NEW ZEALAND INFRASTRUCTURE COMMISSION
Te Waihanga

Draft New Zealand Infrastructure Strategy

Rautaki Hanganga o Aotearoa

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Foreword

Kupu takamua

Message from the Chair

Infrastructure can have a long lifespan. Many of the dams and bridges built by our forebears are with us today and still have a role in shaping the way we live.

Their decisions, their labour and their foresight have built us a strong foundation. A large proportion of our electricity is renewable thanks to our hydroelectric power stations. We can travel and move goods to even the most remote parts of the country, often across challenging geography. We have water networks, schools, hospitals and much more.

We might not always realise it, but this infrastructure is vital to our quality of life. It is also at the heart of our economy, powering our industries, providing high-quality jobs and helping us to share ideas and information so that we can trade with the world.

It is a legacy that we have a duty to look after and to maintain and replace when necessary so future New Zealanders benefit too. Unfortunately, there are too many examples of our failure to do this, whether it is burst waterpipes or congested roads. We now find ourselves facing hard decisions about how we keep up with the increasing demands of a growing population, so we leave an equally valuable legacy to future New Zealanders.

Success means building on that foundation with more infrastructure to support our economic and social aspirations, as well as making full use of the infrastructure we already have. It will also mean looking to what the future will bring, preparing for challenges like climate change and making the most of the opportunities offered by new technology. This also means anticipating the shocks and stresses that come with life on these volatile islands: the earthquakes and volcanic eruptions and the increasing risk of storms and rising seas due to climate change.

These choices and decisions come with a price tag. Our infrastructure represents some of our longest-lived assets and they are also our most expensive. We have to spread these costs fairly, both across and within generations, so that those who are benefiting are paying. At the same time, we can use the way we pay to manage demand and get more efficient use out of our existing infrastructure, such as charges for using our busiest roads at peak times.

We can't do any of this if we continue to look at our infrastructure only as parts, as transport or energy or water. It requires a system-wide approach, one recognising that those various parts work together. It requires a rigorous and systematic assessment of trade-offs to get the very most out of the resources we have. And it requires coordination and collaboration across institutions in the public and private sectors.

This strategy takes that wider view, setting a vision for the future of our infrastructure and setting out tangible steps for progress. It is an important step toward a future that provides the same high quality of life and environment that our forebears hoped for us. It is an important step toward building a New Zealand that thrives.

Dr Alan Bollard CNZM

Board Chair

He Pānui nā te Heamana

I ētahi wā, he roa kē te wā e tū pūmau ai ngā hananga. E tū tonu ana te nuinga o ngā pāpuni me ngā arawhiti i hangā ai e ō tātouu mātua tūpuna, ā, he whakaaweawenga tonu tō aua mahinga ki te āhua noho e whai nei tātou.

Nā runga i ā rātou whakatau, me tā rātou whakapau kaha, tae atu ki tā rātou matakite mai kua whakatakotoria he tūāpapa pakari. Mai kore ake i ā tātou punahiko wai he whakahōu te nuinga o tā tātou hiko. E āhei ana i a tātou te haere me te neke rawa ki ngā wāhanga mamao rawa o te motu, he ahakoa te takoto o te whenua. He whatunga wai, kura, hohipera hoki ā tātou me te maha noa anō hoki o ngā tukuora.

Tēnā pea, kāore tātou i te whai whakaaro ki tēnei i ngā wā katoa, engari, he tino wāhanga nui tō te hanganga ki te tautoko i te kounga o tō tātou ora. Kei te manawa o tō tātou ōhanga te hanganga, e whakakaha ana i ō tātou rāngai, e whakarato ana i ngā mahi tino teitei te kounga, ā, e āwhina ana hoki ki te whakawhitiwhiti whakaaro me ngā kōrero e taea ai e tātou te tauhokohoko ki te ao.

He waihotanga tēnei kua riro mā tātou hei tiaki, hei whakaū, hei whakakapi hoki i ōna wā e whai painga ai anō hoki ngā uri whakaheke o Aotearoa nei. Ko te mea pōuri ia, inā te mahi a ngā tauira kua ngere tātou ki te whai i tēnei, mai i te kōwhā o ngā paipa wai tae atu ki ngā ara kī puru ki ngā motokā. Ināianei, kua tau ki a tātou ngā kōwhiringa whēuaua mō tā tātou whakatutuki i ngā matea o te taupori e tupu ake nei, e waiho ai e tātou he waihotanga tino wāriu ki ngā uri whakaheke o Aotearoa nei.

Ko te tikanga o te angitu ko te hanga hanganga anō ki runga i taua tūāpapa hei tautoko i ō tātou wawata ōhanga, papori anō hoki, me te whakamahi tika i ngā hanganga kua oti kē te whakatū. Arā, ka mate tātou kia arohāngai ake te titiro ki te anamata, me te whakarite anō ki ngā wero pērā i te hurihanga o te āhuarangi me te whai tika i ngā āheinga e whakaratongia ana e ngā hangarau hōu o te wā. Nō reira, me matakite e tātou ngā oho me ngā pēhanga ka kitea i runga i ēnei motu hohe nei: arā, ngā rū whenua me ngā hūnga, tae atu hoki ki ngā tūraru āwhā e piki tonu ake nei, me ngā moana e kake ake nei ko te hurihanga o te āhuarangi te take.

He utu tō ngā kōwhiringa me ngā whakataunga. He tauira o ētahi o ō tātou rawa ora wā roa tō tātou hanganga, whaihoki, he tino nui hoki te utu. Me matatika tā tātou toha i ngā utu, arā, ki ia whakatupuranga, kia utu ai te hunga e whai pai ai. Whaihoki, ka taea e tātou te whakamahi i te utu hei āwhina ki te whakahaere i te whao me te whakamāia ake hoki i te whakamahinga o te hanganga e tū ana i tēnei wā, hei tauira, ko te whakatau utu mō te whakamahi i ngā ara oreore rawa i ngā wā keokeonga.

Kāore e taea e tātou tētahi o ēnei te mahi mehemea ka titiro tonu tātou ki tō tātou hanganga hei wāhanga motuhake, arā, te ikiiki, te ngao rānei, te wai rānei. Me tiro whānui kē ki te punaha katoa, me te mārama tonu e mahi orua ana aua wāhanga katoa. E tika ana kia whāia he aromatawai pākaha, nahanaha hoki o ngā tukunga e tika rawa atu ai te whakamahinga o ngā rawa e wātea ana. Ā, e matea ana te rurukutang ame te mahi ngātahitanga i roto i ngā whakahaere, tūmatanui mai, tūmataiti mai.

Nō reira, ko tā tēnei rautaki he whai i taua tirohanga whānui, e whakarite ana i te whāinga mō te anamata o tō tātou hanganga me te whakarite hoki i te pēwheatanga mō te whanake ki mua. He hīkoi tino whakahirahira tēnei ki te anamata, he mea whakarato i te kounga tino teitei o te ora me te taiao i tūmanakotia ai e ō tātou mātua tūpuna kia riro mai ki a tāgtou. He hīkoi whakahirahira tēnei ki tētahi Aotearoa e momoho ana.

Dr Alan Bollard CNZM

Heamana o te Poari

Message from the Chief Executive

Te Waihanga was established to improve New Zealanders' lives through better infrastructure.

This is no small task. 30 years from now another 1.2 million people may call Aotearoa New Zealand home. Our climate is changing, technology is evolving and we now have to live with a new, highly contagious virus that has the potential to overwhelm our healthcare system. We face a 75% chance of a catastrophic earthquake on the Southern Fault within the next 50 years. Over several years of underinvestment we accrued an infrastructure deficit forecast to exceed $75 billion. These are just a few of the challenges we must address over the next 30 years.

It's our job to think about these challenges, but also to harness the immense opportunity our infrastructure offers. This means looking at the whole infrastructure system, whether its electricity, transport, water, health or education, just to name a few. It also means looking at the way we fund and pay for it and its regulatory settings.

New Zealand needs to act now if we want our infrastructure to improve our wellbeing and grow productivity. Achieving net-zero carbon emissions and moving to a more sustainable future requires a fast and sustained build. But our planning and consenting system is not up to the task. As a result, we import coal to keep the lights on. Halving what we spend on consenting would give us enough money to fund more than half the renewable energy needed for our emission goals.

Getting our infrastructure investment programme right will be critical to meeting these challenges. But we can't just build our way out. We have to find ways to get the biggest bang for our buck. This means encouraging people to drive at less congested times through congestion pricing and financially rewarding those who save water. Within our cities, we need to ease planning restrictions that prevent people from living in areas already well served by infrastructure, we need to push back against NIMBYism and question the substantial increase of 'experts' that on many counts, have captured our consenting system.

We also need a world class construction sector. Since 2000, the number of people working in heavy and civil construction has more than doubled, yet construction labour productivity lags behind the rest of the economy. The cost to build infrastructure has risen rapidly. There are many reasons for this, but a major factor is a labour shortage, now the worst since 1975. By 2024, we'll need around 118,000 more construction workers. Greater certainty is critical. Painting a clear picture of planned investment through a more sophisticated infrastructure pipeline is important and addressing the politicisation of infrastructure decision making is essential. This will give the construction sector and those sectors that support it, the certainty it needs to invest in training and people, modern plant and innovation to improve productivity.

Over the last two years, we've been listening and learning. More than 20,000 people shared their views on infrastructure issues through our Aotearoa 2050 survey. We consulted publicly, met with iwi and stakeholders, as well as our local government reference group and Māori testing panel. This conversation hasn't finished. This strategy is a living document that we'll update every five years. Adopting its recommendations will allow us to build a better Aotearoa, one where our infrastructure drives higher living standards, contributes to a strong economy, enables our culture and society to thrive, and protects our environment. An Aotearoa we are all proud to call home.

Ross Copland

Chief Executive

He Pānui nā te Toihau

He whakapai ake i te oranga o ngā uri o Aotearoa mā te hanganga pai ake te take e tū nei Te Waihanga.

Kāore tēnei i te tūmahi iti noa. Hei te 30 tau ki mua nei 1.2 miriona tāngata anō ka kī ko Aotearoa te ipukarea. E huri haere ana tō tātou āhuarangi, e whanake tonu ana te hangarau, ā, i tēnei wā e mate nei tātou kia ora tātou me tētahi huaketo hōu, materere hoki, he pitomata tō taua huaketo ki te haukerekere i te punaha hauora. 75% te tūponotanga ka pā tētahi rū whenua takerehāia i te Southern Fault i roto i te 50 tau e tū mai nei. I roto i ngā tau, i runga i te matapiko ki te whakangao pūtea, kua piki ake te tarepa hanganga e matapaetia ana ka kō atu i te $75 piriona. Ko ēnei ētahi o ngā wero e tika ana kia whakatikangia hei roto i te 30 tau e whai ake nei.

Kei a tātou te haepapa ki te whai whakaaro ki ēnei wero, whaihoki, kia whāia hoki te āheinga nui taioreore e puta mai ana i tō tātou hanganga. Nō reira, e tika ana kia tirohia te katoa o te punaha hanganga, hiko mai, ikiiki mai, wai mai, hauora ai, mātauranga mai rānei. Nō reira me arotake e tātou te āhua o tā tātou whakangao pūtea, utu anō hoki, me ngā whakaritenga ā-waeture.

Me tū a Aotearoa ināianei ki te hiahia tātou ki te whakapai ake i tō tātou oranga me te whakatupu ake hoki i te whakaputaranga. Te whakatutuki i te kore whakapau waro me te whanake ki tētahi anamata toitū, me tere, me rōnaki anō hoki te whakatūnga. Heoti anō, kāore e rite tō tātou punaha whakamahere, whakaaetanga hoki. Ko te tukunga iho, ka whakaurutia ngā waro e kā tonu ai ngā rama. Mā te whakahaurua i tā tātou whakapau pūtea ki te tukatuka whakaaetanga ka whai pūtea tātou ki te tuku pūtea ki te utu i kō atu i te haurua o te moni e matea ana mō te ngao whakahōu e tutuki ai i a tātou ā tātou tohenga tukunga waro.

Nō reira, he mea nui kia tika tā tātou whakarite i te hōtaka whakangao pūtea ki te hanganga hei whakatutuki i ngā wero. Engari, e kore e taea e te whakatika mā te whakatū hanganga anake. Me kimi e tātou he huarahi e nui rawa atu ai ngā patanga i te whakatū hanganga. Arā, te whakatenatena i ngā tāngata kia taraiwa i ngā wā e iti ana ngā motokā i ngā ara mā te whakarite utu ara popoke me te moni whakapati ki te hunga e iti ana te whakapau wai. I ō tātou tāone, me whakangāwari i ngā herenga whakamahere e aukati ana i ngā tāngata i te noho ki ngā rohe e nui ana te hanganga, me ātete e tātou te NIMBYISM me te pākiki i te pikinga o ngā 'mātanga', ā, ko rātou i te nuinga o te wā e whakapae ana ki tō tātou punaha whakaaetanga.

Ka mutu, me whakatū e tātou tētahi rāngai hanganga e mihia ana e te ao. Nō te tau 2000, kua huarua ake te tokomaha o te hunga e mahi ana ki te hanganga metarahi, toimaha hoki, he ahakoa, e taurewarewa ana te whakaputaranga mahi hanganga ki muri riro atu i te ōhanga katoa. Kua tere piki ake te nui o te utu mō te whakatū hanganga. He maha ngā take he aha e pēnei ai, engari, ko te korenga o ngā kaimahi tētahi take, ā, ko nāianei te wā kino rawa atu nō te tau 1975. Hei te tau 2024, tōna 118,000 kaimahi anō ka matea. He mea tino nui kia nui ake te whakamanawatanga. He mea nui kia mārama kehokeho he aha kei tua i te awe māpara mō te whakangao pūtea i oti ai te whakarite mā tētahi whakaraupapa mahi mātanga, ā, he mea whai take kia arohia te whakatōrangapūtanga o te tukanga whakatau hanganga. Mā te pērā ka nui ake te māia o te rāngai hanganga me ana rāngai tautoko ki te whakangao pūtea ki te whakangungu me ngā tāngata, tae atu ki ngā rawa ahumahi me ngā auahatanga hei whakapai ake i te whakaputaranga.

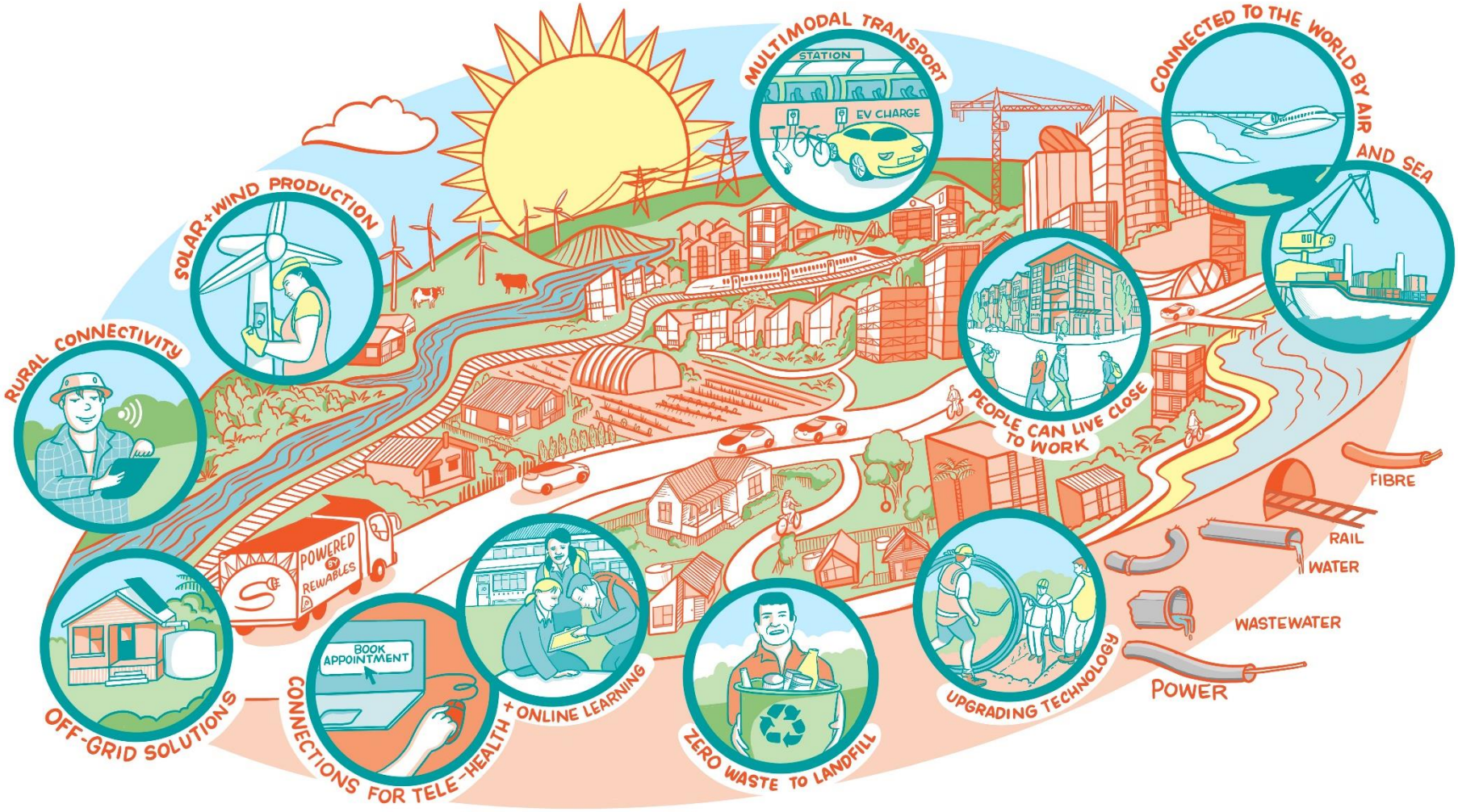
I roto i ngā tau e rua ki muri nei, kua whakarongo mātou, kua ako hoki. Neke ake i te 20,000 tāngata i tāpae whakaaro mai ai ki ngā take hanganga mā tā mātou rangahau Aotearoa 2050. I whakaatu kōrero mātou ki mua i te aroaro o te makiu, i tūtaki hoki ki ngā iwi me ngā rōpū whai pānga, tae atu hoki ki tō mātou rōpū tautoko ā-kaunihera me te paewhiri whakamātautau Māori. Kāore anō kia mimiti noa te puna kōrero. He tuhinga e ora tonu ana te rautaki, ā, ka whakamōhoutia e mātou i ia rima tau. Mā te whakapūmau i ngā marohi kei roto ka āhei i a tātou te hanga i tētahi Aotearoa pai ake, tētahi motu mā ana hanganga e teitei ake ai te kounga o te āhua noho o te katoa, e takoha ana ki tētahi ōhanga pakari,

e whakaahei ana i tō tātou ahurea me tō tātou papori kia momoho, kia tiakina hoki tō tātou taiao. Arā, e ngākau whakaī ai tātou te kī ko Aotearoa tō tātou kāinga.

Ross Copland

Toihau

Infrastructure for a thriving New Zealand




EFFICIENT LIVEABLE CITIES
POWERED BY: CLEAN ENERGY
CONNECTED RURAL COMMUNITIES AND PRODUCERS
AFFORDABLE HEALTHY HOMES
SAFE HEALTHY WHĀNAU
GOOD JOBS
BEAUTIFUL CONNECTED, INCLUSIVE NEIGHBOURHOODS
ACCESS EDUCATION + KNOWLEDGE
RELIABLE, RESILIENT NETWORKS
ELECTRICITY, WATER, RAIL ROAD, INTERNET
GETTING AROUND EASILY
GLOBALLY INTEGRATED DIGITAL CITIZENS
CARE FOR THE ENVIRONMENT THAT SUSTAINS LIFE
AOTEAROA · NZ · CO2 NEUTRAL · CARBON NEUTRAL 2050
BUS STOP
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Overview

Tirohanga whānui

The infrastructure of New Zealand lays a foundation for the people, places and businesses of Aotearoa New Zealand to thrive.

New Zealand's infrastructure faces a historic period of deep and intergenerational change. Historic, because many of the challenges we face are new and uncertain; deep, because it impacts all parts of our society; and intergenerational, because the effort must be sustained, not over months and years, but decades.

It is hard to think of an activity that doesn't use our infrastructure. We commute to work on transport networks that have been constructed and maintained by generations of New Zealanders. These same networks carry the goods that stock our supermarket shelves with food. These supermarkets are powered by electricity produced by power stations built decades ago. This electricity also charges phones that connect to a network of cell towers, which bring us closer to the world and to each other.

Te Waihanga exists to look across these connected networks of infrastructure in a holistic and coordinated way. This strategy takes this more holistic view of the infrastructure system. It also takes a long term view, recognising that the needs and aspirations we have for our society and therefore, our infrastructure, are constantly changing.

Our infrastructure must adapt to our changing needs and aspirations.

The New Zealand of 2050 will be a very different place to live. Within the next three decades our cities could be home to 1.7 million new Kiwis, roughly the size of another Auckland. Our regions face considerable change too, with some parts of New Zealand growing, while others will need to adjust to declining populations. No matter where we live, technology will continue to bring us closer together, altering our expectations of how we connect to each other and the way we work.

Infrastructure can help us to protect the environment.

New Zealand has an ambition of a net-zero carbon emissions economy by 2050. This requires a major energy transition and levels of investment in new infrastructure not seen since the 1970s. Our aspirations for clean drinking water and waterways require our water networks to be updated. Investment in recycling and resource recovery infrastructure can enable a shift to a society where waste is reduced or not even produced at all. Our growing cities can also be good for our environment. Bigger, denser cities where people live in smaller homes, mean less electricity for heating, shorter car trips and more use of public transport, emitting less carbon into the atmosphere.

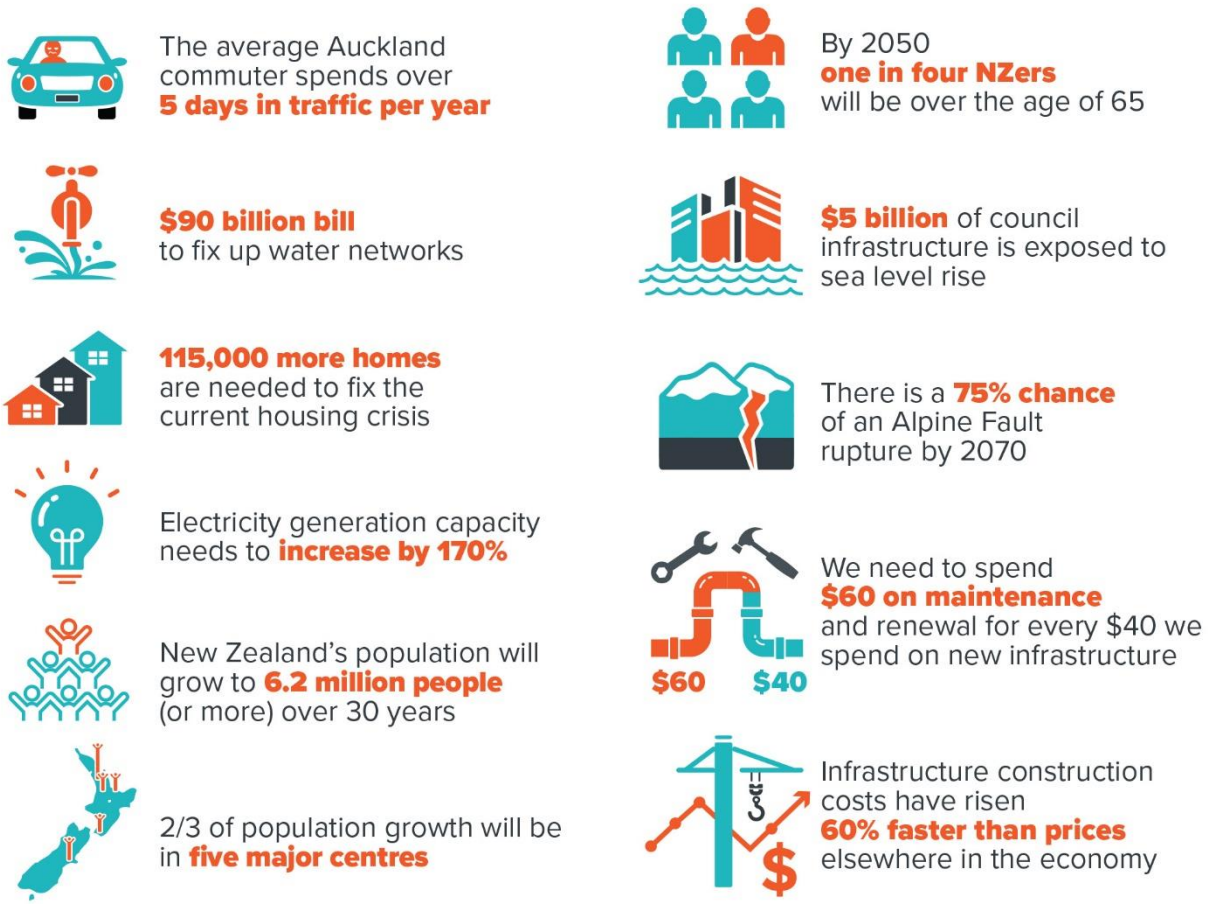
Infrastructure opens up many new opportunities but there are also many challenges.

When built in the right place, transport infrastructure can improve productivity, raise wages, support new businesses and reduce disadvantage by connecting people with work and education. Digital technology is creating new business opportunities in regions. Making our infrastructure more resilient means we can recover faster from natural disasters and other shocks, minimising their impact on our society and economy.

But we are also facing many infrastructure challenges (see Figure 1) such as dealing with unaffordable homes, congested motorways and hospitals that desperately need upgrading. Unless we act, problems like these are only going to get worse, especially as our population grows. We also face the challenges

of our warming climate, which will not only mean major changes to the way we do things, but also more unpredictable and extreme weather.

Figure 1: New Zealand's infrastructure challenge



Source: Sense Partners

We must act now and with urgency. In dealing with COVID-19, New Zealand has shown a responsiveness and agility that is globally unmatched. The challenge for our infrastructure requires a similar, but more sustained commitment.

We must be smarter about how we plan, build and use our infrastructure.

We're building new infrastructure and more is planned for the future. We currently spend around 5.5% of gross domestic product (GDP) on building public infrastructure. This means that for every $20 New Zealand earns, we spend around $1 on infrastructure. This includes our roads, water networks, hospitals, schools and defence facilities (but doesn't include privately provided infrastructure like electricity generation and telecommunications). If we were to simply keep doing what we've always done and try to build our way out of current and future infrastructure challenges, it would cost almost double what we're spending now.

Responding to the challenges doesn't always mean building something new. Building infrastructure will still be an important part of the solution, but we also need to get better use out of our existing infrastructure. When we do build something new, there are changes we can make to get more value from what we spend. We can make better decisions about the projects we select and streamline delivery so that infrastructure is built more quickly and productively.

This strategy is focused on five objectives to achieve a thriving New Zealand.

Based on the infrastructure challenge, we have developed five strategic objectives (as shown in Figure 5: Blueprint for action). These are the things we need to do as a nation to achieve the vision of a thriving New Zealand.

1. Enabling a net-zero carbon Aotearoa through greater development of clean energy and reducing the carbon emissions from infrastructure.
2. Supporting towns and regions to flourish through better physical and digital connectivity and freight and supply chains.
3. Building attractive and inclusive cities that respond to population growth, unaffordable housing and traffic congestion through better long term planning, pricing and good public transport.
4. Strengthening resilience to shocks and stresses by taking a coordinated and planned approach to risks based on good quality information.
5. Moving to a circular economy by setting a national direction for waste, managing pressure on landfills and waste recovery infrastructure and developing waste-to-energy options.

As part of these objectives we need to strengthen partnerships with and opportunities for Māori.

Transforming our infrastructure requires us to seize opportunities that will make the greatest impact.

These objectives will help us to shape a better future, but there are three areas that can have the greatest impact over the next 30 years to transform New Zealand. These are:

- Leveraging our low emissions energy resources.
- Planning for generations to come.
- Better infrastructure through pricing.

Leveraging our low emissions energy resources.

We can grow our low emissions energy generation beyond what we need to meet our climate change commitments, creating economic opportunities and high-paying jobs.

New Zealand has an abundance of low-emission energy potential. We have about two to three times more commercially viable wind, solar and geothermal resources than the Climate Change Commission estimates will be needed to meet our net-zero carbon emissions commitment. Beyond meeting these commitments, unlocking a low-emissions economy could also provide much greater economic benefits for New Zealand.

The potential

By harnessing our low-emissions energy resources alongside other complementary technologies like hydrogen, we could treble our annual electricity supply. If we harness these resources, we can attract energy-intensive industries to grow our economy, create higher paying jobs and improve our quality of life. This is good for us and it's good for the planet.

To leverage our low-emissions energy resources we must have:

- **The right regulatory settings** to enable development of large-scale clean onshore and offshore energy resources and the networks needed to connect them. For example, the planning system needs to enable timely development of clean energy generation.
- **Reliable supporting infrastructure.** This requires an efficient expansion of supporting electricity and telecommunications networks, and making efficient use of our gas network.

- **A skilled workforce.** We need more scientists and researchers helping to improve energy conversion technology, particularly for our dairy processing activities. We also need to retain our skilled oil and gas workers to make the most of gas (and its specialist infrastructure) as we begin to transition to cleaner alternatives, including offshore alternatives.

Planning for generations to come.

We need to overhaul the way we plan infrastructure to keep pace with our growing population and ensure there is enough quality, affordable housing in the right places, supported by well-functioning infrastructure. With long term planning, we can build great communities for generations to come.

We can transform the system so that we get infrastructure before it's needed, not after. This means taking a long term approach, allowing for different levels of growth so we don't limit our future and coordinating our infrastructure planning with the planning we do for our homes and communities so that the two work together.

We need to take a coordinated approach across government and in our communities through:

- **A resource management system that actively prioritises homes and communities.** Reform is already underway, but it will need to set some clear goals for these issues.
- **A long term, open-ended approach to regional planning.** We need an approach to regional planning that allows for infrastructure to be built in the future and ensures that cities and regions have plenty of options for responding to population and economic growth.
- **Protecting areas for infrastructure decades in advance.** Instead of our current 'just-in-time' approach, we can set aside land to provide a pathway for the infrastructure that might be needed in the future, allowing us to deliver more at a lower cost.
- **Planning rules that are equitable and enable more housing and employment in the right places.** We can make it easier to develop land within our towns and cities and for people to live and work where they want, at a lower cost. Planning rules can empower everyone through improved housing affordability, reduced congestion and support for other social objectives.
- **Ensuring that the costs are fairly spread over time.** We need to use funding and financing tools that reflect the period of time over which infrastructure assets deliver services.

The potential

An overhauled planning system would mean it's faster and cheaper to build new homes. Our communities will grow from the centre, with more people living closer to where they work so they can spend more time with their families and less time trying to get to work. When communities do spread outwards, it will happen at the same time as roads or public transport lanes are built. More transport connections, as well as water networks, schools and other essential infrastructure will be part of new communities from the beginning. This will future proof quality of life for generations to come.

Better infrastructure through pricing.

Changing the way we pay for our busiest roads, water services and other infrastructure can reduce the time we spend in traffic, accelerate decarbonisation efforts, conserve water, allow us to lift the quality of infrastructure and give us greater choice for how we want to live.

Our transport and water infrastructure are stretched to capacity. Too many of us are spending hours stuck in traffic and facing rates' rises to pay for water networks that are struggling to keep up with the needs of our growing cities. While we're planning to build more, it won't be enough.

Changing the way we pay for things like roads and water use can provide more choice and better share the load, provided it is done in a fair and equitable way. By introducing prices for our busiest roads at

peak times and charging just for the water we use, we can encourage people to prioritise their trips, move to lower carbon travel and conserve water use.

Some of the actions we need to take include:

- **Pricing for quicker journeys.** Charges and road tolling for the busiest roads at peak times will free up these roads, creating quicker trips for people who must drive, such as couriers, tradespeople and freight.
- **Better transport alternatives.** Alongside better transport pricing, we need to improve transport alternatives such as public transport, walking and cycling to make it easier for people to change their behaviour to avoid prices and move to low emissions transport options.
- **Pricing to pay for water infrastructure.** Charging to match the water we use will reduce the cost for low users, encourage more careful use and reduce the need for costly new infrastructure.
- **Encouraging water conservation.** Alongside changes to water pricing, we need to make it easier for people to conserve water. For instance, we can make it simple and straightforward to install rainwater harvesting and promote toilet flushing with grey non-drinking water.

The potential

A pricing system that better reflects need and provides for options, spreads the load on our infrastructure more evenly. Using our busiest roads at peak times comes with a cost, but journeys are quicker when we need to use them. At the same time, there are better options, like rapid transit, walking and cycling, so we can save money and time by leaving the car at home. We don't have hefty increases in rates, as our water networks don't face the same strain and we only pay for the water we need. If we take steps to save water, like using a rainwater tank to water the garden, we know it's going to save us money in the long term.

To achieve a thriving New Zealand, we need a world class infrastructure system.

To deliver on our aspirations and the possibilities for infrastructure, we require a different approach for managing our resources, including the decisions we make and the capital, labour and technologies we use. We need to work toward best practice, providing stewardship over the resources we have and investing in outcomes that are fair for all New Zealanders. To achieve this, system-wide change is needed across five areas:

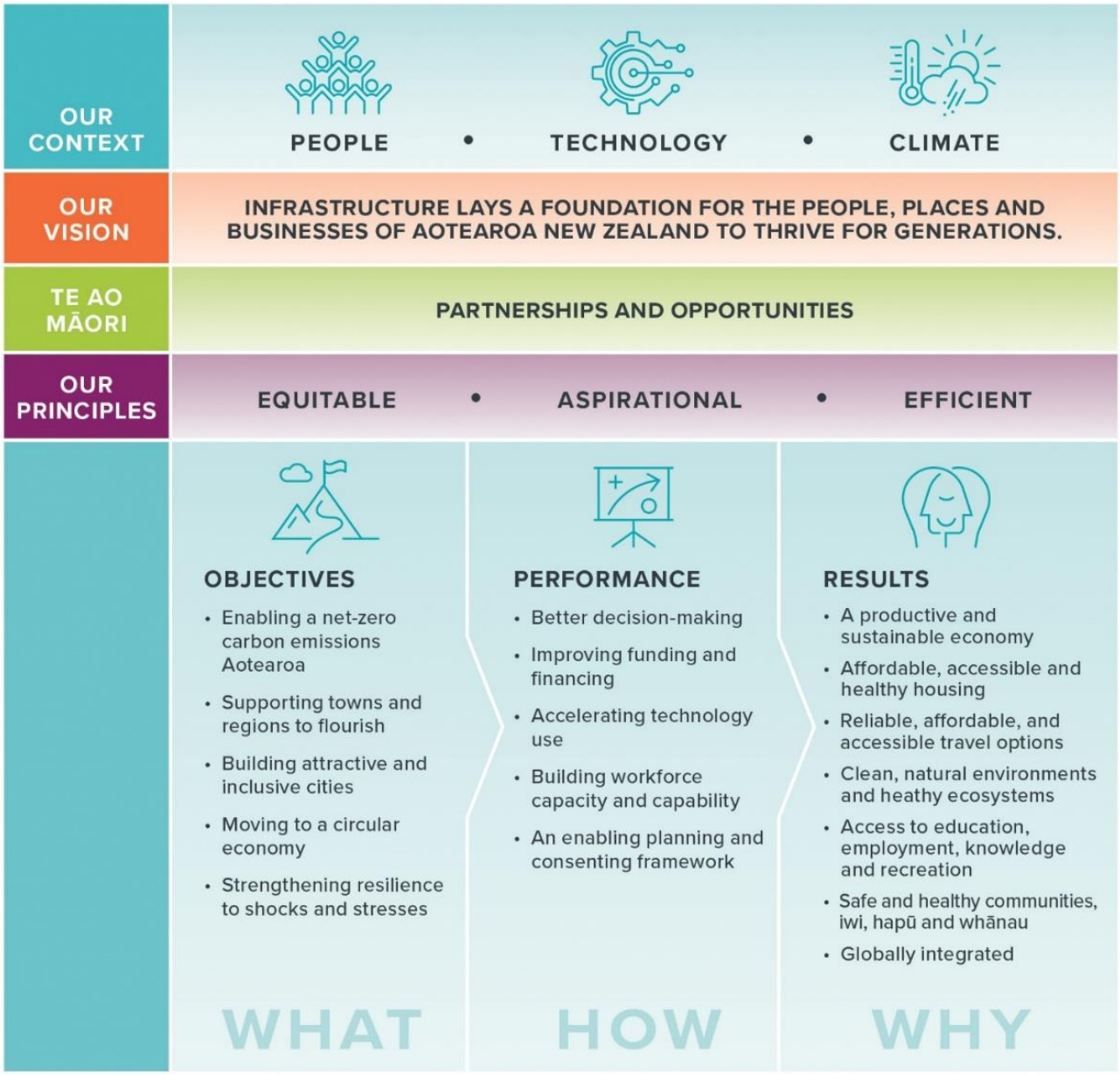
1. **Better decision-making:** There are many things we could invest in, but we cannot invest in everything. We need decision-making that has a relentless focus on selecting the infrastructure that will create the most value for New Zealand.
2. **Improving funding and financing:** Our infrastructure needs adequate funding and access to financing opportunities. In doing so, we need to make the best use of infrastructure pricing that enables demand management, while managing disadvantage, using a comprehensive appraisal of social assistance measures.
3. **An enabling planning and consenting framework:** The infrastructure system requires a planning and consenting system that is strategic, coordinated and commensurate to the urgency of the challenge. It should recognise the unique role infrastructure plays in our collective wellbeing and be enabling of the sustained infrastructure build necessary to meet national objectives.
4. **Accelerating technology use:** Technology is rapidly changing and this has the potential to improve infrastructure delivery. We need to accelerate the adoption and widespread use of technological and digital change across infrastructure industries. This requires a greater focus on open data and adoption of digital technologies to improve productivity and enhance infrastructure planning, delivery and operation.
5. **Building workforce capacity and capability:** We need the right people, at the right time, with the right skills to meet our infrastructure possibilities. Currently, we face an historic workforce shortage across all aspects of infrastructure delivery. Development of a credible infrastructure pipeline and list of priority projects will provide industry with more certainty to invest in worker training and

retention. Improving workforce diversity and safety across the infrastructure sector must also be a priority.

By streamlining our infrastructure systems and processes, we can make better decisions and implement them with the urgency needed to meet our current challenges, as well as those we will face over the next 30 years.

Blueprint for action.

This strategy follows a blueprint for action. This begins by identifying our infrastructure challenges and opportunities, which provides the context for action. Beneath this sits our vision and principles and across everything we do is the need to ensure Te Ao Māori has a part in all aspects of our infrastructure system. Through this framework, the strategy sets objectives for a thriving Aotearoa, recommendations for how we achieve these and the results we can expect.



Source: Te Waihanga

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1. Introduction

Kupu whakataki

What is infrastructure?

Infrastructure is made of layers of connected systems and networks.

These deliver the services we depend on like power, water, transport, healthcare, and education. What is the common factor amongst all of this infrastructure? It allows us to share resources so that we can be more connected, healthier, smarter and innovative. In doing so, it improves our lives in many different ways and contributes to the wellbeing of all New Zealanders.

Figure 2: The infrastructure layers

Source: Te Waihanga, adapted from Cambridge University, Flourishing Systems.

Infrastructure can be categorised in many different ways.

One way is to think of it in terms of economic and social infrastructure and the natural environment (see Figure 2).[1]

Economic infrastructure: This is our energy, telecommunications, transport, waste and water infrastructure.

Social Infrastructure: This is our hospitals, schools, prisons, parks, libraries and community buildings.

Natural environment: There are interconnections and interdependencies between economic and social infrastructure and the natural environment.

Infrastructure has unique features that make it different from other goods and services.

These features relate to how infrastructure is made and how it is used. This affects how infrastructure is funded and how the organisations that provide it are structured and operate. All infrastructure sectors share these features to some degree:

- Infrastructure is **intergenerational**. With good maintenance, infrastructure assets may last for over a century.
- Infrastructure investment is **lumpy** as it involves large up-front costs to develop and upgrade.
- Infrastructure can be **interconnected** and **interdependent**. For instance, a new water pipe can only supply a home with drinking water if it connects to other water pipes that link it to a water source. A hospital can't function without electricity and wastewater.
- Infrastructure often provides **shared services** to a large number of people. For example, when a residential power line fails, every home served by that line loses power.
- Infrastructure generates **spill-over effects**. For example, a new road or a passenger transport service can make an existing road quieter or busier. It may also make it quicker to get to a hospital or to work.

We often think of infrastructure in terms of sectors, like transport, water, electricity, telecommunications, health, education and waste.

While there are many common features between infrastructure sectors, there are some important differences. Telecommunications and energy infrastructure are operated commercially, with funding sourced from charging consumers. Their investments are financed from private sources and independent regulators constrain their revenues and/or prices. In contrast, water, transport, education and health infrastructure are primarily operated as non-profit public entities and are funded mainly through taxes and rates or user charges set by local and central government.

Why we need an infrastructure strategy

We need an integrated and holistic view of the infrastructure system.

New Zealand has a large number of organisations responsible for many different parts of the infrastructure system and lifecycle. To get the most out of our infrastructure, both for the present and the future, we need to look across the whole system, rather than just at any one part. Unlike many countries, New Zealand has not had, until now, an organisation or strategy that takes this system-wide perspective.

This strategy takes this more holistic view of the infrastructure system. It also takes a long term horizon and in doing so, recognises that 30 years is not a long period of time in the lifecycle of most of our infrastructure. A 30-year horizon requires us to think about trends such as technology advancements, our changing climate and population change and the impact these will have on infrastructure decision-making over the coming years and decades.

A long term, integrated framework provides direction for planning and action.

This longer term view focuses our attention on the opportunities and challenges for our infrastructure both now and over the next 30 years. Trade-offs will inevitably need to be made to get the balance right between what we can afford, what we expect our infrastructure to provide and the impacts it has on our communities and our environment. We can't have everything. These trade-offs need to be guided by a framework that provides direction for planning and action.

The impact COVID-19 has had on infrastructure

COVID-19 has changed how we use infrastructure to connect.

Infrastructure is constantly required to respond to a range of shocks and stresses. These are often unforeseen or unexpected. The most recent of these is the COVID-19 pandemic. The pandemic has forced us to rethink how we live our lives and how we use infrastructure to connect and get around.[2] Initially, the pandemic led to uncertainty in the infrastructure pipeline, with projects cancelled or

delayed. Infrastructure was seen as an important channel for economic stimulus, with the government announcing numerous infrastructure programmes to sustain demand and support employment.

The first level 4 lockdown resulted in a sudden and abrupt change in usual patterns of commuting and working arrangements. Public transport usage declined substantially, leading to a funding squeeze for local and regional government.[3] Local government non-rates income, such as from council controlled organisations, investments and dividends, was affected. In some cases, this has resulted in reductions and deferrals in infrastructure expenditure.

COVID-19 also became a reminder of the importance of reliable, safe and efficient supply chains. Global supply chain disruptions have been common, with widespread impacts on global airports and air freight.[4] This has added to the cost of freight,[5] increasing lead times and lowering inventory levels. Many of these impacts are expected to continue for some time.[6] For many suppliers, traditional models of consumer shopping have been replaced with home delivery.[7]

Tourism patterns have changed dramatically and abruptly. The loss of international tourism was estimated to have a significant drag on domestic output,[8] with subsequent impacts to accommodation, hospitality, transport, education and retail sectors. Domestic tourism proved to be an important shock absorber to a drop in global demand. Despite this, international airports and the national airline have also been severely impacted with government assistance necessary.[9] Net migration fell dramatically,[10] putting pressure on labour markets that relied on international expertise, especially construction and engineering.

For many sectors, the pandemic has stimulated an acceleration in the use of telecommunications as a substitute for traditional infrastructure services.

This was most obvious in the health sector where 17 district health boards collectively experienced a 100-fold increase in telehealth consultations, to 34,500 per week.[11] Many education providers were moved online, as were many employees, showing how telecommunications infrastructure can provide an important substitute for physical proximity. After the initial COVID-19 community outbreak, our borders have remained largely closed and there is now greater emphasis on skills shortages, rising costs and the potential for increasing interest rates.

COVID-19 has had significant implications for infrastructure across many sectors. It has impacted short term patterns of infrastructure usage and there is considerable speculation about how we might use infrastructure differently in the future.[12] From an infrastructure perspective, it is a reminder of the importance of a resilient, flexible and agile system. This strategy takes a longer-term perspective to complement shorter-term recovery investment, focusing on how we can better support resilience to shocks of this kind in the future.

What we have heard and learnt

We have read, listened to and thought about a lot of information to develop this strategy.

We have undertaken both a bottom-up, consultation-led approach and a top-down process, where we've learnt from the work of others, such as the Climate Change Commission, the Productivity Commission and the Resource Management Review Panel. We have also learnt from:

- 23,638 responses and 8,500 comments on our Aotearoa 2050 Survey.
- 119 organisations that responded to our Infrastructure Asset Owners Survey.
- Four meetings with iwi, as well as the University of Waikato's Te Kotahi Research Institute.
- Nine stakeholder workshops.
- 112 attendees at our symposium, and a further 174 watched online (see the range of ideas suggested by attendees, illustrated in
- Figure 3).

- 721 submissions on our consultation document.
- 80 stakeholder meetings.
- Te ao Māori testing panel.
- Local Government Reference Group.

Our strategy and our recommendations draw on ideas and work from all of these sources.

The infrastructure system is complex and exists in a rapidly changing world. We need to be flexible and adaptable to change and understand the infrastructure implications. In recognition of this rapidly changing environment, the strategy will be revised at least every five years. It is the beginning of a much longer term, ongoing conversation with all New Zealanders.

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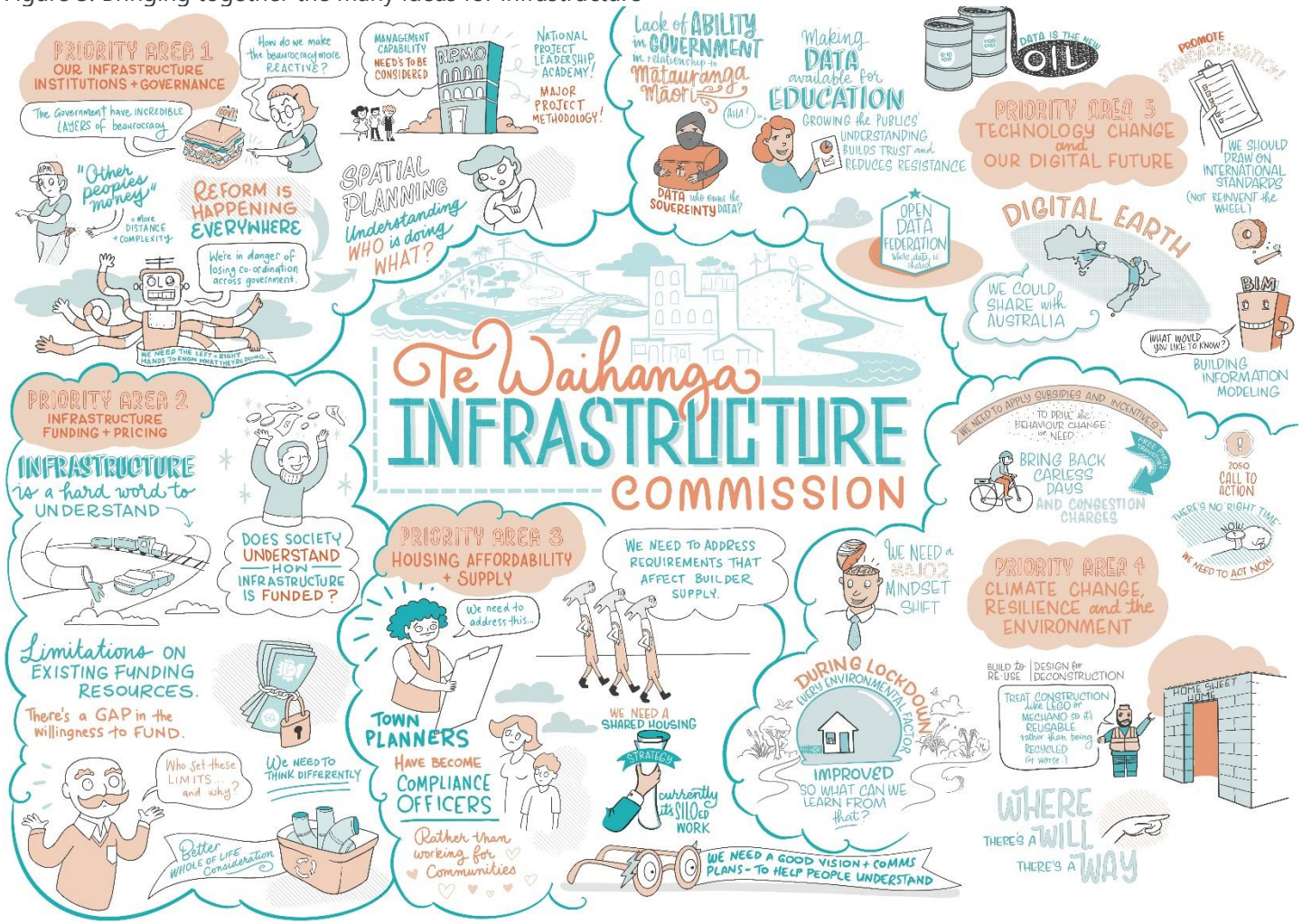
Figure 3: Bringing together the many ideas for infrastructure



Source: Te Waihanga

2. Vision for infrastructure

He tirohanga mō te Hanganga

Infrastructure for a better future

The decisions we make about our infrastructure will shape the way we live for generations.

This strategy learns from the lessons of the past and looks to the future, planning ahead to ensure our infrastructure helps us to meet the challenges we'll face.

> **"Ki te kahore he whakakitenga ka ngaro te iwi –**
> without foresight or vision the people will be lost."
>
> Kingi Tawhiao Potatau te Wherwhero

It looks at the role our infrastructure system has on our wellbeing. This includes its importance to our economy and our jobs, but places equal importance on its contribution to our society, culture and environment. There are few parts of our lives that don't rely on infrastructure.

It recognises Te Tiriti o Waitangi (the Treaty of Waitangi) as the constitutional foundation of Aotearoa, and it draws on concepts of te ao Māori to think about infrastructure from the broad perspectives of wellbeing (oranga), kaitiaki (guardianship and stewardship), integration, longevity and connection to place.

From this perspective, the vision for the strategy is:

Infrastructure lays a foundation for the people, places and businesses of Aotearoa New Zealand to thrive for generations.

E whakatakoto ana te hanganga i te tūāpapa o te ora o te tangata, o ngā wāhi, me ngā pakihi o Aotearoa kia ora rawa atu mō ngā whakatupuranga.

Infrastructure is a foundation for wellbeing.

Looking to 2050, we aim for an infrastructure system that supports wellbeing through:

- A productive, sustainable and carbon-neutral economy.
- Affordable, accessible and healthy housing.
- Reliable, affordable and accessible travel options powered by renewable energy.
- Clean natural environments and heathy ecosystems.
- Access to education, employment, knowledge and recreation.
- Safe and healthy communities, iwi, hapū and whānau.
- A globally integrated economy.
- Resilience to the stresses and shocks the future will inevitably bring.

We are looking to a future where our infrastructure keeps pace with population and economic growth and gives New Zealanders the services they expect. Infrastructure isn't the only contributor to a better future, but it is a foundation that underpins collective wellbeing.

Guiding principles

We have used three guiding principles to develop this strategy; equitable, aspirational and efficient.

Principle	Description	What it can mean
Equitable	We acknowledge that our generation holds the environment in common with other generations, past and future. We promote development that meets the needs of the present without compromising the ability of future generations to meet their own needs. We promote infrastructure that enhances wellbeing for all New Zealanders, including the vulnerable and remote.	• Invest in long-lived infrastructure • Plan for cities that are multiples of their existing size • Use debt to distribute costs over time • Enable sustainable growth and mitigate the effects of climate change • Infrastructure is paid for by those using it • Identify mitigations for vulnerable groups • Diversity across infrastructure industries • Identify opportunities to empower Māori • Integrate land use and infrastructure to maximise access for all
Aspirational	We utilise the smartest minds and look to international best practice to identify and optimise solutions. We collaborate and coordinate across organisations and regions to get the best result for New Zealanders. We set aspirations to focus on improving wellbeing and enabling people to thrive.	We aspire to: • A net-zero carbon economy • 30-minute cities • Universal access for digital services • Zero landfill waste • Zero lives lost from natural disasters
Efficient	We aim for maximum value with minimum wasted effort or expense. Our infrastructure decisions provide value for money. We draw upon compelling evidence to inform trade-offs for New Zealanders. We rapidly adopt and diffuse new technologies.	• Maximise potential of existing infrastructure • Rigorous cost benefit analysis • Balance economic, social and environmental objectives • Minimise waste and conserve resources • Build and disseminate evidence base • Invest for resilience to shocks and stresses • Identify opportunities to drive productivity growth

3. Case for change

Hei Tautoko i te Panonitanga

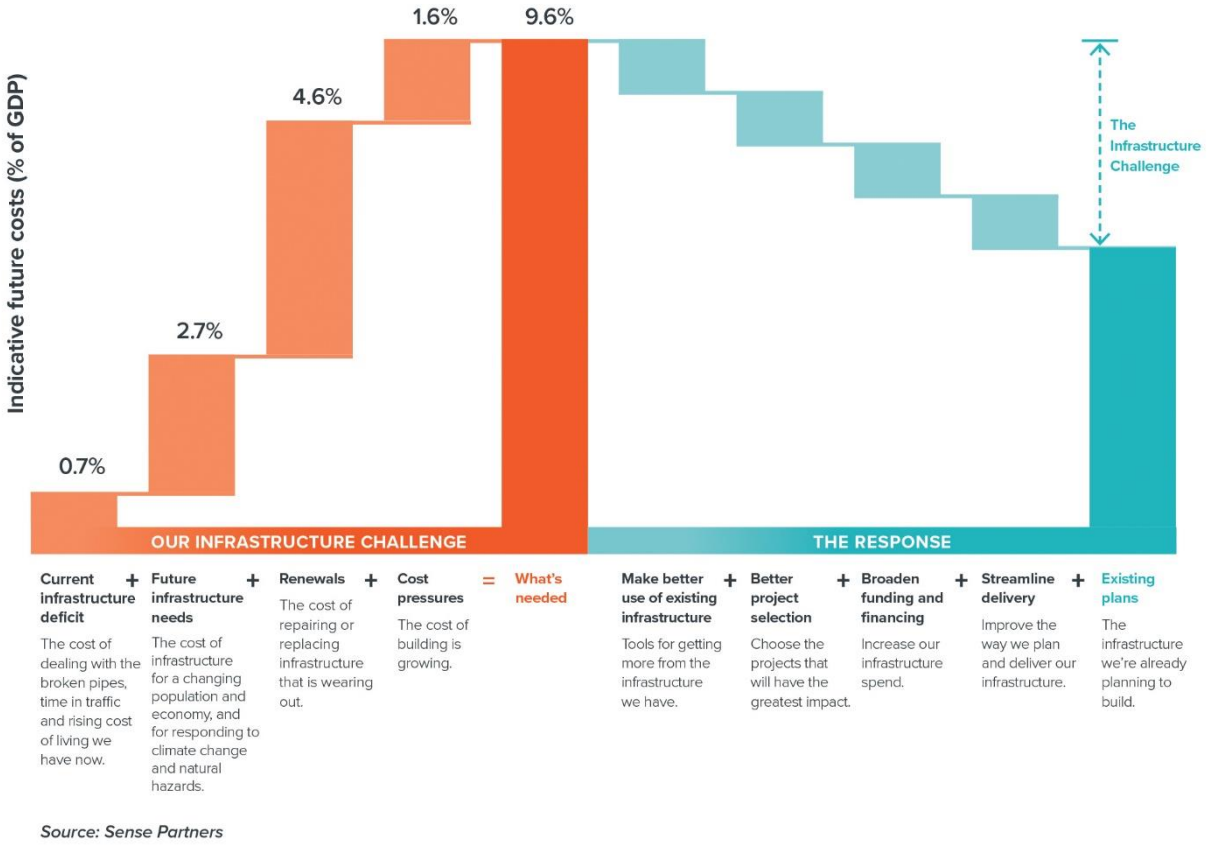
The challenge

New Zealand's infrastructure faces many challenges.

For example, long term trends such as climate change, will have a significant impact on many parts of our infrastructure system. Our population is increasing and changing, which will affect the quantity and quality of the infrastructure we need. And construction costs have been increasing, which places pressure on infrastructure budgets. We have an opportunity to overcome these challenges by taking a new approach to planning, delivering, maintaining, funding and financing infrastructure.

Figure 4 shows the areas where we will need to do better if we are to achieve our vision for infrastructure. The orange section on the left shows the infrastructure challenges we face, while the blue section on the right contains the tools that enable change.

Figure 4: The challenge, the response



Source: Sense Partners

We can't build our way out of every infrastructure challenge.

At present, we spend around 5.5% of GDP on public infrastructure. This includes our transport, water, hospitals, education and defence facilities (but excludes privately provided infrastructure like electricity generation and telecommunications).

If we attempt to build our way out of current and future infrastructure challenges, it will cost around 9.6% of GDP over a 30 year period (equivalent to around $31 billion per year) and almost double what we currently spend. This is caused by several factors, which are set out below.

Historical infrastructure deficit: New Zealand has under-invested in infrastructure in the past, resulting in lower service quality and congested infrastructure. We also lack the infrastructure we need to support housing growth. We estimate that the new investment needed to meet this challenge would cost 0.7% of GDP every year over a 30 year period.

Population and economic growth: New Zealand's population is growing rapidly. It is predicted to rise from 5 million to 6.2 million people by 2048, even assuming that migration slows down.[13] Population and economic growth requires new roads, a rapid transit system, water systems for growing cities, freight and port infrastructure for growing economic activity, as well as trade and telecommunications infrastructure to connect us to each other and to the rest of the world. We estimate that the infrastructure needed for population and economic growth would cost 1.8% of GDP every year over a 30 year period, in addition to the above need.

Improving infrastructure quality: We often expect more from our infrastructure than we did in the past. We expect more reliable public transport, safer cycling and walking options, better maintained roads and cleaner water. This requires the quality of our infrastructure to improve. We estimate that addressing demands for improved infrastructure quality solely through new investment would cost 0.7% of GDP every year over a 30-year period, in addition to the above needs.

Adapting to climate change and recovering from earthquakes: We will need to rebuild, strengthen, or relocate infrastructure in response to our changing climate and to recover from natural disasters, like floods and earthquakes. There is for example, a 75% chance that the Alpine Fault will rupture over the next 50 years, which is likely to trigger an earthquake of magnitude 8 or higher.[14] We estimate that adapting our infrastructure to climate change and repairing infrastructure after earthquakes will cost at least 0.2% of GDP every year over a 30-year period, in addition to the above needs.

Maintaining and renewing infrastructure: Our infrastructure comes with an ongoing cost. For every $100 we spend on new infrastructure, around $60 must be spent to repair and renew worn-out infrastructure. We estimate that the cost of maintenance and renewals could be up to 4.6% of GDP every year over a 30-year period, in addition to the above needs.

Cost pressures: The cost to build infrastructure has been rising more rapidly than costs in other sectors of the economy. It is currently difficult for the construction industry to hire the people and skills it needs to meet increasing demands. This situation is made worse by uncertainty about future investment plans, which discourages companies from investing in skills and machinery, as well as the increasing complexity of our projects, slow and costly consent processes, and competition for labour from an infrastructure boom in Australia, where wages are considerably higher. Unless we address them, these trends mean that we will have to spend more to get the same results. We estimate that these cost pressures will add an additional 1.6% of GDP to our infrastructure costs every year over a 30-year period, in addition to the above needs.

The response

We have an opportunity to improve the way we plan, fund and deliver our infrastructure.

It won't be enough to simply keep doing what we've always done if we want to keep up with our expectations for life in New Zealand. While we will need to invest and build more, this will only be one part of the solution. We can also be smarter in how we plan, deliver and use our infrastructure. We have identified four ways of achieving this:

- Make better use of infrastructure.

- Better project selection.
- Broaden funding and financing options.
- Streamline delivery.

Make better use of infrastructure.

We need to make greater use of both the infrastructure we already have and the new infrastructure we build. We can spread the load on our roads, water networks and other infrastructure through tools like education, regulation, pricing or design, which encourage people to use alternatives or avoid using them at peak times.

This could mean improving bus services so there are fewer cars on our roads, upgrading water pipes to reduce leaks, or by requiring flexibility in zoning policy so more houses are built in areas where there's already infrastructure in place.

More examples of how we can make better use of existing infrastructure are set out in Table 1.

Better project selection.

Infrastructure is too expensive to get wrong. We need to make better decisions so we can be confident that the infrastructure we do build will help solve the problems we face. We can:

- Plan and prioritise the projects we're going to invest in as a country.
- Follow a robust business case process that means we choose the right projects.
- Put frameworks in place to ensure we're always testing other options first, including solutions that don't require construction.

Our project selection process must be robust, replicable, transparent and deliver value for money.

Broaden funding and financing options.

New Zealand lacks a lot of the important infrastructure we need. To address this, we need to increase the amount that both the government and private sector spends on infrastructure over the next 30 years. This will also mean using a broader range of funding and financing options, which could include:

- New funding tools like congestion charging.
- Making greater use of existing tools and debt funding.
- Using debt funding to ensure intergenerational equity.
- Considering alternative models that take greater advantage of private capital.

Funding represents all the money needed to pay for infrastructure. It comes from the community through users, taxpayers or ratepayers. In contrast, **financing** is about when we pay for our infrastructure. It could mean using cash surpluses now or borrowing from sources we need to service and repay later.

We will have to look at the best structures for ownership and governance as part of any funding and financing arrangements.

Streamline delivery.

The scale of our challenge means we need to get faster and more efficient at building infrastructure or else we'll always be on the back foot. Some options for this include:

- Improving our infrastructure institutions and governance to provide greater coordination.
- Investing in early-stage planning, for example spatial planning and corridor protection, to speed up processes for approval and buying land.
- Partnering with Māori through a range of options including collaboration, co-design and co-governance.

- Standardising procurement rules, using prefabrication and supporting the construction sector in training people and improving their processes.

These are steps that can deliver our infrastructure more quickly and improve the results, giving New Zealanders better services at lower cost.

All of these responses are needed to solve the infrastructure challenge.

Each response can make a big difference in solving New Zealand's infrastructure challenge, but the size of the problem is too large for any one action to be enough by itself. We will need to use all four to make a difference.

Table 1: Examples of better use of existing infrastructure

CATEGORY	HEALTH AND EDUCATION	TRANSPORT	WASTE	ENERGY	WATER
DESIGN	Primary and preventative care Digitalisation of health services	Build houses close to work and amenity Integrated traffic and parking management	Product stewardship to reduce waste Second-hand stores	Energy efficiency measures (home insulation, double glazing) Generation close to load, including distributed energy resources	Reducing network leakage Rainwater harvesting
EDUCATE	Health warnings on cigarette packages	Real-time information on travel speeds	Education to reduce recycling contamination	Energy efficiency technology demonstrations to the business sector (conducted by EECA	Behaviour change programs to encourage conservation
REGULATE	Covid-19 elimination strategy Speed limits and road policing	Convert parking to public transit Low emission zones in city centres	Banning hard to recycle products	Information disclosure regulations regarding generation "fuel" stocks	Water performance standards for appliances
PRICE	Cigarette tax	Congestion charging Discounted off-peak public transport fares	Increase waste levy	Real time spot market pricing Discounted off-peak pricing by electricity distributors	Volumetric water charging

Infrastructure is about choices

We have choices about how we address the infrastructure challenge, but these involve making trade-offs.

Because we have limited resources to build, operate, maintain and renew infrastructure, we cannot invest everywhere at once. Improving infrastructure in one area can mean leaving needs unmet in another. Careful prioritisation of investment is needed when deciding where, when and how much to invest.

When faced with options to manage congestion on a network for instance, an operator may consider the use of peak pricing to spread the load across time and avoid expensive new physical assets and ongoing operational costs. This is an example of a lever that makes better use of existing infrastructure. It can be an effective way to manage costs. For instance, Transpower estimates that without a peak-demand charge for transmission, the scale of physical investment would need to be around 2-9% larger.[15] Pricing strategies can be difficult to implement for public infrastructure however, meaning either lower service quality for communities (for instance, rising traffic congestion), or greater infrastructure investment, which comes at a cost to users or taxpayers.

In this way, decision-makers face choices between the appropriate response (better use of existing infrastructure, project selection, delivery and funding and financing) and the service quality that communities experience. If we select bad projects, then the funding required to address our infrastructure challenges may be larger. If we deliver projects inefficiently or slowly and we do not make better use of existing infrastructure, service quality may fall. Depending on the nature, reach and network of infrastructure, these trade-offs can impact local communities, cities, entire regions, or the whole country.

This strategy assumes that we'll need to improve how we use all four responses to maintain and increase the value we gain from infrastructure.

The broader policy environment

This strategy is consistent with the government's broader Economic Plan.

The government's broader economic strategy, called the Economic Plan, aims to tackle long term challenges facing the New Zealand economy to improve the wellbeing and living standards of all New Zealanders. It contains four economic priorities and eight key shifts to build a more productive, sustainable and inclusive economy.[16] This Infrastructure Strategy overlaps and is consistent with the following core tenets of this Economic Plan:

- **Grow and share New Zealand's prosperity more fairly.** Our strategy highlights opportunities to grow the economy and it recommends system-wide change to increase infrastructure productivity and improve access for all New Zealanders.
- **Transition to a clean, green, carbon-neutral New Zealand.** Our strategy focuses on the critical importance of enabling a fast-paced and sustained build of energy infrastructure to provide low-emissions energy. It also identifies key steps to make the right infrastructure choices and minimise carbon emissions from building new infrastructure.
- **Support thriving and sustainable regions.** Our strategy emphasises that infrastructure plays a critical role in enabling the regions to play to their strengths. It identifies the challenges with regional infrastructure and recommends key steps to address them, with a particular focus on closing disadvantage by improving access to employment and social infrastructure, enhancing social cohesion and reducing living costs for those in more isolated locations.

- **Deliver responsible government with a broader measure of success.** Developing a world-class infrastructure system is a key focus of our strategy. In particular, it highlights the need for strong leadership and better decision-making.

The government has several policy reviews and reforms underway which will have big impacts on our infrastructure sectors.

They include:

- Resource Management Reform.
- Responses to climate change adaptation and mitigation.
- Three Waters Reform.
- Health and disability sector reform.
- Review into the Future for Local Government.
- Emergency management reform.
- Review of waste legislation and waste strategy development.

These reviews and reforms are likely to affect the way infrastructure is consented, delivered, owned and governed. The impacts of these reforms on infrastructure are still evolving, but a key challenge will be ensuring they are consistent and coordinated from an infrastructure perspective. As the government's lead infrastructure advisor, Te Waihanga provides advice to the Minister for Infrastructure on many of these reforms.

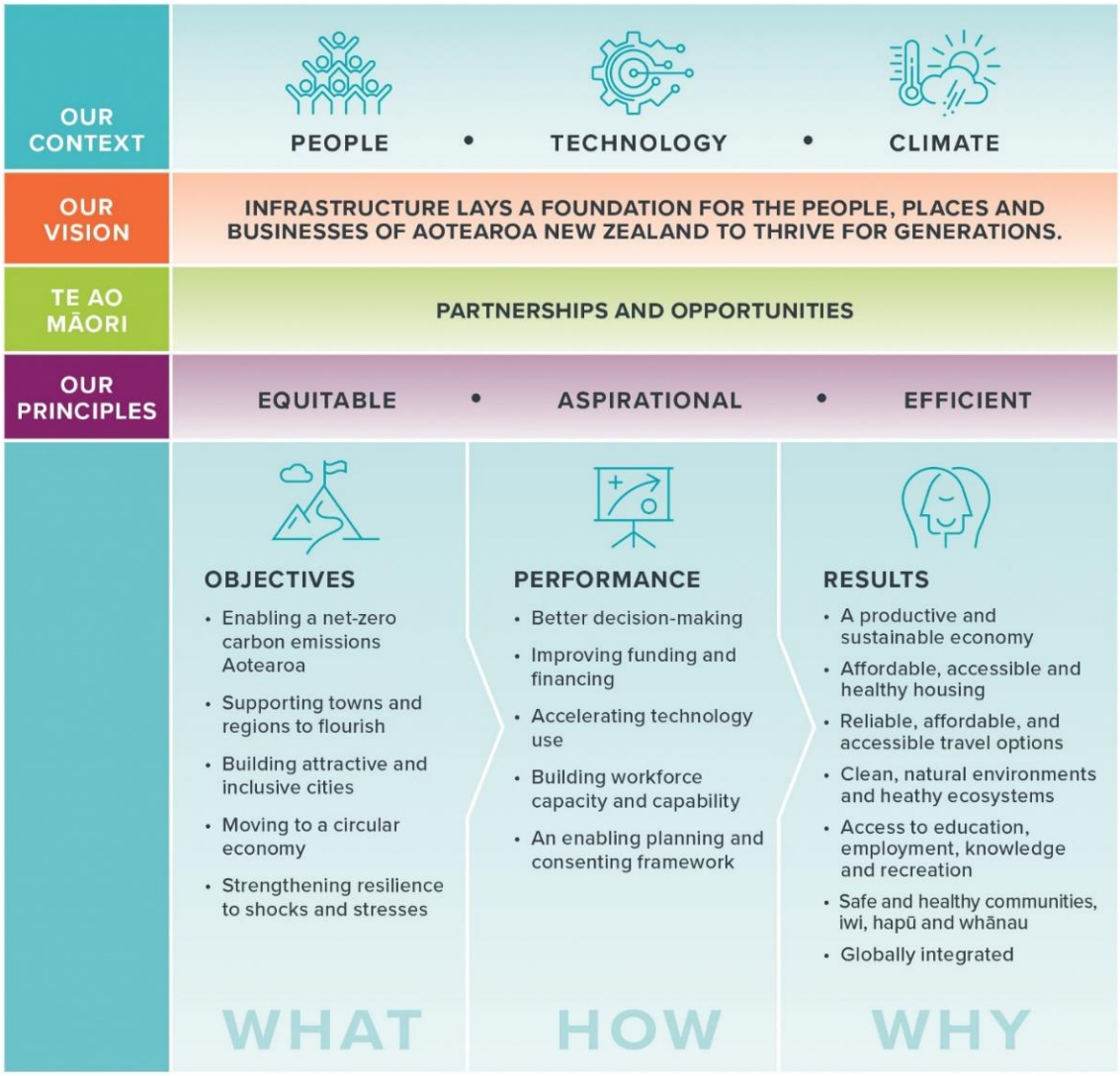
4. Blueprint for action

He mahere hei whakatutuki

This strategy sets a course to navigate significant transformation across New Zealand. As our demographics, technology and climate are changing, we also will need to change. To achieve our ambitions for New Zealand to thrive, the strategy Blueprint sets five key objectives. We envision a New Zealand that is responding to the challenge of net-zero carbon emissions, where our cities and regions are attractive, inclusive and flourishing, where our economy is sustainable and where we are resilient.

This requires a different approach for managing our resources, including the decisions we make and the capital, labour and technologies we use. We aspire to best practice, providing stewardship over the resources we have and investing in outcomes that are fair and recognising of all New Zealanders. In making the transition, we recognise and respect Te Tiriti o Waitangi and look for opportunities to build strong, meanignigful and enduring relationships with Māori. There is much at stake. If we get it right, we will have the ingredients for a productive, sustainable and globally integrated economy, where New Zealanders are healthy, with access to opportunities and able to protect the environment for a future generation of Kiwis.

Figure 5: Blueprint for action



5. Strengthening partnerships and opportunities for Māori

Te Whakapakari i ngā Pātuitanga me ngā Āheinga mō Ngāi Māori

We recognise and respect Te Tiriti o Waitangi. By building strong, meaningful and enduring relationships with Māori, we can ensure our infrastructure works for everyone.

The way Māori interact with infrastructure is growing and evolving.

Māori are users of infrastructure, relying on the services it provides to access work, recreation and education, as well as opportunities for business and entrepreneurship. Māori are also involved in building infrastructure, with 11% employed in the construction sector.[17] Increasingly, Māori are also investors, developers, partners, governors and owners[18] (see Figure 6).

Figure 6: The many roles of Māori in our infrastructure system

Source: Te Waihanga

In these roles, Māori bring a depth of knowledge, experience and values that can expand the knowledge base of infrastructure providers. The challenge for the infrastructure sector is to build mutually empowering relationships with Māori that enrich the sector's knowledge base, develop partnerships and unlock opportunities for Māori.

A strategic approach is needed to build mutually empowering relationships.

These mutually empowering relationships must be based in agreed values and principles. We've drawn on those established in Te Ara Kotahi (Waka Kotahi's Māori Strategy) [19] as a basis for a proposed approach (see Table 2).

Table 2: Te Ara Kotahi (Waka Kotahi's Māori Strategy)

Ngā Uara - Values	**Mātāpona - Principles**
Rangatiratanga: We recognise and respect the individual autonomy and authority of Māori. We respect each other as partners and therefore value each other's aspirations, positions, roles and expertise. **Manaakitanga:** We exercise care and the work we do should be mana enhancing and supportive. **Kaitiakitanga:** We recognise that the environment is a taonga that must be managed carefully. We also recognise that Māori have a responsibility and obligation of care over their communities and environments. **Whanaungatanga:** We foster meaningful and enduring relationships based on good faith, mutual respect, understanding and trust. **Te Tiriti ō Waitangi:** We recognise, respect and uphold the principles of Te Tiriti o Waitangi. **Mana o Te Reo Māori:** Te Reo Māori is highly valued. We actively promote Te Reo Māori within the work we do.	**Huna Kore:** We value a no surprises approach and information flows both ways. **Auahatanga:** We will focus on creativity and innovation to achieve better outcomes. **Whakapono:** We act with integrity and honesty. **Partnership:** We will act reasonably, honourably, and in good faith. **Participation:** We will encourage and make it easier for Māori to more actively participate in our business. **Protection:** We will take positive steps to ensure that Māori interests are protected as appropriate. **Recognition of cultural values:** We will recognise and provide for Māori perspectives, tīkanga (customs) Te Reo Māori and kawa (protocols) in the work we do.

Three areas are prioritised for action: stronger partnerships, unlocking opportunities and incorporating mātauranga Māori

Drawing on Waka Kotahi's framework, we have prioritised three areas for action:

- Creating stronger partnerships with Māori across infrastructure planning and delivery.
- Unlocking opportunities for Māori across the infrastructure system.
- Incorporating mātaruanga Māori into infrastructure design, planning and delivery.

These weave across all aspects of this strategy (see Figure 7).

Figure 7: Weaving Māori objectives across the strategy

Source: Te Waihanga

Strengthening partnerships with Māori.

Across infrastructure planning and design, a partnering approach ensures that Māori values and aspirations are reflected in an infrastructure project from the beginning. This might involve deciding on the location of a hospital, recognising and supporting the potential for iwi investment, or understanding the way changes to a water network might impact the mauri of local waterways. In these ways and many more, partnering with Māori can ensure that a project has the greatest benefit for the community it's designed to serve, unlocking economic, environmental, social and cultural benefits.

Strengthening partnerships requires effective engagement that starts early, uses best practice and is proportional to the issue, nature and strength of Māori interests. It must also recognise and provide for cultural heritage, identity and mātauranga Māori.

We must provide the time and resource for partnerships. Many iwi suffer from intense demands on their time, which is often given voluntarily, as they are invited to consult and partner in an increasingly complex environment. The government is currently leading major reform across water, health, and local government, as well as historic levels of infrastructure investment. This places a significant burden on iwi resources, time and personnel. At the same time, many government agencies and infrastructure providers have varying understanding or capability to engage with Māori. For these reasons, it will be important to build capacity and capability throughout the infrastructure system, as well as within iwi for a partnering approach to succeed.

Unlocking opportunities for Māori.

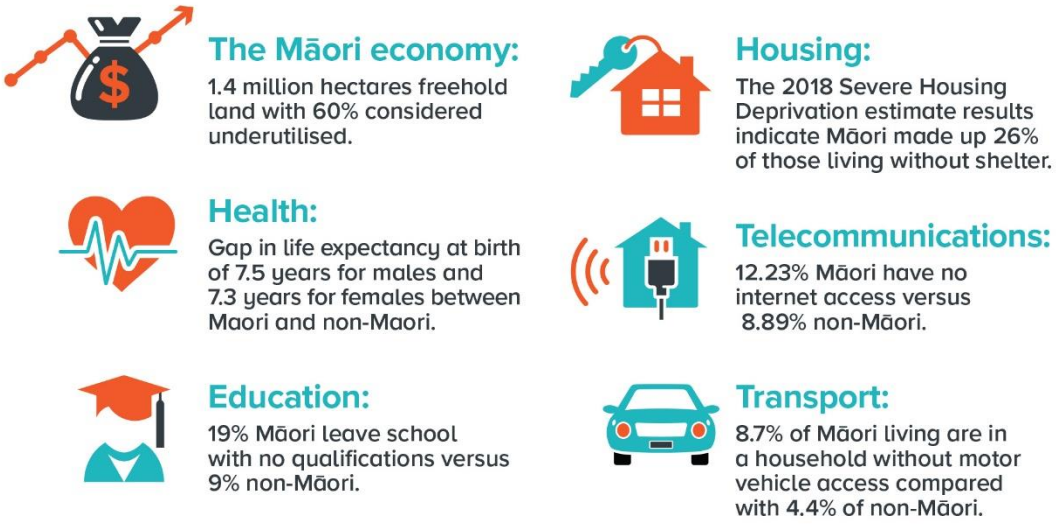
Infrastructure can have a major impact on wellbeing, whether it's providing access to hospitals and schools, powering our workplaces, or creating jobs in building. However, we know that the outcomes for Māori in many of our infrastructure sectors are poor (see Figure 8) and it's important to identify opportunities where infrastructure can have a role in improving Māori wellbeing. Some of these include:

- Caring for the environment and supporting Māori to exercise kaitiakitanga.
- Promoting employment opportunities[20] [21] (see for example Case Study 19: City Rail Link - Māori and Pacific peoples cadetships in Section 7.5).
- Improving diversity across the infrastructure workforce (see Section 7.5).
- Enhancing social wellbeing through access to infrastructure services, such as through telecommunication services that improve connectivity in places that Māori live, transport

infrastructure that brings employment opportunities closer and education that improves economic opportunity.

- Establishing an effective process for partnership within regional spatial plans (see Table 3: Spatial planning in Section 6.2).
- Identifying opportunities in the transition to clean energy required to deliver net-zero carbon emissions and informing a fair transition (see Section 6.1).

Figure 8: Māori outcomes can be improved across our key infrastructure sectors



Source: Climate change commission, Statistics New Zealand, Māori Futures, Ministry of Health, digital.govt.nz

Incorporating mātaruanga Māori into infrastructure design, planning and delivery.

Mātauranga Māori, the knowledge, skills and concepts developed by Māori over centuries of living in Aotearoa, has made important contributions to health, social policy and many other fields. However, the potential for mātauranga Māori to contribute to the development of infrastructure is only just being realised within the sector. We can work to grow information and advice about how mātauranga Māori informs infrastructure planning, policy and delivery, as well as decision-making on infrastructure priorities.

Strengthening the mātauranga knowledge base requires a research agenda. This can draw on best practice from previous projects (see Case Study 1 below). Building a strong evidence base of what works will support better strategy, planning and project delivery across the system and for the benefit of future generations.

Case Study 1: Te Ahu a Turanga-Manawatū Gorge Bypass

A major slip in April 2017 left State Highway 3 through the Manawatū Gorge impassable. A new road is being built over the Ruahine Range, to provide a safe, resilient and efficient route between Woodville and Ashhurst (the Bypass). The approximate project value is greater than $600 million.

Early in the planning phase for the Bypass, key Waka Kotahi managers recognised the value iwi could bring to this project. They established partnership relationships with local iwi (Ngāti Kahungunu ki Tāmaki nui-a-rua, Ngāti Raukawa/Ngāti Kauwhata, Rangitāne o Manawau, Rangitāne o Tamaki nui-ā-rua). Iwi wanted the Bypass in order to address safety and wellbeing for their members crossing between Manawatū and Tararua.

Engagement followed a clear and agreed process between the partners, allowing time for genuine strong partnership to be built. Waka Kotahi sought iwi views on the best way to establish and

maintain the partnership and the parties have maintained a flexible approach to project management structures and processes through its lifecycle. Waka Kotahi has been willing to commit resources to ensure its iwi partners have the capacity and capability to engage as equals. Relationships have been respected and nurtured, with senior management within Waka Kotahi taking responsibility for championing the project and having consistent contacts within the Agency for iwi to build trusting relationships.

As the project has proceeded, the mutual value of these partnerships for the natural environment, the people and the project has been increasingly recognised.

- As partners, the four iwi groups submitted alongside Waka Kotahi as part of the Notice of Requirement for the Bypass and helped develop the consent application, including several key management plans.
- Each iwi was also part of the selection process for the preferred construction consortium, interviewing the applicants and providing a recommendation to the selection panel.
- Once the Construction Alliance was selected, iwi joined the Project Alliance Board and Alliance Management Team.
- Iwi led the design and development of significant cultural design elements, have taken responsibility for cultural monitoring of all project works and have strengthened Māori wellbeing (whare tapa wha and whānau ora) and environmental concepts (maramataka) to the project.

The project is achieving positive outcomes for iwi which include:

- Skills and capability development within iwi across the range of project disciplines, including governance, management and delivery.
- Significant cultural design elements across the entire Bypass that will recognise and honour the relationship of mana whenua to their land and river.
- The development and implementation of cultural baselines to monitor the health of the Manawatū awa.
- Business opportunities for iwi in both in the construction and mitigation arrangements.

Recommendations

No.	What	How	Who	When	Ref.[1]
T1.1	**Strengthen partnerships with Māori across the infrastructure system of Aotearoa New Zealand**	Establish a framework for stronger partnerships with Māori in infrastructure planning and delivery through the following actions: a. Task or establish a Māori advisory group to guide the development of a framework for infrastructure planning and delivery that is based on tikanga Māori and consistent with an all-of-government approach. b. Consider the evolving role of Māori in our infrastructure system. The framework must acknowledge the differing requirements and respective duties of both Crown and Iwi Māori. c. Establish joint governance and ongoing oversight of implementation of the framework.	Iwi, Te Waihanga, Whole of Government, Local Government, Sector	2022-2031	CEM

[1] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[1]
T1.2	**Develop capability and capacity across the infrastructure system for effective partnership with Māori**	A programme to develop capability and capacity for effective partnership should: a. Build specialist Māori infrastructure capability at the centre of government that can support both agencies and iwi Māori b. Consolidate and enhance specific funding for provision of technical support for iwi with infrastructure planning and delivery partnerships (agency or programme specific) c. Broker partnerships with Crown agencies and industry to create fixed term secondment opportunities out to iwi organisations. a. Leverage procurement opportunities for Māori across infrastructure policy, planning, delivery, maintenance and research.	Iwi, Te Waihanga, Whole of Government, Local Government, Sector	2022-2031	CEM
T1.3	**Strengthen the Māori infrastructure evidence base**	A multi-decade research agenda should be designed that: a. Builds an evidence base exploring how infrastructure planning and delivery out to 2050 and beyond can help empower Māori and enable rangatiratanga b. Builds and disseminates a programme of in-depth case studies from leading infrastructure Māori partnership projects. c. Investigates the use of an appropriate national framework for assessing the nationally-agreed effects of infrastructure on cultural values (sometimes referred to as cultural impact assessment, the mauri model or similar), as a supplement to the local, rohe-specific effects (determined on a project-specific basis by iwi and hapu).	Iwi, Te Waihanga, Whole of Government, Local Government, Sector	2022-2050	CEM

6. A thriving New Zealand: what we need to do

Aotearoa Ora Rawa Atu: Me aha tātou

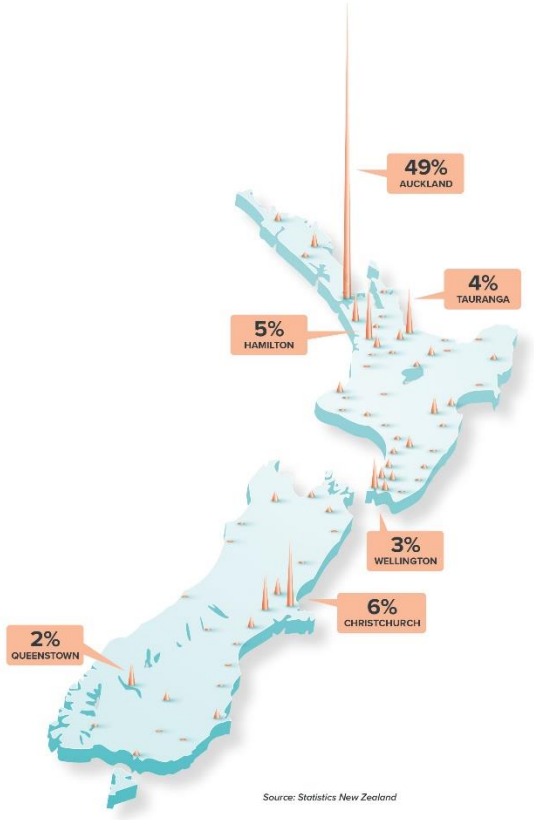
Planning for a 30-year infrastructure horizon requires an understanding of major long term trends. In developing this strategy, we have made assumptions about our population, our changing climate and the inevitable disruption that technological change will cause.

New Zealand is projected to grow by 1.2 million people over the next 30 years.[22]

That's equivalent to the population of the South Island.[23] Like any projection, this comes with significant uncertainty. Our population will be determined by fertility and mortality rates and migration. The population size can also be impacted by policy settings and global events. Under a very high migration scenario for instance, New Zealand could be as large as 7.4 million people, roughly equivalent to a new city the combined size of Auckland, Wellington and Christchurch.[24]

The growth of cities and the dominance of Auckland

Figure 9: Distribution of all population growth 2018 to 2048, by territorial authority



Source: Statistics New Zealand. 2021 "Subnational Population Projections, by age and sex, 2018(base)-2048." Accessed 21 September 2021. http://nzdotstat.stats.govt.nz/wbos/Index.aspx?DataSetCode=TABLECODE7990 Note: Absolute numbers (and annual growth rates) are as follows: Auckland, 648,100 (1.1%); Hamilton urban area (Hamilton City, Waikato District, Waipa District), 123,200 (1.1%); Tauranga urban area (Tauranga City and Western Bay of Plenty District), 71,700 (1.0%); Wellington urban area, 80,100 (0.5%); Christchurch urban area, 122,900 (0.8%); Queenstown, 25,400 (1.6%). Urban areas are based on core city plus neighbouring districts with significant commuter flows from satellite towns.

Two-thirds of population growth is expected to occur in less than 3% of New Zealand's land area.[25]

Our population is urbanising. The populations of cities are likely to increase significantly, placing pressure on existing infrastructure and demanding greater investment. Population growth will likely be concentrated in and around the surrounding areas of five major cities (see Figure 9). These include Auckland, Hamilton, Tauranga, Christchurch and Wellington. Queenstown, although relatively small, is projected to experience the highest rate of growth (1.6% per year), which will place pressure on existing infrastructure services. But it is modest in absolute terms. One year of growth in Auckland is equivalent to 30 years of projected growth in Queenstown.

In absolute terms, most population growth will occur in Auckland. Our largest city is projected to account for 49% of all population growth, growing by around 648,000 people. Under a high-growth scenario, Auckland could grow by as much as 969,000 people.

The population of some parts of New Zealand will stay the same or shrink in the long term. Strategies for managing decline may become more important for these areas. They may need to find ways to reduce the quality of services or even decommission infrastructure to manage the financial burden of maintaining underutilised assets.

> "Of New Zealand's 67 territorial authorities, starting about now and continuing through the 2020's and 2030s, 56 will experience population stagnation or decline" – Dr Paul Spoonley[26]

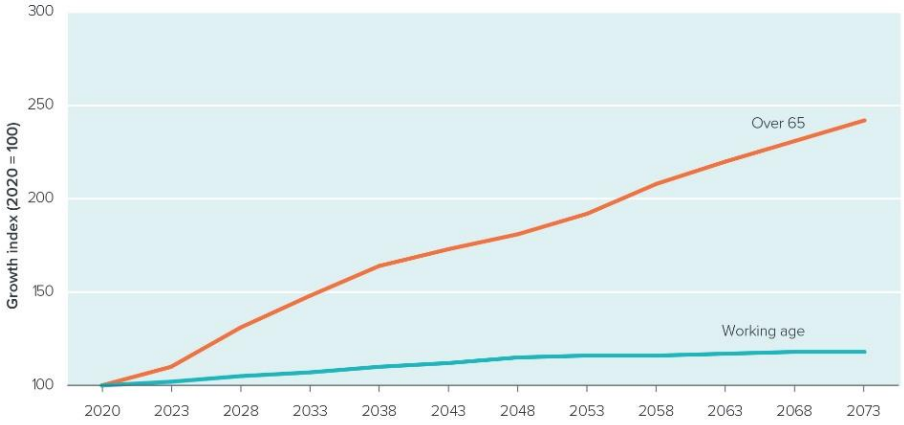
New Zealand's population is generally ageing.

The median age of a New Zealander has risen from 26 in 1970 to 37 today. By the 2030's, half of our population is likely to be over 40 years of age. By the 2070's, the median age could rise to 47. Driven by longer life expectancy and fewer children, the ageing of New Zealand's population will affect what infrastructure we need and where it's needed. It will also have funding implications, particularly for those regions that experience low or declining rates of population growth.

For New Zealand as a whole, the number of people aged over 65 as a proportion of the working age population is expected to increase from 24% today, to 49% in 2073 (see Figure 10). This means that for every person aged over 65, there will be about 2.1 people aged 15 to 64 in 2073, compared to 4.2 people today. This will have an impact on our ability to pay for infrastructure from usual sources like taxes and rates, as well as the type of infrastructure that is needed to support an ageing population.

New Zealand's population is ageing

Figure 10: Rate of population growth for working age and people over 65, 2020 to 2073



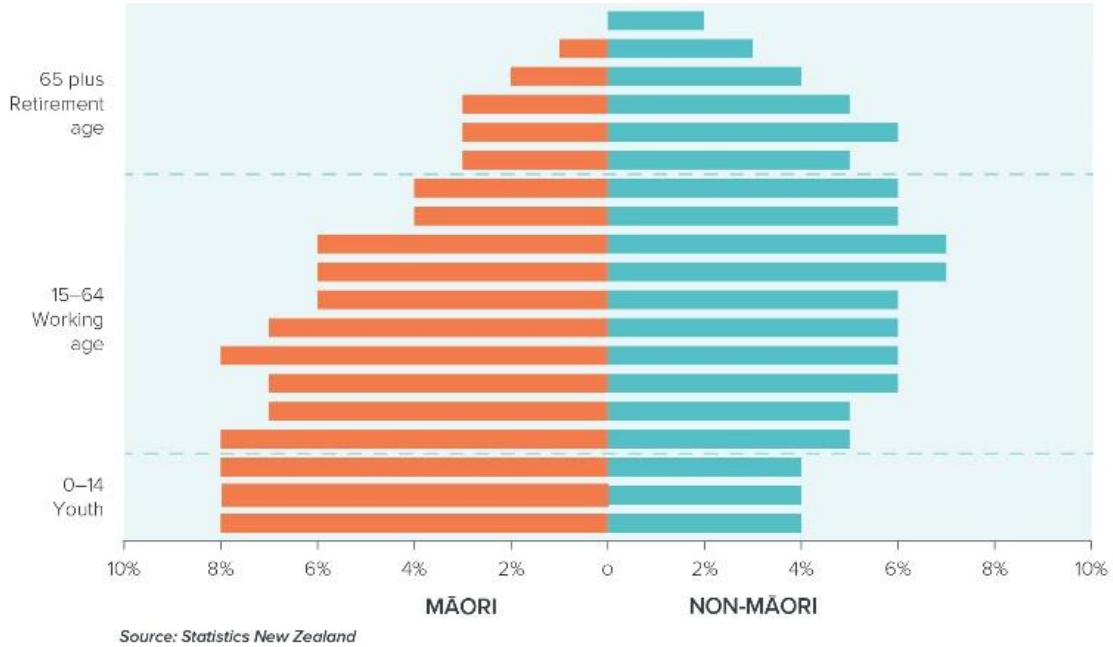
Source: Statistics New Zealand

The Māori population is younger and growing faster.

National demographic trends are not the same across all groups and ethnicities. Māori have different demographics than New Zealand as a whole. Māori are younger and the rate of growth of their working age population is significantly faster than other groups. The median age for Māori is 24, compared with 41 for New Zealand European/Pākehā (see Figure 11). The Māori population is comparatively concentrated in some less urbanised regions of New Zealand, including Northland and the East Coast, even though a quarter of all Māori in New Zealand, live in Auckland.[27]

Māori are younger and growing faster than the rest of New Zealand

Figure 11: Māori and non-Māori by age cohort, 2043



Source: Statistics New Zealand

Our population is becoming more ethnically diverse.

Between the 2013 and 2018 census, Māori, Asian, and Pacific people all rose as a proportion of the usually resident population.[28] These trends are expected to continue, with the Asian ethnic groups

projected to reach 1.2 to 1.4 million in 2038, and the Pacific ethnic group expected to rise to 530,000 to 650,000.[29]

Our climate is changing and will impact on every aspect of infrastructure.

Climate change is already having an impact on our weather. Our rainfall patterns are changing, weather events are getting more extreme and our sea levels are rising.[30] Global temperatures and carbon emissions are dramatically rising (see Figure 12).

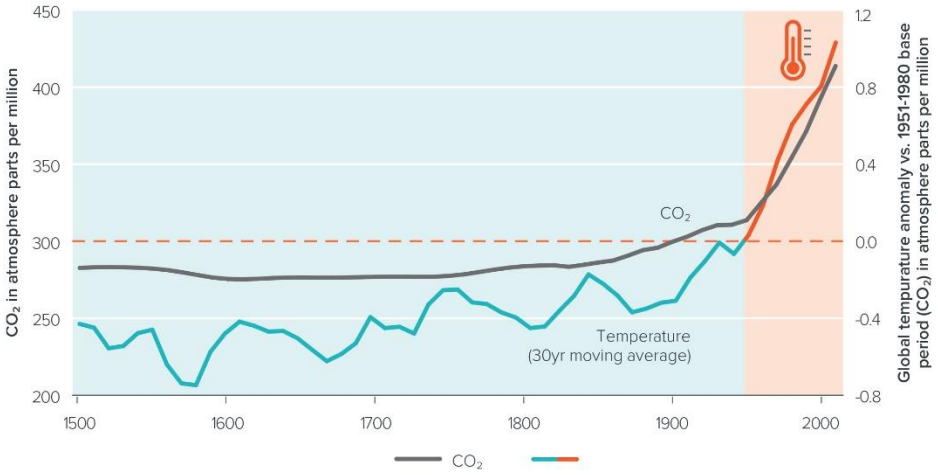
Infrastructure will be impacted by climate change through both mitigation (actions to limit global warming and its related effects) and adaptation (the process of adjusting to current or expected climate change and its effects).

To limit our impact on global warming, it is essential that we invest in infrastructure to achieve the 2050 target of net-zero carbon emissions. Similarly, we will need to change the materials that are used to minimise embodied carbon (or the emissions arising from the manufacture of infrastructure) and reflect the true cost of carbon in infrastructure projects. Infrastructure issues related to mitigation are covered in Section 6.1.

To adjust to climate change, we will need to reconsider where we build. The location of new infrastructure like roads, water pipes, hospitals and schools will all be impacted. Coastal areas, places prone to flooding and locations likely to experience increasingly severe droughts will face difficult decisions. These will include options ranging from sea walls to managed retreat. Infrastructure issues related to adaptation are covered in Section 6.4.

Global temperatures are rising dramatically

Figure 12: Atmospheric CO2 (PPM) and global temperature anomaly, from 1500 to 2020



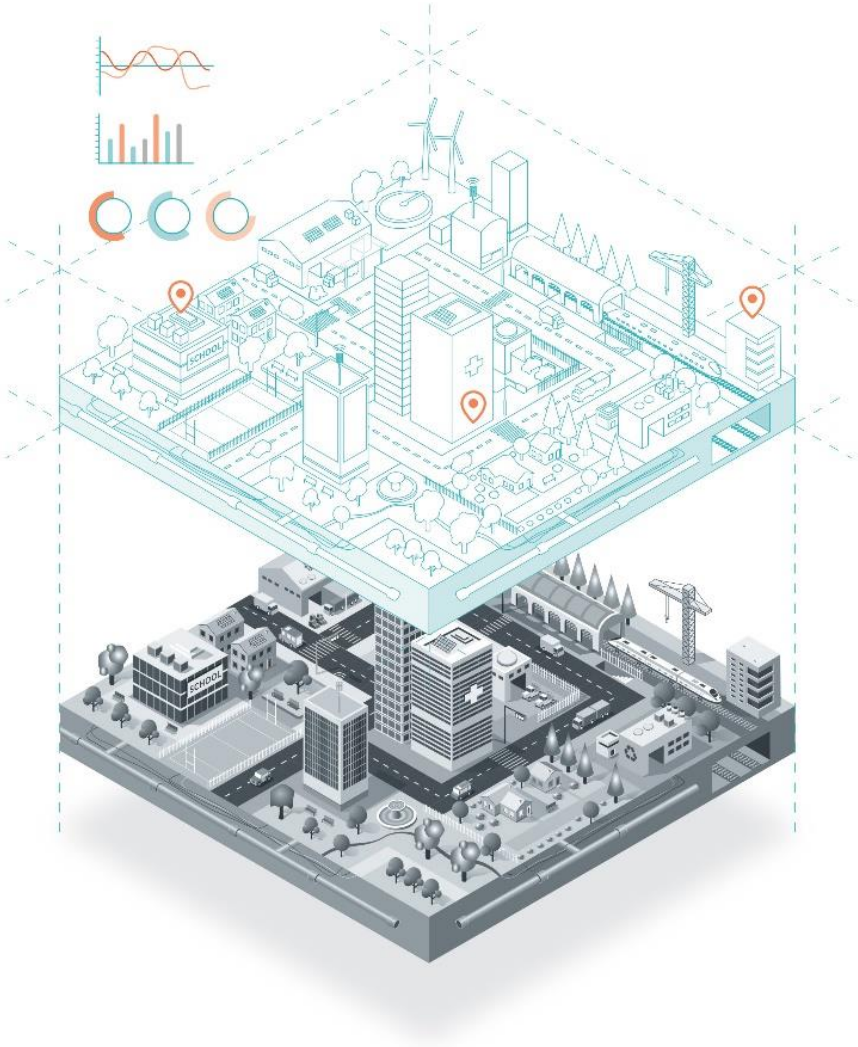
Source: The 2 Degrees Institute

A technological transformation is underway globally and will affect all infrastructure sectors.

It is characterised by almost universal connectivity and immense computing power. It draws on the generation and use of vast amounts of data. The list of potentially transformative technologies is long and includes automation, artificial intelligence, augmented and virtual reality and digital twins. Technology has the potential to create major changes in how assets are managed, priced and funded, enabling asset owners to make better use of existing infrastructure. Digital twins have the potential to transform our thinking of how infrastructure sectors work together as a single system (see Figure 13). There is also an increasing need to identify and respond to cyber security risks facing infrastructure

providers and users, as critical systems are increasingly being controlled by remote, automated systems that are vulnerable to new threats.

Figure 13: Digital twin



Source: Te Waihanga, adapted from Cambridge University, Flourishing Systems.

6.1. Enabling a net-zero carbon emissions Aotearoa

E whakaahei ana i tētahi Aotearoa he kore-more tana tukunga waro

Climate change is the defining challenge of this century. Our infrastructure is a key part of the solution.

Our climate is changing rapidly. Global temperatures are rising faster than anticipated and unless serious change is made, will exceed 1.5°C and 2°C during this century.[31] New Zealand is committed to doing its part to help prevent this, with a target of net-zero carbon emissions by 2050. This is a challenging target that requires immediate and sustained action.

> "The Government must pick up the pace. Aotearoa will not meet its targets without strong and decisive action now to drive low emissions technologies and behaviour change across all sectors. 2050 is not far away – particularly if you consider the life span of infrastructure, vehicles, buildings – and people." – Climate Change Commission[32]

Achieving these targets will require industry and consumers to shift to new technologies like electric vehicles. We are in a fortunate position. Our hydro, wind and geothermal power stations already provide considerable low-emission electricity. We have abundant energy, which can be harnessed to produce more clean electricity than needed to meet our net-zero carbon emissions commitments. This would allow us to create sustainable high-wage jobs for New Zealanders by attracting new companies that produce energy-intensive goods and services.

At the same time, we will need to reduce or manage the emissions we produce when we build or operate our infrastructure. The decisions we make about investing in infrastructure today need to properly consider the long term cost of carbon. The way we plan for, build and operate infrastructure will need to change for the sake of the generations to come.

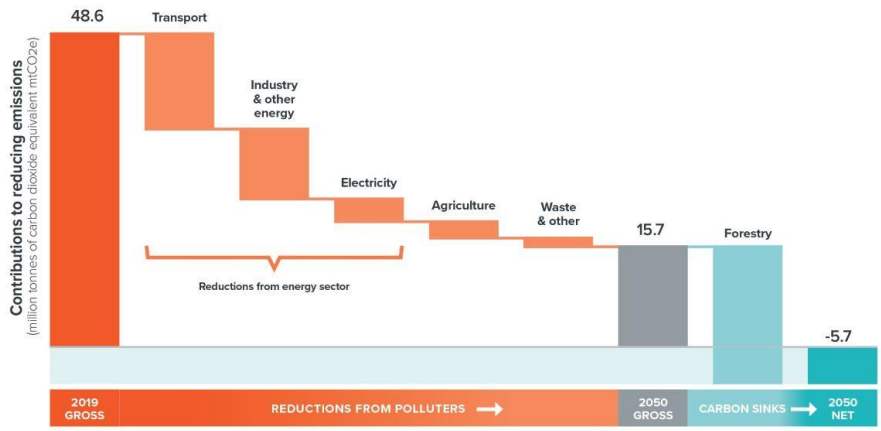
6.1.1. Context

To achieve our 2050 target, large reductions in carbon emissions are needed over the next 30 years.

The reductions will primarily need to come from the transport, industry and forestry sectors, as shown in Figure 14.[33]

Most of the reductions in gross emissions are from the energy sector

Figure 14: Contributions to reducing emissions (million tonnes of carbon dioxide equivalent, mtCo2e)



Source: Climate Change Commission

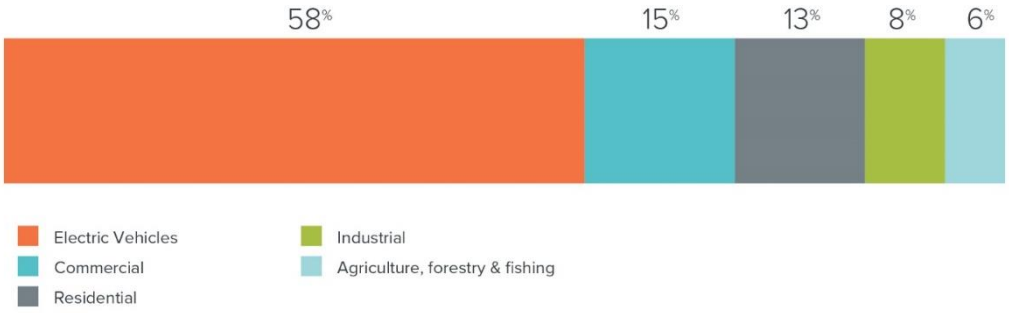
We will need to dramatically alter our energy sources. Currently, only 30% of the energy we consume is from low-emission sources.[34] This will need to increase to 86% by 2050.[35] Most of this is likely to come from greater use of biomass and clean electricity like wind and solar, but it could also come from technologies that capture and store carbon emissions, provided they become cost effective.[36]

Clean electricity will be key to reducing carbon emissions from transport, process heat and agricultural activities.

Electric vehicles are projected to grow from less than 1% of our light vehicle passenger fleet, to 93% by 2050.[37,38] They are expected to account for more than half of the additional electricity we're going to need by 2050 (see Figure 15).[39]

Electric vehicles will account for a large portion of the increase in demand for electricity

Figure 15: Contribution to increased demand for electricity in 2050



Source: Climate Change Commission

Over the next 30 years we will need to build significantly more low emission electricity generation.

This is needed to cater for our growing population, greater use of electric vehicles, agricultural activities that require electricity and to power the heating used in industrial processes (which is known as process heat).[40,41] Most of this low-emission electricity will come from new solar and wind generation and with this come some challenges:

- We will need to prepare for times when wind and sunshine are low, particularly as this often occurs at the same time, in winter, when hydro-electricity generation is also low and demand for power is high.[42]
- As our economy becomes increasingly reliant on electricity, we will also become more reliant on the national grid. This means the consequences of natural disasters like earthquakes, volcanic eruptions in the central plateau and extreme weather events would be very high.[43]

The electricity sector will still produce carbon emissions in 2050.

The operation of geothermal generation is not carbon-free and gas-fired generation may still be needed to provide electricity when our wind, solar, geothermal and hydro generation can't meet demand.[44] There might also be some industrial processes, like steel and cement production, that require very high temperatures and switching to electricity would be overly costly. In cases like these, we will need to explore options for offsetting these carbon emissions, such as by planting more trees or buying emission units from offshore.[45]

6.1.2. What we heard

Our consultation asked people for their views on meeting the government's goal to have 100% renewable electricity by 2030. Submitters told us that setting targets for specific sectors, like transport or electricity, were not useful because of the Emissions Trading Scheme. If we do want to set targets for individual sectors, then submitters suggested the '100% renewable electricity by 2030' target should be

replaced by a broader renewable energy target, such as the one recently proposed by the Climate Change Commission.

We also heard that there's a need to focus more strongly on the role that the gas sector and its infrastructure can play in helping New Zealand transition to cleaner energy sources. Submitters also told us to focus more strongly on the role of gas in ensuring we have a secure source of electricity and sufficient gas supply for industry until better options are available.

6.1.3. Strategic direction

Moving to a low-emissions energy sector

We need to significantly grow our clean electricity generation over the next 30 years. This will require rules and regulations that support this change, sustained investment and the right mix of infrastructure to ensure we have reliable and resilient sources of power.

Streamlined regulatory processes are needed to enable development of new energy projects.

We need to streamline the consenting process to enable low-emission energy infrastructure to be built. There are three areas of focus.[46]

Renewable energy zones: Councils could identify renewable energy zones in their regional spatial plans. These zones are areas that would be suitable for renewable energy infrastructure and where there would be fewer barriers to gaining resource consent. At the same time, transmission and distribution infrastructure will also be needed to carry the energy produced in a renewable energy zone to homes and businesses. In most cases, regulated or contracted revenue will be sufficient to cover Transpower's costs. When this is not the case, innovative funding, financing or indemnity arrangements may be needed to strike a better balance in maintaining incentives on investors to make careful choices, while reducing barriers to grid and network expansion.

> "If we are to achieve our climate change targets and meet the environmental challenge of our generation, the future needs to be very different from the past. …[this is] unlikely to happen fast enough with current policy settings. 3-7 years to consent and enable property access for a major project is simply too long if we are to meet electricity targets" – Transpower, submission on MBIE Accelerating Electrification consultation.[47]

Offshore wind farms: It is currently cheaper to develop wind farms on land. However, it's expected that offshore windfarms will be developed when technology improves and costs decrease. With this will come a need to balance their role in generating electricity with their impact on the environment, as well as the importance of our coast to our economy, lifestyle and culture. Currently, we do not have a specific consenting arrangement for developing our low emission offshore energy resources. To make the best use of those resources, the government may need to specify and allocate rights to certain areas, known as development blocks. New Zealand already has experience in regulating offshore oil and gas exploration and, like Australia, we can use this experience to grow renewable energy.[48]

Distributed energy resources (DERs): Our regulations should help with the uptake of low-emission DERs, which are smaller devices for generating or storing power, such as rooftop solar panels, wind turbines, batteries and demand management systems.[49] Transpower estimates that solar panels that are connected to local networks will provide about 9.1% of total electricity supply by 2050.[50] The Minister of Energy and Resources, the Commerce Commission and Electricity Authority all have key roles in developing a regulatory environment that enables households and businesses to install these types of technologies. The connection of tens of thousands of DERs to a local distribution network will create some challenges for network operators. Electricity distributors will also face additional complexities from

the electrification of transport. Electricity sector regulators will need to continue monitoring distributors to ensure they can meet these challenges in their current structure and if not, whether some should be merged to improve their capabilities and get better results. The sector already has some joint venture and out-sourced management arrangements for operating their networks and more of these types of arrangements may be enough to manage the complexities they will face in the future.

We need to invest more in clean electricity.

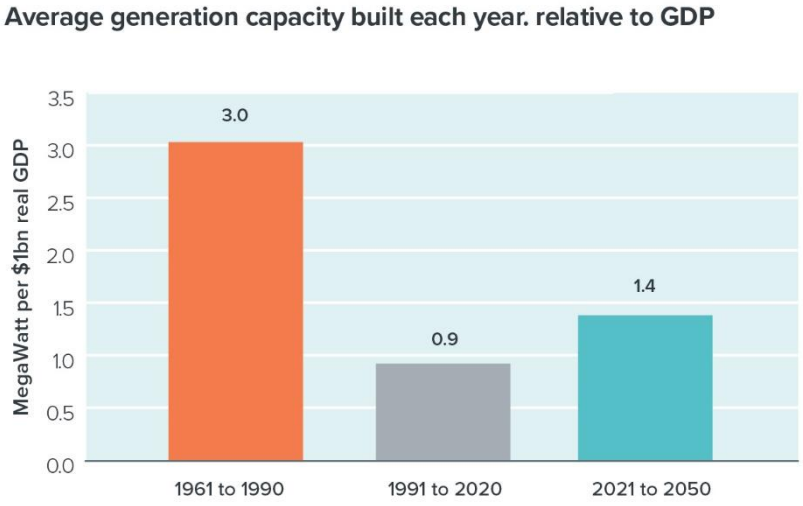
Our growing population and the need to phase out fossil fuels means we will need to increase the amount of electricity we generate each year by up to 70% by 2050.[52,53] New Zealand is fortunate to be embarking on this journey with an electricity system that over the last five years generated 83% from low-emission sources. This will increase over the next five years.[54]

> "Around $2 billion is currently committed to the construction of new renewables, equivalent to 8% of current total annual generation. We are confident that with this and further expected near-term investment, New Zealand will have around 95% renewable electricity generation in the next five years." – Meridian Energy[51]

Experience shows this is achievable. Relative to the size of our economy, we built at a faster pace between 1960 and 1990 than we will need to over the next 30 years (see Figure 16). We now have better construction technology and wind and solar farms should be easier to build than the hydro dams we built in the past. These newer technologies also have less impact on the environment than our hydro dams. Already, two new players have announced plans for large-scale solar farms in the upper North Island and several others have expressed interest in building large-scale offshore wind farms.

The scale of energy infrastructure to meet net-zero carbon. We've done it before.

Figure 16: Historical and projected growth in electricity generation capacity, relative to GDP



Source: Te Waihanga and Electricity Authority

However, there will also be challenges not faced in the 1960s, such as more stringent regulatory barriers to development. We also need to address the perennial challenge of 'dry year' risk.

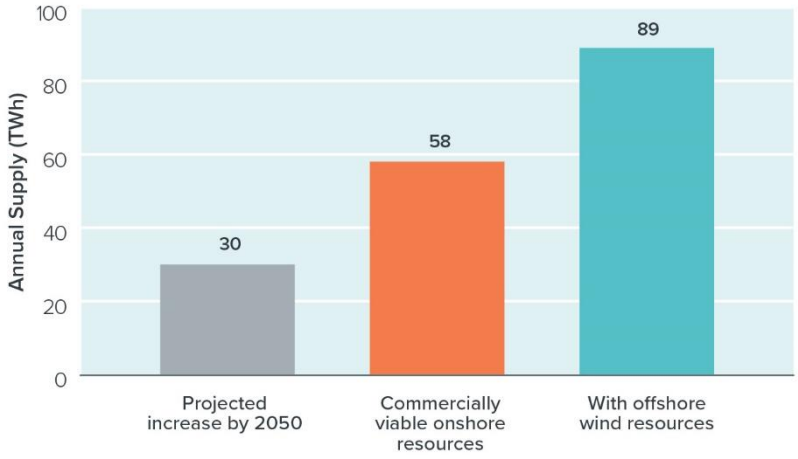
We can leverage our low emissions energy potential for economic advantage.

The Climate Change Commission estimates that to meet our net-zero carbon emissions target, we will need to be generating an extra 30 TWh of electricity a year (see Figure 17).[55,56] But we have enough natural, clean resources like wind, solar and geothermal energy to generate much more than that. Even if we exclude offshore windfarms, we could generate enough power to not only meet our target but still have a surplus of 28 TWh, enough to supply about five aluminium smelters of the same size as the Tiwai Point smelter. The surplus could be used to grow energy-intensive activities, with some of them better

suited to achieving acceptable levels of energy security for households and other consumers than others. These potentially include hyperscale data centres[57] and the production of hydrogen or ammonia.[58] Attracting these activities to New Zealand would reduce global greenhouse gas emissions and create sustainable high-wage jobs for New Zealanders.

Abundant low-emissions energy resources are an economic opportunity

Figure 17: Commercially viable low emissions energy resources



Source: Te Waihanga and Climate Change Commission

An even faster pace is possible if it becomes commercially viable to build windfarms offshore.

The opportunity to expand our energy sector is just one example of ways in which the wider economy may evolve over the next 30 years. We have a small dynamic economy, with sizeable international trade and investment flows, which could affect Emissions Trading Scheme prices and the gap between actual emissions and our international climate commitments.[59] The way the government addresses these issues, for instance through international carbon markets, will be important for investor confidence in the energy sector and more widely and this needs to be addressed sooner rather than later.

Businesses will find it attractive to locate their energy-intensive activities in New Zealand when they can earn higher returns or face lower risks than in other countries. We should not need to subsidise them. We just need to compete by being smart about how we plan, build, operate and regulate our infrastructure. However, we need to act quickly. Other countries are quickly moving ahead of us to leverage their low-emission energy resources (see Case Study 2 for example). To be competitive with Australia and other Asia-Pacific countries, we need to allow large-scale commercial developments (to reduce costs). Our infrastructure and regulatory policies need to be highly reliable. We also need to build supporting infrastructure in a timely and efficient way, as well as develop and retain a skilled workforce.

Case Study 2: Australia-ASEAN Power Link

Australia is considering a 10-gigawatt solar farm and battery storage system in the Northern Territory that would be larger than the capacity of New Zealand's entire electricity system (9.8 gigawatts in 2020).[60] The privately funded project, which is currently seeking financing, is expected to cost AUD$22 billion.

In addition to serving existing domestic energy demands, the solar farm could feed new sources of demand, like producing hydrogen for transport fuels and industrial processes and powering data centres and digital services. The proposal includes a 3,700 kilometre undersea transmission line from Darwin to Singapore that would supply up to 20% of Singapore's electricity demand and generate significant export revenue.[61]

The project was included in the Australian Infrastructure Priority List in 2020, which has enabled permitting and coordination to be expedited.

We can support partnerships and unlock opportunity for Māori in low emissions energy production.

Māori are involved in energy production. A number of iwi are part of joint ventures in electricity generation and some also receive income as a result of geothermal generation on their lands. Many have extensive interests in land, forestry (a source of biomass energy), geothermal and hydro resources. Māori are well positioned to be joint venture partners in many forms of energy production and storage, such as investing in wind and solar generation schemes or in carbon capture and storage of fossil gas. Additional geothermal and hydro generation and storage, such as the proposed Lake Onslow pumped hydro storage scheme, are other obvious areas for Māori involvement.

Māori also have valuable knowledge to contribute to the development of the government's Emissions Reduction Plan and national energy strategy and a regulatory framework that can enable offshore low-emission energy generation and storage.

Increasing energy prices could affect low income and disadvantaged New Zealanders.

New Zealand scores highly in energy equity against 128 other countries surveyed by the World Energy Council.[62] However, the transition to a low emissions economy could disadvantage low-income consumers, those on fixed incomes such as older people and people with disabilities and health needs.[63] Petrol and gas prices are expected to increase significantly over the next 30 years[64] and the daily fixed charge for electricity is estimated to increase by more than 200% by 2050.[65] These increases would disproportionately affect low income New Zealanders and those who can't significantly reduce their use of petrol and diesel for transport and gas for cooking and heating.[66]

Additional government support will be needed for those most disadvantaged. Some government initiatives are underway, such as programmes that offer low-income households with education on how they can reduce their energy costs and a trial of renewable energy technologies for social and Māori housing.[67,68] The government may need to offer some people support to pay the upfront costs for improvements that will save energy over the long term. It may also need to help workers who were in fossil fuel industries to retrain or relocate for new jobs.

Reducing the emissions produced by our infrastructure

Business cases should incorporate the long term cost of carbon.

The long life of our infrastructure and the high cost of replacing or changing it can mean that the decisions we make today result in carbon emissions for years to come. For example, extending or improving the road network can result in emissions for several decades because it is too costly to quickly replace petrol and diesel vehicles with electric and hydrogen ones. When the cost of repurposing or replacing infrastructure is prohibitive, the investment is said to be 'irreversible'.[69] [70]

These irreversible investment decisions need to include the cost of carbon over the life of the infrastructure, as highlighted by Case Study 3. Getting the price right is fundamental to driving infrastructure decisions that support a low-carbon economy. The current New Zealand Emissions Trading Scheme (ETS) price is around $64/tonne of carbon dioxide equivalent.[71] ETS prices may need to be as high as $232/tonne by 2050 to drive decisions that hold global warming at less than 2°C.[72] The Climate Change Commission has recommended changes to the trigger prices in the ETS that would enable it to reach these levels by 2050.[73]

Case Study 3: Long term values for the cost of carbon in the United Kingdom

The United Kingdom (UK) has an emissions trading scheme, but it recognises emission prices produced by the scheme are not appropriate for decisions that lock-in carbon emissions.[74] Since 2009, the UK has used carbon values to assess policy proposals. These values are based on estimates of the cost to society of achieving carbon emission targets. Like New Zealand, the UK recently adopted a target of net-zero carbon emissions by 2050. To be consistent with its new target, the UK Government has recently announced a new carbon value of £245/tonne for 2021 and an intention to increase it to £378/tonne by 2050.[75] Converted to New Zealand dollars, these are equivalent to NZD$475/tonne and NZD$733/tonne, respectively.[76]

Both central and local government make decisions about investing in infrastructure based on business cases. These business cases should incorporate a long term cost of carbon, rather than current ETS prices, to inform better decision-making about which projects are worth investment. This long term cost of carbon should be consistent with New Zealand's net-zero carbon emissions commitment. Adopting a more realistic cost of carbon will also help encourage businesses to develop low-carbon materials and processes for constructing infrastructure.

Carbon is created in the production of many construction materials such as asphalt, cement, steel and aluminium. The heavy machinery used to build infrastructure also emits carbon. A government work programme is needed to understand which construction materials and methods produce the least carbon and then review regulations, standards and codes to encourage their use.

6.1.4. Recommendations

No.	What	How	Who	When	Ref.[2]
S1.1	**Minimise lock-in of future emissions**	Set a strategic direction in Emission Reduction Plans (ERPs) that public sector infrastructure investment programmes must be compatible with meeting our international commitments on carbon emissions. Measures to support this direction should: a. Include full consideration of non-built solutions in all business cases. b. Require appropriate assessment of carbon emissions in all business cases. c. Require the use of a cost of carbon compatible with international commitments on carbon emissions within all cost benefit analysis. d. Measure the carbon impacts of different construction materials used in infrastructure projects. e. Set a timetable for reviewing regulations, standards and codes to ensure they do not inhibit the uptake of low carbon materials. This should be cross-sector and reviewed regularly.	MfE , Climate Change Commission, MBIE	2022-2026	ITN, SRC

[2] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[2]
S1.2	**Achieve net-zero carbon emissions at minimum cost**	Develop, as soon as possible, clear and credible policies and mechanisms for offsetting any differences that arise between actual emissions and our international commitments on carbon emissions. In developing a National Energy Strategy, include measures that achieve net-zero carbon emissions at minimum cost. These should: a. Modify the renewable electricity target to focus on renewable energy. b. Reduce barriers to the prudent expansion of transmission and distribution capacity where needed. c. Ensure the existing gas infrastructure can be redeployed when new alternatives become viable. d. Progress efforts to remove barriers to local generation, storage and demand management activity.	MfE, MBIE, Commerce Commission , Electricity Authority	2022-2031	ARE, ITN, GIC, BZC, EAN, GTG, LEE, TPM
S1.3	**Speed the build of low emissions energy infrastructure to leverage our abundant resources**	Streamline consenting of low emissions energy infrastructure while meeting environmental objectives by: a. Developing a National Environmental Standard for Low-Emission Energy Generation (NES-LEEG). b. Developing a national streamlined approach to consenting that could include renewable energy zones. c. Establishing an offshore regulatory framework to explore and develop low emissions energy resources in territorial waters.	MfE, MBIE	2027-2031	ARE, OCE

No.	What	How	Who	When	Ref.[2]
S1.4	**Ensure a fair, inclusive and equitable transition to a low emissions economy**	Target support to those disproportionately affected in the energy transition, by a. Providing additional financial support to disadvantaged consumers to assist them with the upfront cost of investing in energy efficiency improvements. b. Supporting retraining for displaced workers. c. Involving Māori and iwi in the development of specific energy hardship initiatives.	MSD, MBIE	2022-2031	ITN

6.2. Supporting towns and regions to flourish

Te tautoko i ngā tāone me ngā rohe kia tupu matomato ai

New Zealand's regions are distinct. Our infrastructure supports our towns and regions to play to their strengths.

New Zealand's regions are great places to live, work and visit. Each region is distinct, with its own character and unique combination of natural environment, infrastructure and community. Lower house prices, roads that are free from congestion and a sense of community make the regions attractive to many people. They also offer different job opportunities to our cities, whether it's in the primary sector, within local businesses or remote working. These are some of the reasons why approximately 1.8 million New Zealanders, some 35% of the population, live outside the main cities in small cities, towns and rural areas.[77]

However, some of these same things that make our regions special, such as their smaller scale and remote locations, also pose challenges for their infrastructure. With people living further from main centres, it can be harder to access employment or social infrastructure, like schools and hospitals. It can also be more expensive to maintain infrastructure when populations are smaller. The infrastructure in our regions, like elsewhere in New Zealand, will also need to adapt to the changes we face over the next 30 years. Some areas will need to manage decline. Others, buoyed by the potential of work-from-home, improving broadband and the high cost of urban housing, will experience growth. Wairoa in Hawke's Bay for instance, was projected to decline by 4% between 2013-2020, but instead grew by 8% as people were drawn in from other parts of New Zealand.[78] All will need to work to address climate change, but its impacts might be greater in some regions, such as those by the coast.

6.2.1. Context

New Zealand is a trading nation and the regions are our economic backbone.

In 2019, $131 billion of goods left or entered New Zealand, with 79% by sea and 21% by air.[79] There were 14 million passenger movements through New Zealand's four main international airports.[80] As the home of important sectors like the primary sector and tourism, New Zealand's regions are the country's economic backbone. Prior to COVID-19, primary sector products made up nearly 80% of all the goods we export by value.[81] Tourism, New Zealand's largest export sector prior to COVID-19, contributed a further 20% of total exports. Access to local, national and international markets is critical not only to the economic wellbeing of our regions, but of New Zealand as a whole.

Māori have a strong connection to regional New Zealand.

For Māori, our regions can be whenua, a source of connection and identity. Māori are slightly more likely to live outside main urban areas than other New Zealanders[82] and account for a large share of the population in regions like Gisborne district (where 54% of the population is Māori), Northland region (36% Māori), and Opotiki district (64% Māori).[83] A large proportion of all New Zealand's marae are found in rural New Zealand. The Māori economy is embedded in the fabric of the regions and is dominated by land and a natural resource-based primary sector, with 35% of the Māori economy arising from the primary sector.[84] Māori-owned businesses account for 16% of New Zealand's total primary sector output.[85]

Infrastructure supports the regions to play to their strengths.

Well-organised infrastructure networks are critical to enable goods, services, people and knowledge to move both within New Zealand and overseas. Regional New Zealand will increasingly need rapid, low-

cost connections between regions and cities. Currently, the air services to our regions are infrequent and expensive. The rise of electric aviation and autonomous mobility solutions may help ease these pressures, boost competition and change the nature and economic viability of commercial regional air services. This technology is expected to become common within the next decade,[86] but to prepare for this, significant training and infrastructure preparation is required to support operations on existing runways.[87]

National networked infrastructure, like the road and rail network and electricity transmission lines are largely located in regional New Zealand and form long-distance connections across the country. Maintaining security of supply within often remote and geographically challenging parts of the country is important to all New Zealanders. Road and rail transport will remain fundamental in connecting our regions. However, digital and mobile connectivity are also becoming essential. Moving data and information will become as important to the regions as moving energy or water.

Providing infrastructure in the regions can be challenging.

To thrive, regional New Zealand needs good infrastructure. However, this can come with challenges:

- Smaller populations can make it difficult to pay for costly large-scale investments.
- Dispersed populations can increase the cost of providing infrastructure services to people, which is made more challenging by New Zealand's geography. This increases construction costs.
- Ageing populations in many places increase infrastructure needs while reducing the number of working-age people who can help to pay for infrastructure. This places pressure on the way infrastructure is currently funded.
- Uncertainty about whether the population in a region will grow or decline can create uncertainty about how to pay the ongoing operational and renewal costs for infrastructure. This raises the possibility of stranded assets, which a region cannot afford to operate.
- Managing the impacts of climate change can be more difficult. For example, public transport might not be viable in smaller towns and coastal communities may struggle to fund infrastructure, like sea walls, that they need to adapt to climate change.

These difficulties can limit the viability of infrastructure services in some places. This might mean higher prices, lower service quality or even missing services. For example, public transport options can be limited or non-existent, recycling facilities may be sporadic, internet and mobile service coverage patchy and distances travelled to jobs and recreation may be farther. Health, banking, education and recreational facilities can be impacted. This heightens the importance of transport and digital connectivity for social and economic wellbeing.

6.2.2. What we've heard

"Our smaller towns struggle to pay for infrastructure" was ranked as a 'very important' issue by 44% of respondents to the Aotearoa 2050 survey. Submitters on our consultation document told us that regional roads and freight networks are important for economic and social functions. However, they saw challenges with maintaining rural roads to provide ongoing access to communities and to serve economic needs, such as freight and logging.

Submitters also recognised the role of population and economic growth in driving infrastructure needs. Telecommunications and digital infrastructure is important for ensuring access for everyone living in regional New Zealand, including those who are vulnerable or disadvantaged. It can complement and sometimes be a substitute for transport networks. Air access is also important and regional air links are seen as expensive and sometimes infrequent.

6.2.3. Strategic direction

Accessing safe and reliable infrastructure

Safe and reliable infrastructure is fundamental to wellbeing but can be difficult to fund.

We need access to safe roads, health services, reliable electricity, mobile phone and internet services and clean water. This can be more challenging outside cities, particularly in our more remote areas. But without these services, economic and social opportunities are limited and people face disadvantage.

Existing funding sources like rates are often not enough to provide the quality of infrastructure needed in regional New Zealand. Private enterprise is also unlikely to meet all of these needs. This is particularly the case in areas where few people live, where incomes are low and where communities are marginalised. Poor infrastructure affects regional businesses by, for example, reducing opportunities to improve productivity or innovation. In the case of telecommunications and internet access, poorer communities may also be unable to pay for devices and access. This worsens inequity and disadvantage for these communities. While infrastructure alone cannot remove the underlying causes of disadvantage, it can reduce the impacts by improving access to jobs, education, health and social services. This might be through transport connections like roads or rail links, for example, or through better digital connections.

Infrastructure standards should enable affordable solutions for rural New Zealanders.

For some rural communities, higher infrastructure quality and design standards can create problems and even threaten their access to essential services. For smaller communities, the cost of meeting these standards can be too high when shared among only a small number of people.

This is a particular challenge for water supply. Up to 100,000 New Zealanders get their drinking water from very small suppliers, such as wells that serve a few households.[88] Almost 1,000 schools, marae and community facilities supply their own water.[89] Without help, these suppliers may not be able to afford to meet new drinking water standards.[90]

To help in cases like these, infrastructure standards should allow on-site solutions or low-cost infrastructure designs to be used when they are more affordable for users. For example, electricity distributors are required to supply power to remote users, but they can do this by paying for on-site generation like solar panels or generators if this is a cheaper option.[91]

When government sets standards that apply to local governments and self-service infrastructure, it should ensure that these standards don't pose too high a cost on small communities or those who would struggle to pay. This could be achieved by sharing services among several communities or through subsidies for communities that would otherwise struggle to pay.[92]

Low-cost infrastructure alternatives are important in the regions.

Digital technology, such as online services, can offer alternatives to the services people need from infrastructure. They can mean that instead of needing transport connections for work or study, people can work remotely online. Other alternatives can be local, small-scale solutions that avoid the large upfront costs often associated with big, centralised infrastructure. This could be an off-grid water system or a satellite broadband service, provided it can meet minimum service quality at a lower or comparable cost.

The rise of electric aviation is one technology that has the potential to change the economic viability of commercial regional air services,[93] while also contributing to our net-zero carbon emissions target. While there is less certainty about the use of electric aircraft for long-haul travel due to battery sizes,[94] electric

aircraft for small regional flights is imminent and may be cheaper. Airlines are already investing in electric planes.[95] Preparing airport infrastructure and developing the skills to maintain and operate electric planes will become a priority.[96]

Managing population decline will become a more common challenge in some areas.

It is likely that New Zealand will increasingly have to manage areas where population is in decline. Of New Zealand's 67 territorial authorities, 56 are expected to experience flat or declining growth at some point over the next 30 years (using the median projection).[97] These projections come with considerable uncertainty, however. Only 23 territorial authorities are forecast to grow over the next 30 years, with a high degree of certainty.[98]

With a falling number of users, continuing to fund operational costs will be challenging, particularly where the fixed costs of operation are high. For infrastructure that is commercial, some services will gradually reduce or be replaced with lower cost alternatives, as has occurred with bank closures and internet banking.[99] For non-commercial infrastructure, the transition may be more difficult. Local authorities will need to find ways to reduce or even decommission infrastructure to manage the financial burden of maintaining underutilised assets.

> "The link between depopulation and funding pressures should not be underestimated. […] [A]s population falls the economic base from which to draw revenue falls. […] Once started, population decline is near impossible to reverse. Yet, there is no guidance and few clear success stories of local communities that have downsized their assets. It's not uncommon for elected officials to take the view that if a local authority assumes or starts planning for decline they'll make it happen." – Taituarā, Local Government Professionals Aotearoa

Improving population certainty can help guide infrastructure decision-making.

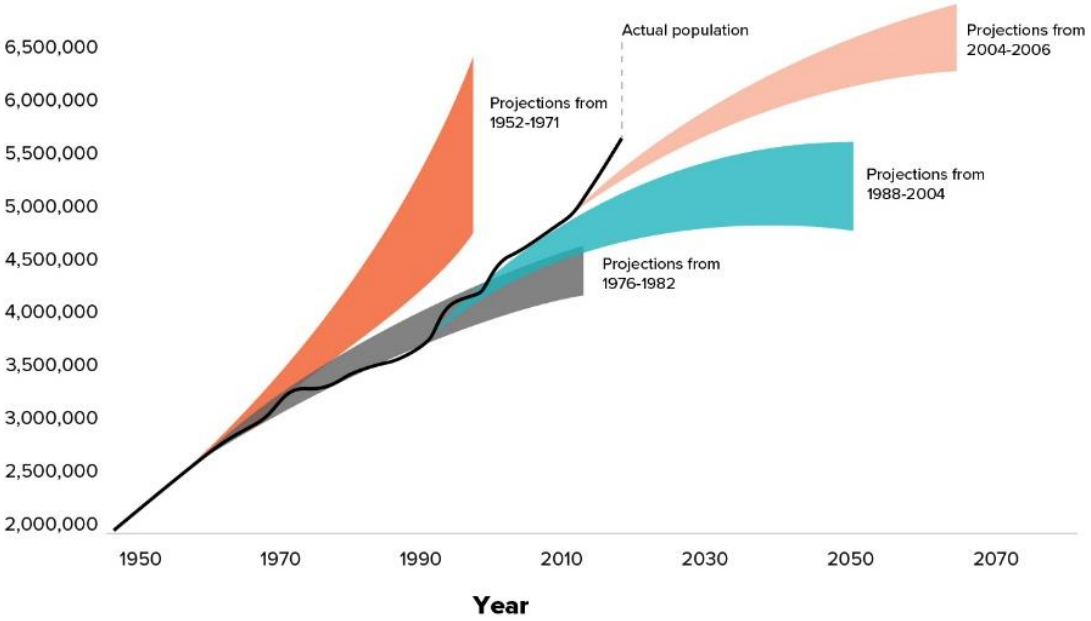
New Zealand's population is expected to grow significantly over the next three decades (see Figure 9). We have the potential to gain significantly from this growth. However, if growth is not adequately planned for or anticipated, it can create infrastructure problems that erode the benefits of growth and undermine public acceptance of a growing population.

Predicting population growth comes with a high degree of uncertainty, however. Historically, median projections have been both far below and far above experienced population (see Figure 18). Because infrastructure is long-lived and often requires long lead times to provide, expectations of growth trajectories are important for delivering the right infrastructure, in the right places, at the right times. The uncertainty of demand through changing population trends can also impact investment decisions.

A long term and stable National Population Plan should focus on reducing uncertainty of future demand for long-lived infrastructure services at the national level, while respecting individual choices over where to live and work. It can also set direction for regional spatial and infrastructure planning and in doing so, help identify supporting policies required to benefit from and shape growth across New Zealand.

Predictions of future population are uncertain

Figure 18: Historical population growth compared with historical population projections



Source: Te Waihanga, adapted from Statistics New Zealand[100] Securing efficient and resilient access for goods and services

Securing and integrating freight and supply chains

Reliable transport networks are critical for the regional economy.

The efficient movement of freight in, out and around New Zealand is critical to the economy and our international competitiveness. Reliable transport networks, including road, rail, ports, airports and inland freight hubs all support our freight sector and provide connections to markets within New Zealand and overseas (see Figure 19). This is especially important for our regions, which produce the bulk of the goods sold overseas. There is also a clear link between infrastructure investment in a region's transport connections and its prosperity.[101], [102], [103] Quicker travel times enable markets to become more integrated. As this occurs, regions will benefit from lower prices and greater movement of people, goods and services.

By 2052, the volume of freight moved around New Zealand is expected to increase by almost 40% (from about 280 million tonnes in 2017/18, to nearly 400 million tonnes by 2052/53).[104] As volumes grow, the issues already faced by our freight system will increase and worsen. We will need to invest more in our transport network and ensure it works more efficiently if we are going to manage these increased levels of freight.[105]

The freight sector faces a number of challenges.

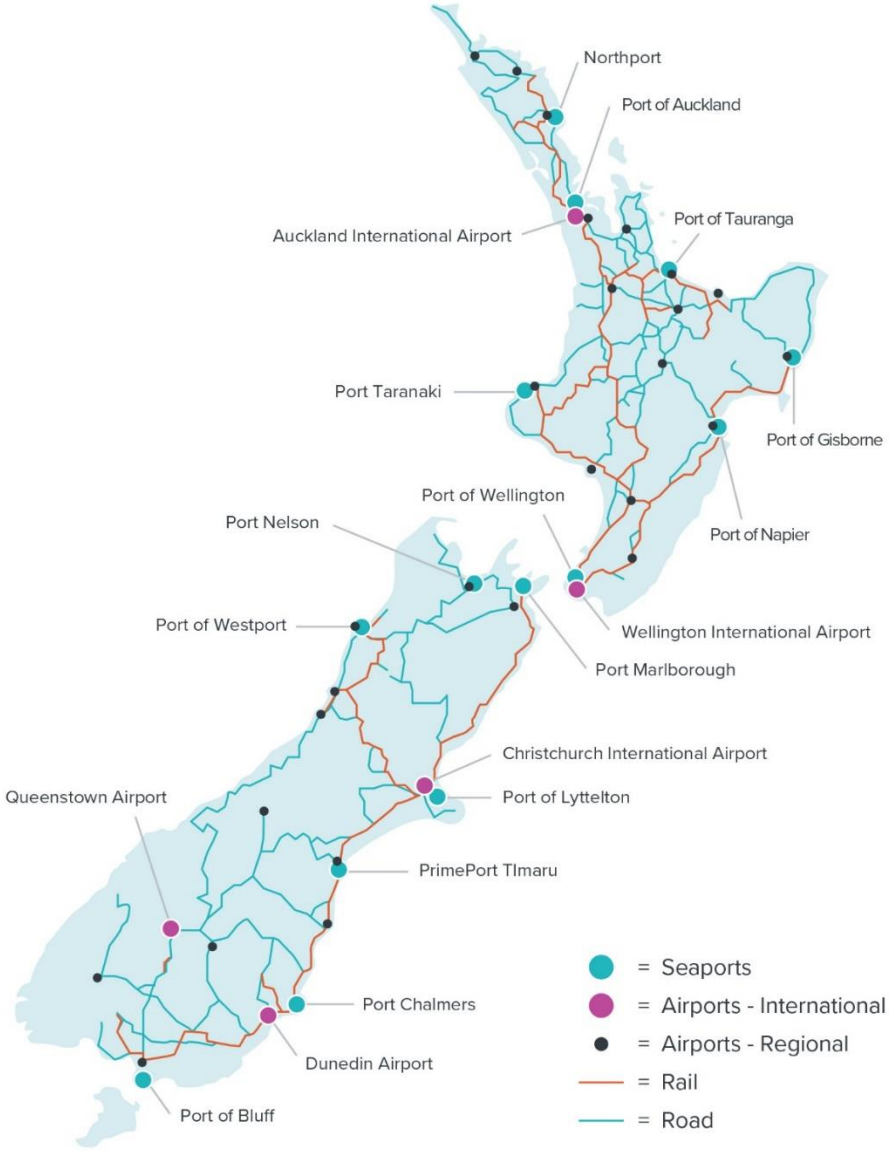
There is a degree of fragmentation in the freight sector. Freight and logistics services are provided by the private sector in New Zealand.[106] Most of the transport infrastructure that supports these services is owned or managed by central or local government entities.[107] Improvements to these ownership and governance structures may be possible,[108] to reduce bottlenecks that otherwise result in a slower pace of planning and investment.[109] [110] Government also controls other levers that can impact on the freight system, such as regulation. Overcoming this fragmentation is needed so that we can make the best use of our national supply chain.

Other challenges for our freight sector include the following.

- The resilience of our supply chains to shocks and stresses, such as the COVID-19 pandemic,[111] adapting to climate change, earthquakes and cyber-attacks.
- The need to keep up with international trends toward much larger volumes of freight and increased efficiency.[112] This includes digitisation and automation of the supply chain and the introduction of bigger ships.
- Reducing freight sector carbon emissions to meet our net-zero carbon emissions target, as well as the need to adapt to evolving consumer preferences (such as for locally produced and eco-friendly products).[113]
- The impact of population growth on our freight system. This can reduce the availability of land used for storing freight and increase traffic congestion, making it slower to move freight.[114]

New Zealand's regions are connected by infrastructure

Figure 19: Selected seaports, airports, road and rail connections



Source: NZTA (Highways), MPI, World Port Source (Seaports), LINZ (Airports and Rail). NZTA and LINZ spatial data is copyrighted under the Creative Commons Public License.

A national freight and supply chain strategy is needed to provide direction for the transport network.

Central and local government and the private sector need to work together to develop a strategy that can better coordinate planning across the entire transport network and prioritise investment. A National Freight and Supply Chain Strategy would look at all transport modes, the whole network and focus on removing barriers to moving freight on important routes. It would also need to adapt to the challenges facing the freight network and provide competition and choice for freight users. This strategy would feed into regional spatial planning and build on existing transport and freight-related strategies and planning, including the New Zealand Rail Plan,[115] Waka Kotahi's Arataki 10-year view[116] and regional strategies like the Auckland Freight Plan and the Western Bay of Plenty Urban Form and Transport Initiative.[117,118]

Regional spatial planning will support our international and domestic trade.

We need to plan ahead for the roads and other transport connections we need to move freight, as it can be hard to build these later, once other development has occurred. Protecting and purchasing land early can help keep costs down and safeguard an efficient future network. Regional spatial planning (see Table 3) is a tool for ensuring that the infrastructure needs of the freight network are part of the decision-making about how land is used. These plans can also ensure that planning for freight infrastructure is a part of economic, social and environmental strategies, supports Māori partnership and is consistent with Te Tiriti o Waitangi.

Table 3: Spatial planning

Regional spatial planning is long term, strategic planning for how land will be used in a region.[119] It gives infrastructure and planning institutions the means to engage and collaborate with each other, mana whenua, the private sector and communities. Spatial planning brings together key public services, physical and non-physical, across a defined area to identify how to respond to long term service delivery needs. While spatial planning can occur at a national or local scale, it is usefully applied at the regional level. Sound governance arrangements are needed for this to succeed.

Spatial planning is an opportunity to rethink how we plan infrastructure and services to keep pace with future population and economic growth. It uses 'place' as a framework for integrating and aligning infrastructure service provision.[120] Achieving this requires infrastructure providers, land use planners and other stakeholders to develop a shared framework for how cities and regions should grow and change over time. Spatial planning should cover issues like how we open up opportunities for homes and businesses to be built, how we will meet the needs of future residents with infrastructure networks and social infrastructure like schools, parks or hospitals and how we manage natural hazards and protect areas with environmental or cultural significance.

Good spatial planning allows for a range of alternative futures over an extended timeframe, such as faster-than-expected growth that could result in a city's population doubling or tripling in the long term.[121] It addresses housing supply and affordability, manages pressure on infrastructure and provides for future economic activity and export activity, as well as rural lifestyles, particularly in regional areas. Plans should avoid prescriptive rules about where people will live and work, in favour of a long term view to identify, develop and build agreement around significant region-shaping future projects.[122] A spatial plan does not sit in isolation. There are a range of supporting planning documents required that need to be consistent with a spatial plan, including district plans and infrastructure funding plans.

History shows that identifying and protecting future infrastructure networks is a crucial part of regional spatial planning. The 1811 Commissioners' plan for New York City set out the street grid for all of Manhattan at a time when only a small portion was inhabited. This street grid is still used today. Barcelona's Cerdà plan looked to how the city could expand beyond its medieval city walls,[123] while

Copenhagen's 1947 Finger Plan[124] laid out future transport networks and regional parks that have accommodated significant growth. These plans have adapted well to economic and population change, some of which could not be anticipated when they were first developed.[125] For example, allowing for wide, straight roads made it easy to build subway systems in New York and Barcelona.

Spatial planning should use a depth of evidence and data to inform regional growth and provides opportunities to apply new smart city technologies. It should be supported by good information on how much growth infrastructure networks can manage and options for upgrading them. Digital twins could be applied to spatial planning to bring real-time data on asset condition and usage into the planning process and establish consistent data standards across regional spatial plans to ensure comparability throughout New Zealand.

Using technology to improve regional advantage and adapt to rapid change

Digital connectivity can transform regional New Zealand.

The long term trend of increasing speed and coverage, as well as the falling cost of digital connections, is an opportunity for New Zealand's regions.

Digital connectivity can transform the way infrastructure services are provided in regional New Zealand, particularly within rural areas, by closing the disadvantage caused by distance. For example, where people in more remote areas might have previously needed roads to connect to work, cellphones and internet access are an increasingly good substitute for a broader range of jobs.

Digital connection is essential for a wide range of economic, social and cultural connections including work meetings, online banking, remote learning, virtual health consultations and applying for government services like passports or car registrations. Case Study 4 highlights the benefits of telehealth, which can improve access to health services if people have good digital connectivity.

Case Study 4: Telehealth

Telehealth has the potential to reduce demand for physical healthcare infrastructure through the following services:

- On-demand virtual urgent care: a direct alternative to emergency department visits.
- Virtual office visits: a direct alternative to general practitioner consults.
- Virtual home health services: services such as patient and care giver education, physical therapy, occupational therapy and speech therapy can all be delivered remotely.
- Tech-enabled home medication administration: where patients can receive some drugs from home.

Telehealth and healthcare services at-a-distance can be demonstrated across the three following emerging technologies with proven application.

- **Artificial intelligence** can enhance the quality of healthcare services including keeping people well, early detection of disease, diagnosis of illness and providing optimised treatment options.
- The **Internet of Things** can increase the availability of data related to the performance, impact and monitoring of medical devices, individual health and health infrastructure. Devices and sensors can be implanted or worn that can measure health performance, trigger alerts and send reports to medical professionals when issues are detected.
- **Augmented reality and virtual reality** increase the ability to deliver healthcare services at a distance, such as conducting clinical appointments remotely.

The importance of telehealth services became apparent during the COVID-19 lockdowns, where 17 district health boards collectively experienced a 100-fold increase in telehealth consultations, to 34,500 per week, with evidence that some of these effects have been sustained.[126]

A national digital strategy will provide a pathway for quality digital access for all New Zealanders.

However, better technology comes at a cost and it's not always economically feasible for private providers to roll it out to parts of regional New Zealand without government support. Despite 86% of New Zealanders being connected to digital services, broadband quality varies across regional New Zealand (see Figure 20) and there are still significant gaps within rural communities.

> "The lack of accessible, affordable high-speed digital connectivity in rural areas remains a significant issue. It is an impediment to business, but it goes well beyond this; it is a significant barrier to maintaining vibrant rural communities." - Agribusiness Agenda 2021[127]

Options for shared ownership of infrastructure (as illustrated by Case Study 5) and new technologies like broadband via satellite networks, may help to bridge the gap.[128,129] However, a national digital strategy is required, which sets out a path for universal access to quality digital services and addresses issues of equity and disadvantage. This is fundamental for the wider infrastructure system.

Case Study 5: Shared ownership of cell phone towers in rural New Zealand

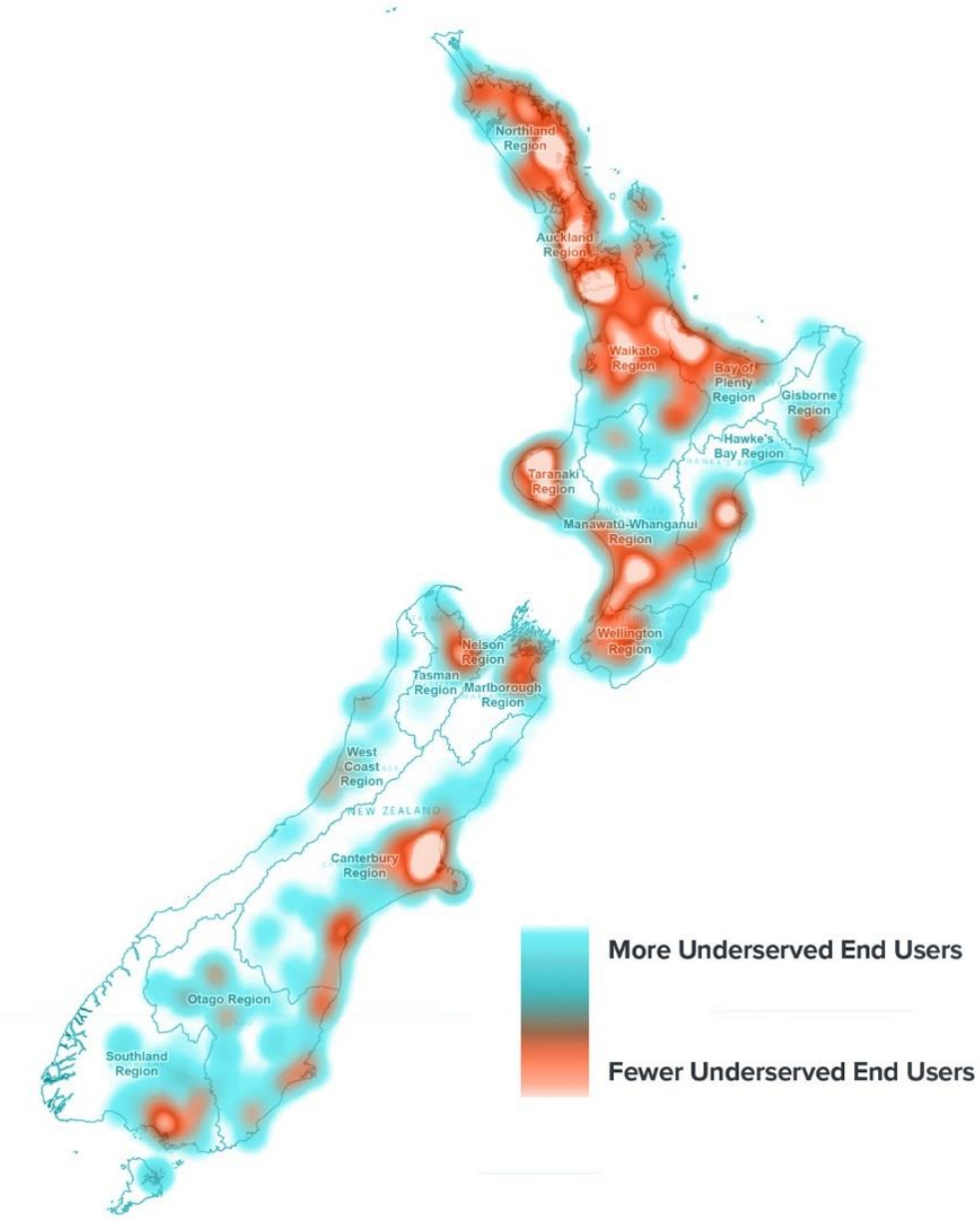
It can be challenging to provide telecommunication services to less populated rural areas because there may not be enough customers to pay for the required infrastructure. In response to this, a shared ownership model for rural cell phone towers has been used to increase network coverage in regional New Zealand.

Crown Infrastructure Partners contracted the Rural Connectivity Group, a joint venture between Spark, Vodafone and 2degrees, to provide essential network infrastructure. The three telecommunication firms have been incentivised to work together in delivering new rural broadband and mobile services to approximately 34,000 rural households and businesses, which makes significant headway in bridging the digital divide for rural New Zealand. The initiative was funded by the government's Rural Broadband Initiative Phase Two and Mobile Black Spot Fund programmes.

These arrangements have removed barriers to market entry and industry collaboration and encouraged greater commercial competition. This has improved the affordability and availability of telecommunication services in rural areas and enabled more people to access digital services, with a greater number of people working, learning and running their own businesses from their rural homes.[130]

Broadband quality is variable across New Zealand

Figure 20: Underserved broadband end users by quality



Source: Crown Infrastructure Partners

6.2.4. Recommendations

No.	What	How	Who	When	Ref.[3]
S2.1	**Improve efficiency and security of freight and the national supply chain**	In developing a long-term National Freight and Supply Chain Strategy, government should: a. Include airports, ports, road, rail and coastal shipping. b. Ensure it is integrated, resilient and multi-modal. c. Identify infrastructure options to improve efficiency, sustainability and security. d. Assess the appropriateness of regulatory and market structures. e. Recommend reforms and investments that will enable the more efficient movement of freight, provide freight users with competition and choice. f. Build national freight and supply chain data capabilities for capturing and sharing securely to improve efficiency. g. Investigate the development of a National Location Registry, where attribute information about physical pickup and delivery locations is digitally stored and accessible to authorised users, leveraging the recent experience of Australia. The Registry should be sensitive to confidential information and privacy concerns.	MoT	2022-2026	FSE, NFD, NLR, NSC

[3] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[3]
S2.2	**Reduce barriers and costs of providing infrastructure services**	In developing a National Digital Strategy, government should: a. Prepare New Zealand for realising the full benefits of a connected digital society, establishing regions where 21st century talent wants to live. b. Fix digital black spot areas and ensure universal access to digital services and skills that remove the limitations of physical distance from major markets nationally and internationally. c. Leverage changing social and economic patterns arising from COVID-19 and rising urban house prices to support the development of regional areas. d. Identify and set out a plan to resolve key telecommunication system resiliency issues. Review infrastructure standard requirements for affordability across regions and infrastructure sectors. Broaden requirements to allow for on-site solutions and other low-cost design when similar service levels are possible.	DIA, MBIE	2022-2026	PTC
S2.3	**Reduce population uncertainties for infrastructure demand, planning and delivery**	Establish a National Population Plan that: a. Presents a preferred population pathway over the next 50 years. b. Provides direction for regional spatial plans. c. Identifies supporting policies required for New Zealand to capitalise on the benefits of greater population, while managing and minimising the costs of growth. Regularly review and publish best practice advice to improve population projection accuracy. Require local governments and other public infrastructure providers to test significant infrastructure projects and investment plans against high and low projections, as well as medium projections.	Productivity Commission, Statistics NZ, MBIE	2027-2031	AIP, GFI

No.	What	How	Who	When	Ref.[3]
S2.4	**Prepare for zero-emissions commercial electric flights**	Prepare existing airport infrastructure for zero-emissions commercial electric flights and leverage wider export opportunities. Measures will need to: a. Develop the requisite training for existing and new pilots and for the maintenance of electric aircraft. b. Prepare power and charging infrastructure networks and capabilities. c. Develop a network of charging stations across New Zealand airports so that alternates are available, in the case of service disruptions. d. Coordinate charging standards to ensure that a wide variety of aircraft can utilise charging equipment. e. Investigate export-ready applications, such as pilot and maintenance training.	MoT, CAA, Airports and Airlines	2022-2031	EAF

6.3. Building attractive and inclusive cities

Te hanga tāone ātaahua, whakakotahi hoki

New Zealand's cities are growing. Our infrastructure and planning policies make them attractive and inclusive places to live, work and play.

Today, 56% of the world's population lives in cities, a proportion that will increase to 68% by 2050.[131] People are attracted to cities by the many work, social and cultural opportunities they offer. In bringing people together, they are also centres of innovation and economic opportunity. The 300 largest cities in the world now account for nearly half of all global economic output.[132]

For more than a century, most New Zealanders have lived in towns and cities.[133] In 2018, New Zealand's five largest cities and their satellite towns accounted for 64% of the New Zealand population.[134] More than two thirds of all population growth to 2050 is expected in just the 3% of land that contain our cities.[135]

There are many ways to define what a **city** is. For this strategy, we're using it to mean areas that are big enough to face 'urban' challenges like peak time traffic congestion. In New Zealand, these places range in size from Queenstown to Auckland. Different places in and around cities may face different infrastructure challenges.

However, our cities face some major challenges. They can be congested, crowded, unaffordable and polluted. Addressing these challenges can unlock the potential of our cities. They can use less energy, provide higher wages and greater productivity and can even result in better health for their residents.[136] To leverage our cities for the benefit of all New Zealanders, we need world class infrastructure that builds on the competitiveness of our cities, safeguards inclusivity and access, promotes the affordability of housing and ensures New Zealand has a place on the global stage.

Our cities need to be attractive and inclusive places to live.

- **Attractive** cities succeed in attracting migrants and retaining New Zealanders because they offer affordable housing, good access to jobs and education and good quality of life.
- **Inclusive** cities offer opportunities for all, regardless of income, age, ethnicity, gender, disability status, or other personal characteristics.

6.3.1. Context

Housing and land prices are high by international standards.

Auckland is now one of the world's most severely unaffordable cities, with a median house price that is 10 times the median household income.[137] All large and mid-sized New Zealand cities have median house prices well over five times the median household income. Since 2000, average house prices have quadrupled in Auckland and tripled in other large, fast-growing cities, including Christchurch, Wellington, Hamilton and Tauranga. Average rents have more than doubled in these cities.[138] Wages have not kept up and New Zealanders now spend more and more of their incomes on housing.[139] There is also a housing shortage. This affects many New Zealanders, particularly Māori and Pacific peoples,

who are less likely to own homes. This housing shortage also means that the most disadvantaged in our society are more likely to live in damp or mouldy homes, experience overcrowding and have poor health and wellbeing as a result.[140,141,142]

There are many issues that are holding us back from building new housing.[143] These include planning policies that limit the height or number of homes that can be built in some areas, insufficient water and transport infrastructure to support new homes and difficulties gaining consents for new housing. Other barriers include challenges to accessing development finance, a building industry that can't keep up with demand and at present, hold ups in the supply of building materials. These constraints are estimated to increase land prices on the edges of our cities by over $200,000 per section in Auckland and Queenstown and between $90,000 and $140,000 in Wellington, Tauranga, Hamilton and Christchurch.[144] The impacts are even higher in inner-city areas, where councils have stricter limits on development.[145]

Poorly performing infrastructure affects our economy and our quality of life.

The infrastructure problems in our cities can affect all of us. By delaying freight and business travel, road congestion in Auckland is estimated to have direct and indirect impacts that are equivalent to 0.5% to 0.9% of the city's gross domestic product.[146] This is on top of the problems it creates for the people who lose personal time while sitting in traffic and the stress this causes.[147] As the population of our cities increases, so will the pressure on road networks.

When infrastructure fails or performs poorly, it is often the disadvantaged who feel it most acutely since they have fewer options. Those with resources easily find alternatives. When energy networks are disrupted or water quality is compromised, they can afford off-grid alternatives like solar power and rainwater collection systems. When congestion worsens, they can afford to live in inner-city locations. These options are not available to people on lower incomes who can't afford to pay for alternatives. Infrastructure is also often poorly designed for people with disabilities.[148]

Historically, the way we have planned and built infrastructure has also had impacts on Māori as land and customary rights were used.[149] An example is the Ōrākei wastewater scheme, constructed in Auckland in 1914, which disposed untreated sewage from Auckland's growing suburbs into the Waitematā Harbour.[150] Sewage outflows contaminated shellfish beds belonging to local iwi, Ngāti Whātua, which had unsuccessfully opposed the scheme.[151] The completion of the Māngere wastewater treatment plant in 1960 allowed the Ōrākei outflow to be closed, but still caused pollution in Manukau Harbour.

What is different about Auckland?

As New Zealand's largest city, Auckland's performance affects all of us.

- Auckland is critical to attracting and retaining migrants and businesses, as it is the only New Zealand city that is big enough and has the international connections to compete with larger Australian cities.[152]
- Auckland's firms and workers contribute more to the economy than similar firms and workers elsewhere in the country.[153]
- Auckland pays as much or even more in taxes than it receives from the government. This is because it has received less government spending, per person, than most other regions in the past.[154]

Auckland also faces some significant challenges.

- House prices and rents are extremely high, which erodes the advantages of living in Auckland, encourages professionals, skilled workers and others to move to Australia and increases pressure on house prices elsewhere in New Zealand.[155]

- Auckland has significant infrastructure issues, including traffic congestion, that makes it more difficult to access jobs and education.[156] It is also expensive to fund the infrastructure needed to keep up with the city's growth.

6.3.2. What we heard

"Our cities can't keep up with growth" was ranked as the sixth most important infrastructure issue facing New Zealand by respondents to the Aotearoa 2050 survey. During our consultation, we also received submissions in favour of changes to urban planning rules, improvements to transport infrastructure in our cities, congestion pricing (provided options or alternatives were available so those on lower incomes would not be made worse off) and lead infrastructure corridor protection, which is where areas of land are protected from development so they can be used for the infrastructure we know we'll need in the future. Both the consultation and the Aotearoa 2050 survey revealed support for low-carbon transport options. Many submitters also supported telecommunications improvements.

The government currently has a number of reform programmes underway that will affect infrastructure in our cities. These include Resource Management Reform, Three Waters Reform and the Local Government Review. Some submitters expressed reservations about aspects of these programmes and asked for Te Waihanga to take a clear position.

We also heard support for addressing issues around housing supply and affordability and the need to consider housing, employment, water and transport in infrastructure planning.

6.3.3. Strategic direction

Taking a long term approach to our infrastructure

We need long term protection for future infrastructure networks as our cities grow.

By 2050, up to 4.8 million people will live in or near New Zealand's five largest cities.[157] To meet this growth, we need to plan for infrastructure networks before they're needed. Otherwise, it can be difficult, if not impossible, to provide them later. This increases the likelihood of future problems such as traffic congestion and a lack of good public transport options.

Preparing for future infrastructure should look at all the different types of infrastructure and transport that will be needed. It should consider:

- The potential for rapid transit networks in existing and future urban areas, even if they may not be needed in the near future.
- How land can be adapted if needs change. For example, land that is protected for a long term rapid transit corridor could instead be used for a busway or rail line, or converted to other uses.
- Designing street networks so they provide for current and future needs. For instance, street grids that distribute traffic across many routes may be better in the long term than street layouts that feed all traffic into a small number of major roads.[158]

It sometimes makes sense to invest in new infrastructure ahead of housing and commercial development in growing areas. However, this can be costly and financially risky. An alternative option is to identify, protect and acquire corridors of land and sites for future infrastructure. This ensures that land is available to provide infrastructure in the future, while also allowing for flexibility in how and when to develop that infrastructure.

We need to remove unnecessary barriers to protecting land for future infrastructure. Resource management reform should make it possible to allow for flexibility in how infrastructure corridors can be used in future. The reform should also enable corridors to be designated well in advance of urban

growth. Current legislation typically only provides protection for five years at a time, which drives up costs.

Finally, the Public Works Act 1991 requires infrastructure providers to buy land as soon as it is designated if the owner would experience hardship from the designation. The alternative is to lift the designation. A dedicated fund for buying corridors of land for future infrastructure needs, supported by a strong set of principles on how it can be used, is needed to make advance property purchases.

Integrating land use regulation and infrastructure

Coordinated regional spatial planning will ease the pressure on infrastructure and housing as our cities grow.

Regional spatial planning is long term, strategic planning for how land will be used in a region (see Table 3: Spatial planning in Section 6.2). This requires infrastructure providers, land-use planners and other stakeholders to develop a shared framework for how to accommodate future population and economic growth while managing impacts of growth on infrastructure and the environment. A good regional spatial plan should allow for alternative futures, such as population growth that's faster than expected, rather than tightly constraining growth.[159] It should be supported by good information on how much growth infrastructure networks can manage and options for upgrading them. This will help to address housing supply and affordability and manage pressure on infrastructure.

Standardising the planning rulebook will provide greater integration between land-use planning and the provision of infrastructure.

The recent National Policy Statement on Urban Development requires councils from our largest cities to provide for housing growth, both 'up' through apartments and high-rise buildings in inner city areas and around rapid transit stations and 'out' through new homes at outskirts of cities.[160] This will enable more homes to be built throughout urban areas. There is a need to monitor progress and strengthen policy directions if needed, for instance by requiring independent hearings panels to review plans.

There is also a need to standardise some planning rules across councils, so developers have greater certainty and clarity. At present, people seeking to build similar homes in different councils often face complex and varying rules. Standardisation should focus on residential and business zoning or rules about transport and utilities where there are strong benefits from a consistent approach, rather than issues where local differences may be more important, such as water regulation. Each council should still have the chance to decide which areas are to be used for homes and which are more suitable for business use.[161]

Coordination across local government boundaries is needed in growing urban areas.

More and more people live in one council area and commute to work in another, as shown in Figure 21. For instance, the share of workers commuting across council boundaries in Hamilton, Waikato and Waipā districts more than doubled between 2001 and 2018. There is an increasing need to coordinate transport infrastructure and public transport service planning across council boundaries to ensure that cross-border journeys work well. Urban planning also needs to be coordinated to ensure that housing can be developed in the right places. Case Study 6 discusses some potential benefits from amalgamating local government in growing urban areas. The review of local government is an opportunity to address this issue.

Case Study 6: Benefits of amalgamating local government in growing urban areas

The growth of our cities and changes to how people live, work and travel are placing increasing pressure on local government structures that were established over 30 years ago. There is a need for:

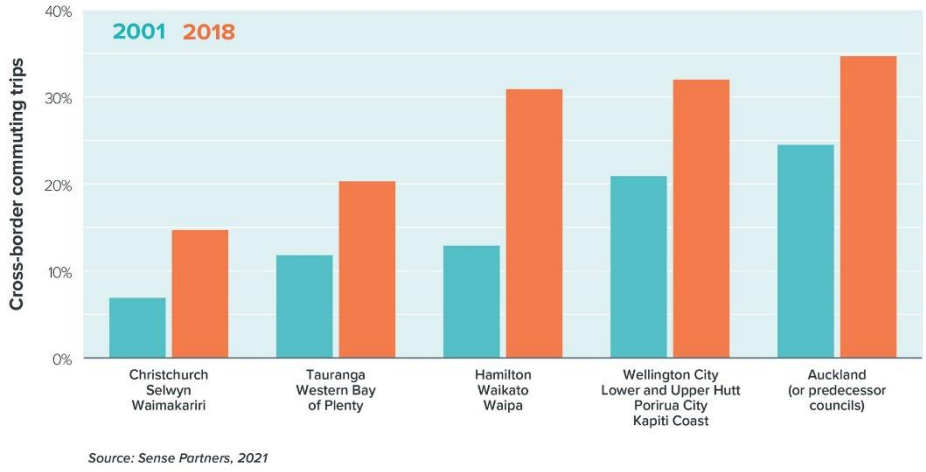
- Coordinating planning for transport infrastructure and public transport services across council boundaries so that travel across boundaries is seamless and bus routes are supported with the right local road infrastructure.
- Coordinating urban planning policies across council boundaries to ensure that planning rules are consistent throughout the city and housing can be developed in the right places.
- Councils with the right capability and capacity to deliver regionally significant projects.

Amalgamating local government in growing urban areas is one way to address these issues. The Organisation for Economic Co-operation and Development (OECD) found that a reduction in the number of local government bodies is associated with faster growth in regional GDP per capita in urban areas, but not in rural areas.[162] This is most likely to be a result of better coordination and service provision. The same relationship is observed in New Zealand.[163] Notably, Auckland, where local government was amalgamated in 2010, is the only region in New Zealand where GDP per capita growth was faster in the 2010s than in the 2000s.

To illustrate why coordination is increasingly important, Figure 21 shows that the share of people commuting across council boundaries has risen significantly in New Zealand's five largest cities as they have expanded. It's likely that cities will become larger and more integrated across council boundaries in the future.

The number of commuting trips across local government boundaries has increased substantially

Figure 21: Share of all commuting trips that traverse local government boundaries from 2001 to 2018



Source: Sense Partners' analysis of census home and workplace location data[164]

For these reasons, amalgamating some councils is likely to have the greatest benefit for New Zealand's fast-growing cities. But it's not a 'one size fits all' approach. It is unlikely to have benefits for rural areas and smaller urban areas where there are fewer issues that relate to their boundaries.

Easing pressure on our infrastructure networks

Congestion pricing is the best way to ease traffic congestion in New Zealand cities, but needs to be fair for everyone.

In the past, transport agencies worldwide have attempted to reduce peak hour traffic congestion by building or widening roads. This hasn't worked. Rather than improving travel times, it has tended to encourage more people to drive.[165] This effect can be seen on some of our recently widened urban motorways where journeys are still slow and unreliable.

Congestion pricing and road tolling have been proven to work in reducing traffic congestion and should be considered in cities where this is currently a problem or is likely to become one. Congestion pricing in Auckland is expected to reduce congestion at peak times by 8 to 12%, generating significant social and economic benefits.[166] The experience of congestion charging in the Swedish city of Stockholm highlights some of the potential benefits (see Case Study 7).

Congestion charging can also contribute to reducing carbon emissions.

Congestion pricing can be an effective way to incentivise residents toward low-carbon transport alternatives, by raising the cost of using a private vehicle relative to public transport and active modes. One recent study found that some congestion pricing schemes have a significant impact, accounting for emissions reductions of more than 10%.[167]

Case Study 7: How Stockholm implemented congestion charging

When it trialled congestion charging in 2006, the Stockholm urban area had nearly 2 million residents. Approximately 320,000 people were employed in the inner city and more than 210,000 commuted from outside the inner city.[168] Car users faced significant delays while crossing congested bridges into the inner city during peak hours.

A congestion charging scheme that charged all traffic entering the inner city was trialled from January to June 2006. The trial was considered a success and most Stockholm City residents voted in favour of making it permanent in a public referendum held that year. As a result, the charge was made permanent in 2007.

Public support for congestion charges has grown from 54% at the time of the referendum to 70% in 2011.[169]

Congestion charging has significantly improved the performance of Stockholm's transport network. Traffic volumes on these roads dropped by 20%, as fewer people made unnecessary car trips and car and bus travel speeds improved.[170]

The money collected through the scheme was used to fund the equivalent of NZD$15 billion of transport projects in the city. This included a significant expansion of bus services to cope with increased demand for public transport. This helped ensure fairness and reduced any impact on lower-income users. No discounts were offered as it was assumed that Sweden's comprehensive welfare system would help those on lower incomes manage the costs.[171]

More public and active transport will give people alternatives to paying a congestion charge.

Improvements to infrastructure for public transport, walking, micro-mobility such as e-scooters and cycling need to be made when congestion charges are introduced, if these options are not already available. This will give people alternatives to driving, lower congestion charges for those who do need to drive because others will be willing to shift in response to a smaller charge[172] and increase public acceptance of congestion charging.[173] Complimenting congestion charging with more flexible zoning policy will also allow for more housing choice inside the congestion charge zone and provide a further option to avoid the charge. In some cases, subsidies may also be needed for those on lower incomes, people with disabilities or others who face significant barriers to paying the charge.

By shifting travel demands, congestion charging will change the way we invest in our transport infrastructure. It could mean that in the short term, we can choose not to widen roads that no longer have issues with traffic congestion and instead increase public transport capacity to cater for increased demand. However, in the long term, even with congestion charging, there will be a need to increase road and public transport capacity to provide for rising travel demands. The results we see from

congestion charging should inform decision-making about when and where to build new transport infrastructure.

Better designed developments can ease pressure on the road network.

There is limited space for creating new roads or public transport routes in areas that have already been developed. Where possible, new development should be planned and designed so that it reduces demand on our roads (see Case Study 8). This can be achieved with transit-oriented development (TOD), which increases housing development near train or other rapid transit stations and mixed-use development, where homes, commercial buildings and shops are combined in an area so people don't need to drive to get to these places.[174,175]

Both developers and infrastructure providers will need to plan carefully and implement consistently to make these changes work.[176] Encouraging people to live near transit stations and use public transport requires streets that make it easy and safe to walk from home to a station. The amount of on-site parking that is supplied with new development can affect people's decisions about how many cars to own and how to travel.[177,178]

Case Study 8: Transport and land use integration at the City Rail Link's Mt Eden Station

Auckland's City Rail Link is described as "Auckland's most transformational place-shaping project" because it will make major changes to the way people live and travel in the city.[179] It will double the number of Aucklanders who live within 30 minutes travel of the central city, especially in West Auckland.[180] This will encourage the development of more homes near rail stations.

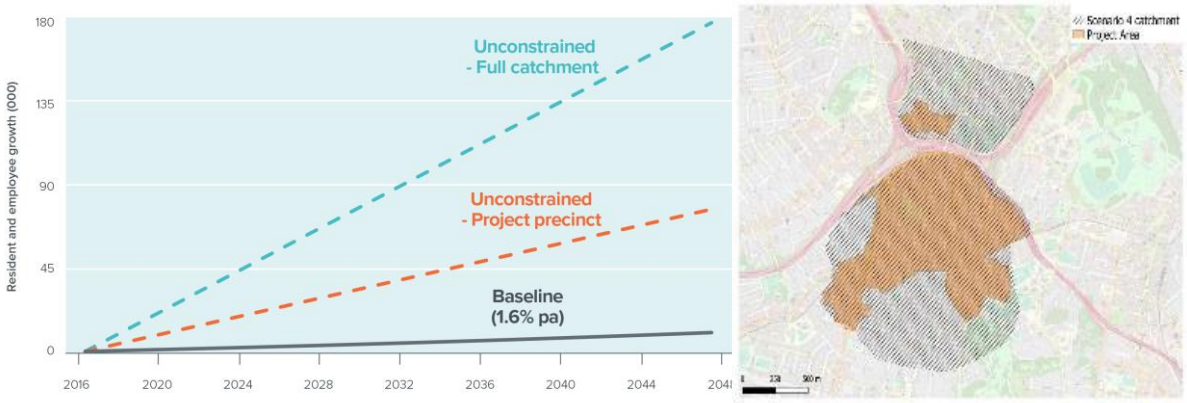
There's an opportunity for significant redevelopment in a 112 hectare area around the new Mount Eden station, which will be only a six minute ride from the city centre.[181,182] City Rail Link Limited owns 3.2 hectares of land close to the station, most of which will be available for development once the station is built.

Even without the City Rail Link, Mount Eden is an area that is attractive to developers. But it will be important to make sure that infrastructure, planning rules and development work together to get the best results. For instance, insufficient water infrastructure and rules protecting views or preventing demolition of older buildings can limit the number of homes that could be built. One study estimated that the demand for housing in the project area was 5 to 12 times higher than the amount that could be supplied without changing planning rules.[183] This raises concerns that the development could result in greater unaffordability, unless planning rules are made more flexible and enabling.

Lessons from the Mount Eden precinct development should inform development around transit stations. There is a need to:

- Establish outcomes, expectations and mandates as early as possible.
- Ensure there is an agreed understanding about how transit infrastructure, homes and other development can be designed to work together.
- Provide a planning framework that allows for flexibility and change.
- Better coordinate funding and delivery of infrastructure.

Figure 22: Existing aspiration is a fraction of estimated demand in station catchment
Panel A: Net population growth projects **Panel B:** Project area map



Source: Auckland Council land use modelling scenario I11.4, CRLL, PwC

Note: The project precinct unconstrained scenario relates to the project catchment area and excludes areas within the station catchment but outside the CRL project area. The full catchment scenario includes a wider assessment of the area to benefit from the new stations. Baseline represents growth assumed in Scenario I11.4 of Auckland Council's land use model. Projected demand in each scenario is calculated using the empirical city-wide relationship between land values and density, incorporating the additional value of the City Rail Link. Planning rules were assumed to be fully enabling of demand.

Remote working may reduce the load on city roads over time.

Improvements in technology have made remote working easier and more attractive. The potential for more people to work from home has been seen during the COVID-19 lockdowns. During New Zealand's alert level 3 and 4 lockdowns in 2020, 42% of employed people worked from home at least part of the time and many organisations adopted remote-working tools and developed flexible working policies.[184] This trend should be monitored as remote working could be used to reduce the load on urban transport networks.

Good incentives are needed to provide quality water infrastructure at an affordable cost.

The cost of maintaining existing water infrastructure and building new water networks to cope with growth is a challenge for growing cities.[185] A lack of water infrastructure can put a handbrake on housing development.

The current Three Waters Reform offers an opportunity to improve the way we provide water infrastructure in growing cities. Reforms can improve the ability of water providers to respond to the need to renew ageing infrastructure, improve water quality and provide for growth.[186] Performance-based economic regulation, which requires high-quality service for both existing and new users and sets incentives for providing services at a more affordable cost, is important for achieving this. This approach is already used in sectors like telecommunication and electricity distribution.[187]

Water and wastewater metering and water conservation can reduce water use and wastage.

We need to improve water conservation and management to reduce the need for costly ratepayer-funded drinking water, wastewater and stormwater infrastructure. This can be done by creating

incentives for users and providers to conserve water, such as charging for use of water, removing regulations that make it hard to take steps to save water such as rainwater collection and ensuring that consumer standards support water conservation.

Volumetric charging for water and wastewater can reduce the amount of water that is wasted. After water meters were introduced, daily water use declined by 25% in Kapiti Coast and 30% in Tauranga during peak periods.[188] Volumetric charging may need to be accompanied by targeted assistance for low-income households and disadvantaged users.

Volumetric water charging should also happen alongside other measures that make it easier for people to save water. Rainwater harvesting and buffer tanks for stormwater or wastewater flows can increase the share of water that's captured and used on-site and reduce the amount of water needed from the network.[189] However, there are barriers to adopting these solutions, such as resource and building consent requirements for rainwater tanks.[190] These barriers should be reviewed and reduced wherever possible.

6.3.4. Recommendations

No.	What	How	Who	When	Ref.[4]
S3.1	**Improve water infrastructure pricing and provision in cities**	Specific actions for new water entities include: a. Implementing performance-based economic regulation and water quality regulation to ensure that water entities are incentivised to drive efficiency and deliver excellent customer service. b. Ensuring the availability of infrastructure for growth, funded by appropriate infrastructure growth charges or other 'user pays' funding tools. c. Allowing volumetric water charges and volumetric wastewater charges for large wastewater sources. d. Allowing entities to use their balance sheet capacity to finance infrastructure for growth, as well as funding asset renewals and improvements to water quality. e. Clarifying the interface between new water entities and developer-financed water infrastructure provided under the Infrastructure Funding and Financing Act 2020. f. Ensuring that developers can benefit appropriately from the provision of infrastructure that has spare capacity. g. Developing cost benefit analysis guidelines to standardise evaluation decisions of water infrastructure against social, environmental and economic benefits	DIA, Local Government (or new water entities), economic regulator	2022-2031	WSA, LFF, MHT

[4] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[4]
S3.2	**Reduce pressure on water infrastructure through better water management and conservation**	Steps that should be taken to reduce pressure on water infrastructure include: a. Designing water and wastewater charges to incentivise conservation. b. Using planning rulebooks to encourage on-site solutions. c. Removing regulatory barriers to water conservation, such as consent requirements to install rainwater harvesting tanks or on-site stormwater management devices. d. Setting performance standards that improve water performance of appliances.	Local Government (or new water entities), MfE	2022-2031	GIW
S3.3	**Amalgamation of local government where appropriate, to improve coordination of infrastructure and planning outcomes in high growth urban areas**	Local governments should be amalgamated where appropriate, to better align key infrastructure and planning decisions. Amalgamation decisions should be guided by: a. An evaluation of adjacent territorial authorities and their role within wider urban labour markets. b. Costs and benefits from integrating regional planning and infrastructure provision. c. Commuting and urban growth patterns. d. Funding streams aligned with best practice principles of infrastructure. Amalgamation should consider mechanisms for local voices to continue to inform decision-making.	DIA, Future for Local Government Review	2027-2031	LMA

No.	What	How	Who	When	Ref.[4]
S3.4	**Increase supply and use of low emissions transport modes**	Transport network planning and funding entities should: a. Improve the quality, speed and reliability of public transport to major employment centres. b. Improve active transport infrastructure, starting with low-cost solutions such as improving pedestrian crossings and reallocating existing road space to provide safe cycling facilities. c. Reduce barriers to cost-effective implementation of low emission transport modes and streamline costly resource management and local government consultation processes. d. Increase certainty of funding for low emission transport modes to scale up efficiently. e. Ensure all options considered for investments are subject to appropriate cost benefit analysis.	Ministry of Transport, Waka Kotahi, Local Government	2022-2041	TCQ, ITN, INH
S3.5	**Reduce costs by optimising infrastructure corridors**	Enable planning and protection of infrastructure corridors in advance of growth through the following steps: a. Develop a lead infrastructure policy and supporting guidance that provides a clear definition of lead infrastructure. The policy should include evaluation techniques for decision-making b. Amend resource management legislation to extend the duration of designations to 30 years and allow designations to be granted based on concept plans. Statutory tests for designations should be based on an established evaluation methodology. c. Establish a corridor reservation fund with a secure funding source that can be used for early corridor protection activities, such as buying designated or identified sites in advance.	MfE, supported by Te Waihanga and infrastructure providers	2022-2031	BUP, CPR, ATA, ITA

No.	What	How	Who	When	Ref.[4]
S3.6	**Optimise the use of urban land**	Review central and local government land holdings to identify opportunities for land swaps, releases of land for development and relocations of major public facilities.	Central and Local Government	2032-2041	ULH, CBG,
S3.7	**Optimise transport investment by considering non-built transport solutions first**	Prioritise investment in non-built solutions, including: a. Using price mechanisms to manage demand. b. Lowering the cost of public transport at non-peak times. c. Real-time parking pricing. d. Making better use of existing space to speed up public transport. e. Using land use policies, like transit-oriented development or mixed-use development, to reduce the need for travel.	Waka Kotahi, Local Government	2022-2031	INH, NOF
S3.8	**Improve the efficiency and consistency of urban planning by standardising planning rulebooks**	Standardise planning policies of regional and district plans. This should: a. Establish national uniform definitions for land use policy. b. Develop a National Planning Framework that appropriately standardises rules, with local authorities required to adopt these rules with limited variations. c. Make consistent provision for papakāinga housing on Māori land and other forms of community housing. d. Merge regional and district plans into 14 combined plans.	MfE, MHUD	2022-2026	RAN, BUP, JUL
S3.9	**Improve delivery of transit-oriented development (TOD)**	Undertake post-implementation reviews of recent TODs. These reviews should: a. Reflect international best practice, be independent and assess actual performance against appraisal, cost schedule and benefits. b. Include recommendations for future TODs.	Ministry of Transport, Waka Kotahi	2022-2026	TSS

No.	What	How	Who	When	Ref.[4]
S3.10	**Improve efficiency and outcomes of infrastructure through spatial planning**	Resource management reforms should include requirements for regional spatial plans that: a. Are consistent with district plans and funding plans. b. Include a mechanism for participation by relevant central government infrastructure suppliers and Māori. c. Require regional spatial plans to provide for cities to double or triple in population and provide alternative scenarios for the spatial distribution of growth, rather than providing for only a single growth scenario. d. Identify future infrastructure requirements, including future transport networks and other major infrastructure.	MfE	2022-2026	BUP, RAN
S3.11	**Reduce congestion and improve urban mobility**	Implement congestion pricing and road tolling in urban centres. Steps should include: a. Implement recommendations from the "The Congestion Question" report for congestion charging in Auckland. Stage implementation as appropriate, considering current and future public transport arrangements. b. Immediately remove legislative barriers to implementing congestion charging and road tolling, such as requirements in the Land Transport Management Act for an alternative non-tolled route. c. Progress implementation on a congestion pricing scheme for Wellington. d. By 2025, identifying other urban areas where congestion pricing may be beneficial.	Ministry of Transport, Waka Kotahi, Local Government	2022-2031	TCQ, LGW, LFF
S3.12	**Target transport investment to areas of highest need using signals from congestion pricing**	Use data and pricing signals from congestion charging to identify where future multi-modal transport investment is needed.	Waka Kotahi, Local Government	2032-2050	LFF,TCQ, LGW

No.	What	How	Who	When	Ref.[4]
S3.13	**Increase housing development opportunities in areas with good access to infrastructure**	Improve development opportunities in areas already well served by infrastructure by: a. Accelerating implementation of the National Policy Statement on Urban Development (NPS-UD) and monitoring compliance, including requirements to upzone around rapid-transit and employment centres. b. Enabling greater urban development, including requirements for minimum levels of mixed-use zoning and upzoning. c. Removing legislative provisions that allow environmental protection arising from subjective amenities that constrain diversity in land use. d. Using national direction to set binding targets for increased housing and business capacity commensurate with future growth expectations, guided by land prices in high-demand areas. e. Adopting independent hearings panels to review district plan changes, with statutory representation from Te Waihanga where appropriate to ensure infrastructure is given appropriate weight in planning.	Local Government, MfE, MHUD	2022-2031	BUP, RAN

No.	What	How	Who	When	Ref.[4]
S3.14	**Improve spatial planning through better information on infrastructure capacity and costs to service growth**	Improve information on the infrastructure cost implications of different growth possibilities by: a. Developing, validating and publishing a spatial model of long-run average infrastructure costs to service growth in different locations, to inform issues like regional spatial planning, local-government development contributions policy and the alignment of development capacity increases with infrastructure capacity and low-cost opportunities for development. This model should cover all relevant types of public infrastructure. b. Requiring water entities to publish geo-spatial information on water asset condition, capacity for growth in existing water networks and capacity for growth due to planned network upgrades. c. Developing a common approach to measuring the condition and capacity of water infrastructure assets.	Te Waihanga, infrastructure owners	2022-2031	CBD, WCB

6.4. Strengthening resilience to shocks and stresses

Te whakapakari i te manahau i ngā oho me ngā pēhanga

New Zealand faces a range of shocks and stresses. Our infrastructure is resilient in the face of these.

New Zealand is vulnerable to a wide range of shocks and stresses. These range from natural hazards such as earthquakes, tsunamis, floods and pandemics, through to manmade threats such as terrorist and cyber-attacks. While we cannot predict everything the future will bring, we do know that there's a high risk of some of these occurring. There is a very high likelihood of a catastrophic earthquake from the Alpine Fault during the next 50 years. We are going to experience more frequent floods and droughts as the climate changes. Cyber threats will become more widespread as digital technologies and the internet become increasingly embedded into the fabric of our society.

We might not be able to prevent these shocks, but we can do more to prepare for them. This can be challenging as our infrastructure is more complex than ever, and many parts of it are dependent on others. For this reason, we'll need to take a coordinated approach in our efforts to prepare for and respond to the risks we face. This will help to maintain or improve the capacity of our infrastructure to absorb and bounce back from shocks and stresses. Actively building resilience into our infrastructure is an important part of the legacy we leave for future generations of New Zealanders.

6.4.1. Context

Our infrastructure is vulnerable to hazards.

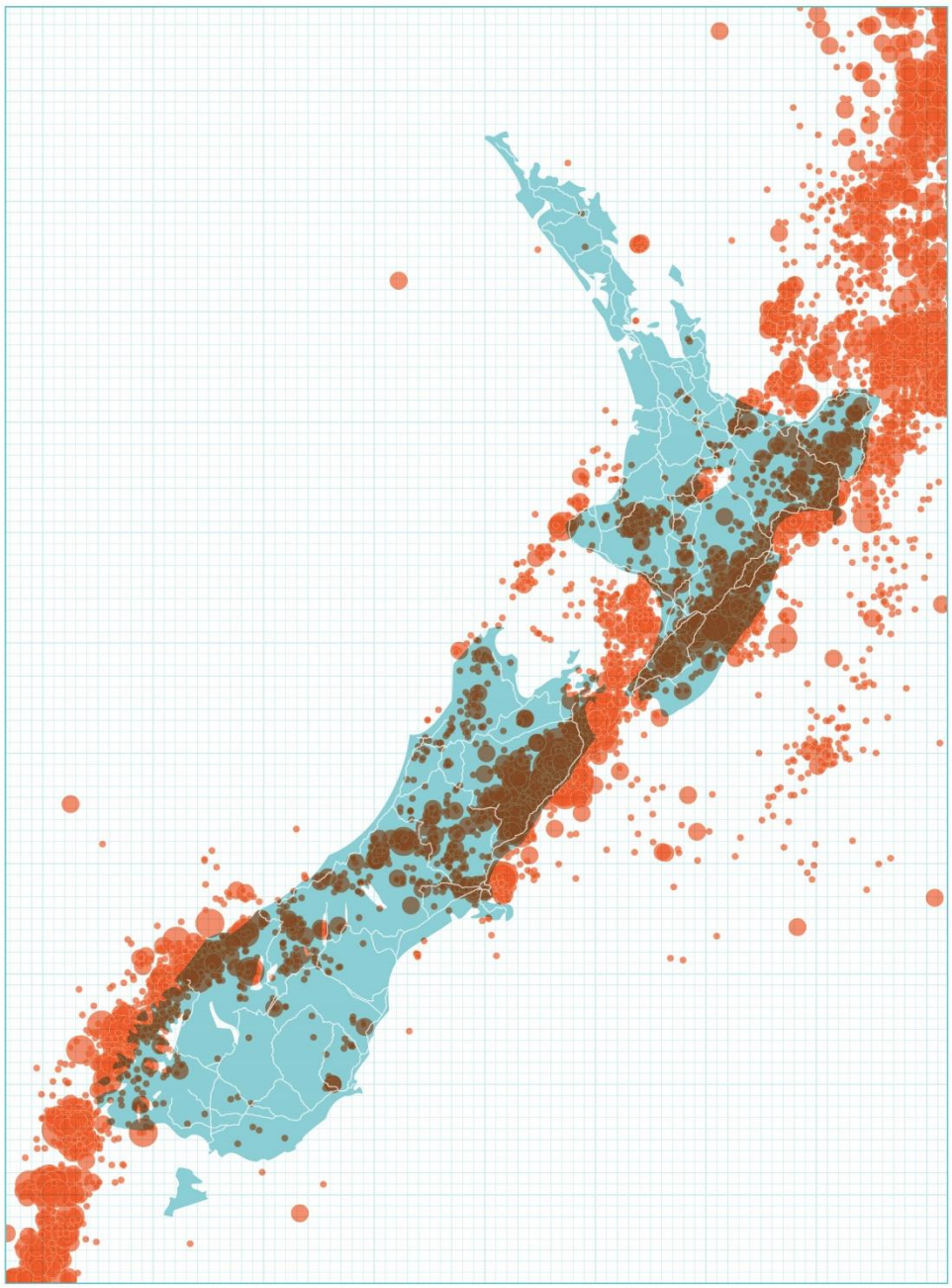
New Zealand sits on the boundary of two active tectonic plates and is at risk of natural disasters like earthquakes, landslides, volcanic activity and tsunamis. Earthquakes are frequent and widespread, as shown in Figure 23. There is a 75% probability of an Alpine Fault earthquake of magnitude 8, or greater, occurring in the next 50 years.[191]

Climate change also poses significant risks to New Zealand's infrastructure. It's increasing the number of storms and floods, as well as the risk of inundation due to sea level rise. New Zealand's geography, with its remote regions and hilly terrain, makes it harder to ensure infrastructure networks, like roads and power lines, are resilient to shocks and stresses. Adding to the challenge is the way infrastructure services rely on each other. This means that the impact of a disaster on one can affect another. There are some technologies, such as solar panels and battery storage, that don't always rely on a network and can help to provide a buffer for shocks. But for the most part, infrastructure networks are highly interdependent.

Manmade threats, such as cyber-attacks, are growing in prevalence and sophistication as infrastructure becomes more connected and reliant on technology. A high proportion of our economy now relies on our telecommunications infrastructure and the majority of our internet capacity is delivered through three critical sub-sea cables.

National state highway network and observed shallow earthquakes from 2010 to 2020

Figure 23: Earthquakes are a widespread challenge for infrastructure[192]



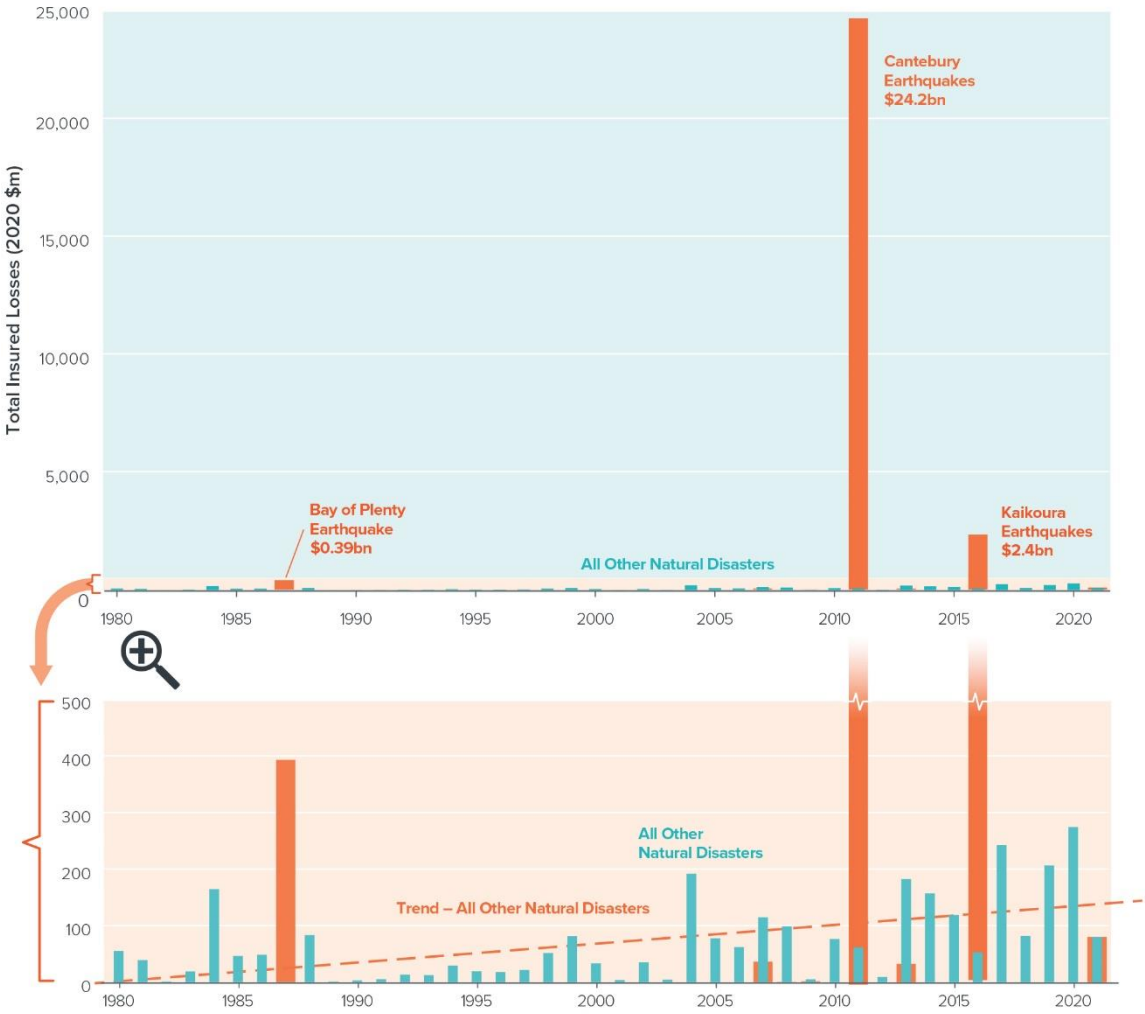
Source: GNS Science

Shocks and stresses can harm people, property and the economy.

Disasters can cause death and displace people from their homes. They can also damage properties and have an indirect impact in reducing economic activity. The cost of disasters has risen over the last 30 years, as shown in Figure 24, in part because our towns and cities are larger and more complex. Damage to infrastructure and buildings poses huge public and private costs. In 2013, the Treasury estimated that the damage caused by the Canterbury earthquakes cost over $40 billion, the equivalent of 20% of gross domestic product.[193] New Zealand has recently been ranked second globally for natural disaster costs, as a proportion of GDP.[194]

Major disasters can result in large losses and the prevalence is increasing

Figure 24: Total insured losses due to natural disasters from 1980 to 2020



Source: Insurance Council of New Zealand[195]

There can also be spillover effects. Over time employers can choose to shift away from areas affected by a disaster and wider supply chains can be severely disrupted. Modelling by the Wellington Lifelines Group found that if there's no investment in making the region's infrastructure more resilient, then a magnitude 7.5 earthquake on the Wellington Fault would create a $16 billion drain on the economy, excluding recovery costs or building damage.[197]

Our insurance system, including Earthquake Commission (EQC) cover, has historically provided a buffer against many of the financial impacts of shocks and stresses. However, insurance markets are evolving, with a reduction in domestic competition, rising premiums and excess charges and increasing scrutiny of risk by reinsurers impacting on asset owners.[198] The increased risk of extreme weather events or sea-level rise, may also mean that our infrastructure assets become more difficult to insure at a reasonable cost in the future, creating operating cost pressures for asset owners.[199] These factors are leading public sector infrastructure owners to strategically assess insurance options, including self-insurance or to only insure specific assets and requiring more accurate resiliency data to help support these assessments.[200,201]

The National Disaster Management Strategy defines resilience as:

"The ability to anticipate and resist the effects of a disruptive event, minimise adverse impacts, respond effectively post-event, maintain or recover functionality, and adapt in a way that allows for learning and thriving"[196]

The COVID-19 pandemic has disrupted our ability to deliver infrastructure and provide services. It has also affected the way we use services provided by infrastructure, in particular transport and telecommunications. On top of this, it has directly disrupted infrastructure construction and the movement of goods that support our economy, including the infrastructure industry.

> "The ability of infrastructure systems to function during adverse conditions and quickly recover to acceptable levels of service after an event is fundamental to the wellbeing of communities."[202]

A recent Australian study found that the indirect and intangible costs of natural disasters was more than double the reported cost of these events.[203] Vulnerable and isolated communities are often disproportionally hard hit by disasters and shocks.

To help minimise the impact and disruption to our communities and our economy, New Zealand's infrastructure and the systems and people that support it need to be resilient to a wide range of shocks and stresses, known and unknown.

6.4.2. What we heard

"Our key infrastructure is vulnerable to natural disasters", was rated as 'very important' by 52% of respondents in the Aotearoa 2050 survey of infrastructure issues. During consultation, submitters told us they felt it was important that New Zealand develops a common definition and framework for critical infrastructure and then uses these to identify this infrastructure.

A number of South Island councils highlighted the significant earthquake risk posed by the Alpine Fault (AF8). Some submitters also felt that resilience should be discussed in terms of 'all hazards', not only earthquakes or natural disasters. Some also noted the importance of planning effectively and not encouraging development or intensification in areas and suburbs with high natural hazard risk, such as flood plains, active faults, volcanic fields, coastal hazard zones, and land susceptible to land instability.

Submitters identified the need to align government work on resilience such as the National Adaptation Plan (NAP) and the work of the Lifelines Council and the Earthquake Commission (EQC), to ensure consistency. It was also considered important to align planning and development of new infrastructure (including services to support new housing) with appropriate hazard risk assessments.

> "Given the scale, importance and life expectancy of critical infrastructure, there is prudent need to take a 100 year planning horizon and be built to a standard that can withstand natural hazard and climate change impacts." – Greater Wellington Regional Council

Some believed more weight should be given to cyber risk and security.

> "Ransomware and cyber-attacks on systems are reminders that any digital system needs to be secure. The sector is slow to adopt technology and is dominated by SMEs, the nature of their projects do not need them to engage with new technology. However there is increasing recognition that digital technologies can help run smart businesses." – Construction Sector Accord

6.4.3. Strategic direction

A coordinated approach to our critical infrastructure is essential

New Zealand has developed a comprehensive all-hazards approach to risk management.

The Civil Defence and Emergency Management Act 2002 (CDEM Act) provides a solid legislative foundation for ensuring our infrastructure is resilient. The CDEM Act:

- Sets out the requirements on and responsibilities of providers of lifeline infrastructure services, such as water and electricity, in central government, local government, and the private sector.
- Identifies 'Lifeline Utilities' as providers of critical infrastructure services, sets out requirements for coordinated preparedness and continuity of these lifeline services in the event of an emergency and information disclosure requirements.
- Requires preparation of the National Disaster Resilience Strategy and the National Emergency Management Plan, which cascades in to coordinated local plans.

Oversight of the Act is carried out by the National Emergency Management Agency (NEMA).

We have a skilled and dedicated risk management workforce in the private sector and at all levels of government, supported by engineers, academic research and community volunteers. This means we generally respond quickly and effectively to natural disasters. Fatalities and injuries as a result of disasters and shocks are low. This provides a solid foundation to build on.

We need to define and identify our critical infrastructure.

International best practice is to define and identify critical infrastructure, systems and supply chains that are essential to support life, the functioning of communities and our economy. The resilience of those assets and systems then needs to be appropriately planned for and managed. This can ensure that the different parties involved in planning for disruptions and managing risk have a common language and are coordinated. This also means the parties who manage infrastructure can plan for services they can provide in the event of shocks or stresses.

The CDEM Act is currently being reviewed as part of a wider programme to update our emergency management system. This review proposes the following changes to help further ensure our infrastructure is resilient:

- **Definition of critical infrastructure:** Infrastructure and the systems that support it that are critical to the functioning of the nation are defined as 'Critical Infrastructure', rather than 'Lifeline Utilities'. This better aligns with international best practice. Once developed, this definition should be adopted across policy and legislation to ensure coordinated and consistent treatment of critical infrastructure. The government would need to set criteria for what is and isn't critical to support decision making and prioritisation of investment.
- **Identification of minimum levels of service:** The requirements for identifying minimum levels of service for critical infrastructure in the event of an emergency are clarified and strengthened. This includes requirements for infrastructure providers to disclose information about preparedness and level of service expectations. Proactive disclosure of this information will help support transparency. This helps government, individuals and organisations to understand the risks they face, prepare and make choices about how best to manage those risks.
- **Coordinated approach to managing risk:** A sustained increase in resourcing is needed to ensure a coordinated approach to managing risk across our critical infrastructure. Lead sector agencies need clearer roles for the coordination of resilience activities within and across critical infrastructure sectors. This reflects the interdependencies across infrastructure networks.

These changes are required to clarify expectations of how resilient our critical infrastructure needs to be and the roles and resourcing of different parties involved in delivering this infrastructure.

A best practice approach is needed to manage cyber security threats.

The National Cyber Security Centre recorded 352 cyber incidents in 2019 to 2020, 83% of which were detected before serious harm occurred.[204] The increasing use of information technology to help manage infrastructure, such as IT systems for remotely managing water and electricity networks, also comes with

cyber security risks. As the use of these technologies continues to grow, the threat of cyber attack is also growing.

New Zealand should adopt a best practice approach to cyber security, with clear standards for critical infrastructure assets to ensure they are protected and resilient. The management of cyber security risks needs to be a component of an updated National Digital Strategy (as discussed in Section 7.4). This could be strengthened to ensure owners of critical infrastructure put the right measures in place to protect against cyber risks to information and operational technology.

Security of supply for essential infrastructure materials must be included in risk management planning.

As a geographically isolated country that's reliant on imports, it is important we have stable and resilient networks for moving goods. Currently, 90% of our construction products are either imported, or contain imported products that can't be easily replaced within New Zealand.[205] COVID-19 has shown that our international supply chains can respond to shocks, but ongoing disruption still has an impact, with prices increasing and some goods becoming hard to obtain.

We rely on either imports or a small number of local manufacturers for many products we need for building infrastructure such as steel rebar and cement.[206] We need a secure supply of essential materials so we can continue to build, renew, and maintain the infrastructure we need and recover from a significant disaster. This should form an important part of risk management planning.

A planned approach for adapting to climate change

The National Adaptation Plan provides the coordinated national approach to managing climate change risk.

The significance and severity of the impacts of climate change will become more evident over time. Our climate is getting warmer, rainfall patterns are changing, weather events are getting more extreme and sea levels are rising.[207] Climate change will worsen many of the extreme weather and flood risks already faced by our infrastructure. For example, the IPCC's Sixth Assessment Report forecasts that extreme sea level events that previously occurred once in 100 years could happen every year by the end of this century.[208]

The 2020 National Climate Change Risk Assessment identified 43 priority climate risks to New Zealand including risks to buildings, drinking water quality and supply, physical and mental health, indigenous and coastal ecosystems, the economy, the financial system, governments, social cohesion, community wellbeing and others.

The government is developing a National Adaptation Plan (NAP) for climate change.[209] This will set out the work needed to prepare New Zealand for the challenges of a changing climate, including the actions we need to take to ensure our infrastructure and the systems that support it are resilient.

The National Adaptation Plan should include objectives for infrastructure.

These objectives should include the following:

- **Reduce vulnerability of exposed assets:** Understand where infrastructure and the services it provides are exposed and vulnerable to the impacts of climate change. The priority will be managing risks that affect services.
- **Ensure all new infrastructure is fit for the future climate:** Consider long-term climate impacts when making infrastructure design and investment decisions so that the right infrastructure is built in the right places. Options for adapting to climate change are understood and financed as part of the business case.

- **Use renewal programmes to improve our ability to adapt:** Consider the future climate when maintaining, upgrading, repairing or replacing existing infrastructure. The process for managing infrastructure will include reviewing resilience, improving the ability to adapt and planning for how services will be provided into the future,

The NAP is a coordinated, national approach to managing climate change risk and progress will be monitored by the Climate Change Commission.

Making information and tools that support resilience available and accessible

Access to the best available information about hazards helps to assess risk.

Giving the government, organisations and individuals more information about hazards can help them to make better decisions about insurance, location and design options when they are planning infrastructure.[210] For individuals, this can help them to plan what they would do if a disaster meant they didn't have services like water or power and it can also be useful when buying or building property. For organisations, it can help their planning on how to operate during a disaster and inform asset management. For central and local government, using the best available hazard information (for instance, see Figure 25) and tools when developing regional spatial plans and planning documents and making other infrastructure investment decisions will help reduce the risk of harm and the costs of poor investment.

Sea levels are rising

Figure 25: Satellite sea level observations, change in sea level from 1993 to 2021

Source: Climate.nasa.gov[211]

Mātauranga Māori is a valuable source of information for risk management planning.

> "Mātauranga Māori – Māori knowledge systems and practices hold a key to climate change response. Mātauranga Māori is community-based and collective knowledge that offers valuable insights that complement Western scientific data with chronological and landscape specific precision and detail. This is critical to verifying climate models and evaluating change scenarios. Māori knowledge systems and practice provide a strong foundation for community-based adaption and mitigation actions. Mana whenua have been able to observe and interpret change through the environment within Tāmaki Makaurau over many generations."[212] – Auckland Council.[213]

Natural disasters like earthquakes, volcanic activity and major floods occur infrequently but have large impacts when they happen. For instance, a major Alpine Fault rupture occurs every 300 years on

average, with the last significant quake occurring in 1717, prior to European settlement of New Zealand.[214] Research on how people rebuild after natural disasters shows that awareness of natural hazards can fade within three generations or less.[215] In this context, traditional knowledge, such as mātauranga Māori can play a role in identifying hazards that occur infrequently. Case Study 9 highlights how information about natural hazards can be preserved and used over time to protect people and infrastructure.

Case Study 9: Using traditional knowledge to preserve information about natural hazards

Japan's tsunami stones

Japan has a long history of earthquakes and tsunamis due to its position on the Pacific 'Ring of Fire'. Its coastline is dotted with stone tablets that record the extent of previous tsunami damage. Some tsunami stones are over 600 years old.

A tsunami stone in Aneyoshi, a small coastal village, provides a straightforward warning: "Remember the calamity of the great tsunamis. Do not build any homes below this point."[216] It was erected after a previous tsunami destroyed the village. Because the town did not rebuild below this level, Aneyoshi was left unharmed by the 2011 Great East Japan Earthquake, which caused extensive damage along the Japanese coast.[217]

Matatā township flooding

The Matatā area in the Bay of Plenty is home to a major reserve with native birdlife, the Awatarariki and Waitepuru streams, and a small township. Local pūrākau (myth/legend) warned that a taniwha resided there that had a long sinuous body and that came down to the Bay of Plenty and cautioned those who wanted to live there to "beware of the taniwha's flicking tail".

In 2005, as predicted by the pūrākau, the taniwha vigorously flicked its tail. The resulting flood and landslide from the Awatarariki and Waitepuru streams inundated Matatā township, triggering a managed retreat from the locality. Dozens of buildings were rendered uninhabitable but none of Matatā's three marae were affected.[218] In February 2021, the Bay of Plenty Regional Council and Whakatāne District Council approved a plan change to end human habitation in locations affected by the 2005 flood and landslide.

A coordinated approach to information collection and management is needed.

A coordinated approach is needed for the long term upkeep of data sets and tools that are useful for resilience and to make them readily available and accessible for use by planners and decision-makers.[219] This should also include consideration of mātauranga Māori. As a rule, the information should be useful, useable and used.[220]

There are multiple examples of research, data sets and tools that have been developed and could continue to support planning and decision-making processes that lead to more resilient outcomes, better understanding and management of risk and lower costs in the long term. Types of data sets and tools include:

- The National Seismic Hazard Model.[221]
- Tools to aid planning, such as the National Forward Works Viewer.[222]
- Tools to support risk and economic impact assessment of hazards, such as the Measuring the Economics of Resilient Infrastructure Tool (MERIT).[223]

Information disclosure and data availability should be driven by a requirement to disclose information relating to infrastructure service levels, as set out above and encourage active communication of this information with infrastructure planners and users.

6.4.4. Recommendations

No.	What	How	Who	When	Ref.[5]
S4.1	**Increase the resilience of critical infrastructure**	To increase the resilience of critical infrastructure the Government should: a. Define and identify Critical Infrastructure in the Civil Defence and Emergency Management Act 2002, replacing the term "Lifelines Utilities" with "Critical Infrastructure". b. Adopt the definition of Critical Infrastructure consistently across the policy and legislative framework for resilience. c. Develop criteria to set the level of criticality of infrastructure. d. Clarify and strengthen requirements for identifying minimum levels of service for Critical Infrastructure in the event of an emergency and disclosure of information about preparedness and level of service expectations. e. Adequately resource the National Emergency Management Agency and lead sector agencies to support the delivery of the requirements set out in the Civil Defence and Emergency Management Act 2002, on a consistent and long term basis.	NEMA, Lead Agencies	2022-2026	HGI, BRN, DIV

[5] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[5]
S4.2	**Improve infrastructure risk management by making better information available**	To make better information available to support risk management, steps should be taken to: a. Require regular disclosure of information about infrastructure preparedness and minimum levels of service in an emergency for Critical Infrastructure under the Civil Defence and Emergency Management Act 2002. b. Resource the maintenance, upkeep and availability of data-sets, information and tools to support decision making that enables resilience outcomes.	NEMA, LINZ, Lead Agencies	2022-2026	PRA, RSN
S4.3	**Prepare infrastructure for the impacts of Climate Change**	To adapt to climate change, action should be taken to: a. Finalise and adopt the infrastructure actions set out in the National Adaptation Plan. b. Support the provision of accessible, consistent, robust information on regional and local climate change impacts across the whole country.	MfE, Te Waihanga, Climate Change Commission	2022-2031	CAT
S4.4	**Support the security of supply of essential materials to build, renew and maintain infrastructure**	To increase the resilience of supply of essential materials, steps should be taken to: a. Incorporate consideration of the security of supply of aggregate, bitumen, cement, concrete, steel and processed timber into risk management planning for critical infrastructure b. require that territorial local authorities undertake a resource scan as part of their long term planning processes and protect sites suitable for aggregate extraction, such as through zoning.	MBIE, MPI, Lead Agencies, Local Government	2022-2050	PRS

6.5. Moving to a circular economy

Te whakawhiti ki tētahi ōhanga porowhita

The environment comes under pressure from human settlement. Our infrastructure supports efforts to reduce waste and improve our environment.

New Zealand produces a lot of waste. We send too much waste to landfill and lack the facilities to recycle much of what we consume. More importantly, we are yet to truly embrace the culture of reducing and designing waste out of our society. This takes bold action.

Infrastructure will play an important role. We need to make different choices about how to provide and manage waste and recycling. We have an opportunity to minimise waste and recycle materials as part of the planning for and construction of infrastructure. Projects can be designed and procured to minimise construction waste and reuse materials at the end of a facility's life. Waste can also be recycled in useful ways, for instance by burning tyres to make cement, converting used plastic into asphalt for roads, or using waste to make energy. With some kiwi ingenuity, investment in the right infrastructure and a commitment to more sustainable living, we can dare to aspire to a zero-waste future.

6.5.1. Context

New Zealand has a waste problem.

New Zealand produces more solid waste per person than any other OECD country.[224] Annually, we throw away around 3.2 tonnes of waste each.[225] We also have the lowest rate of recycling or reuse of waste materials, with only 35% of our waste recycled or reused. [226] The rest is sent to landfill, impacting our environment and, as it breaks down, creating greenhouse gases. Waste is the cause of 4.6% of New Zealand's gross greenhouse gas emissions.[227]

Waste from construction and demolition is the largest source of waste in New Zealand, accounting for 50% of all landfill waste.[228] Businesses and industry are responsible for 24%, while kerbside collection and other sources in our towns and cities create 12%.[229] Our farms and other rural sources account for 10%. Unless we make major changes, our growing population, as well as growing incomes, will only increase the number of things we consume and throw away.[230]

All this waste requires infrastructure like landfills, transfer stations and recycling centres. Reducing the amount of waste we create can also reduce the number of these facilities that we need to build.

A circular economy can reduce the impacts of waste.

A circular economy is one where waste materials are reused, recycled, or not used in the first place, so they never get thrown away. It relies on three principles:

- Design out waste and pollution.
- Keep products and materials in use.
- Regenerate natural systems (such as estuaries, forests and others where natural materials break down and contribute to plant or animal growth).

Moving to a more sustainable waste system can also create jobs and economic opportunities. It's estimated that every 10,000 tonnes of waste that are recycled require 9.2 full -time employees, compared to 2.8 for managing the same amount of waste sent to landfill.[231] There are also jobs involved in sorting, transferring and transforming materials into new products and in processing in New Zealand instead of sending it offshore.[232]

He tirohanga Māori i te ōhanga āmiomio: Māori views on the circular economy.

Māori have a holistic understanding of our environment and see it as an interconnected whole. Māori express a connection with the environment through kaitiakitanga (environmental stewardship / guardianship). This respect for natural resources is demonstrated by maintaining their value for as long as possible before they reach the end of their life, at which point they are disposed of in a way that causes the least harm to the environment. In this way, Māori views on waste and recycling precede the concept of a circular economy (ōhanga āmiomio) but similarly acknowledges the mauri (life force) of natural resources.[233]

6.5.2. What we've heard

> "Waste management and recycling is very poor in NZ. We need to be able to recycle our own." Respondent to the Aotearoa 2050 survey.

There was strong support for reducing waste among respondents to the Aotearoa 2050 survey. "Our lack of recycling means we create too much waste" was ranked as the second most important infrastructure issue, with two out of three respondents rating it as 'very important'. 85% of people said that reducing waste is the best way for New Zealand to prepare for the impacts of climate change. Through both the survey and our consultation process, we learnt that many people felt that a strategic direction for waste infrastructure is needed. Submitters on our consultation document wrote that New Zealand lacked infrastructure for recycling and waste management and this was particularly bad for certain waste products and locations. A strategic approach was seen as important to lift performance and reduce costs.

We also heard that:

- There is a lack of infrastructure to deal with organic waste, other than landfills.
- The potential for waste-to-energy needs to be considered objectively as a way of dealing with waste in New Zealand.
- Relying on the waste levy alone, without alternative ways of dealing with waste, would not reduce the quantity of waste going to landfill and could even lead to worse outcomes like illegal dumping.

6.5.3. Strategic direction

Setting a national direction for waste

A waste strategy will provide direction and help standardise services.

New Zealand introduced the Waste Minimisation Act in 2008 and the New Zealand Waste Strategy in 2010 with the aim of reducing and managing waste. These policies rely on local governments to develop and implement their own waste management policies. Implementation and outcomes vary considerably, but the overall trend has been toward increased waste. Between 2010 and 2018, municipal waste per capita increased by 35% in New Zealand, compared with an average increase of only 3% in all OECD countries.[234]

A national waste strategy that sets out a path toward a circular economy would help to align these varied approaches to waste management and make it clear where councils and others should be investing in waste infrastructure. A clear governance structure for moving toward a circular economy, with a minister and lead agency responsible for assessing and implementing actions, would be an important first step.[236] Central coordination would provide best-practice guidance on how to support a circular economy as part of the pathway to our net-zero carbon emissions target. Supporting legislation and regulation may also be needed for a shared, New Zealand-wide approach.

> "Jurisdictions with high performing recycling and resource recovery systems, such as Wales, Germany, South Korea and South Australia, indicate the foundation of success is an overarching policy framework for waste, recycling and resource recovery. It includes long term commitments and multiple interventions across the material value cycle. Policies, planning and performance monitoring need to be appropriately funded, adapted over time and supported by targets that incentivise performance." – Infrastructure Victoria[235]

A waste strategy should include:

- Direction on improving infrastructure for recycling and processing organic material.
- Strengthening markets for recycled materials.
- Removing barriers to reducing waste.
- Improving planning for any waste infrastructure that is still needed.

It could also help standardise some services, such as kerbside collections and container return schemes. This could be further strengthened by setting a target for zero-waste to landfill by 2050.

Good decision-making requires good data.

A lack of data makes it hard to make good decisions about recycling and waste infrastructure and services. Currently, there is limited publicly available and comparable data on how much waste New Zealanders produce, how it is disposed of and how much waste and recycling infrastructure capacity we have. This is a blind spot that limits our ability to create policy, plan and invest.

In 2013, waste industry group WasteMINZ was granted funding to develop a National Waste Data Framework in partnership with local government. The framework was completed in 2015 but has not been fully implemented.[237] Funding and resources are needed to put the framework into place and to identify types of waste that New Zealand could be recycling, as well as opportunities for reducing waste.

Managing pressure on landfill and waste recovery facilities

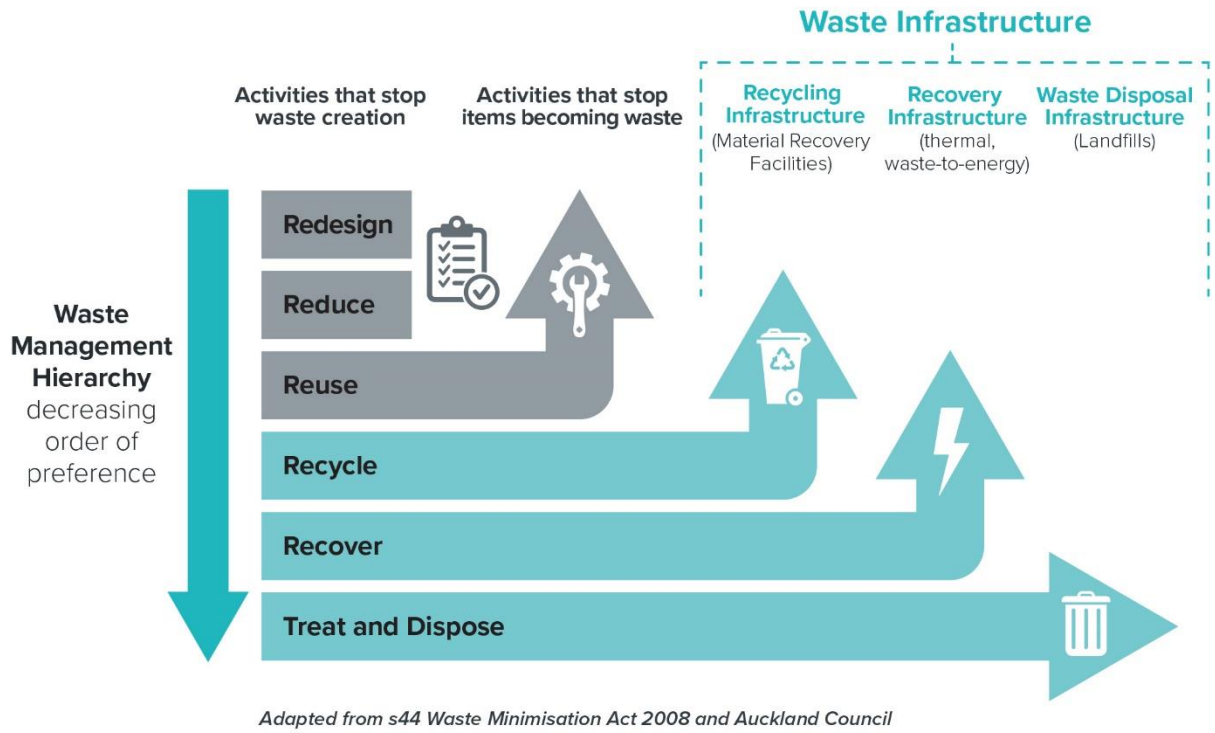
A circular economy requires a new approach to waste infrastructure.

Figure 26 shows the ideal waste management hierarchy, where reducing waste takes priority over methods like recycling or landfill that still need infrastructure. Moving toward a circular economy will prioritise redesigning waste out of production and developing more ways for reusing what would otherwise be waste.

Achieving this requires a different approach to waste infrastructure. It means reducing our reliance on waste disposal infrastructure and instead increasing the need for infrastructure that can help with reusing or recycling waste materials. For any waste where recycling or reuse is not possible, then a clear direction will be needed on waste-to-energy, a process where waste is burned to generate electricity.

Options to reduce waste should be considered before options that require infrastructure

Figure 26: Waste management hierarchy



Source: Te Waihanga

Developing ways to minimise waste: redesign, reduce and reuse.

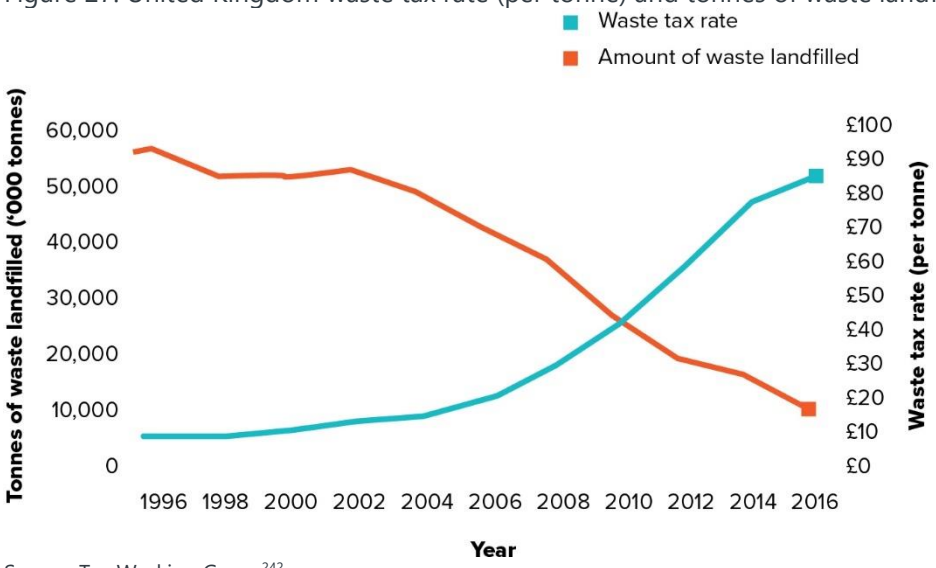
The best way to reduce the need for waste infrastructure is to prevent waste from entering the market in the first place. Encouraging waste-reducing behaviour among consumers like repairing broken items or buying reusable items, is one way of achieving this.[238] Another alternative is to regulate to reduce waste at the source, for instance by introducing product stewardship schemes for hard-to-recycle plastics and electric batteries, or preventing the sale of products that are difficult to recycle.[239]

Changing the way we pay to encourage recycling and waste reduction.[240]

The way we charge to send waste to landfill can encourage people to reduce waste. General taxation methods like rates don't create enough incentive to reduce waste. More targeted prices can be effective, as has been proven overseas. When the United Kingdom increased the cost of disposing waste at landfill, they saw a major decrease in the amount of waste going to landfill. New Zealand is currently increasing our waste disposal levy and it will eventually be $60 per tonne, but further increases, at a minimum to adjust for inflation, should be considered over time.[241]

Waste levy increases can help manage demand and contribute to social objectives

Figure 27: United Kingdom waste tax rate (per tonne) and tonnes of waste landfilled 1996 to 2016



Source: Tax Working Group[242]

Resource recovery infrastructure is needed for priority materials.

New Zealand lacks the infrastructure we need to recycle or recover many materials. There is a need to improve infrastructure for collecting and processing recyclable materials and organic waste. This infrastructure will keep more waste out of landfills and reduce the emissions caused when waste breaks down.[243] The cost of investing in recycling and organic waste infrastructure is estimated to be between $2.1 billion and $2.6 billion, along with an additional $0.9 billion in operational funding over the next 10 years.[244]

There are barriers to improving waste recovery. For instance, it can be difficult to access recycling services, especially when there are long distances between the areas where the waste is created and recycled and the market for the recycled material. This can make recycling infrastructure more economic in cities or large towns than in smaller towns or rural New Zealand.

To work well, recycling and organic collections needs to be simple, easy and consistent. Currently, there are large variations in how we recycle across New Zealand. Only 47% of New Zealand households have access to recycling services for multiple materials like glass, plastics and paper. A simple and consistent sorting and collection system would improve our rate of recycling and the quality of the recycled materials we produce. This is important for the market value of recycled materials.[245] In Auckland, 12% of household recycling is contaminated with food or other waste, which makes recycling infrastructure less economic to build and operate.[246]

Recycled materials can be a part of our infrastructure.

We can use more recycled materials within New Zealand and one opportunity is in the construction of infrastructure itself. As Case Study 10 illustrates, recovered materials can be used in infrastructure construction and maintenance. Increased local demand would encourage people to invest in recycling infrastructure here, instead of sending waste overseas to be recycled where it can be vulnerable to changing prices and import bans. Doing this will require government and waste service providers, like councils, to take a coordinated approach in deciding which recycled materials could be used or sold within New Zealand. Increasing emissions trading prices and an increase in the waste levy can also make opportunities like these more financially appealing.

Case Study 10: New Plymouth - conversion of plastic into asphalt

New Plymouth normally exports approximately 200 tonnes of plastics to China and Thailand for recycling each year. The council was open to trying new ideas to reuse plastics closer to home.[247] In response, around 500kg of type three to seven plastics was used in the 90m of resurfacing of Liardet Street in New Plymouth making it New Zealand's first road to be partly made from recycled plastic in 2019. Downer's Road Science division developed Plas Mix, the asphalt-plastic blend and has been granted a 10 year maintenance contract by the council to trial the new product.[248]

Reducing construction and demolition waste is good for efficiency and the environment.

> "The construction and demolition industry is one of the largest waste-producing industries in New Zealand. Construction and demolition waste may represent up to 50% of all waste generated in New Zealand, with 20% of the waste going to landfill." – BRANZ[249]

With construction waste making up the largest proportion of the waste we send to landfills, we need to focus on reducing this and increasing recycling in the sector. When done well, this can reduce costs for construction businesses by reducing landfill charges and using construction materials more efficiently.

Waste can often be reduced during the planning phase of a project.[250] Public sector infrastructure projects could use their procurement requirements to help reduce waste. For example, these could prioritise designs and materials that produce less waste. They can even factor in disassembly and the reuse or recovery of materials at the end of the infrastructure's lifespan, something known as 'designing for deconstruction'. Using prefabricated parts can also help reduce waste. This is because it is easier to recover and reuse waste from a factory dedicated to making a particular part than on a construction site when it can be mixed with many other types of waste. Finding ways to use recycled materials in construction can also add to the demand for these materials.

Other options to encourage the reuse of materials in construction include:

- Developing a resource exchange mechanism (REM) to minimise waste creation.[251] This is software for matching surplus materials and products to a need for that material or product. There are some REM services in development in New Zealand, such as Civilshare[252] and the sector could look at expanding these to support infrastructure construction.
- Investing in new facilities that can sort and store waste materials from construction, demolition and commercial industries and then recirculate them back to construction activities and other markets.[253]
- Reviewing building material regulations to ensure that they allow for the use of reused or recycled building materials.

Developing waste-to-energy for the waste we still produce

Waste-to-energy can play a role in the waste system.

We want to reduce the amount of waste produced in the first place and reuse or recycle it when this isn't possible. Where waste cannot be prevented or dealt with in these ways, then using it to generate energy is preferable to dumping it in a landfill. This is known as waste-to-energy and most commonly involves incinerating waste to generate electricity or heat for industry. It can also include capturing the gases created when materials break down over time. It's important that waste-to-energy is only used to replace disposal to landfill, not replace recycling or disincentivise efforts to redesign and reduce waste. The use of waste-to-energy also needs to be considered carefully in the context of New Zealand's current renewable energy goals.

Government guidance is needed.

Case Study 11 illustrates how using waste as an energy source can reduce carbon emissions and reduce pressure on landfills. The Ministry for the Environment released guidance on waste-to-energy proposals in 2020.[254] The guidance outlined key questions that investors in waste-to-energy plants should address but did not establish a government position on the future role of waste-to-energy or preferred technologies. A clear position would provide greater certainty and help make it clear when this would be an option or when materials should be targeted for recycling.[255]

Case Study 11: Conversion of tyres into cement in Whangārei.

Golden Bay Cement, a subsidiary of Fletcher Building, is now reusing waste tyres to manufacture cement.[256] Tyres are burned at a high temperature to replace coal for process heat and remaining rubber and metal components are combined into cement.

This will divert up to 3 million tyres from landfill annually, which would represent around 60% of New Zealand's total waste tyres.[257] At full capacity, the plant will reduce annual carbon emissions by 13,000 tonnes and reduce total landfill waste by around 1%.[258]

The total cost of the project was $25 million, $16 million of which was funded from a grant from the Ministry for the Environment's Waste Minimisation Fund.[259]

6.5.4. Recommendations

No.	What	How	Who	When	Ref.[6]
S5.1	**Establish a clear national direction for circularity in waste management**	In developing a National Waste Strategy, provide appropriate direction that: a. Sets out a plan for circularity and is consistent with net zero emission targets. b. Accelerates investment and innovation in waste minimisation, and the recovery of resources. c. Considers an appropriate aspirational target. d. Sets out performance measures for tracking performance. e. Ensures waste markets are well functioning and appropriately incentivised and regulated.	MfE	2022-2031	RRV, WSP
S5.2	**Prioritise options that minimise waste from entering the market to avoid unnecessary infrastructure costs**	Options should include: a. A ban on products that are hard to recycle. b. Development of options to incentivise greater product stewardship. c. Increasing waste-disposal levies sustainably while managing, monitoring and funding enforcement to minimise illegal dumping. The prioritisation of these options should be guided by cost benefit analysis.	MfE, Local Government	2022-2031	FOT, ACW,

[6] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[6]
S5.3	**Improve recycling infrastructure for priority materials**	Options should include: a. Developing processing and biomass utilisation capacity for timber and wood wastes. b. Developing construction and demolition waste collection services. c. Developing a network of regional hubs for e-waste and battery drop-off and aggregation of hubs with adequate storage capacity for plastics consolidation. d. Developing opportunities for local tyre manufacturing and re-treading capacity. e. Improving sorting facilities.	MfE, Local Government	2022-2031	WSP
S5.4	**Use behavioural interventions to address barriers to recycling, reduce waste and avoid contamination**	This should include: a. Standardising kerbside collection services, with a focus on simplicity and consistency across jurisdictions. b. Funding sustained education campaigns that promote and improve social license for recycling and promote options to minimise and avoid waste. c. Coordinate and share behavioural change materials between central and local government.	MfE, Local Government	2022-2031	WSP, RRM
S5.5	**Reduce landfill emissions resulting from organic waste.**	Steps should be taken to: a. Improve the collection of organic waste through greater commercial and household food waste collection services. b. Target education and behaviour change programmes to improve take-up of organic waste collection. c. Require landfill gas capture for all landfills that accept organic waste.	MfE, Local Government	2022-2031	WSP

No.	What	How	Who	When	Ref.[6]
S5.6	**Develop uses for recycled materials in infrastructure**	Responsible agencies should: a. Identify opportunities for more domestic reprocessing, including for plastics (especially e-waste), metals, fibre and glass, plasterboard and aggregate. b. Develop relevant technical specifications and national standards for re-use of recycled construction materials in infrastructure. c. Support innovation in, and procurement of, infrastructure design and construction to enable greater use of recyclable materials in infrastructure.	MfE, MBIE, Local Government	2022-2031	WSP
S5.7	**Clarify the strategic role of waste-to-energy**	The Government should establish a position on waste-to-energy as part of the National Waste Strategy, noting its potential as an alternative to landfill.	MfE, MBIE	2027-2031	WSP, WTE
S5.8	**Improve waste sector data and insight**	Fund improvements in waste data to enable comparisons between volume, performance and processing capacity across waste streams by region and territorial authority, by resourcing the implementation of the National Waste Data Framework.	MfE, Local Government	2022-2031	WSP
S5.9	**Encourage public infrastructure waste minimisation**	This should include the following steps: a. Require all infrastructure projects to incorporate waste minimisation plans in procurement and design objectives and use recycled products where feasible. b. Encourage prefabrication/ standardised options as part of infrastructure delivery. c. Investigate the efficacy of a Resource Exchange Mechanism for infrastructure projects, through a partnership between government and the construction sector.	MfE, Local Government	2022-2031	WSP

7. A world class infrastructure system: how we get there

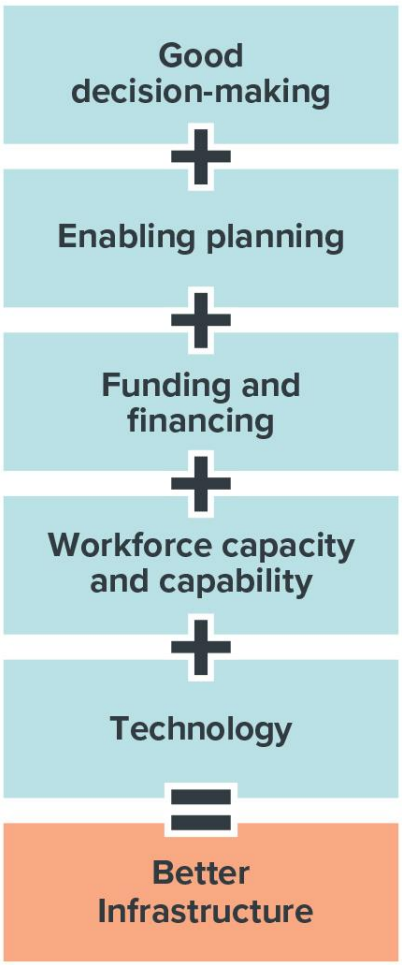
Tētahi pūnaha hanganga kei te taumata o te ao: te huarahi

Infrastructure helps New Zealanders to move around the country, connect, learn, stay safe and live healthy lives. To deliver on our strategic objectives, we need to prioritise the best projects, fund and mobilise the right technology, with the right people and equipment. This needs to be enabled by a fast and effective planning and consenting process that recognises the unique role infrastructure plays in our wellbeing (see Figure 28).

Good decision-making is critical to getting the most from our infrastructure.

There are many things we could invest in, but we cannot invest in everything. Trade-offs exist. We need to prioritise the public infrastructure that will make the biggest difference to our economic, social, cultural and environmental wellbeing and support a high quality of life for all New Zealanders. Since public money is used, the approach needs to be robust, transparent and accountable. Long term strategic infrastructure planning can improve integration across sectors, with infrastructure intentions based on clear service standards and expectations of future growth. Good decision-making does not occur in a vacuum, however. It is entwined within a wider environment, which includes legislation, policy, regulation, institutions, governance and ownership. These vary, often considerably, both across and within sectors and change through time. Improving these system settings is part of enabling good decision-making.

Figure 28: Better system components



Source: Te Waihanga

We will need more infrastructure, but it is not free and someone must pay.

How we choose to fund and finance infrastructure impacts on what projects are implemented, which community needs are met, when they are met, who can access infrastructure and how we use it. There are many different ways to fund infrastructure. Prices or user charges are standard practice in some sectors, while public subsidies are more common in others. Either way, infrastructure is ultimately either by funded users, taxpayers or ratepayers. These choices can have a bearing on which generations pay for the infrastructure (intragenerational and intergenerational equity) and those who are vulnerable or disadvantaged in our society. Assessing how best to mitigate these effects is important to New Zealanders. Determining which generations pay for infrastructure is equally important. Effective financing is needed to spread costs over the term of long-lived infrastructure and can also speed up delivery, by using private sector finance.

An enabling planning and consenting system is essential to deliver the infrastructure needed over the next 30 years.

To deliver on affordable housing, a net-zero carbon emissions economy and other infrastructure objectives, the planning process needs to be strategic, coordinated, equal to the urgency of the challenge and enabling of the government's obligation to deliver a broad range of infrastructure services. The planning rules and the consenting process must recognise the unique role of infrastructure in providing services across the economy. Planning and consenting decision-makers will need to carefully weigh up local effects against national objectives.

Greater use of technology will improve the delivery of infrastructure and the services it provides.

Technological advancements in infrastructure have been rapid in recent years and its trajectory is unwavering. There is significant opportunity to increase the spread and uptake of technology in infrastructure. Greater use has the potential to improve productivity, infrastructure delivery and services, raise wages and improve skill levels in the infrastructure sectors. Leadership and a clear strategic direction are needed from government, along with greater emphasis on an open data environment, which can act as a foundation for technological opportunity. Much of the rapid advancement in technology is being driven by innovation in the digital area, where artificial intelligence has the potential to streamline and speed up regulatory processes, improve decision-making and project selection, improve the prioritisation of maintenance and better integrate infrastructure across sectors.

We need the right people, at the right time, with the right skills to build and run our infrastructure.

Building the skills to improve infrastructure delivery will be an immense challenge over the next 30 years. New Zealand is competing for skills that are highly sought after as international demand for infrastructure accelerates. The skillsets that are required are also changing, shaped by new digital technologies and challenges such as climate change. A credible infrastructure pipeline will become essential to give firms the confidence to invest in skills development and training. Measures to smooth out infrastructure across business cycles are also important for deepening labour pools and giving confidence. This is particularly important for New Zealand given our small size and competition with Australia. Improving the diversity of our infrastructure workforce, particularly in the construction sector is a way not only to address these labour constraints, but also create more employment opportunities for all New Zealanders.

7.1. Better decision-making
Ngā whakataunga kounga ake

Decision-making needs a relentless focus on creating value for New Zealanders.

We can only build high-quality infrastructure at an affordable cost if we make good decisions about how to plan, invest in, deliver and manage our infrastructure. Infrastructure decision-making is affected by a range of factors, including how infrastructure is owned, governed, regulated and funded.

A well-functioning infrastructure system will result in good decision-making that improves economic, environmental, cultural and social outcomes. A poorly functioning system will lead to bad decisions that lower wellbeing over time.

Infrastructure decision-making needs to consider how infrastructure systems are interconnected. For example, our hospitals need good transport connections and reliable electricity to function. Homes can only be built where there are networks or systems for water. People often make choices about where to live and work based on the location of schools, which can then affect congestion on our transport networks at peak times. Technology is further blurring the boundaries of sectors such as energy, transport and telecommunications.

7.1.1. Context

New Zealand is spending more on public infrastructure than ever before. The 2021 Budget proposes to invest $57 billion in infrastructure over the next four years.[260] After a period of low investment in the 1990s, we now invest a greater share of our national income on public capital (which includes public infrastructure plus other capital elements like vehicles) than almost all other developed countries.[261]

> "Past investment surges have often taken place in weak institutional environments or been associated with the circumvention of established decision-making processes. [I]n the absence of a comprehensive and cohesive set of PIM [public investment management] institutions, the potential benefits from a ramping up of investment are much diminished. Countries should therefore factor PIM diagnostics, reform, and capacity building into their plans for ramping-up investment levels." – International Monetary Fund

However, we do not always get the best results from our spending. The World Economic Forum ranks New Zealand's infrastructure performance 46th out of 140 countries.[262] Good decision-making, supported by robust public investment management is essential for lifting performance. Internationally, countries with the best practices get twice as much 'bang' for their investment 'buck' as countries with poor practices.[263,264]

At present, many public infrastructure projects lack sufficient planning and investigation. Only 17 of 30 initiatives reviewed by Treasury's Capital Panel for the 2021 Budget had completed business cases.[265, 266] Government agencies' investment plans are unreliable and poorly signalled in advance, making it difficult to make decisions in a consistent way. This is made worse by the creation of bespoke or ad-hoc governance and delivery agencies for projects.

Limited planning and investigation tends to lead to failures in delivering projects. When decisions are made before the right information is available, they are more likely to lead to problems like cost overruns.[267, 268] In Australia, only one in three major infrastructure projects are announced before their business case is completed, but these projects account for 79% of the total value of cost overruns.[269] Most countries struggle to control costs on major public infrastructure projects and New Zealand has recently experienced major issues in this area.[270]

Poor decision-making can also lead to poor outcomes from infrastructure, such as solving the wrong problem, which means that other needs remain unmet. Internationally, there is evidence that public investment is often allocated in response to political concerns rather than actual need.[271] Large 'iconic' projects may be favoured over smaller, higher-value, investments. Where this occurs, it can reduce the value that we get from our infrastructure investment and reduce economic performance.

To achieve the best results, we need robust decision-making processes, supported by strong and effective governance arrangements and reliable, timely information.

7.1.2. What we've heard

During public consultation, submitters told us there's a lack of cohesion and consistency that is driving avoidable overlap, duplication and delay during infrastructure projects. Some common examples of this include policy and practice leadership and the need for central and local government to work together more closely. Submitters agreed that the Infrastructure Strategy should address this.

We also heard that there is doubt about whether centralisation or greater central control would be better and there is some concern it would be worse. However, support was expressed for:

- Common and transparent frameworks to guide infrastructure.
- The benefits of consistency, rather than centralisation of decision-making and delivery.
- Decision-making rights being made locally or at point of service.
- Wanting to improve information, trust and confidence in decision processes.

7.1.3. Strategic direction

Major infrastructure projects require significant investment and last for a long time. Infrastructure investments begin with an idea, which should then be explored and tested through planning. A preferred investment option is then selected for funding. After this, infrastructure providers procure, deliver and implement to realise their expected benefits. Good decisions must be made at each stage of this process.

We need rigorous decision-making processes so we can get the most out of the infrastructure we build. This requires:

- Robust principles and incentives to drive good decisions.
- Strategic planning to make investment priorities clear.
- Reliable and timely information to guide decision-making.
- Standardised frameworks for procurement and delivery.

Robust principles and incentives to drive good decisions

Good principles and incentives are fundamental to good infrastructure decision-making.

Good decision-making is guided by clear principles about how to invest in and manage infrastructure. These ensure investments are well considered and deliver good value for money. However, decision-making does not happen in a vacuum. How infrastructure providers are structured, owned, governed, funded and regulated can strengthen or weaken incentives for good performance and sound investments.

Core principles inform good decision-making.

International guidance and best practice highlight the importance of sound decision-making principles.[272] A consistent, principled approach to infrastructure decision-making ensures that the best projects are being selected, funded and delivered. This provides the public with confidence and

assurance that the investment of public funds will not only provide value for money, but also improve wellbeing.

Table 4 summarises 10 core principles for infrastructure decision-making that cover decisions at all points in the life of an infrastructure project, from identification of the problems that need to be solved to the project being completed and showing benefits. These principles are adapted from relevant overseas examples, in particular OECD best practice guidance and Infrastructure Australia guidance. They are designed to complement and bolster the Treasury's Investment Management Framework. Public agencies and decision-makers should commit to following these principles when they plan and invest in infrastructure.

Table 4: Core principles for infrastructure decision-making

1. Infrastructure problems and opportunities are quantified as part of long term planning. This includes analysing how existing infrastructure would perform and the level of service it would provide under a range of future scenarios. Planning considers opportunities to partner with and unlock opportunities for Māori, interdependencies with other infrastructure, developments in technology and changes likely to impact infrastructure services over the coming decades.

2. Delivery agencies identify infrastructure needs in response to quantified infrastructure problems. Infrastructure needs are framed as potential responses that are likely to be required under several future scenarios. Delivery agencies should publicly release strategic planning information to explain clearly to the community what the problem is, the cost of the problem and the most attractive solutions.

3. Delivery agencies invest in feasibility studies to scope potential options. These enable the costs and benefits of different options to be meaningfully compared and ensure that any risks can be identified. As part of these studies, delivery agencies should consider a range of options that don't require construction, including those that make better use of existing infrastructure or changes to regulatory and pricing settings.

4. Where an infrastructure need is identified, steps are taken to ensure potential options can be delivered affordably. Land needed for future infrastructure is protected by delivery agencies, who also ensure appropriate integration into long term land use plans.

5. Detailed analysis of a potential project is undertaken through a business case. A business case is used to rigorously examine the potential project's benefits relative to its costs, value the future appropriately, show the project to be resilient to change under a range of future scenarios, and show who benefits and how much. A preferred option or cost profile should not be announced until this detailed analysis has been completed.

6. Delivery agencies assess alternative funding sources for each potential project. Delivery agencies should minimise the need for public funds through consideration of other options and determine a fair funding split between taxpayers, ratepayers, users and other beneficiaries.

7. Meaningful stakeholder engagement is undertaken at each stage, from problem identification and option development all the way through to project delivery. Delivery agencies must seek early engagement with a range of stakeholders, including iwi, communities, businesses, users, private infrastructure owners and operators and, where public funding is required, the general public.

8. All information supporting infrastructure decisions is publicly released. This includes all analysis underpinning long term plans, option development and assessment, through to full business cases once they have been independently assessed. Any protection of information should be genuine and justifiable.

9. Staged and post-completion project reviews are undertaken and publicly released. Delivery dates for these reviews should be confirmed at the outset of a project. Reviews should focus on whether the project was delivered on time and on budget, measuring whether the economic case for a project (in its business case) is realised over time, whether unforeseen risks emerged and how they were managed and extracting lessons to feed into future infrastructure development and delivery.

10. Where projects are funded as part of a broader programme, the corresponding decision-making processes are robust, transparent and prioritise value for money. The objective, scope, scale and expected benefits of a funding programme should be defined and reported openly against clear assessment criteria and objectives. Funding programmes should be routinely assessed and reviewed to ensure investments are delivering against these objectives.

Checks and balances are needed to ensure monopoly infrastructure providers make good investment decisions.

Competition between infrastructure providers can be an incentive for them to operate, maintain and invest in their networks in a way that delivers good quality services to users at a fair and reasonable cost.[273] However, there are many cases where competition doesn't exist and infrastructure providers are monopolies. In some cases, like electricity transmission, water and transport, infrastructure is best managed by a single provider serving each area. In others, like health and education infrastructure, it is provided directly by government to ensure that all New Zealanders have access.

Some monopolies, including electricity and gas transmission and distribution, are regulated by the Commerce Commission. It sets information disclosure requirements, regulates prices and quality of service and reviews major capital investments. The current Three Waters Reforms propose a similar approach for the water sector. The transport, health and education sectors lack external checks and balances and instead rely upon a combination of internal investment approval processes, investment approval by ministers or Cabinet and assurance by the New Zealand Treasury.

A lack of competition and external regulation can lead to poor decision-making.[274] This can take the form of under-investment, over-investment or poor investment choices.[275] Infrastructure providers that are sensitive to political push-back about high user charges or rates may choose to under-invest in their networks in a way that can undermine services or resilience in the long term. On the other hand, infrastructure providers that don't face political push-back about user charges or rates may choose to over-invest in their networks, delivering 'gold plated' upgrades that provide limited benefits to users at a high cost.

The right incentives for good decision-making are required.[276] This may include strengthening existing assurance and review processes such as government's Gateway Review and Better Business Case requirements, strengthening information disclosure requirements and modernising processes and institutions that underpin investment decisions. In doing so, it's important to build upon lessons from sectors that already face external regulation.

Strategic planning to signal investment priorities

A long term view enables infrastructure agencies, as well as construction firms, to better plan for the future.

Good strategic planning looks at factors such as the future demand for infrastructure and long term trends like New Zealand's growing and ageing population.[277, 278] It considers emerging opportunities and challenges, such as a changing environment and rapidly developing technology. Strategic planning also looks across and seeks to integrate with different infrastructure sectors and networks.

Good strategic planning sets clear standards for the quality of service expected from infrastructure, provides a reliable forward view on infrastructure funding plans and signals priority infrastructure projects well in advance. This includes solutions that involve reforming parts of the infrastructure system or making better use of existing infrastructure.

Users and providers should have a clear understanding of service quality.

Standards set the quality and reliability of services that users can expect from infrastructure. They also influence the cost to provide infrastructure and therefore, how much funding is needed from users, taxpayers and ratepayers. There is often a need to manage trade-offs between quality and affordability. For instance, the World Energy Forum describes a 'trilemma' between energy security, environmental sustainability and energy equity.[279] Countries that perform well in one area tend to lag in others.

Clear service quality standards are an important part of the strategic planning process. Minimum service standards exist in some sectors, such as gas and electricity, where the Commerce Commission requires regulated providers to satisfy minimum standards for reliability of supply.[280] However, standards do not exist for all sectors, or they may exist but are not enforced. The cost and funding implications of existing standards are not always well understood. Where service quality standards are not available, they should be developed and published to guide strategic planning and project decision-making.

Government agencies should signal funding intentions further in advance.

Although infrastructure development is often a long term process, public infrastructure agencies don't often share plans for funding beyond the current annual budget cycle. This makes it difficult for others to plan ahead and signal future investments to the market.

Councils are required to develop and publish long term plans that set out investment intentions over a 10-year period.[281] While priorities can change in response to council elections, this provides more certainty about future funding and service quality improvements. The Treasury requires agencies that make significant capital investments to develop Long Term Investment Plans, but generally these plans don't clearly identify investment intentions.[282]

Government agencies should be required to develop and publish capital investment plans for a minimum period of 10 years. To ensure this has the greatest effect, agencies would need increased funding certainty over the same 10-year period.

An infrastructure priority list is needed to provide certainty about future projects.

Projects that can help us solve long term challenges, such as addressing climate change, improving our cities, connecting all regions of New Zealand and providing infrastructure that works for our growing and changing population may be under development or may be signalled as intentions but not yet funded.

An infrastructure priority list, similar to the list developed by Infrastructure Australia, is important for offering greater visibility and assurance about what is planned.[283] Done well, this can have benefits for infrastructure providers, decision-makers and construction firms seeking to understand future capability needs.

A priority list should be developed and published that includes the following:

- **Priority infrastructure projects**. These are large projects or packages of smaller projects that have been through a robust business case process. This process has identified an important problem to solve, considered all options for addressing it and identified an achievable solution that delivers good value for money and is consistent with our need to reduce carbon emissions.

- **Priority infrastructure investigations**. These are projects where an important problem has been identified but planning and investigations have not yet been completed.

The priority list should cover projects from all infrastructure sectors. It should not focus solely on major projects, as many of the problems we are facing require small-scale, distributed improvements. For instance, a water pipe renewal programme or intersection safety improvement programme may qualify for the priority list even though it consists of many small projects.

The priority list will grow as infrastructure providers submit projects for assessment and as more priority investigations are identified. As an independent advisor on infrastructure, Te Waihanga will monitor and advocate for progress of projects and investigations on the list.

Reliable and timely information to guide decision-making

Information that is both reliable and provided at the right time is essential to good decision-making.

If the right information is not available, it can be difficult to make the right decision. Often, there is pressure to make decisions and announcements before sufficient information is available. Decision-makers and public infrastructure providers should commit to improving the standard of information and making decisions when the right information is available.

Public communication should give the community confidence.

Governments usually aim to keep the community informed of proposed new infrastructure projects, often from the very start. There is often high public interest in community impacts, benefits, costs and delivery timetables. Communication is effective when it provides confidence that decision-making is sound, public funds are being well managed and project benefits will be delivered.

Public announcements that are made early in the planning and development of a project can signal intentions, but must be careful to avoid premature announcements about scope, costs and timeframes.[284] Providing these details could disappoint communities if there are changes made later in the project and it places unhelpful pressure on project delivery teams. It can also limit the ability of the project to adapt successfully and as a result, reduce the benefit from the government's investment.[285]

Objective, reliable information is needed to understand how our infrastructure is performing.

There is a shortage of comprehensive, comparable and consistent data on the performance of New Zealand's infrastructure.[286] Good data is available for some sectors, such as electricity distribution, but it can be difficult to compare across sectors or make international comparisons. To address this issue, public infrastructure providers should build a comprehensive performance measurement framework that enables meaningful comparisons and benchmarking between operators and agencies. This includes collecting, analysing and publishing data on performance at multiple levels:

- **Projects**: To understand how individual assets perform in delivery and operation, including construction costs and benefits delivered.
- **Networks**: To understand the relative performance of infrastructure networks over time.
- **Systems**: To understand the performance and integration of networks, particularly in complex urban environments.

There is a particular need for better information on infrastructure delivery costs, including benchmarking to enable us to know how efficiently we invest.[287] There is little systematic information on how and why infrastructure costs have changed in recent decades, how our costs compare to those in leading countries and how cost performance differs between different infrastructure sectors. Regular analysis and benchmarking of cost performance is needed.

Project selection should be guided by rigorous cost-benefit analysis.

For most projects there are alternative options for investment that vary in cost and outcomes. The key is to identify those options that deliver best 'bang for buck'. To do this, public infrastructure providers should commit to preparing and publishing a cost-benefit analysis (CBA) for all major investments.

A good CBA comprehensively considers all relevant benefits and costs, including non-financial economic, social, cultural and environmental impacts. The Treasury's Guide to Social Cost Benefit Analysis outlines principles for assessing and weighing up these impacts.[288] Some infrastructure sectors have additional CBA guidance, such as Waka Kotahi's Monetised Benefits and Costs Manual[289] and the Transpower Capital Expenditure Input Methodology published by the Commerce Commission.[290]

The quality of a CBA is only as good as the quality of information that's analysed. In some cases it may be difficult to model or fully value some impacts, such as environmental impacts.[291] To ensure public confidence in CBAs, key parameters such as the value placed on the future benefits of a project compared to the current benefits, should be reviewed.[292]

Post-completion reviews of infrastructure projects offer a valuable learning opportunity.

Once a project is completed it can be reviewed to compare the project's intended inputs, outputs and outcomes with those actually delivered. This data can then be used to help decision-making on subsequent projects, ensuring they better reflect real-world experience. However, post-completion reviews are rarely done and where they are conducted, lessons are not always taken onboard.[293] The inconsistent use of reviews to measure how well a project delivered against what it was planned to do makes it challenging to identify successes and failures.

Post-completion reviews are considered best practice, especially for major infrastructure projects.[294] They should be prioritised, funded and published after completion. Independent audits of reviews will ensure they are impartial, rigorous and transparent.

Standardised frameworks for procurement and delivery

By improving the government's ability as a client, we can ensure we have an infrastructure system that can deliver the projects we need, now and in the future. New Zealand needs standardised frameworks for procurement and delivery, supported by the right skills in the public sector, to ensure that infrastructure projects are delivered to a high standard.

Procurement proccesses and standards vary across agencies.

Each public sector agency is responsible for the procurement of its infrastructure. This approach has resulted in different processes and standards for infrastructure planning, procurement, construction, operation and maintenance across sectors and agencies. Every government agency with a role in infrastructure has its own procurement policy, templates and methods, each with their own nuances. This can create needless cost and causes confusion for industry.[295]

There is a need to align standards and processes used across projects, sectors and agencies to strengthen government's ability to act as a sophisticated client of infrastructure. This can:

- Enable the sharing of skills and insights across the country.
- Create opportunities for projects to plan and deliver together, where beneficial.
- Broaden the number of possible suppliers such as consultants, contractors and other experts by reducing barriers to entry.

In the long term, getting the best outcomes may also require changes to how agencies are structured, governed, funded and regulated. Significant structural changes should not be undertaken lightly. They require careful consideration of the preferred outcomes, as well as the short term costs of disruption.

Project, asset and risk management would benefit from common frameworks.

There are specific areas where common frameworks would have benefits. A common project management framework would standardise oversight and quality assurance processes, set clearer expectations, enable benchmarking or comparison between entities and projects and make sure lessons are automatically fed back into new infrastructure projects.[296]

An asset and risk management framework that sets a common standard could improve the quality of information, allow this information to be used across a range of systems and support analysis across a range of datasets, particularly for asset management, documentation and mapping.[297] This would improve communication between sectors and reduce maintenance costs. International best practice calls for an independent party to provide assurance (identify, report and take action on risks and challenges) on infrastructure projects, particularly during delivery.

7.1.4. Recommendations

No.	What	How	Who	When	Ref.[7]
B1.1	**Strengthen government as a sophisticated client of infrastructure**	Take the following steps to develop the client capability of the government to better deliver infrastructure: a. Develop service quality standards and standard design methodologies for each major infrastructure asset class with key delivery agencies. b. Require long-term planning informed by service standards to better predict future infrastructure needs. c. Strengthen government capabilities for end-to-end delivery, including governance, commissioning, procuring, negotiation, oversight and whole-of-life management systems for major infrastructure.	MBIE, Government Procurement, The Construction Accord, The Treasury, Delivery agencies	2022-2031	WEF,ROY
B1.2	**Increase clarity of long-term funding intentions for public infrastructure agencies**	Public infrastructure agencies require long term funding certainty to better match planning processes with major infrastructure projects. The annual budget process should provide public infrastructure agencies with a 10-year funding provision within which capital intentions plans are developed.	Treasury, DIA, Local Government	2022-2026	AIP

[7] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[7]
B1.3	**Strengthen independent advice for infrastructure prioritisation**	Establish an independent Infrastructure Priority List to build consensus around key projects and initiatives that address significant long-term problems. Developing the Priority List should include the following steps: a. Publish guidance on criteria for project inclusion and priority investigations, consistent with best practice decision-making principles. b. Solicit applications for priority projects and initiatives from infrastructure providers. c. Assess projects and initiatives and regularly update the Priority List. d. Require long term planning informed by service standards to better predict future infrastructure needs.	Te Waihanga	2022-2026	AIP
B1.4	**Improve infrastructure performance reporting and insight**	Assemble and analyse infrastructure performance across: a. Projects: how individual assets perform in delivery and operation. b. Networks: how infrastructure performs as a network. c. Systems: how networks perform as an integrated system.	Treasury, Te Waihanga	2022-2050	DSA

No.	What	How	Who	When	Ref.[7]
B1.5	**Strengthen project evaluation through cost benefit analysis**	Deliver consistent and transparent project evaluation by requiring: a. Local and central government agencies to undertake and publicly release rigorous social cost benefit analysis on all public infrastructure investment proposals where the whole-of-life costs of the proposals exceed $150 million. b. That analysis is complete prior to projects being announced. c. That analysis appropriately recognise inter-generational choices and include wider environmental and social impacts.	Treasury, MBIE, Te Waihanga	2022-2026	PII
B1.6	**Appropriate consideration of future generations in project evaluation**	Undertake an inquiry into the appropriateness and consistent application of New Zealand's social discount rate policy, which determines how much weight is placed on future outcomes relative to present-day outcomes when analysing public infrastructure investments.	Treasury , Te Waihanga	2027-2031	TNT
B1.7	**Improve the infrastructure project knowledge base**	To improve future project evaluation methods and processes, delivery agencies should: a. Conduct and fund independent post-implementation reviews of major infrastructure projects at completion. b. Publish ex-post reviews in full and measure performance, benefits and cost against business case estimates.	Delivery agencies	2022-2050	DSA

No.	What	How	Who	When	Ref.[7]
B1.8	**Improve infrastructure cost analysis**	Undertake investigations into the cost performance of New Zealand's infrastructure sector that: a. Cover multiple infrastructure sectors to enable the identification of common issues and points of difference. b. Identify recent cost trends and drivers of cost trends within infrastructure sectors. c. Benchmark New Zealand's cost performance against better-performing OECD countries and identify drivers of differences. d. Are repeated at least once every five years to inform ongoing Infrastructure Strategy development.	Te Waihanga	2022-2050	BUP

7.2. Improving funding and financing

Te whakapiki i te whakapūtea me te tuku pūtea

Our infrastructure providers need access to funding and financing, to ensure the right investment.

Improving the way we fund and finance our infrastructure can improve results in the long term. It will mean we can deliver more and better meet our communities' needs. We face significant infrastructure challenges that will require considerably greater investment by government and private providers. Good funding and financing policy, supported by good decision-making, will enable us to meet these challenges.

'Funding' is distinct from 'financing'. **Funding** represents all the money needed to pay for infrastructure. It comes from the community through users, taxpayers, or ratepayers. **Financing** is about when we pay for our infrastructure. It could mean using cash surpluses now or borrowing from sources we need to service and repay later.

We have choices about how to fund and finance projects. These choices have important implications for how much infrastructure can be provided, the quality of that infrastructure, the willingness of users to pay for quality and equity for different groups in society.

For telecommunications infrastructure, users fund infrastructure services when they pay their phone or internet bills. The telecommunications' companies finance their assets (cell phone towers, lines, roadside cabinets, exchanges, spectrum and fibre assets) by borrowing money and issuing shares to investors. Rising customer demand provides companies with the incentive to improve telecommunications infrastructure and services and provide what consumers want. This has allowed telecommunications infrastructure to respond to a tenfold increase in data consumption over the last decade.[298]

7.2.1. Context

New Zealand needs more infrastructure than we have plans to fund.

Both public and private sector investment has increased considerably over the last two decades,[299] with particularly large increases in electricity and telecommunications.[300] However, we still need more infrastructure than we currently have plans to fund (as shown in Section 3).

There are many reasons for these pressures and they include:

- Providing growing cities and export industries with infrastructure.
- Changing expectations about quality and service levels.
- Shifting to a net zero-emissions economy.
- Adapting to climate change and natural hazards like earthquakes.
- Funding operational costs in areas experiencing population decline.
- Renewing assets that have reached end of life.

Analysing specific infrastructure sectors often reveals a need for more investment. Examples include the Department of Internal Affairs' analysis of three waters investment requirements[301] or Transpower's estimates of the renewable electricity generation infrastructure that will be needed to remove carbon emissions.[302] Both of these reviews found that more infrastructure is needed. We have choices about how to respond to these challenges. Increasing infrastructure funding and financing will be part of that response. It must be based on good decision-making principles, be financially sustainable for users and providers and ensure there are good incentives about how to provide and use infrastructure.

7.2.2. What we've heard

Through both our public consultation and stakeholder engagement we heard that funding constraints are one of the biggest barriers contributing to the need for change. A clearer and more consistent approach to funding and financing is required across the system.

There was a general sense that the methods we use to fund infrastructure are under pressure, but that designing new methods is challenging. We heard there is a need to avoid breaking the 'beneficiary pays' (or benefit) principle and that there still needs to be a place for local decision-making about what to build and how much to pay.

Responses highlighted the need for greater central government funding of infrastructure, in particular lead infrastructure. This is infrastructure like transport connections that can encourage development and growth. Suggested mechanisms for distributing that funding were varied, but included a share of GST generated in a region, competitive development funds and greater use of user pays systems.

Stakeholders and submitters have different views about what is causing more problems for infrastructure: funding or financing. Generally, sectors where charging for services is common, such as electricity or telecommunications, felt that financing was a constraint. While sectors, like transport, that rely on general funding pools we more concerned with the impact of funding on infrastructure.

7.2.3. Strategic direction

Applying good principles to guide funding and financing decisions

Choices about how to fund and finance projects have broad impacts.

The way we fund and finance infrastructure affects what projects are built, which community needs are met, who can access infrastructure and how they use it. It also has a large bearing on *when* we pay for it and given the long life and high cost of infrastructure, this can mean future generations need to pay for some infrastructure services.

A principled approach to funding and financing decision-making can give communities clarity on expectations for how infrastructure will be funded and when they will pay. Table 5 outlines six core principles for infrastructure funding and financing, based on best practice.[303] These principles support the broader infrastructure decision-making principles outlined in Section 7.1.

Table 5: Infrastructure funding and financing principles

Principle 1: Those who benefit pay (the benefit principle) - Infrastructure services should be paid for by those benefiting from the services.[304]
Principle 2: Intergenerational equity - Financing and funding arrangements should reflect the period over which infrastructure assets deliver services.
Principle 3: Transparency - Wherever possible, a clear link should be made between the cost of providing infrastructure services and the funding of that cost. If feasible, prices should be service-based and cost-reflective.
Principle 4: Whole-of-life costing - When considering funding requirements for an activity, the whole-of-life costing should be included.
Principle 5: Administratively simple – The costs of administering funding and financing arrangements are an important consideration as they can offset the benefits of 'better' options.

Principle 6: Policies for majority of cases - Funding and financing policies should be written to work in the majority of cases, with alternative or supplementary mechanisms to address the exceptions.

Funding and financing principles are currently applied inconsistently across infrastructure sectors.

The energy and telecommunications sectors make funding and financing decisions that are better aligned with these principles. These sectors are largely commercial, funded through prices paid by consumers and financed by financial institutions, shareholders and debtholders. Competition drives pricing decisions. In areas where there isn't adequate competition, an independent regulator makes sure that prices are fair. By contrast, funding and financing decisions in the water, transport and waste sectors are less consistent with these principles.

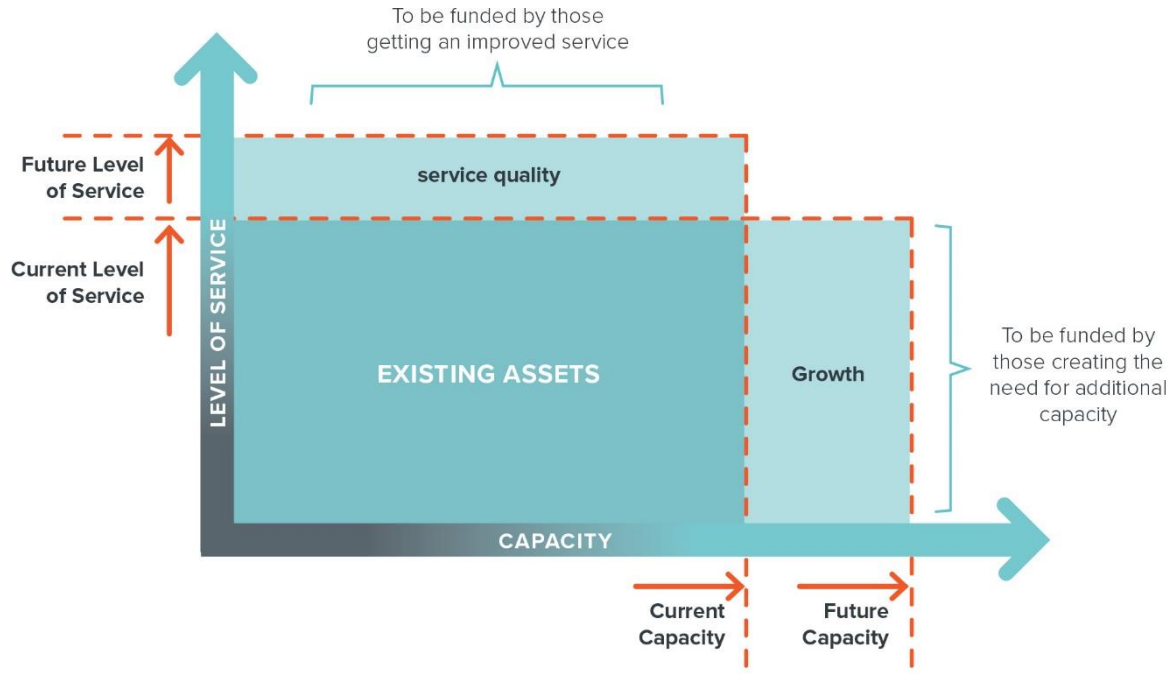
Better use of prices to fund infrastructure services

Infrastructure improvements can have different drivers and beneficiaries.

The need for infrastructure upgrades arises in several ways. Increased demand can mean that more services need to be offered (for example, new homes can drive the need for more water connections and roads) or the quality of the service needs to improve (for example, extend the opening hours for a library). Sometimes both an increase and improvement in services are needed (see Figure 29).[305]

Funding requirements are affected by service quality and demand growth

Figure 29: Illustration of how multiple factors can drive need for investment



Source: Te Waihanga

Charging those who benefit from an infrastructure service should be the predominant funding option.

Charging people directly for the services they get from the infrastructure they use has a range of benefits. It encourages people to think about when they use infrastructure or whether they need to use it at all. For example, charging to use a busy road during peak times can encourage people to take public transport or travel at another time.

This approach is already used in sectors such as electricity.[306] Prices are often higher during the business day than overnight or in the weekends, encouraging users to charge their electric vehicles and run their washing machines, clothes dryers and dishwashers overnight when there is spare capacity. It can also encourage the use of technology that takes advantage of spare capacity, for instance through timers that automatically turn on hot water cylinders in the early hours of the morning.

Charging those who benefit also gives infrastructure providers direct information on how many people are using the service at any given time. This helps providers better plan for how they can improve their service to manage periods of high demand. This might mean planning to build new infrastructure, but it also encourages innovation. If the cost of providing infrastructure increases and users are not prepared to pay the higher price, providers have an incentive to find alternatives. In this way, the use of prices can help save resources and incentivise innovation to meet our infrastructure challenges.

The principle that the person who benefits pays could apply to many infrastructure services:

- In wastewater, allowing local authorities to rate wastewater based on volumes would create an important link between the services provided and the costs to users. This incentivises the use of water efficient toilets and basic maintenance to reduce leaks.
- In water, greater use of charging based on volume of water used (volumetric charging) encourages users to use less, making it an effective mechanism for water conservation.
- In transport, pricing that is time, location and distance sensitive can reduce congestion on busy roads by smoothing peak demand. This helps avoid costly infrastructure upgrades in complex urban environments.
- In tourism, greater use of the tourism levy to fund tourism infrastructure could assist in closing a funding gap for councils that have a greater proportion of infrastructure demand growth from tourists than residents.

Changes to technology can catalyse changes to infrastructure pricing. For instance, the electrification of the vehicle fleet will cause revenue from fuel taxes to decline, which is a challenge because fuel taxes currently provide a significant share of overall transport funding, while digital technologies enable road use to be priced in a more sophisticated way. There is therefore, a need to reform the transport funding system.

Some infrastructure charges, like waste levies or parking fines, discourage behaviour that has negative social or environmental impacts, like landfilling too much waste or overstaying parking time limits. While we often use these, they can often be set in legislation or regulation and are infrequently updated. To ensure these charges are effective over time, they should be automatically adjusted for inflation.

As part of a transition to a pricing-based approach, it will be important to build community understanding and acceptance for this approach.

Pricing across the sectors

Infrastructure service prices should generally be service-based and cost-reflective.[307]

Service-based means prices reflect service types and levels. This is how most of us pay for electricity or telecommunications. For example, there are different prices for phone and data services depending on how many calls you make or data you use and whether you use voice or data services.

Cost-reflective means prices reflect the cost of supplying the service. Cost-reflective pricing often means that there is a fixed cost as well as some that vary with use. A fixed access charge (to cover

the fixed costs, such as the cost of an electricity connection) can be set alongside charges that cover variable costs such as the amount of electricity used.

Although water, transport and waste sectors use some service-based and cost-reflective pricing, this approach is inconsistent across services and regions. For instance, transport infrastructure is funded through a combination of fuel taxes, rates and other user charges like tolls and public transport fares. Fuel taxes and road user charges are not location or time-based, nor specifically related to services delivered and the cost of those services. As a consequence, they do not influence changes in time of use to off-peak periods.

Local government development contributions are a good method of funding infrastructure, but a standardised process is needed.

Councils charge developers of land for the cost of infrastructure that is needed to service new housing (like new roads, wastewater infrastructure, parks and libraries). These charges are called development contributions and are consistent with the benefit principle and the transparency principle. The purpose of development contributions is to recover a fair, equitable and proportionate share of the total cost of infrastructure necessary to service growth over the long term. The aim is to create a clear link between the demand for new infrastructure (caused by more housing) and the cost of providing that additional infrastructure. In principle, this can be achieved by dividing the cost of building new infrastructure by the level of new housing demand. This rate is then used to set what developers need to pay to fund the infrastructure costs associated with new housing.

Councils need to follow processes set out in legislation when calculating development contributions. However, in reality, the way these contributions are calculated is open to interpretation. This leads to debate between councils and developers about how much they need to pay, which causes delays. This can be especially challenging when a new development causes the need for a step-change in infrastructure capacity, making attribution for a single development more difficult. If development contributions are set too low, a funding gap can emerge. If they are set too high, housing development might be impeded.

A single legislative process, similar to national building standards, would make it easier for councils to charge development contributions. A consistent, standardised process could reduce legal challenges, uncertainty and cost. Standardisation is unlikely to go as far as common charges for all locations, but it could standardise the calculation methodology for all local authorities to use.

Rating of Crown properties is consistent with funding and financing principles.

Taxes and rates raise money to fund central and local government spending. However, there are some cases where landowners and others who use infrastructure are exempted from paying taxes and rates. This can lead to a gap between the funds collected and the amount that needs to be spent on infrastructure. Those receiving the exemption also have no incentive to try to reduce their use of infrastructure.

Currently, Crown property is exempt from local government rates.[308] Rating exemptions currently include schools, hospitals and some defence force land, despite many requiring substantial infrastructure investment by local government. There are also some non-Crown exemptions.[309]

Removing these exemptions would remove the disadvantage from Crown land falling within a council area and would allow each council to apply rates more fairly to properties in its area. A range of options should be considered for how this can be introduced. It will be important to avoid creating excessive and unexpected financial liabilities to the Crown. Options could include phasing-in requirements over time or ringfencing activities that do not generate demand for local government infrastructure.

Sometimes the people who benefit from infrastructure are wider than just the users of that infrastructure.

New infrastructure can sometimes cause land and house values to rise.[310] An example is when a train station is built, making it easy for people who live nearby to take public transport. This increases the value of those nearby properties. Funding new infrastructure (like the new train station) by levying charges based on the gain in property value may be appropriate, especially when it is difficult to recover the full cost by only charging the people using the service. This is called 'value capture' charging.

Value capture charging is consistent with the benefit principle. However, there can be practical challenges with value capture charges. Most importantly, people need to be made aware of the charge before property values increase. This may need to be before a project is built or even before it is announced.[311]

A targeted, additional rate for those landowners whose property values increase could be used as a value capture charge to fund new infrastructure. While targeted rates are already widely used to fund improvements,[312] further clarification is needed on whether councils can legally use a change in land value as the basis for a targeted rate.[313] There are also other roadblocks to using them more widely, which arise from consultative processes at the local level. These should be considered as part of the local government review.

Government funding is justified in some cases

There is a place for a public subsidy when there are wider social benefits or it is needed to assist the vulnerable.

For some types of infrastructure, like schools and hospitals, charging users would not be enough to match the need or the benefits they offer. Public transport is another example where the wider social and environmental benefits justify a public subsidy.[314] There are also instances where those on low incomes or with high needs require some level of public subsidy. The primary health sector is an example where low-income customers receive targeted subsidies. In the energy sector, Work and Income administer the Winter Energy Payment that helps with the cost of heating over the winter months for at-risk New Zealanders.[315] When subsidies are needed, the level of subsidy should be transparent and appropriately targeted.

Infrastructure pricing is not always the answer to equity issues.

The efficient pricing of infrastructure services can lead to fairness and equity issues for low-income users if it is not matched by appropriate policies to offset these effects. However, changes to pricing aren't necessarily the right place to manage these issues.

Prices need to be applied consistently to have the greatest impact. For example, charging for water use encourages all consumers to conserve water. Similarly, congestion pricing rewards those who choose not to travel during peak times and provides a source of revenue to fund public transport for those who still need to travel at those times. Well-designed pricing is essential for efforts to manage demand, but the benefits of pricing require complimentary policies to ensure affordability issues are not created for vulnerable New Zealanders. This could include targeted subsidies, discounts and rebates.

A comprehensive assessment of social assistance tools, particularly those held by government agencies outside the infrastructure sector should be undertaken when addressing infrastructure equity issues for vulnerable and disadvantaged New Zealanders to ensure they still have access.

Direct government funding is important, but must be carefully managed.

Central and local government will need to continue funding some infrastructure out of general taxes or rates, particularly where:

- It is not practical to exclude users who do not pay direct prices. This applies to hospitals, parks and footpaths.
- Wider beneficiaries are difficult to identify or are spread widely among the community. This applies to primary and secondary education.
- Infrastructure is provided for social equity reasons. This applies to libraries, schools and community facilities.

In these cases, a mix of government funding and direct pricing may be appropriate. Where this applies, there is a case to increase infrastructure funding to address important challenges. Careful management of public funds is needed and government subsidies for infrastructure should continue to follow the funding and financing principles laid out above.

Consolidating capital funding of infrastructure can improve access to finance and value for money.

Central government has established various infrastructure-related capital funds over the last decade. A selection of these totalling $32 billion is shown in Table 6. Each fund has its own criteria for how it can be spent, repayment terms, reporting and other requirements. Dedicated funding bodies that are responsible for the funds are usually created within relevant government agencies. This helps make the purpose of funds clearer, but it does also spread expertise across agencies and can result in inconsistent project appraisal and delivery. Some also duplicate existing funding sources and can create uncertainty in a market which depends on a consistent, predictable pipeline of work.

Fewer consolidated funds can result in better prioritisation and coordination of programmes at the national level (see Case Study 12: International Examples of Infrastructure Funds). Reducing the number of funds would make it easier to apply consistent, rigorous and transparent criteria and ensure that project evaluation and selection is done by professional management and governance boards. Greater consolidation can also increase competition, improve predictability and stability of funds, take advantage of economies of scale and build capability to deliver best value for money. It may provide opportunities to improve access to financing by using a combination of grants, loans and investments (including domestic and international) to increase financing options.

A consolidated fund should be consistent with best practice principles, provide transparency and be required to demonstrate value for money through an agreed prioritisation and cost benefit analysis methodology. It should implement the political expectations set out in Government Policy Statements. Consolidated funds could still allow for earmarking of funds to specific purposes when appropriate.

Table 6: Examples of recent infrastructure funds

Examples of recent infrastructure funds	**Amount (NZD)**	**Year**
Ultrafast Broadband Initiative[316,317,318]	1.5bn	2011,15
Rural Broadband Initiative Phase 1 and 2[319]	430m	2011,17
Urban Cycleways Program[320]	100m	2014
Irrigation Acceleration Fund & Crown Irrigation Investments[321]	400m	2011,15
Christchurch Regeneration Acceleration Facility[322]	300m	2018
Housing Infrastructure Fund (consisting of 10-year interest free loans)[323,324]	1bn	2016

Provincial Growth Fund[325]	3bn	2017
Tourism Infrastructure Fund[326]	25m	2019
New Zealand Upgrade Programme[327,328]	14bn	2020, 21
COVID-19 Response and Recovery Fund: Infrastructure Reference Group[329]	3bn	2020
Three Waters Reform: Stimulus and Reform Funding[330]	761m	2020
Māori and Public Housing Renewable Energy Fund[331]	28m	2020
Housing Acceleration Fund[332]	3.8bn[333]	2021
Three Waters Reform: Establishment of Water Service Entities[334]	296m	2021
Three Waters Reform: Support for Local Government Transition[335]	2.5bn	2021
Hypothecated Emission Trading Scheme Auction Revenue[336]	3bn	2022

Case Study 12: International Examples of Infrastructure Funds

New South Wales Restart Fund[337]
In 2011 the NSW Government established the Restart NSW Fund to enable the funding and delivery of high-priority infrastructure projects that improve the State's economic growth and productivity. Over A$35 billion from the NSW Government's asset recycling programme has been paid into the fund to date to be invested into infrastructure projects. The Restart NSW Fund is governed by the Restart NSW Fund Act 2011. Under the Act, Infrastructure NSW is responsible for assessing and recommending projects which improve the economic growth and productivity across all sectors. To get funding through the Restart Fund, a project must be recommended by Infrastructure NSW and have a BCR greater than 1. Projects funded from the Restart NSW Fund include a mixture of NSW Government agency-led infrastructure projects, as well as local and community infrastructure projects being delivered by local government, non-government organisations and other entities. Thirty per cent of Restart NSW funding is targeted at regional and rural areas over the lifetime of the fund.

Canada's approach to infrastructure funds[338]

The Investing in Canada Infrastructure Program delivers funding to communities to support the Investing in Canada Plan. The programme provides long-term, stable funding delivered by Infrastructure Canada to invest in infrastructure that supports environmental, community and economic objectives. Under the programme, over $33 billion in funding is being delivered through bilateral agreements between Infrastructure Canada and each of the Canadian provinces and territories. Infrastructure Canada evaluates proposal for funding and has an on-going role in tracking the status of projects. Infrastructure Canada also manages a number of infrastructure related funds on behalf of the Canadian Government, applying consistent service standards across its portfolio.

System solutions to enable effective financing arrangements

Debt funding for long-lived infrastructure is equitable.

The financing of infrastructure is important because infrastructure exists for generations. Financing allows upfront costs to be spread across time, so funding can be more closely aligned with the use of services by current and future users. In principle, aligning financing decisions with the life of infrastructure can mean costs are more fairly shared across generations, something known as intergenerational equity. This results in a better overall outcome for society.

However, this approach locks in infrastructure costs for future generations that might have preferred other options. This is particularly relevant in the age of climate change and rapid technology change.

Financing infrastructure can also speed up delivery compared to cash funding, although there is an interest cost associated with this. In general, communities will benefit from accelerating investments where a project has clear benefits despite these interest costs.

Alternative ownership structures can improve access to funding and financing.

Some councils and local infrastructure entities are unable to borrow more money to finance the infrastructure they need to keep up with population growth, large asset renewals or service quality upgrades. This problem arises due to a combination of two factors:

- Debt incurred to build infrastructure sits on council balance sheets. This happens regardless of whether the debt it incurred by the council directly or indirectly through a council-controlled organisation or an entity that is majority-owned by council.[339] This means that councils are ultimately liable for all debts associated with publicly provided local infrastructure.
- Councils can only borrow at favourable interest rates if their debt-to-income ratios remain within levels required by rating agencies (often called their 'debt ceiling').[340] Taking on more debt without increasing rates and user charges brings financial costs and risks, but increasing rates and user charges is typically unpopular with voters.[341]

The Infrastructure Funding and Financing Act 2020 (IFF) seeks to address this problem using Special Purpose Vehicles (SPVs), where financing of local infrastructure can occur without affecting council debt levels. An SPV established under the IFF is a standalone legal entity that is not owned by a council, so debt is not on a council's balance sheet. SPVs can charge levies on properties benefitting from infrastructure provided by the SPV. Based on this funding source, the SPV can raise finance from the markets to undertake infrastructure development.[342,343]

Public private partnerships are a viable option for delivering infrastructure.

Public-private partnerships (PPPs) are a public-private risk-sharing framework that is widely used internationally. Unlike traditional methods for delivering projects, PPPs involve the private sector and aim to boost efficiency and effectiveness through the project lifecycle. In New Zealand, PPPs are typically a long term contract for the delivery of a service, which involves the construction of new infrastructure or improvement to existing infrastructure that is financed from external sources. Full legal ownership of the asset is retained by the Crown.[344] This arrangement has the advantage of spreading project cost over an extended period, freeing up public funds. By accessing private sector financing, projects can also be delivered more quickly.

There are currently eight PPPs[345] planned or underway in New Zealand and these have a combined total of $4.2 billion.[346] There have been some high profile examples where PPP projects have had delays or cost overruns. However, for the five PPP projects currently operational in New Zealand, they have generally been delivered on-time and on-budget for the Crown. Each operational project has experienced delays of fewer than six months.[347]

In the right circumstances, the PPP model can offer better value for money when compared to more traditional procurement approaches. When looking at how to deliver new infrastructure projects, government should rigorously test the potential for using a PPP as part of the procurement phase.

7.2.4. Recommendations

No.	What	How	Who	When	Ref.[8]
B2.1	**Improve equitable funding of local infrastructure**	Investigate options to phase in requirements for the Crown to pay rates for land, where appropriate and when it generates a demand for infrastructure. The approach should avoid creating excessive and unexpected financial liabilities.	DIA	2027-2031	ULH
B2.2	**Reforming the transport funding system**	Implement a new, fit-for-purpose transport funding system that is sustainable and adequate for meeting future transport investment requirements. The system should incorporate principles of user charges and best practice funding principles, including shifting vehicles onto time, location, distance and level-of-service-based pricing. Establishing a new system should include: a. Establishing a replacement for Road User Charges and Petrol Excise Duty. b. Establishing necessary transport funding requirements. c. Determining how additional funding, if required, should be collected.	MoT	2022-2031	KCM
B2.3	**Improve and streamline the application of development contributions**	Implement a single national legislative process for development contributions policy to assist territorial authorities in interpreting existing legislation for determining development contributions policy. This could be similar to National Building Standards.	DIA	2027-2031	FFI

[8] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[8]
B2.4	**Consolidate existing separate infrastructure capital funds**	Fragmented infrastructure capital funding pools should be consolidated and integrated in a transparent infrastructure capital fund(s). The consolidation of national capital funding programmes for infrastructure would enable the Government to prioritise investments based on national significance, net benefits and enable greater public transparency around infrastructure capital funding decisions. How these funds are held and distributed should be: a. Set out transparently. b. Include consideration of the use of grants, loans and investments, or some combination of these.	Treasury	2022-2031	AIP, FFI, RNS
B2.5	**Improve ability to debt fund infrastructure**	As a way of accessing alternate financing and avoiding debt on local government balance sheets: a. Investigate opportunities to utilise the Infrastructure Funding and Financing Act. b. Explore other Special Purpose Vehicles (SPVs) as a mechanism for new infrastructure investments.	Treasury, DIA	2027-2041	LFF

No.	What	How	Who	When	Ref.[8]
B2.6	**Improve funding of infrastructure services through targeted funding tools**	Establish targeted funding tools for the following applications: a. Tourism: Ensure that the International Visitor Conservation and Tourism Levy be used for tourism infrastructure, especially for local authorities with high international visitor numbers that are otherwise struggling to secure funding sources. b. Transport: The introduction of congestion pricing in urban areas. c. Wastewater: Introducing legislative change that clarifies the ability of local authorities to direct rate wastewater based on volumes would create a better linkage between services and costs to users. d. Waste: An investigation into what funding mechanisms will best achieve the objectives of the Waste Minimisation Act 2008 and National Waste Strategy and incentivise behaviour appropriately.	MBIE, MoT, DIA, MfE	2027-2031	LFF, FFI, TCQ
B2.7	**Encourage the use of value capture tools to fund infrastructure for growth.**	Enable value capture tools through legislation to ensure that value becomes a driver of service provision.	Treasury	2022-2031	BUP, FFI, LFF, MHT
B2.8	**Increase infrastructure funding to meet our infrastructure challenges and boost productivity**	Given current expenditure levels are unlikely to be sufficient to provide for infrastructure needs over coming decades, a material increase in infrastructure funding from both public and private sources is required to meet our infrastructure challenges and boost productivity. Government should increase infrastructure funding to: a. Use infrastructure investment to support opportunities for productivity growth, resilience and to meet environmental targets across the economy. b. Make investments based on rigorous assessments of which projects display clearly positive productivity benefits.	Treasury	2027-2050	FFI, TIC

No.	What	How	Who	When	Ref.[8]
B2.9	**Ensure that infrastructure charges keep pace with inflation.**	Infrastructure related charges, fees and levies that are set out in legislation or regulation should be adjusted for inflation.	Treasury, Local Government.	2022-2026	LFF

7.3. An enabling planning and consenting framework

He anga whakaahei whakamahere, whakaae hoki

Our planning and consenting system needs to be strategic, coordinated and commensurate to the urgency of the challenge.

We use the planning and consenting system to make decisions about how we protect and use natural resources like our water and land. There are many organisations involved in this system, including central government agencies, regional councils and territorial authorities. There are also many policies that impact the planning system, such as national policy statements, environmental standards and regional, unitary and district plans.

It's often a long and costly process to gain planning approval for infrastructure. This will make it difficult to provide the infrastructure that we need to meet future challenges, such as a net-zero carbon emissions economy, larger populations, affordable housing, greater resilience to shocks and stresses, as well as lift our environmental performance. Our planning system needs to enable us to get the infrastructure required to meet these challenges.

7.3.1. Context

A good planning system provides a number of benefits for infrastructure.

Key features of a good planning system include:

- Enabling infrastructure to be constructed, maintained and upgraded in a timely way to ensure that government can fulfil its obligation to deliver infrastructure services.
- Efficiently managing the environmental impacts of infrastructure development in a way that is proportional to the magnitude of impacts.
- Considering the benefits of infrastructure provision, including national environmental benefits from reducing greenhouse gas emissions, as well as the costs.
- Coordinating across multiple institutions and providing clear and certain guidance about how to consent projects.

Our planning system slows down essential infrastructure projects.

New Zealand suffers from long delays between project planning and delivery. Infrastructure projects must go through a resource consent or designation process. Resource consent applications typically require detailed analysis of environmental, social, cultural and economic impacts of projects. They are tested through a hearings process that has been described as adversarial, with the right to appeal decisions to the Environment Court or High Court. This process can take a long time and is costly for everyone involved.[348]

As well as requiring resource consent, infrastructure projects can require approvals from multiple agencies, including funding approval. When these approval processes are poorly coordinated, it can add further cost and delay, or even halt a project.[349]

Infrastructure requires special consideration within the planning framework because of its unique characteristics.

Infrastructure often depends on an entire functioning network such as a water system or transport network. Its benefits are usually distributed over a large area. These benefits could serve whole communities (in the case of a school or town hall), cities (such as a road network), regions (like a water

system) or all of New Zealand (through our country's electricity network). We rely on a planning system that recognises and enables infrastructure that delivers these wider benefits.

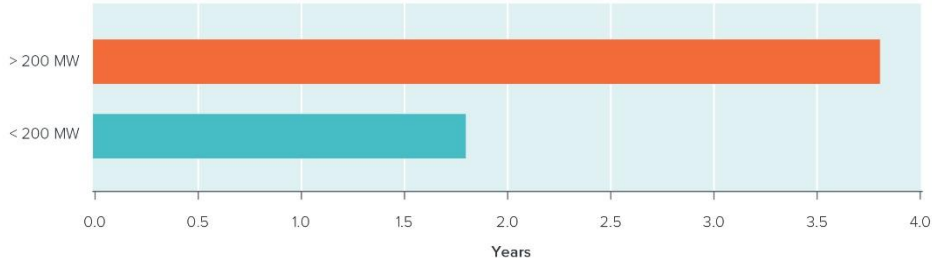
It can take years to get consents for infrastructure projects like wind farms.

Figure 30 shows the time to obtain a resource consent decision for ten wind farm applications. Four were for wind farms exceeding 200 MW capacity and six were for smaller wind farms.[350] In every case, the consenting decisions for large farms took more than three years. The longest took more than five years and was withdrawn. The average for the four larger wind farms is 3.8 years, compared to 1.8 years for the smaller wind farms. Reducing consenting timeframes for large wind farms will be essential for meeting our net-zero carbon emissions targets by 2050.

No consent applications have been made for offshore wind farms, but they could occur in the next 10 years. Among European countries, Denmark and the United Kingdom appear to have the fastest consenting timeframes, at less than 1.5 years for offshore wind farms.[351] There are similarities in their consenting processes, which we should consider when reviewing our onshore and offshore consenting systems.

Consents take far longer for large wind farms

Figure 30: Time taken to consent wind farms in New Zealand



Source: Te Waihanga

Consenting delays are only the tip of the iceberg.

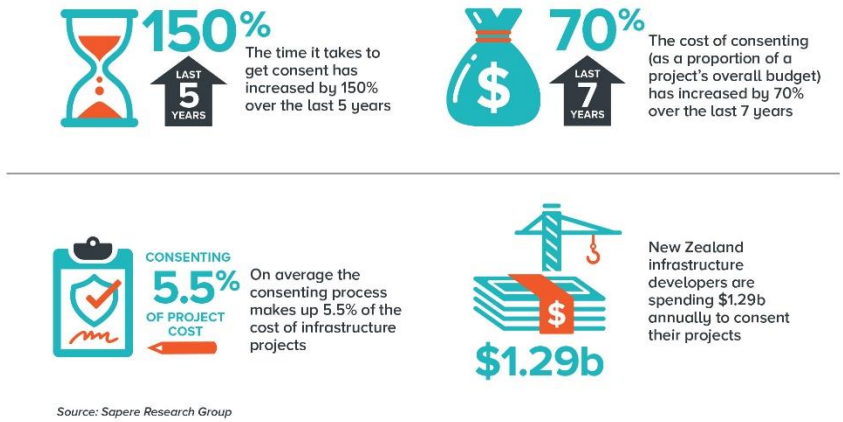
Public infrastructure projects can be delayed for many reasons, including poor coordination among organisations making decisions. For example, Auckland's Northern Busway was originally proposed in 1987, but was only completed in 2008. The 21-year timeframe was primarily caused by the number of planning and funding agencies involved, rather than consenting delays.[352] Auckland's second busway, the Eastern Busway, is currently scheduled for completion in 2028, over 20 years since planning began.[353] By contrast, Brisbane's first busway was proposed in 1995 and completed in 2001, only six years later.[354] Brisbane delivered two more busways between 2004 and 2011.[355]

Consenting infrastructure is costly and the costs are increasing.

The consenting process is not only time consuming, but also costly (see Figure 31). On average, consenting accounts for 5.5% of the total cost of infrastructure projects.[356] This includes application preparation and hearing costs, as well as financing costs due to delay. These costs appear to be higher than in other developed countries.

The consenting process can add significant time and cost to projects

Figure 31: Key statistics on time and cost impacts of infrastructure consenting processes



Source: Sapere, 2021

The time it takes to gain consent is another important cost, with considerable differences across projects. A consent decision takes between 63 and 91 days for a typical project, but this increases to between 167 and 214 days for projects that are a little more complex. For even more complex projects, the time increases to between 365 and 425 days. Each day taken up by this process corresponds to approximately $4,000 in direct costs incurred by the applicant. It is important to identify opportunities to speed up the consenting time for infrastructure projects so that communities, cities, regions and New Zealand as a whole can make the most of the shared services that infrastructure provides.

The cost of consenting appears to be rising over time, as councils are taking longer to make decisions and application requirements are becoming more complex. Consenting costs and project delays can be significant even for relatively straightforward infrastructure upgrades, as shown in Figure 31. Consenting is also disproportionately large for smaller projects. It accounts for more than 20% of the cost of projects under $1 million but less than 2% of the cost of projects over $100 million.

Infrastructure consenting costs an estimated $1.29 billion every year. If we were able to reduce this by 50%, we would save the same amount of money that's needed to build an additional 270 megawatts of wind generation capacity every year. This would be enough to meet over half of our net zero carbon emissions goals, which requires us to build around 490 megawatts of renewable energy generation every year.

Source: Sapere, Transpower, Te Waihanga Analysis[357]

7.3.2. What we've heard

In Te Waihanga's Aotearoa 2050 survey, 82% of respondents said that the environment should either be a 'very high' or 'high priority' when making future decisions on how New Zealand should get ahead with its infrastructure. The length of time it takes to build new transport options was ranked the fifth most important infrastructure issue.

Infrastructure providers have told us that a significant increase in the rate of investment in infrastructure will be required. The existing planning system poses challenges to this by adding uncertainty, time and cost.

7.3.3. Strategic direction

Enabling the government's obligation to deliver infrastructure

The planning system must enable infrastructure to be delivered as required by legislation.

Legislation[358] requires the government to ensure that the wellbeing of New Zealanders is upheld and improved by:

- The supply and use of electricity.
- The supply of telecommunications.
- An effective, efficient and safe land transport system.
- The protection of the interests of New Zealand.
- Public safety and the maintenance of a just society.
- Improving, promoting and protecting public health.
- Access to free enrolment and free education.
- The supply of 'safe drinking water' and obligations regarding wastewater and stormwater.

These services are delivered in many ways. For example, the government owns and maintains infrastructure, such as state highways, defence facilities, hospitals and schools. For other types of infrastructure, such as water networks, it sets the water quality standards that local government must comply with. With electricity and telecommunications, which are delivered privately, the government must ensure that policy and regulations enable firms to deliver services to New Zealanders in the most efficient and effective way.

The planning system should lead to decisions that improve social and economic outcomes, while balancing the need to protect the environment. The outcomes could be safety on a road, increased prison capacity or extra transmission lines to meet electricity demand. Decision-makers will need to consider how infrastructure that's required by legislation can be delivered in ways that meet the requirements for protecting the environment.

Resource Management Act directions have been applied too broadly.

The Resource Management Act (RMA) focuses on environmental planning. Under the RMA, conditions can be imposed on infrastructure providers to avoid, remedy or mitigate the environmental effects of their projects. These conditions have become very broad, increasing costs and affecting the viability of some government projects. For example, the RMA has been used to require unrelated activities such as establishment of mussel beds,[359] construction of a national hockey stadium[360] and redevelopment of a pony club to be funded in order to gain consent for an infrastructure project.[361] In some cases, the definition of an 'effect' has extended beyond the management of natural and physical resources to areas like the impact on neighbouring businesses.

Other regulation that creates unintended barriers should be reviewed.

The RMA isn't the only example of regulation that can create barriers to infrastructure provision or increase costs. Regulations that are intended to achieve other worthy outcomes, such as environmental quality, health and safety and Building Act requirements may deliver limited benefits at a high cost, or result in unintended consequences for project delivery. Regulations that are intended to achieve other worthy outcomes, such as environmental quality, health and safety and Building Act requirements may deliver limited benefits at a high cost, or result in unintended consequences for project delivery.

Anecdotally, some recent changes to health and safety rules may slow down construction without significant benefits for safety. Potential examples include recent changes to temporary traffic management procedures, which are reported to increase roadwork costs and slow down project delivery

in urban areas[362] and requirements to use scaffolding when working on single storey buildings.[363] Restrictions on the hours when work can be done may also have a similar effect.

There is a need to consider whether other regulatory requirements have an adverse impact infrastructure construction while delivering few benefits.

Using spatial planning to coordinate infrastructure delivery

For spatial planning to be effective, it relies on well-informed long term decisions.

Regional spatial planning offers an opportunity to take a more strategic approach to planning by considering how different investments and uses for the land can have wider economic, social, cultural and environmental impacts.[364] Regional spatial planning is discussed at greater length in Section 7.2.

Addressing place-based social and economic issues like unemployment, poverty, housing affordability and crime should all be as central to spatial planning as the delivery of roads and water. The longer outlook and strategic nature of spatial planning means everyone involved can commit to a long term plan on the projects and planning initiatives that are needed.

As part of the spatial planning process, all participants (regional councils, territorial authorities, central and local government infrastructure providers, mana whenua and private companies) need to supply high-quality data and information. This can include population growth projections, environmental reporting, locations suitable for energy resources and sites of cultural, historical or natural significance. This information needs to be regularly refreshed so that decision-makers can make up-to-date decisions when spatial plans are reviewed. Robust and consistent data on these issues is also essential for making informed decisions on consent applications.

However, spatial planning may not work for all infrastructure providers or provide communities with the right infrastructure solutions. Some infrastructure, like electricity generation and transmission, simply has to be based in certain locations to be viable. Spatial planning must also not impose unreasonable requirements on the ability of private providers to operate commercially. An example would be a requirement to share commercially sensitive information. This is particularly relevant to electricity and telecommunications entities.

Supporting a fast-paced and sustained infrastructure build that meets strategic objectives

The planning system is currently undergoing significant reform and needs to meet the pace of the challenges ahead.

> "There is an urgent need to decarbonise the transport and process heat sectors through electrification and to accommodate many more renewable and distributed energy resources into the system ... Meeting this will require the addition of around 25 new, grid-scale, renewable generation and battery developments to 2035 and significant investment to expand and increase the capacity and flexibility of the transmission system" - Transpower, Transpower Tomorrow, 2018

The current system is 'effects' based. This means that it focuses on the impacts that a development or activity has on the immediate environment. Those seeking consent need to minimise impacts on other residents, activities and the environment. Under this system, an infrastructure project that makes a positive contribution to the national environment (for instance, a hydroelectric scheme), but a negative contribution to a local environment, can be delayed or not given consent. This approach can have a large impact on infrastructure, because it regularly creates benefits for a larger group of people than just those in the area where it's built.

"We tend to think of fraught environmental issues as environment versus economy. But sometimes the conflict is environment versus environment. Building a hydroelectric scheme on a wild and scenic river is one. Hydroelectricity is good for the environment because it is a way of generating electricity without emitting the greenhouse gas carbon dioxide. Wild and scenic rivers are good for the environment too – they are a precious part of our environmental heritage, and New Zealanders love their rivers." - Parliamentary Commissioner for the Environment

Quarrying provides an example. Existing quarries need to be expanded and new quarries opened to meet the increasing demand for aggregates such as gravel, which is an essential component for roads, highways, railroads, bridges, dams and other residential and commercial construction. Because of the low value and high transport cost of aggregates, quarries need to be close to demand, which is often on the edge of cities. But residents are reluctant to live near quarries because of the impacts they have on the local area such as noise, dust, unsightly views and truck movements. These issues are becoming more of a problem as our cities grow and boundaries expand, making it more difficult to gain consent. This in turn can compromise other objectives, such as improving housing supply.

A consistent performance management framework would provide standardised direction on the management of effects like noise and dust.

For nationally or regionally significant activities that can have negative local impacts, there will always be trade-offs. But the current decision-making framework is not working well in resolving these and a more consistent performance management framework is needed. This would give clear and consistent national direction, with clear rules for operators on the management of issues such as noise and dust.

The reform of the existing planning system needs to set clearly prioritised, focused, national objectives that, when appropriate, can override regional and local objectives. Meeting the net-zero carbon emissions target or building cities that are affordable for future generations means infrastructure will need to be built in certain locations at certain times. The government will need to provide national direction on how objectives like these are prioritised.

In some cases, a faster decision-making process for infrastructure will be warranted.

The planning system should recognise infrastructure's unique contribution to achieving wider social, economic, cultural and environmental objectives. Specific guidance is needed to make sure that a clear consenting process exists for infrastructure projects, while still managing environmental effects. The benefits of a faster decision-making process were seen following natural disasters (such as the Hurunui/Kaikōura earthquake discussed in Case Study 13) where the process was streamlined and infrastructure services could be established far more quickly than would normally be the case under the RMA. With the right enabling environment, New Zealand can build with speed.

New infrastructure can deliver significant public value. Its scale may have some impacts locally, but provide substantial regional or even national benefits. Infrastructure can unlock a green economy through sustainable energy, improve water quality for entire regions and reduce congestion for cities. Network infrastructure that operates as part of a system (like roads and power lines) is only as good as its weakest part. For example, electricity transmission cannot be delivered with only a 90% complete transmission network and a rail network cannot work if rail bridges cannot be crossed. Sometimes this type of infrastructure will need to pass through sensitive environments so the rest of the wider network can function properly.

Infrastructure requires a planning system that is more permissive, based on a greater use of national standards and a lower need for consents. This includes more permitted activities, particularly where the

effects are well known and understood and/or can be readily monitored. A mechanism is also needed for resolving conflicts between multiple outcomes to avoid the need for litigation.

Case Study 13: Streamlining the consenting process for infrastructure post the Kaikōura earthquake

The 7.8 magnitude Kaikōura earthquake struck on 14 November 2016. It caused massive damage to the coastal road and rail routes between Picton and Christchurch. In response, the Hurunui/Kaikōura Earthquakes Recovery Act 2016 was passed on 12 December 2016. The Act was time limited (to 31 March 2018) and allowed for:

- Activities that enabled economic recovery, repair of land and infrastructure, safety and resilience, restoration of social and cultural wellbeing.
- Orders in Council to be passed as 'necessary and desirable' to achieve the purpose of the Act.

The ensuing Hurunui/Kaikōura Earthquakes Recovery (Coastal Route and Other Matters) Order 2016 allowed for restoration work on the coastal corridor to be undertaken as a controlled, non-notified activity with the following provisions:

- Limited engagement and consultation.
- Broad descriptions and desktop assessments.
- No objections or appeal rights.
- Two pathways for Resource Management Act applications:
    - Before 31 March 2017: A 9-day process with conditions pre-written.
    - After 31 March 2017: A 21-day process.

The rail corridor was partially reopened within 10 months and the State Highway was opened to all traffic by 15 December 2017. The $1.2 billion project was completed in December 2020.[365]

7.3.4. Recommendations

No.	What	How	Who	When	Ref.[9]
B3.1	**Strengthen the government's mandate to deliver infrastructure**	Ensure that the Natural and Built Environments Act 'gives effect' to existing requirements for the government to deliver infrastructure.	MfE	2022-2026	NBE
B3.2	**Improve evidence-base for environmental consent applications**	Robust and consistent data is essential for making informed decisions on environmental consent applications. Steps to increase the quality of data available include: a. Improving the evidence base on and knowledge of the effects from urban development and infrastructure on the quality of water, air, soil and biodiversity (species and habitat). b. Centralisation of knowledge to enable consistent application across regional jurisdictions, for the purpose of determining environmental consent applications.	MfE	2022-2031	NBE
B3.3	**Deliver reasonable environmental limits and targets in the Natural and Built Environments Bill**	Steps to achieve this recommendation include: a. A focus on environmental limits and targets to matters sustaining life (e.g. air, water, soil, biodiversity) rather than human values and preferences (e.g. heritage, character and amenity). b. Standardised national minimum environmental limits. Where possible, ensure that environmental limits are measurable, targeted and quantifiable.	MfE	2022-2026	NBE

[9] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[9]
B3.4	**Develop greater certainty for infrastructure providers in the Natural and Built Environment legislation**	Steps that should be implemented to deliver greater certainty include: a. Standardise and codify a National Planning Framework for infrastructure in emerging Natural and Built Environment legislation, that sets requirements and conditions that infrastructure providers are required to meet for routine matters like noise and dust management, to minimise variations and increase certainty. b. Provide a mechanism for resolving conflicts between multiple outcomes to avoid litigation of the interpretation of the outcomes. c. Narrow the definition of an 'effect' to those relating to the natural and physical environment, so that other matters (like effects on trade competition) are not unreasonably used to restrict new infrastructure. d. Require that externalities unrelated to natural and physical resources are addressed elsewhere, such as in the project business case.	MfE, Te Waihanga	2022-2041	NBE

7.4. Accelerating technology use

Te whakatere ake i te whakamahinga o te hangarau

We need to accelerate the adoption and diffusion of technological and digital change.

A thriving world of innovators are developing technology that can revolutionise the way we plan, design, procure, construct, operate and decommission infrastructure**.** Digital twins, which are virtual, real-time models of infrastructure, can help our cities work more efficiently. New tunnelling technologies are lowering the cost of construction.[366] Crowd sourcing can help speed up maintenance by making it easy to report faults like potholes. However, much of the technology we need to transform our infrastructure already exists. There is limited need for high-risk investment at the cutting edge of technology. New Zealand can see huge benefits through the fast adoption of existing technologies.

Adopting these technologies requires the infrastructure sector to be organised and coordinated so it can seize opportunities as they arise. There is much to gain. Existing technologies alone have the potential to lift infrastructure service levels for the vulnerable, reduce cost and overruns, improve operations and maintenance and decarbonise with greater speed.

7.4.1. Context

Technology uptake has been slow.

While other industries have embraced new technologies, infrastructure and construction lag behind. The characteristics of infrastructure can make it more difficult to adopt technology. The long life of infrastructure can lock in older technologies. The need for a consistent approach across large infrastructure networks like roads or water networks can make incremental change difficult. Fragmented and decentralised ownership or operation can make coordination across much of our infrastructure system expensive and unwieldy. Even so, there are many opportunities for technological change to improve our infrastructure.

Technology can improve productivity and lift service levels.

Technology can enable responsive and intelligent data-driven infrastructure systems. Technological innovation and prosperity are closely linked.[367] with adoption of information and communications technologies (ICT) a key determinant of productivity in infrastructure.[368] This presents New Zealand with an opportunity to address chronic productivity issues in the infrastructure sector. Through greater use of technology we can help turn this around. Currently, our construction sector uses ICT less than any other industry.[369] While some infrastructure sectors, such as telecommunications and some regions have made considerable progress in technology adoption, others have failed to keep up.

New Zealand is well placed to utilise rapid digital change.

New Zealand is well placed to leverage many of the advances in digital technologies that have occurred in the last decade. We have built a high-quality broadband network and have coverage that, while not universal, is widespread. Strong market competition in sectors such as energy and telecommunications has proven important to incentivise pockets of technological excellence. New Zealand is also small and agile with a rich history of adopting new digital technologies with speed, dating back as far as 1985, when New Zealand was one of the first countries to adopt a national system of electronic fund transfers (known as EFTPOS).[370]

7.4.2. What we have heard

We have heard that industry has not invested significantly in technological advancement for several reasons: their major customer (in many cases, the government) does not really demand it and there has been a lack of certainty about a long term pipeline of work, as well as serious labour and skills challenges. There is though, a clear understanding and support for moves toward open data and recognition that common infrastructure metadata standards are needed to adopt digital twins and other digital technologies.

Submitters told us that a national digital strategy is needed to galvanise action and drive behaviour change. There is also a need for strong and clear mandated requirements at the procurement stage of a project. This could include requirements for digital modelling, efficiency dividends and decarbonisation which will speed up the adoption of technology across the infrastructure sector. A clearer pipeline of work for several decades to come will help reduce uncertainty and give industry the confidence to increase investment into capabilities and skills.

7.4.3. Strategic direction

Clear strategic direction and leadership

Government leadership is critical for speeding up the use and spread of technology.

Based on international best practice from across the OECD,[371] there are several common themes for how the government can provide stronger leadership in the adoption of technology.

A national digital strategy: A clear strategic approach is a powerful lever for shaping a more intelligent and technology-enabled infrastructure system. National digital strategies must provide guidance on the growth and direction of infrastructure technology.

Procurement: The government's procurement and contracting approach can drive the adoption of digital technology and the shared benefits this would bring across major infrastructure programmes. Government is the largest procurer of infrastructure in many sectors. The procurement requirements it sets can ripple through the wider infrastructure system. This means procurement can be used to increase the uptake and maturity of technology across the infrastructure system by:

- Encouraging vendors with strong technology experience.
- Setting minimum efficiency dividends for major works.
- Including carbon emission targets.
- Requiring regular data on the performance of infrastructure using common standards.

Climate change targets: Clear targets for reducing carbon emissions from infrastructure encourages technology to be used to help address the climate change impacts of infrastructure.

Spatial planning strategies: These can be used to reinforce the greater digitalisation of infrastructure. Regional spatial plans will also give industry more certainty to invest in technology and develop capabilities, particularly when combined with a clear long term direction on the pipeline of infrastructure work.

Regulation: The legal and regulatory environment for setting and updating technical standards, such as minimum energy performance standards (MEPS), needs to be responsive to technological change. Regulators must have the power and responsiveness to set standards that reflect this, as well as an obligation to review these regularly.

Data for the public good

Prioritising data across infrastructure industries.

There is much to be gained from a data-rich infrastructure system. Project selection can be improved through more sophisticated modelling and better assessment of community needs. Entire networks can be better managed through digital twins or real-time pricing. Case Study 14 shows how maintenance can be streamlined through digitised asset management. Digital solutions can also help infrastructure operators and regulators manage our critical national systems more effectively. Sharing data, with the appropriate security and privacy arrangements in place, can spark innovation and improve outcomes for users. But we will only see the real expression of data when it is readily available.

Case Study 14: The City of Boston's Street Bump Initiative: applying smartphones to support more efficient road maintenance

Potholes are a significant issue on the City of Boston's roads and over the first quarter of 2014 the city filled more than 10,000. Historically, reporting potholes could be time consuming. This led to under reporting, which often meant more damage to the road network occurred than might have otherwise been the case.

The City of Boston has sought to use technology and innovation to make the identification of potholes more efficient and therefore, speed up their repair and reduce overall cost. This innovative initiative, called "Street Bump', allowed an app to be installed on smartphones that used motion sensing technology to detect potholes when they were driven over. The initiative sought to crowd source information on city road conditions from residents. While there were numerous hotlines and websites in place for drivers to report potholes, Street Bump was the city's first attempt to automate this reporting process. As well as increasing the efficiency of repairs and improving user satisfaction, the app provided valuable insight into the condition of the city's roads. For example, it was found that the most frequently reported problem was sunk manhole covers. Working with utility companies in Boston, the city fixed 1,250 of the worst manhole covers. [372]

Collaboration and data sharing across the infrastructure industry.

An open data environment is one where all infrastructure data is available, secure, free of anything that could identify an individual and standardised so it can inform decisions. It's used by operators and can inform machine learning, a process where data is analysed to improve the accuracy of digital technologies. As the value of data grows with rapid digital change, it is likely that network operators and utilities will benefit from greater sharing of data about infrastructure[373.] This is demonstrated in platforms like Port Community Systems, which are neutral and open digital platforms that facilitate automated port processes through intelligent and secure information exchange between all stakeholders.[374] While some examples are emerging, this collaboration is not yet happening across infrastructure sectors in a coordinated way. Commercial confidentiality often hampers the willingness to share ideas and data. Not all data is or can be open. Some data, such as that which is sensitive or critical, may not be able to be shared widely and may require security mechanisms. At other times, data will need to be anonymised to protect privacy. Despite this, greater progress toward more open data should be undertaken, since optimising our infrastructure investments require good information about design, construction and operation.

Key elements to move towards a more open data environment for infrastructure include:

- Development of common national infrastructure metadata standards.
- Clear identification of the ownership of the data, independence for those institutions that have kaitiakitanga over it and capabilities to generate value from its management.

- Robust cyber security management systems, protocols and safeguards.
- A balance between leveraging data and protecting the security and privacy of New Zealanders.
- Trusted stewards and institutions for data.
- A shift to minimum levels of commercial confidentiality

> "The purpose … is to send a clear message to the Government and private sector. [We] need to open up infrastructure data and make full use of data science and machine learning to get more out of existing infrastructure and to make the right decisions about future infrastructure." – United Kingdom National Infrastructure Commission[375]

A move toward open data needs to respect Māori data sovereignty and Te Tiriti o Waitangi.

A shift is currently occurring in the way that mātauranga Māori is accessed, grown and shared intergenerationally. The traditional ways of handing this knowledge forward through whakapapa are being rapidly challenged by digital forms of knowledge.

Infrastructure creates large amounts of data through its operation, maintenance and use. This will continue to increase over the next 30 years and the processing power of artificial intelligence means data and knowledge will be intertwined. This has significance for Māori. Knowledge is taonga and as we look to increase the use of open data in infrastructure, we will need to identify the value, ownership and management of data and consider Māori data sovereignty and the principles of Te Tiriti o Waitangi.

Adopting existing technologies

The adoption and spread of existing technologies is a priority.

The key to unlocking the vast productivity, performance and wellbeing benefits of technology is not always invention, but speedy adoption, increased certainty and putting in place incentives. Greater use of technology across the infrastructure system can raise productivity and performance, create higher skilled jobs, build transparency and improve resilience.[376]

There are well established technologies that could be implemented now in New Zealand's water, waste, energy, transport, telecommunications, education and health sectors. Some key benefits include:

- Better monitoring and managing of the vast existing infrastructure asset base.
- Using better transport and energy systems to help achieve a net-zero carbon emissions economy by 2050.
- Reducing the demand on the health system and the corresponding demand for health infrastructure by enabling technology at distance services like telehealth systems.
- Increasing the speed of consenting and development by digitising these processes.

Building Information Modelling (BIM)

Integrated BIM uses digital 3D models to streamline design processes and manage an integrated design process through centralised data storage. In the future it is envisaged that integrated BIM will also include cost, time and resource management.

A programme to improve the incentives for adopting technology would be a useful first step. The key elements of this are shown in Table 7 and would bring together requirements to build skills, a public sector and industry commitment to growing the infrastructure data available and ultimately, moving toward a system of open data where possible. It would also identify opportunities to standardise the way technologies are used to reduce cost barriers by taking advantage of economies of scale.

Regulatory and legal frameworks are required to keep pace with new technologies and applications, while also managing the security risks.

Table 7: Steps to improve the adoption and diffusion of technology

Barrier	Explanation
Skills and capability Skills and capabilities for design, delivery and operation	Developing people's skills and capability for technology development and widespread use in infrastructure, while avoiding market shortages and rising labour costs.
Data How information is generated	An open system of infrastructure data can grow the development of technology and the resulting benefits, efficiencies, insights and innovations.
Standardisation Greater diffusion through data standards or common interfaces	Standardisation of technologies that can have benefits through widespread adoption, such as digital twins and digital consenting. A common data framework and standard interface can make it easier for individuals and companies to work together.
Commissioning / procurement Mandatory requirements, selection criteria, conditions and models of contracting	Moving from lowest cost to highest value. Setting requirements for digital, incentives structures or preferential selection criteria as part of the procurement process. Utilising a mission-based approach (or targets) to motivate greater technology uptake (for instance, net-zero carbon emission 2050).
Regulatory / Legal Enabling legislation	Resolving the regulatory and legal issues that arise from new technologies, such as privacy issues (for instance, collection and access to personal information, such as biometrics).
Security Managing the risks of new technology	Managing and resolving the security issues that arise from new technologies, such as the risk of cyber attack.

Investing in digital innovation can have better returns than physical infrastructure.

Digital innovation is flourishing, producing new technologies that are changing the way we deliver and operate infrastructure (see Table 8 and Case Study 15). Artificial intelligence techniques, such as machine learning, can deliver greater insights into infrastructure and systems, enabling greater efficiency. Building Information Modelling (BIM), the digital representation of a structure, can vastly improve design, while 3D printing could change the nature of construction. These powerful tools can help planners and developers tailor the delivery of infrastructure systems to meet the needs of communities and leverage technology to enable better infrastructure and better outcomes.

Table 8: Digital technologies that can transform infrastructure industries

Artificial intelligence (AI) – machine learning: Enables digital devices to respond and learn from their environment. AI is anticipated to streamline tasks, especially those that are repeatable and continue to learn and develop through completing tasks and receiving feedback.

Digital twins: A digital twin is a "realistic digital representation of assets, processes or systems in the built or natural environment". It can be used to analyse historical performance and then predict how infrastructure will perform in the future by mimicking real world behaviour (see Case Study 16)

Digital consenting: Digital consenting is an application of BIM and digital twins which streamline the consenting and approval process. Traditionally, consenting and approval of changes to the built environment relies on people checking compliance. Digital consenting removes the human element by integrating the consenting and compliance checks into BIM and digital twin applications.

Immersive media (augmented reality (AR) / virtual reality (VR)): AR and VR are both technologies that help visualise digital information. AR merges digital information into the real world through headsets or mobile devices so that the digital elements appear as additions to the real environment. VR involves full immersion into a digital space removed from the real environment. Both technologies can make use of sensors and devices to allow human interaction with digital elements.

The internet of things (IoT:) The IoT is a network of physical objects capable of collecting, sharing and acting on data without human intervention. At its core, the IoT relies on physical devices, sensors and telecommunication networks to improve processes based on a greater set of data from the whole network of devices. The Internet of Things will impact the way infrastructure is managed through greater real-time communication between the different parts of a network.

Case Study 15: KiwiRail digital shields

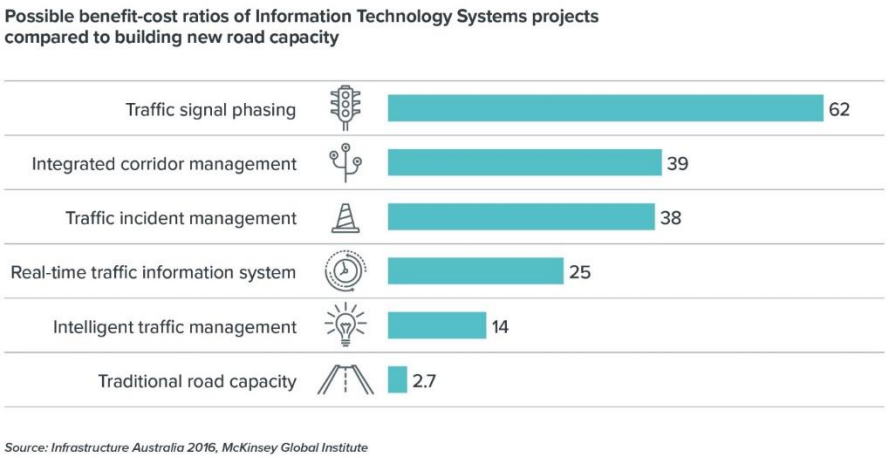
Digital shields "are made by creating a virtual twin of the physical environment, using a laser scanner. This survey technique collects millions of points of data, which are then used to build a 3D digital model. These models allow us to create digital shields a set distance from the position of the real-world objects. Once a shield is created, it is sent to a computer onboard the excavator that is linked to a GPS unit. The system on the excavator knows where the machine is, and through a series of sensors, what shape it is, as well as where the shield sits. If the excavator comes into contact with the location of the digital shield, then a signal is sent to the hydraulic system and the controls are locked out, preventing the machine from coming too close to the real-world hazard."

"It can be applied to underground pipes and cables, as well as above ground items. Alternatively, it can be used to protect newly constructed items, avoiding accidental damage and rework." [377]

To realise the benefits of digital technology, the infrastructure industry needs to adapt to the new world of big data and data analytics and work together. For example, the disciplined and consistent use of BIM technology was estimated to have saved the government of the United Kingdom the equivalent of $4 billion over a six-year period.[378] Many information technology solutions projects have been shown to have a lower cost and a better return on investment than built options, while delivering the same service outcome (see Figure 32).

Possible benefit-cost ratios of ITS projects compared to building new road capacity

Figure 32: Information technology investments can provide value for money



Source: McKinsey, 2013[379]

Digital twins in spatial planning

There is an opportunity to develop digital twins for our infrastructure as part of the emerging spatial planning process.

Regional and urban digital twins, aided by big data and machine learning approaches, can bring together all the data held about individual infrastructure, capture data on the connections between infrastructure systems (such as between water, transportation and energy) and support the development of a data-driven economy.

The aspiration is to develop a National Digital Twin that brings together the digital information of spatial plans. The approach could begin with a digital twin that is an adequate representation of the real world (see Case Study 16) and moves toward one that can analyse and predict the future performance of an asset, network or system. This modelling could improve maintenance, support planning decisions and enable better performance. Initially, the digital twin could be used to help integrate land use and transportation planning at a regional level, plan for future corridors of growth and identify areas where growth is likely or appropriate for new projects (for instance, following international examples in using digital earth technologies to identify renewable energy projects).[380] As capability grows, it could become an important decision-making tool for national infrastructure networks.

This technology could also help grow understanding of the way the infrastructure system works. In the future, it may be possible to ask questions of the digital twin, like: If the population of Auckland were to increase by 50% by 2050, how might we change the way we use existing transport networks?

Case Study 16: Wellington digital twin

Wellington City Council has been developing a digital twin of itself that looks like, behaves like and is fused to the everyday reality of the city. This digital reflection connects complex infrastructural, social,

economic and environmental systems with the decisions being made by the Council and their impacts on communities.

Wellington digital twin showing carpark availability from sensors across the city.

This ability to connect decisions and impacts comes from the evolving architecture of the digital twin. The base course of the digital twin is made of data, whether it's models of buildings and assets, surface or regulatory data, or real-time data from sensors or business processes. This data can then be shared and used for analysis or prediction. The final component of the digital twin is the experience layer. This allows people to see and use the data. Over the past five years the evolving digital twin has been used to assist the earthquake response, the creation of Wellington's Resilience Strategy, urban planning, public engagement of climate change and social harm reduction. The digital twin helps the council coordinate growth, communicate what its investment can mean for the city and understand the longer-term future of climate adaptation.

7.4.4. Recommendations

No.	What	How	Who	When	Ref.[10]
B4.1	**Increase diffusion of existing technologies to increase productivity in the infrastructure sector**	Increase diffusion of existing technologies through the following steps: a. Review all Government procurement and contracting against this recommendation and make appropriate changes. b. Develop a technology plan that establishes a clear time-bound mission and actions to increase the diffusion of technology. This should include consideration of all demand side drivers, and barriers to uptake. c. Devolve decision making for technical standard setting (i.e. minimum energy performance standards, housing codes, waste and water efficiency) to responsible regulators as appropriate and ensure they review and update regularly.	DIA, MBIE	2022-2026	PTC
B4.2	**Accelerate adoption of open data and common standards for the infrastructure sector**	Accelerate the adoption of open data and common standards through the following steps: a. Identify the legislative and administrative steps required to move toward full open data for central and local government (including infrastructure). b. Fund, develop and mandate common national infrastructure metadata standards.	DIA, Government Chief Data Steward	2022-2031	PTC

[10] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[10]
B4.3	**Accelerate the digitalisation of infrastructure**	Accelerate digitalisation across the infrastructure lifecycle by implementing the following steps: a. Facilitate consistent use of Building Information Management systems and provide detailed implementation guidance. b. Accelerate investigations into city, region and nation-wide digital twins to embed them as a process and tool of choice for spatial planning development. c. Fund and launch a series of artificial Intelligence-powered use cases across infrastructure sectors.	MBIE, MfE	2027-2031	PTC

7.5. Building workforce capacity and capability

Te whakapiki ake i te kahapupuri o te ohu mahi me te kaha

We need the right people, at the right time, with the right skills to meet our infrastructure possibilities

Delivering, operating and maintaining our infrastructure takes the combined energy and effort of hundreds of thousands of New Zealanders. These people ensure our infrastructure investments are the right ones, built as designed, operated to a high standard, safe for use and able to be quickly returned to service after disruption.

The infrastructure sector gives New Zealanders opportunities for employment and income, career progression and the ability to make a meaningful contribution to our country's future. However, it's also a sector that is constantly changing and as it does, so do its workforce needs. Achieving New Zealand's infrastructure ambitions requires people who are highly capable and technologically savvy. The sector needs to be internationally competitive and have the capacity to ramp up when needed. Getting it right will require coordination. We need to invest in our people to ensure we have the workforce to meet the infrastructure challenges and opportunities ahead.

7.5.1. Context

New Zealand is experiencing historic workforce shortages.

New Zealand has approximately $61 billion worth of infrastructure projects planned in its pipeline of upcoming work.[381] Most of these projects are planned for the next three to five years. Over the next 30 years, this pipeline is anticipated to grow by as much as $140 billion.[382] There is also significant demand for residential and other types of construction that adds to our capacity challenges.[383]

The share of construction firms reporting labour shortages is now at its highest ever level (see Figure 33). This is made worse by on-going international competition for talent. Australia also has a severe labour shortage and with weekly wages that are, on average, NZD$500 higher than ours, many New Zealanders cross the Tasman for work.[384]

These labour shortages are likely to continue for years to come. Forecasts show New Zealand will have a shortfall of approximately 118,500 construction workers in 2024.[385] Skill shortages are particularly noticeable in regions like Auckland, where it's holding up work on important projects.[386,387]

Net number of construction firms reporting difficulty finding labour

Figure 33: Construction labour shortages are at their highest since 1975

Source: NZIER Quarterly Survey of Business Opinion

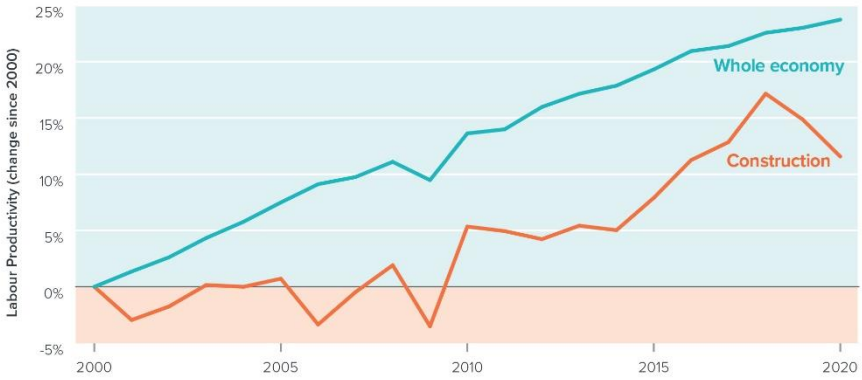
We need more skilled people to build and operate the infrastructure we're planning.

While there are many skilled, capable people working in the infrastructure sector, we do not have enough of these people and in some areas we may entirely lack the skills we will need in the future. These include client and project leadership, engineering, technical professions, construction management, skilled trades and labourers.

Our workforce challenges hold us back from improving the productivity of our construction sector, which limits our ability to build infrastructure at a reasonable cost. Since 2000, the number of people working in heavy and civil construction has more than doubled, but construction labour productivity has lagged behind the overall economy and even declined in both 2019 and 2020 (see Figure 34)

Labour productivity is growing more slowly in construction

Figure 34: Labour productivity, construction sector vs whole (measured) economy, change since 2000



Source: Statistics New Zealand Industry Productivity Statistics

Poor health and safety track record affects productivity.

Between 2011 and 2020, the construction industry reported 76 work-related fatalities.[388] This makes construction the fifth most dangerous industry for workers.[389] Non-fatal injuries in construction have risen substantially since 2016.[390] Suicide rates in the construction sector are also extremely high. Between 2007 and 2017, 300 construction workers died from suicide, the most from any single industry.[391] Failing to protect the health and wellbeing of infrastructure workers is a threat to our ability to develop and retain skilled people in the sector.

Good leadership prioritises health and safety and provides practical tools to improve performance. This includes supporting health and safety and mental health programmes, promoting and adopting 'safety in design' principles and creating appropriate health and safety certifications and prequalification standards to better address known challenges.[392]

"We need leadership and follow through, not road cones and rules

We are not calling for more road cones, more lists to check or hi-vis clothing. Indeed, our view is that this overly reductionist and simplistic view of "H&S" has actually resulted in effort and attention going into the wrong areas.

We are calling for a delivery environment that supports profitable businesses to be able to design work that enables working people to physically and mentally thrive. For that environment to become a reality we need leadership, collaboration and follow through by those in a position of influence and authority."

- Business Leaders Health and Safety Forum submission

Poor diversity in the infrastructure sector limits its ability to draw on the talents of all New Zealanders.

The number of women working in the infrastructure sector is low. For example, women only make up approximately 13% of all those employed in construction. Just 2.5% of construction tradespeople or apprentices are women.[393] Women face hurdles with employer perceptions, as well as physical and site-specific issues, like a lack of lifting equipment, that act as barriers to their entry into the sector.

While many Māori and Pacific peoples work in the infrastructure sector, they are overrepresented in the lowest earning occupations, such as low-skilled and unskilled contract labour and self-employed trades, working as subcontractors to larger construction firms. Just over 1% of all chartered professional engineers and an estimated 4% of registered architects identify as Māori and/or Pacific peoples.[394] The number of Māori and Pacific peoples in the managerial, professional and higher skilled occupations within the infrastructure industry is growing but needs to increase.[395]

7.5.2. What we've heard

> "One of the biggest challenges is going to be skills … The world is going to be queueing up on the skillsets that are needed. So we better double down on training our own and we better figure out where we are going to get the skills from to get it done … or we'll have the strategy, we'll have the finance, we'll have the vision, but we will fall woefully short on execution." - Dr Rod Carr, Infrastructure Commission Symposium 2021

We've heard that there's a need to address current and future skill shortages, ensure that construction work is safe and make sure our future workforce has the necessary skills.

Submitters on our consultation told us that the infrastructure sector needs to do better at diversity and inclusion by increasing the participation of women and improving the participation by Māori and Pacific peoples at professional and decision-making levels.

Some submitters also pointed out that preparing for climate change will require our future workforce to have new skills, many of which will be in high demand internationally.

Many felt that building workforce capability in procurement, asset management and project management is necessary. There was support for the establishment of a Major Projects Leadership Academy in New Zealand, particularly if it was underpinned by a broader capability and development framework.

7.5.3. Strategic direction

Building capability to improve infrastructure delivery

New Zealand needs people with the skills to plan, build, operate and maintain the infrastructure we need.

We need to lift the capacity and skills of our people and organisations across all stages of infrastructure planning and delivery, including:[396]

- **Client and project leadership:** Roles such as client leadership, planning, procurement, asset management and project management.
- **Engineering and technical:** This includes civil and structural, mechanical, and electrical designers, architects and engineers. It also includes specialist areas such as business information modelling.
- **Construction management:** Roles such as site supervisors, site engineering staff and construction managers.
- **Skilled trades and labour:** On-site roles such as electricians, welders, carpenters, scaffolders, steel fixers, fitters, tunnellers, plant operatives and labourers.

The skills and ability of our contractors are becoming more important as our projects become larger and more complex.[397] It is vital therefore, to retain and grow design and construction firms that can successfully deliver infrastructure projects.

There is a need to use technology to lift productivity. This may involve robots and automation to undertake repetitive work or the use of digital information and analytics to augment work undertaken by skilled employees. Higher productivity means that our workforce can deliver more and better infrastructure.[398]

New Zealand also needs to build its competitiveness for international talent. One way of doing this it to develop a trans-Tasman procurement market by taking a consistent approach to qualifications, product and building standards and contracting and procurement processes.

More investment is needed in standardised training and education to increase workforce skills and improve productivity.

Investment in workforce training and education must focus on the areas we will need in the future, including the skills required to deliver major projects in the infrastructure pipeline. Government, industry and the education sector will need to work together to provide education that's fit for the future needs of employers and delivers the skills learners need to thrive. This will improve workplace productivity, raise skills and improve planning for the number of workers we are going to need over the long term.

A good example of coordinated leadership and collaboration can be seen in the Construction Sector Accord, which brings together industry and government to improve the construction sector. The Construction Sector Accord has developed a Transformation Plan, that includes the development of a construction skills strategy.[399]

The Transformation Plan provides a template for other important long term workforce challenges, such as the response to climate change. These challenges will create an even greater need for skilled workers. Industry and government must come together to respond to this and review both the training currently on offer and the need to bring more people into the industry either from within New Zealand or overseas. The current government reform of vocational education provides an opportunity to do this.

Common procurement, delivery and asset management frameworks will lift performance and help building our competitiveness for talent.

Central government is the largest single procurer of infrastructure.[400] There are a range of government agencies who have roles in procuring, delivering and managing infrastructure. However, there are no frameworks for common capability and development across these agencies. As infrastructure projects get larger and more complex, it will be increasingly important for government agencies to improve their leadership and capability.

Government should establish common capability and development frameworks for agencies that procure and project manage infrastructure projects and manage the infrastructure itself. These frameworks would:

- Support development of capabilities that can be shared across the infrastructure sector.
- Encourage government agencies to be more transparent about the skills they need and make it easier for people to move to the areas in the public sector where their skills are needed.
- Help establish infrastructure procurement, management, or project management as career pathways in the public sector.
- Build a trans-Tasman procurement market by ensuring a consistent approach to contract and procurement processes.

Well-regarded overseas frameworks can set the benchmark for how we create a more consistent approach in New Zealand. These include the United Kingdom's Civil Service Project Delivery Capability Framework[401] and the Institute of Public Works Engineering Australasia Asset Management Pathway.[402] Increasingly, complex infrastructure projects require stronger project leadership skills. The establishment of a Major Projects Leadership Academy would grow the skills of our infrastructure project leaders, by raising their planning, delivery and leadership capabilities (see Case Study 17). This should be underpinned by a competencies framework that practitioners would be required to complete before attending the Major Projects Leadership Academy.

Case Study 17: United Kingdom Major Projects Leadership Academy

A 2011 review found that only one-third of major public infrastructure projects in the United Kingdom were delivered to time, budget, or met quality expectations. A key factor was that most government project leaders did not have the right skills to deliver such complex projects.[403]

In response, the United Kingdom has invested heavily in building the capability of government project managers and lifting the status of project management as a rewarding long term career option. This included establishing a Major Projects Leadership Academy to train senior project leaders for complex major projects.[404] The academy is underpinned by a comprehensive Project Delivery Capability Framework that builds the capacity of civil service project management practitioners throughout their career and provides guidance for career discussions and promotion decisions.[405] These initiatives provide a common approach for the knowledge, skills and abilities needed to deliver projects across all areas of government.

Giving industry the certainty to invest in their people and equipment

A credible infrastructure pipeline is an essential workforce planning tool.

The infrastructure sector will face ongoing workforce pressures over the coming decades. An infrastructure pipeline, a tool that shows all upcoming planned work in the sector, can help the sector to face these challenges. It provides certainty, which can:

- Offer a single, trusted source of information for the construction industry on medium-term investments.
- Enable the construction industry to plan its resource needs accurately, so it can invest in training its people and in equipment that increases productivity.
- Enable more coordinated planning of investment in New Zealand.

There are underlying challenges to achieving a credible and transparent infrastructure pipeline. These include a lack of wider integrated planning, fragmented and relatively short term funding arrangements and on-going change within government agencies. Many of the recommendations in this strategy, such as achieving longer-term funding commitments, can reduce this uncertainty.

At present, there are several construction investment pipelines in New Zealand, which cover different sectors and take different approaches to the detail they include.[406,407] Te Waihanga's Infrastructure Pipeline currently focuses on committed or funded projects from major infrastructure providers, but does not yet include investment that has been signalled but not confirmed, as this is more difficult to forecast.[408]There is a need to build on and improve Te Waihanga's Infrastructure Pipeline to provide a more credible and transparent infrastructure pipeline that the consultancy and construction sectors can use for workforce planning.

A priority list of planned infrastructure investment will give industry certainty.

The Infrastructure Pipeline can provide a medium-term view on planned investment, but there is also a need to give industry and others more certainty about solutions to long term challenges, such as addressing climate change, improving our cities, connecting all regions of New Zealand and providing infrastructure that works for our growing and changing population. Solutions may be under development or may be signalled as intentions but not yet funded. This can make it difficult for firms to invest in people and skills for meeting these needs. An infrastructure priority list can improve how we identify and respond to long term challenges. This is discussed in further detail in Section 7.1.

The pipeline and priority list will help identify future workforce needs that can be addressed through trade and tertiary training, immigration policy, and technology adoption.[409]

Smoothing out boom and bust construction cycles can helps us to keep our skilled workers.

A credible infrastructure pipeline and priority list can help smooth out boom and bust cycles in the construction sector. These cycles make it hard for construction firms to grow and retain their staff, improve skills and invest in productivity-improving technology. Showing the industry which projects are planned well in advance and procuring them in a predictable fashion can help to smooth out boom and bust cycles.

Major infrastructure investment has a relatively limited role to play in fighting recessions. This is because it can take so long to plan, procure and build major infrastructure projects that a recession might be over by the time they are underway.[410] Other macroeconomic policies, including the consistent application of monetary policy and prudent counter-cyclical fiscal policy, are typically more effective in recessions. However, infrastructure maintenance can be a good way to stimulate the economy as it can be procured and delivered relatively quickly.[411]

Improving diversity in the infrastructure sector

Our infrastructure sector needs to offer attractive careers for all New Zealanders.

New Zealand's infrastructure workforce faces diversity and inclusion challenges. Case Study 18 highlights some of the barriers women experience when seeking to work in the construction sector.

Case Study 18: Women in Trades, Ministry of Women's Affairs

A 2020 survey of the construction sector commissioned by the Ministry for Women on women entering trades found that many women suffered from negative employer perceptions that been barriers to finding work. Some of these perceptions were that women lacked the physical strength for trade roles and that they were not worth investing in as they would have to leave to have children.[412] For women who worked in the construction sector, or wished to enter it, the most common barriers were:

- Lack of knowledge about opportunities within the trades.
- Lack of direct work experience which often made it difficult to enter the sector.
- The difficulty finding employers willing to employ women, showing that traditional views on gender roles were still prevalent.
- The male-dominated culture of the trades was intimidating, which reduced applications from women.
- Lack of flexible work practices impacted on the ability of women to both work and to undertake parental duties.
- On-site constraints such as the lack of lifting equipment and poor conditions.
- Lack of support for women in the trades.

Interviews with six employers by the Ministry of Women's Affairs in 2011[413] found that, once employed, women were seen as important to their teams. Employers said the key benefits included:

- An improvement of work culture. For example, better behaviour, less competition and more collaboration.
- Competitive advantage. For example, a plumbing firm got more work as their female plumber could work in public women's bathrooms/changing areas without the need to temporarily close these.
- Women brought different and valuable skills to the roles. For example, it was frequently noted that they had excellent attention to detail and provided good customer service.

A training and career development pipeline is needed to help bring groups that are currently underrepresented into the construction sector. This will grow our construction workforce and also offer many other benefits. Greater diversity has been demonstrated to improve staff recruitment and retention, innovation and group performance, reputation and responsibility, and financial performance.[414]

Government and industry have been working to improve the participation, retention, and career advancement of women, Māori and Pacific peoples within the infrastructure sector.[415,416,417,418] This work has focused on changing employer perceptions, increasing awareness of jobs through open days, establishing cadetships (see Case Study 19), broadening public sector procurement rules, the use of ambassadors, building support networks and having events to celebrate success. But more work needs to be done.

Progress will also need to be monitored. The Construction Sector Accord Transformation Plan should set targets for the participation, retention, and career advancement of women, Māori and Pacific peoples. The progress made on these targets should be published annually and reviewed regularly.

Case Study 19: City Rail Link - Māori and Pacific peoples cadetships

The City Rail Link's Progressive Employment Programme is an example of social procurement in action. It provides Māori and Pacific peoples aged 16 to 25 with on-the-job training over a 16-week period and ideally a full-time role on the project at the end of the programme. The intention is to be work ready at the end of the 16 weeks.

The introduction to employment is progressive. Participants start at 10 hours a week and build to 28 hours a week for the last four weeks of the programme, which lets the young people adapt to the working environment. As well as undertaking real jobs within the project, the young people also learn about employment contracts, KiwiSaver and budgeting.

Of the 12 young people who have completed the programme so far, 10 are now in stable employment and six with the City Rail Link. There are five more young people currently engaged in the programme.

7.5.4. Recommendations

No.	What	How	Who	When	Ref.[11]
B5.1	**Develop the right talent required to deliver New Zealand's future infrastructure**	Deliver a national infrastructure skills plan to ensure New Zealand has the right people with the right skills to deliver our infrastructure over the medium to long term. A dedicated public and private sector working group should be established to develop a skills plan that: a. Provides information on the likely professional and workforce requirements to deliver planned and forecast infrastructure supply over the next 15 years and beyond. b. Ensures our education system supports our future workforce needs, in particular through the promotion of science, technology, engineering and mathematics education programmes. c. Provides advice on critical specialist infrastructure skills deficiencies that could delay construction, or add to the costs of projects and maintenance. d. Achieves increased diversity in all parts of the infrastructure system. e. Advises on opportunities to improve coordination across projects and sectors, and how employers can work more effectively in partnership with training providers.	NZ Government Procurement (Lead), Public Service Commission (Lead), Te Waihanga, MBIE, Tertiary Education Commission, Treasury, Construction Sector Accord parties	2022-2031	AIP

[11] For full details refer to Section 10 "Want to know more"

No.	What	How	Who	When	Ref.[11]
B5.2	**Build New Zealand's competitiveness for international talent**	Develop a trans-Tasman procurement market by ensuring a consistent approach in: a. Product and building standards. b. Qualification requirements. c. Contract and procurement processes. Identify and reduce barriers for international experts to work in New Zealand by adopting international standards by default, unless there is a compelling rationale for the development of a bespoke New Zealand standard.	NZ Government Procurement, MBIE	2027-2031	AIP
B5.3	**Provide certainty to industry to invest in skills and training development**	Strengthen Te Waihanga's infrastructure pipeline to: a. Broaden the detail of information provided b. Improve coverage across all regions and sectors Use the aggregated data to provide insight on the capacity of the economy to deliver the pipeline, inform forecasts of labour requirements and inform the direction of government infrastructure spending during times of economic downturn.	Te Waihanga	2022-2031	PSS

No.	What	How	Who	When	Ref.[11]
B5.4	**Strengthen government client-side capability to plan, design and deliver projects**	Improve project outcomes by increasing public sector capability and excellence in infrastructure delivery by: a. Introducing comprehensive procurement, asset management and project management practitioner development frameworks and underpinning accreditation systems across government. b. Creating career development opportunities in the public sector by increasing the number of entry level technical roles in client agencies to support the placement and rapid professional growth of newly graduated practitioners. c. Building effective partnerships between delivery agencies and New Zealand's academic institutes to disseminate international best practice and lift the prioritisation of advance research in infrastructure. d. Aligning remuneration between public and private sectors to improve competition across infrastructure types.	Public Service Commission, Delivery agencies	2027-2031	AIA

No.	What	How	Who	When	Ref.[11]
B5.5	**Recognise major project leadership as a role with comparable complexity to organisational leadership**	The following steps should be put in place to recognise the complexity of major project leadership: a. Develop guidance on the skill sets and appointment processes appropriate for the leaders of New Zealand's largest projects. b. Establish a New Zealand Major Projects Leadership Academy based on proven international approaches and make completion a requirement for project leaders. c. Ensure both accountability mechanisms and remuneration are aligned with the complexity and risk project leaders are managing on behalf of the Government.	Public Service Commission (Lead), Te Waihanga	2022-2031	MPL

8. What happens next

Ka aha ināianei

Finalising this strategy.

Our legislation sets out the programme for finalising this strategy:

- This draft strategy has been presented to the Minister for Infrastructure for feedback, which is to be provided by the end of December 2021. At the same time, we will continue analysis, engagement and environmental scanning to continue to refine this draft strategy.
- We will then consider the Minister's feedback and the final strategy will be given to the Minister by March 2022 to be tabled in Parliament when practicable. Within six months of receiving the final strategy, the government must provide its response.

Supported recommendations will be built into our work programme or transitioned to delivery by other agencies.

Implementing the strategy.

Preparing New Zealand's first Infrastructure Strategy is the start of our journey to change the way we plan and deliver infrastructure. It makes 67 recommendations to government, local government and the infrastructure sector. These are grouped under the strategic objectives and system-wide components of the strategy. The recommendations are spread across the 30-year outlook of the strategy (see Figure 35) and across the four ways we can respond to the infrastructure challenge (see Figure 36). Many recommendations cut across more than one infrastructure sector (see Figure 37) or relate to more than one strategic objective or system wide component.

In forming the draft recommendations, we have ensured the proposals are deliverable, evidence-based and will have lasting impacts over the long term. Together, they form a programme of work which will help us to address current and future infrastructure challenges more efficiently and with urgency. However, this is New Zealand's strategy. We all need to work together to achieve its vision and objectives.

We will work with the appropriate stakeholders for each recommendation agreed by the government. Te Waihanga's contribution will range from a monitoring role, to becoming an active participant in the delivery by others, or in some cases, the responsible lead agency.

Figure 35: Split of recommendations by time period

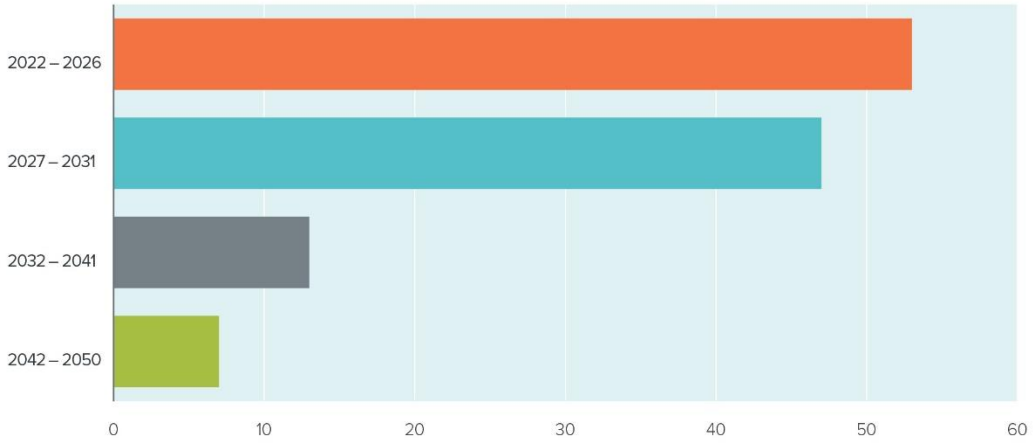


Figure 36: Split of recommendations by change lever

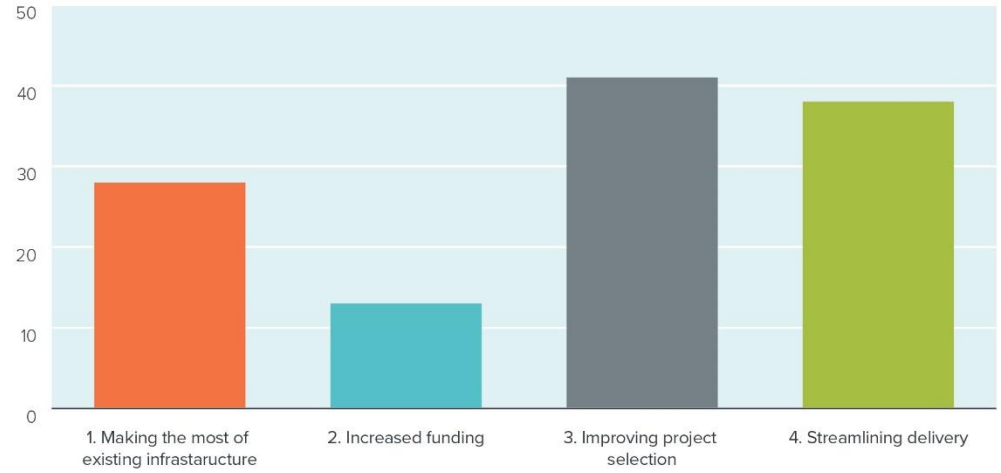
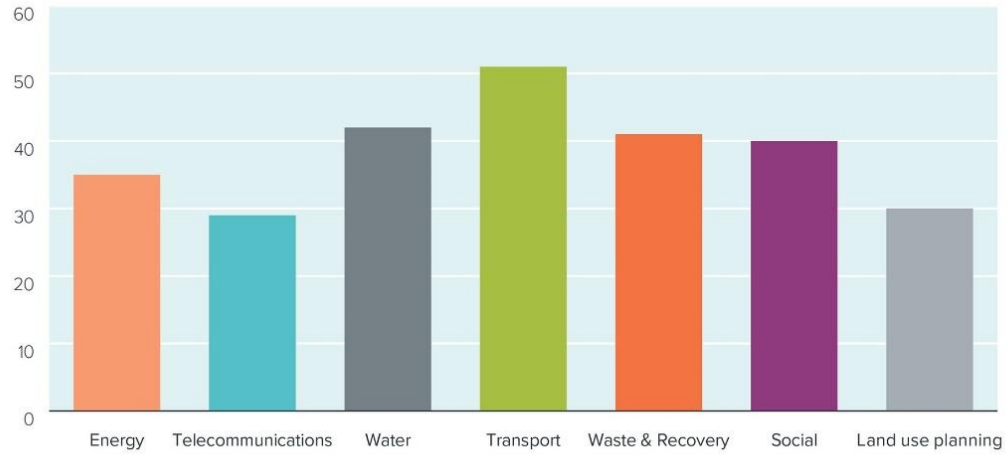


Figure 37: Split of recommendations by sector



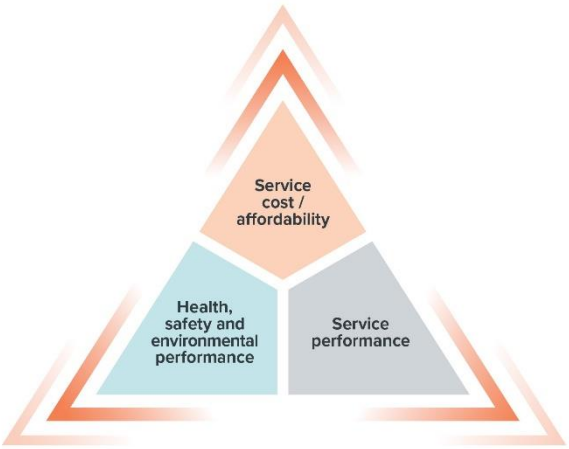
Monitoring and reporting progress.

The strategy will be supported by a monitoring, evaluation and reporting framework to support greater accountability, transparency and analysis of progress against outcomes. As the strategy will be updated at least every five years, the framework will support continuous, systematic collection of data to measure and assess how the strategy and infrastructure have performed over the long term to raise the wellbeing of New Zealanders. Monitoring will help to track progress against the strategy's recommendations, vision and objectives and ensure the strategy is driving the right outcomes. We will report on progress on an annual basis.

To track the performance over time, we will also report on three broad key performance indicators (KPIs) for each infrastructure sector (see Figure 38).

- **Service costs:** The average costs of providing an infrastructure service. This performance measure is sometimes used as a measure of affordability.
- **Service performance:** The volume of services produced and the attributes of those services, such as their quality, reliability, accessibility and appropriateness.
- **Health, safety and environmental (HSE) performance:** The impact of the infrastructure service on workers and users' health and safety, emissions and other environmental impacts.

Figure 38: Infrastructure Performance



Source: Te Waihanga

Te Waihanga's work programme.

Once finalised, the strategy will be used to guide our work programme and will include:

- Research and deep dives into topics identified in the strategy and emerging issues.
- Providing major project delivery advice and support.
- Developing the pipeline and a list of priority projects.
- Providing ongoing advice on infrastructure related aspects of policy and reform programmes.
- Evaluation of major infrastructure proposals in terms of alignment with the strategy and potential interfaces with other infrastructure initiatives.
- Providing advice on infrastructure related Budget initiatives.
- Identifying initiatives that require further investigation or advice to government.
- Delivering the 2027 New Zealand Infrastructure Strategy

9. List of recommendations

He rārangi tūtohunga

No.	What	How	Who	When	Ref.
Section 5 - Strengthening partnerships and opportunities for Māori					
T1.1	**Strengthen partnerships with Māori across the infrastructure system of Aotearoa New Zealand**	Establish a framework for stronger partnerships with Māori in infrastructure planning and delivery through the following actions: a. Task or establish a Māori advisory group to guide the development of a framework for infrastructure planning and delivery that is based on tikanga Māori and consistent with an all-of-government approach. b. Consider the evolving role of Māori in our infrastructure system. The framework must acknowledge the differing requirements and respective duties of both Crown and Iwi Māori. c. Establish joint governance and ongoing oversight of implementation of the framework.	Iwi, Te Waihanga, Whole of Government, Local Government, Sector	2022-2031	CEM
T1.2	**Develop capability and capacity across the infrastructure system for effective partnership with Māori**	A programme to develop capability and capacity for effective partnership should: a. Build specialist Māori infrastructure capability at the centre of government that can support both agencies and iwi Māori b. Consolidate and enhance specific funding for provision of technical support for iwi with infrastructure planning and delivery partnerships (agency or programme specific) c. Broker partnerships with Crown agencies and industry to create fixed term secondment opportunities out to iwi organisations. d. Leverage procurement opportunities for Māori across infrastructure policy, planning, delivery, maintenance and research.	Iwi, Te Waihanga, Whole of Government, Local Government, Sector	2022-2031	CEM

No.	What	How	Who	When	Ref.
T1.3	**Strengthen the Māori infrastructure evidence base**	A multi-decade research agenda should be designed that: a. Builds an evidence base exploring how infrastructure planning and delivery out to 2050 and beyond can help empower Māori and enable rangatiratanga. b. Builds and disseminates a programme of in-depth case studies from leading infrastructure Māori partnership projects. c. Investigates the use of an appropriate national framework for assessing the nationally-agreed effects of infrastructure on cultural values (sometimes referred to as cultural impact assessment, the mauri model or similar), as a supplement to the local, rohe-specific effects (determined on a project-specific basis by iwi and hapu).	Iwi, Te Waihanga, Whole of Government, Local Government, Sector	2022-2050	CEM
Section 6.1 - Enabling a net-zero carbon emission Aotearoa					
S1.1	**Minimise lock-in of future emissions**	Set a strategic direction in Emission Reduction Plans (ERPs) that public sector infrastructure investment programmes must be compatible with meeting our international commitments on carbon emissions. Measures to support this direction should: a. Include full consideration of non-built solutions in all business cases. b. Require assessment of carbon emissions in all business cases. c. Require the use of a cost of carbon compatible with international commitments on carbon emissions within all cost benefit analysis. This should be cross-sector and reviewed regularly.	MfE, Climate Change Commission	2022-2026	ITN, SRC
S1.2	**Achieve net-zero carbon emissions at minimum cost**	Develop, as soon as possible, clear and credible policies and mechanisms for offsetting any differences that arise between actual emissions and our international commitments on carbon emissions. In developing a National Energy Strategy, include measures that achieve net-zero carbon emissions at minimum cost. These should:	MfE, MBIE, Commerce Commission , Electricity Authority	2022-2031	ARE, ITN, GIC, BZC, EAN,

No.	What	How	Who	When	Ref.
		a. Modify the renewable electricity target to focus on renewable energy. b. Reduce barriers to the prudent expansion of transmission and distribution capacity where needed. c. Ensure the existing gas infrastructure can be redeployed when new alternatives become viable. d. Progress efforts to remove barriers to local generation, storage and demand management activity.			GTG, LEE, TPM
S1.3	**Speed the build of low emissions energy infrastructure to leverage our abundant resources**	Streamline consenting of low emissions energy infrastructure while meeting environmental objectives by: a. Developing a National Environmental Standard for Low-Emission Energy Generation (NES-LEEG). b. Developing a national streamlined approach to consenting that could include renewable energy zones. c. Establishing an offshore regulatory framework to explore and develop low emissions energy resources in territorial waters.	MfE, MBIE	2027-2031	ARE, OCE
S1.4	**Ensure a fair, inclusive and equitable transition to a low emissions economy**	Target support to those disproportionately affected in the energy transition, by a. Providing additional financial support to disadvantaged consumers to assist them with the upfront cost of investing in energy efficiency improvements. b. Supporting retraining for displaced workers. c. Involving Māori and iwi in the development of specific energy hardship initiatives.	MSD, MBIE	2022-2031	ITN
Section 6.2 - Supporting towns and regions to flourish					
S2.1	**Improve efficiency and security of freight and the national supply chain**	In developing a long term National Freight and Supply Chain Strategy, government should: a. Include airports, ports, road, rail and coastal shipping. b. Ensure it is integrated, resilient and multi-modal.	MoT	2022-2026	FSE, NFD, NLR, NSC

No.	What	How	Who	When	Ref.
		c. Identify infrastructure options to improve efficiency, sustainability and security. d. Assess the appropriateness of regulatory and market structures. e. Recommend reforms and investments that will enable the more efficient movement of freight, provide freight users with competition and choice. f. Build national freight and supply chain data capabilities for capturing and sharing data securely to improve efficiency. g. Investigate the development of a National Location Registry, where attribute information about physical pickup and delivery locations is digitally stored and accessible to authorised users, leveraging the recent experience of Australia. The Registry should be sensitive to confidential information and privacy concerns.			
S2.2	**Reduce barriers and costs of providing infrastructure services**	In developing a National Digital Strategy, government should: a. Prepare New Zealand for realising the full benefits of a connected digital society, establishing regions where 21st century talent wants to live. b. Fix digital black spot areas and ensure universal access to digital services and skills that remove the limitations of physical distance from major markets nationally and internationally. c. Leverage changing social and economic patterns arising from COVID-19 and rising urban house prices to support the development of regional areas. d. Identify and set out a plan to resolve key telecommunication system resiliency issues. Review infrastructure standard requirements for affordability across regions and infrastructure sectors. Broaden requirements to allow for on-site solutions and other low-cost design when similar service levels are possible.	DIA, MBIE	2022-2026	PTC
S2.3	**Reduce population uncertainties for**	Establish a National Population Plan that: a. Presents a preferred population pathway over the next 50 years.	Productivity Commission,	2027-2031	AIP, GFI

No.	What	How	Who	When	Ref.
	infrastructure demand, planning and delivery	b. Provides direction for regional spatial plans. c. Identifies supporting policies required for New Zealand to capitalise on the benefits of greater population, while managing and minimising the costs of growth. Regularly review and publish best practice advice to improve population projection accuracy. Require local governments and other public infrastructure providers to test significant infrastructure projects and investment plans against high and low projections, as well as medium projections.	Statistics NZ, MBIE		
S2.4	**Prepare for zero-emissions commercial electric flights**	Prepare existing airport infrastructure for zero-emissions commercial electric flights and leverage wider export opportunities. Measures will need to: a. Develop the requisite training for existing and new pilots and for the maintenance of electric aircraft. b. Prepare power and charging infrastructure networks and capabilities. c. Develop a network of charging stations across New Zealand airports so that alternates are available, in the case of service disruptions. d. Coordinate charging standards to ensure that a wide variety of aircraft can utilise charging equipment. e. Investigate export-ready applications, such as pilot and maintenance training.	MoT, CAA, Airports and Airlines	2022-2031	EAF
Section 6.3 - Building attractive and inclusive cities					
S3.1	**Improve water infrastructure pricing and provision in cities**	Specific actions for new water entities include: a. Implementing performance-based economic regulation and water quality regulation to ensure that water entities are incentivised to drive efficiency and deliver excellent customer service.	DIA, Local Government (or new water entities),	2022-2031	WSA, LFF, MHT

No.	What	How	Who	When	Ref.
		b. Ensuring the availability of infrastructure for growth, funded by appropriate infrastructure growth charges or other 'user pays' funding tools. c. Allowing volumetric water charges and volumetric wastewater charges for large wastewater sources. d. Allowing entities to use their balance sheet capacity to finance infrastructure for growth, as well as funding asset renewals and improvements to water quality. e. Clarifying the interface between new water entities and developer-financed water infrastructure provided under the Infrastructure Funding and Financing Act 2020. f. Ensuring that developers can benefit appropriately from the provision of infrastructure that has spare capacity. g. Developing cost benefit analysis guidelines to standardise evaluation decisions of water infrastructure against social, environmental and economic benefits	economic regulator		
S3.2	**Reduce pressure on water infrastructure through better water management and conservation**	Steps that should be taken to reduce pressure on water infrastructure include: a. Designing water and wastewater charges to incentivise conservation. b. Using planning rulebooks to encourage on-site solutions. c. Removing regulatory barriers to water conservation, such as consent requirements to install rainwater harvesting tanks or on-site stormwater management devices. d. Setting performance standards that improve water performance of appliances.	Local Government (or new water entities), MfE	2022-2031	GIW
S3.3	**Amalgamation of local government where appropriate, to improve coordination of infrastructure and**	Local governments should be amalgamated where appropriate, to better align key infrastructure and planning decisions. Amalgamation decisions should be guided by: a. An evaluation of adjacent territorial authorities and their role within wider urban labour markets.	DIA, Future for Local Government Review	2027-2031	LMA

No.	What	How	Who	When	Ref.
	planning outcomes in high growth urban areas	b. Costs and benefits from integrating regional planning and infrastructure provision. c. Commuting and urban growth patterns. d. Funding streams aligned with best practice principles of infrastructure. Amalgamation should consider mechanisms for local voices to continue to inform decision-making.			
S3.4	**Increase supply and use of low emissions transport modes**	Transport network planning and funding entities should: a. Improve the quality, speed and reliability of public transport to major employment centres. b. Improve active transport infrastructure, starting with low-cost solutions such as improving pedestrian crossings and reallocating existing road space to provide safe cycling facilities. c. Reduce barriers to cost-effective implementation of low emission transport modes and streamline costly resource management and local government consultation processes. d. Increase certainty of funding for low emission transport modes to scale up efficiently. e. Ensure all options considered for investments are subject to appropriate cost benefit analysis.	Ministry of Transport, Waka Kotahi, Local Government	2022-2041	TCQ, ITN, INH
S3.5	**Reduce costs by optimising infrastructure corridors**	Enable planning and protection of infrastructure corridors in advance of growth through the following steps: a. Develop a lead infrastructure policy and supporting guidance that provides a clear definition of lead infrastructure. The policy should include evaluation techniques for decision-making. b. Amend resource management legislation to extend the duration of designations to 30 years and allow designations to be granted based on concept plans. Statutory tests for designations should be based on an established evaluation methodology.	MfE, supported by Te Waihanga and infrastructure providers	2022-2031	BUP, CPR, ATA, ITA

No.	What	How	Who	When	Ref.
		c. Establish a corridor reservation fund with a secure funding source that can be used for early corridor protection activities, such as buying designated or identified sites in advance.			
S3.6	**Optimise the use of urban land**	Review central and local government land holdings to identify opportunities for land swaps, releases of land for development and relocations of major public facilities.	Central and local government	2032-2041	ULH, CBG,
S3.7	**Optimise transport investment by considering non-built transport solutions first**	Prioritise investment in non-built solutions, including: a. Using price mechanisms to manage demand. b. Lowering the cost of public transport at non-peak times. c. Real-time parking pricing. d. Making better use of existing space to speed up public transport. e. Using land use policies, like transit-oriented development or mixed-use development, to reduce the need for travel.	Waka Kotahi, Local Government	2022-2031	INH, NOF
S3.8	**Improve the efficiency and consistency of urban planning by standardising planning rulebooks**	Standardise planning policies of regional and district plans. This should: a. Establish national uniform definitions for land use policy. b. Develop a National Planning Framework that appropriately standardises rules, with local authorities required to adopt these rules with limited variations. c. Make consistent provision for papakāinga housing on Māori land and other forms of community housing. d. Merge regional and district plans into 14 combined plans.	MfE, MHUD	2022-2026	RAN, BUP, JUL
S3.9	**Improve delivery of transit-oriented development (TOD)**	Undertake post-implementation reviews of recent TODs. These reviews should: a. Reflect international best practice, be independent and assess actual performance against appraisal, cost schedule and benefits. b. Include recommendations for future TODs.	Ministry of Transport, Waka Kotahi	2022-2026	TSS

No.	What	How	Who	When	Ref.
S3.10	**Improve efficiency and outcomes of infrastructure through spatial planning**	Resource management reforms should include requirements for regional spatial plans that: a. Are consistent with district plans and funding plans. b. Include a mechanism for participation by relevant central government infrastructure suppliers and Māori. c. Require regional spatial plans to provide for cities to double or triple in population and provide alternative scenarios for the spatial distribution of growth, rather than providing for only a single growth scenario. d. Identify future infrastructure requirements, including future transport networks and other major infrastructure.	MfE	2022-2026	BUP, RAN
S3.11	**Reduce congestion and improve urban mobility**	Implement congestion pricing and road tolling in urban centres. Steps should include: a. Implement recommendations from the "The Congestion Question" report for congestion charging in Auckland. Stage implementation as appropriate, considering current and future public transport arrangements. b. Immediately remove legislative barriers to implementing congestion charging and road tolling, such as requirements in the Land Transport Management Act for an alternative non-tolled route. c. Progress implementation on a congestion pricing scheme for Wellington. d. By 2025, identifying other urban areas where congestion pricing may be beneficial.	Ministry of Transport, Waka Kotahi, Local Government	2022-2031	TCQ, LGW, LFF
S3.12	**Target transport investment to areas of highest need using signals from congestion pricing**	Use data and pricing signals from congestion charging to identify where future multi-modal transport investment is needed.	Waka Kotahi, Local Government	2032-2050	LFF,TCQ, LGW

No.	What	How	Who	When	Ref.
S3.13	**Increase housing development opportunities in areas with good access to infrastructure**	Improve development opportunities in areas already well served by infrastructure by: a. Accelerating implementation of the National Policy Statement on Urban Development (NPS-UD) and monitoring compliance, including requirements to upzone around rapid-transit and employment centres. b. Enabling greater urban development, including requirements for minimum levels of mixed-use zoning and upzoning. c. Removing legislative provisions that allow environmental protection arising from subjective amenities that constrain diversity in land use. d. Using national direction to set binding targets for increased housing and business capacity commensurate with future growth expectations, guided by land prices in high-demand areas. e. Adopting independent hearings panels to review district plan changes, with statutory representation from Te Waihanga where appropriate to ensure infrastructure is given appropriate weight in planning.	Local Government, MfE, MHUD	2022-2031	BUP, RAN
S3.14	**Improve spatial planning through better information on infrastructure capacity and costs to service growth**	Improve information on the infrastructure cost implications of different growth possibilities by: a. Developing, validating and publishing a spatial model of long-run average infrastructure costs to service growth in different locations, to inform issues like regional spatial planning, local-government development contributions policy and the alignment of development capacity increases with infrastructure capacity and low-cost opportunities for development. This model should cover all relevant types of public infrastructure. b. Requiring water entities to publish geo-spatial information on water asset condition, capacity for growth in existing water networks and capacity for growth due to planned network upgrades. c. Developing a common approach to measuring the condition and capacity of water infrastructure assets.	Te Waihanga, infrastructure owners	2022-2031	CBD, WCB

No.	What	How	Who	When	Ref.
Section 6.4 - Strengthening resilience to shocks and stresses					
S4.1	**Increase the resilience of critical infrastructure**	To increase the resilience of critical infrastructure the Government should: a. Define and identify Critical Infrastructure in the Civil Defence and Emergency Management Act 2002, replacing the term "Lifelines Utilities" with "Critical Infrastructure". b. Adopt the definition of Critical Infrastructure consistently across the policy and legislative framework for resilience. c. Develop criteria to set the level of criticality of infrastructure. d. Clarify and strengthen requirements for identifying minimum levels of service for Critical Infrastructure in the event of an emergency and disclosure of information about preparedness and level of service expectations. e. Adequately resource the National Emergency Management Agency and lead sector agencies to support the delivery of the requirements set out in the Civil Defence and Emergency Management Act 2002, on a consistent and long term basis.	NEMA, Lead Agencies	2022-2026	HGI, BRN, DIV
S4.2	**Improve infrastructure risk management by making better information available**	To make better information available to support risk management, steps should be taken to: a. Require regular disclosure of information about infrastructure preparedness and minimum levels of service in an emergency for Critical Infrastructure under the Civil Defence and Emergency Management Act 2002. b. Resource the maintenance, upkeep and availability of data-sets, information and tools to support decision making that enable resilience outcomes.	NEMA, LINZ, Lead Agencies	2022-2026	PRA, RSN

No.	What	How	Who	When	Ref.
S4.3	**Prepare infrastructure for the impacts of Climate Change**	To adapt to climate change, action should be taken to: a. Finalise and adopt the infrastructure actions set out in the National Adaptation Plan. b. Support the provision of accessible, consistent, robust information on regional and local climate change impacts across the whole country.	MfE, Te Waihanga, Climate Change Commission	2022-2031	CAT
S4.4	**Support the security of supply of essential materials to build, renew and maintain infrastructure**	To increase the resilience of supply of essential materials, steps should be taken to: a. Incorporate consideration of the security of supply of aggregate, bitumen, cement, concrete, steel and processed timber into risk management planning for critical infrastructure. b. Require that territorial local authorities undertake a resource scan as part of their long-term planning processes and protect sites suitable for aggregate extraction, such as through zoning.	MBIE, MPI, Lead Agencies, Local Government	2022-2050	PRS
Section 6.5 - Moving to a circular economy					
S5.1	**Establish a clear national direction for circularity in waste management**	In developing a National Waste Strategy, provide appropriate direction that: a. Sets out a plan for circularity and is consistent with net zero emission targets. b. Accelerates investment and innovation in waste minimisation, and the recovery of resources. c. Considers an appropriate aspirational target. d. Sets out performance measures for tracking performance e. Ensure waste markets are well functioning and appropriately incentivised and regulated.	MfE	2022-2031	RRV, WSP
S5.2	**Prioritise options that minimise waste from entering the market to**	Options should include: a. A ban on products that are hard to recycle. b. Development of options to incentivise greater product stewardship.	MfE, Local Government	2022-2031	FOT, ACW,

No.	What	How	Who	When	Ref.
	avoid unnecessary infrastructure costs	c. Increasing waste-disposal levies sustainably while managing, monitoring and funding enforcement to minimise illegal dumping. The prioritisation of these options should be guided by cost benefit analysis.			
S5.3	**Improve recycling infrastructure for priority materials**	Options should include: a. Developing processing and biomass utilisation capacity for timber and wood wastes. b. Developing construction and demolition waste collection services. c. Developing a network of regional hubs for e-waste and battery drop-off and aggregation of hubs with adequate storage capacity for plastics consolidation. d. Developing opportunities for local tyre manufacturing and re-treading capacity. e. Improving sorting facilities.	MfE, Local Government	2022-2031	WSP
S5.4	**Use behavioural interventions to address barriers to recycling, reduce waste and avoid contamination**	This should include: a. Standardising kerbside collection services, with a focus on simplicity and consistency across jurisdictions. b. Funding sustained education campaigns that promote and improve social license for recycling and promote options to minimise and avoid waste. c. Coordinating and sharing behavioural change materials between central and local government.	MfE, Local Government	2022-2031	WSP, RRM
S5.5	**Reduce landfill emissions resulting from organic waste.**	Steps should be taken to: a. Improve the collection of organic waste through greater commercial and household food waste collection services. b. Target education and behaviour change programmes to improve take-up of organic waste collection. c. Require landfill gas capture for all landfills that accept organic waste.	MfE, Local Government	2022-2031	WSP

No.	What	How	Who	When	Ref.
S5.6	**Develop uses for recycled materials in infrastructure**	Responsible agencies should: a. Identify opportunities for more domestic reprocessing, including for plastics (especially e-waste), metals, fibre and glass, plasterboard and aggregate. b. Develop relevant technical specifications and national standards for re-use of recycled construction materials in infrastructure. c. Support innovation in, and procurement of, infrastructure design and construction to enable greater use of recyclable materials in infrastructure.	MfE, MBIE, Lead Agencies, Local Government	2022-2031	WSP
S5.7	**Clarify the strategic role of waste-to-energy**	The Government should establish a position on waste-to-energy as part of the National Waste Strategy, noting its potential as an alternative to landfill.	MfE, MBIE	2027-2031	WSP, WTE
S5.8	**Improve waste sector data and insight**	Fund improvements in waste data to enable comparisons between volume, performance and processing capacity across waste streams by region and territorial authority, by resourcing the implementation of the National Waste Data Framework.	MfE, Local Government	2022-2031	WSP
S5.9	**Encourage public infrastructure waste minimisation**	This should include the following steps: a. Require all infrastructure projects to incorporate waste minimisation plans in procurement and design objectives and use recycled products where feasible. b. Encourage prefabrication/ standardised options as part of infrastructure delivery. c. Investigate the efficacy of a Resource Exchange Mechanism for infrastructure projects, through a partnership between government and the construction sector.	MfE, Local Government	2022-2031	WSP
Section 7.1 - Better decision making					

No.	What	How	Who	When	Ref.
B1.1	**Strengthen government as a sophisticated client of infrastructure**	Take the following steps to develop the client capability of the government to better deliver infrastructure: a. Develop service quality standards and standard design methodologies for each major infrastructure asset class with key delivery agencies. b. Require long-term planning informed by service standards to better predict future infrastructure needs. c. Strengthen government capabilities for end-to-end delivery, including governance, commissioning, procuring, negotiation, oversight and whole-of-life management systems for major infrastructure.	MBIE, Government Procurement, The Construction Accord, The Treasury, Delivery agencies	2022-2031	WEF, ROY
B1.2	**Increase clarity of long-term funding intentions for public infrastructure agencies**	Public infrastructure agencies require long-term funding certainty to better match planning processes with major infrastructure projects. The annual budget process should provide public infrastructure agencies with a 10-year funding provision within which capital intentions plans are developed.	Treasury, DIA, Local Government	2022-2026	AIP
B1.3	**Strengthen independent advice for infrastructure prioritisation**	Establish an independent Infrastructure Priority List to build consensus around key projects and initiatives that address significant long term problems. Developing the Priority List should include the following steps: a. Publish guidance on criteria for project inclusion and priority investigations, consistent with best practice decision-making principles. b. Solicit applications for priority projects and initiatives from infrastructure providers. c. Assess projects and initiatives and regularly update the Priority List.	Te Waihanga	2022-2026	AIP
B1.4	**Improve infrastructure performance reporting and insight**	Assemble and analyse infrastructure performance across: a. Projects: how individual assets perform in delivery and operation. b. Networks: how infrastructure performs as a network. c. Systems: how networks perform as an integrated system.	Treasury, Te Waihanga	2022-2050	DSA

No.	What	How	Who	When	Ref.
B1.5	**Strengthen project evaluation through cost benefit analysis**	Deliver consistent and transparent project evaluation by requiring: a. Local and central government agencies to undertake and publicly release rigorous social cost-benefit analysis on all public infrastructure investment proposals where the whole-of-life costs of the proposals exceed $150 million. b. That analysis is complete prior to projects being announced. c. That analysis appropriately recognises intergenerational choices and includes wider environmental and social impacts.	Treasury , MBIE, Te Waihanga	2022-2026	PII
B1.6	**Appropriate consideration of future generations in project evaluation**	Undertake an inquiry into the appropriateness and consistent application of New Zealand's social discount rate policy, which determines how much weight is placed on future outcomes relative to present-day outcomes when analysing public infrastructure investments.	Treasury, Te Waihanga	2027-2031	TNT
B1.7	**Improve the infrastructure project knowledge base**	To improve future project evaluation methods and processes, delivery agencies should: a. Conduct and fund independent post-implementation reviews of major infrastructure projects at completion. b. Publish ex-post reviews in full and measure performance, benefits and cost against business case estimates.	Delivery agencies	2022-2050	DSA
B1.8	**Improve infrastructure cost analysis**	Undertake investigations into the cost performance of New Zealand's infrastructure sector that: a. Cover multiple infrastructure sectors to enable the identification of common issues and points of difference. b. Identify recent cost trends and drivers of cost trends within infrastructure sectors. c. Benchmark New Zealand's cost performance against better-performing OECD countries and identify drivers of differences.	Te Waihanga	2022-2050	BUP

No.	What	How	Who	When	Ref.
		d. Are repeated at least once every five years to inform ongoing Infrastructure Strategy development.			
Section 7.2 – Improving funding and financing					
B2.1	**Improve equitable funding of local infrastructure**	Investigate options to phase in requirements for the Crown to pay rates for land, where appropriate and when it generates a demand for infrastructure. The approach should avoid creating excessive and unexpected financial liabilities.	DIA	2027-2031	ULH
B2.2	**Reforming the transport funding system**	Implement a new, fit-for-purpose transport funding system that is sustainable and adequate for meeting future transport investment requirements. The system should incorporate principles of user charges and best practice funding principles, including shifting vehicles onto time, location, distance and level-of-service-based pricing. Establishing a new system should include: a. Establishing a replacement for Road User Charges and Petrol Excise Duty. b. Establishing necessary transport funding requirement c. Determining how additional funding, if required, should be collected.	MoT	2022-2031	KCM
B2.3	**Improve and streamline the application of development contributions**	Implement a single national legislative process for development contributions policy to assist territorial authorities in interpreting existing legislation for determining development contributions policy. This could be similar to National Building Standards.	DIA	2027-2031	FFI
B2.4	**Consolidate existing separate infrastructure capital funds**	Fragmented infrastructure capital funding pools should be consolidated and integrated in a transparent infrastructure capital fund(s). The consolidation of national capital funding programs for infrastructure would enable the Government to prioritise investments based on national significance,	Treasury	2022-2031	AIP, FFI, RNS

No.	What	How	Who	When	Ref.
		net benefits and enable greater public transparency around infrastructure capital funding decisions. How these funds are held and distributed should be: a. Set out transparently. b. Include consideration of the use of grants, loans, and investments, or some combination of these.			
B2.5	**Improve ability to debt fund infrastructure**	As a way of accessing alternate financing, and avoiding debt on local government balance sheets: a. Investigate opportunities to utilise the Infrastructure Funding and Financing Act. b. Explore other Special Purpose Vehicles (SPVs) as a mechanism for new infrastructure investments.	Treasury, DIA	2027-2041	LFF
B2.6	**Improve funding of infrastructure services through targeted funding tools**	Establish targeted funding tools for the following applications: a. Tourism: Ensure that the International Visitor Conservation and Tourism Levy be used for tourism infrastructure, especially for local authorities with high international visitor numbers that are otherwise struggling to secure funding sources. b. Transport: The introduction of congestion pricing in urban areas. c. Wastewater: Introducing legislative change that clarifies the ability of local authorities to direct rate wastewater based on volumes would create a better linkage between services and costs to users. d. Waste: An investigation into what funding mechanisms will best achieve the objectives of the Waste Minimisation Act 2008 and National Waste Strategy and incentivise behaviour appropriately.	MBIE, MoT, DIA, MfE	2027-2031	LFF, FFI, TCQ
B2.7	**Encourage the use of value capture tools to**	Enable value capture tools through legislation to ensure that value becomes a driver of service provision.	Treasury	2022-2031	BUP, FFI,

No.	What	How	Who	When	Ref.
	fund infrastructure for growth.				LFF, MHT
B2.8	**Increase infrastructure funding to meet our infrastructure challenges and boost productivity**	Given current expenditure levels are unlikely to be sufficient to provide for infrastructure needs over coming decades, a material increase in infrastructure funding from both public and private sources is required to meet our infrastructure challenges and boost productivity. Government should increase infrastructure funding to: a. use infrastructure investment to support opportunities for productivity growth, resilience and to meet environmental targets across the economy. b. make investments based on rigorous assessments of which projects display clearly positive productivity benefits.	Treasury	2027-50	FFI, TIC
B2.9	**Ensure that infrastructure charges keep pace with inflation**	Infrastructure related charges, fees and levies that are set out in legislation or regulation should be adjusted for inflation.	Treasury, Local Government.	2022-2026	LFF
7.3 – An enabling planning and consenting framework					
B3.1	**Strengthen Crown mandate to deliver infrastructure**	Ensure that the Natural and Built Environments Act 'gives effect' to existing requirements for the Crown to deliver infrastructure.	MfE	2022-2026	NBE
B3.2	**Improve evidence-base for environmental consent applications**	Robust and consistent data is essential for making informed decisions on environmental consent applications. Steps to increase the quality of data available include: a. Improving the evidence base on and knowledge of the effects from urban development and infrastructure on the quality of water, air, soil and biodiversity (species and habitat).	MfE	2022-2031	NBE

No.	What	How	Who	When	Ref.
		b. Centralisation of knowledge to enable consistent application across regional jurisdictions, for the purpose of determining environmental consent applications.			
B3.3	**Deliver reasonable environmental limits and targets in the Natural and Built Environments Bill**	Steps to achieve this recommendation include: a. A focus on environmental limits and targets to matters sustaining life (e.g. air, water, soil, biodiversity) rather than human values and preferences (e.g. heritage, character and amenity) b. Standardised national minimum environmental limits; Where possible, ensure that environmental limits are measurable, targeted and quantifiable.	MfE	2022-2026	NBE
B3.4	**Develop greater certainty for infrastructure providers in the Natural and Built Environment legislation**	Steps that should be implemented to deliver greater certainty include: a. Standardise and codify a National Planning Framework for infrastructure in emerging Natural and Built Environment legislation, that sets requirements and conditions that infrastructure providers are required to meet for routine matters like noise and dust management, to minimise variations and increase certainty. b. Provide a mechanism for resolving conflicts between multiple outcomes to avoid litigation of the interpretation of the outcomes. c. Narrow the definition of an 'effect' to those relating to the natural and physical environment, so that other matters (like effects on trade competition) are not unreasonably used to restrict new infrastructure. d. Require that externalities unrelated to natural and physical resources are addressed elsewhere, such as in the project business case.	MfE	2022-2041	NBE
Section 7.4 - Accelerating technology use					

No.	What	How	Who	When	Ref.
B4.1	**Increase diffusion of existing technologies to increase productivity in the infrastructure sector**	Increase diffusion of existing technologies through the following steps: a. Review all Government procurement and contracting against this recommendation and make appropriate changes. b. Develop a technology plan that establishes a clear time-bound mission and actions to increase the diffusion of technology. This should include consideration of all demand side drivers, and barriers to uptake. c. Devolve decision making for technical standard setting (e.g. minimum energy performance standards, housing codes, waste and water efficiency) to responsible regulators as appropriate and ensure they review and update regularly.	DIA, MBIE	2022-2026	PTC
B4.2	**Accelerate adoption of open data and common standards for the infrastructure sector**	Accelerate the adoption of open data and common standards through the following steps: a. Identify the legislative and administrative steps required to move toward full open data for central and local government (including infrastructure). b. Fund, develop and mandate common national infrastructure metadata standards.	DIA, Government Chief Data Steward	2022-2031	PTC
B4.3	**Accelerate the digitalisation of infrastructure**	Accelerate digitalisation across the infrastructure lifecycle by implementing the following steps: a. Facilitate consistent use of Building Information Management systems and provide detailed implementation guidance. b. Accelerate investigations into city, region and nation-wide digital twins to embed them as a process and tool of choice for spatial planning development. c. Fund and launch a series of artificial intelligence-powered use cases across infrastructure sectors.	MBIE, MfE	2027-2031	PTC
Section 7.5 - Building workforce capacity and capability					

No.	What	How	Who	When	Ref.
B5.1	**Develop the right talent required to deliver New Zealand's future infrastructure**	Deliver a national infrastructure skills plan to ensure New Zealand has the right people with the right skills to deliver our infrastructure over the medium to long term. A dedicated public and private sector working group should be established to develop a skills plan that: a. Provides information on the likely professional and workforce requirements to deliver planned and forecast infrastructure supply over the next 15 years and beyond. b. Ensures our education system supports our future workforce needs, in particular through the promotion of science, technology, engineering and mathematics education programmes. c. Provides advice on critical specialist infrastructure skills deficiencies that could delay construction, or add to the costs of projects and maintenance. d. Achieves increased diversity in all parts of the infrastructure system. e. Advises on opportunities to improve coordination across projects and sectors, and how employers can work more effectively in partnership with training providers.	NZ Government Procurement (Lead), Public Service Commission (Lead), Te Waihanga, MBIE, Tertiary Education Commission, Treasury, Construction Sector Accord parties	2022-2031	AIP
B5.2	**Build New Zealand's competitiveness for international talent**	Develop a trans-Tasman procurement market by ensuring a consistent approach in: a. Product and building standards. b. Qualification requirements. c. Contract and procurement processes. Identify and reduce barriers for international experts to work in New Zealand by adopting international standards by default, unless there is a compelling rationale for the development of a bespoke New Zealand standard.	NZ Government Procurement, MBIE	2027-2031	AIP
B5.3	**Provide certainty to industry to invest in**	Strengthen Te Waihanga's infrastructure pipeline to: a. Broaden the detail of information provided b. Improve coverage across all regions and sectors	Te Waihanga	2022-2031	PSS

No.	What	How	Who	When	Ref.
	skills and training development	Use the aggregated pipeline data to provide insight on the capacity of the economy to deliver the pipeline, inform forecasts of labour requirements and inform the direction of government infrastructure spending during times of economic downturn.			
B5.4	**Strengthen government client-side capability to plan, design and deliver projects**	Improve project outcomes by increasing public sector capability and excellence in infrastructure delivery by: a. Introducing comprehensive procurement, asset management and project management practitioner development frameworks and underpinning accreditation systems across government. b. Creating career development opportunities in the public sector by increasing the number of entry level technical roles in client agencies to support the placement and rapid professional growth of newly graduated practitioners. c. Building effective partnerships between delivery agencies and New Zealand's academic institutes to disseminate international best practice and lift the prioritisation of advance research in infrastructure. d. Aligning remuneration between public and private sectors to improve competition across infrastructure types.	Public Service Commission, Delivery agencies	2027-2031	AIA
B5.5	**Recognise major project leadership as a role with comparable complexity to organisational leadership**	The following steps should be put in place to recognise the complexity of major project leadership: a. Develop guidance on the skill sets and appointment processes appropriate for the leaders of New Zealand's largest projects. b. Establish a New Zealand Major Projects Leadership Academy based on proven international approaches and make completion a requirement for project leaders. c. Ensure both accountability mechanisms and remuneration are aligned with the complexity and risk project leaders are managing on behalf of the Government.	Public Service Commission (Lead), Te Waihanga	2022-2031	MPL

10. Want to know more

Hiahia he mōhiohio anō

The following documents are ones that we found particularly useful in the development of the draft recommendations. References link to where we have used them in the development of our thinking. These documents give additional information on the problems identified, the case for action, or how recommendations might work in practice.

Ref.	Document	Author	Link
ACW	**Auckland Council Waste Management and Minimisation Plan, 2018**	Auckland Council	https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/topic-based-plans-strategies/environmental-plans-strategies/docswastemanagementplan/auckland-waste-management-minimisation-plan.pdf
AIA	**Australian Infrastructure Audit 2019**	Infrastructure Australia	https://www.infrastructureaustralia.gov.au/publications/australian-infrastructure-audit-2019
AIP	**Australian Infrastructure Plan**	Infrastructure Australia	https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/Australian_Infrastructure_Plan.pdf
ARE	**Acceleration of renewable energy and energy efficiency**	Ministry for Business, Innovation and Employment	https://www.mbie.govt.nz/assets/discussion-document-accelerating-renewable-energy-and-energy-efficiency.pdf

Ref.	Document	Author	Link
ATA	**Australian Transport Assessment and Planning Guidelines: O8 - Real Options Assessment**	Transport and Infrastructure Council	https://www.atap.gov.au/sites/default/files/documents/real_options_public_consultation_draft.pdf
BUP	**Better Urban Planning**	The New Zealand Productivity Commission	https://www.productivity.govt.nz/assets/Documents/0a784a22e2/Final-report.pdf
BRN	**Ministerial Review: Better Responses to Natural Disasters and Other Emergencies in New Zealand 2018**	Department of Prime Minister and Cabinet	https://dpmc.govt.nz/departmental-agency/nema/ministerial-review-better-responses-natural-disasters-and-other-emergencies
BZC	**Bringing Zero Carbon Gas to Aotearoa: Hydrogen Feasibility Study - Summary Report**	First Gas Group	https://firstgas.co.nz/wp-content/uploads/Firstgas-Group_Hydrogen-Feasibility-Study_web_pages.pdf
CAT	**Adapting to Climate Change in New Zealand, Recommendations from the Climate Change Adaptation Technical Working Group**	Climate Change Adaptation Technical Working Group	https://environment.govt.nz/assets/Publications/Files/ccatwg-report-web.pdf

Ref.	Document	Author	Link
CBD	**The costs and benefits of urban development**	MRCagney	https://environment.govt.nz/assets/Publications/Files/costs-and-benefits-of-urban-development-mr-cagney_0.pdf
CBG	**Auckland Council Cost Benefit Analysis for publicly owned golf courses**	Auckland Council	https://ourauckland.aucklandcouncil.govt.nz/media/qp0d0do1/2018_golf_cba-model-and-methodology.pdf
CCC	**Draft Advice for Consultation**	He Pou a Rangi, the Climate Change Commission	https://ccc-production-media.s3.ap-southeast-2.amazonaws.com/public/evidence/advice-report-DRAFT-1ST-FEB/ADVICE/CCC-ADVICE-TO-GOVT-31-JAN-2021-pdf.pdf
CEM	**Crown Engagement with Māori (Engagement Framework & Guidelines)**	Te Arawhiti	https://www.tearawhiti.govt.nz/te-kahui-hikina-Māori-crown-relations/engagement/
CPR	**Corridor Protection: Planning and investing for the long term**	Infrastructure Australia	https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/CorridorProtection.pdf
DIV	**Draft 30 Year Strategy**	Infrastructure Victoria	https://www.infrastructurevictoria.com.au/wp-content/uploads/2020/12/Victorias-Draft-30-Year-Infrastructure-Strategy-Volume-1-1.pdf

Ref.	Document	Author	Link
EAF	**Washington Electric Aircraft Feasibility Study**	WSDOT, 2020	https://wsdot.wa.gov/sites/default/files/2020/11/18/Electric-Aircraft-Feasibility-Study-Nov2020.pdf
EAN	**Advice on Creating Equal Access to Electricity Networks**	Electricity Authority	https://www.ea.govt.nz/assets/dms-assets/26/26594Equal-Access-IPAG.pdf
FFI	**Financing and funding of infrastructure in New Zealand**	Kevin Ramsay Consulting (a report for the New Zealand Infrastructure Commission, Te Waihanga)	Forthcoming
FOT	**Future of Tax**	Tax Working Group	https://taxworkinggroup.govt.nz/resources/future-tax-final-report-vol-i-html.html
FSE	**Developing the Freight Sector Elements**	Deloitte	https://infracom.govt.nz/assets/Uploads/Freight-Sector-Review.pdf
GFI	**Grow for it - How population policies can promote economic growth, NZIER working paper 2012/1.**	Yeabsley, 2012	https://nzier.org.nz/publication/grow-for-it-how-population-policies-can-can-promote-economic-growth-nzier-working-paper-20121.

Ref.	Document	Author	Link
GIC	**Submission on Climate Change Commission's 2021 Draft Advice for Consultation**	Gas Industry Company	httpts/news/gas-industryco-submission-on-climate-change-commissions-2021-draft-advice-forconsultation/document/7241
GIW	**Guiding Integrated Urban and Water Planning**	Cooperative Research Centre for Water Sensitive Cities	https://watersensitivecities.org.au/wp-content/uploads/2021/02/IRP3-project-overview-s://www.gasindustry.co.nz/about-us/news-and-even260221.pdf
GTG	**Greening the Grid: Implementing Renewable Energy Zones for Integrated Transmission and Generation Planning**	Getman, D., and Hurlbut, D.	https://greeningthegrid.org/trainings-1/transcript-implementing-renewable-energy-zones-for-integrated-transmission-and-generation-planning
HGI	**Compendium of Policy Good Practices for Quality Infrastructure Investment**	OECD	https://www.oecd.org/mcm/Compendium-CMIN-2020-3-EN.pdf
INH	**Intervention Hierarchy**	Waka Kotahi, NZ Transport Agency	https://www.nzta.govt.nz/assets/resources/The-Business-Case-Approach/PBC-intervention-hierarchy.pdf
ITA	**Report of the Minister for the Environment's Infrastructure Technical Advisory Group**	Infrastructure Technical Advisory Group	https://environment.govt.nz/assets/Publications/Files/Itag-Report-Final.pdf

Ref.	Document	Author	Link
ITN	**Inaia Tonu Nei: A Low Emissions Future for Aotearoa**	He Pou a Rangi Climate Change Commission	https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/
JUL	**Introduction of Urban Land Use Planning System in Japan**	Ministry of Land, Infrastructure, and Transport	https://jica-net-library.jica.go.jp/library/jn325/UrbanLandUsePlanningSystem_all.pdf
KCM	**Keeping Cities Moving**	Waka Kotahi NZ Transport Agency	https://nzta.govt.nz/assets/resources/keeping-cities-moving/Keeping-cities-moving.pdf
LEE	**Low Emissions Economy**	New Zealand Productivity Commission	https://www.productivity.govt.nz/assets/Documents/lowemissions/4e01d69a83/Productivity-Commission_Low-emissions-economy_Final-Report_FINAL_2.pdf
LFF	**Local government funding and financing**	New Zealand Productivity Commission	https://www.productivity.govt.nz/assets/Documents/a40d80048d/Final-report_Local-government-funding-and-financing.pdf
LMA	**Are local infrastructure decision-making bodies right sized? Challenges from growing labour market areas**	Sense Partners (a report for the New Zealand Infrastructure Commission, Te Waihanga)	https://www.tewaihanga.govt.nz/strategy/reports/

Ref.	Document	Author	Link
LGW	**Draft Programme Business Case Report**	Let's Get Wellington Moving	https://lgwm.nz/assets/Documents/Programme-Business-Case/LGWM-PBC-Report-21-June-2019-Draft.pdf
MFP	**Municipal Fragmentation and Economic Performance of OECD TL2 Regions.**	Bartolini ,D (OECD Regional Development Working Papers)	https://www.oecd-ilibrary.org/docserver/5jrxqs60st5h-en.pdf?expires=1630332365&id=id&accname=guest&checksum=E655FEE9DB1600BB3172895AF5FFF98F
MHT	**Mayoral Housing Taskforce Report**	Mayor of Auckland	https://www.aucklandcouncil.govt.nz/mayor-of-auckland/mayor-priorities/Documents/house-taskforce-report.pdf
MPL	**Major Projects Leadership Academy, MPLA Handbook**	Infrastructure and Projects Authority	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/850739/MPLA_Handbook_for_IPA_Website__2_.pdf
NBE	**Inquiry on the Natural and Built Environments Bill: Parliamentary Paper**	Submission by the New Zealand Infrastructure Commission Te Waihanga to the Environment-Select-Committee ,August 2021:	https://www.tewaihanga.govt.nz/assets/Uploads/Te-Waihanga-Natural-and-Built-Environments-Bill-submission-to-Environment-Select-Committee.pdf

Ref.	Document	Author	Link
NFD	**National Freight Data Hub, Options Discussion Paper, August 2020.**	The Australian Department of Infrastructure, Transport, Regional Development and Communications	https://www.infrastructure.gov.au/transport/freight/national-freight-data-hub/files/national-freight-data-hub-options-discussion-paper-august-2020.pdf.
NLR	**National Location Registry - Freight and Logistics**	GS1 Australia	https://www.gs1au.org/nlr/freightlogistics
NOF	**Network Optimisation Framework**	Queensland Department of Transport and Main Roads	https://www.tmr.qld.gov.au/business-industry/Business-with-us/Getting-the-most-out-of-existing-infrastructure
NSC	**National Freight and Supply Chain Strategy**	Australian Transport and Infrastructure Council	https://www.freightaustralia.gov.au/sites/default/files/documents/national-freight-and-supply-chain-strategy.pdf
OCE	**Offshore Clean Energy Infrastructure Framework**	Department of Industry, Science, Energy and Resources	https://consult.industry.gov.au/offshore-exploration/offshore-clean-energy-infrastructure/supporting_documents/offshorecleanenergyregulatoryframeworkdiscussionpaper.pdf

Ref.	Document	Author	Link
PII	**Productivity Commission Inquiry Report on Public Infrastructure**	Australian Productivity Commission	https://www.pc.gov.au/inquiries/completed/infrastructure/report
PRA	**A Pathway to Infrastructure Resilience Advisory Paper 1: Opportunities for systemic change**	Infrastructure Australia and Infrastructure NSW, August 2021	https://www.infrastructureaustralia.gov.au/sites/default/files/2021-08/Advisory%20Paper%201%20-%20A%20pathway%20to%20Infrastructure%20Resilience%20FINAL.pdf
PRS	**Physical Resources Study**	New Zealand Infrastructure Commission, Te Waihanga	Forthcoming
PTC	**Preparing for technological change in the Infrastructure Sector**	BECA, Polis (a report for the New Zealand Infrastructure Commission, Te Waihanga)	https://infracom.govt.nz/assets/Uploads/Preparing-for-Technological-Change-in-the-Infrastructure-Sector.pdf"
PSS	**Pipeline Satisfaction Survey**	The New Zealand Infrastructure Commission, Te Waihanga	Forthcoming

Ref.	Document	Author	Link
RAN	**New directions for resource management in New Zealand**	Randerson, T	https://environment.govt.nz/assets/Publications/Files/rm-panel-review-report-summary.pdf
RNS	**RestartNSW**	Infrastructure New South Wales	https://www.infrastructure.nsw.gov.au/restart-nsw.aspx
RRM	**Infrastructure Victoria, Advice on recycling and resource recovery infrastructure, Melbourne**	Infrastructure Victoria	www.infrastructurevictoria.com.au/wp-content/uploads/2020/03/Advice-on-recycling-and[1]resource-recovery-FINAL-REPORT.pdf
RSN	**Resilience Strategy For Natural Hazard Risk Reduction 2019 - 2029**	Earthquake Commission	https://www.eqc.govt.nz/sites/public_files/documents/grants/EQC%20Resilience%20Strategy%202019.pdf
RRV	**Recycling and resource recovery infrastructure in Victoria: International and Australian comparisons**	AlphaBeta ((report for Infrastructure Victoria)	www.infrastructurevictoria.com.au/wp-content/uploads/2019/10/International-and[1]Australian-comparisons-Alphabeta-September-2019-FINAL-REPORT.pdf
SNZ	**How accurate are population estimates and projections?**	Statistics New Zealand Submission on "He Tuapapa ki te Ora"	Forthcoming

Ref.	Document	Author	Link
SRC	**Stern Review: The Economics of Climate Change**	Sir Nicholas Stern	https://www.cambridge.org/core/books/economics-of-climate-change/A1E0BBF2F0ED8E2E4142A9C878052204
TCQ	**The Congestion Question**	Ministry of Transport	https://www.transport.govt.nz//assets/Uploads/Report/TheCongestionQuestionMainFindings.pdf
TIC	**The Infrastructure Challenge**	Sense Partners (a report for the New Zealand Infrastructure Commission, Te Waihanga)	https://www.tewaihanga.govt.nz/strategy/reports/
TNT	**Economics like there's no tomorrow**	NZIER	https://nzier.org.nz/static/media/filer_public/e7/bf/e7bfe44f-1915-41c6-9f4e-9609f0921bfb/nzier_insight_32_-_economics_like_theres_no_tomorrow.pdf
TPM	**TPM Development First Mover Disadvantage Consultation**	Transpower	https://www.transpower.co.nz/sites/default/files/uncontrolled_docs/TPM%20Development%20First%20mover%20disadvantage%20consultation%20-%20final.pdf
TSS	**The TOD Standard Scorecard**	Institute for Transportation and Development Policy	https://www.itdp.org/library/standards-and-guides/tod3-0/the-tod-standard-scorecard/

Ref.	Document	Author	Link
ULH	**Using land for housing**	New Zealand Productivity Commission	https://www.productivity.govt.nz/assets/Documents/6a110935ad/using-land-for-housing-final-report-v2.pdf
WCB	**A methodology for strategic assessment of the wider costs and benefits of urban growth**	PwC	https://www.hud.govt.nz/assets/Urban-Development/Urban-Growth-Agenda/Methodology-report-A-methodology-for-strategic-assessment-of-the-wider-costs-and-benefits-of-urban-growth.pdf
WEF	**Shaping the Future of Construction A Breakthrough in Mindset and Technology**	World Economic Forum	http://www3.weforum.org/docs/WEF_Shaping_the_Future_of_Construction_full_report__.pdf
WSA	**Economic analysis of water services aggregation**	Water Industry Commission for Scotland	https://www.dia.govt.nz/diawebsite.nsf/Files/Three-waters-reform-programme/$file/Analysis-of-economic-impacts-of-water-services-aggregation-Briefing-to-Minister.pdf
WSP	**Resource Recovery and Waste State of Play**	New Zealand Infrastructure Commission, Te Waihanga	https://www.tewaihanga.govt.nz/strategy/state-of-plays/resource-recovery-and-waste/

Ref.	Document	Author	Link
WTE	**Energy from Waste Infrastructure Plan 2021**	New South Wales Environmental Protection Authority	https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/waste/21p3261-energy-from-waste-infrastructure-plan.pdf

Glossary

Papakupu whāiti

Agencies	All government departments as defined by the Public Finance Act 1989, Crown agents, Autonomous Crown entities, Independent Crown entities, Crown entity companies, companies listed on Schedule 4A of the PFA. Also referred to as Procuring Agencies.
Aotearoa 2050	Te Waihanga's campaign to collect feedback from New Zealanders to help shape what New Zealand's infrastructure will look like in 2050.
Artificial Intelligence (AI) – Machine Learning	Enables digital devices to respond to and learn from their environment. AI is anticipated to streamline tasks, especially those that are repeatable, and continue to learn and develop through completing tasks and receiving feedback.
Augmented reality	Augmented reality (AR) is an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli delivered via technology.
Autonomous vehicles	An autonomous vehicle is one that can drive itself from a starting point to a predetermined destination in 'autopilot' mode using various in-vehicle technologies and sensors.
Better Business Case framework (BBC)	A five case (or 5 question) model that provides objective analysis and consistent information to decision-makers, to enable them to make smart investment decisions for public value.
Biomass energy	Bioenergy (or biomass energy) provides heat, electricity and fuel for transport from solid biofuels (such as wood chips, wood pellets or organic waste), liquids (such as biodiesel from tallow or used cooking oil) or gas (such as those produced in wastewater or sewage treatment plants).
Building Information Modelling (BIM)	The holistic process of creating and managing information for a built asset. Based on an intelligent model and enabled by a cloud platform, BIM integrates structured, multi-disciplinary data to produce a digital representation of an asset across its lifecycle, from planning and design to construction and operations.

Business case	A management tool that supports decision-making for an investment. A robust business case can provide an explicit and systematic basis for decision-making, transparency and accountability, assurance that the proposed investment optimises value for money, and a plan for realising the expected benefits, and for managing costs and risks.
Carbon Dioxide Equivalent (CO2E)	This is a way to describe different greenhouse gases on a common scale that relates the warming effect of emissions of a gas to that of carbon dioxide. It is calculated by multiplying the quantity of a greenhouse gas by the relevant global warming potential.
Circular economy	A model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible.
Cities	Urban areas that have enough size and density to face 'urban' challenges like peak-time traffic congestion. In New Zealand, these places range in size from Queenstown to Auckland. Attractive cities offer affordable housing, good access to jobs and education, and good quality of life and therefore succeed in attracting migrants and retaining New Zealanders. Inclusive cities offer opportunities for all, regardless of income, age, ethnicity, gender, disability status, or other personal characteristics.
Civil Defence and Emergency Management Act 2002	Created a framework within which New Zealand can prepare for, deal with, and recover from local, regional and national emergencies.
Commercial viability	The ability of a business, product, or service to compete effectively and to make a profit.
Congestion pricing	Congestion pricing is a method used to improve network performance by charging road users to encourage some to change the time, route or way in which they travel.
Construction Sector Accord	A shared commitment between government and industry to transform the construction sector.
Cost benefit analysis (CBA)	A systematic process that businesses use to analyse which decisions to make and which to forgo. The cost-benefit analysis sums the potential rewards expected from a situation or action and then subtracts the total costs associated with taking that action.
Crown Land	Land vested in Her Majesty which is not for the time being set aside for any public purpose or held by any person in fee simple.

Cybersecurity	Cybersecurity is the practice of protecting critical systems and sensitive information from digital attacks.
Digital consenting	Digital consenting is an application of BIM and digital twins that streamline the consenting and approval process. Traditionally, consenting and approval of changes to the built environment relies on people checking compliance. Digital consenting removes the human element by integrating the consenting and compliance checks into BIM and digital twin applications.
Digital twins	A digital twin is a virtual model designed to accurately reflect a physical object. The object being studied, for example, a wind turbine, is outfitted with various sensors related to vital areas of functionality. These sensors produce data about different aspects of the physical object's performance, such as energy output, temperature, weather conditions and more. This data is then relayed to a processing system and applied to the digital copy.
Distributed energy resources (DERs)	Distributed energy resources (DER) is the name given to renewable energy units or systems that are commonly located at houses or businesses to provide them with power. Common examples of DER include rooftop solar PV units, battery storage, thermal energy storage, electric vehicles and chargers, smart meters, and home energy management technologies.
Economic infrastructure	This is our energy, telecommunications, transport, waste, and water infrastructure.
Economic stimulus	Economic stimulus refers to targeted fiscal and monetary policy intended to elicit an economic response from the private sector.
Electric aircraft	An electric aircraft is an aircraft powered by electricity, almost always via one or more electric motors which drive propellers. Electricity may be supplied by a variety of methods, the most common being batteries or solar cells.
Electricity generation	Electricity generation is the process of generating electric power from sources of primary energy.
Electrification	The conversion of a machine or system to the use of electrical power.
Emissions Reduction Plan (ERP)	An emissions reduction plan contains policies and strategies to reduce emissions and increase removals to meet the emissions budget.

Emissions Trading Scheme (ETS)	The New Zealand ETS was created through the Climate Change Response Act 2002 (the Act). The Act was passed in recognition of New Zealand's obligations under the Kyoto Protocol. It is the primary method for the New Zealand Government to achieve its long term commitment to reduce our greenhouse gas emissions.
Energy transition	Energy transition refers to the global energy sector's shift from fossil-based systems of energy production and consumption, including oil, natural gas and coal, to renewable energy sources like wind and solar.
Externalities	Situations when the effect of production or consumption of goods and services imposes costs or benefits on others which are not reflected in the prices charged for the goods and services being provided.
Financing	How capital is accessed to meet the upfront costs of new projects.
Funding	Funding represents all the money needed to pay for infrastructure. It comes from the community through users, taxpayers, or ratepayers.
Gas-fired generation	Gas-fired generation refers to a thermal power station which burns natural gas to generate electricity.
Gateway™	An independent project/programme peer review methodology that provides advice and support to the Senior Responsible Owner (SRO) of a programme or project.
GDP	Gross Domestic Product.
Geothermal energy	Geothermal power is electrical power generated from geothermal energy.
Gigawatt	The gigawatt (GW) is equal to one billion (109) watts or 1 gigawatt = 1000 megawatts. This unit is often used for large power plants or power grids.
Governance	The provision of leadership, strategic direction, control and accountability. A key objective of governance is to make decisions efficiently, effectively and transparently. It is the system by which an organisation or project is directed and controlled.
Immersive media	Technologies, like AR and VR, that help visualise digital information. AR merges digital information into the real world through headsets or mobile devices so that the digital elements appear as additions to the real environment. VR involves full immersion into a digital space removed from the real environment. Both technologies can make use

	of sensors and devices to allow human interaction with digital elements.
Information and communications technologies (ICT)	Diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the internet (websites, blogs and emails), live broadcasting technologies (radio, television and webcasting), recorded broadcasting technologies (podcasting, audio and video players and storage devices) and telephony (fixed or mobile, satellite, visio/video-conferencing etc.).
Infrastructure	Fixed, long-lived structures that facilitate economic performance and wellbeing. Infrastructure includes 'horizontal' physical networks (principally transport, water and energy, telecommunications); and 'vertical' infrastructure (buildings such as hospitals, schools and prisons). The latter are also known as social assets.
Infrastructure funds	Infrastructure funds refer to entities that consolidate funds for the purpose of acquiring infrastructure assets (the infrastructure assets will be defined by the mandate of each fund and can differ substantially for different funds).
Infrastructure pipeline	The infrastructure pipeline tool being published on the Infrastructure Commission website, which provides visibility of timing, sequencing and scale of future infrastructure projects.
Infrastructure Transactions Unit (ITU)	The Infrastructure Transactions Unit (ITU) was created within the Treasury to support agencies and local authorities to procure and deliver major infrastructure projects. It moved into the New Zealand Infrastructure Commission, Te Waihanga upon establishment.
Institute of public works engineering Australasia	The peak association for the professionals who deliver public works and engineering services to communities in Australia and New Zealand.
International Visitor Conservation and Tourism Levy (IVL)	A non-refundable levy of $35 charged to international visitors. This contributes directly to helping protect the natural environment they enjoy, and the infrastructure they use.
Internet of Things	The Internet of Things describes physical objects (or groups of such objects), that are embedded with sensors, processing ability, software, and other technologies, and that connect and exchange data with other devices and systems over the internet or other communications networks.

Investment	The commitment of capital or balance sheet resources to the delivery of government services via projects, programmes or portfolios.
Investor Confidence Rating (ICR)	A three-yearly assessment of the performance of investment intensive agencies in managing investments and assets that are critical to the delivery of New Zealand Government services.
Joint venture	A joint venture is a strategic alliance between two or more parties working to accomplish a specific task or project.
Key Performance Indicators (KPIs)	A measurable value that demonstrates how effectively a company is achieving key business objectives.
Lifecycle costs	The cost of replacing or refurbishing asset components during the contract period.
Metadata	Information that describes other information in order to help you understand or use it.
Minimum Energy Performance Standards (MEPS)	Minimum energy efficiency standards that products must meet to be sold in New Zealand.
Monopolistic	Relating to a person or business that has exclusive possession or control of the supply of or trade in a commodity or service.
National Policy Statement on Urban Development (NPS-UD)	Aims to ensure that New Zealand's towns and cities are well-functioning urban environments that meet the changing needs of our diverse communities.
National waste data framework	Establishes a set of definitions to act as a common language for collecting and reporting waste data and determines what data is gathered.
Natural environment	Interconnections and interdependencies between economic and social infrastructure and the natural environment, which can include ecosystem services, flood alleviation, recreation and waste disposal.
Net-zero carbon emissions commitment	The Climate Change Response (Zero Carbon) Amendment Act 2019 sets a new domestic greenhouse gas emissions reduction target for New Zealand to: reduce net emissions of all greenhouse gases (except biogenic methane) to zero by 2050; and reduce emissions of biogenic methane to 24–47% below 2017 levels by 2050, including to 10% below 2017 levels by 2030.

Net-zero carbon emissions economy	Net-zero refers to the balance between the amount of greenhouse gas produced and the amount removed from the atmosphere. We will reach a net-zero carbon emissions economy when the amount we add to the atmosphere is no more than the amount taken away.
Notice of requirement	To begin the process of designating land, a requiring authority must serve a notice of requirement on the relevant territorial authority or lodge it with the Environmental Protection Authority. A notice of requirement is a proposal for a designation.
OECD nation	The Organisation for Economic Co-operation and Development (OECD) is an international organisation that works to build better policies for better lives. An OECD nation is a member of the OECD.
Potential supplier	A private sector entity that may have the capability, capacity and willingness to provide services required for a major infrastructure project.
Pumped hydro storage	Pumped hydro captures and stores water in two places. Using surplus electricity, water can be pumped uphill to a storage lake. When demand for electricity cannot be met by other means, that water can be released via a steep drop to power turbines and generate electricity.
Regulatory settings	Regulatory settings means laws, ordinances, rules, regulations, orders, codes, and other legally enforceable requirements in effect and applicable to the performance of work.
Renewable energy zone	These zones are areas that would be suitable for renewable energy infrastructure and where there would be fewer barriers to gaining resource consent.
Resource exchange mechanism	A mechanism to facilitate the trade of surplus materials, products, components and assets across UK infrastructure projects.
Resource Management Act (RMA)	An Act to promote the sustainable management of natural and physical resources in New Zealand.
Resource Management Review Panel	The Resource Management Review Panel was appointed by the Minister for the Environment, the Hon David Parker, to undertake a comprehensive review of the resource management system in New Zealand.
Resource recovery	Resource recovery involves the development of innovative waste minimisation and recycling technologies and resource recovery processes that are beneficial to our environment and economy.

Social cost-benefit analysis	A decision support tool that measures and weighs various impacts of a project or policy.
Social discount rate policy	Social discount rates (SDRs) are used to put a present value on costs and benefits that will occur at a later date.
Social infrastructure	These are our hospitals, schools, prisons, parks, libraries, and community buildings.
Spatial planning	Spatial planning is about setting a direction and a long term goal to promote the four well-beings (social, economic, environmental and cultural) through integration of considerations for land use change, infrastructure development and delivery, environmental management and recognition of cultural values.
Special Purpose Vehicles (SPVs)	A Special Purpose Vehicle (SPV) is a separate legal entity created by an organization. Usually, they are created for a specific objective, often to isolate financial risk.
Spillover effects	A spillover effect can refer to a positive or a negative economic, social or political impact that is experienced due to an independent event occurring from a seemingly unrelated event.
Spot electricity market	The half-hour price of wholesale market electricity.
Supply chain	A supply chain is a network between a company and its suppliers to produce and distribute a specific product to the final buyer. The supply chain also represents the steps it takes to get the product or service from its original state to the customer.
Telecommunications infrastructure	Telecommunications infrastructure includes telephone wires, cables (including submarine cables), satellites, microwaves, and mobile technology such as fifth-generation (5G) mobile networks.
Telehealth	The provision of healthcare remotely by means of telecommunications technology.
Territorial authority	Territorial authorities are the second tier of local government in New Zealand, below regional councils .
Transit-oriented development (TOD)	Transit-oriented development aims to develop high-density, mixed-use living options in close proximity to local amenities, with links to reliable and frequent public transport.

TWh	A watt-hour is the amount of energy produced by a one-watt source running for one hour. A terawatt-hour (TWh) is one trillion Wh, or 1,000 GWh.
Waste-to-energy	Waste-to-energy is the process of generating energy in the form of electricity and/or heat from the primary treatment of waste, or the processing of waste into a fuel source.

New Zealand Infrastructure Strategy: Te Reo Glossary

Aotearoa	The Te Reo name for New Zealand.
Auahatanga	Creativity.
Hapū	Kinship group, clan, tribe, subtribe - section of a large kinship group and the primary political unit in traditional Māori society. It consisted of a number of whānau sharing descent from a common ancestor, usually being named after the ancestor, but sometimes from an important event in the group's history.
Huna kore	To not try to conceal or hide.
Iwi	Extended kinship group, often referring to a large group of people descended from a common ancestor and associated with a distinct territory.
Kāinga Ora	The Government's primary housing and urban development delivery arm focused on providing public housing principally for those most in need and initiating or undertaking urban development.
Kaitiaki (verb)	Guardian/steward. Tangata whenua, whānau, hapū, Iwi exercising responsibilities of kaitiakitanga (guardianship) inherited through whakapapa Māori.
Kaitiakitanga (noun)	Guardianship/stewardship. Tangata whenua, whānau, hapū, Iwi holding this responsibility.
Kawa	Protocol or etiquette.
Mana	Prestige, authority, control, power, influence, status, spiritual power, charisma - mana is a supernatural force in a person, place or object.
Mana Ōrite	Literally translates to "same mana", or a relational agreement where both sides contribute and benefit.
Mana Whenua	Territorial rights, power from the land, authority over land or territory, jurisdiction over land or territory - power associated with possession and occupation of tribal land.
Manaakitanga	Hospitality, support. The process of showing respect and care for others.

Maramataka	Māori lunar calendar - a planting and fishing monthly almanac. For most tribes the lunar months began with the new moon, but for some with the full moon. The start of each month was aligned to the morning rising of particular stars.
Mātauranga Māori	Māori knowledge systems encompassing Māori world views and perspectives.
Muaūpoko	Muaūpoko are the descendants of Tara, the eponymous ancestor of the Ngai Tara tribe. He and their descendants discovered, explored and named places throughout Aotearoa, and these remain on the land, coast and sea today, most notably Te Whanganui ā-Tara (Wellington).
Ōhanga Āmiomio	The circular economy.
Oranga	Wellbeing.
Papakāinga housing	Papakāinga translates as 'nurturing place to return to' and reflects a type of housing development that is located on multiply-owned Māori or ancestral land.
Rangatiratanga	Chieftainship, right to exercise authority.
Raukawa ki te Tonga Trust	Ngāti Raukawa was required under the Māori Fisheries Act 2004 to establish a Mandated Iwi Organisation (MIO) so it could receive Treaty of Waitangi Fisheries Settlement assets. On the 11 March 2007, the iwi agreed to set up such a body. Raukawa ki te Tonga Trust is this body, and was ratified in September 2010.
Tangata Whenua	People of the land.
Te Ao Māori	The Māori world view (Te Ao Māori) acknowledges the interconnectedness and interrelationship of all living and non-living things.
Te Ara o Te Ata	The name given for the construction Alliance comprised of the Transport Agency, Downer Construction, Heb Construction, Opus International Consultants and Tonkin + Taylor. The Alliance has been given the name 'Te Ara o Te Ata' by Ngāti Tama. Te Ata is a local taniwha which manifests on the coast of Parininihi (Whitecliffs) and is of cultural significance to Ngāti Tama.
Te Tiriti o Waitangi	The Treaty of Waitangi.

Te Waihanga	The New Zealand Infrastructure Commission. Translates to 'the cornerstone' in Te Reo.
Tikanga	Correct procedure, customary system of values.
Tikanga Māori	Correct procedures and system of values based upon Mātauranga Māori (Māori perspectives) and Māori knowledge.
Whakapono (verb)	To believe, to trust.
Whanaungatanga	Kinship, sense of family connection – a relationship through shared experiences and working together which provides people with a sense of belonging. It develops as a result of kinship rights and obligations, which also serve to strengthen each member of the kin group.

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305 Because infrastructure services are often shared services, capacity expansions can affect service levels for existing users. For example, if capacity expansion fails to keep pace with population growth, existing users experience deteriorating service levels, such as increased traffic congestion or crowded hospitals. Other funding complications arise when infrastructure networks are interconnected and interdependent. In these cases, capacity expansions in one part of the network affect service levels elsewhere on the network.

306 The electricity sector also has a spot electricity market, where prices are highly dynamic as they change every 30 minutes at over 200 locations around the country. This approach has been adopted because supply and demand are highly dependent on weather conditions and must be kept in close balance to keep the transmission system stable. Very few residential or small business consumers choose to pay spot market prices, but most large industrial consumers do so because they can cut their demand quickly when prices increase beyond what they're willing to pay. The electricity sector will be moving to real-time pricing in 2022, which is where prices are set every 5 minutes rather than every 30 minutes. Dynamic pricing is also used in the gas sector. It is not used much in telecommunications as supply and demand do not need to be kept closely in balance.

307 Further details about service-based and cost-reflective pricing is provided in Hansen, C., "How Funding and Financing Affects Productivity: Implications for Three- Waters Reform and for Local Government Funding and Financing," New Zealand Productivity Commission, 2019, 41-47 and Appendix B. https://www.productivity.govt.nz/assets/Documents/659d4a291a/CSA_Implications-

of-3W-reforms.pdf. A more academic treatment is provided in Wolak, F.A., 'Public Utility Pricing and Finance', New Palgrave Dictionary of Economics 2nd Edition, 2008, p2.

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311 There is also the contentious issue that some opponents would characterise a value-capture charge as a tax on the unrealised capital gain on a property.

312 Targeted rates are not a pure value capture charge as they cannot be applied to value uplift between two points in time.

313 The New Zealand Productivity Commission, "Local Government Funding and Financing, Final Report," NZ Productivity Commission, 2019, 4. https://www.productivity.govt.nz/assets/Documents/a40d80048d/Final-report_Local-government-funding-and-financing.pdf.

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Adler, Martin, and Jos N. van Ommeren. "Does Public Transit reduce Car Travel Externalities?." (2015). https://papers.tinbergen.nl/15011.pdf
Anderson, Michael L. "Subways, strikes, and slowdowns: The impacts of public transit on traffic congestion." *American Economic Review* 104, no. 9 (2014): 2763-96. https://www.nber.org/papers/w18757
Ministry of Transport. 2013. *The Transport impacts of the 20 June 2013 storm*. Wellington, New Zealand: Ministry of Transport. Accessed 21 September 2021. https://web.archive.org/web/20180202160530/https://www.transport.govt.nz/assets/Uploads/News/Documents/Transport-impacts-in-Wellington-storm-June-2013.pdf

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[324] Smith P. & English B. (2016, July 3). New Zealand Government Release. 1b fund accelerate housing infrastructure. https://www.beehive.govt.nz/release/1b-fund-accelerate-housing-infrastructure.

[325] New Zealand Government Release. Hon Shane Jones. Minister of Regional Economic Development. (December 2017). "The Provincial Growth Fund." https://www.beehive.govt.nz/sites/default/files/2018-02/December%202017%20PGF%20Cabinet%20Paper_0.pdf.
Only some of the total fund is used for infrastructure investment. As of 31 March 2020, $533.4 million was committed to rail; $376.5 million to tourism and $244.9 million to roads.

[326] Ministry of Business, Innovation and Employment. Tourism Infrastructure Fund. https://www.mbie.govt.nz/immigration-and-tourism/tourism/tourism-funding/tourism-infrastructure-fund/.
This fund is expected to provide up to $25 million per year.

[327] New Zealand Government Release. (2020, January 29). "The New Zealand Upgrade Program." https://www.beehive.govt.nz/feature/new-zealand-upgrade-programme.

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[330] New Zealand Government Release. (2020, August 4). "Government announces allocation of three water funds for councils". https://www.beehive.govt.nz/release/government-announces-allocation-three-waters-funds-councils.

[331] Ministry of Business, Innovation and Employment. (August 2020). "Māori and Public Housing Renewable Energy Fund".

[332] Ministry of housing and urban development. "Housing Acceleration fund".https://www.hud.govt.nz/urban-development/the-housing-acceleration-fund/.

[333] Including $1bn Infrastructure Acceleration Fund, $350m Māori Infrastructure Fund

[334] Wellbeing Budget 2021 – Water. New Zealand https://budget.govt.nz/budget/2021/wellbeing/budget-investments/reforms-intergenerational-wellbeing/water.htm.

[335] New Zealand Government release. (2021, July 15). Government provides support water reforms jobs and growth.beehive.govt.nz/release/government-provide-support-water-reforms-jobs-and-growth.

[336] Wellbeing budget 2021. Press release. (2021, May 20). *Ministry of Climate Change*. "Foundation laid for strong climate action." https://budget.govt.nz/budget/pdfs/releases/r9-shaw-foundations-laid-for-strong-climate-action.pdf
The $3 billion figure is an estimate of funds allocated by the fund over 5 years, from 2022. The actual size of the fund may differ in practice.

[337] Infrastructure New South Wales. Australia. "Restart NSW." https://www.infrastructure.nsw.gov.au/restart-nsw/

[338] Canada Infrastructure Bank. https://cib-bic.ca/en/about-us/

[339] Productivity Commission. 2019. *Local government funding and financing: Final report*. Wellington, New Zealand: Productivity Commission. https://www.productivity.govt.nz/assets/Documents/a40d80048d/Final-report_Local-government-funding-and-financing.pdf.

[340] Lenders and credit-rating agencies place various debt limits on councils, the most common one being a requirement that their ratio of total debt to income must stay under 270%. Generally, if a council exceeds 270% the agencies will downgrade the council's credit rating, forcing it to pay higher interest rates. Although COVID-19 has significantly affected debt ratios for many councils, many have retained their credit ratings. This is because agencies recognise serious shocks can

occur and in these circumstances, they pay considerable attention to a council's governance strength and plans and actions to return to acceptable financial conditions.

341 Even if a council is well within its debt ceiling, it can struggle to increase debt levels to fund more infrastructure due to public opposition to incurring debt that might result in future rates increases.

342 New Zealand Productivity Commission. (2019). Local government funding and financing

343 To date, the Milldale development in Auckland is the only SPV that has been completed. This involved Auckland Council, together with Crown Infrastructure Partners, Treasury and developer Fulton Hogan, establishing an SPV that raised nearly $50 million in long term finance to fund five bulk roading and wastewater infrastructure projects for a new housing subdivision. The SPV is responsible for building infrastructure to the specifications of Auckland Transport and Watercare, who become the owners once the infrastructure is completed. In principle, SPVs could also be used for infrastructure upgrades needed to service new development in existing urban areas. To work in those situations, the loan-servicing charges would need to be compulsory for existing property owners, rather than negotiated on a voluntary basis.

344 NZ Infrastructure Commission / Te Waihanga. 2021. *New Zealand Public Private Partnership Model Review*.https://www.tewaihanga.govt.nz/assets/Uploads/TeWaihanga_New_Zealand_Public_Private_Partnership_Model_Review.pdf

345 This includes three Ministry of Education projects, delivering 11 new primary and secondary schools; three Department of Corrections projects, delivering around 2000 additional prison beds; and two Waka Kotahi, NZ Transport Agency (Waka Kotahi) projects, delivering c.45km of Motorway.

346 Infrastructure Partnerships Australia. 2020. *Measuring the value and service outcomes of social infrastructure PPPs in Australia and New Zealand.* https://www.tewaihanga.govt.nz/assets/Uploads/Social_Infrastructure_PPPs_Report.pdf

347 While significant issues have occurred on Waka Kotahi's Transmission Gully and Puhoi to Warkworth projects, these have been driven by factors not specific to the procurement model and include site conditions, several storm events, the 2016 Kaikoura earthquake and land purchase issues.

348 Adversarial consenting processes have been shown to increase costs to review and consent projects, and potentially also reduce environmental outcomes due to delays.
See for instance Kagan, R.A., 1998. Trying to have it both ways local discretion, central control, and adversarial legalism in American environmental regulation. *Ecology LQ*, 25, p.718.

349 This is sometimes called the 'double veto' effect. The overall impact is to delay or stop projects. This is well documented in the case of housing development, for instance: Fischel, William A. "Centralized control: Do we want a double-veto system?." *Journal of the American Planning Association* 55, no. 2 (1989): 205-206.

350 The consent decisions are for wind farms that became operational since 1 January 2010 or the consent decision was made since 1 January 2010. The ten decisions are Lammermoor (630 MW, 5.4 years), Hauauru Ma Raki (540 MW, 2.9 years), Kaiwera (240 MW, 3.8 years) and Turitea (222 MW, 3.1 years). The six smaller ones are Waipipi (133 MW, 1.2 years), Te Uku (64.4 MW, 1.9 years), Mill Creek (59.8 MW, 1.0 years), Mahinerangi (36 MW, 3.3 years) Mt Stuart (7.65 MW, 1.9 years) and Flat Hill (6.8 MW, 1.2 years). Note, the timeframe for Lammermoor is conservative as it only includes the process to January 2012, which is when Meridian withdrew its consent application after opponents appealed a High Court decision to the Court of Appeal. Meridian has since re-commenced the consent process.

351 Data on consenting timeframes for offshore windfarms is from Salvador, Santiago, Luis Gimeno, and F. Javier Sanz Larruga. "Streamlining the consent process for the implementation of offshore wind farms in Spain, considering existing regulations in leading European countries." *Ocean & Coastal Management* 157 (2018): 68-85.

A 2010 review found that best-practice European countries averaged less than 1.5 years to consent a wind farm. Average processing timeframes were longer for onshore windfarms than for offshore windfarms.
http://www.ewea.org/fileadmin/files/library/publications/reports/WindBarriers_report.pdf

352 The Royal Commission, ' Report of the Royal Commission on Auckland Governance' March 2009. Volume 1.

353 Auckland City Council. Auckland-Manukau Eastern transport initiative (AMETI). 2002. https://web.archive.org/web/20070220084136/http://www.aucklandcity.govt.nz/auckland/transport/eastern/default.asp https://www.stuff.co.nz/national/politics/local-overnment/125555558/funding-squeeze-slows-aucklands-14b-eastern-busway

354 Tanko, Michael, and Matthew Burke. "Why busways? Styles of planning and mode-choice decision-making in Brisbane's transport networks."

355 https://brtdata.org/location/oceania/australia/brisbane

356 Sapere Research Group were appointed to undertake this study between March – July 2021.

357 This is based on an average capital cost of around $2.4 million per megawatt of wind farm capacity, based on wind farm projects completed over the last decade. Wind farm costs are expected to fall in the future due to technology and manufacturing improvements, so this represents a conservative estimate. Transpower estimates that an additional 14.8 gigawatts of new electricity generation are needed over the next 30 years. Note these forecast additions include additional wind, solar and geothermal generation plus added firming generation of an unspecified type. The 14.8-gigawatt figure was derived from data in Figure 4 tab in spreadsheet Whakamana i te Mauri Hiko Data Report Table, by adding to the net increase in generation capacity the capacity of plant expected to be decommissioned over the next 30 years. The spreadsheet is available at "Whakamana I Te Mauri Hiko - Empowering Our Energy Future," n.d. Accessed September 1, 2021. https://www.transpower.co.nz/resources/whakamana-i-te-mauri-hiko-empowering-our-energy-future. Data Report

358 Electricity Act 1992, Telecommunications Act 2001, Land Transport Management Act 2003, Defence Act 1990, Corrections Act 2004, Health Act 1956, Education Act 1989, Water Services Bill (as at 27 Aug 2021)

359 As part of Te Ara Tupua Project in Wellington. Waka Kotahi – NZ Transport Agency. Wellington. https://www.nzta.govt.nz/projects/te-ara-tupua/.

360 As part of the Northern Corridor Improvements Project in Auckland. Waka Kotahi – NZ Transport Agency. https://www.nzta.govt.nz/projects/the-western-ring-route/auckland-northern-corridor/.

361 Ibid.

362 Tilton, D. 2019. "Temporary Traffic Management – Auckland is awash with cones" https://www.greaterauckland.org.nz/2019/04/16/temporary-traffic-management-auckland-is-awash-with-cones/
One recent pipe repair in Wellington incurred traffic management costs that averaged $10,000 a week: https://www.stuff.co.nz/dominion-post/news/wellington/125346383/31000-for-one-week-on-one-project-traffic-management-in-wellington

363 Branz. Extern Research Report # ER24 (2017). "Falling from heights – Cost benefit analysis of scaffolding for single storey houses." Project KR0489. https://d39d3mj7qio96p.cloudfront.net/media/documents/ER24_Falling_from_heights_cost_benefit_analysis_of_scaffolding_for_single_storey.pdf

364 Infrastructure New Zealand. "Building Regions." August 2019. https://www.infrastructure.org.nz/resources/Documents/Reports/Infrastructure%20NZ%20Reforming%20New%20Zealands%20Governance%20Report.pdf.

365 Waka Kotahi – NZ Transport Agency. Kaikōura earthquake response. https://www.nzta.govt.nz/projects/kaikoura-earthquake-response/

366 For instance, Norway has built tunnels at a relatively lower cost from opportunities to learn and improve technology and methods. This includes practices around maximum allowable gradient, minimum required rock cover, and rock mass quality to address leakage issues. We Build Value. 2018. *The highway of the fjords*. Accessed 22 September 2021. https://www.webuildvalue.com/en/infrastructure/the-highway-of-the-fjords.html Bergh-Christensen, Jan, and Morten Knudsmoen. "Norwegian sub sea tunnels." *Tunnels & Tunnelling International* 35, no. 3 (2003). https://trid.trb.org/view/644566 Østlid, Håvard, and Karl Melby. "Road tunnels in Norway: A fifty year experience." *Norwegian Tunnelling Society: Subsea Tunnels*, no 18 (2009). https://nff.no/wp-content/uploads/sites/2/2020/04/Publication-18.pdf

367 West D. Brookings Report. "Technology and the Innovation Economy. October 19, 2011. https://www.brookings.edu/research/technology-and-the-innovation-economy/.

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