vulnerable to drought also experience significant relocation. Spikes in demand for housing occur due to climate-driven immigration from other parts of the world and increasing numbers of climate refugees. Populations concentrate around regions that are more climate resilient. This introduces significant demand for construction activity in areas where resettlement is occurring. The relocation of large industry and new housing will create large private sector demand.

2031-2050	2081-2100
8.6%	26.1%

Increase in rainfall intensity

(from a 1986-2005 baseline)

Properties in floodplains experience increasing insurance premiums and likely experience insurance retreat by 2040. Properties lose value and become stranded assets. Premiums on coastal commercial properties may increase to the point of permanent unprofitability, leading to them being stranded by 2030. Construction in hazardous areas becomes increasingly dangerous and some commercial property owners experience liability risk as heatwaves cause fatalities to occur onsite. Insurance rates for construction companies also increase.

8. Sector Risks and Opportunities

Identifying climate-related risks and opportunities is a key aspect of conducting climate scenario analysis. Table 6 outlines the XRB standards' definitions of transition and physical risks, and climate-related opportunities, based on the TCFD framework.

The construction and property sector includes a particularly diverse group of industries and sub-sectors and therefore the working group participating in the development of the sector scenarios involved members from a range of backgrounds. For that reason, many climate-related risks or opportunities may not be material to the entire sector but could be material to certain sector participants.

Tables 7 to 9 outline potential risks and opportunities that may apply to sector participants. The example risks and opportunities are intended to provide a 'starter for 10' for sector participants, who can each draw from it when using these scenarios for their organisation's climate-related disclosures. **Organisations should still perform their own risk and opportunity assessments**.

Table 6: Definitions of risks and opportunities under the XRB's standards

Transition risks Risks related to the transition to a low-emissions, climate-resilient global and domestic economy, such as policy, legal, technology, market and reputation changes associated with the mitigation and adaptation requirements relating to climate change.
Physical risks Risks related to the physical impacts of climate change. Physical risks emanating from climate change can be event-driven (acute) such as increased severity of extreme weather events. They can also relate to longer-term shifts (chronic) in precipitation and temperature and increased variability in weather patterns, such as sea level rise.
Climate-related opportunities The potentially positive climate-related outcomes for an entity. Efforts to mitigate and adapt to climate change can produce opportunities for entities, such as through resource efficiency and cost savings, the adoption and utilisation of low-emissions energy sources, the development of new products and services and building resilience along the value chain.

Table 7: Transition risks

TRANSITION RISKS	
Reputational	Emissions reduction targets are seen as insufficiently ambitious. *For example, due to not having a benchmark for different building types.*
	Disclosed emissions reduction targets aren't met or are revised downward. *In association with sustainability loans, there may be fines or increased interest loans.*
	Oversale of green credentials resulting in greenwash accusations.
	Reluctance to disclose climate targets or solutions resulting in green-hush accusations.
Policy & Legal	Stricter building regulations and retrofitting of existing buildings, resulting in increased operational expenses and need for large capital expenditure. *For example: higher rates if capital values increase due to stricter building regulations.*
	Slow adoption of building standards for retro-fit in low income / lower value households, such as those in the rental market, leading to inequity in resilience.

Policy & Legal	Carbon price increases costs of materials, construction operations, and buildings' operations. *Further impact on financing on building projects due to uncertainty around costs and timelines.*
	Policy changes progressing faster than supply chains can adapt results in construction activity slowdown.
	Contract clauses on performance and triggers are no longer fit for purpose in a changing physical climate with more acute events (e.g. flooding).
	Unstable supply and pricing of renewable energy as renewable sources enter the market ahead of policy / market guidance.
	Legal risks for buildings that are not climate resilient.
	Stricter land-use and planning requirements may create a need for changes to business models.
Market	Failure to meet consumer, client, and investor expectations for decarbonization and sustainable innovation. *There may be a disconnect between stakeholder expectations and what can be provided.*
	Declining market attractiveness due to increased vulnerability and exposure to higher costs. *Impacts access to international capital for investment in NZ.*
	Risks to reputation and market positioning, with stakeholder demand for companies where climate risks are included in the investment calculation.
	Decarbonisation affects local markets, with demand and asset values dropping in areas dependent on declining emissions-intensive industries. *Additional impacts on crime and safety, and viability of services.*

Market	Demand for low carbon materials exceeds supply or that low availability of low carbon materials leads to delays. *Additional risk of greenwashing through proliferation of low-quality standards.* *High demand for EPD/LCA experts in NZ.*
	Cost of Environmental Product Disclosures becomes a financial barrier to demonstrating low carbon status.
	Lack of sufficient skilled labour in the industry to support decarbonisation and climate change adaptation.
	Decrease in productivity as companies deal with acute hazards in real time.
	Increase in taxes/rates to pay for strengthening infrastructure.
	Cost of materials and labour increasing beyond economic means.
	Insurance retreat from emissions intensive industries and assets.
Technology	Substitution of existing building products and services with lower emissions options.
	Tightening of regulations around specification of materials in design limits the ability to improve materials once consents are gained.
	Technology required to make new and existing buildings more efficient is costly and a barrier to adoption. *Additionally, technology solutions advance faster than building code and therefore are hard to gain consent for.*
Social	Resistance to change and push back against climate science and policies causes local and national political instability and inertia.

Table 8: Physical risks

PHYSICAL RISKS	
Risk type	**Risk description**
Chronic	
Sea-level rise	Sea-level rise slowly but steadily exacerbates the risk of coastal inundation of properties, utilities or other infrastructure during high rides and storms.
	Sea level rise leads to insurance retreat from coastal locations.
	Gravity based stormwater hindered by high tides.
Average temperature rise	Increased cooling demand and energy consumption impacting on costs and any performance-based contracts / certification requirements. *Trend predictions will need to be incorporated into certifications. This will be a significant challenge as trends themselves are unpredictable.*
	Increased discomfort or health risks for occupants in properties without climate control (including those in external spaces, and construction activities).
	Reduced yield from solar PV generation affects energy supply to grid.
	Increased instances of illness due to diseases ability to survive in warmer climates.
Average rainfall increase	Changes in ground conditions and slope stability undermines assets and connected infrastructure. *Additional impact on buildable areas, potentially rendering significant parts of towns/cities uninhabitable.*
	Reduction in earthworks season.
	Reduction in ability of infrastructure to cope with frequent increased rainfall.
	Transport system affected, reducing workers' ability to commute.
Increase in drought conditions	Reduced availability of potable water (limiting construction and property maintenance activities).
	Loss of vegetation providing asset protection (slope stability, stormwater attenuation, shade and heat island impacts, etc). *Additional impacts on asset or corporate level biodiversity targets.*
	Lack of fresh fruit and vegetables affecting long-term health of population.
Acute	
All	Cost of direct physical damage to assets caused by extreme weather events (e.g. storms, floods).
	Health and safety risks to staff, contractors, stakeholders, and building occupants due to extreme events (e.g. storms, heatwaves).
	Increase in construction programmes and costs due to weather-related delays or damage *(onsite and in supply chain)*.
	Extreme events overwhelming response teams.
	Accelerated deterioration of building products and materials due to heat stress/ cycling, hail impacts, corrosion, fading (resulting in increased maintenance, replacements, and repairs).
High intensity rainfall/storm events	Increased intensity of rainfall events inundates buildings and sites.
	Increased intensity of rainfall events causing overloading of infrastructure resulting in flooding/damage limiting access to physical assets. *Further overwhelming the supply chain and construction workers in the recovery period.*
	Damage to local infrastructure leading to higher rates and cost of occupancy.
	Contamination of waterways or potable water supplies (limiting construction and property maintenance activities).

Heatwaves	Failure of active building systems or overloading upstream electrical infrastructure. *Further risk of inability of grid to supply power in required quantities at peak times.*
	Overheating of air-conditioned spaces impacting on critical asset functions or occupant safety.
	Accelerated pathogen growth in local water storage.
	Rural buildings at risk of fires.

Table 9: Opportunities

OPPORTUNITIES	
Opportunity type	**Opportunity description**
Resource efficiency, energy sources, and resilience	Improved energy efficiency of assets results in better resource efficiency and reduced operational costs. *Developers rewarded for both new and renovated buildings with higher energy efficiency.* *Local authorities able to drive changes by providing incentives for improving energy efficiency of buildings.*
	The need to repair buildings post-climate events provides the opportunity to make them more energy efficient.
Products and services	Demand for low carbon materials and other green technologies drives investment and innovation for materials providers in NZ. *Forward thinking manufacturers will be rewarded with business for issuing EPDs.*
	Increased demand for construction services to support infrastructure and buildings necessary for adaptation and a decarbonised economy. *Further opportunity to train the building industry on how to achieve low carbon goals.*
Products and services	Standardisation/prefabrication of design methodologies increases building performance and construction speed, allowing more high-quality buildings to be built in shorter periods of time.
Products and services, market	Demand increase in NZ due to climate refugees or related immigration.
	Higher demand for rentals as they are seen as more resilient, particularly as temporary solutions during extreme weather events.
	Early adopters and ambitious entities able to access lower cost capital as banks and investors seek climate focused investments.
Increased average rainfall	Increased yield to rainwater harvesting systems reducing potable water consumption and costs.
	More water sensitive designs will be needed, for which new manufacturers and installers would be required. *Further opportunity to upskill the market / industry.*
Increased average temperature	Reduced demand for heating from fossil fuels.
Reputation	Being an early adopter of lower carbon technologies or services.

9. Limitations and Disclaimers

This section outlines the key limitations and considerations for the draft Construction and Property sector climate scenarios presented in this document.

Consolidation of information in scenarios

The scenarios presented here have been developed based on input from the NZGBC Technical Working Group (TWG), the Leadership Group (LG), and from Beca's specialist advisory team. NZGBC, the TWG and LG, and the Financial Markets Authority (FMA) have had an opportunity to provide feedback on the strawman scenarios distributed 20 December 2022.

Every effort has been made to ensure the scenarios are reflective of the information collated from the workshops, relevant external data, and the feedback provided, however not all this information could be included. Information has been prioritised for inclusion that:

- Relates to the priority climate driving forces (drivers) for the property & construction sector, voted on by the TWG (see **Appendix F**).
- Was considered by Beca's specialist advisory team to be key additional information to include in each scenario.

In conclusion, the consolidated information included in each scenario may not be a direct representation of all comments collected from the workshops but attempts to incorporate all key perspectives of the TWG and LG.

For the climate scenario analysis, CREs should use the long narratives in the **Full Scenarios** section that includes information that 'underlies' each scenario at both the global and sector level.

Purpose of Variables & Indicators & Quantification

The purpose of quantifying variables and indicators in the scenarios is to enable the evaluation of strategy resilience and to complement the scenario narratives. The variables and indicators in the scenarios are not intended to demonstrate precise future values and should **not** be used to conduct probabilistic calculations.

Inclusion of Data – Variables & Indicators

Following a second workshop, Beca asked the TWG to vote on the preferred climate variables and indicators to be included in the scenarios. Beca suggested a long-list of potential variables/indicators at this stage and allowed members to suggest additional items. It was not possible to include data for all the preferred variables and indicators due to data availability constraints.

The scenarios do not include numerical data for the following variables and indicators:

VARIABLE / INDICATOR	REASON FOR NOT INCLUDING
Severity and frequency of storm events	NIWA have not downscaled storm event or cyclone projections for New Zealand, as there is low confidence in region specific projections. According to the IPCC, it is likely that the frequency of tropical cyclones will decrease or remain unchanged out to 2100. However, it is likely that maximum wind speeds and rainfall intensity will increase. Both these variables have been included.
Insurance premiums / insurance costs ($)	Qualitative descriptions of how insurance costs and insurance retreat play out under each scenario is included in the long version scenarios (Section 8). There is no readily available projected data for insurance costs in dollar figures for New Zealand under different climate scenarios. Modelling to develop new data would be an extensive exercise and is outside the scope of this project.

Working from home %	The Beca team undertook desktop research and was unable to locate any existing, credible projections for future rates of working from home in New Zealand. This indicator is dependent on many potential factors. Conducting extensive data modelling of the kind required to come up with new projections is outside the scope of this project. Further, it would not be appropriate to extrapolate out available data for present rates, since the best available data was collected by StatsNZ during 2020. It is therefore unlikely to reflect current (2023) or future, post-Covid Alert Level rates of working from home.

Timeframe selection

The TWG members and Leadership Group feedback received during workshops indicated a preference for focusing on short to medium term timeframes in the scenarios (i.e. present-2050). Although some entities are conducting asset planning beyond 2050, the short and medium term (up to 2050) is the predominant focus for business strategy planning. Testing an entity's strategy is the main purpose of climate scenario analysis.

Asset management planning is typically informed by a detailed climate risk assessment (in accordance with **Ministry for the Environment guidance**), as a parallel activity to climate-related disclosure reporting. Whilst it is important for entities to understand climate risk for long lived assets out to 2100 and beyond for strategy testing, aspects of the narratives up to 2050 include indications of these risks (such as stranding risk, insurance retreat, etc.). The scenarios have, therefore, focused on the present up to 2050, particularly for transition risks and opportunities. Some additional narrative description also covers physical risk in the long term (2050 – 2100).

Choice of timeframes for some of the physical variables are constrained by available NIWA data. Downscaled data for average temperatures increase, number of hot days, rainfall intensity, and increase in wind speeds are publicly available for two timeframes: 2031-2050 and 2081-2100. This is reflected in both the short and long form scenarios. Climate Change Commission projections for carbon price and emission grid factors are only available up to 2050. Therefore, data for these indicators has not been included beyond 2050.

Indicator data has been included for 2025 and 2050 in the 'Scenarios on a Page,' as 2025 data best illustrates the differences between Scenario One and Two. More data points (2030, 2035, and 2040) have been included where possible for variables/indicators in **Appendix D**.

Alignment with Existing Scenarios

As discussed in the Methodology Section, the XRB recommends roughly aligning each sector scenario with a set of existing scenarios. The benefit of doing this is so that the new sector scenarios are based on a set of commonly recognised assumptions. Each Construction and Property sector scenario is aligned with a set of existing scenarios in a logical manner. Note, however, that choosing existing scenarios to align with involves an element of creativity and best judgement. Each set of existing scenarios was developed by different entities for different purposes, which means they are not directly comparable.

Alignment with Downscaled NIWA Data

NIWA is due to publish downscaled SSP projections for New Zealand by around 2024. NIWA have confirmed they will be downscaling[13]:

- SSP1-2.6
- SSP2-4.5
- SSP3-7.0

NIWA will not be downscaling New Zealand projections for SSP1-1.9 or SSP5-8.5. NIWA considers these two extreme

[13] NIWA (2021). **Updated national climate projections for Aotearoa New Zealand**

scenarios to be less plausible. Best practice for downscaling the global SSP scenarios is to prioritise the three "middle" scenarios over the two extremes. Figure 7 shows the full range global SSP scenarios for reference.

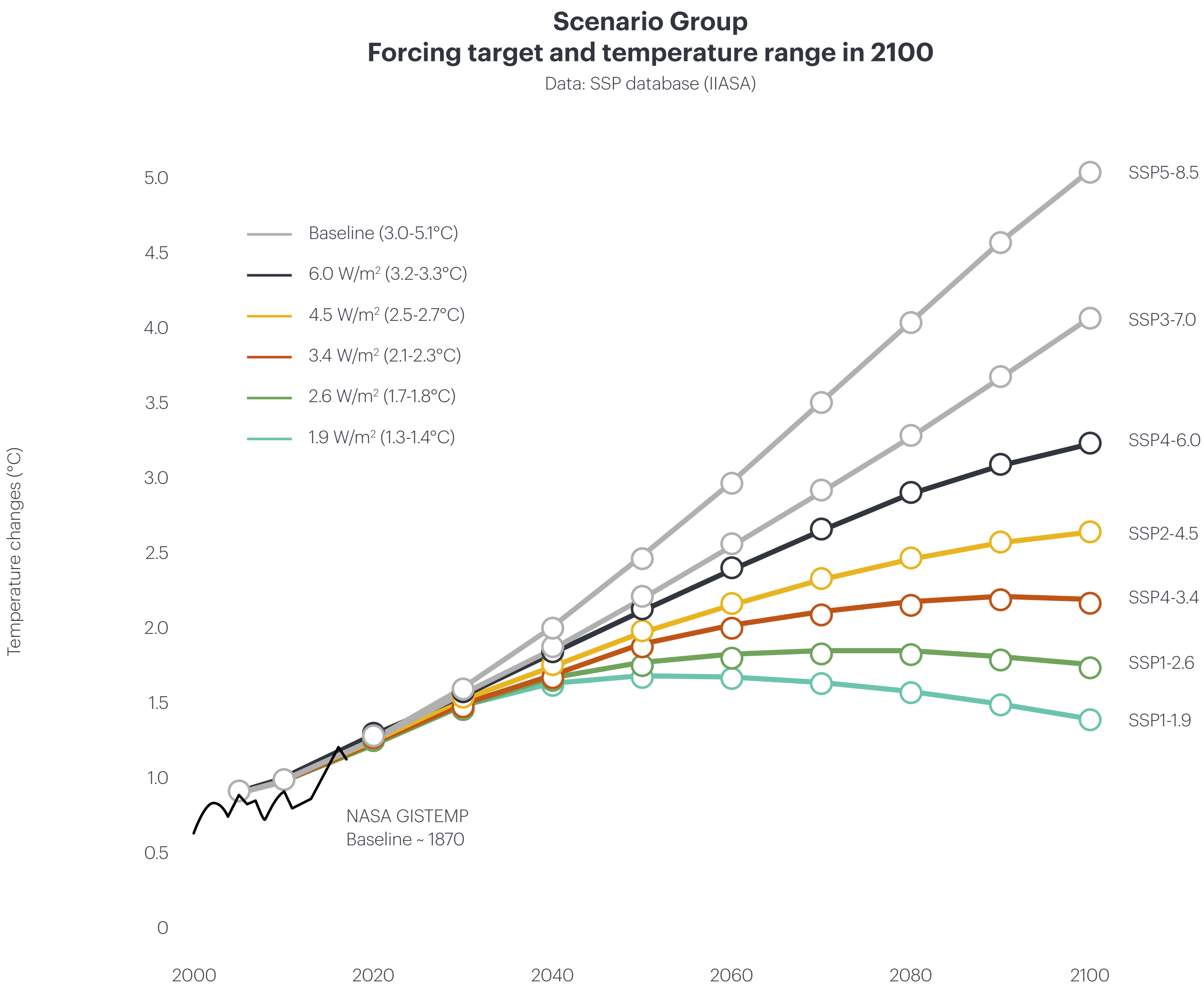


Figure 7: The IPPC Shared Socio-economic Pathway scenarios

Due to NIWA's downscaled SSP data not being available until at least 2024, NIWA's existing downscaled RCP data has been used to generate the climate variables for the scenarios. Therefore, each sector scenario has been aligned with a logical RCP equivalent.

The intended end use for the downscaled scenarios is primarily to inform scientific research, as well as climate risk assessments and adaptation planning. The downscaled scenarios therefore have a different primary end use compared with sector scenarios for climate scenario analysis. Sector scenarios must align with the XRB's standard requirements. The end purpose of climate scenario analysis is to inform shareholders about the resilience of an entity's strategy.

For the sector scenarios, meeting the XRB requirements and being "fit for purpose" for climate scenario analysis is the primary consideration. As a second consideration, where relevant and appropriate the scenarios have been aligned with the due-to-be-downscaled NIWA data. This will:

- Enable variable data for some sector scenarios to be updated when the new downscaled NIWA data becomes available.
- Ensure easier integration of CREs climate-related disclosure reporting with any parallel climate risk assessment work they may carry out.

Scenario One – Alignment with SSP1-1.9 and RCP2.6

The XRB requires a scenario aligned with limiting warming to below 1.5°C. The 1.5°C scenario needs to align with SSP1-1.9, the only SSP that aligns with this degree of warming.

At workshops with TWG and Beca team participants, it was acknowledged that a shift away from considering a 1.5°C-aligned scenario as a 'plausible' scenario is expected within the next couple of years and the XRB standards may be updated to reflect this. For this work, the scenarios are aligned with the XRB requirements of a 1.5°C scenario. If the XRB's standard changes, the sector scenarios can be updated accordingly.

NIWA have agreed that given the XRB requirements, alignment of the 1.5°C-aligned scenario with SSP1-1.9 is relevant in this context. This scenario will not directly align with the downscaled data NIWA is producing.

Regarding the NZ-specific data underlying the climate variables, Scenario One is linked to RCP2.6, which has a 0.9-2.3°C warming alignment so is most suitable for aligning to the required 1.5°C.

Scenario Three - Alignment with SSP3-7.0 and RCP8.5

The XRB requires that one scenario have >3.0°C of warming. Although it was initially recommended to have the >3.0°C scenario aligned with SSP5-8.5, as it is best able to test the extremes of physical risks due to its high degree of warming, NIWA will not be downscaling SSP5-8.5 because they consider it to be beyond the limit of plausibility. Therefore, scenario three has been aligned with SSP3-7.0 which also aligns with the required >3.0°C of warming and is being downscaled by NIWA.

Regarding the NZ-specific data underlying the climate variables, the >3°C scenario is linked to RCP8.5, which sits somewhere between SSP3-7.0 and SSP5-8.5 in terms of equivalency. This approach was agreed upon with NIWA during scenario development.

Scenario Two – Alignment with SSP1-2.6 and RCP2.6

The XRB requires a third alternative scenario. As discussed in the Methodology Section, a 'Disorderly' scenario narrative was chosen as the alternative scenario, as this was considered the scenario type best able to test entity's risks and opportunities in the shorter term. This scenario logically aligns with SSP1-2.6 (regarding relative degree of warming). NIWA will be downscaling SSP1-2.6.

Disclaimers

Third Party Reliance

This report has been prepared on the instructions of NZGBC, for the purpose of assisting entities within the Construction and Property Sector to assess the resilience of their business and strategy under various future climate-related scenarios and to assist climate-related entities within the sector in meeting their climate reporting obligations. By its nature, the report outlines plausible future scenarios, which are not intended to be probabilistic or predictive, and accordingly the NZGBC and Beca accept no liability to any entity in respect of any reliance they may place on this report.

The information contained in this report is not intended to address the circumstances of any particular entity or individual. Climate Reporting Entities (CREs) are independently responsible for ensuring they meet XRB Standard requirements when preparing their climate-related disclosures. Although every effort has been made to ensure the scenarios presented here meet current XRB standard requirements (as of March 2023), Beca does not accept liability under any circumstance for CREs independently ensuring that they meet XRB Standard disclosure requirements.

Inherent Limitations

The information presented here is based on publicly available information and information provided by the NZGBC's Technical Working Group and Leadership Group. Unless otherwise stated the accuracy and completeness of any publicly available information and information provided in connection with this project has not been independently verified.

The scenarios presented here have been developed based on the best available data at the time and in line with present XRB Standard requirements (as of March 2023). There is no guarantee that information or data provided here is accurate as of the date it is received or will continue to be accurate in the future. These scenarios will require updating as new data becomes available, or in the event of changes to the XRB Standard requirements.

Individuals using these scenarios for any reason should read this report in its entirety, including the Disclaimers, Limitations Section and Appendices.

Beca Ltd. is under no obligation for any reason to update this report, in either oral or written form, for reasons or events occurring after this report has been issued in final form.

Appendix A

Acknowledgements

The development of the Construction and Property sector climate scenarios has been made possible by the contributions of the Leadership Group, Technical Working Group and Beca Specialist Team, listed below. NZGBC and Beca would like to acknowledge their commitment and valuable contributions to the workshops and the feedback process throughout the development of the scenarios.

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Appendix B

Scenario development methodology

This appendix provides an overview of the methodology followed to develop the Construction and Property Sector Scenarios.

The scenarios presented in this report have been developed in accordance with the **draft XRB guidance on developing sector scenarios under NZ CS 1 (2022)**.

The XRB guidance outlines six main steps for developing climate scenarios:

Steps 1 and 2: Engage sector stakeholders and set focal questions, scope and timeframe for the scenario development process.

Step 3: Identify & prioritise driving forces of relevance to the sector. Driving forces (also known as 'drivers') are typically broad scale factors which influence the direction of future change.

Step 4: Select outcomes and pathways. Select outcome and pathway combinations for narrative development which are of greatest relevance and provide the greatest challenge (e.g. using the four NGFS narrative quadrants).

Step 5: Draft narratives and quantify variables. Draft scenario narratives which follow a clear internal logic. Synthesise any relevant data from existing scenarios and projections. Generate new data if doing so is feasible and adds value.

Step 6: Review and finalise the scenarios. Check the scenarios are internally consistent and fit for purpose. Document methodology in a comprehensive report. Publish final scenarios and make publicly available.

Prioritising climate drivers (workshop one)

In the first workshop that Beca facilitated with the TWG (25th October 2022), the project was introduced and the TWG brainstormed potential driving forces of relevance to the Construction and Property sector. Following workshop one, Beca issued a questionnaire to the TWG asking members to:

- Prioritise climate drivers, as well as variables and indicators to be included in the scenarios.
- Indicate preferred alignment for the sector scenarios with existing scenarios (e.g., SSPs, RCPs and NGFS scenarios). This provided Beca with a high-level indication of preferred outcomes and pathways ahead of workshop two.

In the second workshop with the TWG, Beca presented and confirmed the selected priority drivers (based on questionnaire votes). The priority drivers were:

1. Increasing frequency and severity of extreme weather events

2. Availability of low carbon materials to meet regulations and/or market demand

3. Regulatory changes (including resilience, low carbon, and circular economy regulations)

4. Pressures on centralised infrastructure / aging infrastructure

5. Price of carbon (and impact on cost of materials)

The complete long list of drivers, and the list of priority drivers voted on by the TWG are available in **Appendix F**.

Building the Scenario 'Foundations'

The purpose of the three sector scenarios is to help an entity to identify its climate-related risks and opportunities and develop a better understanding of the resilience of its business model and strategy. For this reason, the **XRB scenario development guidance** recommends aligning each scenario with a different **Network for Greening the Financial System (NGFS)** narrative 'quadrant' (see Figure 8).

In workshop two Beca recommended three scenario 'foundations' based on the TWG's questionnaire responses (see Figure 9) and Beca's specialist inputs. Beca recommended aligning the Construction and Property sector scenarios with:

- **An 'Orderly' scenario** – to meet XRB requirements for a 1.5°C scenario.
- **A 'Hot House World' scenario** – to meet the XRB requirements for a >3.0°C scenario.
- **A 'Disorderly' scenario** – to meet the XRB requirements for a third alternative scenario.

Beca recommended the selection of a 'Disorderly' scenario over a 'Too Little, Too Late' scenario as the third alternative scenario, because a 'Disorderly' scenario was:

- best aligned with the TWG survey results.
- aligned with a pre-existing, detailed NGFS scenario, which enables an additional layer of "credibility" to the scenario 'foundations.'
- focuses on a shorter timeframe with transition risk becoming extreme in 2030, which may be most useful for CREs wanting to focus on nearer-term timeframes for testing potential transition risk.

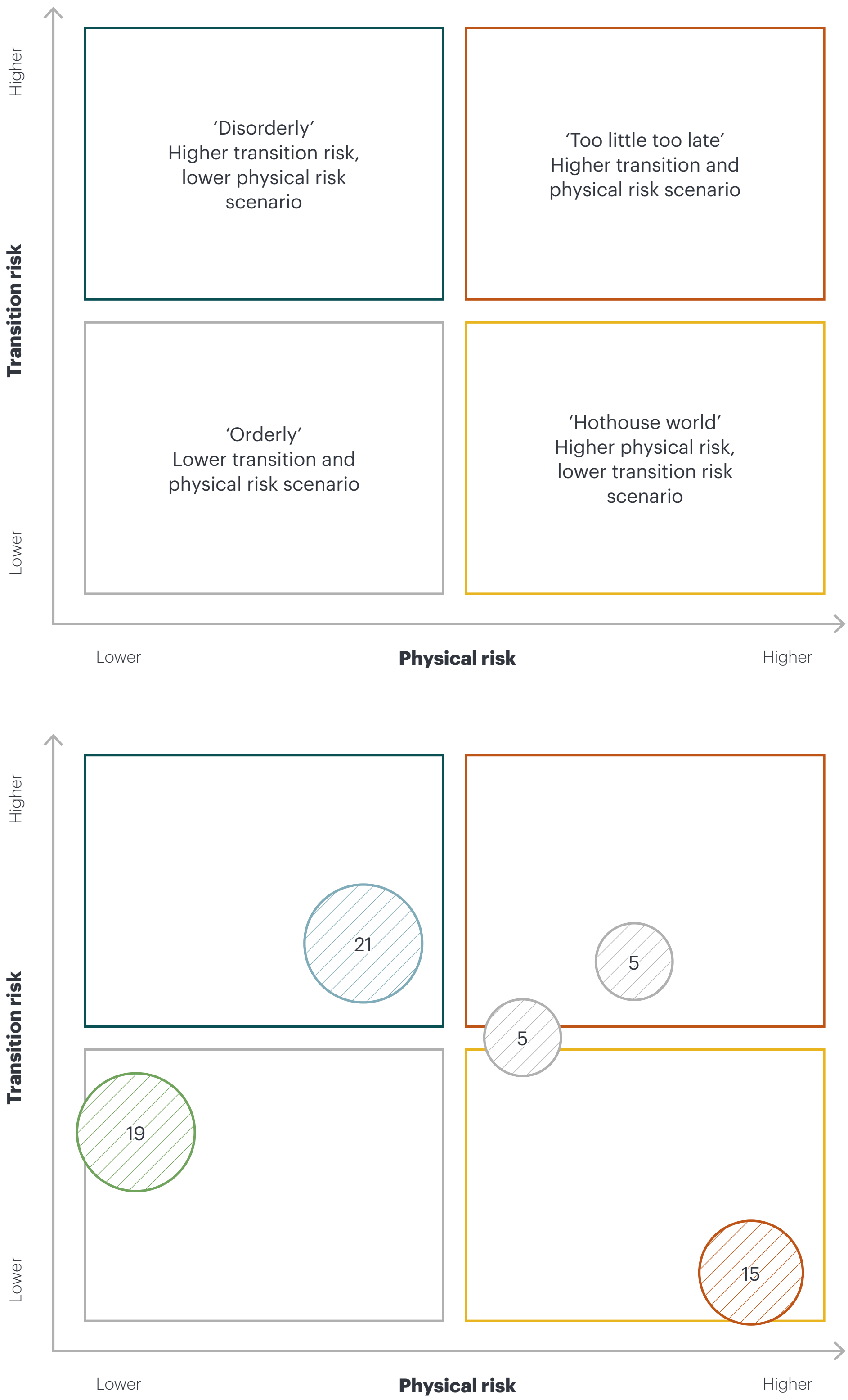


Figure 8: The TWG's votes on existing scenarios to be used as foundations for the C&P sector scenarios (aligned with the NGFS scenario quadrants as per XRB's recommendations).

After selecting appropriate narrative 'quadrants' for each scenario, the XRB guidance recommends that sectors develop their scenarios by using existing scenarios as 'building blocks.' This may include, for example, the IPCC's global scenarios (SSPs and RCPs), the NGFS global narrative scenarios, International Energy Agency (IEA) scenarios, and relevant NZ-specific scenarios. Creating a scenario 'foundation' from existing (or parts of existing) scenarios creates a starting point for developing the sector-specific aspects of each scenario (see figure 6).

Choosing existing scenarios as the building blocks of each sector scenario is, to borrow the XRB's language, "as much of an art as it is a science." The building blocks chosen for each scenario should be logical, but it is important to acknowledge that existing scenarios were all developed for different purposes and therefore may not precisely align.
For example, it would not be logical to align an SSP1-1.9 narrative with the NGFS 'Current Policies' scenario as these are starkly contrasted. It could, however, be considered logical to align an SSP1-1.9 narrative with an NGFS 'Net Zero 2050' scenario, as there are enough similarities between them despite having been developed for different purposes.

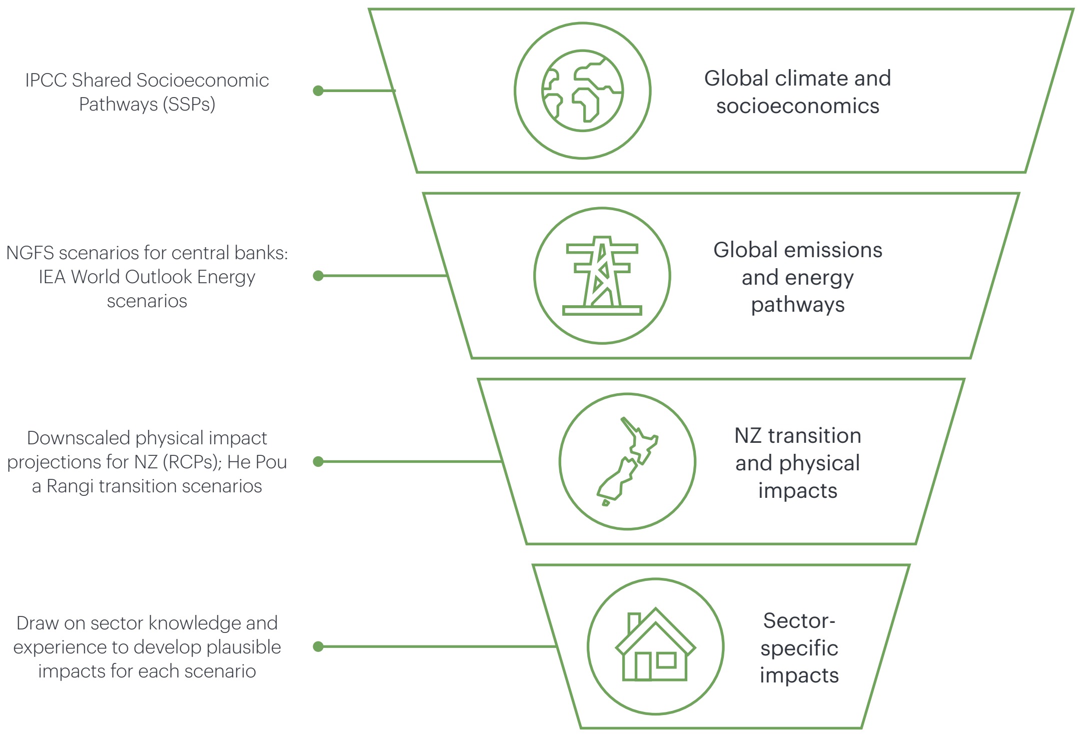


Figure 9: Existing scenarios should be used as the 'building blocks' for each sector scenario. (Adapted from XRB 2022 Scenario analysis: getting started at the sector level).

The benefits of aligning sector scenarios with existing global and national scenarios include:

- Forming a scenario 'foundation' helps to set a logical direction of travel for developing the sector-specific parts of each scenario.
- Drawing on a common set of assumptions from existing scenarios will enable greater comparability with scenarios used or developed by other sectors and sub-sectors.
- Using existing scenarios as 'building blocks' helps add credibility to the new sector scenarios.
- It makes updating the sector scenarios easier as and when new climate change information/data is released (e.g., new IPCC projections).

In building the scenario foundations, each scenario has been roughly aligned with the most appropriate SSP, NGFS scenario, IEA World Outlook Energy scenario, downscaled RCP data for New Zealand, and a Climate Change Commission transition scenario. These existing scenario alignments are provided in the long version of each scenario (Section 8).

Developing sector-specific impacts (workshop two)

In a second workshop facilitated by Beca, the TWG members brainstormed how the selected priority climate drivers might logically play out in line with each of the three scenario quadrants selected. These outputs formed the sector-specific impacts for each scenario. TWG discussion points and comments from workshop two were recorded (via hard copy or on a Miro Board).

Leadership Group review

The Beca team presented a progress update on the scenario development to the NZGBC Leadership Group on 6th December 2022. The Leadership Group (LG) were asked to discuss and confirm the selected scenario outcomes and pathways (and their respective alignment to existing NGFS and SSP scenarios). The Leadership Group confirmed selection of a 'Disorderly' scenario as the preferred choice for a third alternative scenario (as opposed to a 'Too Little, Too Late' scenario). The LG confirmed that a 'Disorderly' scenario was best suited for enabling entities to test strategies and risks & opportunities in the shorter term (2022-2040) compared with as 'Too Little, Too Late' scenario.

Strawman scenarios

The Beca team organized and consolidated the outputs from workshops one and two. Members of the Beca specialist team reviewed the outputs and added additional information and comments to address gaps. The Beca team then took this consolidated information and synthesized it into both long and short draft versions of the narrative for each sector scenario.

This set of draft scenarios was distributed to the TWG, XRB and FMA for feedback. This allowed the Beca team to incorporate a broad range of inputs from across the construction and property sector, climate-related disclosure, and financial disclosure specialists, in the final climate scenarios.

TWG feedback and prioritisation of risks and opportunities (workshop three)

The TWG provided feedback prior to workshop three, allowing the Beca team to present it back to the group and facilitate discussion. This allowed the technical team to request any final feedback and ensure the feedback being taken on board for the final scenarios was comprehensive and clear.

The TWG also brainstormed potential sector-specific risks and opportunities under each scenario. These will enhance the scenarios and make them more user friendly for CREs when conducting climate scenario analysis. A full list of these can be found in the **Sector Risks and Opportunities** section of this report.

Development of final Construction and Property sector scenarios

The Beca team has synthesised the outputs from the workshops and the feedback on the strawman scenarios to inform the development of the final Construction and Property sector scenarios presented in this report.

Appendix C

Glossary

Carbon Dioxide Removal (CDR): Anthropogenic activities removing CO_2 from the atmosphere and durably storing it in geological, terrestrial, or ocean reservoirs, or in products. It includes existing and potential anthropogenic enhancement of biological or geochemical sinks and direct air capture and storage but excludes natural CO_2 uptake not directly caused by human activities.

Climate-related disclosures: By providing a consistent framework for entities, climate-related disclosures (CRDs) enable primary users (e.g. shareholders) to assess how well entities are assessing and managing their climate-related risks and opportunities and the related financial impacts. If successful, CRDs would shift capital towards activities consistent with an international transition to a low-emissions, climate resilient future.

Climate reporting entity (CRE): According to the Financial Markets Conduct Act 2013, a climate reporting entity is one of the following:

a) a listed issuer that—
   i. is a large listed issuer; and
   ii. is not an excluded listed issuer:
b) a registered bank that is large:
c) a licensed insurer that is large:
d) a credit union that is large:
e) a building society that is large

Climate-related scenario: A plausible, challenging description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces and relationships covering both physical and transition risks in an integrated manner. Climate-related scenarios are not intended to be probabilistic or predictive, or to identify the 'most likely' outcome(s) of climate change. They are intended to provide an opportunity for entities to develop their internal capacity to better understand and prepare for the uncertain future impacts of climate change.

Climate variable: A physical variable or a group of linked variables that critically contributes to the characterisation of Earth's climate, including mean temperature, maximum and minimum temperatures, frosts or hot days, mean precipitation, dry days or very wet days, droughts, storms, extreme wind speeds, circulation, solar radiation, relative humidity, and mean sea-level pressure.

Downscaling: Deriving local climate information from larger-scale model or observational data. Two main methods exist – statistical and dynamical. Statistical methods develop statistical relationships between large-scale atmospheric variables (e.g. circulation and moisture variations) and local climate variables (e.g. rainfall variations). Dynamical methods use the output of a regional climate/weather model driven by a larger-scale global model.

Driving forces ('Drivers'): Driving forces (also known as 'drivers') are typically broad scale factors which influence the direction of future change. Understanding which driving forces will have the greatest influence in shaping outcomes for the sector is an essential step in creating climate-related scenarios.

External Reporting Board (XRB): New Zealand's External Reporting Board, which issues national reporting standards for entities across the private, public and not-for profit sectors.

Financial Markets Authority (FMA): The FMA is the financial market's regulatory enforcement body in New Zealand and is responsible for the independent monitoring and enforcement of the CRD regime, as well as providing guidance about compliance expectations, and reporting on our monitoring activities and findings.

Intergovernmental Panel on Climate Change (IPCC): The United Nations body for assessing the science related to climate change, and to provide governments at all levels with scientific information that they can use to develop climate policies.

International Energy Agency (IEA): The IEA provides authoritative analysis, data, policy recommendations, and real-world solutions to help countries provide secure and sustainable energy for all. Their core activity is to provide advice to its 31 member states and 11 associated countries to advance the transition to clean energy.

Network for Greening the Financial System (NGFS): A group of central banks (including the Reserve Bank of NZ) who develop environment and climate risk management in the financial sector and mobilise mainstream finance to support the transition toward a sustainable economy.

Paris Agreement: Also called the Paris Climate Accords, is a legally binding international treaty signed during COP21 in Paris by 196 Parties. It sets targets to limit global warming to well below 2°C.

Representative Concentration Pathways (RCP): Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover. The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes the fact that not only the long-term concentration levels, but also the trajectory taken over time to reach that outcome are of interest.

Scenario Analysis: A process for systematically exploring the effects of a range of plausible future events under conditions of uncertainty. Engaging in this process helps an entity to identify its climate-related risks and opportunities and develop a better understanding of the resilience of its business model and strategy.

Sector: Refers to a segment of organizations performing similar business activities in an economy. A sector generally refers to a large segment of the economy or grouping of business types, while "industry" is used to describe more specific groupings of organizations within a sector.

Shared Socio-economic Pathways (SSP): Based on five narratives, the SSPs describe alternative socio-economic futures in the absence of climate policy intervention, comprising sustainable development (SSP1), regional rivalry (SSP3), inequality (SSP4), fossil–fueled development (SSP5), and a middle-of-the-road development (SSP2). The combination of SSP-based socio-economic scenarios and Representative Concentration Pathway (RCP)-based climate projections provides an integrative frame for climate impact and policy analysis.

Socio-political instability: In the context of the three sector scenarios presented here, socio-political instability refers to phenomena and events triggered by physical climate change drivers. For example: the level of social and political instability due to climate-driven famine, war, resource scarcity, and mass migration.

TCFD framework: The Task Force for Climate-Related Disclosures (TCFD) framework, an internationally adopted structure for disclosing an organisation's climate-related risks and opportunities to investors, lenders and insurance underwriters.

Table 10 contains the TCFD's definitions for risk and opportunity categories, along with examples.

Table 10: Definitions of risks and opportunities under the TCFD framework

TRANSITION RISK: **Risks posed to the company by transition to a net zero carbon economy (e.g., policy and technology changes).**	
Types of transition risk	Examples
Policy and Legal	Increased pricing of greenhouse gas emissions, enhanced emissions reporting obligations
Market	Changing customer behaviour, uncertainty in market signals
Technology	Substitution of existing products and services with lower emissions options
Reputation	Increased stakeholder concern for climate-related issues, failure to meet emissions targets
PHYSICAL RISK: **Risk posed to the company by potential physical impacts of climate change (e.g., sea level rise and extreme weather events).**	
Types of physical risk	Examples
Acute	Increased frequency and severity of extreme weather events (floods, cyclones, droughts)
Chronic	Rising mean temperatures, rising sea level
OPPORTUNITY: **The potential financial opportunities that climate change may present (e.g., for new services).**	
Types of opportunity	Examples
Resource efficiency	Efficiency in transport, production and distribution, reduced water and electricity
Products and services	Development of low emissions goods and services, innovation, shift in consumer preferences
Markets	Access to new markets, use of public sector incentives
Resilience	Resource substitutions and diversification
Energy sources	Use of lower emission energy sources, use of new technologies, shift towards decentralised energy generation

Appendix D

Visual Representation of Scenarios

This appendix presents a visual representation of the variables and indicators that underlie each scenario. All data has been referenced in the end notes of the appendix.

Table 11: Physical Indicators

Increase in average global air temperature[1] (relative to preindustrial levels)	**2041 - 2060**	**2081 – 2100***
	1.6°C	1.4°C
	1.7°C	1.8°C
	2.1°C	3.6°C
Increase in number of hot days in NZ[2] (from a 1986-2005 baseline)	**2031 - 2050**	**2081 – 2100***
	40% increase	40% increase
	40% increase	40% increase
	100%	300%
Increase in rainfall intensity in NZ[3] (from a 1986-2005 baseline)	**2031 - 2050**	**2081 – 2100***
	6% increase	6% increase
	6% increase	6% increase
	8.6%	26.1%
Increase in extreme wind speeds in NZ[4] (from a 1986–2005 baseline)	**2031 - 2050**	**2081 – 2100***
	Approx. <5% increase in parts of the country. Most robust increases occur in southern half of North Island, and throughout the South Island.	Approx. <5% increase in parts of the country. Most robust increases occur in southern half of North Island, and throughout the South Island.
	Approx. <5% increase in parts of the country. Most robust increases occur in southern half of North Island, and throughout the South Island.	Approx. <5% increase in parts of the country. Most robust increases occur in southern half of North Island, and throughout the South Island.
	Approx. 5-10% increase in parts of the country. Most robust increases occur in southern half of North Island, and throughout the South Island.	Up to 10% or more in parts of the country. Most robust increases occur in southern half of North Island, and throughout the South Island.

Scenario 1 Scenario 2 Scenario 3

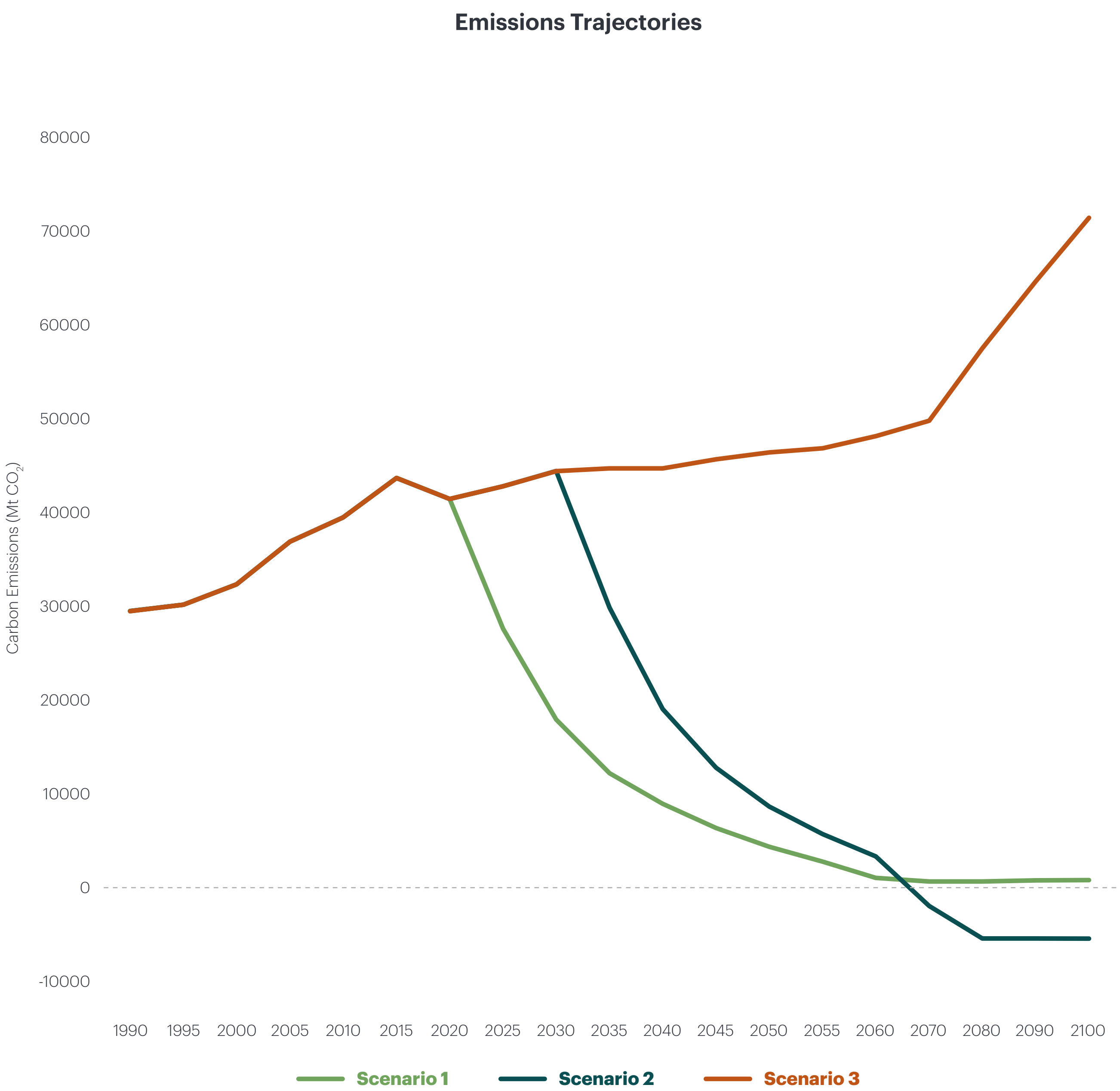


Figure 10: Emissions trajectories for Scenarios One, Two and Three[5]

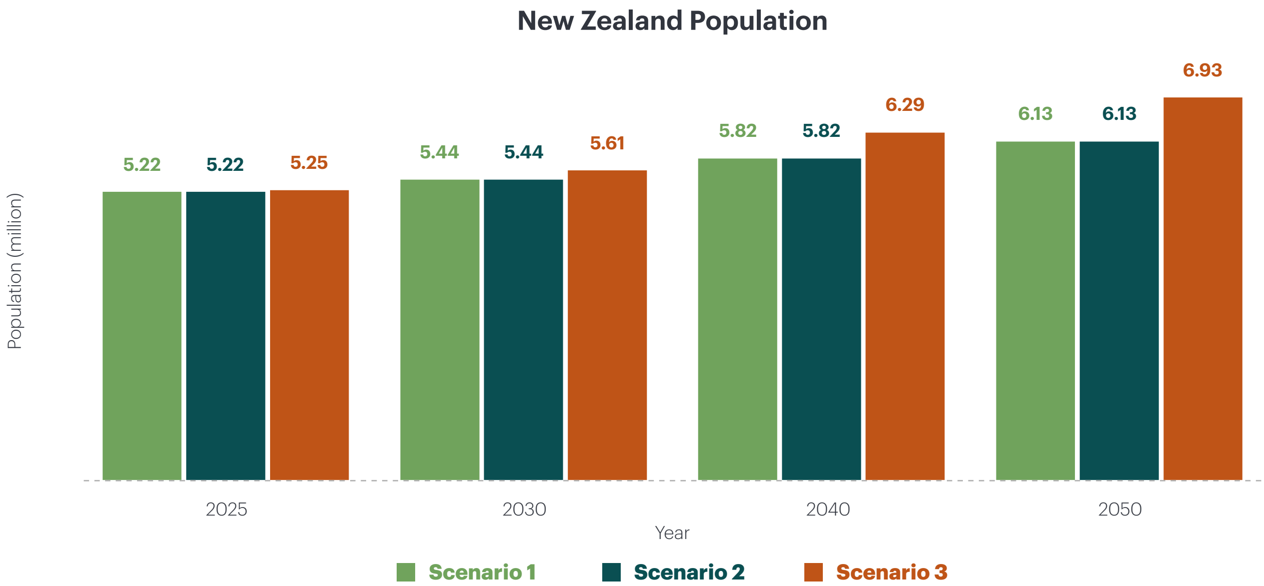


Figure 11: New Zealand population[6]

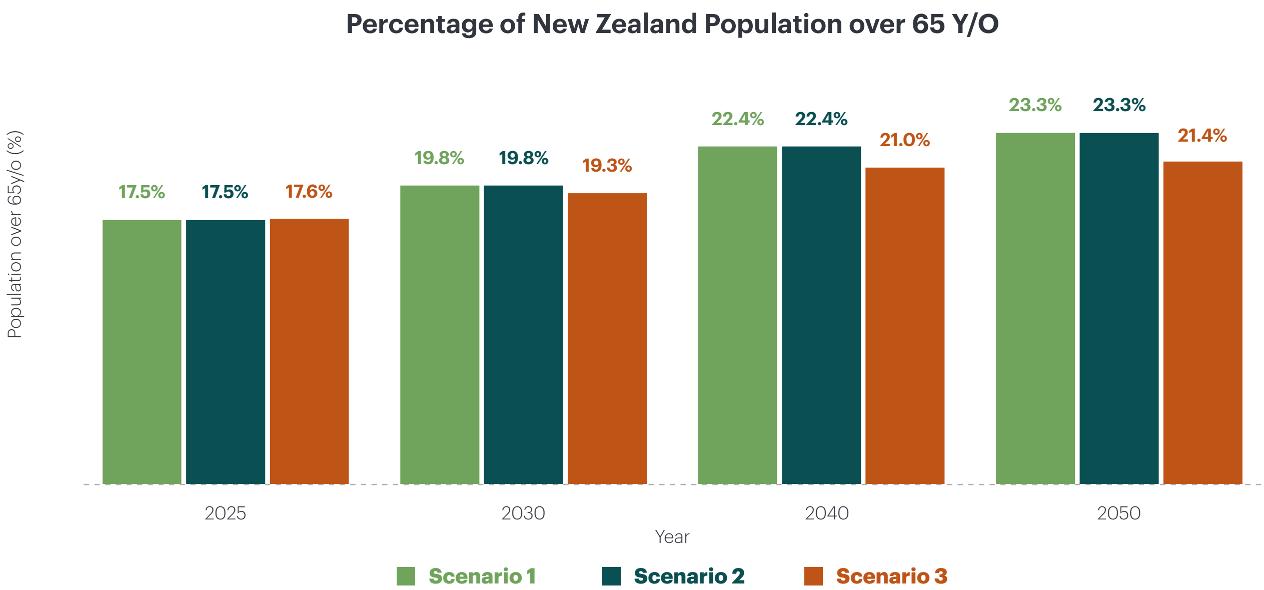


Figure 12: Percentage of New Zealand population over 65 years[6]

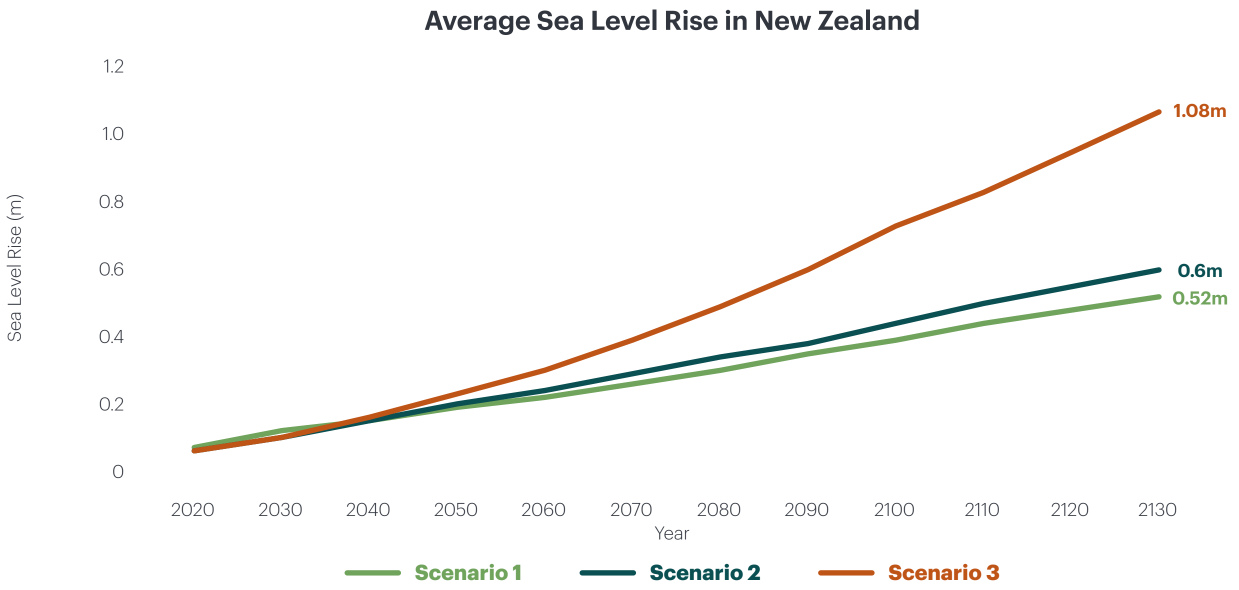


Figure 13: Average sea-level rise projections for Scenarios One, Two and Three[7]

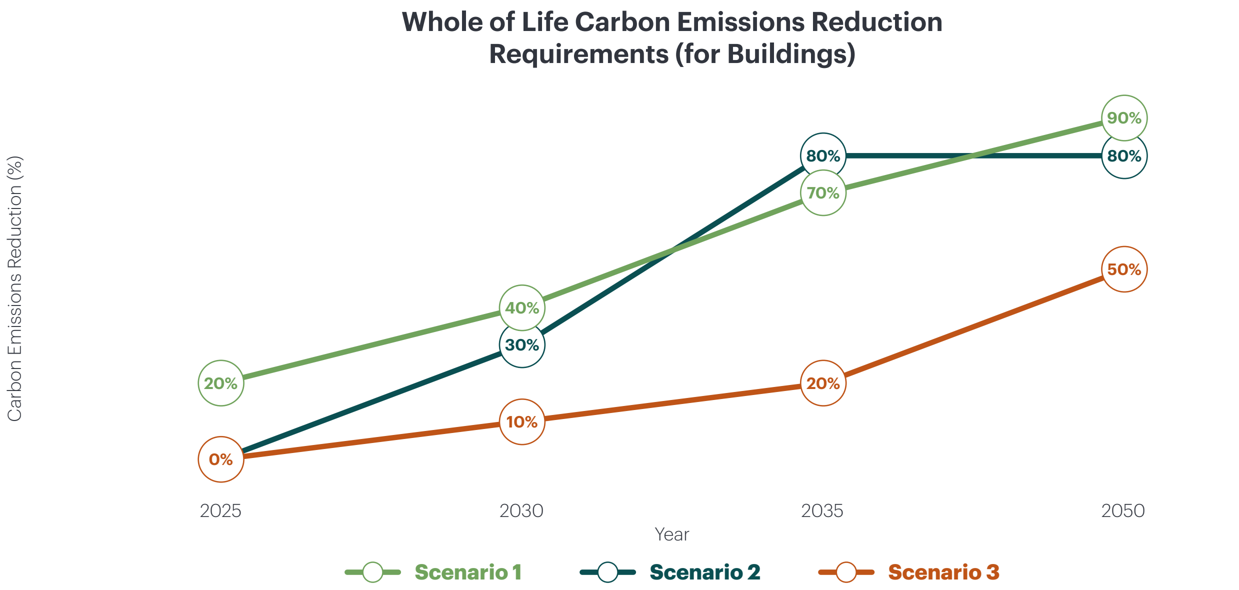


Figure 14: Whole of life carbon emissions reduction requirements (for buildings) for Scenarios One, Two and Three[8]

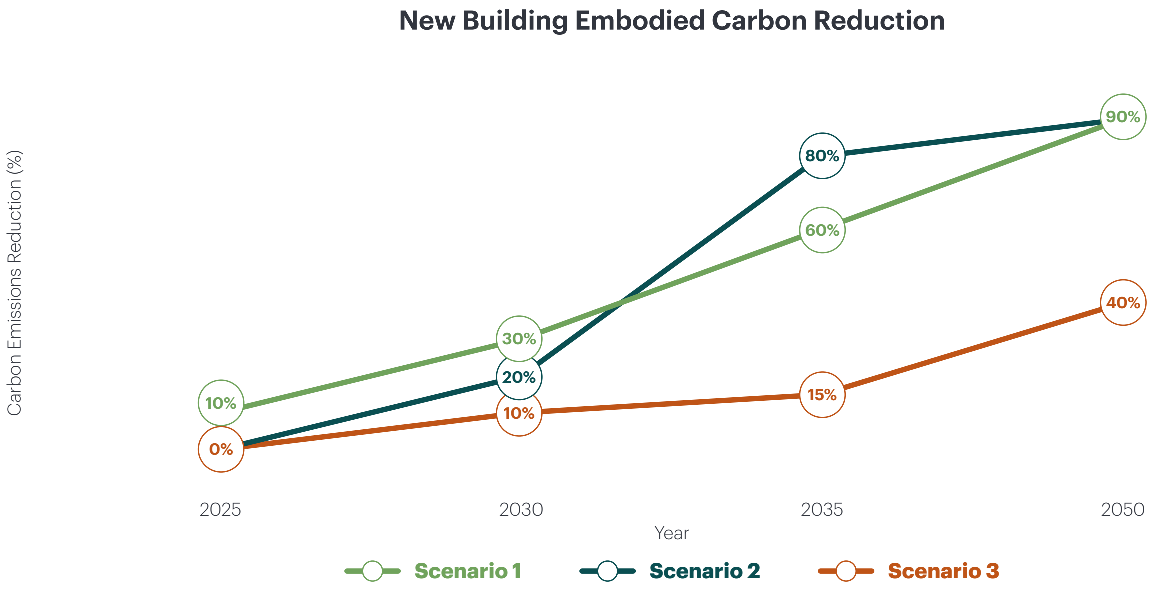


Figure 15: New building embodied carbon reductions for Scenarios One, Two and Three[8]

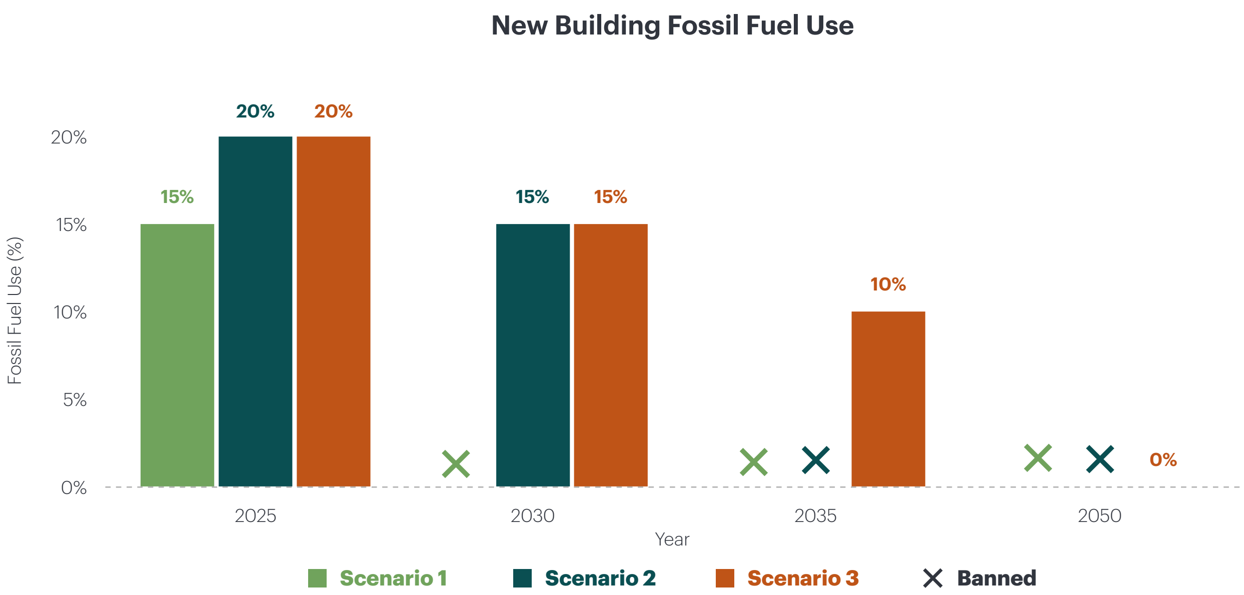


Figure 16: New Building Fossil Fuel Use[8]

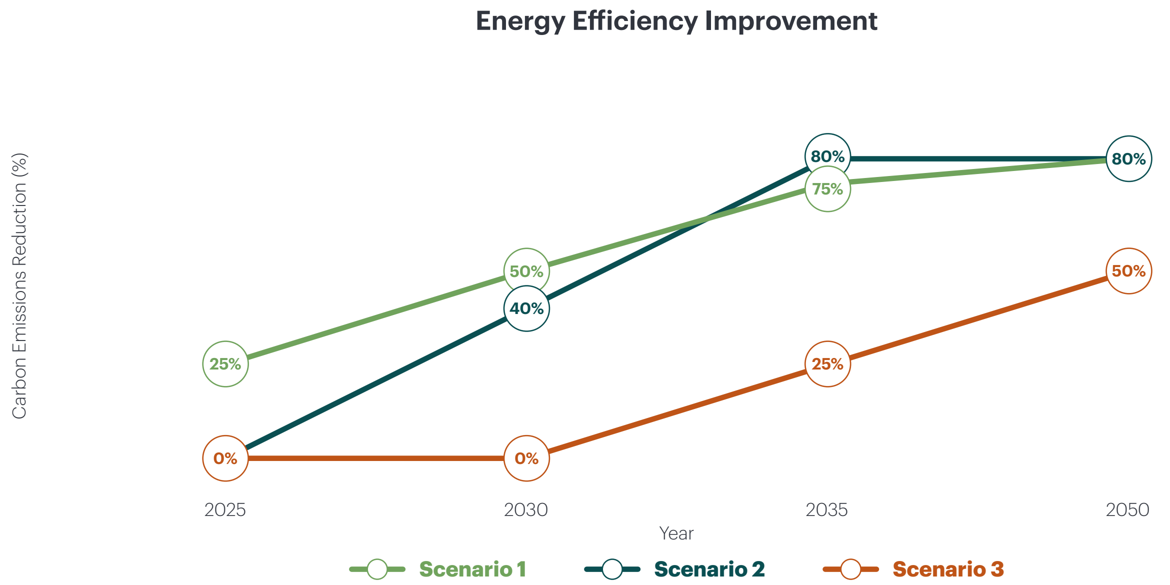


Figure 17: Percentage of energy efficiency improvement[8]

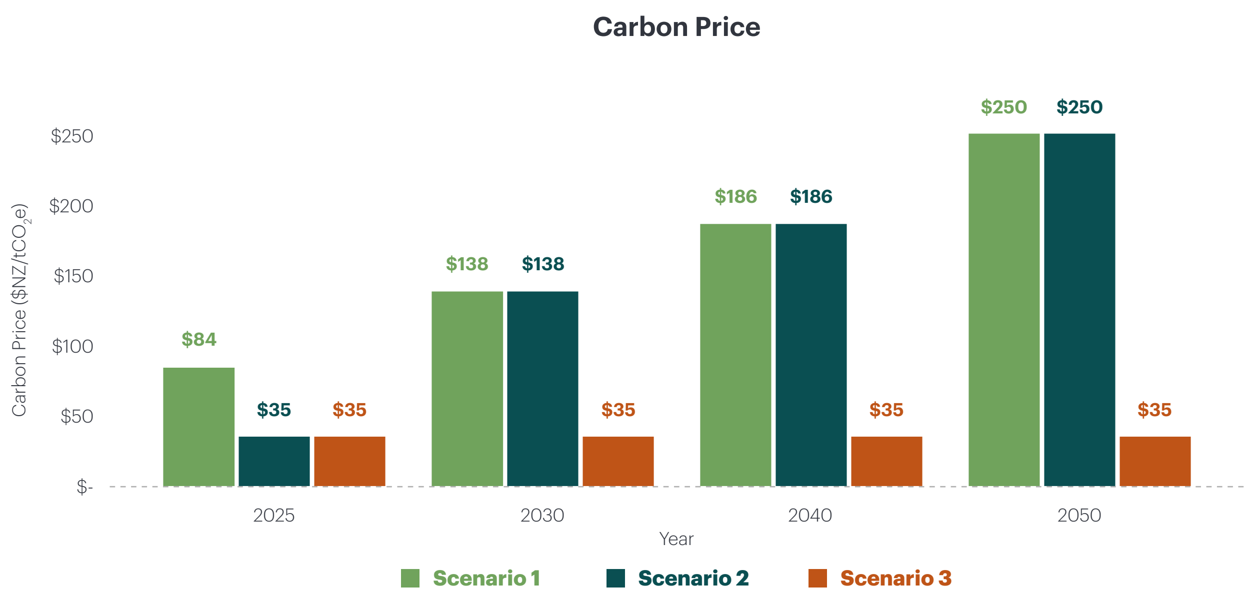


Figure 18: Carbon price under Scenarios One, Two and Three[9]

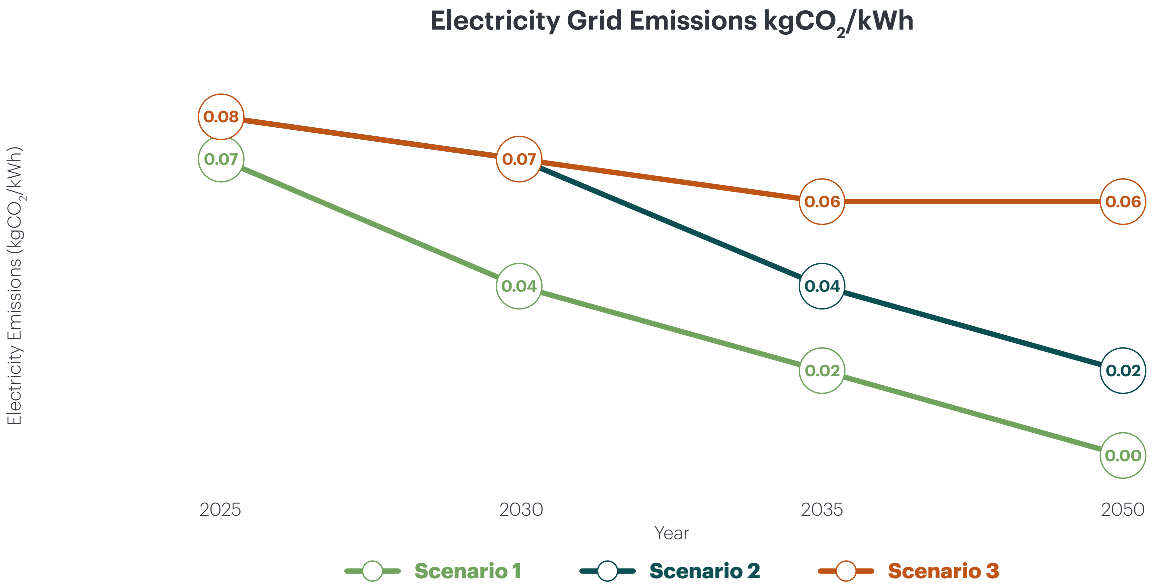


Figure 19: Electricity grid emissions under Scenarios One, Two and Three[10]

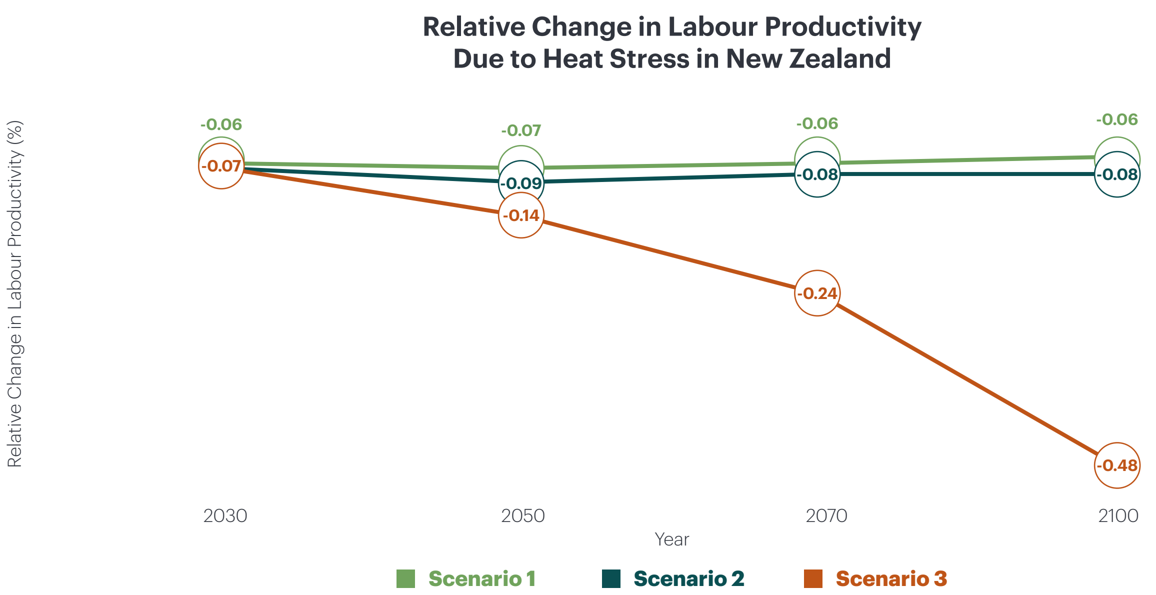


Figure 20: Relative Change in Labour Productivity Due to Heat Stress in NZ[11]

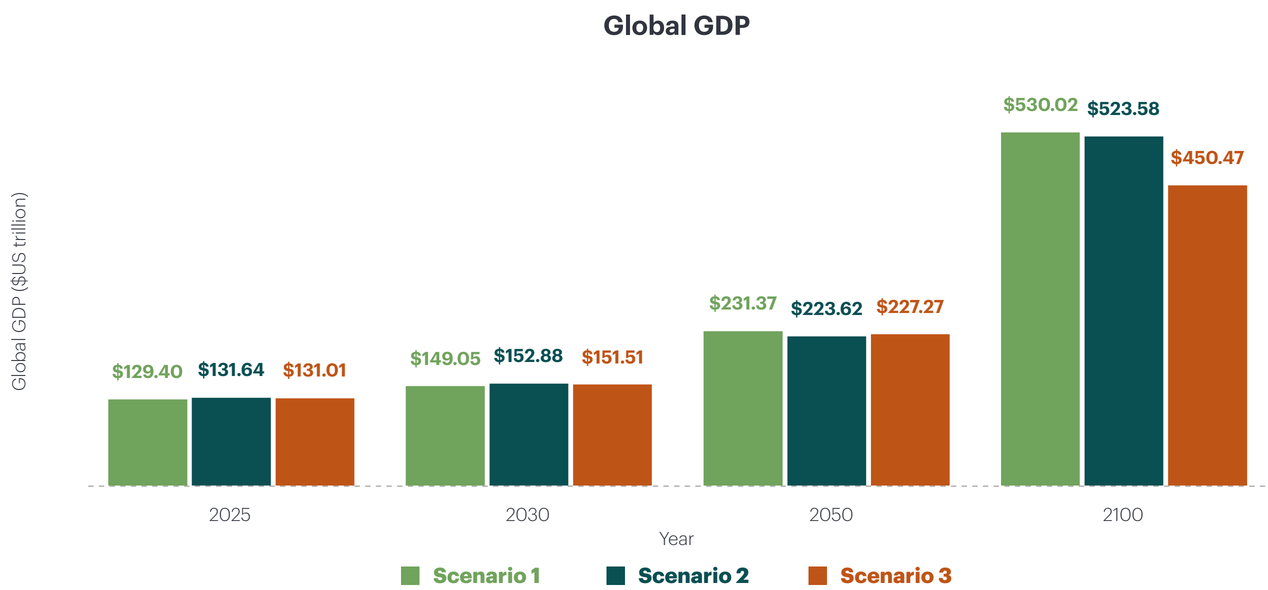


Figure 21: Global GDP[12]

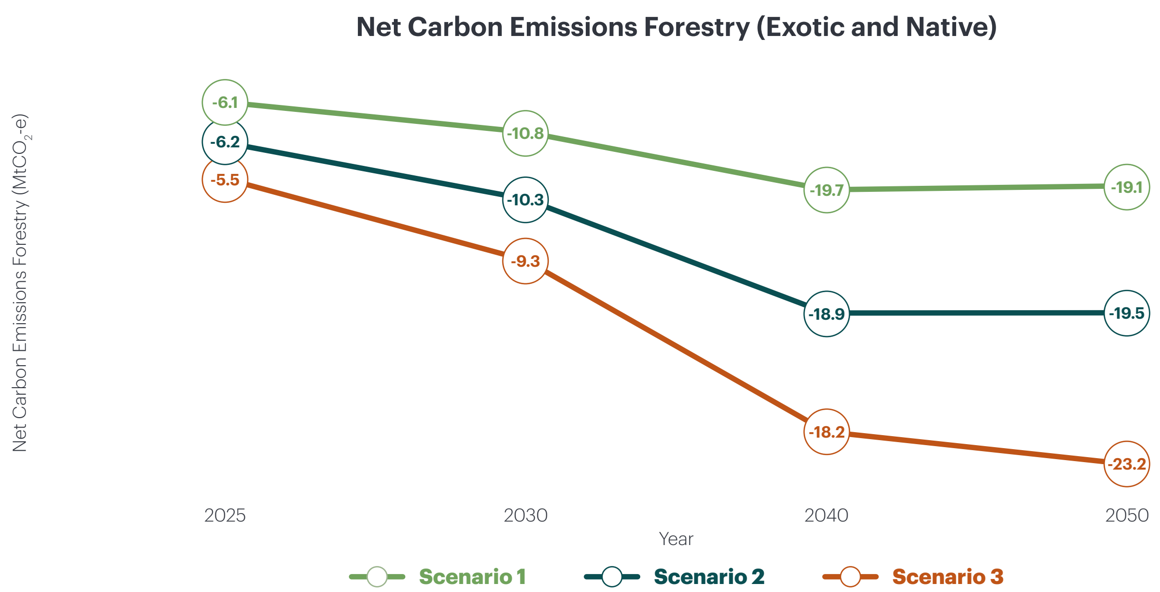


Figure 22: Net carbon emissions forestry (exotic and native)[13]

[1] **Increase in average global mean air temperature taken from:** IPCC 2021. Summary for Policy Makers. In: **The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change**. Data for Scenario One aligns with SSP1-1.9, data for Scenario Two aligns with SSP1-2.6, and data for Scenario Three aligns with SSP3-7.0.

[2] **Percentage increase in average number of hot days per year** has been taken from the **Climate Change Projections for New Zealand: Atmosphere Projections Based on Simulations from the IPCC Fifth** Assessment, 2nd Edition. Data for Scenarios One and Two align with RCP2.6 downscaling and Scenario Three aligns with RCP 8.5 downscaling. Note there is significant variability between regions for baseline (1986-2005) number of hot days per year, however, percentage changes are similar across different locations. Baseline data for different regions is available in **Appendix E**.

[3] **Increase in rainfall** intensity data has been taken from the **Climate Change Projections for New Zealand: Atmosphere Projections Based on Simulations from the IPCC Fifth Assessment, 2nd Edition**. Data for increase in rainfall intensity was calculated using projected increase in rainfall depth for a 12 hour, ARI 100yr ("1 in 100 year") rainfall event (as a proxy). Calculations for Scenarios One and Two are based on the projected degree of warming for RCP2.6 and Scenario Three is based on the projected degree of warming for RCP8.5.

[4] **Increase in extreme wind speeds** data has been taken from the **Climate Change Projections for New Zealand: Atmosphere Projections Based on Simulations from the IPCC Fifth Assessment, 2nd Edition**. An approximate estimate for increased in wind speed at different timeframes was taken from tables presented on page 106 of the MfE 2018 report referenced. The data for Scenarios One and Two was taken from RCP2.6 projections and Scenario Three was taken from RCP8.5 projections.

[5] **Emissions trajectory** data has been sourced from **NGFS emissions modelling available on the NGFS IIASA Scenario Explorer**. The emissions trajectories for the scenarios presented in this report have been aligned with the NGFS global emissions trajectories as follows: Scenario One aligns with NGFS Net-Zero 2050, Scenario Two with NGFS Disorderly and Scenario Three with NGFS Hot-House World.

[6] **New Zealand population and age distribution projections** taken from: Tatauranga Aotearoa / StatsNZ 2020. **National population projections: 2020(base)–2073**. Data for scenarios one and two taken as the 50th percentile for selected timeframes and data for Scenario Three was taken from the 'High Migration' projections as a proxy for increased climate-driven migration under this scenario.

[7] **Average sea level rise (NZ)** data taken from: Te Tai Pari o Aotearoa / NZ Sea Rise 2022. **Maps: For Public**. Data for average NZ sea level rise was derived from a random data point with the vertical land movement correction removed (this derives the same number across all data points). The data for Scenarios One, Two and Three align with NZSeaRise projections for SSP1-1.9, SSP1-2.6 and SSP3-7.0 respectively. Timeframes for sea level rise data have been provided out to 2130, given that significant variation in average sea level rise between scenarios will not be realised until beyond 2100.

[8] **Projected changes in carbon, fossil fuel use, and energy efficiency for buildings** have been estimated under each scenario using **MBIE's Building for Climate Change programme intentions** as a benchmark.

[9] **Carbon price and oil price** projections taken from: He Pou a Rangi / Climate Change Commission 2021. Scenarios dataset for the **Commission's 2021 Draft Advice for Consultation (output from ENZ model)**. Carbon price and oil price data for Scenario One is aligned with the Climate Change Commission's 'Tailwinds' scenario. Scenario Two utilises a combination of the 'Headwinds' and 'Tailwinds' scenarios and Scenario Three aligns with 'Current Policy Reference Case'.

[10] **Electricity grid emissions** have been assigned a sensible estimate for each scenario at different timeframes based on the **Climate Change Commission's Electricity Market Modelling Datasets 2021**.

[11] **Relative change in labour productivity due to heat stress in NZ** has been determined using the **NGFS Climate Impact Explorer**. The projections use average annual temperatures and are displayed with spatial aggregation method using a population-weighted average. The data for Scenarios One, Two and Three align with NGFS Net-Zero 2050, Delayed Transition, and Current Policies scenarios respectively.

[12] **Global GDP** data is taken from NGFS projections in the **NGFS IIASA Scenario Explorer**. The data for Scenario One aligns with NGFS Net-Zero 2050 and assumes a medium chronic physical risk damage estimate. Scenario Two aligns with NGFS Disorderly and assumes a medium chronic physical risk damage estimate. The data for Scenario Three aligns with NGFS Current Policies and assumes a high chronic physical risk damage estimate. See **Appendix G** for limitations.

[13] **Net carbon emissions forestry** data has been sourced from modelling completed by the **Climate Change Commission**. Scenario One aligns with the 'Tailwinds' scenario, Scenario Two with 'Headwinds' and Scenario Three aligns with 'Current Policy Reference Case'.

Appendix E

Baseline (1986-2005) Number of Hot Days for Different Regions

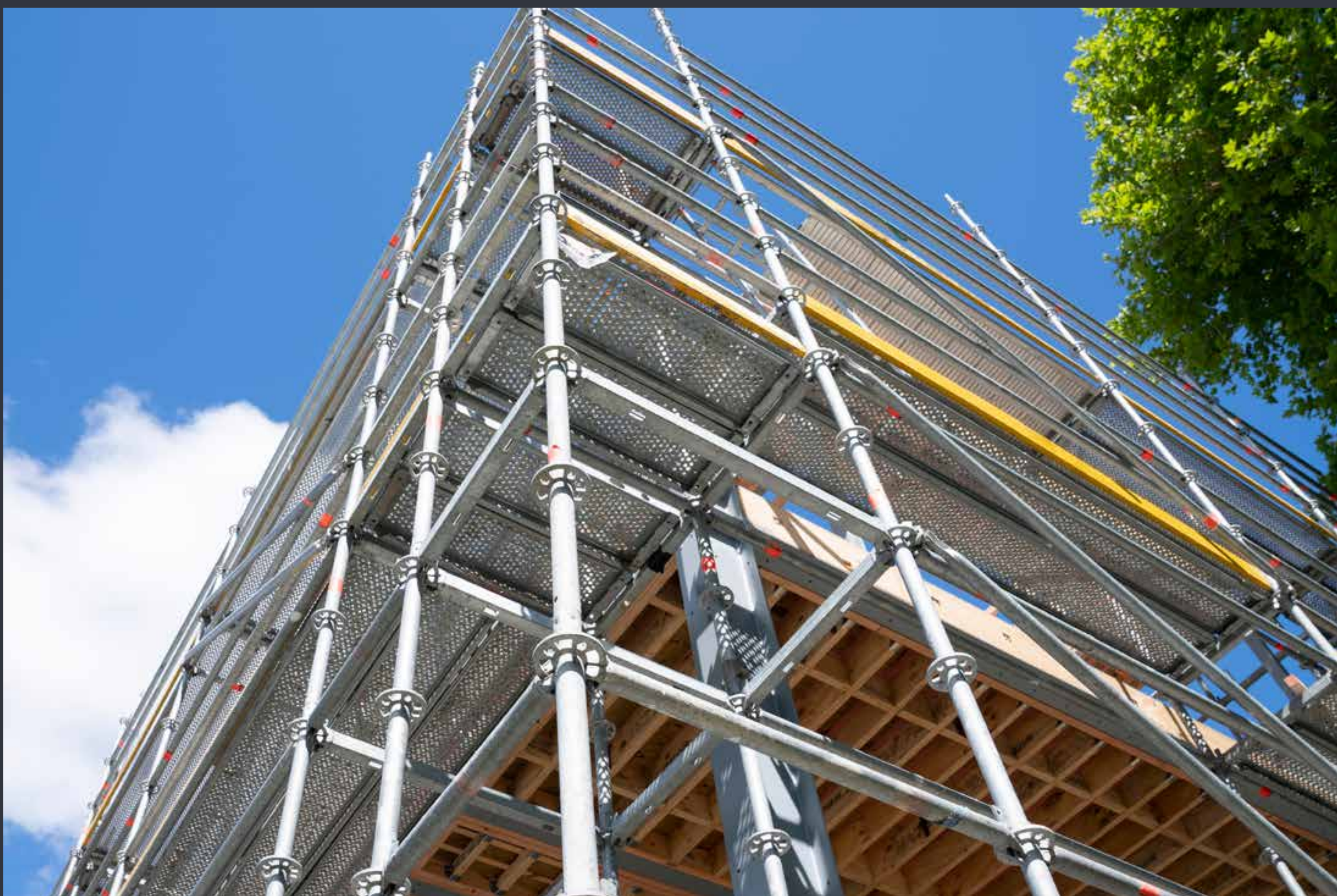
There is significant variability between regions for baseline (1986-2005) number of hot days per year, however, percentage change increases are similar across different locations. Baseline data for different regions is provided here for reference.

Table 12: Baseline data for average number of hot days for regions around New Zealand

REGION	BASELINE (1986-2005) AVERAGE NO. OF HOT DAYS (>25.0°C) PER YEAR[1]
Northland	24.5
Auckland	19.7
Bay of Plenty	16.3
Waikato	23.6
Taranaki	6.5
Gisborne	24.2
Hawke's Bay	27.5
Manawatu	18.6
Wellington	20.1
Marlborough	14.0
Tasman	11.0
West Coast	8.0
Canterbury	27.3
Otago	17.8
Southland	7.6

Appendix F

Long List of
Climate Drivers
& Priority Drivers



Driving forces are typically broad scale external factors which influence the direction of future change.
Drivers underly the narrative of each climate scenario – they're the points of difference that shape outcomes for the sector. This list consolidates drivers brainstormed in the TWG's first workshop. Some additional drivers have also been added by Beca specialists.

PHYSICAL DRIVERS

- Sea level rise
- Increasing frequency and severity of extreme weather events
- Heatwave days
- Wind extremes
- Heavy rainfall days
- Drought
- Fire weather
- Weather disrupting access to various areas/regions

ENERGY & INFRASTRUCTURE

- Pressures on centralised infrastructure
- Distributed energy systems
- Aging infrastructure
- Network gas supply reduction (and increased cost)
- Water restrictions / scarcity
- Electricity demand and security of supply

GENERAL POLICY LANDSCAPE

- Māori Co-Governance
- Spatial strategies and land use changes (e.g. increased densification)
- Decarbonisation policies
- Policies to enact behaviour change (e.g. congestion charges)
- Emissions reduction targets
- Increasing role of the state
- Level of financial support provided by central government for managed retreat

REGULATORY CHANGES

- Design for resilience / managed retreat regulations
- Low carbon design regulations
- Circular economy regulations (i.e. re-use, re-purposing, recycling of existing materials) – 'designing out waste'
- Regulatory changes impacting construction & operation costs

SUPPLY CHAIN / LAND AVAILABILITY

- General availability of building materials (supply chain disruption due to climate hazards)
- Scarcity of low carbon materials to meet regulations and/or market demand
- Onshoring of previously off-shored production (creates need for new assets)
- Land availability

TECHNOLOGY CHANGES

- Technology availability
- Availability of GIS data
- Data availability for purchasers / owners
- Accessibility and comparability of technology / tools to measure embodied carbon
- Financial viability of renewables
- Barriers for entry to market for emerging technologies (i.e. technology costs)
- Research funding availability

INSURANCE

- Increased insurance and rates costs (will exacerbate inequality)
- Insurance retreat
- Insurability of new technology

SOCIAL DRIVERS

- Population growth
- Changing demographics in high-risk locations
- Aging population (means more vulnerable population)
- Human health & safety
- Exacerbated inequities

MARKET & BEHAVIOUR CHANGES

- Price of carbon (and impact on cost of materials)
- Property value changes
- Changes in interest rates
- Cost of capital
- Market demand for energy efficient buildings
- Tenant/investor flight from higher carbon assets/ portfolios
- Affordable housing demand
- Changing behaviours (e.g. purchasing, risk awareness)
- New industries, jobs, innovation (driven by design for disassembly / adaptability / managed retreat)
- Implementation of Mātauranga Māori and traditional building methods/materials
- Rising cost of building maintenance
- Circular economy business models = better utilisation / profitability of existing assets
- Changing ownership models (due to upfront cost of sustainable buildings)
- Changing nature of work (decentralised work locations)
- ‘Climate positive’ replaces ‘net zero’ as market standard
- Level of sustainable building literacy for owners and tenants
- Available funding/lending for sustainable buildings
- Circular economy & degrowth thinking (“build less”)
- Spikes in construction demand
- Workforce competency & talent availability within sector (to meet climate challenges)

Appendix G

GDP and Labour Heat Stress Limitations

Global GDP

The Global GDP data for each scenario, displayed in **Appendix D**, was sourced from the NGFS IIASA Scenario Explorer.

There are a series of limitations associated with the NGFS data. The key limitations are summarised below.

- Not all chronic physical effects are captured through damage functions and effects on GDP. The aggregate empirical damage function captures productivity effects, e.g. from impacts on labour productivity or agricultural productivity, related to temperature shocks. It does not capture the effects from extreme events, sea-level rise, non-market impacts or indirect effects e.g. through conflict[13].
- The selected statistics are for Global GDP rather than NZ GDP, because the three Integrated Assessment Models (IAMs) used for the NGFS scenarios don't all use data specific to New Zealand. Instead, the IAMs mostly use globally downscaled model data as a substitute[14].
- IAMS have inherent limitations. They convey the impression that planetary wide economic growth and thus continued expansion of material and energy use is feasible. This distracts from development of alternatives better able to assess the potential future risks of climate change, which would in turn lead to more appropriate policy responses at a basic societal level. In so far as IAMs promote complacency, they undermine attempts to inform the public and induce appropriate concern, despite that there clearly is increasing disquiet being expressed in many quarters regarding Climate Emergency and ecological breakdown[15].

Further limitations, including those around the macro-economic impacts from climate physical risks, are summarised in the **NGFS Scenario Portal frequently asked questions**.

Labour Heat Stress

The relative change in labour productivity due to heat stress in NZ data presented in **Appendix D** was sourced from the NGFS Climate Impact Explorer.

There are a series of limitations associated with the NGFS data. The key limitations are summarised below.

- Projections weighted by population or GDP were calculated assuming that both the size and the repartition of these two parameters would stay constant as of 2005.
- The projected changes in temperature and relative humidity underlying these results were obtained with established climate models, which nevertheless depict a simplified, hence imperfect representation of the evolution of heatwave conditions under climate change. Limited number of climate models were used to derive them; therefore short-term fluctuations can reflect the influence of natural climate variability rather than the response to anthropogenic climate change.
- Heat stress was quantified looking at wet bulb globe temperature, and uses a combination of five exposure response functions to translate projected variations in wet bulb globe temperature into changes in labour productivity. These functions have been derived from field studies focusing on the impact of heat stress on the conduction of tasks specific to a work field (e.g., in agriculture) or a location; hence there is substantial uncertainty around their applicability at global scale. Confidence in the results decreases for high warming levels, which have been attained in a smaller number of the climate model simulations underlying these results, and especially as of 2.5-3°C of global warming.
- All projections are calculated assuming that socio-economic conditions (population, land-use, management practices, etc.) will remain constant as of 2005, therefore the CIE isolates the sole effect of climate change on the indicators it provides information on. All display materials and the underlying data can be downloaded through the CIE interface.

Further limitations are summarised in the **NGFS Scenario Portal frequently asked questions.**

[14] NGFS (2021). **Scenarios Portal: Frequently asked questions**
[15] Asefi-Najafabady, Villegas-Ortiz and Morgan (2021). **The failure of Integrated Assessment Models as a response to 'climate emergency' and ecological breakdown: the Emperor has no clothes**