Telecommunications Sector Scenarios

Prepared for: New Zealand Telecommunications Forum

Prepared by: Tonkin & Taylor Ltd

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Telecommunications Sector Scenarios

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one.nz

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enable fibre broadband

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Northpower FIBRE

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Contents

Executive Summary

Executive Summary

This report documents the telecommunications sector climate change scenarios, developed by a collective of telecommunications organisations under the New Zealand Telecommunications Forum (TCF). Tonkin & Taylor Ltd (T+T) was engaged to facilitate this process.

The sector scenarios contained within this report provide differing, plausible views of the future. These are based on key drivers of change and uncertainty identified by the sector. They are considered plausible stories about conditions and events which may occur, however, they are not presented as predictions about what will occur. While scenarios are not plans or policies, they support strategy, planning and policy development. Sectoral scenarios are inherently broad and encompass elements and storylines relevant to the range of organisations within the sector they have been produced for. Organisations themselves may wish to further extend scenario development within their own organisation, building on these sector scenarios.

These organisations include climate reporting entities (CREs), who are required to undertake scenario analysis in line with the External Reporting Board (XRB) reporting standard NZ CS 1.

Under NZ CS 1, 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.'

Under this standard, the XRB requires the development of, at minimum, three climate change scenarios. The three sector-specific scenarios presented in this report align with NZ CS 1, and were agreed as follows:

- Scenario 1: Orderly Transition (Paris Agreement- aligned transition scenario).
- Scenario 2: Hot House World (high-warming scenario).
- Scenario 3: Disorderly Transition (additional scenario).

A smaller 'project management' team and wider 'stakeholder group' were established to support and oversee this work. The project management team consisted of six individuals that represented different organisations. Their role was to communicate information and project progress to the wider stakeholder group, and be a challenge team for T+T, as well as consolidating feedback. While the wider stakeholder group consisted of 20+ individuals across the nine organisations involved, their role was to bring their sector expertise to this engagement process and provide the inputs for the scenario development.

A shortlist of 19 drivers were identified and mapped across each of the three scenarios during two in-person workshops. A select number of drivers were chosen to be 'featured' or key to the scenario narrative, while others were identified as being 'supporting'. Each of the narratives is presented in a timeline that stretches across the three timeframes established for the sector. The table below presents the three worlds developed for the telecommunications sector, alongside the direction each of the scenario narratives follows.

Orderly Transition	Hot House World	Disorderly Transition
New Zealand (NZ) and the world transitions to net zero by 2050 with strong policy and market changes clearly signalled by the government. Physical impacts from climate change are limited and align with the SSP1-1.9 scenario. Average global temperatures are limited to 1.5 degrees above pre-industrial levels by 2050.	NZ and the world abandon net zero targets, and there is no national or global movement to reduce emissions. Existing policies are reversed, and fossil fuel use continues. Physical impacts from climate change are severe with annual average global temperatures rising to 2 degrees above pre-industrial levels by 2050 and 3.6 degrees by 2100 (in alignment with SSP3-7.0).	NZ and the developed world are delayed in their transition to net zero, and continue to use fossil fuels over the short-term. This results in a steady increase in temperature and physical impacts in alignment with SSP2-4.5 (2 degrees by mid-century). By 2030, NZ and the developed world realise that urgent action is needed to reach net zero, which results in abrupt and poorly signalled policy and market changes.

ORDERLY TRANSITION WORLD

2025-2030
The Transition Gathers Steam, Connectivity Prioritised

- Government supports investment in decarbonisation of energy grid.
- Periodic disruptions to energy supply throughout this period.
- Update to Emergency Management Act in 2026 that prioritises connectivity in emergency response.
- High demand and increased costs associated with imported products (related to decarbonisation).
- Telco's struggle to absorb costs, which are partly passed through to customers.
- Rapid societal transition adds costs to entire economy, which impacts cost of living between 2025-2030.
- Social inequities exacerbated. Government takes some responsibility for digital inequity in 2030.
- Consumers shift away from high-carbon transport, placing more reliance on digital connectivity.

2030-2045
Off-Shore Investors Look To New Zealand

- Stronger land use management regulations, and better collaboration across infrastructure providers.
- Disruption to energy sector is significantly reduced.
- Telco sector shifts towards circularity and repairability. Legacy infrastructure retained for longer.
- Off-shore investors and tech developers are attracted to NZ's clean energy grid. Opportunities arise for telco sector.
- Population growth increases slowly. Migration focused on skilled workers.

2045 +
The Prosperity Era Begins

- Climate system begins to stabilise.
- Extreme weather events are less severe and frequent, with better and more coordinated emergency response.
- Restoration of connectivity is still a priority.

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HOT HOUSE WORLD

2025-2030
The Decade Of Deluge

Repeated unprecedented events cause significant damage to infrastructure.

Geopolitical unrest and heightened nationalism disrupt global trade.

Rural communities spend weeks with no or poor levels of service.

Communities are driven to self-sufficiency including the use of satellite-enabled services.

2030-2045
Telecommunications Sector Disruption

NZ and the world abandon emissions reduction targets.

Government and councils embark on widespread investment in adaptation.

Deepening cost of living crisis. Government borrowing increases.

Government mandates resilience standards.

Satellite services and hybrid connectivity take market share. International players target NZ consumers aggressively.

Lack of coordination across infrastructure providers means the telco sector cannot rely on continuity of grid power supply or roading access.

Pressure from Australia on accepting climate refugees.

A number of telecommunication companies face potential failure. This signals to the government that co-funding is required.

2045 +
The Network Restoration Crisis

Annual average temperatures surpass 2 degrees.

NZ accepts large numbers of climate refugees, and many NZers return home.

Technology continues to evolve at pace. However, NZ telco's struggle to maintain and upgrade services.

Across the sector, business survival becomes sole imperative, and collaboration is significantly reduced.

In 2052, telcos announce they will not restore services in 10 coastal communities. Councils and communities left to 'fend for themselves'.

2055 sees a new conflict in space. This disrupts NZ consumers and telco companies and drives customers back to terrestrial mobile and fixed-line services.

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DISORDERLY TRANSITION

2025–2030
The Inquiry Sparks Change

Two deadly storms hit the central and east coast regions of the North Island. Followed by a severe flooding event in the South Island in 2027.

There is no progress on reducing emissions.

Government inquiry leads to National Resilience Strategy (NRS). Minimum resilience standards expected of critical infrastructure providers.

Major implications for the sector, due the heavy reliance on energy and transport.

Telco companies raise practicality concerns; however, the new requirements are enacted.

2030–2045
The Double Whammy

Improved coordination across critical infrastructure providers due to the NRS.

NRS results in reduction in investment towards innovation, advanced technologies and network upgrades.

Renewed global and national pivot towards reducing emissions. Significant changes to the fourth Emissions Reduction Plan (2035).

Significant disruptions across the energy sector for a 10-year period as they transition.

Demand for key and conflict minerals alongside increased scrutiny on the impacts of mining, leads to shortage and price hikes.

2035 and 2036 sees a number of climatic events that test the sector.

Some telco companies can no longer afford to maintain, repair and upgrade networks. A number of public-private partnerships (PPPs) are established in 2037.

Bipartisan agreement in 2040 to prioritise climate change resilience and managed retreat.

Significant migration to NZ from Pacific Island Nations.

2045 +
The Turnaround

Annual average temperatures reach 2 degrees above pre-industrial levels.

Energy sector has built sufficient capacity within the grid to manage demand spikes.

2040 managed retreat agreement leads to a 10-year programme involving property acquisition and relocation of coastal communities.

From 2050, increased funding from PPPs allows the telco sector to upgrade infrastructure, make technology advancements and improve digital equity.

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Project Background and Purpose

1.0 Project Background and Purpose

1.1 Background

The impacts of climate change are already being experienced across a broad spectrum of society, resulting in damage and loss to individuals, communities, and organisations. As a result, there is a growing recognition of the risks and opportunities posed by climate change, and an increased demand for climate-related information across all sectors of society.

For example, investment considerations are gradually shifting, with investors showing a growing interest in evidence that organisations are considering the impacts of climate change within their business decisions. In line with this broader trend, New Zealand (NZ) became the first country in the world to pass legislation making Climate-related Disclosures mandatory for banks, insurers, asset managers, and larger listed companies (October 2021).

The goals of mandatory Climate-related Disclosures are to (XRB, 2024):

- Ensure that the effects of climate change are routinely considered in business, investment, lending and insurance underwriting decisions.
- Help climate reporting entities better demonstrate responsibility and foresight in their consideration of climate issues.
- Lead to more efficient allocation of capital, and help smooth the transition to a more sustainable, low emissions economy.

The legislation effectively enabled the New Zealand's Climate Standards (developed and governed by the XRB). The standards require the development and use of climate scenarios, and the XRB have recommended that sectoral scenarios are developed, which can then be used by entities within sectors (as shown in Figure 1.1).

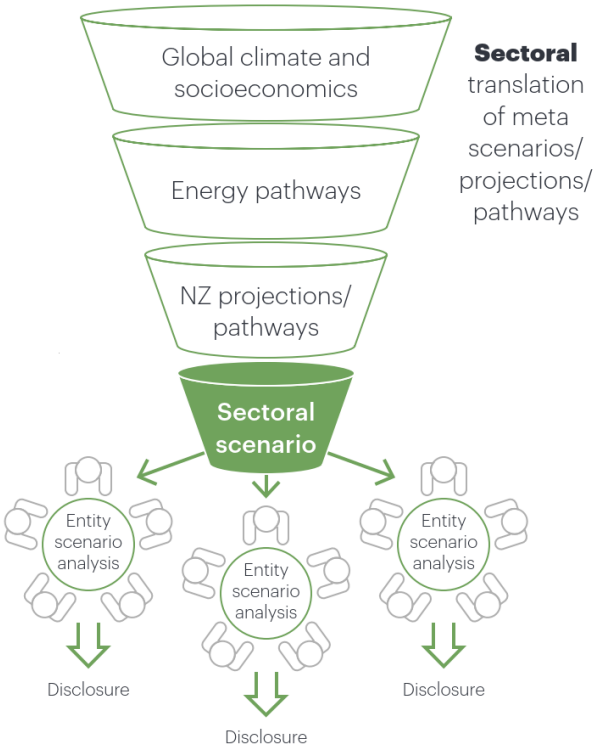

Figure 1.1: The development of sectoral scenarios for use by CRE's

1.2 Climate Impacts and the Telecommunications Sector

The telecommunications sector is dealing with the impacts of climate change more than ever before, with the Auckland Anniversary floods and Cyclone Gabrielle (2023) highlighting the need for resilience not only for telecommunications, but across other interconnected sectors also (such as energy and transport). Resilience is a major focus for the TCF and its organisations as they provide connectivity, an essential service, across NZ (NZ Telecommunications Forum, 2023).

Climate hazards can result in a number of impacts on operations, communities and connectivity including:

- Extreme weather events – causing disruptions to connectivity across the telecommunications sector, and other key critical infrastructure interdependencies (e.g., energy and transport).
- Increased frequency and severity of events resulting in further impacts to infrastructure already weakened by prior damage. This puts additional financial pressure on the telecommunications sector and could lead to reputational risks.
- Increased temperatures and the demand for cooling, resulting in energy surges and disruptions to connectivity.

The objective for this project was to create sectoral climate change scenarios to allow organisations to progress their Climate-related Disclosure reporting, and to allow for consistency across the sector in this reporting. The scenarios will also be used to support activity to mitigate the effects of climate change and for resilience purposes.

It is noted that this project only involved developing scenarios for the telecommunications sector. The *analysis* and *use* of the scenarios by organisations is a separate process that each company will approach in its way.

1.3 Purpose of Scenarios

Faced with increasing operational uncertainties in a changing climate, it can be challenging to make long-term decisions. The development of scenarios can help organisations to identify and prepare for uncertain impacts, and can inform the development of responses to safeguard communities, and strengthen the resilience of the telecommunications sector.

The focal question sets the purpose and direction for the scenario planning exercise and guides the development of the telecommunications sector scenarios. The chosen focal question was agreed at the outset of the project and is as follows: *"How could climate change plausibly disrupt the Telecommunications Sector over the short (5 years), medium (15 years) and long term (30+ years)?".*

It is noted that the term 'disrupt' does not only relate to the physical disruption to assets but also other types of disruption, such as economic disruption, business continuity and business opportunities resulting from climate change.

Scenario Planning Approach

2.0 Scenario Planning Approach

Climate scenario planning is a tool that can help organisations navigate complex and uncertain futures. The process involves developing scenarios (which are plausible, hypothetical narratives about what the future might look like) that can then help with strategic planning. Within the climate change context, scenarios are often used to test strategies, identify climate-related risks and opportunities, and then assist with transition planning. The purpose of scenario analysis under NZ CS 1 is to help entities explore the climate-related risks and opportunities they may face and therefore better understand the resilience of their business model and strategy. Figure 2.1 provides a visual example of the scenario development process.

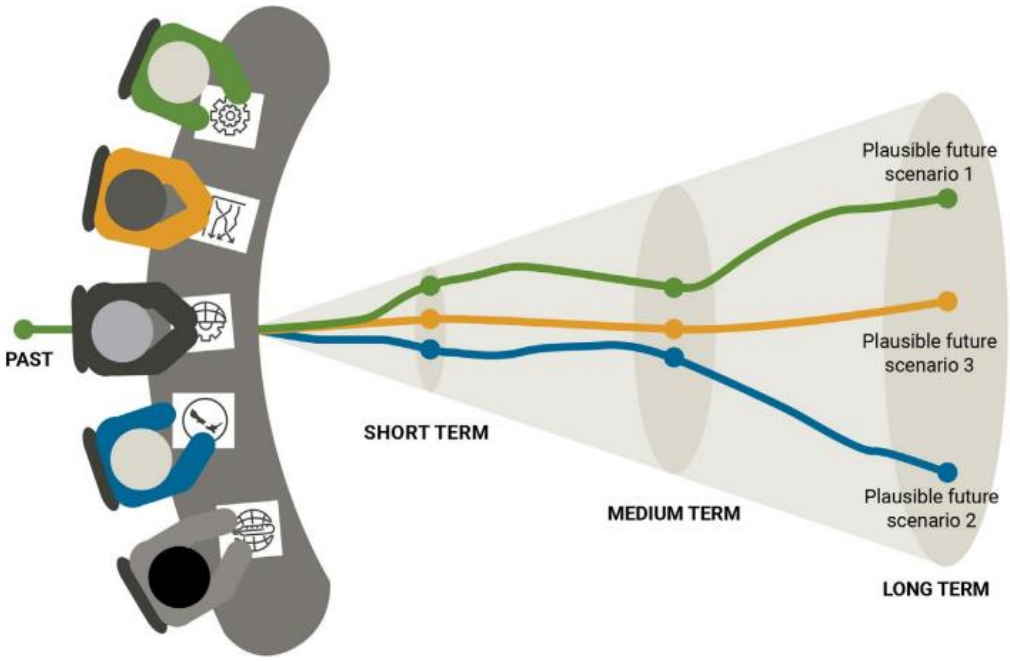

Figure 2.1:Visual example of climate scenario development

Scenarios are not plans or policies, they support strategy, planning and policy development. Scenarios should be:

- challenging,
- provide significantly different yet plausible views of futures,
- be specific and decision-relevant to an organisation.

Sectoral scenarios are inherently broad and encompass elements and storylines relevant to the range of organisations within the sector they have been produced for. Organisations themselves may wish to further extend scenario development within their own organisation, informed by these and other sector scenarios.

Defining the Scope of the Telecommunications Sector

3.0 Defining the Scope of the Telecommunications Sector

The telecommunications sector in NZ encompasses the development, deployment and provision of communication services and technologies across the country. This sector connects markets, enables new technologies and is essential for accessing key services such as education, health, financial and government services (New Zealand Infrastructure Commission, 2020), as well as being key for emergency response management. The telecommunications sector in NZ includes:

- Fixed line networks (such as fibre and copper)
- Retail service providers
- Mobile network operators;
- Wireless internet service providers (WISPs)
- Tower companies
- Land-mobile radio operators
- Satellite participants.

Regulated by government authorities such as the Ministry for Business, Innovation and Employment (MBIE) and the Commerce Commission (CC), the sector aims to ensure that telecommunications services are accessible, affordable and of high quality for both consumers and businesses. There are also various other actors that can influence the telecommunications sector (Figure 3.1).

The New Zealand Telecommunications Forum (TCF) brings together Network Providers and Retail Service Providers to resolve regulatory, technical and policy issues. Nine TCF members participated in the development of the scenarios: Chorus, Spark, 2degrees, Enable Networks, Tuatahi First Fibre, One NZ, Mercury, FortySouth and Northpower Fibre.

The figure below (Figure 3.1) presents the telecommunications sector scope delineated for this project. It does not explicitly identify upstream, inputs or downstream components, as it was recognised that what may be upstream for some organisations is an input for others. The main objective with the sector scope, was to ensure it included high level components that each individual organisation could aggregate their value chain to.

Telecommunication Scope

The Telecommunication Scope identifies those high-level aspects that the sector relies on, or is affected by, that were taken into account when developing the sector scenarios. These aspects created the guard rails for this process.

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Suppliers

- Energy
- Network equipment
- Raw materials e.g. Lithium and Cobalt
- Devices
- Landowners
- Contractors

Critical Infrastructure

- Electricity transmission
- Transport
- Communications
- International connectivity E.g. Southern Cross Cables
- Infrastructure corridors

Telecommunication Service Providers

Including wireless internet providers, fixed line operators, mobile virtual network operators and satellites

- Physical infrastructure e.g. towers, cables, fibre network data centres, office buildings, exchanges, poles
- Non-physical assets e.g. IoT networks, cloud services, asset data radio spectrum, backhaul
- Emergency equipment e.g. mobile exchanges & cell sites on wheels
- Personnel and operations

Customers

- Businesses
- Households
- Other critical infrastructure
- Retail service providers
- Critical Customers e.g. hospitals and emergency services

Actors: Actors in this context are those organisations, policies or acts that may influence the telecommunication sector. Having these identified will help inform drivers in the upcoming workshops

Policy/Legal

- Telecommunication Act
- Civil Defence and Emergency Management Act
- DPMC policy work on resilience and critical infrastructure
- Telecommunications Service Obligation (TSO)
- Resource Management Law Reform

Organisations

- Ministry of Innovation and Employment
- Commerce Commission
- Regional Lifeline Utility Groups
- Regional Councils
- National Emergency Management Agency
- Iwi
- Ministry for the Environment

Other

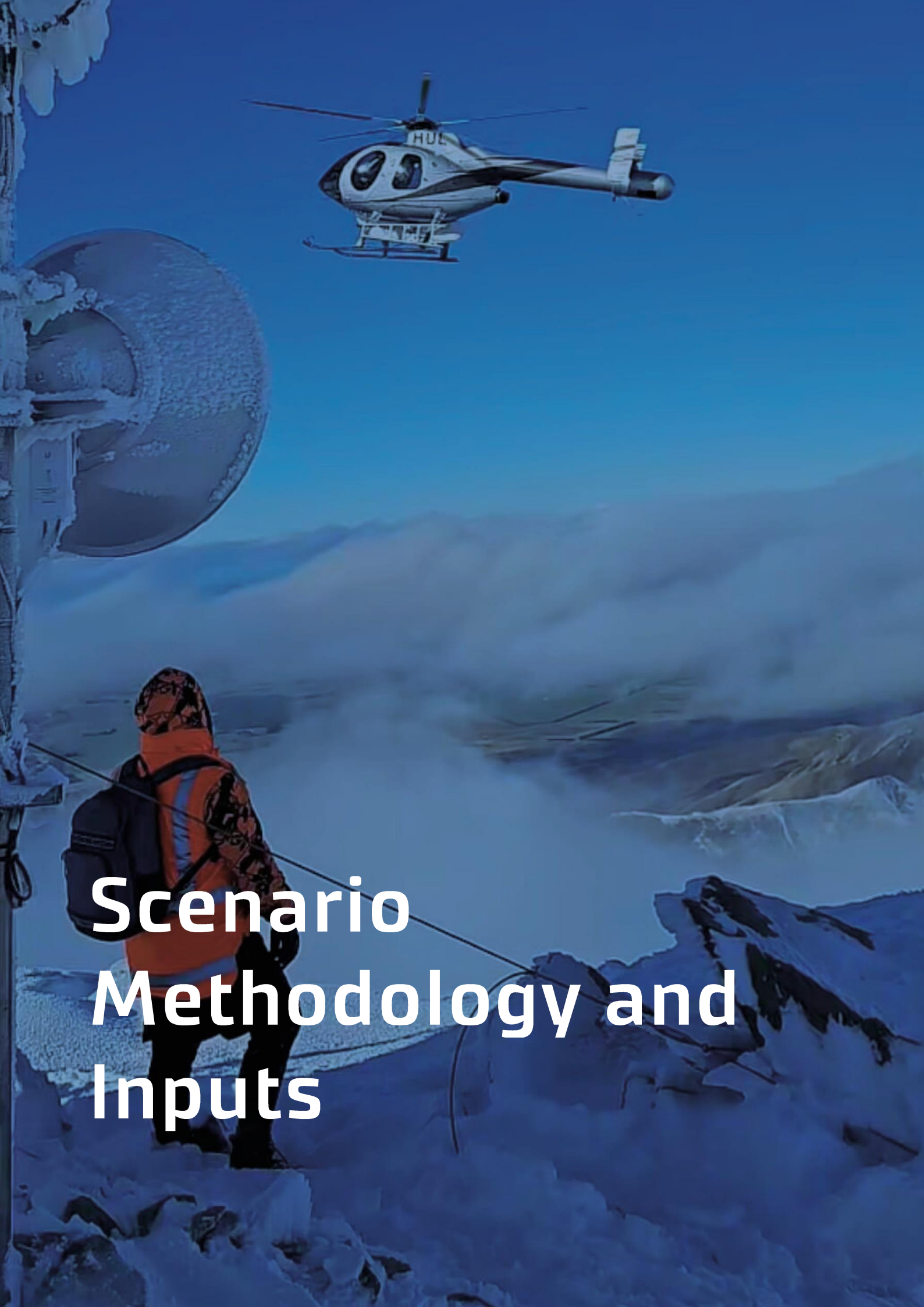
- Insurance
- National Climate Change Risk Assessment
- National Adaptation Plan
- National Emissions Reduction Plan

Likely to be upstream inputs for most telecommunication service providers

Likely to be main inputs for most telecommunication service providers

Likely to be downstream inputs for most telecommunication service providers

Actors



Scenario Methodology and Inputs

4.0 Scenario Methodology and Inputs

The climate scenarios presented have been developed for use by the telecommunications sector to undertake climate scenario planning and analysis. These are intended to be used to test the resilience of an entity's strategies and plans under plausible, yet challenging futures. *The data contained in these scenarios has been derived from various sources and should not be relied upon as predictive or probabilistic when making decisions.* The data is reflective of the available information at the time these scenarios were developed (December 2023-April 2024). Updates should be made to these scenarios as new information becomes available and/ or as timeframes within scenarios are reached (e.g. short term).

This section summarises the key elements of the methodology and inputs.

4.1 Methodology Overview

The approach taken to develop the scenarios was based on guidance from TCFD and the XRB. Six steps were undertaken, as shown in the Figure 4.1. One online meeting and two half day in-person workshops were completed with a range of stakeholders (representing the organisations involved) were held through February and March 2024.

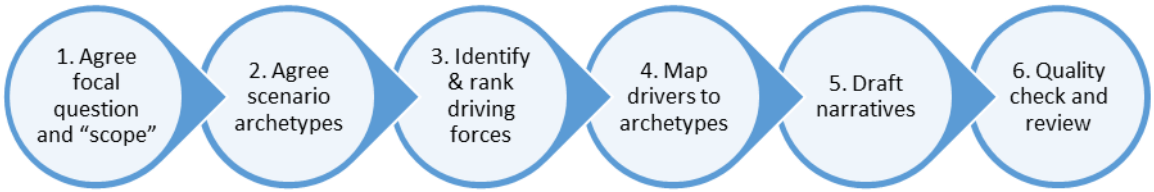


Figure 4.1: Summary of key project steps

4.2 Time Horizons

The time horizons selected for the telecommunications sector have been based on those used by telecommunications sector organisations in previous assessments (e.g., physical and transition risk assessments, emissions reduction plans, previous scenario analysis). They differ from those in other sectors due to the lifespan of telecommunications infrastructure and technology (Table 4.1).

Table 4.1: Time horizons chosen by the telecommunications sector

	Short term	Medium term	Long term
Time horizon	5 years	15 years	30 + years
Rationale for selection	Aligns with telecommunications organisations emissions reductions targets.	Aligned with average life of current assets, and when they are likely to be renewed.	Aligned with further materialisation of physical risks, particularly on infrastructure.

4.3 World Descriptions and Reference Scenarios

The three world descriptions agreed on were:

- Scenario 1: Orderly transition
- Scenario 2: Hot house world
- Scenario 3: Disorderly transition.

In order to further describe these three worlds, they were aligned with global reference scenarios – the IPCC Shared Socioeconomic Pathways (SSPs):

- The SSPs describe major global developments that together lead to different challenges for mitigation and adaptation to climate change (UNECE, 2024).
- The SSPs are based on five narratives describing alternative socioeconomic developments including sustainable development (SSP1), middle of the road development (SSP2), regional rivalry (SSP3), inequality (SSP4), and fossil-fuelled development (SSP5) (Riahi, et al., 2017).

To provide a robust foundation for creating the scenario narratives, each telecommunications sector world has been referenced to one of the SSPs. The three scenarios are summarised in Table 4.2.

Table 4.2: International and national scenario alignment

Category	Worlds		
	Orderly Transition	Hot House World	Disorderly Transition
Global climate and socio-economic parameters	SSP1-1.9 (IPCC)	SSP3-7.0 (IPCC)	SSP2-4.5 (IPCC)
NZ specific climate parameters	RCP 2.6 (NIWA downscaled reporting)	RCP 8.5 (NIWA downscaled reporting)	RCP 4.5 (NIWA downscaled reporting)
Summary	NZ and the world transitions to net zero by 2050 with strong policy and market changes clearly signalled by the government. Physical impacts from climate change are limited and align with the SSP1-1.9 scenario. Average global temperatures are limited to 1.5 degrees above pre-industrial levels by 2050.	NZ and the world abandon net zero targets, and there is no national or global movement to reduce emissions. Existing policies are reversed, and fossil fuel use continues. Physical impacts from climate change are severe with annual average global temperatures rising to 2 degrees above pre-industrial levels by 2050 and 3.6 degrees by 2100 (in alignment with SSP3-7.0).	NZ and the developed world are delayed in their transition to net zero, and continue to use fossil fuels over the short-term. This results in a steady increase in temperature and physical impacts in alignment with SSP2-4.5 (2 degrees by mid-century). By 2030, NZ and the developed world realise that urgent action is needed to reach net zero, which results in abrupt and poorly signalled policy and market changes.

4.4 Identifying Driving Forces

Driving forces are key to scenario development and application. They are key external and influential factors, outside of an organisation or sector's control, that can have a material impact or influence. The XRB outlines the importance of 'understanding which driving forces will have the greatest influence in shaping outcomes for the sector is an essential step in creating climate-related scenarios' (XRB, 2023).

Driving forces were identified during a half day in-person workshop, using the STEEP categories as a guide to channel participants thoughts. A long list of drivers was generated, and then ranked to identify a short list of drivers (Table 4.3). The ranking was determined based on impacts to the telecommunications sector. Four key areas were highlighted to aid participants' thinking:

- Financial
- Legal/ reputation
- People (workplace, customer health and safety, loss of connectivity)
- Operation (service interruption).

A short list of drivers was then mapped across each of the three agreed scenarios, which then informed the creation of the three scenario narratives.

Table 4.3: Shortlisted Driving Forces

STEEP Category	Driver
Social	**S1:** Customer / investor expectations around ESG – including decarbonisation, conflict minerals, other. **S2:** Digital accessibility and equity. **S3:** Migration to NZ. **S6:** Population and demographic change e.g., age.
Technology	**T1:** Reliance on connected technology for public services e.g., health (+ subsequent increased vulnerability) and emergency management. **T2:** Material shortages which NZ feels more acutely due to geographic isolation (e.g., lithium, batteries, mobile antennas, sim cards etc.).
Economy	**Ec2:** Changes to the cost of living. **Ec4:** Access to finance. **Ec5:** Changes to the global geopolitical landscape. **Ec6:** Changes to global trade and supply chain.
Environmental	**En1:** Change in frequency and severity of extreme events (inc flooding and landslides). **En3:** Extreme temperatures leading to health and infrastructure impacts.
Political	**P1:** Legislation changes focusing on emissions reduction, biodiversity, e-waste and broader ESG. **P2:** Legislation changes focusing on technology and networks. **P4:** Sectoral reform. **P5:** Disruption to the interdependencies that exist between different critical infrastructure sectors. **P6:** Legislation on managed retreat/ adaptation. **P7:** Legislation changes to trade policy or trade agreements. **P8:** Legislation changes to environment (land use).

World Narratives

5.0 World Narratives

This section presents the three 'worlds' developed for the telecommunications sector. These worlds align with both global and national scenarios, namely the IPCC SSP scenarios and the NZ Climate Change Commission scenarios.

Each world's narrative is created using shortlisted drivers, with some drivers more prominent than others within differing worlds. Two to three drivers were identified as being 'featured', and being key to each world narrative, while others were identified as being supporting. Table 5.1 presents which drivers were 'featured' and 'supporting' for each of the worlds.

- Key drivers are those that dictate the direction of the narrative and have influence over impacts and outcomes.
- Supporting drivers are those that are either already defined in terms of their direction i.e., through the narrative already established at the SSP level or play a 'supporting character' role in the narrative.

Supporting drivers may also be those drivers that are influenced by the featured driver. For example, access to finance is dictated by the direction established at the SSP level, therefore it is a 'supporting' driver.

Table 5.1: Driver overview for each world

ID	Driver	Orderly Transition	Hot House World	Disorderly Transition
P5	Disruption to interdependencies	Featured	Featured	Supporting
T1	Reliance on connected technology	Supporting	Supporting	Supporting
P2	Legislation changes (technology and networks)	Not featured	Featured	Featured
T2	Material shortages	Not featured	Not featured	Featured
Ec4	Access to finance	Supporting	Supporting	Supporting
Ec2	Changes to the cost of living	Supporting	Supporting	Supporting
Ec5	Changes to geopolitical landscape	Supporting	Supporting	Supporting
Ec6	Changes to global trade and supply chain	Featured	Supporting	Supporting
P7	Legislation changes (trade policy)	Featured	Not featured	Featured
P1	Legislation changes (emissions reductions and ESG)	Featured	Supporting	Featured
S1	Customer/ investor expectations (ESG)	Supporting	Not featured	Featured
S2	Digital accessibility and equality	Supporting	Supporting	Supporting
S3	Migration to NZ	Supporting	Supporting	Supporting
S6	Population and demographic change	Supporting	Supporting	Supporting
P4	Sector reform	Not featured	Not featured	Not featured
P6	Legislation changes (managed retreat)	Not featured	Supporting	Featured
P8	Legislation changes (land use)	Supporting	Supporting	Supporting
En1	Extreme weather events	Supporting	Featured	Featured
En3	Increased temperature	Supporting	Featured	Supporting

Scenarios are broken down into the global context, followed by time periods where drivers play out. The featured drivers for each scenario are spoken to first within the narrative, followed by the outcomes and any relevant supporting drivers.

World Narrative 1: Orderly Transition

5.1 World Narrative 1: Orderly Transition Scenario

Global Context

There is an urgent and coordinated global response, with immediate climate action taken in high-polluting countries. Technological breakthroughs facilitate deep emissions reductions, and the provision of government support helps to reduce transition risks in countries. The rapid shift in capital from high-emitting sectors to low-risk, low-carbon investments, causes significant short-term market disruption, but minimises long-term economic impacts.

Throughout the 2020s, major corporate polluters commence rapid emissions cuts following a series of legal judgements across jurisdictions. This facilitates action amongst the world's major emitters, including China. NZ is an early mover, leading the way in climate action globally. Driven by ambitious policies and legislation, NZ rapidly decarbonises its economy by mid-century.

Physical risks continue throughout the century due to 'locked in' levels of warming, with global average temperatures rising by around 2°C by 2050, and then declining to 1.4 °C above pre-industrial levels by 2100.

2025-2030: "The Transition Gathers Pace, and Connectivity Prioritised"

The NZ government supports investment into decarbonising the energy grid, leading to significant build-out of renewable energy between 2025-2030. However, due to the scale of planning and commissioning of new generation and grid upgrades, and the intermittent nature of these new renewables, there are periodic disruptions to energy supply over this period. This decrease in reliability of energy supply (and higher prices) has significant implications for the telecommunications sector and consumers with increased power outages.

NZ continues to experience extreme weather events throughout the 2020's, with periodic damage and disruption to telecommunications assets and services. There is increased emphasis on adaptation in vulnerable communities and ensuring there is backup communications equipment alongside community emergency preparedness. Further to this, telecommunications organisations prioritise having critical spares and invest more in communication diversity – such as satellite backhaul and connectivity for emergency response.

The telecommunications sector's voice is heard more in critical infrastructure conversations, and within emergency management. An update to the Emergency Management Act in 2026 establishes a hierarchy for critical infrastructure restoration, which provides clarity of responsibilities during the response phase of an event. Restoring connectivity becomes a post-disaster priority, and greater collaboration is required between critical infrastructure providers. This is coordinated through regional lifelines groups. Network resilience standards are also introduced, setting minimum requirements for critical infrastructure providers.

With global decarbonising gathering pace, imported products with high embodied carbon and products that are in high demand for mitigation, become costly. This increases costs for the telecommunications sector and creates demand for alternative (lower carbon) products. There is also a focus on technology that is less material and waste intensive (e.g., product manufacturers supporting products for longer). This poses challenges for NZ telecommunications organisations as there is no local manufacturing capability and an inability to make this viable given the size of the country. This issue remains throughout the rest of the 2020's, as organisations continue to incur significant costs for some imported goods.

Energy reliability issues, supply chain cost increases and the growing pressure for the sector to reduce emissions all drive cost increases. Telecommunications organisations struggle to absorb these costs, which are partly passed through to customers, with broader price increases continuing to be assessed by organisations in the context of the broader market and competitive dynamics.

The rapid societal transition adds cost across the entire economy which impacts cost of living from 2025-2030. The impacts of this are felt more significantly in regions with high-emitting sectors that are also facing localised economic transitions, such as Taranaki and the West Coast. This creates localised economic impacts and minor internal migration of people out of these areas.

Alongside the increasing costs across the economy, consumers shift away from the use of high-carbon transport (e.g., air and car travel). In the short term, this leads to an increase in the number of people working more from home, placing more reliance on digital connectivity. This creates additional opportunities for service providers, to support this increased demand.

The above factors exacerbate societal inequities and reduce the ability for some New Zealanders to access services over this period. This is recognised in 2030, when the government takes some responsibility for addressing digital equity issues by providing support to lower socio-economic communities to enhance digital access.

2030-2045: "Off-shore Investors Look to New Zealand"

The decade starts with the implementation of stronger land use management regulations that significantly reduce building consents in high-risk locations. These regulations also consider critical infrastructure locations, soil management and land use practises (such as forestry slash management) to help ensure impacts like those experienced in Cyclone Gabrielle are not repeated. The industry adopts a collaborative approach to building and upgrading infrastructure - which is delivered in a co-ordinated and resilient way.

The disruptions from the decarbonisation of the energy sector are significantly reduced from 2030 onwards due to major grid upgrades and improvements in reliability. This frees up resources for the telecommunications sector to focus efforts elsewhere, such as continuing to reduce emissions, supporting customer's decarbonisation programmes and addressing supply chain constraints/costs. In an effort to manage supply chain costs, the sector begins to shift towards circularity and repairability, alongside extending product lifecycles. Delayed consumer uptake of new technologies means the decommissioning of legacy assets is deferred resulting in the delayed adoption of new technologies.

Due to NZ having a clean energy grid and being a fast-mover to decarbonise, it is seen as an attractive place for investment and off-shore developers (e.g., data centres) and this drives demand for digital solutions across major emitting sectors, including in buildings, transport, and agriculture. This creates business opportunities for the telecommunications sector.

The transition to a low carbon economy drives a need for an increase in skilled workers across the entire economy. The telecommunications sector relies heavily on skilled migrants, and even with supportive migration policies, there are still shortages.

2045 and Beyond: "The Prosperity Era Begins"

Due to the rapid and sustained effort across the last 20 years to decarbonise the global economy, the climate system begins to stabilise. Extreme weather and temperature events still occur, however they are less severe and frequent. Better and more coordinated emergency management response alongside the diversification of energy supply allows for a reduction in outage times, with restoration of connectivity still a priority across key critical infrastructure providers.

World Narrative 2: Hot House World

5.2 World Narrative 2: Hot House World

Global Context

The world moves into an era defined by extreme nationalism and geopolitical tension. Domestic issues are prioritised over regional (Pacific) and global concerns, with efforts to address greenhouse gas emissions being supplanted by a focus on economic growth.

As there is minimal action to reduce emissions, global average temperatures surpass 2°C by 2050 and increase to 3.6°C above pre-industrial levels by 2100. Severe, frequent, and in some cases irreversible, physical impacts result, causing widespread loss and damage.

Economic development is severely hindered, and poverty increases in climate vulnerable countries across the century. Weather events and geopolitical disruption drive a significant long-term decrease in GDP. Government institutions at all levels are challenged due to the multiple and cascading implications of climate risks and poor economic performance.

2025-2030: "The Decade of Deluge"

Geopolitical unrest and heightened nationalism remains throughout the 2020s and comes at a cost to broader global outcomes, including emission reductions. This unrest significantly disrupts global trade and supply chains, and countries increasingly seek to source materials locally or from their closest neighbours. The telecommunications sector in NZ is impacted severely by this.

The frequency and intensity of extreme weather events increases markedly over the decade, with repeated and unprecedented events causing significant damage to infrastructure across the telecommunications network in NZ. The frequency of events, and associated response and recovery costs put significant strain on the telecommunications and critical infrastructure sectors, and results in long delays in restoring service. Delays are exacerbated by supply chain constraints and shortages in materials.

Smaller, rural communities are worst affected, and some spend weeks with no or extremely poor levels of service following weather events. This drives these communities and consumers to plan for self-sufficiency, including the use of satellite-enabled services, which are perceived as more resilient in rural areas, particularly during extreme weather events. In-turn, satellite-enabled services increase their market share in these areas. However, satellite services also face challenges as their services become more congested and their land-based infrastructure is also affected by severe weather events.

2030-2045: "Telecommunications Sector Disruption"

Following the 'Decade of Deluge', in 2030, the government and councils embark on widespread investment in adaptation, particularly focussed on flood protection. However, critical infrastructure providers struggle to coordinate planning efforts, resilience improvements are delayed, and many communities continue to experience service disruptions.

The cumulative implications of extreme events, supply chain disruptions and wider economic slowdown leads to a deepening cost of living crisis. Government borrowing increases significantly in an effort to maintain core government services.

In an effort to bring better levels of service to high-risk communities, the government passes legislation mandating resilience standards. These standards put significant financial pressure on telecommunications organisations, driving up costs for the sector and prices to customers, particularly in sparsely populated or high climate risk areas. This increases the cost to stay connected, further exacerbating the digital divide.

Some consumers, particularly in remote and vulnerable locations, are attracted to satellite services, some of which are provided by international providers who aggressively target NZ consumers. As a result, satellite services and hybrid connectivity continue to take market share from fixed-line and fixed-wireless connectivity. Telecommunications organisations build up their existing partnerships with satellite companies to take

advantage of market opportunities. Satellite services continue to face capacity challenges to meet growing demand and customers experience increased service degradation due to more frequent significant weather events.

There is lack of coordination across critical infrastructure providers, which puts pressure on the telecommunications sector as it cannot rely on continuity of grid power supply, or roading access to sites in vulnerable regions. This adds to the service issues and necessitates significant investment in network resilience, including further backhaul redundancy and extended power backup to ensure regulated service standards are maintained during climate events.

Immigration policy settings limit immigration over this period, with only skilled migrants being prioritised. However, the government is put under ongoing pressure from Australia to create a dedicated framework for accepting climate refugees from the Pacific. This comes as a reaction to the number of refugees and illegal immigrants making their way to Australian shores as a result of climate change. These pressures are identified by the telecommunications sector, and plans are formulated to prepare for potential population increases.

In 2040, a number of telecommunications companies face potential failure due to declining revenue and increasing costs associated with resilience and repair. Initially this leads to a failure to transition and provide consistent coverage, followed shortly after by a signal to government that co-funding is required to ensure nationwide resilience and service levels. However, nothing is actioned in this decade due to the increasing welfare spending pressures.

2045 and Beyond: "The Network Restoration Crisis"

With no emissions reduction action occurring globally, the annual average temperatures surpass 2°C above pre-industrial levels by 2050. This results in significantly hotter and longer heatwaves through summer and autumn months – increasing demand for cooling, both for communities and for technology infrastructure across NZ.

Due to public and political pressure, in 2052, NZ resets immigration policy and accepts large numbers of climate migrants and refugees from the Pacific. Many New Zealanders are also returning home given the extreme temperatures being experienced around the world. The combined impact of refugees and returning New Zealanders puts pressure on essential infrastructure. Internal migration also occurs, for both people and vulnerable critical infrastructure, to avoid cities and towns experiencing increased temperature and weather extremes.

The combination of population growth and increased demand for cooling, drive peak energy demand skywards. This results in periodic disruption to energy supply across large parts of NZ. This affects a range of critical infrastructure services including telecommunications.

Globally, technology continues to evolve at a rapid pace. In NZ however, the telecommunications providers continue to struggle to maintain and upgrade services – given supply chain and cost constraints, and the deteriorating condition and resilience of the network. Finance is increasingly difficult to obtain, and smaller private companies sell to larger ones.

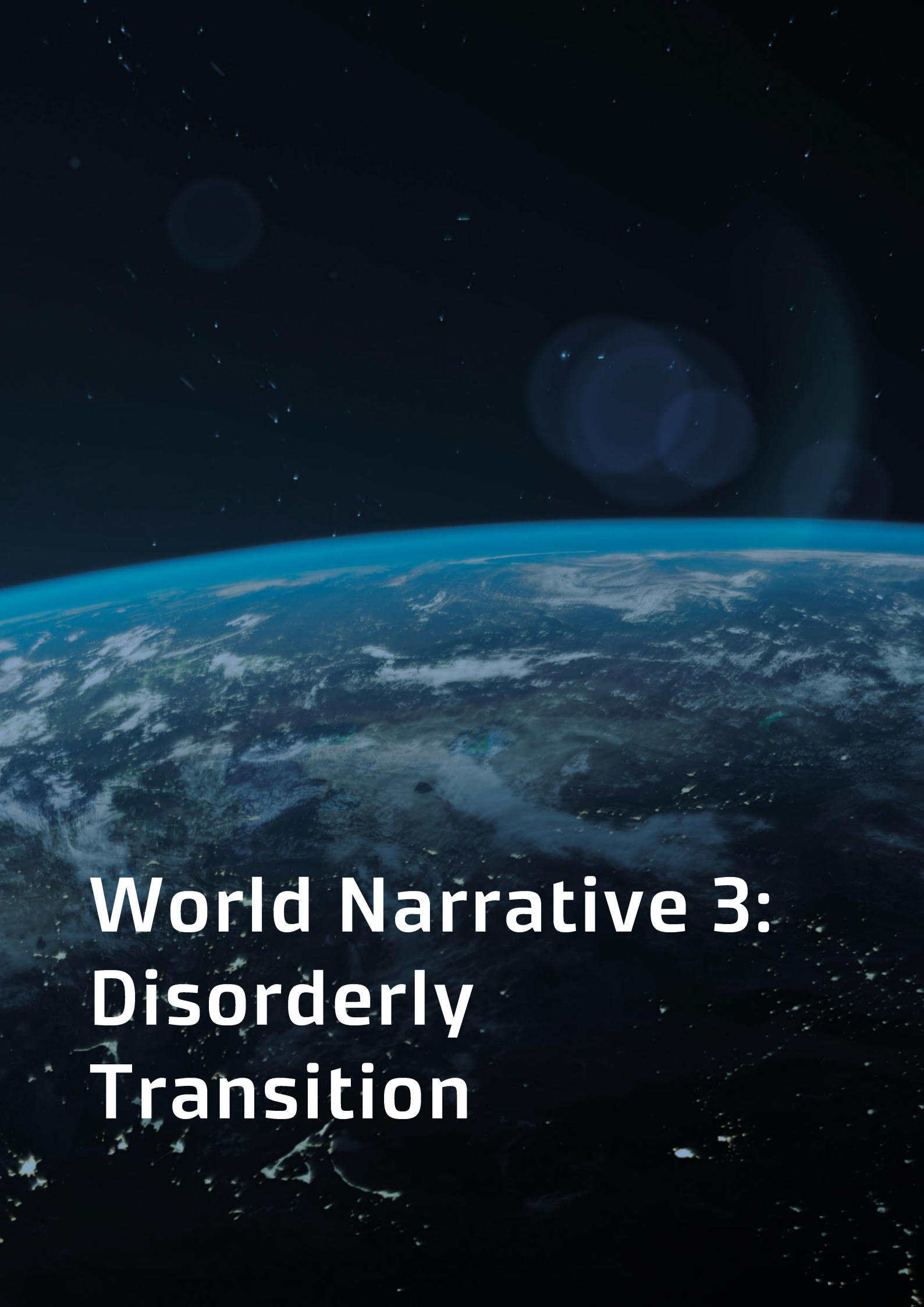
These challenging conditions drive a long-term decrease in New Zealand's GDP. Across the telecommunications sector, business survival becomes the sole imperative, with sector collaboration significantly reduced.

Highly exposed locations around NZ continue to be impacted by extreme events, causing significant damage and loss of life. Poor land-use management and planning further exacerbates the impacts of these events. Government has not yet been able to plan or co-ordinate managed retreat from exposed areas, leaving many councils and communities to 'fend for themselves'. Homes are abandoned, and many lose all their equity.

In 2052 following a devastating ex-tropical cyclone, telecommunications companies announce plans not to restore services in ten coastal and low-lying communities. This drives the government to act, and a co-funding partnership is set up to ensure services continue in these communities. However, this collapses after four years as many in these communities no longer tolerate the risks, and over time relocate to other parts of the country.

2055 sees a new conflict arise in space, where geopolitical disruption sees satellites become strategic targets

between warring nations. This impacts connectivity, disrupting NZ consumers and telecommunications companies using satellite services. This in turn undermines confidence in the long-term resilience of satellite services, driving consumers back to terrestrial mobile and fixed-line services.



World Narrative 3: Disorderly Transition

5.3 World Narrative 3: Disorderly Transition

Global context

The world follows a path in which social, economic, and technological trends do not shift markedly from current patterns. While global ambition and rhetoric are high, the implementation of climate policies and legislation is generally slow, and varied across countries. Inaction continues until the early 2030's, when the need for rapid decarbonisation is realised.

NZ is also delayed in transitioning, however from 2035, following the lead of the USA, a large number of developed countries (including NZ) pursue aggressive emission reductions, creating significant economic disruption in the medium term. The developing world, however, does not follow suit in pursuing aggressive emission reductions, and as a result, physical risks increase throughout the century. Global average temperatures reach 2°C by 2050 and increase to 2.7°C above pre-industrial levels by 2100, causing widespread impacts from climate hazards.

2025-2030: "The Inquiry Sparks Change"

Over this period there is no progress on reducing emissions in NZ.

The country continues to feel the impacts of climate change, with two deadly storms hitting the central and east coast regions of the North Island in the summer of 2027. This is followed by a severe flooding event in the South Island during the winter of the same year.

The impacts of the North Island events are catastrophic. Emergency management services are overstretched, and critical services are out for weeks. Many lives are lost. Communities despair at the lack of action following the many reviews commissioned after Cyclone Gabrielle in 2023, and demand accountability from politicians.

A government inquiry is commenced, which leads to a new National Resilience Strategy (NRS) being developed in 2029. As part of this, the government passes legislation that requires minimum resilience standards across all critical lifeline utilities. The aim of these standards is to increase investment by infrastructure owners and build 'gold standard' levels of resilience across networks. This has major implications for the telecommunications sector, not least because they are dependent on both the transport and energy sectors to achieve these levels of service. As part of the NRS the Government also commits to ensuring there is access to nationally consistent hazard datasets, and practical support, to facilitate information exchange between critical infrastructure sectors, government agencies and local government.

Due to the significant cost and practicality concerns relating to minimum standards as well as the additional resourcing needed for reporting, the telecommunications sector raises concerns – particularly for high-risk areas and flow-through impacts to customer prices. Despite this, the new requirements are enacted with annual reporting required from 2030, driving up the cost of telecommunications services, and exacerbating the digital divide.

2030-2045: "The Double Whammy"

Between 2030-2035 there is improved coordination across critical infrastructure providers due to the data and information sharing facilitated under the NRS. The telecommunications sector prioritises meeting the minimum resilience standards for infrastructure, which reduces the funds available to invest in innovation, advanced technologies and network upgrades.

In the early 2030's there is a renewed global and national pivot towards emissions reductions, given the extreme nature of the climatic events seen around the world. The government makes significant changes to the fourth Emissions Reduction Plan (2035), which results in the implementation of aggressive decarbonisation action across the energy and transport sectors.

The energy sector invests significantly in new renewable energy generation and upgrading the grid. However, demand spikes, combined with uncoordinated planning and roll-out, lead to significant disruptions to the network across a 10-year period. This, alongside continued extreme weather events puts pressure on the telecommunications sector.

Globally, the rapid transition causes a spike in demand for material inputs including key minerals and conflict minerals. This, alongside an increased scrutiny on the social and environmental impacts of mining in developing countries, leads to shortages and steep price increases. NZ feels the impact of this more severely due to being geographically isolated. This results in cost increases for the sector.

Across the economy, rising costs of mitigation and adaptation create challenging economic conditions, putting pressure on business and household spending, which impacts revenues for the sector.

Continued growth of Environmental, Social, Governance (ESG) expectations from investors and consumers (particularly younger generations), alongside shortages in materials drives the need for innovation in the sector.

The need for increasingly resilient services alongside constant innovation creates significant demand for skilled workers globally. New Zealand struggles to compete for these workers which puts increased pressure on the telecommunications sector to maintain levels of service.

However, 2035 and 2036 sees a number of climate events that test the sector, including ex-tropical cyclones impacting coastal communities, and significant flood events. With the cumulative costs of adaptation and decarbonisation, network operators struggle to meet the government's mandate on resilience standards. This is most acute in sparsely populated and highly exposed areas such as the West Coast, Bay of Plenty, and Otago.

In 2037, the government steps in and establishes a number of public-private partnerships (PPP), to ensure continued provision of telecommunications services in high risk and low population areas, where provision of services is not economically viable. These PPPs provide capital and the ability to secure debt finance, which then enables basic (essential) infrastructure upgrades. This new service model also begins a conversation between the telecommunications sector and the government, on managed retreat – given the infeasibility of providing adequate levels of service in highly exposed areas.

These conversations spark a broader dialogue across government, critical infrastructure providers and industry (including insurance), which leads to a bipartisan agreement in 2040 to prioritise climate change resilience and managed retreat. This requires a major overhaul of how the government finances infrastructure – including reform of the tax system and increases in international borrowing. The increased tax rates further push up the cost of living, and exacerbates social inequalities (including the digital divide).

There is significant migration to NZ from Pacific Island nations due to the impacts of sea level rise. This influx in population, in key city centres across NZ puts increased strain on the energy sector as it tries to transition, while keeping up with increased demand.

2045 and Beyond: "The Turnaround"

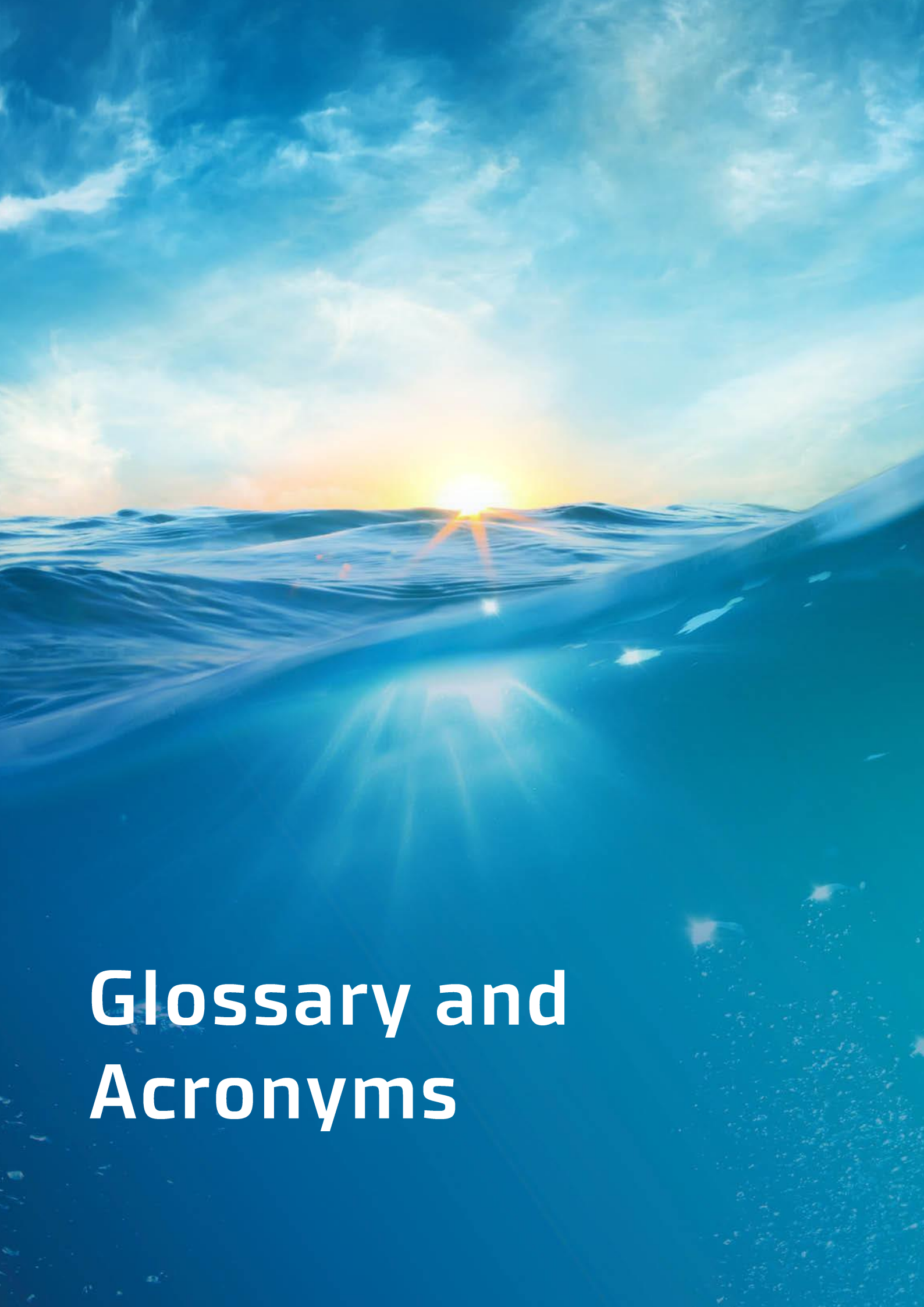
The delayed and disorderly transition means annual average temperatures reach 2°C above pre-industrial levels by 2050. The temperature extremes associated with this result in significantly hotter and longer heatwaves through summer and autumn months, with temperatures exceeding 35°C in some areas. This increases the demand for cooling both for communities and technology infrastructure across NZ. Following sustained investment over the previous decade, the energy sector has built sufficient capacity and resilience into the grid to manage demand spikes. This reduces potential reliability issues for the telecommunications sector.

The 2040 managed retreat agreement leads to a 10-year programme of work beginning in 2045, which involves property acquisition and relocation in many smaller coastal and low-lying towns. The complexity of the incremental decommissioning of the networks, and construction of new networks, alongside the negative publicity that the governments broader managed retreat programme receives in the media, initially requires significant attention and resourcing from the sector.

From 2050, increased funding under the PPP allows the telecommunications sector to upgrade infrastructure

and improve resilience. This, in turn, provides better and more resilient connectivity to communities across NZ throughout the 2050's. The financial support and upgrades to the network also allow NZ to keep up with technology advancements and improve digital equity.

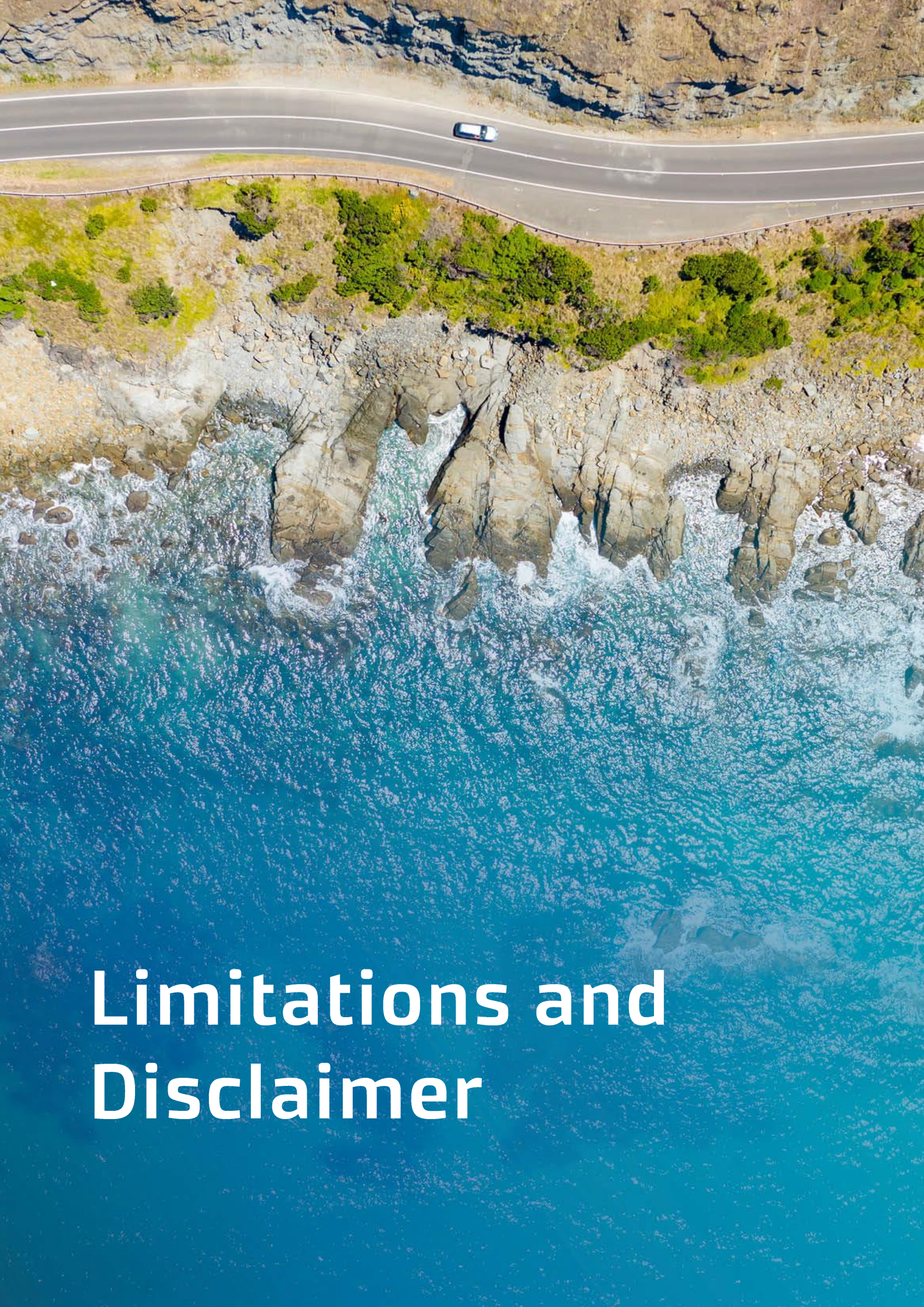
Due to locked-in levels of emissions, intense weather events and temperature extremes still occur in the 2050s and beyond. However, damage and recovery times are reduced due to better coordination across key critical infrastructure providers, and the improved resilience within the network.



Glossary and Acronyms

6.0 Glossary and Acronyms

Adaptation	The process of adjustment to actual or expected climate and its effects.
Climate reporting entity (CRE)	Climate reporting entities include those entities which are required to issue climate-related disclosures under NZ legislation.
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.
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-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' outcomes(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.
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 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.
Paris Agreement	The Paris Agreement is an international treaty on climate change that was adopted in 2015. The agreement covers climate change mitigation, adaptation, and finance, and 195 members of the United Nations Framework Convention on Climate Change (UNFCCC) are currently parties to the agreement.
Physical risks	Risks related to the physical impacts of climate change. Physical risks 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.
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.
Shared Socio-economic Pathways (SSP)	These are climate change scenarios of projected socioeconomic global changes up to 2100 as defined in the IPCC Sixth Assessment Report (AR6) in 2021. They are used to derive greenhouse gas emissions scenarios with different climate policies. The SSPs provide narratives describing alternative socio-economic developments. These storylines are a qualitative description of logic relating elements of the narratives to each other.
TCFD framework	The Task Force for Climate-Related Disclosures (TCFD) framework, is an internationally adopted structure for disclosing an organisation's climate-related risks and opportunities to investors, lenders and insurance underwriters.
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.



Limitations and Disclaimer

7.0 Limitations and Disclaimer

This section outlines the key limitations and considerations for the telecommunications sector climate scenarios presented in this report, and a disclaimer for using the sector scenario narratives.

7.1 Limitations

7.1.1 Consolidation of information in scenarios

The scenarios presented here have been developed based on input from the stakeholder representatives from the nine organisations involved in this project, and have been compiled by T+T. While every effort has been made to ensure the scenarios are reflective of the information collated from the workshops, and the feedback provided, not all information collated has been utilised in the scenarios. Information has been prioritised for inclusion that relates to the priority drivers discussed during the workshops for the telecommunications sector, voted on by the stakeholders.

The consolidated information included in each scenario may not be a direct representation of all comments collected from the workshops, each scenario attempts to incorporate key perspectives from the stakeholders involved. Stakeholders have been provided the opportunity to review and comment on scenarios.

7.1.2 Purpose of sector scenarios

The scenarios have been developed at a sector level to primarily illustrate how the external environment could change in the future, based on those driving forces that were shortlisted. The narratives have been developed to explore how these driving forces may impact the sector in general, on other driving forces, or on specific entities and organisations within the sector. It is not, however, possible to explore all possible direct and indirect implications resulting from future climate change impacts for all sectoral organisations/entities. This is the purpose of entity-level scenario analysis and should be undertaken separately, as needed. For the climate scenario analysis, CREs should use the narratives contained in Section 6.

7.2 Disclaimer

7.2.1 Third party reliance

This report has been prepared by T+T, on the instructions of the TCF project manager (based on feedback from participating TCF members), for the purpose of assisting organisations within the telecommunications sector to assess the resilience of their operations, services and strategies under various future climate-related scenarios. For CREs, which need to make climate-related disclosures under NZ legislation, these scenarios have also been developed to support entity-level scenario analysis under this process.

By its nature, the report outlines plausible future scenarios, which are not intended to be probabilistic or predictive, and accordingly the stakeholders and their respective organisations, and T+T accept no liability to any entity or any other person 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.

CREs are independently responsible for ensuring they meet XRB requirements, and their other legislative 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 April 2024), T+T and the individuals and organisations involved in this project do not accept liability under any circumstance for CREs independently ensuring that they meet XRB Standard disclosure and NZ legislative requirements.

Individuals and entities using these scenarios for any reason should read this report in its entirety, including the limitations and disclaimers section, appendix, and footnotes.

These scenarios may require updating as new data or information becomes available, or in the event of changes to the XRB Standard requirements. T+T 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.

7.2.2 Disclaimer on data and information used in the scenarios

The information presented here is based on publicly available information, information provided by the wider stakeholder group and expert judgement from T+T staff. Other than the review undertaken by the wider stakeholder group (including the TCF), and unless otherwise stated, the accuracy and completeness of any information provided in connection with this project has not been independently verified.

The scenarios presented here have been developed based on the best available information and data at the time and in line with present XRB Standard requirements (as of April 2024). There is no guarantee that the information or data provided here is accurate as of the date it is received or will continue to be accurate in the future.

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Document control and review

Document control and review

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29/04/24	0.1	DRAFT for client review	M. Lindsay	P. Cochrane
29/05/24	0.2	DRAFT V2 for client review	M. Lindsay	P. Cochrane
20/06/24	0.3	DRAFT V3 for client review	M. Lindsay	P. Cochrane
09/07/24	0.4	DRAFT V4 for TCF project manager review	M. Lindsay	P. Cochrane
15/07/2024	1.0	Final report	M. Lindsay	P. Cochrane

Quality management

To ensure alignment with our Quality Management System, technical review of differing elements within this report is documented below.

Quality management

Element:	Prepared by:	Reviewed by:
Sector scenarios and methodology	M. Lindsay	A. Cartwright J. Hughes

12 Jul 24

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Appendix A: Driver Mapping

Appendix A. Driver Mapping

A.1 Shortlisted drivers mapped out to each scenario

The following table describes how each of the drivers plays out at a high level for each of the different scenarios.

ID	Driver	Orderly Transition	Hot House World	Disorderly Transition
P5	Disruption to interdependencies	• Initial disruption to energy supply as the sector rapidly decarbonises and tries to keep up with current demands. • Update to Emergency Management Act that sets a hierarchy for critical infrastructure restoration. Connectivity is a priority.	• Response and recovery costs increase across all critical infrastructure sectors due to repeat extreme events. • Critical infrastructure providers struggle to coordinate planning efforts and resilience improvements are delayed.	• National Resilience Strategy (NRS) is developed that requires minimum emergency levels of service across all critical lifeline utilities. It also provides nationally consistent hazard datasets and coordination between critical infrastructure sectors. • This mandate drives better coordination across critical infrastructure providers.
T1	Reliance on connected technology	• Initial disruptions to connection due to energy sector decarbonisation. • Improved connected technology due to prioritisation of connectivity in emergency response. • Additional adoption of IoT monitoring technologies to support climate response.	• Loss of life occurs due to disruptions to connectivity during extreme events. • Rural communities are worst affected with some spending weeks without service.	• Two significant weather events cause emergency management to be overstretched and critical services are out for weeks. • Coordination and recovery timeframes improve due to investment made under the National Resilience Strategy (2030-2045).
P2	Legislation changes (technology and networks)	• No major legislation changes to technology or networks. • Circularity and repairability approach taken with technology and infrastructure. Renewals occur around 2040.	• No major legislation changes to technology and networks. • Technology evolves at a rapid pace. New Zealand struggles to maintain and upgrade services.	• Minimum resilience standards are mandated for telecommunication infrastructure across New Zealand. • Standards cannot be reached in high risk locations across the 2030's, which initiates a private-public partnership to help reach these mandates.
T2	Material shortages	• No material shortages, however, a shift in focus to more locally sourced materials.	• Material shortages occur due to damage caused by severe weather events and over	• Rapid transition causes a spike in demand for materials (key and conflict minerals).

ID	Driver	Orderly Transition	Hot House World	Disorderly Transition
			exploitation.	• Increased scrutiny on the social and environmental impacts of mining leads to shortages and steep price increases.
Ec4	Access to finance	• Access to finance is linked to ESG incentives. • Offshore investors help bring money into the sector due to the 'clean green' energy grid.	• Government borrowing increases significantly in an effort to maintain core government services. • Finance is increasingly scarce with some businesses facing potential failure.	• Telecommunication organisations struggle to finance upgrades to meet resilience standards set by mandate. Public-private partnership provides capital and the ability to secure debt finance.
Ec2	Changes to the cost of living	• Rapid societal transition adds cost across the entire economy which impacts cost of living between 2025-2030. • This stabilises post 2030.	• Extreme events, supply chain disruptions and wider economic slow down leads to a deepening cost of living crisis.	• Increased tax rates from 2040 further push up the cost of living.
Ec5	Changes to geopolitical landscape	• Coordinated global response.	• The world moves into an era of extreme nationalism and geopolitical tension. • Domestic issues are prioritised over regional and global concerns. • Conflict in space, where satellites are seen as a major strategic target.	• Geopolitical tensions remain over the short to medium term. • Better global response (particularly in developed countries) from early 2030's.
Ec6	Changes to global trade and supply chain	• Focus on sourcing products and materials locally.	• Significant disruption to global supply chains due to both extreme events and geopolitical instability.	• Disruptions in supply chains occur due to extreme weather events globally. • Material shortages due to a demand spike post 2030.
P7	Legislation changes (trade policy)	• Imported products with high embodied carbon become costly.	• Countries seek to source materials locally or from closest neighbours. • Certain countries are put on trade-bans.	• Imported products with high embodied carbon become costly from 2035.
P1	Legislation changes (emissions reductions and ESG)	• Ambitious policies and legislation are put in place early, to ensure New Zealand decarbonises rapidly.	• Minimal action taken by the New Zealand government on reducing emissions.	• Global and national pivot towards emissions reductions occurs in early 2030's. • Emissions Reduction Plan update in 2035 sees aggressive decarbonisation across the energy and transport sectors.
S1	Customer/ investor expectations (ESG)	• Customer and investor expectations are aligned with the global direction of	• Little to no increase in customer or investor expectation in ESG.	• Continued growth in ESG expectations from consumers (particularly younger

ID	Driver	Orderly Transition	Hot House World	Disorderly Transition
		reducing emissions. • Offshore investors		generations) and investors.
S2	Digital accessibility and equality	• Increased costs and a rapid transition mean the digital divide is increased in the short term. • Government investment in digital equity in the medium and long term helps reduce the digital divide.	• Smaller rural communities are worst affected, and are hit with poor levels of service and connectivity. • Costs associated with staying connected rise significantly.	• No substantial changes to the digital divide over the short term. • Increased tax rates from 2040 further exacerbates inequalities. • Increased funding from 2050 allows technology advancements to occur and ensures digital equality across New Zealand.
S3	Migration to New Zealand	• Steady migration, with a focus on skilled workforce. • "Green migrants" increase with environmental conscious individuals moving to NZ.	• Short term immigration policy settings limit immigration, with only skilled migrants being prioritised. • Ongoing pressure from Australia for New Zealand to create a framework for accepting climate refugees occurs. • Influx of climate refugees and expats returning from 2040 onwards.	• Significant migration to New Zealand from Pacific Island Nations due to sea level rise. • Influx of population in key city centres.
S6	Population and demographic change	• Slow population growth. • Ageing population.	• Population increases over time, with both climate refugees and New Zealanders returning home from overseas. • Skilled worker shortage.	• Population growth is steady, with an influx of climate refugees. • Skilled workers available.
P4	Sector reform	• No sector reform.	• No sector reform but private-public partnerships established.	• No sector reform but private-public partnerships established.
P6	Legislation changes (managed retreat)	• No legislation needs to be implemented due to better land use management.	• No legislation on managed retreat. Government and councils prioritise adaptation, particularly in flood protection. • Councils and communities are left to 'fend for themselves'. Homes are abandoned and many lose all equity.	• Repeated climatic events, and telecommunication businesses going into receivership opens a conversation with government on managed retreat. • Bipartisan agreement in 2040 to prioritise climate change resilience and managed retreat. • Major property acquisition occurs over a 10 year period from 2045 to relocate many

ID	Driver	Orderly Transition	Hot House World	Disorderly Transition
				smaller coastal and low-lying towns.
P8	Legislation changes (land use)	• Stronger land use management legislation is put in place to restrict developers and communities being built in highly exposed areas. • Better soil management and forestry practises are put in place.	• No changes to land use planning. Developers are not incentivised to build outside of highly exposed areas. • No focus on better land use management, therefore, impacts from poor soil management and forestry slash are seen during extreme weather events.	• No immediate focus on land use changes, to improve resilience. Shift in focus occurs from 2040 to ensure development does not occur in highly exposed locations.
En1	Extreme weather events	• Extreme weather events continue to occur, resulting in periodic disruption. • Climate stabilises into the late century back to 2020 levels.	• Extreme weather events increase in severity and frequency for the rest of the century. • No climate stabilisation occurs and significant impacts are felt globally.	• Extreme weather events continue to occur and increase in frequency and intensity. • Better management and planning post 2035 helps reduce the impacts of these events.
En3	Increased temperature	• Annual average temperatures increase to 2°C by 2050 (above pre-industrial levels). Then rapidly declines to 1.4°C above pre-industrial levels by 2100.	• Annual average temperatures surpass 2°C by 2050 (above pre-industrial levels). Then increase to 3.6°C above pre-industrial levels by 2100.	• Annual average temperatures increase to 2°C by 2050 (above pre-industrial levels). Then increases to 2.7°C above pre-industrial levels by 2100.