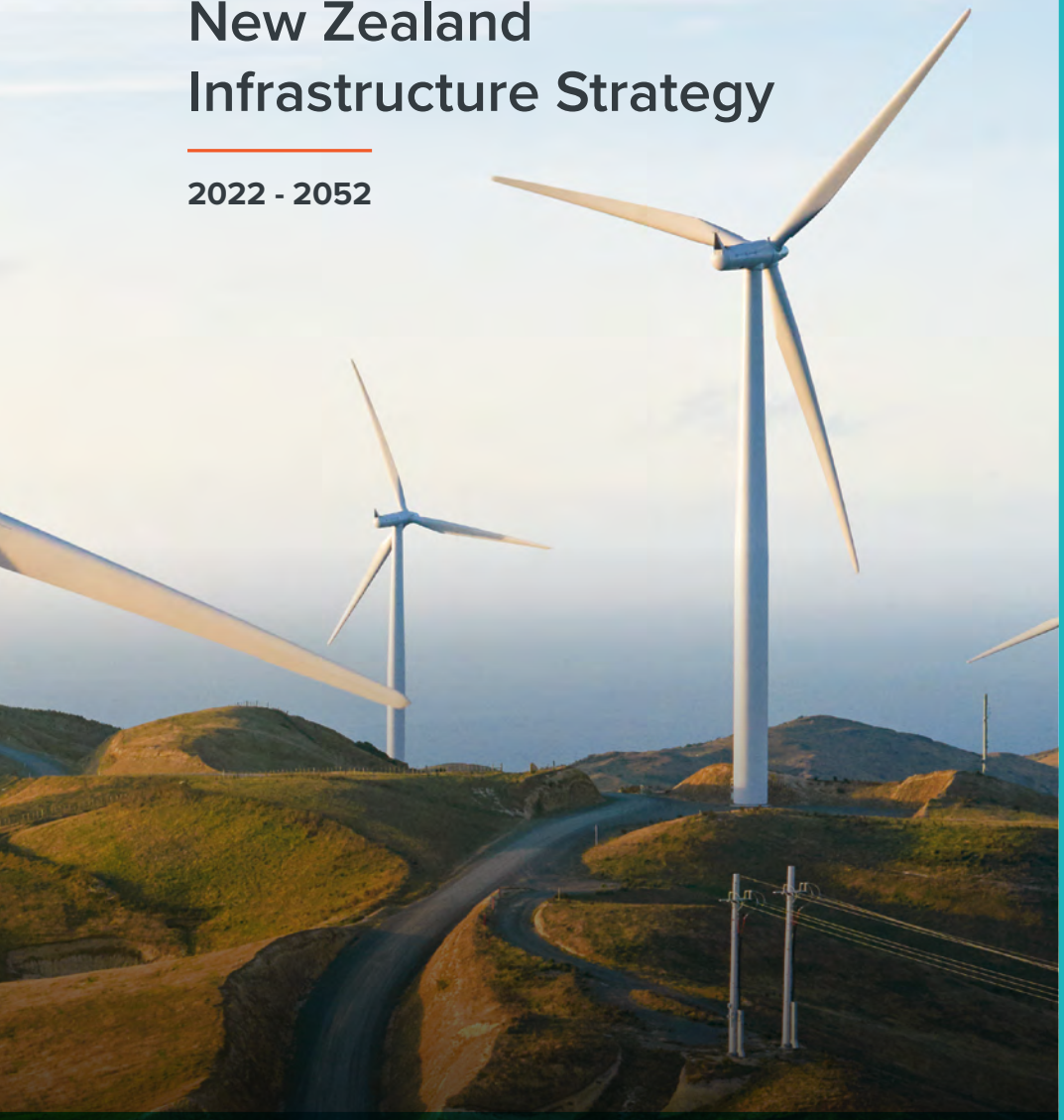
NEW ZEALAND
INFRASTRUCTURE
COMMISSION
Te Waihanga

Rautaki Hanganga o Aotearoa

New Zealand Infrastructure Strategy

2022 - 2052



Te Kāwanatanga o Aotearoa
New Zealand Government

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NEW ZEALAND INFRASTRUCTURE COMMISSION *Te Waihanga*

Te Kāwanatanga o Aotearoa
New Zealand Government

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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's 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's 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's 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 means looking to what the future will bring, preparing for challenges like climate change and making the most of the opportunities offered by new technology. It 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're 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 through 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 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's an important step towards a future that provides the high quality of life and environment that our forebears hoped for us. It's 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 up to 1.7 million new kiwis will call New Zealand home. Our climate is changing, technology is evolving, congestion is growing and this generation faces a 75% chance of a catastrophic earthquake on the Alpine Fault during their lifetime. Decades of underinvestment have accrued a large infrastructure deficit. A strategy of building our way out of the deficit and the predicted growth would mean nearly doubling the proportion of GDP we invest in infrastructure annually.

The purpose of this work is to develop a strategic response to the many challenges we face. This means looking at the infrastructure system as a whole: users, regulators, planners, investors, insurers, builders, asset owners, iwi and communities. In a world of converging networks and complex needs, understanding the interdependencies and optimising the system across all sectors is our focus.

High quality investing is critical, but we also need to extract more value from existing assets. This means encouraging people to change travel patterns through congestion pricing and rewarding those who conserve water or produce less waste. Within our cities, planning restrictions prevent people living in areas already well served by infrastructure, which reduces housing supply. Achieving net-zero carbon emissions by 2050 is one more good reason why we need a planning system that is up to the task.

A fit-for-purpose public service that can move at the pace required to meet policy commitments, stay ahead of technology shifts and scale up investment is essential. It needs to be empowered to apply pricing strategies and potentially unpopular behaviour-change policies in a fair and transparent manner. It needs to provide politicians with a range of built and non-built solutions to well-defined problems to enhance the quality of decision making.

We also need a world-class construction sector. Construction labour productivity lags behind the rest of the economy and the cost of building infrastructure has risen much faster than consumer price inflation. Our labour shortage is acute, now the worst since 1975. By 2024, we will need around 118,000 more construction workers. The industry tells us certainty is critical. Painting a clear picture of planned investment is important and addressing the politicisation of infrastructure decision-making is essential. This will give the construction sector the certainty it needs to invest in training, technology and innovation to improve productivity.

Over the past two years, we have been listening and learning as we developed this Infrastructure Strategy. More than 20,000 people shared their views on infrastructure issues and aspirations through our Aotearoa 2050 survey. We consulted publicly and met with iwi and stakeholders, as well as our local government reference group and Te Ao Māori testing panel. These conversations haven't finished. This strategy is a living document that we will update every five years.

Working with the sector to implement these recommendations will allow us to build a better New Zealand, one where our infrastructure drives higher living standards, contributes to a strong economy, enables our culture and society to thrive, and protects our environment. A New Zealand we're 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.

Ehara tēnei i te tūmahi iti noa. Hei te 30 tau ki mua nei 1.7 miriona tāngata anō ka kī ko Aotearoa te ipukarea. E huri haere ana tō tātou āhuarangi, e whanake tonu ana te hangarau, waihoki e tupu tonu ana te popoketanga o ngā rori, ā, he 75% te tūponotanga ka pā tētahi rū whenua takerehāia i te Alpine Fault i roto i te 50 tau e tū mai nei. I roto i ngā ngahurutau, i runga i te matapiko ki te whakangao pūtea, kua piki ake te tarepa hanganga. Ki te whai tātou ki te whakamahi i te hanganga hei whakatika i te tarepa, me tāpara e tātou te nui o te riterite o te tapeke wāriu hokonga ā-tau e whakangao pūteatia ana e tātou ki te hanganga.

Ko te whāinga o tēnei mahi he whakawhanake urupare rautaki ki ngā take huhua e arohia ana e tātou. Nō reira, me arohaehae e tātou te pūnaha katoa: arā, ngā kaiwhakamahi rātou ko ngā kaiwhakarite waeture ko ko ngā kaimaherehere ko ngā kaihaumi ko ngā pakihi inihua ko ngā kaihanga ko ngā tāngata whai huarawa ko ngā iwi ko ngā hapori. I tēnei wā o te ūngutu haere o ngā whatunga me ngā matea matatini, ko tō mātou aronga ko te mārama ki ngā taupuhipuhinga me te whakatika i ngā pūnaha huri noa i ngā rāngai.

He mea nui taioreore kia eke te kounga o ngā mahi whakangao pūtea, engari, me nui hoki ngā hua i ngā huarawa o tēnei wā. Me whakatenatena ngā tāngata kia tīnihia te momo ikiiki e kawe ana i a rātou ki te mahi mā te whakarite utu popoketanga, waihoki, me hoatu he moni whakapati ki te hunga e tiaki ana i te wai, e whakaheke iho ana rānei i te nui o ngā para. I ō tātou tāone nui, ko ngā herenga maherehere e aukati ana i ngā tāngata i te noho ki ngā rohe kua whai hanganga, ā, ko te tukunga iho o te aukatinga ka iti iho ngā whare wātea ana. Ko te whakatutuki i ngā whāinga tukuwaro hei te tau 2050 tētahi tino take anō e whai tikanga ana kia whai tātou i tētahi pūnaha e taea ana ngā mahi te whakatutuki.

E whai take ana kia whakatūria tētahi rāngai tūmatanui e taea ana te tere huri ki te whakatutuki i ngā herenga kaupapa here, me te tū rite mō ngā whakawhanaketanga o te hangarau, me whai pūtea hoki mō te whakangao moni. Me whakamana tēnei kia hāngai tonu ki ngā rautaki whakarite utu, ā, tērā te tūpono me whakamahi i ngā kaupapa here hoki kāore pea te makiu e mariu i runga i te tika me te pono. Me hoatu ki ngā kaitōrangapū i ētahi rongoā kua hangaia, kāore anō rānei kia hangaia, hei whakapiki ake i te kounga o ngā whiriwhiringa.

Ka mutu, me whakatū e tātou tētahi rāngai hanganga e mihia ana e te ao. Engari, e takamuri tonu ana te whakaputaranga o te rāngai hanganga ki muri rawa i te ōhanga katoa, ā, kua tere ake te piki ake o te utu o te hanganga whare i te utunga rawa kiritaki. Ko te korenga o ngā kaimahi tētahi tino 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 ki te whakangao pūtea ki te whakangunguc, ki te hangarau, me ngā auahatanga hei whakapai ake i te whakaputaranga.

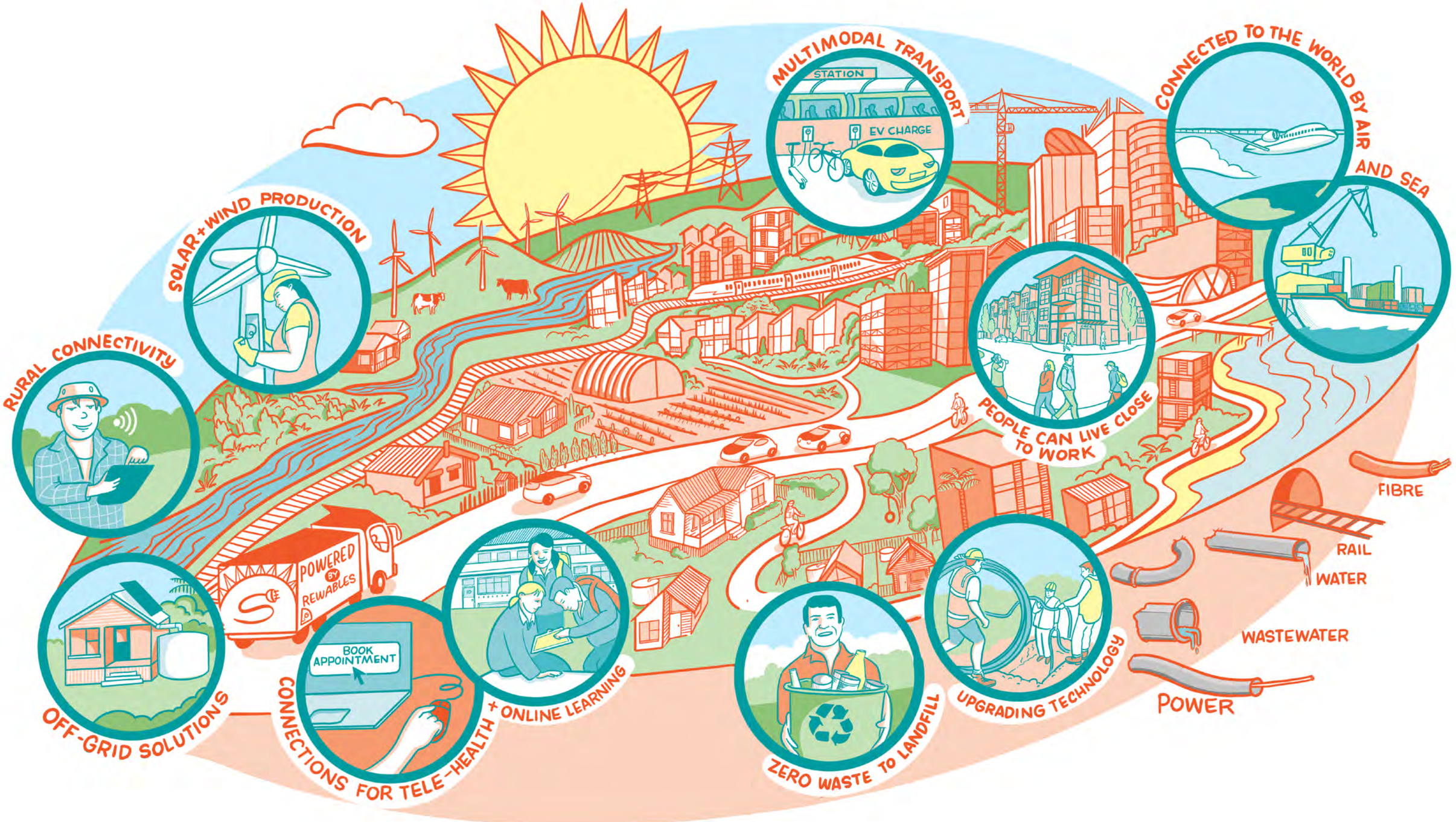
I roto i ngā tau e rua ki muri nei, kua whakarongo mātou, kua ako hoki i tā mātou whakawhanake i tēnei Rautaki Hanganga. Neke ake i te 20,000 tāngata i tāpae whakaaro mai ai ki ngā take hanganga mā tā mātou rangahau Aotearoa 2050. I whakaatu kōrero mātou ki mua i te aroaro o te makiu, i tūtaki hoki ki 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 ngā kōrerorero kia mutu noa. He tuhinga ora tonu 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 whakahīhī ai tātou te kī ko Aotearoa tō tātou kāinga.

Ross Copland

Toihau

Infrastructure for a thriving
New Zealand



Overview

Tirohanga whānui

Our infrastructure 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 over decades.

It's hard to think of an activity that doesn't use 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 from the New Zealand of today. Within the next three decades our cities could be home to 1.7 million new people, roughly the size of another Auckland. Our regions will 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 committed to 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 healthy and readily available drinking water and clean waterways requires adequate investment in wastewater treatment plants and other infrastructure. 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.

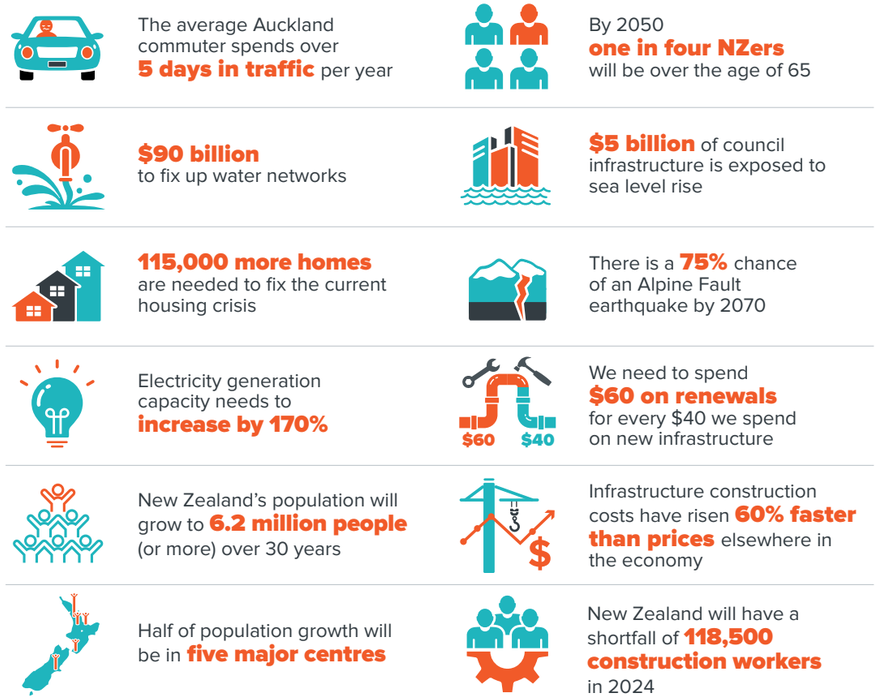
Infrastructure opens up many new opportunities, but there are also many challenges.

When built in the right place, transport infrastructure can help to 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 and investing in resilience planning will enable us to recover faster from natural disasters (such as earthquakes and floods) as well as other shocks (like cyber-attacks), minimising their impacts on our society and economy.

But we're also facing many infrastructure challenges (see Figure 1) such as dealing with unaffordable homes, congested motorways and hospitals that desperately need upgrading. New Zealand is also experiencing historic workforce shortages that limit our capacity and capabilities across all stages of infrastructure planning and delivery and this is predicted to worsen. Unless we act, these challenges will grow, especially as our population increases. We also face the challenges of our warming climate, which will not only mean major changes in the way we do things, but also more unpredictable and extreme weather.

Figure 1: New Zealand's infrastructure challenge



Source: Te Waihanga, data from Sense Partners (2021), Climate Change Commission (2021), Alpine Fault Magnitude 8 (2021), Statistics New Zealand (2021), WIP (2021), Simonson (2019)

We must act now and with urgency. In dealing with COVID-19, New Zealand has shown a responsiveness and agility that's among the best in the world. Overcoming 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 simply to keep doing what we've always done and try to build our way out of current and future infrastructure challenges, we would need to spend 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 must 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 case for change, we've developed five strategic objectives. 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 emissions Aotearoa** through rapid 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 a framework for the operation of waste-to-energy infrastructure.

As part of these objectives we need to strengthen partnerships with and unlock 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 in transforming 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 export opportunities and high-paying jobs.

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.

New Zealand has an abundance of low-emission energy potential. We have two to three times more commercially viable wind, solar, hydro 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.

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

- **The right regulatory settings** to enable the 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 the timely development of clean energy generation.
- **Reliable supporting infrastructure:** This requires an efficient expansion of supporting electricity and telecommunications networks and an efficient use of our gas and fuel networks.
- **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 changing population and ensure there's enough quality, affordable housing in the right places, supported by well-functioning infrastructure. With long-term planning, we can build a legacy of great communities for generations to come.

We can transform the system so that we are able to meet demand for infrastructure when it is needed. 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:

- **A resource management system that gives effect to national priorities:** Reform is already underway and the replacement to the Resource Management Act (RMA) must perform the dual roles of protecting the environment and allowing for development. It must enable infrastructure providers to meet policy commitments, which could include decarbonisation, efficient transport networks, adequate competition in the supply chain, universal digital access and timely provision of social infrastructure.
- **A long-term, flexible 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 demographic change and economic growth. It should also reduce uncertainty where possible, such as through a national population plan.
- **Protecting areas for infrastructure decades in advance:** Instead of our current 'just-in-time' approach, we can identify and protect strategic infrastructure corridors 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 funding and financing tools that reflect the period of time in which infrastructure assets deliver services.

The potential

An overhauled planning system would make it 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 connections 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.

Providing better infrastructure through pricing.

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

Our transport and water infrastructure is stretched to capacity in many places. 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 provides more choice and better shares the load, provided it's 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.

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 carriers.
- **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 costs 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 will come with a cost, but our car journeys will be quicker as a result. At the same time, there are better options, like rapid transit, walking and cycling, so we can save money and time by leaving our cars 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.

We need a world-class infrastructure system to meet our aspirations for the future.

To deliver on our aspirations, we need a different approach to managing our infrastructure systems, processes and resources, including in the decisions we make and the people, capital and technologies we use. We must work towards best practice, better manage the resources we have and invest in outcomes that are fair for all New Zealanders. To achieve this, system-wide change is needed. Many of the changes will be small and incremental, but collectively they will contribute to the development of a world-class infrastructure system.

Making the best possible decisions provides the foundation. We need decision-making frameworks that ensure a relentless focus on selecting the infrastructure that will create the most value for New Zealand, and doing more with the infrastructure we already have. Good decision-making takes place within and must be supported by a fit-for-purpose funding and financing system that makes appropriate use of infrastructure pricing to manage demand.

The infrastructure system requires the right people, at the right time, with the right skills to achieve our aspirations and address the challenges ahead. Currently, we face a historic workforce shortage in all aspects of infrastructure planning, construction and delivery, which is predicted to worsen. The 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.

Implementing good decisions requires a strategic and coordinated planning and consenting system that can respond quickly to our infrastructure needs. It also requires a bold approach to the adoption and use of technological and digital change across the infrastructure sector. This requires a greater focus on open data and the adoption of digital technologies to improve productivity and enhance infrastructure planning, delivery and operation.

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

Blueprint for action.

This strategy follows a blueprint for action. It begins by identifying our infrastructure challenges and opportunities, which provide 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 New Zealand, recommendations for how we achieve these and the results we can expect.

Our Context

People | Technology | Climate

Our Vision

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

Te Ao Māori

Partnerships and opportunities

Our Principles

Equitable | Aspirational | Efficient

What	How	Why
Objectives	**Performance**	**Results**
• Enabling a net-zero carbon emissions Aotearoa • Supporting towns and regions to flourish • Building attractive and inclusive cities • Moving to a circular economy • Strengthening resilience to shocks and stresses	• Better decision-making • Improving funding and financing • Accelerating technology use • Building workforce capacity and capability • An enabling planning and consenting framework	• A productive, sustainable and carbon-neutral economy • Affordable, accessible and healthy housing • Reliable, affordable and accessible travel options • 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 stresses and shocks

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How to read this strategy

Me pēhea e pānui ai i tēnei rautaki

This strategy sets out the actions New Zealand needs to take over the next 30 years to make sure our infrastructure system meets the challenges and opportunities that lie ahead. Here's what you will find in each section.

Overview

A high level view of the strategy, with a focus on the areas that will have the greatest impact in transforming New Zealand over the next 30 years.

Introduction

The importance of infrastructure to our lives and why we need a strategy for the future.

Vision for infrastructure

The vision for New Zealand's infrastructure and the aims and principles that support this vision.

Case for change

The significant challenge our infrastructure system faces and the tools we have for meeting these challenges.

Blueprint for action

The strategy in a snapshot. This shows how all of the elements of the strategy fit together.

Strengthening partnerships with and opportunities for Māori

A strategic approach to and recommendations for creating stronger partnerhips, unlocking opportunities and incorporating mātauranga Māori into infrastructure design, planning and delivery.

A thriving New Zealand: what we need to do

Five **strategic objectives** based on the infrastructure challenges and opportunities we have identified. Each objective contains a number of **recommendations** for change, with information on which institutions or organisations need to progress them and timeframes for action.

A world class infrastructure system: how we get there

Five **cross-cutting themes** that will build a better infrastructure system to support and enable the achievement of the strategic objectives. Each theme contains a number of **recommendations** for change, tagged to specific agencies and organisations and with timeframes for action.

The remaining sections share next steps, the complete list of recommendations, a list of further information and resources, as well as detailed end notes.

1 Introduction
Kupu whakataki

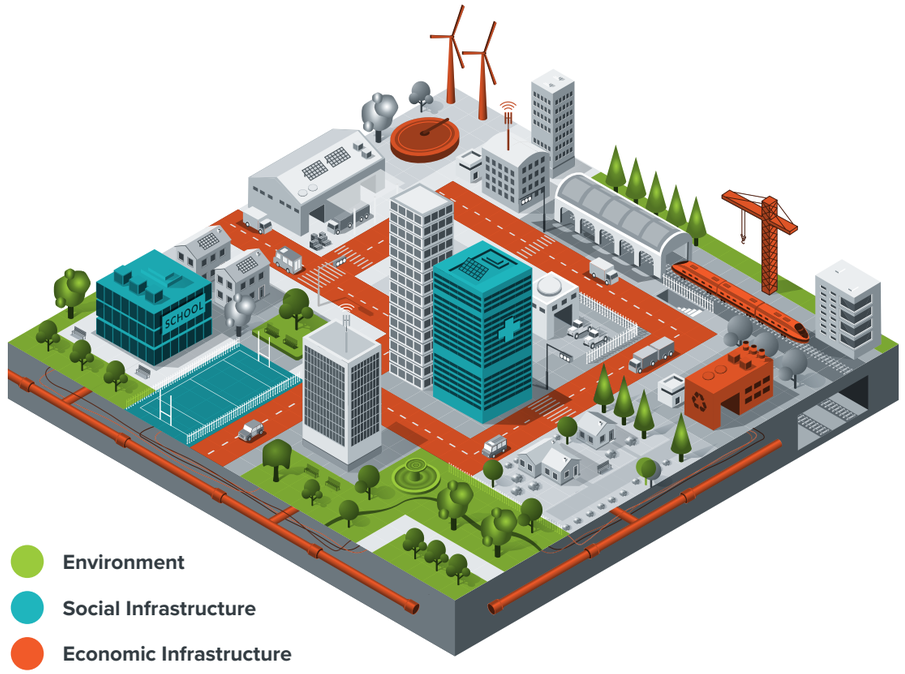
Looking south over Wellington City and CentrePort.

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's the common factor in all 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 ways and contributes to the wellbeing of all New Zealanders.

Figure 2: The infrastructure layers



Source: Te Waihanga, data from Schooling, Burgess, & Enzer (2020)

Infrastructure can be categorised in many 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 features that make it different from other goods and services.

These features relate to how infrastructure is made and how it's 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 help people to get to a hospital or to work more quickly.

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

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

Infrastructure is provided by both the public sector (central and local governments) and the private sector. This strategy speaks to all types of infrastructure, regardless of ownership. However, many of the recommendations in the strategy are targeted specifically at public infrastructure providers.

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

This strategy takes this more holistic view of the infrastructure system. It also has a longer-term horizon. A 30 year horizon requires us to think about trends such as technology advancements, our changing climate and population change, and the impacts these will have on infrastructure decision-making over the coming years and decades.

A longer-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 be needed to get the balance right between what we can afford, what we expect our infrastructure to provide and the impacts it will have 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.

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 Alert 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 governments.[3] Local government non-rates income, such as from council-controlled organisations, investments and dividends, were affected. In some cases, this resulted in reductions and deferrals in infrastructure spending.

Tourism patterns have changed dramatically and abruptly. The loss of international tourism has been estimated as having a significant drag on domestic output,[4] with impacts on the accommodation, hospitality, transport, education and retail sectors. Domestic tourism has proved to be an important shock absorber for a drop in global demand. Despite this, the aviation sector has been severely impacted, with government assistance necessary.[5]

COVID-19 has highlighted challenges with supply-chain resilience and infrastructure workforce capacity and capability.

COVID-19 is a stark reminder of the importance of reliable, safe and efficient supply chains. Global supply chain disruptions have been common, with widespread impacts on global shipping and air freight.[6] These have added to the cost of freight,[7] increasing lead times and lowering inventory levels. Many of these impacts are expected to continue for some time.[8] For many suppliers, traditional models of consumer shopping have been replaced with home delivery[9], while consumer demand has shifted from domestic services (such as eating out at restaurants) to durable goods, that require importing.[10]

COVID-19 has affected the supply of materials and labour needed to deliver infrastructure. As a result, construction prices have risen rapidly and project schedules have been pushed out due to supply chain and work site disruptions. New Zealand has experienced its highest level of construction price inflation since well before the Global Financial Crisis, but it is not the only country to experience these issues.[11]

Global supply-chains are more interdependent than ever. Raw materials and components may be shipped between countries multiple times to produce finished goods. By disrupting factory and port operations in many countries, COVID-19 has delayed shipments of goods, often leading to price increases for materials that are available and delays to projects while they wait on machinery and materials.

Availability of labour for infrastructure planning and delivery has also been challenging. New Zealand relies upon immigration to fill capacity and capability gaps, including specialist engineering and construction skills that are needed for complex projects. Restrictions on international travel during the COVID-19 pandemic has caused net migration to fall dramatically.[12] This has made it more difficult to complete projects and lift investment to address infrastructure challenges.

While these issues will be moderate in the medium-term, they highlight the importance of building resilient supply chains and ensuring that we are planning for future workforce capacity and capability needs.

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

This has been 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 in April 2020.[13] Many education providers were moved online, as were many employees, showing how telecommunications infrastructure can provide an important substitute for physical proximity.

COVID-19 has had significant implications for infrastructure across many sectors. It's impacted short-term patterns of infrastructure usage and there's considerable speculation about how patterns of land use may change and how we might use infrastructure differently in the future.[14,15] From an infrastructure perspective, it's a reminder of the importance of a resilient, flexible and agile system.

This strategy takes a longer-term perspective to complement shorter-term investment in recovery, focusing on how we can better support resilience to shocks of this kind in the future.

What we've heard and learnt

We've read, listened to and thought about a lot of information in developing this strategy.

We've 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've also learnt from:

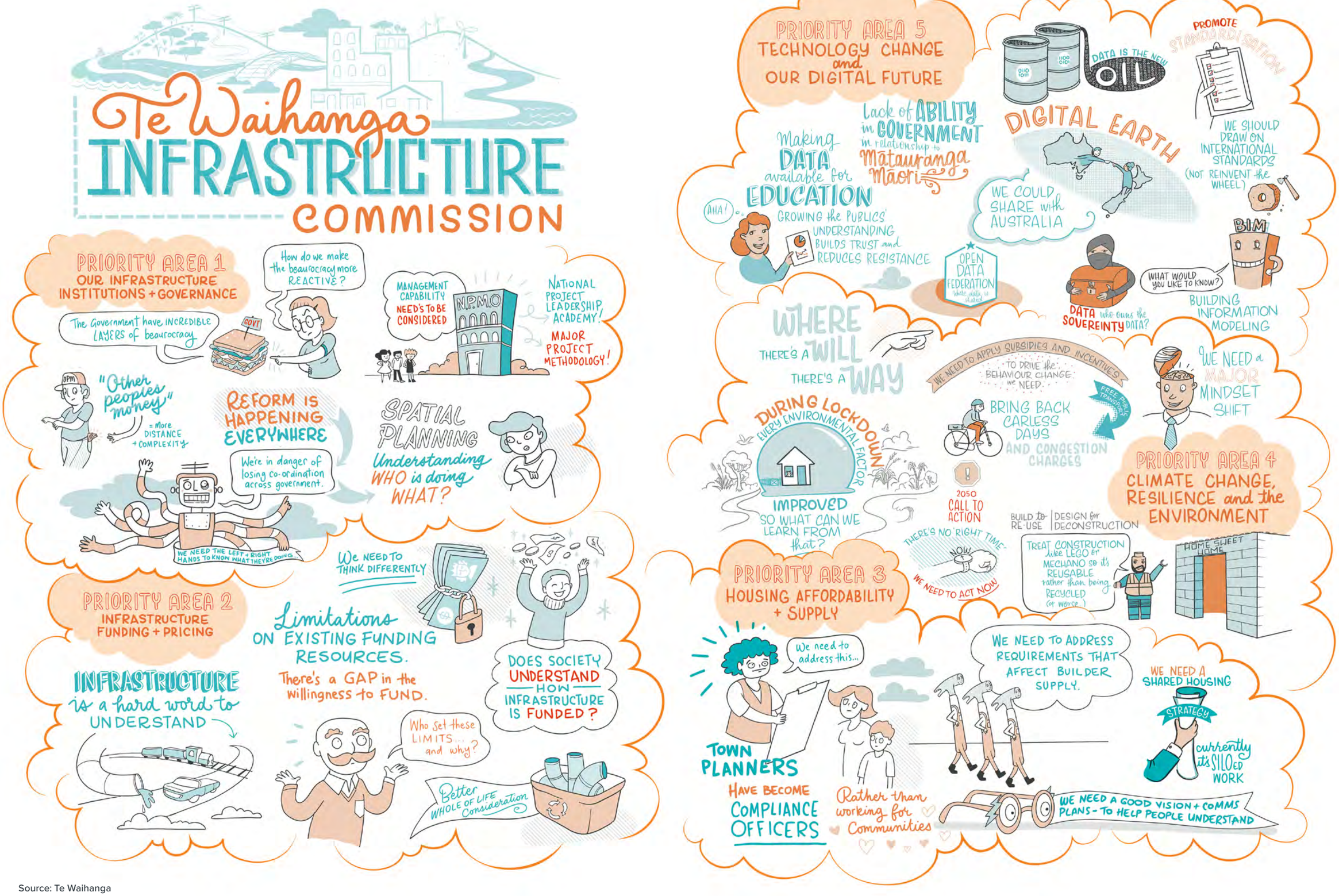
- 23,638 responses to and 8,500 comments on our Aotearoa 2050 survey.
- 721 submissions on Te Waihanga's consultation document, He Tūāpapa ki te Ora Infrastructure for a Better Future,[16] including 178 from organisations.
- 119 organisations that responded to our Infrastructure Asset Owners Survey.
- Four meetings with iwi, as well as the University of Waikato's Te Kotahi Research Institute.
- Nine stakeholder workshops.
- Workshops at Te Waihanga's symposium, Infrastructure 2021: Looking Ahead[17] (see Figure 3), and the 2020 Infrastructure New Zealand ReBuilding Nations conference.
- 80 stakeholder meetings.
- Te ao Māori testing panel.
- A local government reference group.

Our strategy and our recommendations draw on ideas from and work with all these sources. It also draws on the work of many institutions, organisations and academics from across our infrastructure system.

This is just the beginning.

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.

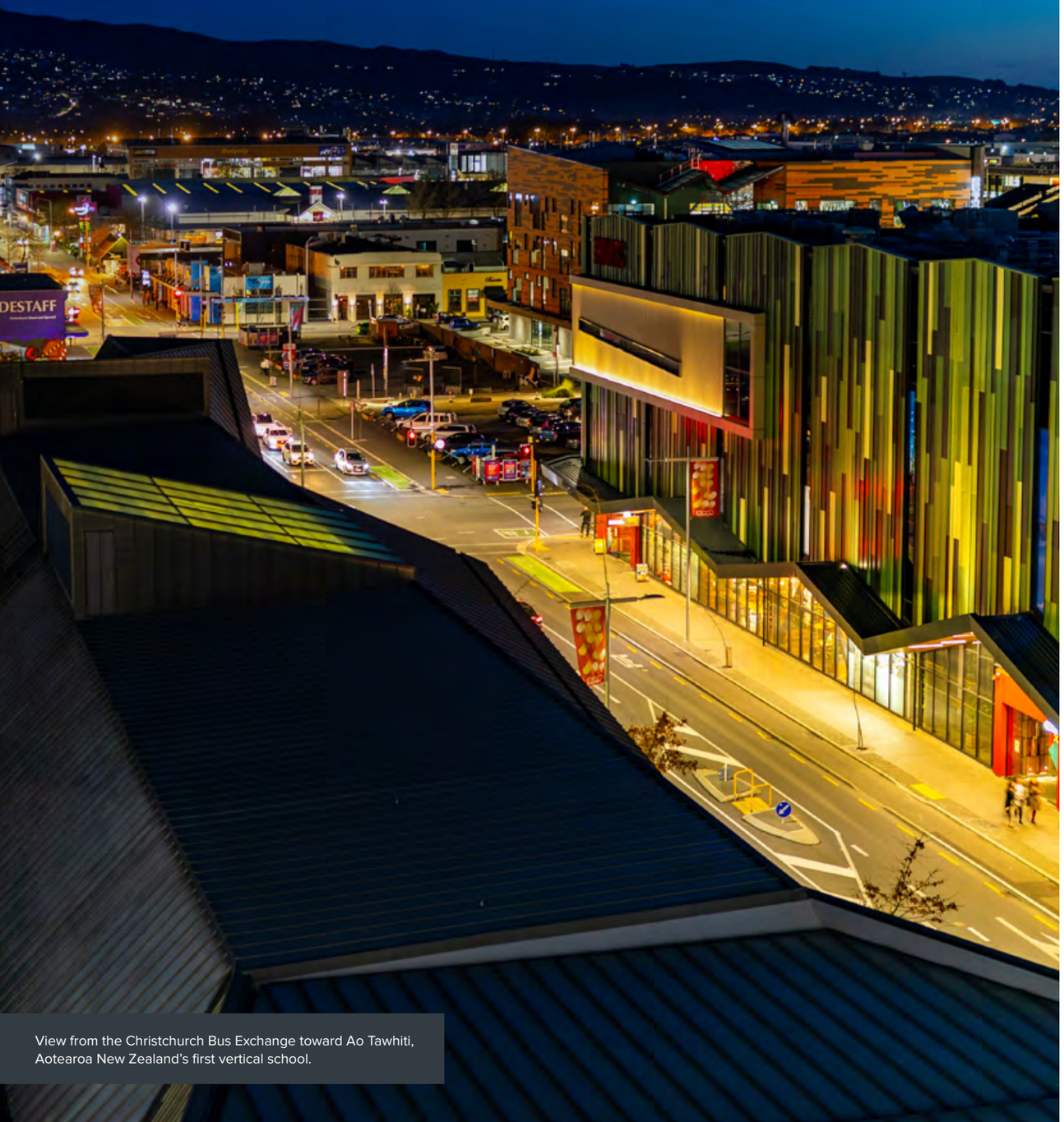
Figure 3: Bringing together the many ideas for infrastructure



Source: Te Waihanga

2 Vision for infrastructure

He tirohanga mō te hanganga



View from the Christchurch Bus Exchange toward Ao Tawhiti, Aotearoa New Zealand's first vertical school.

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 will help us to meet the challenges we'll face.

It looks at the role our infrastructure system has in our wellbeing, including its importance to our economy and our jobs. It 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.

The strategy also 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:

> "Ki te kahore he whakakitenga ka ngaro te iwi – without foresight or vision the people will be lost." – **Kingi Tāwhiao Pōtatau te Wherowhero**

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.

This strategy sets a path to a 2050 where infrastructure continues to support wellbeing. We have a strong economy, options for how we get around, clean energy and access to health and education as our population grows and moves, and as technology changes. We're resilient to shocks and stresses, including those that climate change brings. Infrastructure plays its part in supporting these and other goals, offering a foundation for a thriving New Zealand.

The koru below (Figure 4) contains the many ways in which we expect infrastructure to support New Zealand's people, places and businesses through to 2050.

Figure 4: How infrastructure supports New Zealand's people, places and businesses

Source: Te Waihanga

Guiding principles

We've 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.	• 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. • There is 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 infrastructure solutions. We collaborate and coordinate across organisations and regions to get the best result for New Zealanders. We set aspirations that focus on improving wellbeing and enabling people to thrive.	We aspire to: • A net-zero carbon economy. • 30-minute cities. • Universal access to 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 the potential of existing infrastructure. • Undertake rigorous cost-benefit analysis. • Integrate economic, social and environmental objectives. • Minimise waste and conserve resources. • Build and disseminate the evidence base. • Invest for resilience to shocks and stresses. • Identify opportunities to drive productivity growth.

3 Case for change
Hei tautoko i te panonitanga

Pedestrians crossing near the construction site of the Auckland City Rail Link.

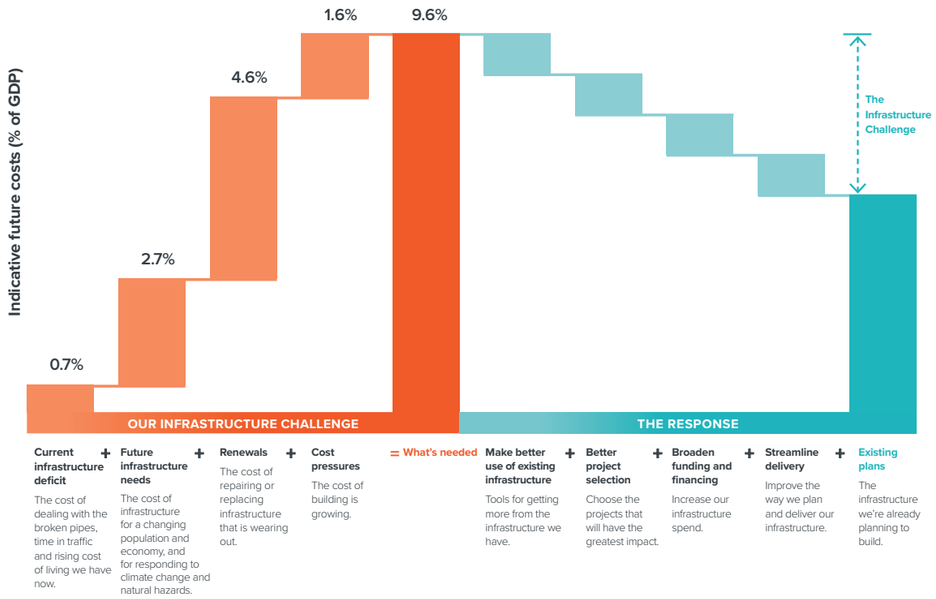
The challenge

New Zealand's infrastructure faces many challenges.

For example, long-term trends such as climate change will have significant impacts on many parts of our infrastructure system. Our population is increasing and changing, and this will affect the quantity and quality of the infrastructure we need. And construction costs have been increasing, placing 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 5 shows the areas where we'll 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 5: The challenge, the response



Source: Adapted from Sense Partners (2021)

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

At present, we spend around 5.5% of gross domestic product (GDP) on public infrastructure. This includes our transport, water, hospital, education and defence facilities and excludes privately provided infrastructure like electricity generation and telecommunications.[18] 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. This is equivalent to $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, which has lowered 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.

Demographic change and economic growth: New Zealand's infrastructure must evolve to serve a growing and changing population and economy. Our population is predicted to rise from 5 million to 6.2 million by 2048 (or 6.7 million under a high growth scenario), even after assuming that migration slows down.[19] The nature of work and the nature of our workforce will continue to evolve.[20] An ageing population and regional differences in growth rates will also affect infrastructure use. Responding to these trends will require new roads, improved public transport systems and water systems for growing cities, freight and port infrastructure for growing economic activity, and trade and telecommunications infrastructure to connect us to each other and to the rest of the world. We estimate that the infrastructure needed to support 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. Improved infrastructure is fundamental to achieving goals such as reducing carbon emissions, providing safe drinking water, lifting environmental quality and creating built environments that improve the wellbeing of all New Zealanders. 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'll 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, likely triggering an earthquake of magnitude 8 or higher.[21] 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 ongoing costs. For every $100 we spend on new infrastructure, around $60 must be spent on repairing and renewing 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 of building infrastructure has been rising more rapidly than costs in other sectors of the economy. It's currently difficult for the construction industry to hire the skilled people it needs to meet increasing demands. We face competition for labour from an infrastructure boom in Australia, where wages are considerably higher. Uncertainty about future investment plans can reduce productivity growth by discouraging companies from investing in skills and machinery. Cost and schedule overruns on one project can worsen this by increasing financing costs and delaying other projects in turn. Costs are also driven by the increasing complexity of our projects and slow, costly and bespoke consent processes. Unless we address these root causes, these trends mean we'll have to spend more to get the same results. We estimate that these cost pressures will add 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'll 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've identified four ways of achieving this:

- Make better use of infrastructure.
- Undertake better project selection.
- Broaden funding and financing options.
- Streamline delivery.

Make better use of infrastructure.

We need to make better 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 and design, which encourage people to use alternatives (such as public transport) or avoid using them at peak times.

This could mean improving bus services so there are fewer cars on our roads, using water metering to identify and fix leaks, or 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.

Undertake 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 always test 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 the private sector spend on infrastructure over the next 30 years. It will also mean using a broader range of funding and financing options, which could include:

- New funding tools.
- 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.

To create incentives to use both existing and new funding and financing tools to address our infrastructure challenges, we also have to consider the best structures for ownership and governance.

Funding represents all the money needed to pay for infrastructure. It comes from the community through users, taxpayers and 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 repay later.

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. Options for this include:

- Improving our infrastructure institutions and governance to provide greater coordination and increase resilience.
- Investing in early-stage planning, for example spatial planning (see Section 6.2.3) and corridor protection (see Section 6.3.3), to speed up the 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 processes.

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

All these responses are needed to solve the infrastructure challenge.

Each response can make a big difference to 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'll 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 programmes 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

Source: Te Waihanga

Infrastructure is about choices

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

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

When faced with options to manage congestion on an infrastructure network for instance, an operator may charge more at peak periods to spread the load across time and avoid the need for 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 electricity transmission, the scale of physical investment would need to be around 2-9% higher.[22] 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, streamlined delivery and funding and financing) and the service quality that communities will experience. If we select bad projects, the funding required to address our infrastructure challenges may be higher. If we deliver projects inefficiently or slowly and don't 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 the long-term challenges facing the New Zealand economy to improve the wellbeing and living standards of all New Zealanders. It names four economic priorities and eight key shifts that are needed to build a more productive, sustainable and inclusive economy.[23] This strategy overlaps and is consistent with the following core principles of the Economic Plan:

- **Grow and share New Zealand's prosperity more fairly:** This strategy highlights opportunities to grow the economy and recommends system-wide change to increase infrastructure productivity and improve access for all New Zealanders.
- **Transition to a clean, green, carbon-neutral New Zealand:** This 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 making the right infrastructure choices and minimising carbon emissions from building new infrastructure.
- **Support thriving and sustainable regions:** This 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 that will have big impacts on our infrastructure sectors.

These reviews and reforms will touch and affect most, if not all of New Zealand's infrastructure delivery in some way and are relevant to the implementation of this strategy. They're likely to affect the way infrastructure is consented, delivered, owned and governed.

Some of the key reforms are discussed below.

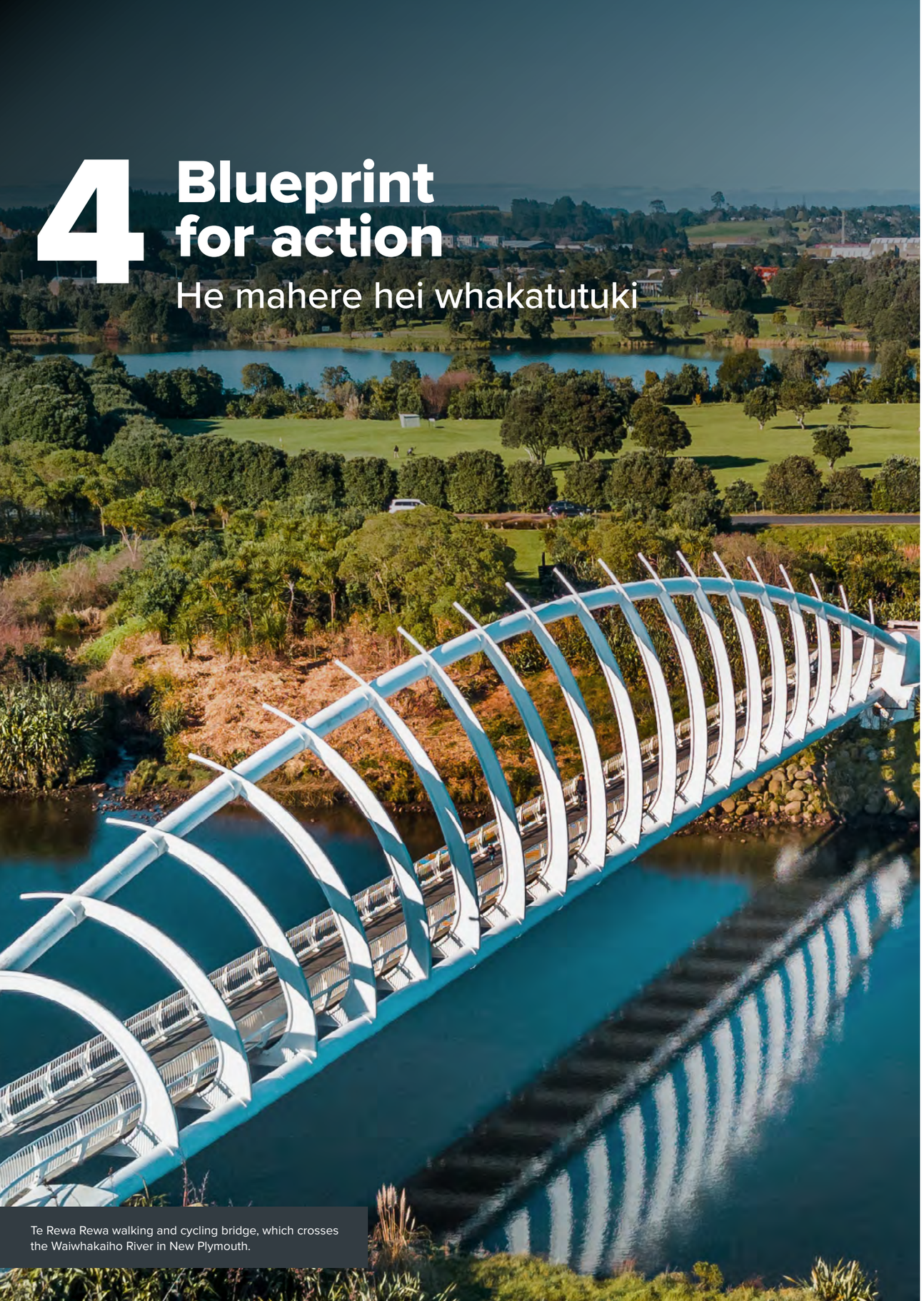
- **Resource management reform:** This major reform programme will change how infrastructure is planned, consented and delivered. It will for example, require regional spatial strategies, which will ensure a more integrated approach to land use and infrastructure planning.
- **Government Policy Statement on Housing and Urban Development:** This reform places a spotlight on increasing affordable housing supply, including through the Urban Growth Agenda and Urban Growth Partnerships.
- **Responses to climate change adaptation and mitigation:** Key reforms include an Emissions Reduction Plan and a National Adaptation Plan, which both have a major focus on infrastructure.
- **Three Waters Reform:** New Zealand's three waters infrastructure is worth around $64 billion.[24] This reform package proposes a major change to the ownership and governance arrangements for three waters and as a result, the way this core infrastructure is planned, delivered, maintained and operated.
- **Review into the Future for Local Government:** Local government is currently responsible for over $140 billion of assets and a wide range of services, including infrastructure provision. The local government review is looking at options for effective local governance, including functions and roles, taking into account the government's broader reforms.[25]
- **Health and disability sector reform:** The health sector oversees approximately $24 billion of assets and is currently undergoing a major structural reform, with the 20 district health boards being amalgamated into a new national entity, Health New Zealand, operating from four regional offices. The reform envisions changes to health service delivery. For example, some health services may be provided closer to where people live using digital technology and distributed services. This will encourage the use of smaller and repurposed buildings in the future, rather than big campus developments.
- **Emergency management reform:** A broad, multi-year work programme of reform is underway to deliver extensive change to New Zealand's emergency management system. This includes a review of the existing legislation under the National Emergency Management Agency's Regulatory Framework Review Programme (also known as the 'Trifecta Programme'). Changes proposed include enhancing the roles and responsibilities of those agencies covered by emergency management legislation. Work undertaken within the Trifecta Programme will align with the National Adaptation Plan and the National Disaster Resilience Strategy.
- **Development of fit-for-purpose energy and digital strategies:** The government is developing a number of strategies as part of preparations for a net-zero carbon emissions New Zealand by 2050, as well as other challenges and opportunities New Zealand will face in the next 30 years (including a Digital Strategy for Aotearoa).
- **Supply chain strategy review:** Workstreams are investigating new approaches to cooperation, regulation and investment to strengthen New Zealand's supply chain. The main drivers for change are decarbonisation, resilience to threats and events, productivity and innovation, and wellbeing.
- **Waste sector legislation and strategy review:** This includes enabling a reduction of waste through a programme of targeted waste levies, end-of-life solutions for certain products, the phase-out of particular plastics, reducing construction and demolition waste and improving compliance, monitoring and enforcement. This matters to infrastructure because it will impact the future need for landfills.
- **Air navigation system review:** Work is underway on a broad, first principles review focusing on settings in three key areas of the air navigation system; policy & regulatory, institutional and funding.
- **Future of the transport revenue system review:** This is a first principles review of the current land transport revenue system to ensure it is fit for purpose and can meet future requirements.

Other government reforms and work programmes are noted in the relevant parts of this strategy. The strategy acknowledges and looks to build on the many reforms that are underway. It also recommends further government reforms and actions in several areas.

The impacts of these reforms on infrastructure are still evolving, but a key challenge will be ensuring they're 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



Te Rewa Rewa walking and cycling bridge, which crosses the Waiwhakaiho River in New Plymouth.

This strategy sets a course for significant transformation across New Zealand. As our demographics, technology and climate are changing, our approach to infrastructure will also need to change. To achieve our ambition for New Zealand to thrive, the strategy's blueprint for action (Figure 6) sets **five strategic objectives**. We envision a New Zealand that's responding to the challenge of net-zero carbon emissions, where our cities and regions are attractive, inclusive and flourishing, our infrastructure is resilient to shocks and stresses and we're moving towards a circular economy.

We also propose **five cross-cutting themes** to lift the performance of our infrastructure system. New Zealand requires a different approach to managing its resources, including the way we make decisions and the capital, labour and technologies we use. We aspire to best practice, providing stewardship for the resources we have and investing in outcomes that are fair and recognise all New Zealanders. In making the transition, we recognise and respect Te Tiriti o Waitangi and look for opportunities to build strong, meaningful and enduring relationships with Māori. There's much at stake. If we get it right, we'll have the ingredients for a productive, sustainable and globally integrated economy, where New Zealanders are healthy, have access to opportunities and are able to protect the environment for future generations.

Figure 6: Blueprint for action

Our Context

People | Technology | Climate

Our Vision	Te Ao Māori
Infrastructure lays a foundation for the people, places and businesses of Aotearoa New Zealand to thrive for generations.	Partnerships and opportunities

Our Principles

Equitable | Aspirational | Efficient

What	How	Why
Objectives	Performance	Results
• Enabling a net-zero carbon emissions Aotearoa • Supporting towns and regions to flourish • Building attractive and inclusive cities • Moving to a circular economy • Strengthening resilience to shocks and stresses	• Better decision-making • Improving funding and financing • Accelerating technology use • Building workforce capacity and capability • An enabling planning and consenting framework	• A productive, sustainable and carbon-neutral economy • Affordable, accessible and healthy housing • Reliable, affordable and accessible travel options • 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 stresses and shocks

Source: Te Waihanga

5 Strengthening partnerships with and opportunities for Māori

Te whakapakari i ngā pātuitanga me ngā āheinga mō ngāi Māori

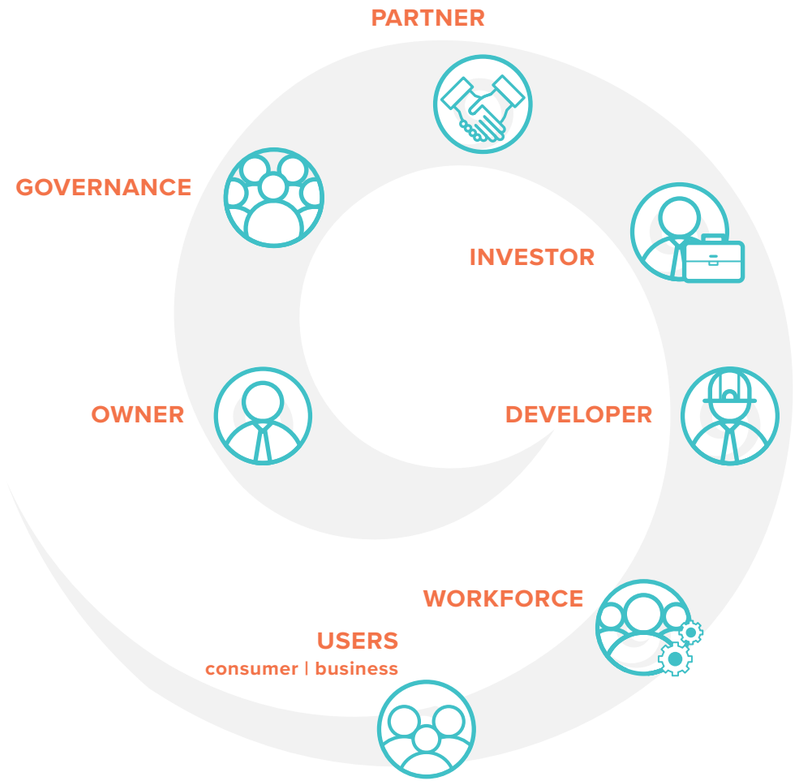
Children playing in Te Oro, the Glenn Innes Community Centre. The name 'Te Oro' has been gifted to the centre by Ngāti Pāoa with the endorsement of Ngāi Tai ki Tāmaki and Ngāti Whātua Ōrākei.

We recognise and respect Te Tiriti o Waitangi. Building strong, meaningful and enduring relationships with Māori is one of the foundations to 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 to run their businesses and provide opportunities for entrepreneurship. Māori are also investors, developers, partners, governors and owners (see Figure 7). For example, Te Ōhanga Māori (the Māori economy), is growing. It accounted for $17 billion in production GDP (6.5%) in 2018.[26] Māori are also involved in building infrastructure, with 12% of the Māori workforce employed in the construction sector.[27]

Figure 7: The many roles of Māori in our infrastructure system



Source: Te Waihanga

In these different roles, Māori bring a depth of knowledge, experience and values that can expand the knowledge base of all infrastructure providers. Building mutually empowering relationships with Māori will enrich the knowledge of the entire sector and unlock opportunities for Māori.

A strategic approach is needed to build mutually empowering relationships.

These mutually empowering relationships must be based on agreed values and principles. We've drawn on those established in Te Ara Kotahi (the Waka Kotahi Māori Strategy)[28] as the basis for a proposed approach (see Table 2).

Table 2: Te Ara Kotahi (the Waka Kotahi 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 o 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, 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.

Source: Adapted from Waka Kotahi (2020)

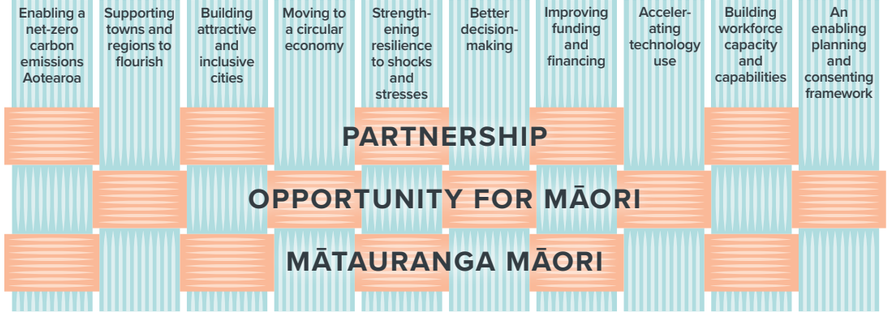
Three areas for action: partnerships, unlocking opportunities and incorporating mātauranga Māori.

Drawing on the Waka Kotahi framework, we've prioritised three areas for action:

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

These weave into all aspects of this strategy (see Figure 8).

Figure 8: Weaving Māori objectives into 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 infrastructure projects 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.

Partnership principles approved by the government provide the following guidance.[29]

- Build the relationship before focusing on the work.
- Plan together from the start.
- Value each party's contribution and knowledge.
- Ensure outcomes are meaningful to all parties.
- Be open, be flexible and accept risk.
- Share decision-making.

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. The development of a framework for building stronger partnerships during infrastructure planning and delivery is an important step in this process. The framework must be based on tikanga Māori, recognise that different partnership models will be appropriate for different types of infrastructure and must be consistent with an all-of-government approach. The development of this framework would be guided by a joint advisory group. This would need to be developed in a way that's consistent with other government partnership approaches currently being considered under various policy reforms.

We must provide the time and resources for partnerships, as well as proactive, clear and timely dialogue on the direction of infrastructure investment. Many iwi suffer from intense demands on their time, which is often given voluntarily, as they're 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 vary in their understanding of engagement with Māori and their capabilities to do so. For these reasons it will be important to build the capacity and capabilities for a successful partnering approach throughout the infrastructure system, as well as within iwi. It needs to be built in a way that's sustainable and enduring. This work has started with the development of the Māori Crown Relations Capability Framework.[30]

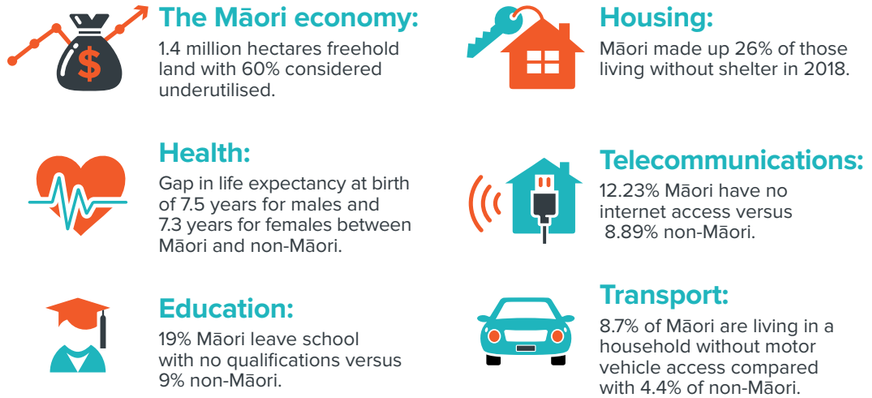
Unlocking opportunities for Māori.

Infrastructure can have a major impact on wellbeing, whether it's providing access to hospitals and schools, powering our workplaces or creating jobs in construction. However, we know that the outcomes for Māori in many of our infrastructure sectors are poor (see Figure 9) and that it's important to identify opportunities where infrastructure can have a role in improving Māori wellbeing. These opportunities include:

- Caring for the environment and supporting Māori to exercise kaitiakitanga (environmental stewardship/guardianship).
- Promoting employment opportunities[31,32] (see Section 7.5).
- Improving diversity across the infrastructure workforce (see Section 7.5).
- Enhancing social wellbeing through access to infrastructure services. For example, through telecommunication and internet services that improve connectivity in places where 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 Section 6.2).
- Identifying ways the infrastructure system can support an equitable transition for Māori, for example in the transition to clean energy required to deliver net-zero carbon emissions and informing a fair transition (see Section 6.1).
- Using procurement as a mechanism to unlock opportunities for Māori. For example, in 2020 the government announced that it would require mandated agencies to ensure that at least 5% of relevant contracts are awarded to Māori.
- Recognising and respecting Māori rangatiratanga while supporting iwi aspirations, plans and goals.

Figure 9: Māori outcomes can be improved across our key infrastructure sectors



Source: Climate Change Commission (2021), Statistics New Zealand (2021), Digital Public Service (2020), Tokona Te Raki Māori Futures Collective (2019), Ministry of Health (2019)

Incorporating mātauranga 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). Building a strong evidence base of what works will support better strategy, planning and project delivery across the system.

CASE STUDY 1

Engineering Cadet Emily Kang at the Parahaki Bridge site.

Te Ahu a Turanga: Manawatū Tararua Highway[33]

A major slip in April 2017 left State Highway 3 through Manawatū Gorge impassable. A new four-lane highway with shared use path is being built over the Ruahine Range, to provide a safe, resilient and efficient route between Woodville and Ashhurst. The project value is around $620 million.

In an historic 'first', Waka Kotahi have partnered with local iwi to form Te Ahu a Turanga Alliance. Iwi partners include Rangitāne o Manawatū, Rangitāne o Tamaki nui-a-Rua, Ngāti Kahungunu ki Tāmaki nui-a-Rua, Ngāti Raukawa ki te Tonga and Ngāti Kauwhata. This special partnership sets the project apart and has been seen as an approach to be replicated on future infrastructure projects.

Soon after the slip in 2017, Waka Kotahi sought to involve iwi in the project. The offer of partnership was extended and relationships were built with collaboration and time. Today, iwi partners are represented throughout the project: on the Alliance Board, an iwi specific forum (Iwi Working Group), at senior management (through the appointment of a Kaiārahi, Kaikōkiri and Kaihāpai), at the operational level with Kaimahi working on the design of the project and how it is constructed, and Kaitiaki working within the construction team.

Relationships have been respected and nurtured, with senior management within Waka Kotahi taking responsibility for championing the project and maintaining consistent contact with iwi to enable trusting relationships to be built. As the project has proceeded, the mutual value of these partnerships for the natural environment, the people and the project has been recognised.

- As partners, iwi made submissions on the Notice of Requirement for the highway alongside Waka Kotahi and helped develop the consent application, including several key management plans.
- Each iwi was 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 and have taken responsibility for cultural monitoring of all project works.
- The mauri of the Project has been strengthened through the application of project values founded in Mātauranga Māori, including initiatives based on the Te Whare Tapa Whā model of wellbeing and Whānau Ora.

While there'll inevitably be areas for improvement, the project is achieving positive outcomes for iwi that include:

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

Recommendations

No.	What	How	Who
1	**Strengthen partnerships with Māori across the infrastructure system of Aotearoa New Zealand** CEM 2022-2031	a. Undertake a 'State of Play' of current Māori engagement activity for infrastructure to help inform and educate readers on how infrastructure providers can engage and work with Māori in a way that works for Māori and infrastructure providers. b. Identify a lead government agency that will establish a Māori advisory group to develop a framework for strengthening partnerships with Māori in infrastructure planning and delivery. The framework should be based on Te Tiriti o Waitangi and tikanga Māori and consistent with an all-of-government approach. The advisory group should also consider the evolving role of Māori in the infrastructure system and options for ongoing governance and oversight of the framework.	Iwi, Te Waihanga, Te Arawhiti, Central Government, Local Government, Sector
2	**Develop capabilities and capacity across the infrastructure system for effective partnerships with Māori** CEM 2022-2031	Put in place a programme to develop capabilities and capacity for effective partnership that should: a. Build specialist Māori infrastructure capabilities at the centre of government that can support agencies and Māori. b. Consolidate and enhance specific funding for the 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 for iwi organisations. d. Leverage procurement opportunities for Māori across infrastructure policy, planning, delivery, maintenance and research.	Iwi, Te Waihanga, Te Arawhiti, Central Government, Local Government, Sector
3	**Strengthen the Māori infrastructure evidence base** CEM 2022-2050	A collaborative 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 Māori infrastructure 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 a 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 hapū).	Iwi, Te Waihanga, Te Arawhiti, Central Government, Local Government

Refer to Section 10 | Time

Pou Tū Te Rangi at Britomart, Auckland, by Chris Bailey. Pouwhenua, carved wooden posts, mark territorial boundaries or places of significance.

6 A thriving New Zealand: what we need to do

Aotearoa ora rawa atu: Me aha tātou

Cyclists on the Ōmarukaikuru/Point Jerningham cycleway in Wellington.

Planning for a 30-year infrastructure horizon requires an understanding of major long-term trends. In developing this strategy, we've 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.[34]

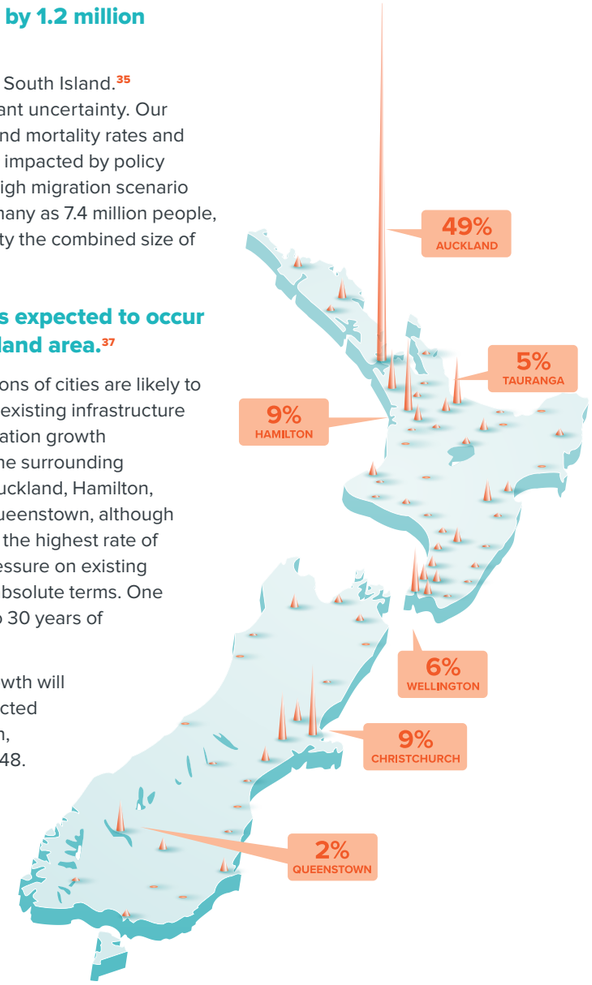
That's equivalent to the population of the South Island.[35] Like any projection, it comes with significant uncertainty. Our population will be determined by fertility and mortality rates and migration. The population size can also be impacted by policy settings and global events. Under a very high migration scenario for instance, New Zealand could have as many as 7.4 million people, an increase roughly equivalent to a new city the combined size of Auckland, Wellington and Christchurch.[36]

Two-thirds of population growth is expected to occur in less than 3% of New Zealand's land area.[37]

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 10): 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's modest in absolute terms. One year of growth in Auckland is equivalent to 30 years of projected growth in Queenstown.

In absolute terms, the 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 by 2048. Under a high-growth scenario, Auckland could grow by as many as 969,000 people by 2048.

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.



The growth of cities and the dominance of Auckland

Figure 10: Distribution of all population growth 2018 to 2048, by territorial authority

Source: Te Waihanga, data from Statistics New Zealand (2021)

> "Of New Zealand's 67 territorial authorities, starting about now and continuing through the 2020's and 2030's, 56 will experience population stagnation or decline"
> **– Dr Paul Spoonley**[38]

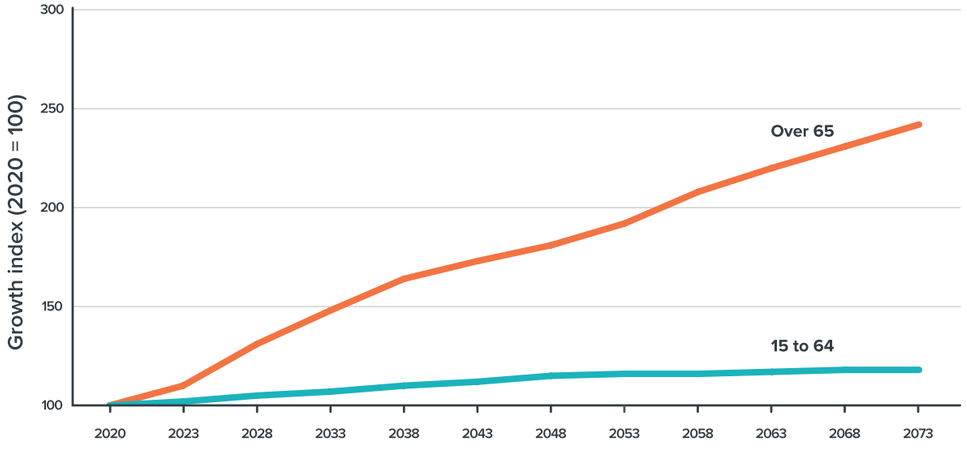
New Zealand's population is generally ageing.

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 have risen to 47. Driven by longer life expectancy and fewer children, the ageing of New Zealand's population will affect the infrastructure we need and where it will be 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 is expected to more than double, while the number of people under 15 years is expected to decline. For every person aged over 65, there'll be only 2.1 people aged 15 to 64 in 2073, compared to 4.2 people today (see Figure 11). We can, therefore, expect the proportion of the population earning an income to reduce.[39] This will affect both our ability to pay for infrastructure through income taxes and the capacity of our workforce to build and maintain infrastructure in the future. We may also see change in the types of infrastructure that are needed, with less infrastructure required for children and more infrastructure required to support an ageing population.

New Zealand's population is ageing

Figure 11: Rate of population growth for the working age population 2020 to 2073



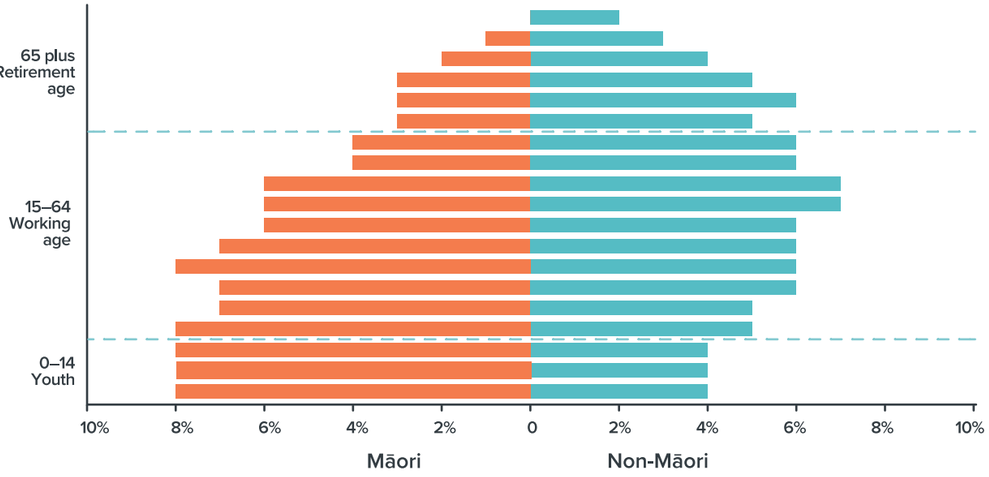
Source: Te Waihanga, data from Statistics New Zealand (2021)

The Māori population is younger and growing faster than the general population.

National demographic trends aren't the same across all groups and ethnicities and this will have a range of infrastructure implications. Māori have different demographics to New Zealanders as a whole. Māori are younger and the rate of growth of their working age population is significantly faster than it is in other groups. This will for example, change workforce composition over time. The median age for Māori is 24, compared to 41 for New Zealand European/Pākehā (see Figure 12). 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.[40]

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

Figure 12: Māori and non-Māori by age cohort, 2043



Source: Te Waihanga, data from Statistics New Zealand (2021)

Our population is becoming more ethnically diverse.

Between the 2013 and 2018 censuses, the number of Māori, Asian and Pacific people rose as a proportion of the usually resident population.[41] These trends are expected to continue, with the Asian ethnic groups projected to reach 1.2-1.4 million in 2038, and the Pacific ethnic group expected to rise to 530,000 to 650,000.[42]

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

Climate change is already impacting on our weather. Our rainfall patterns are changing, weather events are getting more extreme and our sea levels are rising.[43] Global temperatures and carbon emissions are rising dramatically (see Figure 13).

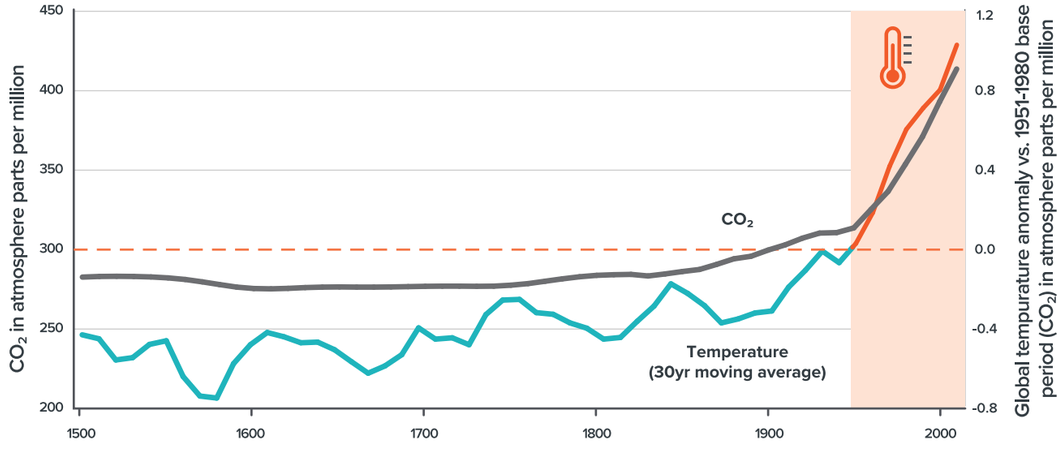
Infrastructure will be impacted by climate change through both mitigation (actions to limit global warming and its related effects) and adaptation (the process of adjusting to current or expected climate change and its effects).

To limit our impacts on global warming, it's essential that we invest in infrastructure to achieve the 2050 target of net-zero carbon emissions. Similarly, we need to change the materials that are used in order to minimise the emissions arising from the building of infrastructure (embodied carbon) 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'll 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 13: Atmospheric CO2 (parts per million) and global temperature anomaly 1500 to 2020



Source: Adapted from The 2 Degrees Institute (2022)

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

It's 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, which are virtual, real-time models of infrastructure, have the potential to transform our thinking on how infrastructure sectors work together as a single system (see Figure 14). There's 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.

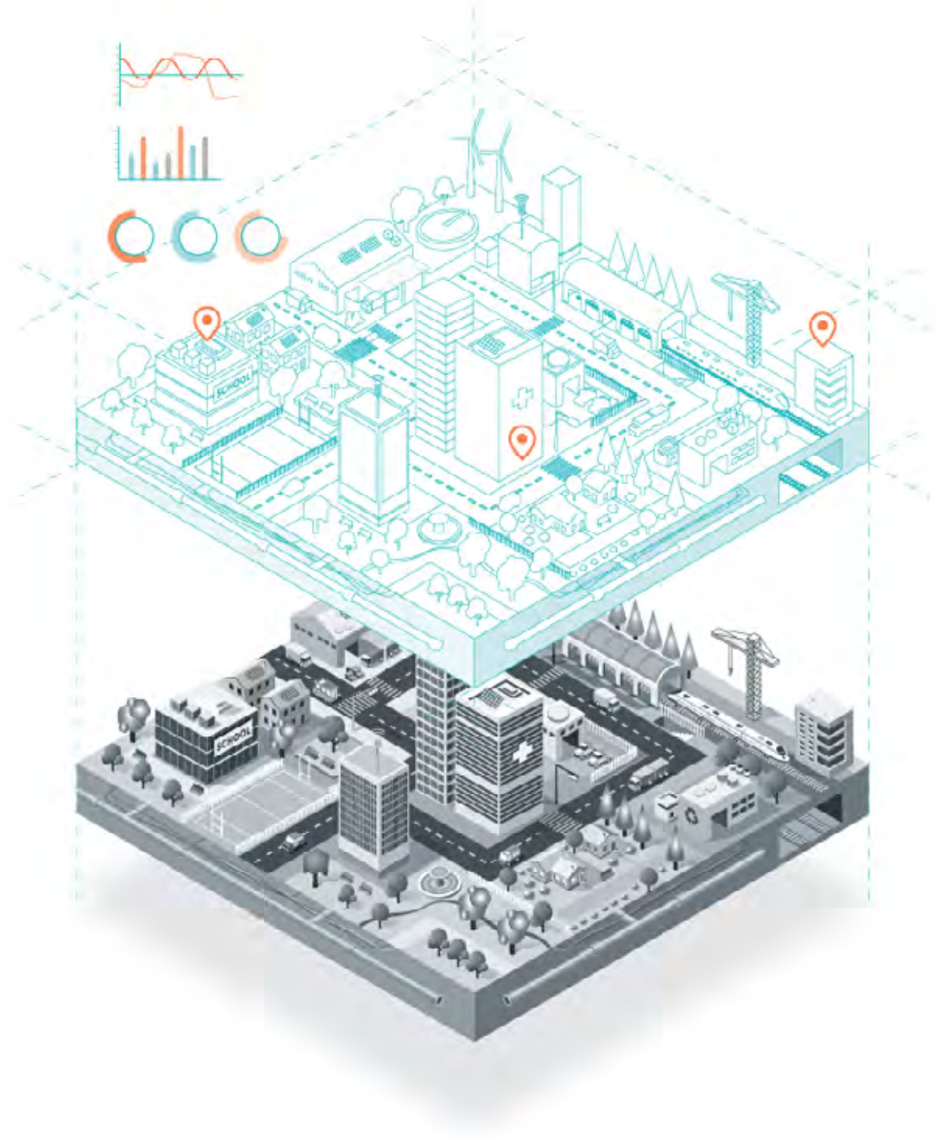


Figure 14: Digital twins are virtual, real-time models of infrastructure

Source: Te Waihanga, data from Schooling, Burgess, & Enzer (2020)[44]

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, we will exceed at least 1.5°C of warming this century.[45] New Zealand is committed to doing its part to help prevent this. The Climate Change Response Act 2002 was amended in 2019 to set three targets: net-zero carbon emissions by 2050, and biogenic methane emissions reduced below 2017 levels by 10% by 2030 and by 27 to 47% by 2050. These are challenging targets that require 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[46]**

To meet our 2050 emissions targets, the Minister for Climate Change will set emissions budgets that will act as stepping stones to our long-term targets and emissions reduction plans that will set policies and strategies for meeting the budgets. Emissions reduction plans will include sector-specific emissions reduction plans and ways to mitigate the impacts that reducing emissions will have on people.

Achieving the above targets will also require industry and consumers to shift to new technologies like electric vehicles. We're in a fortunate position. Our hydro, wind and geothermal power stations already provide considerable low-emission electricity. We have abundant potential sources of 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'll need to reduce or manage the emissions we produce when we build and operate our infrastructure. The decisions we make about investing in infrastructure today need to consider properly 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

Decarbonising the transport sector will be a significant challenge.

Transport makes up 38% of New Zealand's non-agricultural emissions, with most of these emissions arising from fossil fuels used to power vehicles.[47] Emissions from domestic transport have continued to rise in recent times. Biofuels, hydrogen and electrifying the transport system are likely to drive the decarbonisation of the transport sector, alongside increased levels of walking and cycling, mass public transport and mode-shift to reduce the carbon impacts of the domestic freight network. Emissions will still arise though, when the transport infrastructure and vehicles are built, although some of those emissions occur overseas and are not attributed to New Zealand.

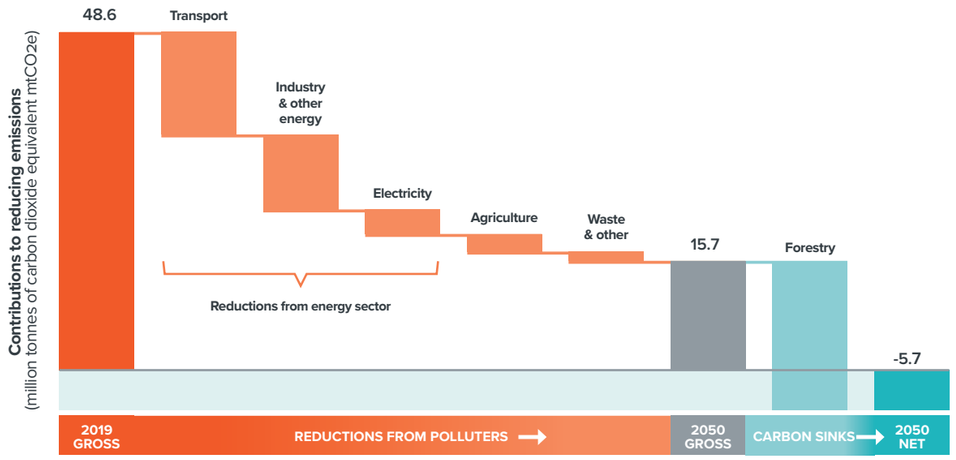
Non-built solutions need to be considered, such as congestion charging to smooth traffic peaks. Local government must also encourage a greater use of public transport by making better use of existing urban space and increasing housing density in areas close to employment and other amenities. These mechanisms are only viable where options for public transport, walking and cycling exist. These issues are discussed further in Section 6.3, which focuses on building attractive and inclusive cities.

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 15.[48]

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

Figure 15: Contributions to reducing emissions (million tonnes of carbon dioxide equivalent)



Source: Te Waihanga, data from Climate Change Commission (2021)

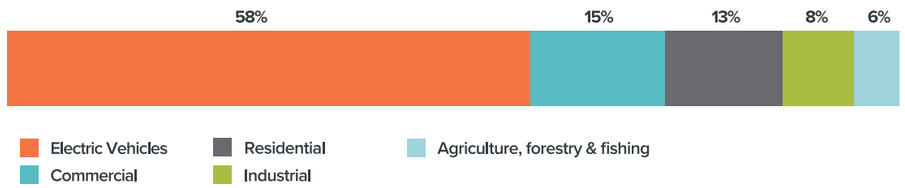
We'll need to dramatically alter our energy sources and remove carbon emissions where possible. Currently, only 30% of the energy we consume is from low-emission sources.[49] This will need to increase to 86% by 2050.[50] Most of this is likely to come from a greater use of biomass and clean electricity like wind and solar.[51] Clean electricity will likely be used to produce hydrogen to fuel heavy vehicles and to power the heating used in industrial processes (high-temperature process heat). Biofuels are also likely to be used directly to fuel heavy vehicles and medium-temperature process heat. Capturing and storing carbon emissions from using gas and coal may be another option if the technology becomes cost effective. Over the next 30 years our existing gas and petroleum infrastructure will need to be re-purposed to support these alternative energies.[52]

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

The percentage of electric vehicles in our light-vehicle passenger fleet is projected to grow from less than 1% to 93% by 2050.[53,54] They're expected to account for more than half of the additional electricity we're going to need by 2050 (see Figure 16).[55]

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

Figure 16: Contribution to increased demand for electricity in 2050



Source: Te Waihanga, data from Climate Change Commission (2021)

Over the next 30 years we'll need to build significantly more low-emissions electricity generation.

This is needed to cater for our growing population, the greater use of electric vehicles, agricultural activities that require electricity and process heat.[56,57] Most of this low-emissions electricity will come from new solar and wind generation and with this come some challenges:

- We'll need to prepare for times when quantities of 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.[58]
- As our economy becomes increasingly reliant on electricity, we'll 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.[59]

The electricity sector will still produce carbon emissions in 2050.

The operation of geothermal generation isn't 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.[60] 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'll need to explore options for offsetting these, such as by planting more trees and buying emission units from offshore.[61]

6.1.2. What we've 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 and electricity, weren't useful because of the Emissions Trading Scheme (ETS). If we do want to set targets for individual sectors, the submitters suggested the '100% renewable electricity by 2030' target should be replaced with a broader renewable energy target.

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 a 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 grow our clean electricity generation significantly 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 the 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.[62]

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 renewable energy zones to homes and businesses. In most cases regulated or contracted revenue will be sufficient to cover Transpower's and the distributor's costs. When this isn't the case, innovative funding, financing or indemnity arrangements may be needed to strike a better balance between maintaining incentives for investors to make careful choices and reducing barriers to grid and network expansion. Similar arrangements may also be needed for other situations (outside of renewable energy zones) where Transpower or distributors may need to incur significant costs to provision for projected demand increases due to electrification of industry and transport.

Offshore wind farms: It's currently cheaper to develop wind farms on land than offshore. However, it's expected that offshore wind farms will be developed when technology improves and costs decrease. With this will come a need to balance their role in generating electricity with their impacts on the environment, as well as the importance of our coast to our economy, lifestyles and cultural values. Currently, we don't 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.[63]

> "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 Ministry of Business Innovation and Employment Accelerating Electrification consultation.[64]**

Distributed energy resources: Our regulations should help with the uptake of low-emission distributed energy resources, which are smaller devices for generating or storing power, such as rooftop solar panels, wind turbines, batteries and demand management systems.[65] Transpower estimates that solar panels that are connected to local networks will provide about 9.1% of total electricity supply by 2050.[66] 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 distributed energy resources to local distribution networks 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 these networks and more of these types of arrangements may be enough to manage the complexities they'll face in the future.

We need to invest more in clean electricity.

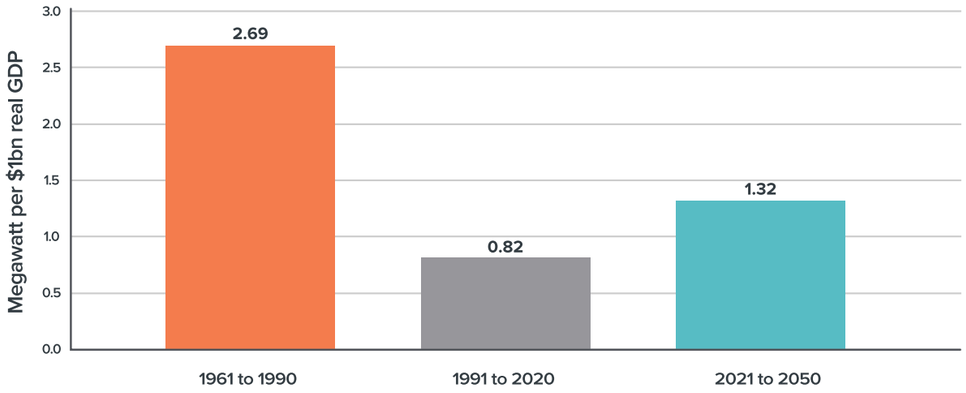
Our growing population and the need to phase out fossil fuels means we'll need to increase the amount of electricity we generate each year by up to 70% by 2050.[67,68] New Zealand is fortunate to be embarking on this journey with an electricity system that in the past five years has generated 82% from low-emission sources. This will increase over the next five years.[69]

> "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[70]**

Experience shows this is achievable. Relative to the size of our economy, we built at a faster pace between 1960 and 1990 than we'll need to over the next 30 years (see Figure 17). We now have better construction technology and wind and solar farms should be easier to build than the hydro dams we've built in the past. These newer technologies also have lower impacts on the environment than our hydro dams. Already, four new players have announced plans for large-scale solar farms in New Zealand and several others have expressed interest in building large-scale offshore wind farms.[71,72,73,74,75]

The scale of energy infrastructure needed to meet net-zero carbon emissions has been done before.

Figure 17: Historical and projected growth in electricity generation capacity, relative to GDP



Source: Te Waihanga, data from Electricity Authority (2018)

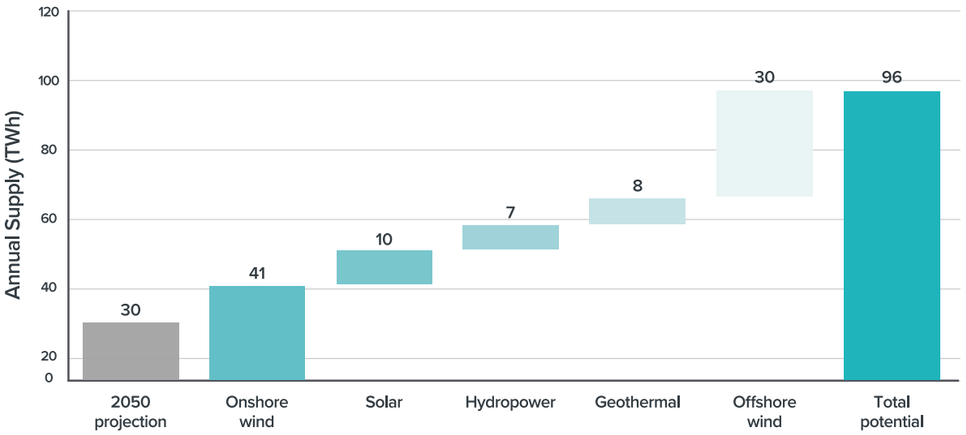
There will be challenges not faced in the 1960s, such as more stringent regulatory barriers to development. We also need to address the perennial challenge of 'dry year' risk.

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'll need to be generating an extra 30 terawatt-hours (TWh) of electricity a year (see Figure 18).[76,77] But we have enough natural, clean resources like wind, solar, geothermal and hydro 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 35 TWh, enough to supply about seven aluminium smelters of the same size as the Tīwai Point smelter. The surplus could be used to grow energy-intensive activities, with some of them better suited than others to achieving acceptable levels of energy security for households and other consumers. These potentially include hyperscale data centres[78] and the production of hydrogen or ammonia.[79] 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 18: Potentially viable low-emissions energy resources



Source: Te Waihanga, data from Climate Change Commission (2021), Ministry of Business, Innovation and Employment (2020)

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 ETS prices and the gap between our actual emissions and our international climate commitments.[80] 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. The Government has work underway to address these issues.

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 they would 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-emissions 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).[81] 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.[82]

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

We can support partnerships with and unlock opportunities 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 land. 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 and in carbon capture and fossil-gas storage. Additional geothermal and hydro generation and storage, such as the proposed Lake Onslow pumped hydro storage scheme, are other possible areas for Māori investment.

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 scored highly in energy equity against 128 other countries surveyed by the World Energy Council.[83] 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.[84] Petrol and gas prices are expected to increase significantly over the next 30 years[85] and the daily fixed charge for electricity is estimated to increase by more than 200% by 2050.[86] These increases would disproportionately affect low income New Zealanders and those who can't reduce significantly their use of petrol and diesel for transport and gas for cooking and heating.[87]

Additional government support will be needed for those most disadvantaged. Some government initiatives are underway, such as programmes that offer low-income households education on how they can reduce their energy costs and a trial of renewable energy technologies for social and Māori housing.[88,89] The government may need to offer support to some people to pay the upfront costs of 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. This would come under its Just Transitions programme of work.

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 costs 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 replace petrol and diesel vehicles quickly with electric and hydrogen ones. When the cost of repurposing or replacing infrastructure is prohibitive, the investment is said to be 'irreversible'.[90,91] Irreversible investment decisions need to include the cost of carbon over the life of the infrastructure, as highlighted in Case Study 3. Getting the price right is fundamental to driving infrastructure decisions that support a low-carbon economy. In February 2022, the New Zealand ETS spot price reached $82.50 per tonne of carbon dioxide equivalent.[92] ETS prices may need to be as high as $232 per tonne by 2050 to drive decisions that hold global warming at less than 2°C.[93] The Climate Change Commission has recommended changes to the trigger prices in the ETS that would enable it to reach these levels by 2050.[94]

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 that emission prices produced by the scheme aren't appropriate for decisions that lock in carbon emissions.[95] Since 2009, the UK has used carbon values to assess policy proposals. These values are based on estimates of the costs 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 per tonne for 2021 and an intention to increase it to £378 per tonne by 2050.[96] Converted to New Zealand dollars, these are equivalent to NZD$475 per tonne and NZD$733 per tonne respectively.[97]

Both central and local government make decisions about investing in infrastructure based on business cases. These business cases should incorporate the expected future carbon-abatement costs, rather than current ETS prices, to inform better decision-making on which projects are worth investment. The cost of carbon used in business cases should be consistent with New Zealand's net-zero carbon emissions commitment and reflect projected changes in the cost of carbon over the next 30 years. Adopting a more realistic cost of carbon will also help encourage businesses to develop low-carbon materials and processes for constructing infrastructure.

Although carbon-emission impacts should be considered in all business cases, carbon impacts are often locked-in at the strategic planning stage. For example, often the locations and nature of infrastructure investment shape the urban forms of our towns and cities, which can lock in long-term behaviour and associated emission impacts for generations. Where feasible, carbon impacts should be considered at the strategic planning stage, such as when spatial plans are developed.

Consider whole-of-life emissions when making infrastructure decisions.

As we make decisions on the infrastructure in which we invest, we need to consider the whole-of-life carbon emissions associated with infrastructure in our business cases.

Carbon is created in the production of many construction materials including asphalt, cement, steel and aluminium. The heavy machinery used to build and decommission infrastructure also emits carbon. The production of cement and steel are amongst the largest carbon-emitting processes on earth. Per tonne produced, steel emits roughly 1.9 and cement emits roughly 0.8 tonnes of carbon emissions.[98] These embodied emissions can be very high in infrastructure projects due to the use of carbon-intensive materials.

After construction, there'll be ongoing emissions from the operations, maintenance and use of infrastructure. Emissions generated from operations, maintenance and renewal are referred to as operational emissions and can include the emissions from the energy used in a building.[99] Emissions from third parties using infrastructure are referred to as enabled emissions and can include the carbon emissions generated from driving on a road. Emissions can also arise when removing infrastructure, which we refer to as disposal emissions. Some infrastructure, such as a new hospital, can increase overall emissions. Other projects, such as wind farms, can decrease overall emissions.

A whole-of-life approach to carbon emissions looks at embodied, operational, enabled and disposal carbon emissions over the expected life of infrastructure. For projects that are intended to reduce carbon emissions, there'll usually be a net increase in emissions during the construction phase that will be outweighed by reductions during the operational phase.

Using a whole-of-life approach to emissions can help us make investment decisions that are consistent with net-zero carbon emissions targets and should be used for projects that reduce and increase carbon emissions. A full consideration of whole-of-life emissions can encourage non-built infrastructure solutions, less carbon-intensive infrastructure options and the use of low-carbon construction materials.[100]

A government work programme is needed to identify and 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
4	**Minimise lock-in of future emissions** ITN, SRC, LER 2022-2026	Set a strategic direction in emissions reduction plans that requires public sector investment programmes to be compatible with our international commitments on carbon emissions. Measures to support this direction should: a. Require that infrastructure policies and strategic plans take into account, where feasible, their implications for locking in carbon emissions. b. Include a full consideration of non-built solutions and decarbonising existing infrastructure in all business cases. c. Require assessments of whole-of-life carbon emissions, including embodied, enabled, and operational emissions, in all business cases. d. Require the use of a cost of carbon compatible with international commitments on carbon emissions within all cost benefit analyses, outlined in the Treasury CBAx tool. e. Measure the carbon impacts of different construction materials used in infrastructure projects. f. Set a timetable for reviewing regulations, standards and codes to ensure they don't inhibit the uptake of low-carbon materials. This should be cross-sector and reviewed regularly.	Ministry for the Environment (MfE), Climate Change Commission
5	**Achieve net-zero carbon emissions at minimum cost** ARE, ITN, GIC, BZC, EAN, GTG, LEE, TPM, LER 2022-2031	Develop 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 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, in particular ensuring distributors have reasonable access to the metering data they need to manage their networks safely and efficiently.	MfE, Ministry of Business, Innovation and Employment (MBIE), Commerce Commission, Electricity Authority
6	**Speed the build of low-emissions energy infrastructure to leverage our abundant resources** ARE, OCE, LER 2027-2031	Streamline consenting of low-emissions energy infrastructure while meeting environmental objectives by: a. Strengthening existing Resource Management Act 1991 national direction for renewable energy generation and transmission b. Developing a streamlined approach to planning and consenting under the Natural and Built Environments legislation, which could include tools such as environmental standards for project consenting and development of renewable energy zones. c. Establishing an offshore regulatory framework to explore and develop low-emissions energy resources in territorial waters.	MfE, MBIE
7	**Ensure a fair, inclusive and equitable transition to a low-emissions economy** ITN, LER 2022-2031	Target support to those disproportionately affected in the 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.	Ministry of Social Development, MBIE

Refer to Section 10 | Time

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 has its own character and unique combination of natural environment, infrastructure and community. Lower house prices, roads that are free of congestion and a sense of community make the regions attractive to many people. They also offer job opportunities that are different to those in our cities, whether they're in the primary sector, in local businesses or involve remote working. These are some of the reasons for approximately 1.8 million New Zealanders, some 35% of the population, living in small cities, towns and rural areas outside the main urban areas.[102]

However, some of these things that make our regions special, such as their smaller scale and remote locations, pose challenges for their infrastructure. For people living away from main centres, it can be hard to access employment and social infrastructure, like schools and hospitals. It can also be more expensive to maintain infrastructure when populations are smaller.

Like elsewhere in New Zealand, the infrastructure in our regions will need to adapt to meet the changes we'll 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 and 2020, but instead grew by 8% as people were drawn there from other parts of New Zealand.[103] All regions will need to work to address climate change, but its impacts might be greater in some, 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.[104] There were 14 million passenger movements through New Zealand's four main international airports.[105] 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 exported by value.[106] 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 to the success of not only our regions, but New Zealand as a whole.

Māori have strong connections 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 and account for a large share of the population in regions like the Gisborne district (where 54% of the population is Māori), the Northland region (36% Māori), and the Opōtiki district (64% Māori).[107] 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.[108] Māori-owned businesses account for 16% of New Zealand's total primary-sector output.[109]

Infrastructure supports the regions to play to their strengths.

Well-organised infrastructure networks are critical to enabling 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 more common within the next decade,[110] but to prepare for this, significant training and infrastructure preparation is required to support operations on existing runways.[111]

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

Providing infrastructure in the regions can be challenging.

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

- It can be difficult to pay for costly, large-scale investments in places with small populations.
- The costs of providing infrastructure services to dispersed populations can be high and made more challenging by New Zealand's geography.
- Ageing populations in many places increase infrastructure needs while reducing the number of working-age people who can help to pay for and operate 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 of infrastructure. This raises the possibility of stranded assets, which a region can't afford to operate.
- Managing the impacts of climate change can be more difficult. For example, public transport might not be viable in small 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. They 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 may be patchy and long distances may be travelled to jobs and recreation. 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 were important for economic and social functions. However, they saw challenges with maintaining rural roads to provide ongoing access to communities and to meet economic needs, such as for 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 and disadvantaged. It can complement and sometimes be a substitute for transport networks. Air access is also important, but regional air links are seen as expensive and sometimes infrequent.

A thriving New Zealand: what we need to do
Aotearoa ora rawa atu: Me aha tātou
6

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 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 and 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 can't 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 and rail links, for example, or through better digital connections.

Infrastructure standards should enable affordable solutions for rural New Zealanders.

For some rural communities, high 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.[112] Almost 1,000 schools, marae and community facilities supply their own water.[113] Without help, these suppliers may not be able to afford to meet new drinking-water standards.[114]

To help in cases like these, infrastructure standards should allow on-site solutions or low-cost infrastructure designs to be used when they're more affordable for users. For example, electricity distributors are required to supply power to remote users. They can do this by paying for on-site generation like solar panels or generators if they are cheaper options.[115]

When the government sets standards that apply to local governments and self-service infrastructure, it should ensure that those standards don't pose too-high costs 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.[116]

Low-cost infrastructure alternatives are important in the regions.

Digital technology through for example, the use of online services, can offer alternatives to the services people need from infrastructure. It can mean that instead of using 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. Examples are off-grid water systems and satellite broadband services, provided they can meet minimum service quality standards at lower or comparable costs. In the health sector, there are opportunities to move service delivery closer to the regions using digital technology, which allows the use of small and repurposed buildings.

The rise of electric aviation is one development that has the potential to change the economic viability of commercial regional air services,[117] while also contributing to our net-zero carbon emissions target. While there's some uncertainty about the use of electric aircraft for long-haul travel due to battery sizes,[118] electric aircraft for small regional flights is imminent and may be cheaper than the alternatives. Airlines are already investing in electric planes.[119] Preparing infrastructure and developing the skills to maintain and operate electric planes will become a priority for infrastructure providers, particularly airports.[120] There'll likely be a role for the government to review regulatory frameworks and standards and identify other network implications. Many of these issues should be identified or informed by the Air Navigation System Review being undertaken by the Ministry of Transport. There are other technologies that could also impact inter-regional connectivity including electric vertical take-off and landing aircraft e-VTOL, smaller drones and unmanned aircraft that can transport low-volume, time-sensitive goods, and the automation of existing aircraft. The aviation system will need to prepare for these technology changes, with likely implications for regulation, investment and safety standards.

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

It's likely that New Zealand will increasingly have to manage areas where populations are in decline. Of New Zealand's 67 territorial authorities, 56 are expected to experience flat or declining growth at some point in the next 30 years (using the median projection).[121] These projections come with considerable uncertainty, however. Only 23 territorial authorities are forecast to grow in the next 30 years, with a high degree of certainty.[122]

With a falling number of infrastructure users, it will be challenging to continue funding operational costs, particularly where the fixed costs of operation are high. For infrastructure that's commercial, some services will gradually reduce or be replaced with lower-cost alternatives, as has occurred with bank closures and internet banking.[123] 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. […] [As 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.

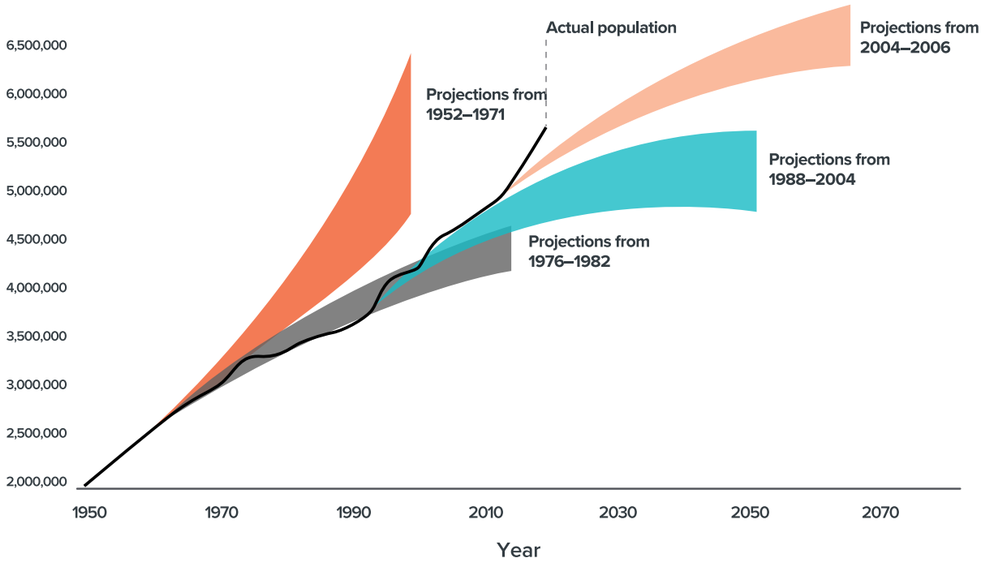
New Zealand's population is expected to grow significantly in the next three decades (see Figure 10). We have the potential to gain significantly from this growth. However, if growth isn't adequately planned for or anticipated, it can create infrastructure problems that erode the benefits of growth and undermine public acceptance of a growing population. Volatility in population growth might place pressure on absorptive capacity.

Predicting population growth comes with a high degree of uncertainty, however. Historically, median projections have been both far below and far above experienced populations (see Figure 19). Because infrastructure is long-lived and often requires long lead times to be provided, 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. This is because, for infrastructure providers, a population growing more slowly than anticipated creates financing risk and a place that reaches a smaller total population than expected creates funding risk.

A long-term and stable National Population Plan should focus on reducing the uncertainty of future demand for long-lived infrastructure services at the national level, while respecting individual choices on where to live and work. It can also provide direction for regional spatial and infrastructure planning and support policies that shape growth across New Zealand.

Predictions of future population are uncertain

Figure 19: Historical population growth compared with historical population projections



Source: Te Waihanga, adapted from Statistics New Zealand (2021)[124]

Securing and integrating freight and supply chains and services

Reliable transport networks are critical for the regional economy.

The efficient movement of freight into, out of 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 20). They're especially important for our regions, which produce the bulk of the goods sold overseas. There's also a clear link between infrastructure investment in a region's transport connections and its prosperity.[125,126,127] Quicker travel times enable markets to become more integrated. As this occurs, regions benefit from lower prices and a 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 to 2018, to nearly 400 million tonnes by 2052 to 2053).[128] As volumes grow, the issues already faced by our freight system will increase and worsen. We'll need to invest more in our transport network and ensure it works more efficiently to manage these increased levels of freight.[129]

The freight sector faces a number of challenges.

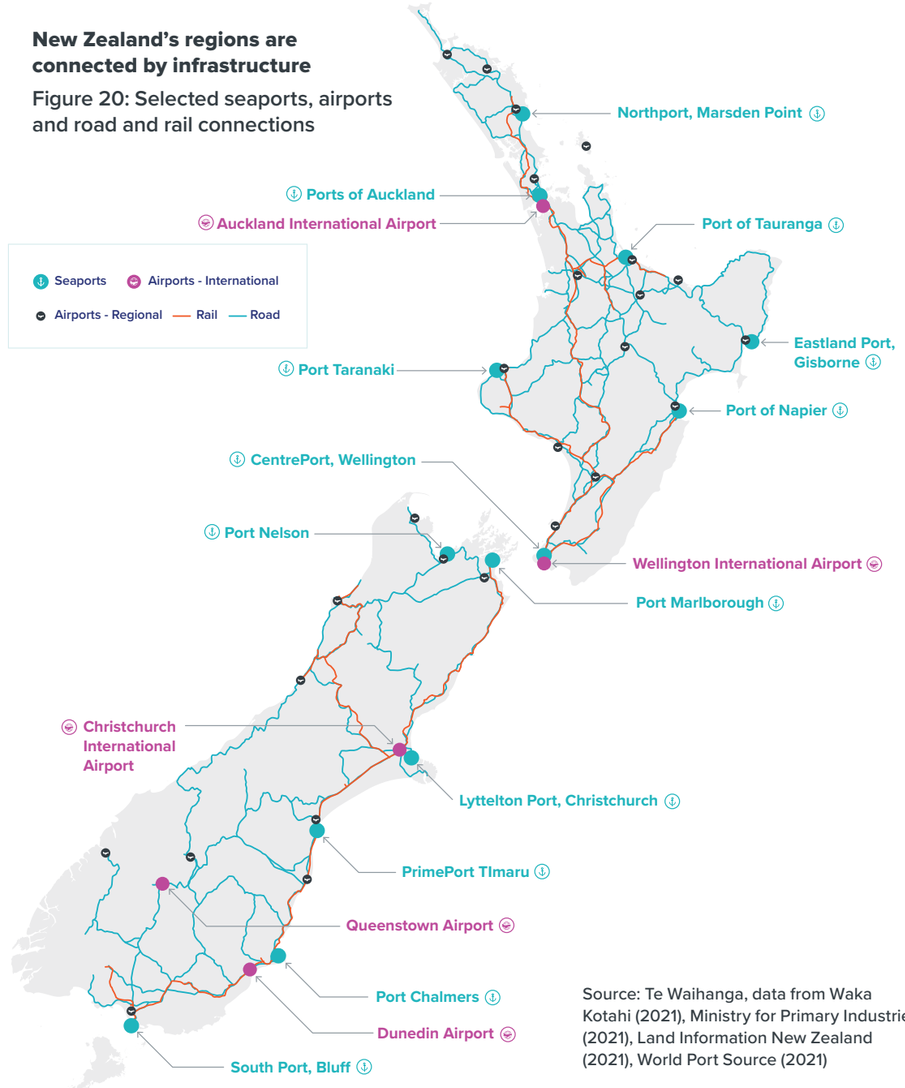
There's a degree of fragmentation in the freight sector. Freight and logistics services are provided by the private sector in New Zealand.[130] Most of the transport infrastructure that supports these services is owned or managed by central or local government entities.[131] Improvements in these ownership and governance structures may be possible,[132] to reduce bottlenecks that would otherwise result in a slower pace of planning and investment.[133,134] The government also controls other levers that can impact the freight system, such as regulation. This fragmentation needs to be overcome 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 need to adapt to climate change, earthquakes and cyber-attacks.
- Adapting to pressures associated with the COVID-19 pandemic, such as reduced international air freight capacity, increasing costs and changes to distribution and storage models.[135,136]
- The need to keep up with international trends for much larger volumes of freight and increased efficiency.[137] These include the digitisation and automation of supply chains and the introduction of bigger ships.
- The need to reduce 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).[138]
- The impacts of population growth on our freight system. This could reduce the availability of land for storing freight and increase traffic congestion affecting freight movements.[139]

New Zealand's regions are connected by infrastructure

Figure 20: Selected seaports, airports and road and rail connections



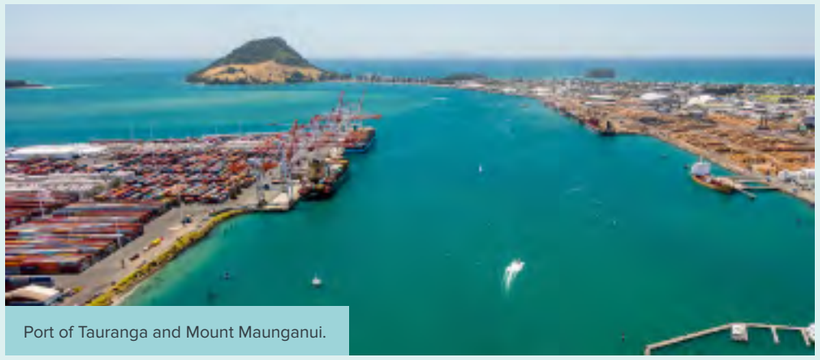
Source: Te Waihanga, data from Waka Kotahi (2021), Ministry for Primary Industries (2021), Land Information New Zealand (2021), World Port Source (2021)

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. The National Freight and Supply Chain Strategy, which is currently led by the Ministry of Transport, should look at all transport modes (land, air and sea) and the whole network and focus on removing barriers to freight movements on important routes. The strategy also needs to address the challenges facing the freight network and provide for competition and choice for freight users. The strategy would feed into regional spatial planning and build on existing transport and freight-related strategies and planning, including the New Zealand Rail Plan,[140] the Waka Kotahi Arataki 10-year view[141] and regional strategies like the Auckland freight plan and the Western Bay of Plenty Urban Form and Transport Initiative.[142,143]

Regional spatial planning will support our international and domestic trade.

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



Port of Tauranga and Mount Maunganui.

Regional spatial planning

Regional spatial planning is long-term, strategic planning for how land will be used in a region.[144] 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's usefully applied at the regional level. Sound governance arrangements are needed for it 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.[145] Achieving it requires infrastructure providers, land-use planners and other stakeholders to develop shared frameworks for how cities and regions should grow and change over time. Spatial planning should cover issues like how we'll open up opportunities for homes and businesses to be built, how we'll meet the needs of future residents with infrastructure networks and social infrastructure like schools, parks and hospitals and how we'll manage natural hazards and protect areas with environmental or cultural significance.

Good spatial planning allows for a range of futures over an extended timeframe, such as future with faster-than-expected growth that could result in a city's population doubling or tripling in the long-term.[146] 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. Spatial plans should avoid prescriptive rules about where people will live and work, in favour of taking a long-term view to identify, develop and build agreement on significant region-shaping future projects.[147] A spatial plan does not sit in isolation. It requires a range of supporting planning documents that are consistent with the 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. For example, 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. That street grid is still used today. Barcelona's Cerdà plan looked at how the city could expand beyond its medieval city walls,[148] while Copenhagen's 1947 Finger Plan[149] laid out future transport networks and regional parks that have accommodated significant growth. These plans have adapted well to economic and population changes, of which some couldn't have been anticipated when they were first developed.[150] 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 can 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 increases in internet speed and coverage, as well as the falling cost of digital connections, provides opportunities for New Zealand's regions.

Digital connectivity can transform the way infrastructure services are provided in regional New Zealand, particularly in rural areas, by closing the disadvantage caused by distance. For example, where people in remote areas might have previously needed roads to connect to work, cellphones and internet access are an increasingly good substitute for a broad 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 and car registrations. Case Study 4 highlights the benefits of telehealth, which can improve access to health services if people have good digital connectivity.

Over time, digital connectivity will likely become ever more fundamental. The importance of connectivity was recognised internationally in 2016, when the United Nations General Assembly passed a non-binding resolution declaring internet access as a human right.[151] The satellite technology required for universal access is increasingly available, meaning the biggest challenge in the future will be the affordability of access.

CASE STUDY 4

Telehealth - reducing demand for physical healthcare infrastructure

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 are demonstrated across the three following emerging technologies with proven application:

- **Artificial intelligence** can enhance the quality of healthcare services, such as through keeping people well, detecting disease early, diagnosing 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 to measure health performance, trigger alerts and send reports to medical professionals when issues are detected.
- **Augmented reality (AR) and virtual reality (VR)** increase the ability to deliver healthcare services at a distance, such as by conducting clinical appointments remotely.

The importance of telehealth services became apparent during the COVID-19 lockdowns, when 17 district health boards collectively experienced a 100-fold increase in telehealth consultations, to 34,500 per week. There's evidence that some of these effects have been sustained.[152]

"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 [153]

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 21) and there are still significant gaps within rural communities.

Options for shared ownership of infrastructure (as illustrated in Case Study 5) and new technologies like broadband via satellite networks, may help to bridge the gap.[154,155] However, a national digital strategy is required, that sets out a path for universal access to quality digital services in areas where people live and work, and addresses issues of inequity and disadvantage. This is fundamental for the wider infrastructure system.

CASE STUDY 5

Shared ownership of cell phone towers in rural New Zealand

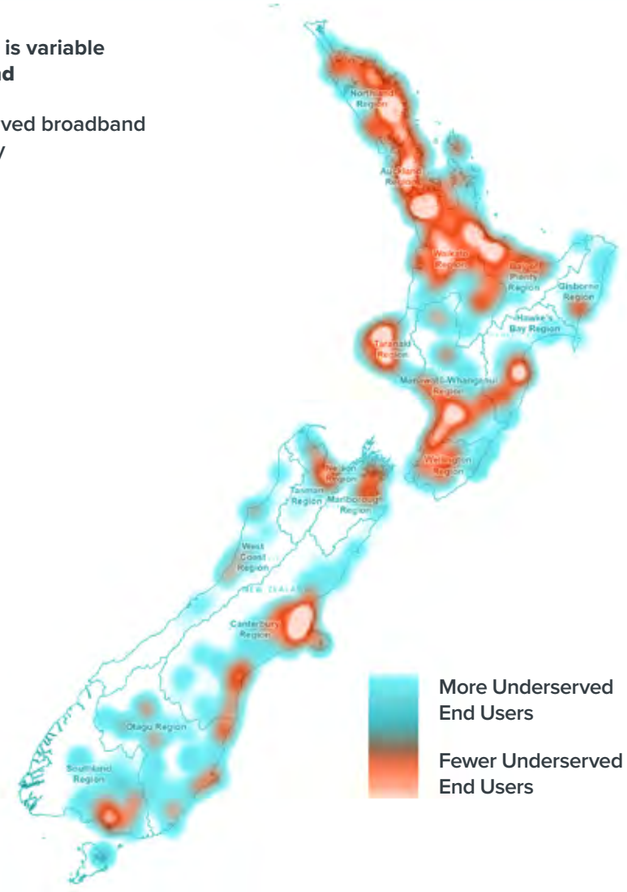
It can be challenging to provide telecommunication services to less populated rural areas because there may not be enough customers to pay for the required infrastructure. In response to this, a shared ownership model for rural cell phone towers has been used to increase network coverage in regional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

Crown Infrastructure Partners contracted the Rural Infrastructure Group, a joint venture between Spark, Vodafone and 2degrees, to provide essential network infrastructure. The three telecommunication firms were incentivised to work together in delivering new rural broadband and mobile services in 20 rural locations in New Zealand. The new sites provide high-speed wireless broadband access to 1,600 rural homes, 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 Spots 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.[156]

Broadband quality is variable across New Zealand

Figure 21: Underserved broadband end users by quality



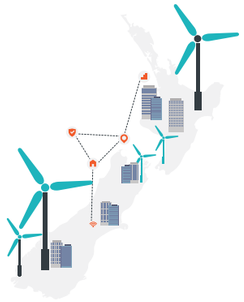
Source: Te Waihanga, data from Crown Infrastructure Partners (2020)

6.2.4. Recommendations

No.	What	How	Who
8	**Improve efficiency and security of freight and the national supply chain** FSE, NFD, NLR, NSC 2022-2026	In developing a long-term National Freight and Supply Chain Strategy, the government should: a. Include airports, ports, road, rail and coastal shipping. b. Ensure it is integrated, resilient and multi-modal. c. Identify infrastructure needs and 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.	Ministry of Transport (MoT)
9	**Reduce barriers to and costs of providing infrastructure services** PTC 2022-2026	In developing a National Digital Strategy, the government should: a. Prepare New Zealand for realising the full benefits of a connected digital society and 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. e. Identify options to improve trust in digital services and address digital privacy concerns. Review standard infrastructure 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.	Department of Internal Affairs (DIA), MBIE
Refer to Section 10		Time	

No.	What	How	Who
10	**Reduce population uncertainties for infrastructure demand, planning and delivery** AIP, GFI 2027-2031	Establish a National Population Plan that: a. Presents a likely population pathway over the next 50 years and identifies requisite supporting policies. b. Provides direction for regional spatial plans. c. Identifies supporting policies required for New Zealand to capitalise on the benefits of a larger 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, medium and low projections.	Productivity Commission, Stats NZ, MBIE
11	**Prepare for zero-emissions commercial electric flights and unmanned aircraft** EAF 2022-2041	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 alternatives 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. f. Upgrade the aviation system and existing airport infrastructure to cater for greater use of unmanned aircraft.	MoT, Civil Aviation Authority, Airports and Airlines
Refer to Section 10		Time	

A thriving New Zealand: what we need to do
Aotearoa ora rawa atu: Me aha tātou
6



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 in which to live, work and play.

There are many ways to define a city. For this strategy, we use 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.

Today, 56% of the world's population lives in cities, a proportion that will increase to 68% by 2050.[157] 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.[158]

For more than a century, most New Zealanders have lived in towns and cities.[159] In 2018, New Zealand's five largest cities and their satellite towns accounted for 64% of the population.[160] More than two-thirds of all population growth to 2050 is expected on just the 3% of the land that contains our cities.[161]

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 so they can use less energy, provide higher wages and have greater productivity. It can even result in better health, greater social connection and improved community wellbeing for their residents.[162] 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, enables access and mobility, 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 in which 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 and 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's 10 times the median household income.[163] 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.[164] Wages haven't kept up and New Zealanders now spend more and more of their incomes on housing.[165] There's also a housing shortage. This is affecting many New Zealanders, particularly Māori and Pacific peoples, who are less likely than others to own homes. The housing shortage also means that the most disadvantaged in our society are more likely than others to live in damp or mouldy homes, experience overcrowding and have poor health and wellbeing as a result.[166,167,168]

Many issues are holding us back from building new housing.[169] These include planning policies that limit the height and number of homes that can be built in some areas, insufficient water and transport infrastructure to support new homes, and difficulties gaining resource consent for new housing. Other barriers include inefficient building consent processes, 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. Planning constraints are estimated to have increased 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.[170] The impacts are even higher in inner-city areas, where councils have historically set strict limits on development.[171]

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

The infrastructure problems in our cities can affect all of us. As a key contributor to delays in freight and business travel, road congestion in Auckland is estimated to be having direct and indirect impacts that are equivalent to 0.5% to 0.9% of the city's GDP.[172] These are on top of the problems it's creating for the people who lose personal time while sitting in traffic and the stress this causes.[173] As the population of our cities increases, so will the pressure on road networks.

When infrastructure fails or performs poorly, it's 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 aren't available to people on lower incomes who can't afford to pay for alternatives. Infrastructure is also often poorly designed for people with disabilities.[174]

Historically, the way we planned and built infrastructure also had impacts for Māori.[175] An example is the Ōrākei wastewater scheme, constructed in Auckland in 1914, which disposed of untreated sewage from Auckland's growing suburbs into the Waitematā Harbour.[176] Sewage outflows contaminated shellfish beds belonging to local iwi, Ngāti Whātua, which had unsuccessfully opposed the scheme.[177] 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's different about Auckland?

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

- Auckland is critical to attracting and retaining migrants and businesses, as it's the only New Zealand city that's big enough and has the international connections to compete with larger Australian cities.[178]
- Auckland's firms and workers contribute more to the economy than similar firms and workers elsewhere in the country.[179]
- Auckland pays as much or even more in taxes than it receives from the government. This is because it's received less government spending, per person, than most other regions in the past.[180]

Auckland also faces some significant challenges.

- House prices and rents are extremely high and this is eroding the advantages of living in Auckland, encouraging professionals, skilled workers and others to move to Australia and increasing pressure on house prices elsewhere in New Zealand.[181]
- Auckland has significant infrastructure issues, including traffic congestion, that make it more difficult for people to access jobs and education.[182] It's also expensive to fund the infrastructure needed to keep up with the city's growth.

6.3.2 What we've 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 that those on lower incomes would not be made worse off).
- Lead corridor protection for infrastructure, which is where areas of land are protected from development so that 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 Review into the Future of Local Government. 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.[183] To meet this growth, we need to plan for infrastructure networks before they're needed. Otherwise, it may 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.

The preparation for future infrastructure should look at all the 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's protected for a long-term rapid transit corridor could either 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.[184]

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 that infrastructure will be developed.

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.

In addition, the Public Works Act 1991 requires infrastructure providers to buy land as soon as it's 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.[185]

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 "Regional spatial planning" in Section 6.2). It requires infrastructure providers, land-use planners and other stakeholders to develop a shared framework for accommodating future population and economic growth while managing the 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.[186] It should be supported by good information on how much growth infrastructure networks can manage and options for upgrading them. It should also identify opportunities to optimise government landholdings, noting that there are already some existing initiatives in this space.[187] 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 in 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 the outskirts of cities.[188] This will enable more homes to be built throughout urban areas. There's a need to monitor progress and strengthen policy directions for resource and building consenting if required. One opportunity is the mandatory use of independent hearing panels to review plans for fast-growing cities.

There's also a need to use resource management reform to standardise some planning rules across councils, so developers have greater certainty and clarity. While the recent Medium Density Residential Standards have introduced some consistency, people seeking to build similar housing, business, or infrastructure developments in different council areas often face complex and varying rules.[189] Standardisation should focus on residential and business zoning or rules about transport and utilities where there are strong benefits to be gained 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 on the areas that are to be used for homes and those that are more suitable for business use.[190]

Coordination between local governments is needed in growing urban areas.

An increasing number of people are living in one council area and commuting to work in another, as shown in Figure 22. For instance, the share of workers commuting across council boundaries in the Hamilton, Waikato and Waipā districts more than doubled between 2001 and 2018. There's an increasing need to coordinate transport infrastructure and public transport service planning between councils to ensure that cross-border journeys work well.[191] 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 of better coordination between local governments in growing urban areas. There's a need to review the boundaries and responsibilities of local governments to ensure these benefits are achieved.

CASE STUDY 6

Benefits of local government coordination in growing urban areas

The growth of our cities and changes in 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:

- Coordinated planning for transport infrastructure and public transport services across council boundaries so that travel across boundaries is seamless and bus routes (provided by regional councils) are supported with the right local road infrastructure (provided by territorial authorities).
- Coordinated 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 capabilities and capacity to deliver regionally significant projects and the right incentives to collaborate to optimise the use of shared resources and infrastructure assets.

To illustrate why coordination is increasingly important, Figure 22 shows that the share of people commuting across council boundaries has risen significantly in New Zealand's five largest cities as they've expanded. As these trends continue, 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 22: Share of all commuting trips that cross local government boundaries 2001 to 2018

Source: Adapted from Sense Partners (2021)

There are multiple ways to improve coordination and service provision. Realignment of council boundaries and roles may be beneficial in some instances, but it should not be seen as a 'one-size-fits-all' solution. 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.[192] This is most likely to reflect better coordination and service provision. The same relationship is observed in New Zealand.[193] Notably, Auckland, where local government was amalgamated in 2010, is the only region in New Zealand where per capita GDP growth was faster in the 2010s than in the 2000s.

Easing pressure on our infrastructure networks

Congestion pricing is the best way to improve access and mobility in New Zealand cities, but it needs to be fair for everyone.

A well-functioning urban transport system should enable mobility and access to jobs, education and other opportunities, ensure that people are safe while travelling and contribute to reducing carbon emissions. Different approaches are needed to achieve better outcomes in these areas.

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's tended to encourage more people to drive, causing more congestion and carbon emissions.[194] These effects 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 increase access and mobility by reducing excessive traffic congestion. They 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.[195] 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 towards 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 had a significant impact, accounting for emission reductions of more than 10%.[196]

CASE STUDY 7

Congestion charging gantries in Stockholm.

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.[197] 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 grew from 54% at the time of the referendum to 70% in 2011.[198]

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

The money collected through the scheme was used to fund the equivalent of NZD$15 billion of transport projects in the city. These included a significant expansion of bus services to cope with the increased demand for public transport. This helped ensure fairness and reduced any impacts on low-income users. No discounts were offered as it was assumed that Sweden's comprehensive welfare system would help those on low incomes to manage the costs.[199]

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 aren't already available. This will increase the effectiveness and public acceptance of congestion charging, because it will give people alternatives to driving and reduce the charging levels needed to ease congestion.[200,201] Increasing the availability of public transport and active transport options will also contribute to reducing carbon emissions from transport.

Complementing congestion charging with a 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 and 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'll 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 on when and where to build new transport infrastructure.

Better designed developments can ease pressure on the road network.

There's 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 and other rapid transit stations and mixed-use development. This is development where homes, commercial buildings and shops are co-located in an area and people don't need to drive between these places.[202,203]

Better coordination between central and local government and private sector organisations is needed to deliver an effective TOD. Both developers and infrastructure providers will need to plan carefully and implement consistently to make these changes work.[204] Providing streets that make it easy and safe for people to walk from home to the transit station will encourage them to live near transit stations and use public transport. The amount of on-site parking that's supplied with new development can affect people's decisions on how many cars to own and how to travel.[205,206]

CASE STUDY 8

Transport and land use integration at the City Rail Link's Mount 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.[207] It will double the number of Aucklanders who live within 30 minutes travel of the central city, especially in West Auckland.[208] 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.[209,210] City Rail Link Limited owns 3.2 hectares of land close to the station, of which most will be available for development once the station has been built (see Figure 23).

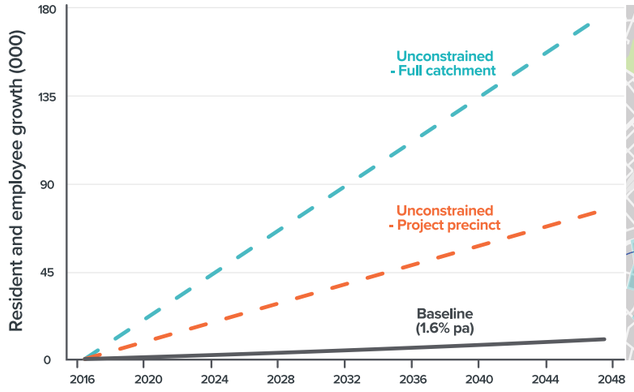
Even without the City Rail Link, Mount Eden is an area that is attractive to property developers. However, it's important to make sure that infrastructure, planning rules and development work together to get the best results. For instance, insufficient water infrastructure and rules protecting views or preventing the demolition of older buildings could 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 of development space that could be supplied without changing planning rules.[211] Unless planning rules are made more flexible and enabling of higher density housing, there is the possibility that the development could result in greater housing unaffordability in the future.

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

- Establish outcomes, expectations and mandates as early as possible.
- Ensure there's an agreed understanding of 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 the funding and delivery of infrastructure.

Figure 23: Existing aspiration is a fraction of estimated demand in station catchment

Panel A: Net population growth projects



Panel B: Project area map

Source: Adapted from City Rail Link (2020)

Note: The project precinct unconstrained scenario relates to the project catchment area and excludes areas within the station catchment but outside the City Rail Link project area. The full catchment scenario includes a wider assessment of the area that will benefit from the new stations. The baseline in **Panel A** represents the level of growth assumed in the 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 was seen during the COVID-19 lockdowns, although remote working is not available for everyone. 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.[212] This trend should be monitored, as remote working may have significant impacts on urban transport networks. Some of these impacts could be positive for instance, if remote working reduces peak-hour congestion, while others may be negative, for instance, if reduced public transport use results in the need to increase fares or reduce service frequencies.

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.[213] A lack of water infrastructure can put a handbrake on housing development.

Water-sector reforms offer opportunities 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.[214] Performance-based economic regulation, which requires high-quality service for both existing and new users and sets incentives for providing services at an affordable cost, is important to achieving this. This approach is already used in sectors like telecommunication and electricity distribution.[215]

To improve responsiveness to new housing development, there's a need to unlock the ability of water providers to:

- Borrow to finance new infrastructure.
- Set prices for access to and use of water networks that allow the cost of infrastructure upgrades to be paid back over time.[216]

There's also a need to recognise the role that private developers may play in providing water infrastructure, such as through the use of the Infrastructure Funding and Financing Act 2020 or through agreements that allow developers to benefit from providing spare capacity that can be shared with other users.

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 drinking water, wastewater and stormwater infrastructure. This can be done by creating incentives for users and providers to conserve water, such as through volumetric charging for water and wastewater, using metering to identify leaks, 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 can reduce the amount of water that's wasted. After water meters were introduced, daily water use declined by 25% on the Kapiti Coast and 30% in Tauranga during peak periods.[217] Volumetric charging may need to be accompanied by targeted assistance for low-income households and disadvantaged users.

Better water pricing should also happen alongside other measures that make it easy for people to save water. Rainwater harvesting and buffer tanks for stormwater and 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.[218] However, there are barriers to adopting these solutions, such as resource and building consent requirements for rainwater tanks.[219] These barriers should be reviewed and reduced wherever possible.

6.3.4. Recommendations

No.	What	How	Who
12	**Improve water infrastructure pricing and provision in cities** WSA, LFF, MHT 2022-2031	The water, wastewater and stormwater sector should be reformed, including by: a. Implementing performance-based economic regulation and water quality regulation to ensure that water providers are incentivised to drive efficiency and deliver excellent customer service. b. Ensuring that there's a clear link between the cost of providing water services and the prices that are charged to users, following the principles in Section 7.2 c. Allowing entities to use their balance sheet capacity to finance infrastructure for growth, as well as funding asset renewals and improvements in water quality. d. Clarifying the interface between water service entities and developer-financed water infrastructure provided under the Infrastructure Funding and Financing Act 2020. e. Ensuring that developers can benefit appropriately from the provision of infrastructure that has spare capacity. f. Developing cost-benefit analysis guidelines to standardise evaluation decisions on water infrastructure against social, environmental and economic benefits.	DIA, Local Government (or New Water Entities), MBIE (or Economic Regulator)
13	**Reduce pressure on water infrastructure through better water management and conservation** GIW 2022-2031	Steps that should be taken to reduce pressure on water infrastructure include: a. Using planning rulebooks to encourage on-site solutions. For example, building coverage could be increased in exchange for installation of on-site stormwater-management devices. b. Removing regulatory barriers to water conservation, such as consent requirements to install rainwater harvesting tanks. c. Setting performance standards that improve the water performance of appliances.	Local Government (or New Water Entities), MfE, MBIE, DIA, Taumata Arowai
14	**Realign local government boundaries, where appropriate, to improve coordination of infrastructure and planning outcomes** LMA 2027-2031	Where appropriate, local government boundaries should be redrawn to better align borders with functional labour-market boundaries to enable the coordination of key infrastructure and planning decisions. The realignment of boundaries should be guided by: a. The alignment of borders with wider urban labour markets, commuting and urban growth patterns. b. The costs and benefits of integrating regional planning and infrastructure provision. c. An integration of infrastructure planning, ownership and operation to enable the efficient provision of infrastructure. d. The alignment of funding streams with the infrastructure funding and financing principles outlined in Section 7.2. e. A consideration of mechanisms for local voices to continue to inform decision-making.	DIA, Review into the Future for Local Government

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No.	What	How	Who
15	**Increase the supply and use of low-emissions transport modes** TCQ, ITN, INH 2022-2041	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 the cost-effective implementation of low-emissions transport modes and streamline costly resource management and local government consultation processes. d. Increase certainty of funding to enable low-emissions transport modes to scale up efficiently. e. Ensure all options considered for investments are subject to appropriate cost-benefit analyses.	MoT, Waka Kotahi NZ Transport Agency (Waka Kotahi), MfE, Local Government
16	**Reduce costs by optimising infrastructure corridors** BUP, CPR, ATA, ITA 2022-2031	Enable the 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 and Treasury, supported by Te Waihanga and Infrastructure Providers
17	**Optimise the use of urban land** ULH, CBG, 2032-2041	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 Government, Local Government
18	**Improve the efficiency and consistency of urban planning by standardising planning rulebooks** RAN, BUP, JUL 2022-2026	Standardise the 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 a smaller number of combined plans.	MfE, Ministry of Housing and Urban Development (MHUD), Local Government

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No.	What	How	Who
19	**Improve the delivery of transit-oriented development (TOD)** TSS 2022-2026	Undertake post-implementation reviews of recent transit-oriented development (TOD) opportunities. These reviews should: a. Reflect international best practice, be independent and assess actual performance against appraisal, cost schedule and benefits. b. Recommend changes to practices and policies to increase the effectiveness of TOD delivery.	MoT, Waka Kotahi, MHUD, Kāinga Ora
20	**Improve the efficiency and outcomes of infrastructure through spatial planning** BUP, RAN 2022-2026	Resource management reforms should include requirements for regional spatial plans that: a. Provide clear direction to district plans and funding plans. b. Include mechanisms for participation by relevant central government infrastructure suppliers and Māori. c. Provide for cities to double or triple in population and provide alternative scenarios for the spatial distribution of growth, rather than providing only for a single growth scenario. d. Identify future infrastructure requirements, including future transport networks and other major infrastructure.	MfE, MHUD
21	**Reduce congestion and improve urban mobility** TCQ, LGW, LFF 2022-2031	Implement congestion pricing and road tolling in urban centres by: a. Implementing recommendations in the "The Congestion Question" report[220] for congestion charging in Auckland. Stage implementation as appropriate, considering current and future public transport arrangements. b. Immediately removing legislative barriers to implementing congestion charging and road tolling, such as requirements in the Land Transport Management Act 2003 for alternative untolled routes. c. Progressing planning for congestion pricing schemes for Wellington and other cities as appropriate. d. By 2025, identifying other urban areas where congestion pricing may be beneficial. e. Assigning responsibility for setting and adjusting prices to an appropriate independent institution.	MoT, Waka Kotahi, Local Government
22	**Target transport investment to areas of highest need using signals from congestion pricing** LFF, TCQ, LGW 2032-2050	Share and use data and signals from congestion pricing to identify where future multi-modal transport investment is needed.	Waka Kotahi, Local Government

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No.	What	How	Who
23	**Increase housing development opportunities in areas with good access to infrastructure** BUP, RAN 2022-2031	Improve development opportunities in areas already well served by infrastructure by: a. Accelerating the implementation of the National Policy Statement on Urban Development 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. Prioritising provision of human necessities, such as housing, over preservation of subjective preferences (e.g. heritage, character and amenity). 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. Adopting independent hearings panels to review district plan changes.	Local Government, MfE, MHUD
24	**Improve spatial planning through better information on infrastructure capacity and costs to service growth** CBD, WCB 2022-2031	Improve information on the infrastructure cost implications of different growth possibilities by: a. Developing, validating and publishing a spatial model of the long-run average infrastructure costs of servicing growth in different locations, to inform issues like regional spatial planning, local government development contributions policies 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.	MHUD, Te Waihanga, Infrastructure Providers

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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, to manmade threats such as terrorism and cyber-attacks. While we can't predict everything the future will bring, we do know that there's a high risk of some of these occurring. There's a very high likelihood of a catastrophic earthquake from the Alpine Fault in the next 50 years. We're going to experience rising sea levels and 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 and collaborative approach in our efforts to prepare for and respond to the risks we face. This will help us 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 will 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 24. There's a 75% chance of an Alpine Fault earthquake of magnitude 8, or greater, occurring in the next 50 years.[221]

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 that 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. It means that the impacts of a disaster on one service can affect those on another. There are some technologies, such as

National State Highway network and observed shallow earthquakes from 2010 to 2020

Figure 24: Earthquakes are a widespread challenge for infrastructure[222]

Source: Adapted from Geonet (2021)

solar panels and battery storage, that don't always rely on a network and can help to provide buffers 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.

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

Natural disasters, severe weather events and manmade threats can cause deaths and displace people from their homes. They can also damage properties and have indirect impacts in reducing economic activity. The cost of disasters has risen in the past 30 years, as shown in Figure 25, in part because our towns and cities have increased in size and complexity. Damage to infrastructure and buildings imposes 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 GDP.[223] New Zealand has recently been ranked second globally for natural disaster costs as a proportion of GDP.[224]

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

Figure 25: Total insured losses due to natural disasters from 1980 to 2020

Source: Te Waihanga, data from Insurance Council of New Zealand (2021)[225]

There can also be spillover effects. Over time employers can choose to shift away from areas affected by disasters and wider supply chains can be severely disrupted. Modelling by the Wellington Lifelines Group found that if there were no investment in making the region's infrastructure more resilient, a magnitude 7.5 earthquake on the Wellington Fault would create a $16 billion drain on the economy, excluding recovery costs and building damage.[226]

Our insurance system, including Earthquake Commission cover, has historically provided a buffer against many of the financial impacts of shocks and stresses. However, insurance markets are evolving and we are seeing a reduction in domestic competition, rising premiums and excess charges, and an increasing scrutiny of risk by reinsurers that is affecting asset owners.[227] The increased risk of extreme weather events and sea-level rise also mean that our infrastructure assets will become more difficult to insure at a reasonable cost, creating operating-cost pressures for asset owners.[228] These factors are leading public sector infrastructure owners to assess their insurance options strategically, with options including self-insurance and insuring specific assets only. They will require more accurate resilience data to help support these assessments.[229,230]

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."[231]

The COVID-19 pandemic has disrupted our ability to deliver infrastructure and provide services. It's also affected the way we use services provided by infrastructure, in particular transport and telecommunications. On top of this, it's 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."[232]

A recent Australian study found that the indirect and intangible costs of natural disasters were more than double the reported costs of these events.[233] Vulnerable and isolated communities are often disproportionately hard hit by disasters and shocks.

To help minimise the impacts on 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.

6.2.4. What we've 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 develop a common definition of and framework for critical infrastructure and then use them to identify this infrastructure.

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

Submitters identified the need to align government work on resilience such as the proposed National Adaptation Plan with the work of the New Zealand Lifelines Council and the Earthquake Commission, to ensure consistency. It was also considered important to align planning for and the 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 an all-hazards approach to risk management.

New Zealanders rely on critical infrastructure to lead safe, secure and fulfilling lives. For this reason our infrastructure systems must be resilient to a range of hazards and risks, both natural (such as earthquakes) and manmade (such as cyber-attacks and terrorism).

New Zealand's infrastructure owners have primary responsibility for managing risks to their operations, including national security risks. This responsibility is complemented in some sectors by regulatory requirements, with each regime's requirements tailored to reflect its unique market structure, ownership structure and risks.[234]

New Zealand's approach to infrastructure hazard readiness and response is set-out in the Civil Defence and Emergency Management Act 2002.[235] This Act:

- Sets out the requirements for 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 the requirements for the coordinated preparedness and continuity of these lifeline services in the event of an emergency, and includes information-disclosure requirements.
- Requires the preparation of a National Disaster Resilience Strategy and National Civil Defence Emergency Management Plan, which cascade into coordinated local plans.

The Civil Defence and Emergency Management Act requires lifeline utilities to 'function to the fullest possible extent' following an emergency. Infrastructure asset owners and operators have invested to support this objective. An example is the work of the New Zealand Lifelines Council and regional Lifelines Groups, which are building, with government support, awareness of the investment needed in coordinated resilience before and after an event.

Other risks that affect infrastructure resilience are being managed across sectors. For example:

- Risks posed by overseas investment (for example, risks of economic coercion and data theft) are managed by the Overseas Investment Act 2005.
- Infrastructure owners and operators are supported in managing cyber and other national security risks by Government agencies, including the intelligence community, who provide guidance (such as the New Zealand Information Security Manual[236]), expertise and specialist technical capabilities.
- Climate change risks and responses are being considered through the development of a National Adaptation Plan.

We have a skilled and dedicated risk management workforce in the private sector and at all levels of government, supported by engineers, academic researchers 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 the 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 ensures that the parties involved in planning for disruptions and managing risk have a common language and are coordinated. It also means that the parties that manage infrastructure are able to plan for the services they can provide in the event of shocks and stresses.

The OECD recommends developing a shared understanding among government and critical infrastructure owners and operators of the 'optimal' level of resilience against all hazards and risks.[237] A shift towards framing objectives around desired resilience instead of individual owners' risk tolerance and appetites, will provide a connected and consistent national picture of hazard-risk management and lead to more consistent decisions over time.

The following steps should be taken to help further ensure our infrastructure system is resilient:

- **Define and identify critical infrastructure:** A principles-based definition of critical infrastructure should be developed to align with international best practice. Once developed, this definition should be adopted across policy and legislation to ensure a coordinated and consistent treatment of critical infrastructure. The government should set criteria for what is and isn't critical to support decision-making and the prioritisation of investments.
- **Identification of minimum service levels:** The requirements for identifying minimum service levels for critical infrastructure in the event of an emergency should be clarified and strengthened. These should include requirements for infrastructure providers to disclose information about preparedness and service level expectations. The proactive disclosure of this information will help support transparency. This will help government, individuals and organisations to understand the risks they face and making 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 government agencies need clearer roles for the coordination of resilience activities within and across critical infrastructure sectors. This reflects the interdependencies of infrastructure networks.

These changes are required to clarify expectations of the resilience of our critical infrastructure and the roles and resourcing of the different parties involved in delivering a resilient infrastructure system.

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

The nature and scale of the cyber security risks facing infrastructure are growing. The National Cyber Security Centre recorded 352 cyber incidents between 2019 and 2020, of which 83% were detected before serious harm occurred.[238] Our regulatory system is being outpaced by new technologies that are changing what's traditionally thought of as 'infrastructure' (such as cloud storage) and the risks facing it (such as the infiltration and/or compromise of those data sets).

The increasing complexity of and connectivity and co-dependency between different types of infrastructure (such as information technology systems for remotely managing water and electricity networks) also come with cyber security risks. For example, if the information technology system is compromised by a cyber-attack, this may affect the ability to deliver water or electricity. As the use of these technologies continues to grow, the risk associated with cyber-attacks is also growing.

New Zealand should adopt a best practice approach to cyber security, with clear standards for critical infrastructure assets to ensure they're protected and resilient. The management of cyber security risks needs to be a component of the Digital Strategy for Aotearoa (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, New Zealand needs stable and resilient networks for moving the goods and services required to construct, maintain and operate infrastructure.

Currently, 90% of our construction products are either imported or contain imported products that can't be easily sourced within New Zealand.[239] COVID-19 has shown that our international supply chains can respond to shocks, but ongoing disruption still has impacts, with prices increasing and some goods, skills and services becoming hard to obtain.

We rely on either imports or a small number of local manufacturers for many products we need for building new infrastructure (such as steel reinforcing and cement[240]), as well as the goods and services we require to maintain and operate existing infrastructure (for example, fuels and lubricants, skilled operators and technicians, silicon chips and other technologies). Limits on our ability to access any of these critical inputs, whether arising from natural disasters, supply chain constraints or intentional acts, would have significant negative implications for the safety and security of all New Zealanders. We need a secure supply of essential materials and services so we can continue to build, renew and maintain our infrastructure and recover from any significant disaster. This should form an important part of risk management planning.

A planned approach to adapting to climate change

A National Adaptation Plan will provide a 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.[241] Climate change will increase many of the extreme weather and flood risks already faced by our infrastructure. For example, the Intergovernmental Panel on Climate Change'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.[242]

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 and community wellbeing.

Meeting the challenges of climate change for both existing and new infrastructure assets will be a significant task. For example, a 2019 study estimated that local government infrastructure to the estimated value of up to $8 billion is at risk from 1.5 metres of sea level rise.[243]

In response, the government is developing a National Adaptation Plan for climate change.[244] 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 as proposed contains a number of objectives for infrastructure.

These proposed objectives are as follows:

- **Reduce the 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 to manage 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 should be 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 and replacing existing infrastructure. The process for managing infrastructure should include reviewing resilience, improving the ability to adapt and planning for how services will be provided into the future.

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

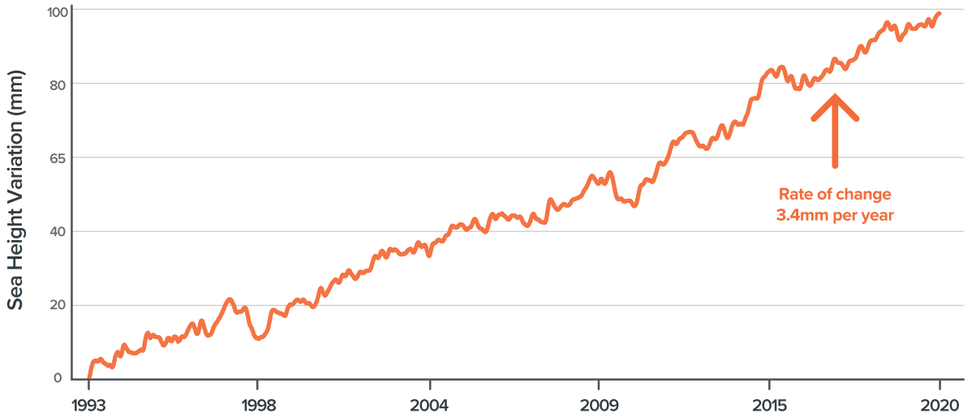
Making information and tools that support resilience available and accessible

Access to the best available information on hazards and threats helps in assessing risk.

Giving the government, organisations and individuals information about hazards and threats can help them to make good decisions on insurance, location and design options when they're planning infrastructure.[245] For individuals, it can help them to plan what they'd do if a disaster meant they wouldn't have services like water or power, and it can also be useful when buying and building property. For organisations, it can help them to plan 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 26) and tools when developing regional spatial plans and planning documents and making other infrastructure investment decisions will help them to reduce the risk of harm and the costs of poor investment.

Sea levels are rising

Figure 26: Satellite sea-level observations, change in sea level from 1993 to 2021



Source: Adapted from Physical Oceanography Distributed Active Archive Center (2021)[246]

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."[247] **– Auckland Council.**

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.[248] Research on how people rebuild after natural disasters shows that awareness of natural hazards can fade within three generations or fewer.[249] 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.

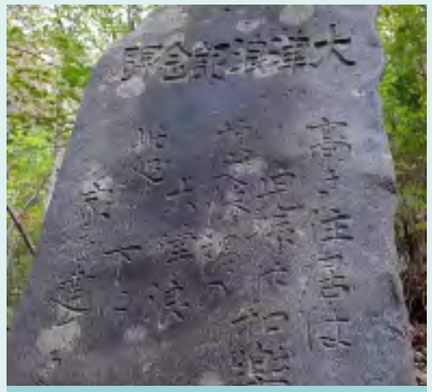
CASE STUDY 9

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:



1933 tsunami stone, Aneyoshi Village, Japan.

"Remember the calamity of the great tsunamis. Do not build any homes below this point."[250] It was erected after a previous tsunami destroyed the village. Because the village didn't rebuild below the level, Aneyoshi was left unharmed by the 2011 Great East Japan Earthquake, which caused extensive damage along the Japanese coast.[251]

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 it went 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 the three marae in Matatā were affected.[252] 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.

We need a coordinated approach to the long-term upkeep of research, data sets and tools that are useful for resilience planning and preparation. This information needs to be readily available for use by planners and decision-makers.[253] It should also include a consideration of mātauranga Māori. As a rule, the information should be useful, useable and used.[254]

The research community, including universities, Crown Research Institutes and others, also contribute strongly to increasing the knowledge base for infrastructure resilience. Further coordination and information-sharing between government, industry and academia would strengthen the links between scientific research and decisions on infrastructure policy and delivery.

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, a better understanding and management of risks and lower costs in the long-term. The data sets and tools include:

- The National Seismic Hazard Model.[255]
- Tools that aid planning, such as the National Forward Works Viewer.[256]
- Tools that support risk and economic impact assessment of hazards, such as the Measuring the Economics of Resilient Infrastructure Tool.[257]

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 to infrastructure planners and users.

6.4.4. Recommendations

No.	What	How	Who
25	**Increase the resilience of critical infrastructure** HGI, BRN, DIV 2022-2026	To increase the resilience of critical infrastructure the government should: a. Develop a principles-based definition of critical infrastructure. b. Apply the definition of critical infrastructure consistently across the policy and legislative framework for resilience. c. Develop the criteria to set infrastructure criticality levels and then identify New Zealand's critical infrastructure. d. Clarify and strengthen requirements to identify minimum service levels for critical infrastructure in the event of an emergency. e. Adequately resource lead resilience agencies to carry out the functions required to support the delivery of critical infrastructure, on a consistent and long-term basis.	National Emergency Management Agency (NEMA), Department of Prime Minister and Cabinet (DPMC), Treasury
26	**Improve infrastructure risk management by making better information available** PRA, RSN 2022-2026	To make better information available to support risk management steps should be taken to: a. Require regular disclosures of information about critical infrastructure preparedness and minimum service levels in an emergency. b. Resource the maintenance, upkeep and availability of research, information, data-sets and tools to support decision-making that enables resilience outcomes.	NEMA, DPMC, LINZ, Central Government
27	**Prepare infrastructure for the impacts of climate change** CAT 2022-2031	To adapt to climate change, actions 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 and robust information on regional and local climate change impacts across the whole country.	MfE, Te Waihanga, Climate Change Commission
28	**Support the security of supply of essential materials, goods and services to build, operate and maintain infrastructure** PRS 2022-2050	To increase the resilience of supply of essential materials, steps should be taken to: a. Incorporate into all risk-management planning for critical infrastructure a consideration of the security of supply of materials and goods required for the construction, operation and maintenance of infrastructure (including aggregate, bitumen, cement, concrete, steel and processed timber) and other essential goods and services. b. Require that regional councils, in conjunction with territorial authorities, undertake resource scans as part of their long-term planning processes and protect sites suitable for aggregate extraction, including through zoning.	MBIE, Ministry for Primary Industries, Central Government, Local Government

Refer to Section 10 | Time

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're 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 we 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 tyres can be burned to make cement, used plastic can be converted to asphalt for roads, and waste can be used to make energy. With some 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 is among the top waste producing nations in the OECD.[258] Annually, we throw away around 3.2 tonnes of waste each.[259] We also have the lowest rate of recycling or reuse of waste materials, with only 35% of our waste recycled or reused.[260] 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.[261]

Waste from construction and demolition is the largest source of waste in New Zealand, accounting for 50% of all landfill waste.[262] Businesses and industry are responsible for 24%, while kerbside waste collection and other waste sources in our towns and cities create 12% of landfill waste.[263] 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.[264]

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 and forests 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.[265] There are also jobs involved in sorting and transferring materials and transforming them into new products and in processing in New Zealand instead of sending them offshore.[266]

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. This respect for natural resources is demonstrated by maintaining their value for as long as possible before they reach the end of their lives, at which point they're 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 acknowledge the mauri (life force) of natural resources.[267]

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 was 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 was 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 was a lack of infrastructure to deal with organic waste, other than landfills.
- The potential for waste-to-energy needed to be considered objectively as a way of dealing with waste in New Zealand.
- Relying on the waste disposal 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. Both 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.[268]

A National Waste Strategy that sets out a path towards 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. The development of a waste strategy is on the government work programme, as is reform of the waste sector. A clear governance structure for moving towards a circular economy, with a minister and lead agency responsible for assessing and implementing actions, would be an important first step.[270] 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**[269]

A waste strategy should include:

- Direction on improving the infrastructure for recycling and processing organic material.
- Strengthening markets for recycled materials.
- Removing barriers to reducing waste.
- Improving planning for any waste infrastructure that's 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 of 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's limited publicly available and comparable data on how much waste New Zealanders produce, how it's 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.[271] 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

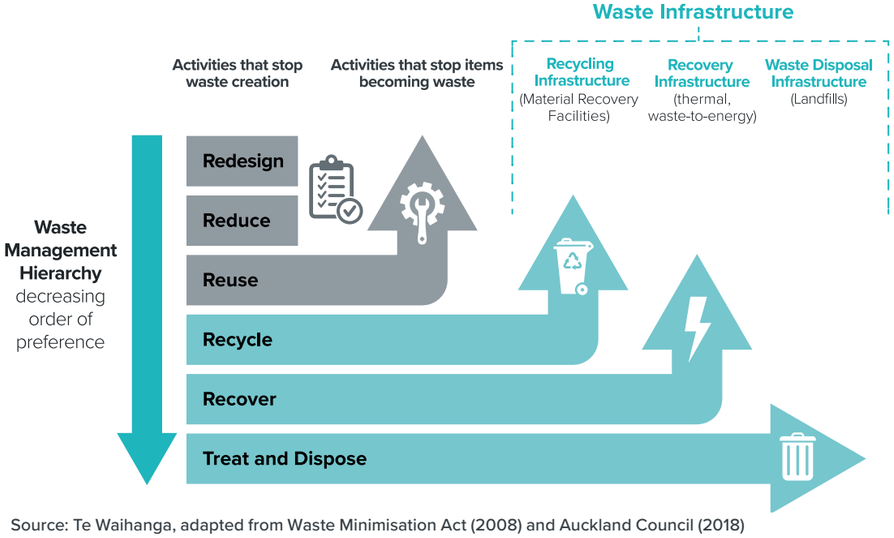
A circular economy requires a new approach to waste infrastructure.

Figure 27 shows the ideal waste-management hierarchy, where reducing waste takes priority over methods like recycling and landfill that still need infrastructure. A movement towards 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 isn't possible, 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 27: Waste management hierarchy



Source: Te Waihanga, adapted from Waste Minimisation Act (2008) and Auckland Council (2018)

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

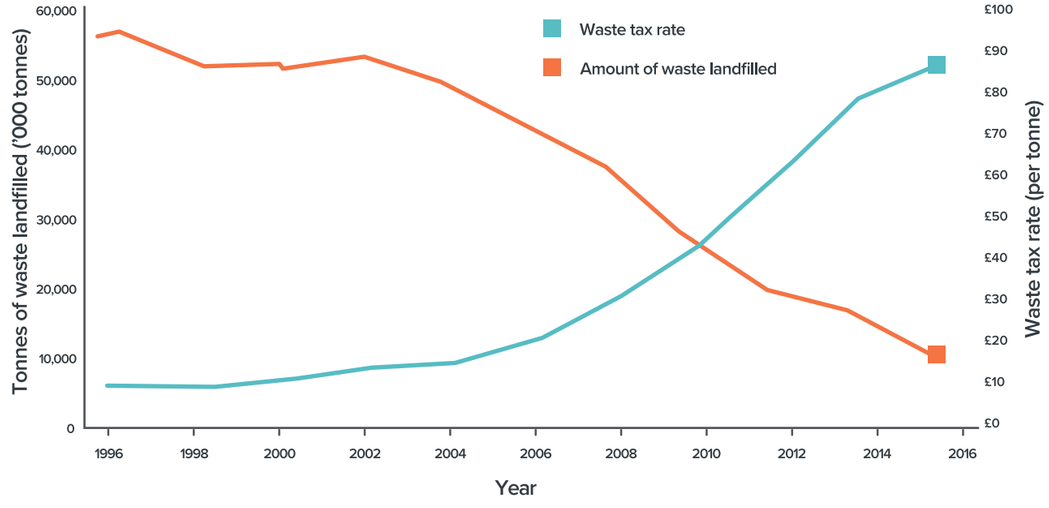
The best way to reduce the need for waste infrastructure is to prevent waste entering the market in the first place. Encouraging waste-reducing behaviour among consumers, like repairing broken items or buying reusable items, is one way of achieving this.[272] Another option is to regulate to reduce waste 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.[273]

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

The way we charge to send waste to landfill can encourage people to reduce waste.[274] General taxation methods like rates don't create enough incentives 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, it saw a major decrease in the amount of waste going to landfill (see Figure 28). New Zealand is currently increasing its 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.[275,276]

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

Figure 28: United Kingdom waste tax rate (per tonne) and tonnes of waste landfilled 1996 to 2016



Source: Tax Working Group (2019)[277]

Resource recovery infrastructure is needed for priority materials.

New Zealand lacks the infrastructure we need to recycle or recover many materials. There's a need to improve infrastructure for collecting and processing recyclable materials and organic waste. This infrastructure would keep more waste out of landfills and reduce the emissions caused when waste breaks down.[278] 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.[279]

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, where it is recycled and the markets where the recycled material is sold. This can make recycling infrastructure more economical in cities and large towns than in small towns and rural New Zealand.

To work well, recycling and organic collection needs to be simple, easy and consistent. Currently, there are large variations across New Zealand in how we recycle. While all New Zealand councils

offer recycling services, 10 councils either have drop-off only services or privately provided kerbside recycling services. There is no standardisation of recycling collection methodology in New Zealand. Councils determine what is collected, how clean the waste must be and what materials are collected together.[280] 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.[281] In Auckland, 12% of household recycling is contaminated with food or other waste, which makes recycling infrastructure less economical to build and operate.[282]

Recycled materials can be 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 could be vulnerable to changing prices and import bans. Doing this would 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 disposal levy could also make opportunities like these more financially appealing.

CASE STUDY 10

Using waste plastic to fix roads in New Plymouth

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 for reusing plastics closer to home.[283] In response, in 2019 around 500 kilograms of types 3 to 7 plastics were used in the 90 metres of resurfacing of Liardet Street in New Plymouth. It was New Zealand's first road to be partly made from recycled plastic. 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 elsewhere.[284]

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**[285]

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.[286] Procurement specifications for public sector infrastructure could be used to help reduce waste. For example, they could prioritise designs and materials that produce a lower amount of waste. They could even factor in disassembly and the reuse or recovery of materials at the end of the infrastructure lifespan, something known as 'designing for deconstruction'. Using prefabricated parts can also help reduce waste. This is because it's easier to recover and reuse waste from a factory dedicated to making a particular part than on a construction site where 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 to minimise waste creation.[287] This is software for matching surplus materials and products to needs for those materials and products. There are some resource exchange mechanism services in development in New Zealand, such as CivilShare,[288] 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, then recirculate them to construction activities and other markets.[289]
- Reviewing building-material regulations to ensure they allow for the use of reused and/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 can't 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 (for instance, converting organic wastes to biogas/biomethane).[290] 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 pressure on landfills. The Ministry for the Environment released guidance on waste-to-energy proposals in 2020.[291] The guidance outlined key questions that investors in waste-to-energy plants should address but didn't 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.[292]

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.[293] 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.[294] At full capacity, the plant will reduce annual carbon emissions by 13,000 tonnes and reduce total landfill waste by around 1%.[295]

The total cost of the project was $25 million, of which $16 million was funded by a grant from the Ministry for the Environment's Waste Minimisation Fund.[296]

6.5.4. Recommendations

No.	What	How	Who
29	**Establish a clear national direction for circularity in waste management** RRV, WSP 2022-2031	In developing a National Waste Strategy, provide appropriate direction that: a. Sets out a plan for circularity and is consistent with net-zero emissions 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
30	**Prioritise options that minimise waste entering the market to avoid unnecessary infrastructure costs** FOT, ACW 2022-2031	Options should include: a. A ban on products that are hard to recycle. b. The 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 analyses.	MfE, Local Government
31	**Improve recycling infrastructure for priority materials** WSP 2022-2031	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-offs and the 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
32	**Use behavioural interventions to address barriers to recycling, reduce waste and avoid contamination** WSP, RRM 2022-2031	This should include: a. Improving the ease of recycling for consumers, with a focus on simplicity and consistency across jurisdictions. b. Funding sustained education campaigns that promote and improve the social licence 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
33	**Reduce landfill emissions resulting from organic waste** WSP 2022-2031	Steps should be taken to: a. Improve the collection of organic waste through more commercial and household food waste collection services. b. Target education and behaviour-change programmes to improve the take-up of organic waste collection. c. Require landfill gas capture for all landfills that accept organic waste.	MfE, Local Government
34	**Develop uses for recycled materials in infrastructure** WSP 2022-2031	Responsible agencies should: a. Identify opportunities for more domestic reprocessing, including for plastics (especially e-waste), metals, fibreglass, plasterboard and aggregate. b. Develop relevant technical specifications and national standards for the re-use of recycled construction materials in infrastructure. c. Support innovation in, and the procurement of, infrastructure design and construction to enable a greater use of recyclable materials in infrastructure.	MfE, MBIE, Local Government
35	**Clarify the strategic role of waste-to-energy** WSP, WTE 2027-2031	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
36	**Improve waste sector data and insight** WSP 2022-2031	Fund improvements in waste data to enable comparisons between volume, performance and processing capacity across waste streams by region and territorial authority. This might be achieved by resourcing the implementation of the National Waste Data Framework.	MfE, Local Government
37	**Encourage public infrastructure waste minimisation and designing for deconstruction** WSP 2022-2031	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 and 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

Refer to Section 10 | Time

A thriving New Zealand: what we need to do
Aotearoa ora rawa atu: Me aha tātou
6

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

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

West Wind Farm, Mākara generates enough electricity each year to supply about 73,000 average New Zealand homes.

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 and 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 29).

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

There are many things we could invest in, but we can't 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 doesn't occur in a vacuum, however. It's entwined with a wider environment that 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.

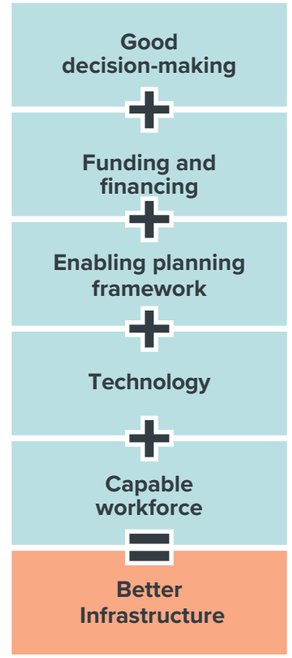


Figure 29:
Better system components
Source: Te Waihanga

We'll 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, the community needs that are met and when they're met, who can access infrastructure and how we use it.

There are many options about how to fund infrastructure. Prices and user charges are standard practice in some sectors, while public subsidies are more common in others. Either way, infrastructure is ultimately funded by users, taxpayers or ratepayers. Choices about how infrastructure is funded affect how the costs are distributed between different people, which can affect equity for people who are vulnerable or disadvantaged in some way.

There are also many options about how to finance infrastructure. Some infrastructure is financed on a 'pay as you go' basis, meaning that revenues from current users pay for upgrades. Other infrastructure is financed using loans or equity investments, allowing up-front costs to be repaid over time. Choices about how infrastructure is financed can affect intergenerational equity. Effective financing spreads the costs of long-lived infrastructure fairly over time and may also speed up delivery by leveraging new sources of finance.

An enabling planning and consenting system is essential to delivering 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 need to carefully weigh up local effects against national objectives.

A 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 the trajectory is unwavering. There's a significant opportunity to increase the spread and uptake of technology in infrastructure. This can contribute to improved productivity and infrastructure delivery and services, raise wages and improve skill levels across the infrastructure sector. Leadership and a clear strategic direction are needed from government, along with a greater emphasis on an open data-environment, which can act as a foundation for technological opportunities. Many of the rapid advancements in technology are being driven by innovation in the digital area. 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 skill sets 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 to 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 on 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 locations 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 infrastructure than ever before. The 2021 Budget included investment of $57 billion in infrastructure over the next four years, and private sector providers are also making considerable investments.[297] After a period of low investment in the 1990s, we now invest a greater share of our national income into public capital (which includes public infrastructure plus other capital elements like vehicles) than most other developed countries.[298]

However, we don't always get the best results from our spending. The World Economic Forum ranks New Zealand's infrastructure performance as 46th out of 140 countries.[299] New Zealand is one of the least efficient high-income countries when it comes to turning public-investment into quality infrastructure.[300] International evidence shows that good decision-making, supported by robust public investment management and a stable long-term pipeline of investment intentions, is essential for lifting performance. Countries with the best public investment management practices get twice as much 'bang' for their investment 'bucks' as countries with poor practices.[301,302]

> "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**

At present, many public infrastructure projects lack sufficient planning and investigation. Fewer than half of the initiatives reviewed by the Treasury's Capital Panel for the 2021 Budget had completed business cases.[303,304] 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're more likely to lead to problems like cost overruns.[305, 306] In Australia, only one in three major infrastructure projects are announced before their business cases have been completed, but these projects account for 79% of the total value of cost overruns.[307] Most countries struggle to control the costs on major public-infrastructure projects and New Zealand has recently experienced major issues in this area.[308]

Poor decision-making can also lead to poor outcomes from infrastructure, such as solving the wrong problem, which means other needs remain unmet. Internationally, there's evidence that public investment is often allocated in response to political concerns rather than actual need.[309] 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 investments 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 was a lack of cohesion and consistency that was driving avoidable overlap, duplication and delay during infrastructure projects. Some common examples of this included policy and practice leadership and the need for central and local government to work together more closely. Submitters agreed that the strategy should address this.

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

- Common and transparent frameworks to guide infrastructure.
- The benefits of consistency in, rather than centralisation of, decision-making and delivery.
- Decision-making rights being made locally or at point of service.
- A desire 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 the 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 on how to invest in and manage infrastructure. These ensure investments are well considered and deliver good value for money. However, decision-making doesn't 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.[310] A consistent, principled approach to infrastructure decision-making ensures that the best projects are 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 3 summarises 10 core principles of infrastructure decision-making that cover decisions at all points in the life of an infrastructure project, from the identification of the problem that needs 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're 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 3: 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 will perform and the level of service it will 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 in 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 publicly release strategic planning information to explain what the problem is, the cost of the problem and the potential 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.	Low-cost options for addressing the need are considered, and planning and design seeks opportunities to minimise delivery costs. Land needed for future infrastructure is protected by delivery agencies, which also ensures appropriate integration into long-term land-use plans.
5. A detailed analysis of a potential project is undertaken through a business case.	A business case is used to rigorously examine a 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 is not announced until this detailed analysis has been completed.
6. Delivery agencies assess alternative funding sources for each potential project.	Delivery agencies minimise the need for public funds by considering other funding options and determining a fair funding split between taxpayers, ratepayers, users and other beneficiaries.
7. Meaningful stakeholder engagement is undertaken at appropriate points throughout project development and delivery.	Delivery agencies should engage with relevant stakeholders when identifying problems and before arriving at a preferred solution. Depending upon the project, relevant stakeholders could include iwi, users, affected neighbours or other interest groups, private infrastructure owners and operators and, where public funding is required, the general public.

Core principles for infrastructure decision-making (continued)

8. All information supporting infrastructure decisions is publicly released.	This includes all analyses underpinning long-term plans and option development and assessment, and extends 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 reviews are confirmed at the outset of a project. The reviews should focus on whether the project was delivered on time and on budget, measuring whether the economic case for the project (in its business case) was 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 a project is funded as part of a broader programme, the corresponding decision-making processes are robust and transparent and prioritise value for money.	The objective, scope, scale and expected benefits of a funding programme are defined and reported against clear assessment criteria and objectives. Funding programmes are routinely assessed and reviewed to ensure investments are delivering against their objectives.

Source: Te Waihanga

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 ways that deliver good-quality services to users at fair and reasonable costs.[311] However, there are many sectors 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's provided directly by the 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 the quality of service and reviews major capital investments. Water sector reform proposes 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 Treasury.

A lack of competition and external regulation can lead to poor decision-making.[312] This can take the form of under-investment, over-investment or poor investment choices.[313] Infrastructure providers that are sensitive to political push-back about high user charges or rates may choose to under-invest in their networks in ways 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.[314] These may include strengthening existing assurance and review processes such as the 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 on lessons from sectors that already face external regulation.

Strategic planning to signal clear investment priorities

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

Signalling investments in advance and maintaining stable investment levels over time can improve the efficiency of infrastructure delivery.[315]

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.[316,317] 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 of infrastructure funding plans and signals priority infrastructure projects well in advance. These include 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 service quality and reliability 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's 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.[318] 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.[319] However, standards don't exist for all sectors, or they may exist but aren't enforced. The cost and funding implications of existing standards are not always well understood. Where service quality standards aren't available, they should be developed and published to guide strategic planning and project decision-making.

Government agencies should signal funding intentions further in advance and raise standards for asset management planning.

Although infrastructure development is often a long-term process, public infrastructure agencies don't often share plans for funding beyond the annual government budget cycle. This can undermine infrastructure delivery and asset management by making it difficult for agencies to invest in the right capabilities and credibly signal future investments to the market.[320]

Councils are required to develop and publish long-term plans that set out their investment intentions over a 10-year period.[321] While priorities can change in response to elections, these provide a degree of certainty about future funding and service-quality improvements. The Treasury requires central government agencies that make significant capital investments to develop Long-Term Investment Plans, but generally these plans don't clearly identify investment intentions.[322] Forward planning tends to be more successful in organisations that have more certainty about their long-term capital budgets.[323]

Government agencies should be required to develop and publish capital investment plans for a minimum period of 10 years. To ensure they're credible, investment plans should be aligned with agency service-delivery priorities and strategies, fiscally sustainable and linked with budget allocations and other sources of financing.[324]

To achieve this, there needs to be a lift in asset management planning among many central government infrastructure providers, with the aim of closing large observed variations in the quality of asset management plans.[325] The approach to lifting quality should lean on the experiences of local government and regulated infrastructure, where certain standards are clearly specified and disclosure requirements exist. International best practice also indicates the importance of independent assurance (to identify, report on and take action on risks and challenges) to ensure that investment plans are credible and linked with government budget allocations.[326] Common standards in asset management

would help further, allowing asset information to be used across a range of systems and support a range of data sets, particularly for documentation and mapping.[327] This could also improve communication between sectors, reduce maintenance costs and assist with efforts to integrate spatial planning.

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

Projects that can help us solve long-term challenges, such as those 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 visibility of and assurance about what's planned.[328] When developed well, this can have benefits for infrastructure providers, decision-makers and construction firms seeking to understand future capability needs.

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

- **Priority infrastructure projects**. These are large projects or packages of smaller projects that have been through a robust business case process. This process identifies important problems to solve, considers all options for addressing them and identifies achievable solutions that deliver good value for money and are 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 haven't yet been completed.

The priority list should cover projects from all infrastructure sectors. It shouldn't focus solely on major projects, as many of the problems we're 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 and more priority investigations are identified. As an independent advisor on infrastructure, Te Waihanga will monitor and advocate for the progress of projects and investigations on the list.

Reliable and timely information to guide decision-making

Information that's 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's 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 that's available and making decisions when the right information is available.

Public communication should give the community confidence.

Governments usually aim to keep communities informed of proposed new infrastructure projects, often from the very start. There's 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 government must be careful to avoid premature announcements about scope, costs and timeframes.[329] Providing these details could disappoint communities if changes are made later in the project and it places unhelpful pressure on project delivery teams. It can also limit the ability of a project to adapt successfully and, as a result, reduce the benefits of the government's investment.[330]

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

There's a shortage of comprehensive, comparable and consistent data on the performance of New Zealand's infrastructure.[331] Good data is available for some sectors, such as electricity distribution, but it can be difficult to make comparisons 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 should include collecting, analysing and publishing data on performance at multiple levels:

- **Projects**: To understand how individual assets perform in delivery and operation, including the 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.

The value and importance of regular objective review and reporting on project outcomes are highlighted in Case Study 12 on the publication of an annual report on the United Kingdom's Major Projects Portfolio.

CASE STUDY 12

United Kingdom Government's Major Projects Portfolio publication

The Infrastructure and Projects Authority (IPA) publishes an annual report each year as part of the government's commitment to transparency.

The annual report tracks the progress of projects currently in the Government Major Projects Portfolio (GMPP) and provides analyses of how they're performing. Project managers are required to provide quarterly data returns on delivery progress. This data is used to monitor progress across the portfolio and risks and insights are shared with departments and the centre of government. The 2020/21 GMPP snapshot comprises 184 projects with a total Whole Life Cost of £542 billion and £826 billion of monetised benefits that are delivered by 18 departments and their arms' length bodies.

The IPA assesses the likelihood of each project delivering its objectives to time and cost with a Delivery Confidence Assessment (DCA). Ratings are categorised into five groups, with each providing an indication of the likelihood of successful delivery and level of associated risks.

The annual report reflects the IPA principle for project success of "Tell it like it is".[332] GMPP projects are the government's most difficult and challenging projects to deliver. They are, by definition, large, complex or innovative, with many 'breaking new ground'. This is often reflected in the pattern of delivery confidence. In the 2021 report, 51 projects were assigned Red or Amber/Red (28%).[333]

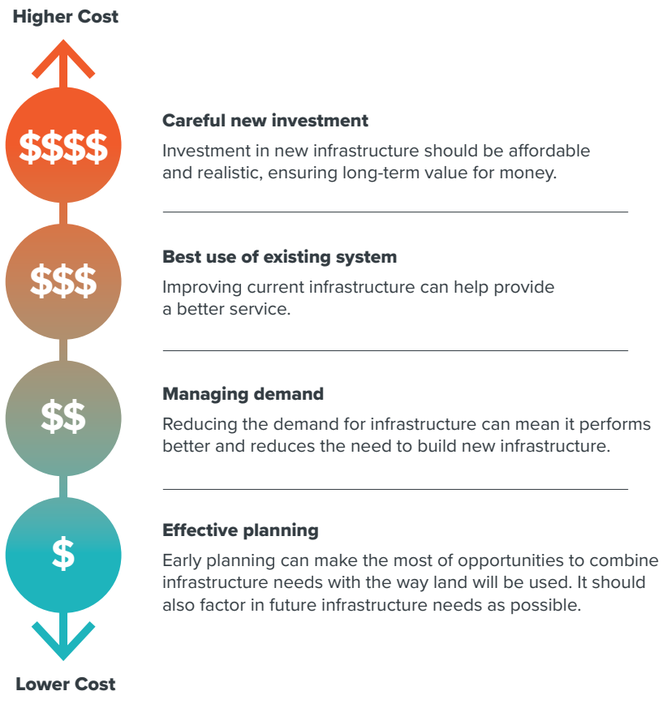
Regular, objective reviews of a project's likelihood of success have been an important part of improving the delivery performance of the GMPP. The regular reviews help ensure that government resources are deployed to priority areas and align with the IPA's commitment to increasing the focus on the most difficult projects in order to set them up for success. Combined with other accountability measures, including a clear identification of project Senior Responsible Officers and regular reviews of the management of delivery challenges by the Public Accounts Committee, DCAs are often improved over time.[334]

There's a particular need for better information on infrastructure delivery costs, including benchmarking to enable more efficient investments.[335] There's little systematic information on how and why infrastructure costs have changed in recent decades, how our costs compare with those in leading countries and how cost performance differs in different infrastructure sectors. Regular analysis and benchmarking of cost performance is needed.

Robust assessments of options, including non-built options, are essential.

When choosing whether and how to invest, it's important to consider the full range of alternatives rather than prematurely focusing on a single infrastructure-based solution. Identifying and prioritising non-built solutions to infrastructure challenges will increase the value of infrastructure for the community and the environment and reduce the risk of committing to a solution that's not technically feasible to deliver.

Figure 30: Decision-making hierarchy



Source: Te Waihanga

Infrastructure planning should consider options that don't involve building new infrastructure, including effective planning, demand management and improvements to existing infrastructure (see Figure 30).

Examples include:

- Variable pricing to spread demand between peak and off-peak periods, for instance through congestion pricing, lower off-peak electricity prices, or off-peak discounts for public transport fares.
- The use of digital solutions like telehealth to deliver services.
- Energy and water efficiency standards that manage demand on these networks.
- Planning initiatives like transit-oriented development that reduce the need to travel.

Where non-built options are viable, they allow infrastructure challenges to be addressed in a cost-effective, low-carbon way. They're especially important to consider in light of the need to mitigate carbon emissions.

Infrastructure providers often face uncertainty about the future demand for infrastructure and the likelihood and impact of natural hazards, including sea-level rise. Where appropriate, infrastructure planning should build in flexibility to adapt to uncertainty. Examples include protecting infrastructure corridors in advance of development and designing infrastructure that can be cost-effectively relocated or strengthened in response to increasing coastal hazards. Planning tools like dynamic adaptive policy pathways and real options analysis can be used to guide these decisions.[336]

Project selection should be guided by a 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 the best 'bang for buck'. To do this, public infrastructure providers should commit to preparing and publishing a cost-benefit analysis (CBAs) for all major investments.

A good CBA comprehensively considers all relevant costs and benefits, including non-financial economic, social, cultural and environmental impacts and long-term impacts. The Treasury's Guide to Social Cost Benefit Analysis outlines principles for assessing and weighing up these impacts.[337] Some infrastructure sectors have additional CBA guidance, such as the Waka Kotahi monetised benefits and costs manual[338] and the Transpower capital expenditure input methodology published by the Commerce Commission.[339]

The quality of a CBA is only as good as the quality of the information that's analysed. In some cases it may be necessary to consider separately impacts that are difficult to model or fully value, such as environmental impacts and equity impacts.[340] Key parameters should be published and regularly updated to ensure public confidence in the analysis.[341] To ensure that CBA supports investment for the long-term, the social discount rate, which determines how much weight is placed on the future benefits of a project compared to the current benefits, should be reviewed.[342]

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

Once a project is completed it can be reviewed to compare its intended inputs, outputs and outcomes with those actually delivered. The data can then be used to guide decision-making on subsequent projects, ensuring they better reflect real-world experience. However, post-completion reviews are rarely done and when they're conducted, lessons aren't always taken onboard.[343] The inconsistent use of reviews to measure how well projects deliver against what was planned, makes it challenging to identify successes and failures.

Post-completion reviews are considered best practice, especially for major infrastructure projects.[344] They should be prioritised, funded and published after completion. Independent audits of reviews will ensure they're impartial, rigorous and transparent.

Standardised frameworks for procurement and delivery.

By improving the government's abilities 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 processes 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 its own nuances. This can create needless costs and causes confusion for industry.[345]

There's a need to align the standards and processes used across projects, sectors and agencies to strengthen the 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 be planned and delivered together, where beneficial.
- Broaden the number of possible suppliers, consultants, contractors and other experts by reducing barriers to entry.

Provide consistency and clarity to suppliers on the wider public outcomes sought through the procurement process.

Each of the projects in the infrastructure pipeline provides an opportunity to deliver a set of wider public outcomes, such as opportunities for Māori, waste minimisation, emissions reductions, the adoption of digital technology, and improved professional development that would not otherwise be delivered.[346] However, inconsistent expectations of suppliers can create confusion for industry and limit the number of possible suppliers for projects. Providing consistency and clarity on the wider public outcomes sought through procurement can both broaden the number of possible suppliers and ensure that wider public outcomes are achieved.

In the long-term, getting the best outcomes may also require changes in how agencies are structured, governed, funded and regulated. Significant structural changes shouldn't 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.[347]

7.1.4. Recommendations

No.	What	How	Who
38	**Strengthen government as a sophisticated client of infrastructure** WEF, ROY 2022-2031	Take the following steps to develop the client capabilities 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 in end-to-end delivery, including governance, commissioning, procurement, negotiation, oversight and whole-of-life management systems for major infrastructure.	Treasury, Central Government Delivery Agencies
39	**Increase the clarity of long-term investment intentions for public infrastructure agencies** AIP 2027-2031	Central government requirements for long-term investment planning and asset management planning for all public infrastructure providers should be aligned with standards for local government and regulated infrastructure. Long-term investment planning should be transparent, aligned with agency service-delivery priorities and strategies, and linked with budget allocations and other sources of financing.	Treasury, DIA, Local Government
40	**Strengthen independent advice for infrastructure prioritisation** AIP 2022-2026	Establish an independent infrastructure priority list to build consensus on key projects and initiatives that address significant long-term problems. The development of 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 update the priority list regularly.	Te Waihanga
41	**Improve infrastructure performance reporting and insight** DSA 2022-2050	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

Refer to Section 10 | Time

42	**Optimise infrastructure investment by considering non-built solutions first** INH, NOF 2022-2031	Consider and prioritise non-built options when choosing how to address infrastructure challenges, including: a. Using pricing to manage demand. b. Making better use of existing infrastructure by adapting or re-using it. c. Using regulation and education to manage infrastructure demands. d. Considering lower-cost options before progressing to higher-cost options.	Treasury, Central Government Delivery Agencies, Local Government
43	**Strengthen project evaluation through cost-benefit analysis** PII 2022-2026	Deliver consistent and transparent project evaluation by requiring: a. Local and central government agencies to undertake and publicly release rigorous social cost-benefit analyses of all public infrastructure investment proposals where the whole-of-life costs of the proposals exceed $150 million. b. Commitments to projects to only be made after the completion of this analysis, rather than prior to undertaking the analysis. c. Analysis to recognise inter-generational choices appropriately and include wider environmental and social impacts.	Treasury, MBIE, Te Waihanga
44	**Ensure an appropriate consideration of future generations in project evaluation** TNT 2027-2031	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
45	**Improve the infrastructure project knowledge base** DSA 2022-2050	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 costs against business case estimates.	Central Government Delivery Agencies
46	**Improve infrastructure cost analysis** BUP 2022-2050	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 every five years to inform ongoing Infrastructure Strategy development.	Te Waihanga

Refer to Section 10 | Time

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 investments are made.

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

We have choices in how we fund and finance projects. These choices have implications for how much infrastructure can be provided, the quality of that infrastructure and the willingness of users to pay for that quality, and equity implications 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 and exchanges) 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 10-fold increase in data consumption in the past decade.[348]

It is common for funding and financing to be used interchangeably. From a technical perspective they do have different meanings so in this strategy we use these words in the following way. Funding represents all the money needed to pay for infrastructure. It comes from the community through users, taxpayers and ratepayers. Financing is about when we pay for our infrastructure. It could mean using cash surpluses now or borrowing and repaying later.

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 past two decades,[349] with particularly large increases in electricity and telecommunications.[350] However, we still need more infrastructure than we currently have plans to fund (as shown in Section 3).

The many reasons for these pressures include:

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

Analyses of specific infrastructure sectors often shows a need for more investment. Examples include the Department of Internal Affairs' review of three waters investment requirements[351] and Transpower's estimates of the renewable electricity generation infrastructure that will be needed to remove carbon emissions.[352] Both of these reviews found that more infrastructure is needed. We have choices on 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 and be financially sustainable for infrastructure users and providers.

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 were under pressure, but that designing new methods was challenging. We heard there was a need to avoid breaking the 'person who benefits pays' (or benefit) principle and that there still needed to be a place for local decision-making on 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 that can encourage development and growth, like transport connections. Suggested funding mechanisms were varied, but included a share of GST generated in a region, competitive development funds and a greater use of user-pays systems.

Stakeholders and submitters had different views on what is causing more problems for infrastructure: funding or financing. Generally, sectors where charging for services is common, such as electricity and telecommunications, felt that financing was a constraint. Sectors that rely on general funding pools, like transport, were 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 that's built now.

A principled approach to funding and financing decision-making gives communities clarity on how infrastructure will be funded and when they'll pay. Table 4 outlines six core principles for infrastructure funding and financing, based on best practice.[353] These principles support the broader infrastructure decision-making principles outlined in Section 7.1.

Table 4: Core principles for infrastructure funding and financing

Infrastructure funding and financing principles	
Principle 1:	Those who benefit pay – Infrastructure services should be paid for by those benefiting from the services (the benefit principle) or creating a need for the service (the causer principle).
Principle 2:	Intergenerational equity – Funding and financing arrangements should reflect the period over which infrastructure assets deliver services and be affordable for current and future generations.
Principle 3:	Transparency – There should be a clear link between the cost to provide infrastructure services and how services are funded. Wherever possible, prices should be service-based and cost-reflective.
Principle 4:	Whole-of-life costing – Funding requirements should include the ongoing costs to maintain and operate an infrastructure asset and the cost to renew or dispose of it at the end of its life as well as the up-front cost to construct or purchase it.
Principle 5:	Administratively simple and standardised – Administrative costs for both providers and users should be minimised unless there are clear benefits from more complex funding and financing arrangements.
Principle 6:	Policies for majority of cases – Funding and financing policies should be written to work for the majority of cases. If needed, alternative or supplementary mechanisms should be added to provide flexibility and ensure fairness.

Source: Te Waihanga

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.

These examples highlight that institutional incentives affect how funding and financing tools are used in practice. As well as providing new funding and financing options, infrastructure providers need incentives to make better use of tools that are already available.

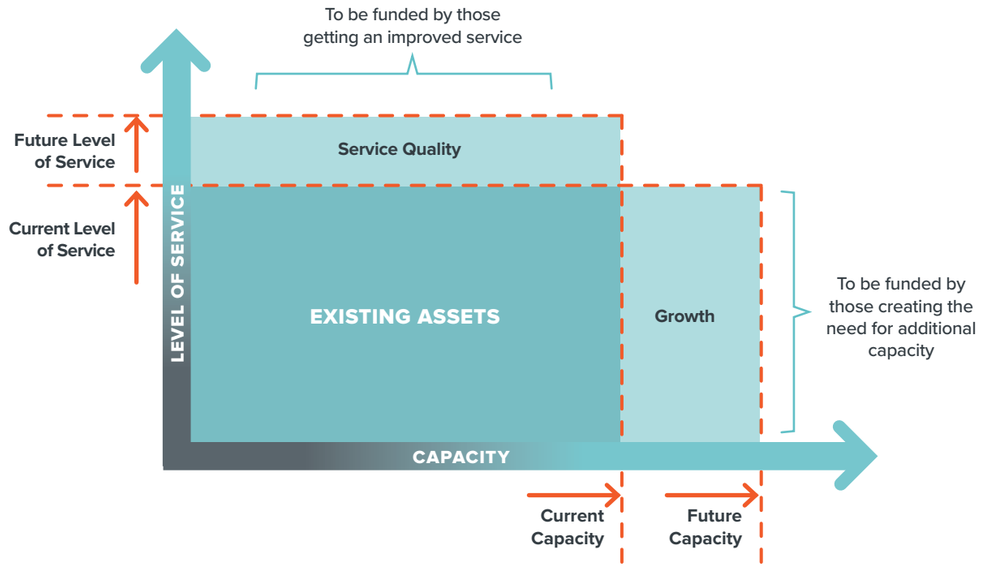
Better use of prices to fund infrastructure services

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, extending the opening hours for a library). Sometimes both an increase and an improvement in services are needed (see Figure 31).[354]

Funding requirements are affected by service quality and demand growth

Figure 31: Multiple factors can drive the need for investment



Source: Te Waihanga

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

Charging people directly for the services they get from the infrastructure they use has a range of benefits. Charging those who benefit gives infrastructure providers direct information on how many people are using the service and a revenue stream to fund upgrades where they're needed. This helps providers to better plan for how they can improve their service to manage periods of high demand. It might mean planning to build new infrastructure, but it also encourages innovation. If the cost of providing infrastructure increases and users aren't prepared to pay the higher price, providers have an incentive to find alternative ways to provide quality services at a lower cost.

Charging also 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 other times. This approach is already at used in sectors such as electricity.[355] 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's 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.

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

- In wastewater, allowing local authorities to rate wastewater based on volumes creates an important link between the services provided and the costs to users. It encourages the use of water-efficient toilets and basic maintenance to reduce leaks.
- In water, a 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's time, location and distance sensitive can reduce congestion on busy roads by smoothing peak demand. This helps avoid the need for costly infrastructure upgrades in complex urban environments.
- In tourism, a 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 in technology can spark changes to infrastructure pricing. For instance, the electrification of the vehicle fleet will cause revenue from fuel taxes to decline. This is a challenge because fuel taxes currently provide a large share of overall transport funding. Digital technologies enable road use to be priced in a more sophisticated way. There's a need therefore, to reform the transport funding system.

Some infrastructure charges, like waste levies and 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 be set in legislation or regulation and infrequently updated. To ensure these charges are effective over time, they should be automatically adjusted for inflation.

The transport funding system will need to change.

Many of New Zealand's existing transport funding tools have been world leading, but increasingly they're in need of change. The existing transport funding system:

- Is a source of inequity between road users.
- Provides few demand management signals to resolve congestion issues or contribute to emissions reductions.
- Faces some long-term sustainability challenges as vehicles become more efficient or as modal shift increases.[356]

In addition, while revenue from traditional transport funding sources wasn't declining prior to the COVID-19 pandemic,[357] it's increasingly insufficient to meet the requirements of new infrastructure. How New Zealand pays for large-scale transport projects is a challenging issue, particularly when these projects are intended to enable greater housing and urban renewal, as the users and the beneficiaries of the projects may not be the same. At the same time, debt limits are constraining local government's contribution to land transport projects. Unlike other categories of infrastructure, transport funding is complicated by the fact that assets generally don't generate revenue once built.

As work on a new transport funding system continues, it will need to consider:

- How to reflect adequately the cost of infrastructure provision to users, potentially including variations in infrastructure costs between locations.
- How social costs, such as peak-time urban road congestion and carbon emissions, are passed on to users.
- The role of technology and especially digital technology.
- The contributions from users across different modes.
- The extent to which equity considerations will be addressed directly within the funding system or need to be addressed outside the system.

Better communication is needed to improve public understanding of infrastructure funding options, including pricing for services.

It will be important to build public understanding and acceptance of the transition towards different ways of pricing and funding infrastructure. Pricing approaches vary across different infrastructure sectors (see the 'pricing across the sectors' box below) and existing approaches don't always support provision of quality infrastructure in an equitable and efficient way. However, pricing mechanisms where those who benefit pay aren't always well supported unless people understand the benefits of implementing them.

Better communication about infrastructure choices, including the link between how infrastructure is paid for and the quality of the services that are provided, could help improve community understanding and acceptance of pricing for infrastructure services and other funding options. This could be done through infrastructure providers' regular communications with their customers, or new information campaigns.

A world-class infrastructure system: how we get there
Tētahi pūnaha hanganga kei te taumata o te ao: Te huarahi

Pricing across the sectors

Infrastructure service prices should generally be **service-based** and **cost-reflective**.[358]

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's a fixed cost, as well as some charges that vary with use. A fixed access charge (to cover 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 the 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, road-user charges, rates and other user charges like tolls and public transport fares. Road-user charges are related to the cost of providing roads, as they are higher for heavier vehicles that have greater impacts on maintenance costs. However, transport charges are not typically location or time-based and as a result, don't send signals to users to avoid congested urban roads at peak times.

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 the infrastructure that's needed to service new housing (like new roads, wastewater infrastructure, parks and libraries). These charges are called development contributions and are consistent with Principle 1, the benefit principle and Principle 3, the transparency principle (see Table 4). 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 infrastructure. In principle, this can be achieved by dividing the cost of building new infrastructure by the level of new housing demand. This amount would then be 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 on how much the developers 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're 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. This 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, or making other payments in lieu. This can lead to a gap between the funds collected and the amount that needs to be spent on infrastructure. Those receiving the exemptions also have no incentive to try to reduce their use of infrastructure.

Currently, Crown property is exempt from local government rates.[359] Exempted property include schools, hospitals and some defence force land, despite much of the property requiring substantial infrastructure investment by local government. There are also some non-Crown exemptions.[360] However, in some cases they may pay for services, such as fees for waste disposal or volumetric water charging.

Removing rates exemptions would remove the disadvantage of Crown land falling within council areas 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, ringfencing activities that don't generate demand for local government infrastructure, or implementing user pays systems for some services.

Sometimes the people who benefit from infrastructure are not just the users of that infrastructure.

When new infrastructure generates wider benefits, this should be reflected in funding arrangements. An example is when a train station is built, making it easy for people who live nearby to take public transport. This can benefit road users by shifting demand off congested roads and also increase the value of nearby properties.[361] In this example, the users aren't the only group to benefit from infrastructure services. Funding should come partly from the wider group that benefits, especially if it's difficult to recover the full cost by only charging the people using the service.

One way to do this is by levying charges based on the gain in property value. 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's announced.[362]

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,[363] further clarification is needed on whether councils can legally use a change in land value as the basis for a targeted rate.[364] There are also other roadblocks to using them more widely, which arise from consultative processes at the local level.[365] These should be considered as part of the review of local government.

Government funding is justified in some cases

There's a place for a public subsidy when there are wider social benefits or it's needed on the grounds of equity.

For some types of infrastructure, like schools and hospitals, charging users would not be enough to match the need for their services or the benefits they offer. Public transport is another example where the wider social and environmental benefits justify a public subsidy.[366] There are also instances where vulnerable groups, which could be those on low incomes or with high needs, require some level of public subsidy. The primary health sector is an example of low-income consumers receiving 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.[367] When subsidies are needed, they represent an exception to Principle 1, the benefit principle (see Table 4). However, consistency with Principle 3, the transparency principle, must remain by making the level of subsidy transparent and appropriately targeted.

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

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

- It's not practical to exclude users who do not pay direct prices. This applies, for instance, 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, community facilities and social housing.

In these cases, a mix of government funding and direct pricing may be appropriate. Where this applies, there's a case to increase infrastructure funding to address important challenges. However, these instances require careful management of public funds as the resulting cross-subsidies can mean that one group of people is required to pay for use by another group. Where this approach is taken, government subsidies for infrastructure should continue to follow the funding and financing principles.

Infrastructure often has implications for equity, but lowering prices isn't always the answer.

The pricing of infrastructure services can lead to fairness and equity issues for low-income users if it's not matched by appropriate policies to offset these effects. However, making changes to pricing isn't necessarily the right way to manage these issues. This is because any policy decision to lower prices for all users below the cost of provision can result in funding problems that restrict infrastructure services. This can create other equity issues.

Prices need to be applied consistently to provide sustainable funding for infrastructure services and to encourage the efficient use of infrastructure networks. 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 policies to ensure affordability issues aren't created for vulnerable New Zealanders. These 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 continue to have access. Assistance should be targeted to the vulnerable, as it's often more effective when focused on people rather than places.[368,369] Place-based approaches to mitigating equity impacts can have unintended consequences as people move in to take advantage of improved infrastructure or cheaper prices. For instance, in certain circumstances New Zealand transport investments have been shown to raise land prices and increase the cost of housing in areas that benefit.[370] However, a place-based approach can be appropriate for certain infrastructure and under certain circumstances, for instance when low-income groups show limited mobility (which can't be addressed through other policies[371]) or where targeted groups have a strong connection to the land.

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

Central government has established various infrastructure-related capital funds in the last decade. A selection of these totalling $32 billion is shown in Table 5. Some of these funds are still active, while others have been exhausted or largely exhausted. Each fund has its own criteria for how it can be spent, repayment terms, and 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 the funds clearer, but it also spreads 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 that depends on a consistent, predictable pipeline of work.

Fewer consolidated funds in the future would result in better prioritisation and coordination of programmes at the national level (see Case Study 13). 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 the predictability and stability of funds, take advantage of economies of scale and build a 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 deliver on the political expectations set out in Government Policy Statements. Consolidated funds could still allow for earmarking of funds to specific purposes when appropriate.

Table 5: Examples of recent infrastructure funds

Examples of recent infrastructure funds	Amount (NZD)	Year
Ultrafast Broadband Initiative[372,373,374]	1.5bn	2011, 2015
Rural Broadband Initiative Phase 1 and 2[375]	430m	2011, 2017
Urban Cycleways Programme[376]	100m	2014
Irrigation Acceleration Fund and Crown Irrigation Investments[377]	400m	2011, 2015
Christchurch Regeneration Acceleration Facility[378]	300m	2018
Housing Infrastructure Fund (consisting of 10-year interest free loans)[379,380]	1bn	2016
Provincial Growth Fund [381]	3bn	2017
Tourism Infrastructure Fund[382]	25m	2019
New Zealand Upgrade Programme[383,384]	14bn	2020, 2021
COVID-19 Response and Recovery Fund: Infrastructure Reference Group[385]	3bn	2020
Three Waters Reform: Stimulus and Reform Funding[386]	761m	2020
Māori and Public Housing Renewable Energy Fund [387]	28m	2020
Housing Acceleration Fund[388,389]	3.8bn	2021
Three Waters Reform: Establishment of Water Service Entities[390]	296m	2021
Three Waters Reform: Support for Local Government Transition[391]	2.5bn	2021
Hypothecated Emission Trading Scheme Auction Revenue[392]	3bn	2022
National Land Transport Fund[393]	16.3bn	2021–2024

CASE STUDY 13

International Examples of Infrastructure Funds

New South Wales Restart NSW Fund[394]

In 2011, the New South Wales (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 AUD$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 that improve economic growth and productivity across all sectors. To get funding through the Restart NSW Fund, a project must be recommended by Infrastructure NSW and have a cost-benefit ratio 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. 30% of Restart NSW Fund is targeted at regional and rural areas over the lifetime of the fund.

Canada's blended approach to infrastructure funds[395]

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 CAD$33 billion in funding is being delivered through bilateral agreements between Infrastructure Canada and each of the Canadian provinces and territories. Infrastructure Canada evaluates proposals 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 it 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's an interest cost associated with this. In general, communities will benefit from accelerating investments where they have 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 two factors:

- Debt incurred to build infrastructure sits on council balance sheets. This happens regardless of whether the debt has been incurred by a council directly or indirectly through a council-controlled organisation or an entity that's majority-owned by the council.[396] This means 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 ceilings').[397] 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.[398]

The Infrastructure Funding and Financing Act 2020 seeks to address this problem by using Special Purpose Vehicles (SPVs), where financing of local infrastructure can occur without affecting council debt levels. An SPV established under the Act is a standalone legal entity that's not owned by a council, so debt isn't on the council's balance sheet. SPVs can charge levies on properties benefiting from infrastructure provided by the SPVs. Based on this funding source, the SPV can raise finance to undertake infrastructure development.[399,400]

Public-private-partnerships are a viable option for delivering infrastructure.

A public-private-partnership (PPP) is a public-private risk-sharing framework that's widely used internationally. Unlike traditional methods for delivering projects, PPPs involve the private sector and aim to boost efficiency and effectiveness through the project lifecycles. In New Zealand, a PPP is typically a long-term contract for the delivery of a service that involves the construction of new infrastructure or improvement to existing infrastructure that is financed from external sources. Full legal ownership of the assets is retained by the Crown.[401] 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 than they might otherwise.

There are currently eight PPPs[402] planned or underway in New Zealand and these have a combined total cost of $4.2 billion.[403] There have been some high-profile examples of PPP project delays and cost overruns. However, the five PPP projects currently operational in New Zealand have generally been delivered on-time and on-budget for the Crown. Each operational project has experienced delays of less than six months.[404]

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

7.2.4. Recommendations

No.	What	How	Who
47	**Improve equitable funding of local infrastructure** ULH 2027-2031	Investigate options and timing to phase in the removal of existing Crown exemptions from paying rates, recognising when a demand for infrastructure is generated. The approach should avoid creating excessive and unexpected financial liabilities.	DIA
48	**Reform the transport funding system** KCM 2022-2031	Implement a new, fit-for-purpose transport funding system that's sustainable and adequate for meeting future transport investment requirements. The system should incorporate principles for user charges and best-practice funding and include shifting vehicles to time, location, distance and level-of-service-based pricing. Establishing a new system should include: a. Establishing necessary transport funding requirements. b. Introducing necessary complements or replacements to Road User Charges and Petrol Excise Duty. c. Determining how additional funding, if required, should be collected.	MoT
49	**Improve and streamline the application of development contributions** FFI 2027-2031	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
50	**Consolidate existing separate infrastructure capital funds** AIP, FFI, RNS 2022-2031	Fragmented infrastructure capital funding pools should be consolidated and integrated in a transparent infrastructure capital fund, or funds. The consolidation of national capital funding programmes for infrastructure would enable the Government to prioritise investments based on national significance and net benefits and enable greater public transparency of infrastructure capital funding decisions. How funding is held and distributed should: a. Be set out transparently. b. Include a consideration of the use of grants, loans and investments, or some combination of these.	Treasury
51	**Improve the ability to debt fund infrastructure** LFF 2027-2041	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 2020. b. Explore other Special Purpose Vehicles as a mechanism for new infrastructure investments.	Treasury, DIA
Refer to Section 10	Time		

No.	What	How	Who
52	**Improve funding of infrastructure services through targeted funding tools** LFF, FFI, TCQ 2027-2031	Establish targeted funding tools for the following applications: a. Tourism: Ensure that the International Visitor Conservation and Tourism Levy can be used for tourism infrastructure, especially by local authorities with high international visitor numbers that are otherwise struggling to secure funding sources. b. Wastewater: Introduce legislative change that clarifies the ability of local authorities to direct-rate wastewater based on volumes, to create a better link between services and costs to users. c. Waste: Investigate what funding mechanisms will best achieve the objectives of the Waste Minimisation Act 2008 and the National Waste Strategy and incentivise behaviour appropriately.	MBIE, MoT, DIA, MfE
53	**Encourage the use of value capture tools to fund infrastructure for growth** BUP, FFI, LFF, MHT 2022-2031	Enable value capture tools through legislation to ensure that more funding is available for infrastructure that generates value for users and communities.	Treasury
54	**Increase infrastructure funding to meet our infrastructure challenges and boost productivity** FFI, TIC 2027-2050	Given that current expenditure levels are unlikely to be sufficient to provide for infrastructure needs in coming decades, a material increase in infrastructure funding from both public and private sources is required to meet our infrastructure challenges and boost productivity. The government should increase infrastructure funding where there are opportunities to use investment to support productivity growth, resilience and improvements in environmental outcomes. Investments should be made based on rigorous assessments of which projects deliver positive value for money.	Treasury
55	**Ensure that infrastructure charges keep pace with inflation** LFF 2022-2026	Infrastructure related charges, fees and levies that are set out in legislation or regulation should be adjusted for inflation.	Treasury, Local Government
56	**Improve public understanding of how infrastructure is funded** FFI 2022-2026	Improve communication about how infrastructure is priced and funded to build public understanding, including: a. How infrastructure is priced in different infrastructure sectors, and what implications this has for equity and the quality of infrastructure provision. b. The link between how infrastructure is paid for and the quality of services that are provided.	Te Waihanga, Infrastructure Providers
		Refer to Section 10	Time

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 with the urgency of the challenge.

We use the planning and consenting system to make decisions on 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 affect 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 we need to meet future challenges, such as those relating to a net-zero carbon emissions economy, larger populations, affordable housing and a greater resilience to shocks and stresses, as well as lift our environmental performance. Our planning system must enable us to get the infrastructure we need to meet these challenges.

7.3.1. Context

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

A good planning system:

- Enables infrastructure to be constructed, maintained and upgraded in a timely way to ensure that the government can fulfil its obligation to deliver infrastructure services.
- Efficiently manages the environmental impacts of infrastructure development in ways that are proportional to the magnitude of impacts.
- Considers the benefits of infrastructure provision, including national environmental benefits from reducing greenhouse gas emissions, as well as the costs.
- Coordinates across multiple institutions and provides clear and certain guidance on how to consent projects.

Our planning system slows down essential infrastructure projects.

New Zealand suffers from long delays between project planning and delivery. Many infrastructure projects must go through a resource consent or designation process. Resource consent applications typically require detailed analyses of the environmental, social, cultural and economic impacts of projects. They're 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.[405]

As well as requiring resource consent, infrastructure projects can require approvals from multiple agencies, including funding approval. Some infrastructure projects, such as schools and hospitals, also require a building consent. When these approval processes are poorly coordinated, they can add further costs and delays, or even halt a project.[406]

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 can serve whole communities (in the case of a school or town hall), cities (through a road network), regions (through 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.

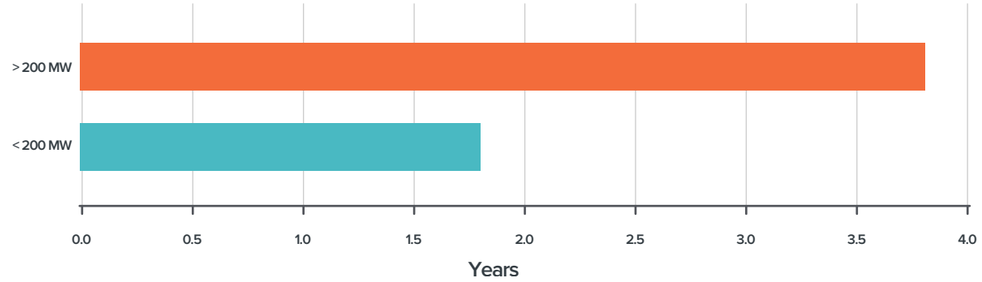
It can take years to get consents for infrastructure projects like wind farms.

Figure 32 shows the time taken to obtain a resource consent decision for 10 wind farm applications. Four were for wind farms exceeding 200 megawatt capacity and six were for smaller wind farms.[407] In every case, the consenting decisions for large projects took more than three years. The longest took more than five years and was withdrawn. The average for the four larger wind farms was 3.8 years, compared to 1.8 years for the smaller wind farms. Reducing consenting timeframes for large wind farms will be essential to 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.[408] There are similarities in their consenting processes that we should consider when reviewing our onshore and offshore consenting systems.

Consents take far longer for large wind farms

Figure 32: Time taken to consent wind farms in New Zealand



Source: Te Waihanga

Consenting delays are only the tip of the iceberg.

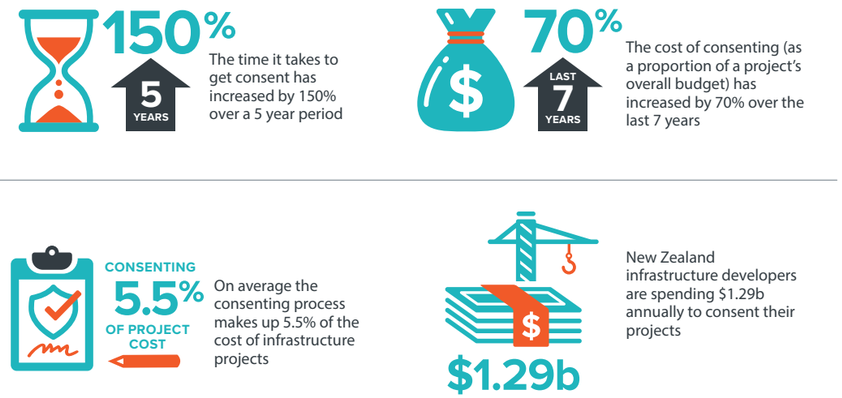
Public infrastructure projects can be delayed for many reasons, including poor coordination among organisations making decisions. For example, Auckland's Northern Busway was originally proposed in 1987 but was only completed in 2008. The 21-year timeframe was primarily caused by the number of planning and funding agencies involved, rather than consenting delays.[409] Auckland's second busway, the Eastern Busway, is currently scheduled for completion in 2028, over 20 years since planning began.[410] By contrast, Brisbane's first busway was proposed in 1995 and completed in 2001, only six years later.[411] Brisbane delivered two more busways between 2004 and 2011.[412]

Consenting infrastructure is costly and the costs are increasing.

The resource consenting process is not only time consuming, but also costly (see Figure 33). On average, consenting accounts for 5.5% of the total cost of infrastructure projects.[413] It includes application preparation and hearing costs, as well as financing costs due to delays. These costs appear to be higher than in other developed countries.

The consenting process can add significant time and cost to projects

Figure 33: Key statistics on the time and cost impacts of infrastructure consenting processes



Source: Te Waihanga, data from 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 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's 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 33. 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[414]

7.3.2. What we've heard

In the Aotearoa 2050 survey undertaken by Te Waihanga, 82% of respondents said that the environment should be either a 'very high' or 'high priority' when making decisions on how New Zealand should get ahead with its infrastructure. The length of time it takes to build new transport options was ranked as 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[415] requires the government to ensure that the wellbeing of New Zealanders is upheld and improved through:

- 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 meeting 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 quality standards that local government must comply with. For 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 resource management reforms need to enable the government to deliver on this legislative mandate, rather than inhibit it. The proposed Natural and Built Environments legislation doesn't need to relitigate whether it's the right decision to improve safety on a road, build a new prison or upgrade a transmission line. The mandate to provide for infrastructure has already been given to the government under existing legislation.

Instead, decision-makers under the proposed National and Built Environments legislation should consider 'how' legislatively mandated infrastructure can be delivered within environmental constraints, not 'if' the infrastructure should happen. 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,[416] the construction of a national hockey stadium[417] and redevelopment of a pony club to be funded in order for an infrastructure project to gain consent.[418] In some cases the definition of an 'effect' has extended beyond the management of natural and physical resources to effects like impacts 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 those relating to environmental quality, health and safety and building quality, 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 delivering significant safety benefits. Examples include recent changes to temporary traffic management procedures, which have been reported to increase roadwork costs and slow down project delivery in urban areas,[419] and requirements to use scaffolding when working on single storey buildings.[420] Restrictions on the hours when work can be done may have a similar effect.

While health and safety should be a priority, an evidence-based approach is needed for designing health and safety requirements. Consideration of the costs and benefits of all new requirements is required, focusing on those areas where the benefits of action are demonstrated to be the greatest.

Using spatial planning to coordinate infrastructure delivery

Effective spatial planning relies on well-informed long-term decisions.

Regional spatial planning offers an opportunity to take a strategic approach by considering how different investments in and uses of the land can have wider economic, social, cultural and environmental impacts.[421] Regional spatial planning is discussed at greater length in Section 6.2.

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 view for 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 reports and information on locations suitable for energy resources and sites of cultural, historic 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 placed 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 it focuses on the impacts that a development or activity may have on the immediate environment. Those seeking consents need to minimise the 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 infrastructure regularly delivers benefits to a larger group of people than that 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 in 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 often means being on the edge of cities. But residents are reluctant to live near quarries because of the impacts they have on their local areas such as noise, dust, unsightly views and truck movements. These issues are becoming more of a problem as our cities grow and boundaries expand, and are 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 and regionally significant activities that can have negative local impacts, there'll always be trade-offs. But the current decision-making framework isn't working well in resolving this and a more consistent performance management framework is needed. This would give a 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 and 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 have been seen following natural disasters (such as the Hurunui/Kaikōura earthquake discussed in Case Study 14) when the process was streamlined and infrastructure services were established far more quickly than would have normally been 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 in 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 can't be delivered with only a 90% complete

A world-class infrastructure system: how we get there
Tētahi pūnaha hanganga kei te taumata o te ao: Te huarahi
7

transmission network and a rail network can't work if rail bridges can't be crossed. Sometimes this type of infrastructure needs to pass through sensitive environments so the rest of the wider network can function properly.

Infrastructure requires a planning system that's more permissive, based on a greater use of national standards and a lower need for consents. It 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 14

The slip at Ohau Point, north of Kaikōura following the 2016 earthquake.

Streamlining the consenting process for infrastructure after the Kaikōura earthquake

The 7.8-magnitude Hurunui/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 an economic recovery, repair of land and infrastructure, safety and resilience, and the 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:

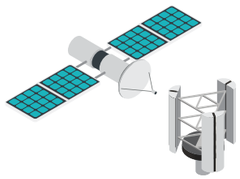
- Limited engagement and consultation.
- Broad descriptions and desktop assessments.
- No objections or appeal rights.
- Two pathways for RMA applications:
  - Before 31 March 2017: A nine-day process with conditions pre-written.
  - After 31 March 2017: A 21-day process.

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.[422]

7.3.4. Recommendations

No.	What	How	Who
57	**Strengthen the government's mandate to deliver infrastructure** NBE, CCI 2022-2026	Ensure that the Natural and Built Environments legislation 'gives effect' to existing requirements for the government to deliver infrastructure.	MfE
58	**Improve the evidence-base for environmental consent applications** NBE, CCI 2022-2031	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 of 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 assessing environmental consent applications.	MfE
59	**Deliver reasonable environmental limits and targets in the Natural and Built Environments legislation** NBE 2022-2026	Steps to achieve this recommendation include: a. Focusing on environmental limits and targets for matters sustaining life (for example air, water, soil and biodiversity) rather than human values and preferences (for example heritage, character and amenity). b. Standardising national minimum environmental limits. Where possible, ensure that environmental limits are measurable, targeted and quantifiable.	MfE
60	**Develop greater certainty for infrastructure providers in the Natural and Built Environments legislation** NBE, CCI 2022-2031	Steps that should be implemented to deliver greater certainty include: a. Standardising and codifying a National Planning Framework for infrastructure in the emerging Natural and Built Environments legislation, which 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. Providing a mechanism for resolving conflicts between multiple outcomes to avoid litigation on the interpretation of the outcomes. c. Narrowing the definition of 'effects' to those relating to the natural and physical environment, so that other matters (like effects on trade competition) aren't unreasonably used to restrict new infrastructure. d. Requiring that externalities unrelated to natural and physical resources are addressed elsewhere, such as in a project business case.	MfE, Te Waihanga

Refer to Section 10 | Time



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 can help our cities work more efficiently. New tunnelling technologies are lowering the cost of construction.[423] Crowd sourcing can help speed up maintenance by making it easy for people to report faults like potholes. However, much of the technology we need to transform our infrastructure already exists. There's limited need for high-risk investments at the cutting edge of technology. New Zealand could 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's much to gain. Existing technologies alone have the potential to lift infrastructure service levels for the vulnerable, reduce costs 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. The characteristics of infrastructure can make it more difficult to adopt new technology. The long life of infrastructure can lock in older technologies. The need for a consistent approach across large infrastructure networks like roads and water networks can make it difficult to make incremental change. 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[424] to the adoption of information and communications technologies (ICT), a key determinant of productivity in infrastructure.[425] Technology presents New Zealand with an opportunity to address chronic productivity issues in the infrastructure sector. Currently, our construction sector uses ICT less than any other industry.[426] 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 leverage many of the advances in digital technology that have occurred in the past decade. We've 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 in incentivising 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).[427]

7.4.2. What we've heard

We've heard that industry hasn't invested significantly in technological advancements for several reasons: its major customers (in many cases, the government) haven't really demanded 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 will be needed if we're to adopt digital twins and other digital technologies.

Submitters told us that a national digital strategy was needed to galvanise action and drive behaviour change. There was also a need for strong and clear mandated requirements at the procurement stage of a project. These could include requirements for digital modelling, efficiency dividends and decarbonisation that will speed up the adoption of technology across the infrastructure sector. A clearer pipeline of work for several decades to come would help reduce uncertainty and give industry the confidence to increase investment in capabilities and skills.

7.4.3. Strategic direction

Clear strategic direction and leadership

Central leadership and an all-of-government approach are critical to speeding up the use and spread of new technology.

Based on best practice from across the OECD,[428] several common themes are key to stronger government leadership in the adoption of new technologies.

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. The government is currently developing a Digital Strategy for Aotearoa.

Procurement: The government's procurement and contracting approach can drive the adoption of digital technology and the shared benefits this would offer to major infrastructure programmes. The 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 the use of technology to help address the climate change impacts of infrastructure.

Spatial planning strategies: These can be used to reinforce the greater digitalisation of infrastructure by ensuring that the regulatory framework enables telecommunications and associated providers to invest in the network more easily and efficiently. Regional spatial plans should aspire to give industry more certainty in investing in technology and developing 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, needs to be responsive to technological change. Regulators must have the power and responsiveness to set standards that reflect this, as well as obligations to review them regularly.

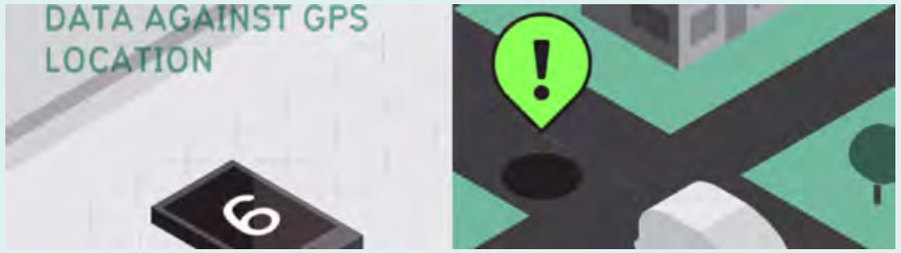
Skills: A key constraint to progressing technology capabilities in the infrastructure space is labour market constraints.[429] This is an important part of developing our workforce capacity and capabilities as detailed in Section 7.5.

Data for the public good

Prioritising data across infrastructure industries.

There's much to be gained from a data-rich infrastructure system. Project selection can be improved through more sophisticated modelling and better assessments of community needs. Entire networks can be better managed through digital twins and real-time pricing. Case Study 15 shows how maintenance can be streamlined through digitised asset management. Digital solutions can also help infrastructure operators and regulators to 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'll only see the real expression of data when it's readily available.

CASE STUDY 15



Street Bump: using smartphones to support more efficient road maintenance

Potholes are a significant issue on the City of Boston's roads, and in the first quarter of 2014 the city filled more than 10,000. Historically, reporting potholes had been time consuming. It had 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 sought to use technology and innovation to make the identification of potholes more efficient and therefore, speed up their repair and reduce overall costs. 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 from residents on city road conditions. While there were numerous hotlines and websites in place for drivers to report potholes, Street Bump was the city's first attempt to automate the reporting process. As well as increasing the efficiency of repairs and improving user satisfaction, the app provided valuable insights 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.[430]

Collaboration and data sharing across the infrastructure industry.

An open-data environment is one where all infrastructure data is available, secure, free of information 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's likely that network operators and utilities will benefit from greater sharing of data about infrastructure.[431] 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.[432] While some examples are emerging, this collaboration isn't 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 needs to be anonymised to protect privacy. Despite this, greater progress toward more open data should be made, since optimising our infrastructure investments requires good information about design, construction and operation.

The key elements required to move towards a more open data environment for infrastructure include:

- The development of common national infrastructure metadata standards, building on existing government initiatives.
- A 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**[433]

A move towards 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. 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'll 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 isn't always invention, but speedy adoption, increased certainty and putting in place incentives for technology uptake. A greater use of technology across the infrastructure system can raise productivity and performance, create higher-skilled jobs, build transparency and improve resilience.[434]

There are well established technologies that could be implemented now in New Zealand's water, waste, energy, transport, telecommunications, education and health sectors. Key benefits include:

- Better monitoring and managing of the vast existing infrastructure asset base.
- Better transport and energy systems to help achieve a net-zero carbon economy by 2050.
- Reduced demand on the health system and a corresponding demand for health infrastructure by enabling technology-at-distance services like telehealth systems.
- Faster 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. It is envisaged that in the future, integrated BIM will also include cost, time and resource management.

A programme to improve the incentives for adopting new technologies would be a useful first step. The key elements of this are shown in Table 6 and would bring together requirements to build skills, ensure a public sector and industry commitment to growing the infrastructure data available and ultimately, move towards 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 security risks.

Table 6: Steps to improve the adoption and diffusion of technology

Barrier	Explanation
Skills and capabilities Skills and capabilities for design, delivery and operation	Developing people's skills and capabilities 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	The 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 incentive 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 by 2050).
Regulatory / Legal Enabling legislation	Resolving the regulatory and legal issues that arise from new technologies, such as privacy issues (for instance, the collection of 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-attacks.

Source: Te Waihanga

Investing in digital innovation can have better returns than investing in physical infrastructure.

Digital innovation is flourishing, producing new technologies that are changing the way we deliver and operate infrastructure (see Table 7 and Case Study 16). Artificial intelligence techniques, such as machine learning, can deliver more 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 to tailor the delivery of infrastructure systems to meet the needs of communities and leverage technology to enable better infrastructure and better outcomes.

Table 7: Digital technologies that can transform infrastructure industries

Artificial intelligence – machine learning: Artificial intelligence enables digital devices to respond and learn from their environment. It is anticipated to streamline tasks, especially those that are repeatable and continue to learn and develop through completing tasks and receiving feedback.
Digital twins: Digital twins 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 17)**
Digital consenting: Digital consenting is an application of BIM and digital twins that streamlines the consenting and approval process. Traditionally, the consenting and approval of changes to the built environment rely 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 / virtual reality): Augmented and virtual reality are technologies that help visualise digital information. Augmented reality merges digital information with the real world through headsets or mobile devices so that the digital elements appear as additions to the real environment. Virtual reality 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: The Internet of Things is a network of physical objects capable of collecting, sharing and acting on data without human intervention. At its core, the Internet of Things relies on physical devices, sensors and telecommunication networks to improve processes based on a larger set of data from the whole network of devices. The Internet of Things will affect the way infrastructure is managed through greater real-time communication between the different parts of a network.

Source: Te Waihanga

CASE STUDY 16

Digital shields can protect assets and improve safety.

Using digital shields to improve safety and productivity in the rail corridor

KiwiRail has pioneered the use of digital shields for excavators working on, or near rail corridors.

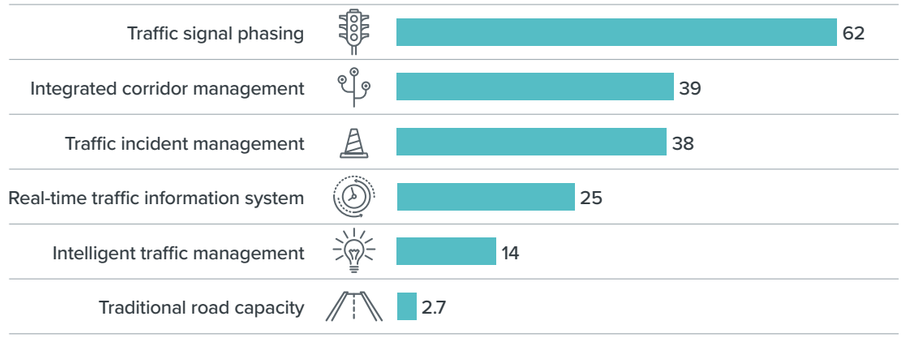
Digital shields are made by creating a virtual twin of the physical environment, using a laser scanner. This survey technique collects millions of points of data, which are then used to build a 3D digital model. These models allow us to create digital shields a set distance from the position of the real-world objects. Once a shield is created, it is sent to a computer on board 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.[435]

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 has been estimated to have saved the government of the United Kingdom the equivalent of NZD $4 billion over a six-year period.[436] Many information-technology solutions projects have been shown to cost less and deliver better returns on investment than built options, while delivering the same service outcome (see Figure 34).

Possible cost-benefit ratios of Information Technology Systems projects compared to building new road capacity

Figure 34: Information technology investments can provide value for money



Source: Adapted from McKinsey (2013)[437]

Digital twins in spatial planning

There's an opportunity to develop digital twins for our infrastructure as part of the emerging spatial planning process.

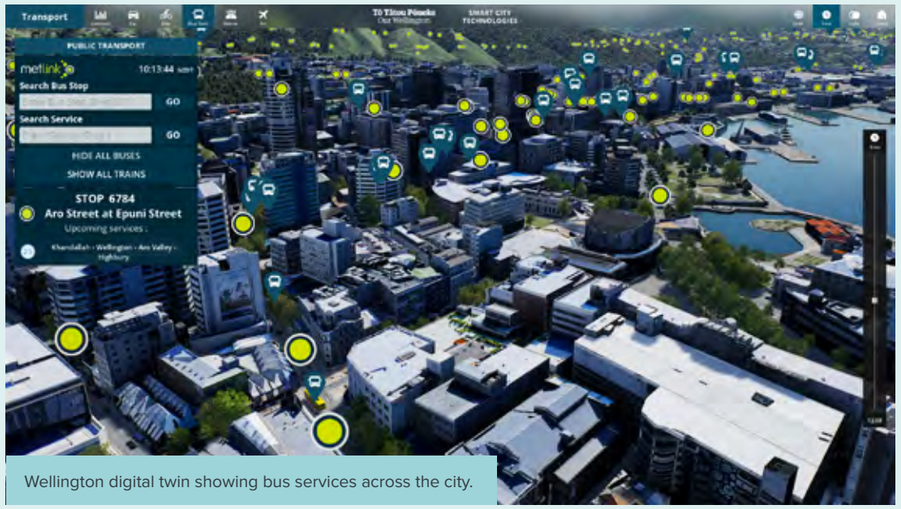
Regional and urban digital twins, aided by big data and machine-learning approaches, can bring together all the data held about individual infrastructure, capture data on the connections between infrastructure systems (such as between water, transportation and energy) and support the development of a 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's an adequate representation of the real world (see Case Study 17) and moves towards 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).[438] As capability grows, it could become an important decision-making tool for national infrastructure networks.

This technology could also help grow our understanding of the way the infrastructure system works. In the future, it may be possible to ask questions of the digital twin, such as: "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 17

Wellington digital twin – connecting decisions and impacts



Wellington digital twin showing bus services across the city.

Wellington City Council has been developing a digital twin 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.

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. In the past five years the evolving digital twin has been used to assist in earthquake response, the creation of Wellington's Resilience Strategy, urban planning, public engagement on climate change and social harm reduction. The digital twin helps the council to coordinate growth, communicate what its investments can mean for the city and understand the longer-term future of climate adaptation.

7.4.4. Recommendations

No.	What	How	Who
61	**Increase the diffusion of existing technologies to increase productivity in the infrastructure sector** PTC 2022-2026	Increase diffusion of existing technologies through the following steps: a. Review approaches to procurement at an agency level and consider whether there are barriers to technology diffusion within current systems and practices. 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 (such as minimum energy performance standards, housing codes, waste and water efficiency) to responsible regulators where there are productivity gains and ensure the standards are reviewed and updated regularly.	DIA, MBIE
62	**Accelerate the adoption of open data and common standards for the infrastructure sector** PTC 2022-2031	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, building on existing government initiatives.	DIA, Stats NZ
63	**Accelerate the digitalisation of infrastructure** PTC 2027-2031	Accelerate digitalisation across the infrastructure lifecycle by implementing the following steps: a. Facilitate the 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
		Refer to Section 10	Time

7.5 Building workforce capacity and capabilities

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 returned to service quickly after disruption.

The infrastructure sector gives New Zealanders opportunities for employment, incomes and career progression and the ability to make meaningful contributions to our country's future. However, it's also a sector that's constantly changing and as it does this, 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 requires 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 $64 billion worth of infrastructure projects planned and in its pipeline of upcoming work.[439] Most of these projects are planned for the next three to five years. Over the next 30 years the pipeline is anticipated to grow by as much as $140 billion.[440] There's also significant demand for residential and other types of construction that adds to our capacity challenges.[441]

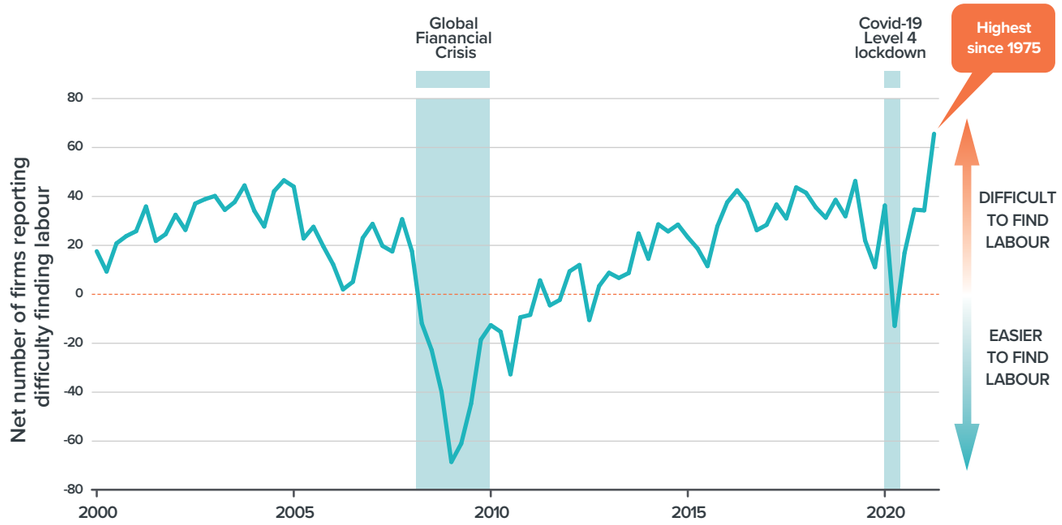
The share of construction firms reporting labour shortages is now at its highest-ever level (see Figure 35). This has been made worse by on-going international competition for talent. Australia also has a severe labour shortage and with weekly wages that are, on average, NZD$500 higher than ours, many New Zealanders are crossing the Tasman for work.[442]

These labour shortages are likely to continue for years to come. Forecasts show that New Zealand will have a shortfall of approximately 118,500 construction workers in 2024.[443] Skill shortages are particularly noticeable in regions like Auckland, where they're holding up work on important projects.[444,445]

We also know that as well as construction, there are shortages in infrastructure planning, delivery and maintenance that are impairing our ability to provide the infrastructure we need. At the planning and investigation stage, we're seeing a failure to include completed business cases for a large proportion of major projects.[446] At the asset management stage, we see considerable variation in asset management capabilities.[447] More work is needed to identify the key components of workforce shortages and what's needed to develop the right talent to deliver New Zealand's future infrastructure.

Net number of construction firms reporting difficulty finding labour

Figure 35: Construction labour shortages are at their highest since 1975



Source: Adapted from NZIER Quarterly Survey of Business Opinion (2021)

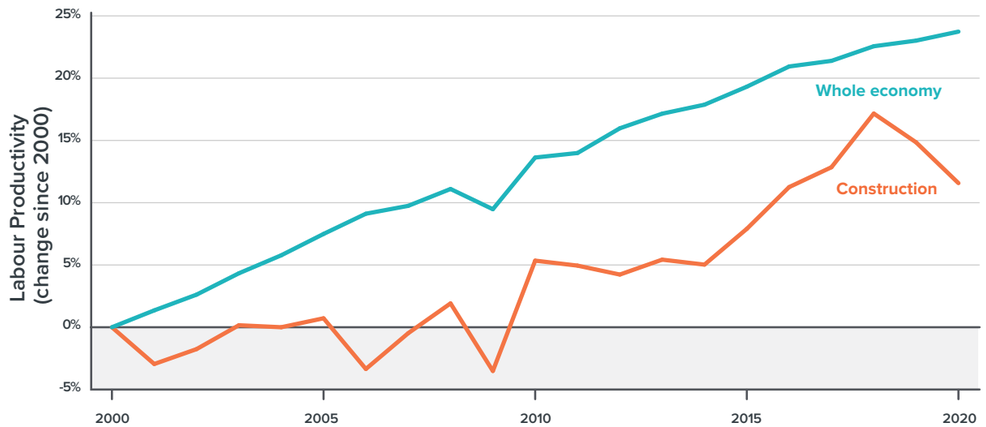
We need more skilled people to build and operate the infrastructure we're planning.

While there are many skilled, capable people working in the infrastructure sector, we don't have enough of them, and in some areas we may entirely lack the skills that will be needed in the future. These include skills in client and project leadership and management, engineering, technical professions, construction management and trades and labour.

Our workforce challenges hold us back from improving the productivity of our construction sector and 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 36).

Labour productivity is growing more slowly in construction

Figure 36: Labour productivity, construction sector vs whole economy since 2000



Source: Te Waihanga, data from Statistics New Zealand (2021)

Health, safety and wellbeing are key to addressing our need for a well-trained, highly engaged workforce

Providing workplaces that promote health, safety and wellbeing is core to addressing our need for a well-trained, highly engaged workforce.

“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

Between 2011 and 2020, the construction industry reported 76 work-related fatalities. This made construction the sixth most dangerous industry for workers.[448]

Health and safety is more than just avoiding serious injuries and fatalities. It’s about having healthy workplaces that support wellbeing and employee satisfaction. Non-fatal injuries in construction have risen substantially since 2016.[449] 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.[450] A failure to protect the health and wellbeing of infrastructure workers is a threat to our ability to develop and retain skilled people in the sector.

There’s also an opportunity for technological innovation to improve health and safety, workplace satisfaction and productivity. Innovation in the workplace can take a range of forms, including improvements in existing tools such as ergonomics, the use of new tools such as lifting equipment to make tasks safer and the automation of hazardous tasks.

Good leadership prioritises health and safety and proactively seeks 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.[451]

Poor diversity in the infrastructure sector limits its ability to draw on the talents of all New Zealanders.

Our historic workforce shortages have been made worse by the fact that the infrastructure sector isn’t equally drawing on the talents of all New Zealanders, especially in managerial, professional and higher-skilled roles. The number of women working in the infrastructure sector is low. For example, women make up approximately 13% of all those employed in construction. Just 2.5% of construction tradespeople and apprentices are women.[452] Women are also under-represented in engineering and while women represent 18% of people completing engineering qualifications, they only represent 8% of chartered professional engineers and 8% of engineers on senior management teams.[453] There’s poor retention of women in the engineering industry, with over a quarter of women leaving the profession in the first five years after study. Women face hurdles with employer perceptions, as well as physical and site-specific issues that act as barriers to their entry into the sector.

While many Māori and Pacific peoples work in the infrastructure sector, they’re 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.[454] The number of Māori and Pacific peoples in the managerial, professional and higher-skilled occupations in the infrastructure industry needs to continue to grow.[455]

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’d better double down on training our own and we’d 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 document told us that the infrastructure sector needed to do better at diversity and inclusion by increasing the participation of women and improving the participation of Māori, and Pacific peoples at professional and decision-making levels.

Some submitters also pointed out that preparing for climate change would require our future workforce to have new skills, of which many will be in high demand internationally.

Many felt that building workforce capabilities in procurement, asset management and project management was necessary. There was support for the establishment of a Major Projects Leadership Academy in New Zealand, particularly if it is underpinned by a broader capability and development framework.

7.5.3. Strategic direction

Building capabilities 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:[456]

- **Planning and asset management:** Roles such as client leadership, business case development, planning, procurement, asset management and project management.
- **Engineering and technical:** This includes civil and structural, mechanical, and electrical engineers, data analysts, architects and designers. It also spans specialist areas such as building 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 abilities of our contractors are increasingly important as our projects become larger and more complex.[457] It’s important to retain and grow design and construction firms that can successfully deliver infrastructure projects of all sizes.

New Zealand needs to build its attractiveness for international firms and products. One way of doing this is to develop a trans-Tasman procurement market by taking a consistent approach to qualifications, product and building standards and contracting and procurement processes.

Technology can also be used to lift productivity. It may involve using robots and automation to undertake repetitive and dangerous work or using digital information and analytics to augment work undertaken by skilled employees. Higher productivity means that our workforce can deliver more and better infrastructure.[458]

We need to adapt our workforce to an evolving infrastructure sector.

New Zealand's infrastructure faces a historic period of deep and intergenerational change and this means that our infrastructure must adapt to meet our changing needs and aspirations.

Key strategic shifts that will influence workforce capacity and capabilities include:

- **A move to a low-emissions and circular economy:** This will change the roles and skills needed to support our infrastructure (See Sections 6.1 and 6.5).
- **A drive for better decision-making:** The sector will need to build more capacity and capabilities in cost-benefit analysis, project management, and procurement (See Section 7.1).
- **An increased use of data:** The sector will need to expand its ability to collect, maintain and analyse data in coordinated formats (See Section 7.4).
- **Accelerating technology use:** Our workforce will need to increase its technological capabilities to unlock the productivity and infrastructure-delivery benefits of technological advancements (See Section 7.4).

While these strategic shifts may present capacity and capability challenges, they also present an opportunity to improve the diversity of the infrastructure sector. The infrastructure industry will increasingly require a broader range of skills. This provides an opportunity to recruit talent from a wider range of educational backgrounds (beyond traditional pathways such as engineering degrees) and is likely to increase gender and ethnic diversity.[459]

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'll need in the future, including the skills required to deliver major projects in the infrastructure pipeline. The 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're going to need in the long-term.

An existing 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.[460]

The Transformation Plan provides a template for other important long-term workforce challenges, such as the response to climate change. Industry and the government must come together to respond to these challenges and review both the training currently on offer and the need to bring more people into the industry from either 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 build our competitiveness for talent.

Central government is the largest single procurer of infrastructure.[461] However, while a range of government agencies have roles in procuring, delivering and managing infrastructure, there are no common capability and development frameworks across these agencies. As infrastructure projects get larger and more complex, it will be increasingly important for government agencies to improve workforce capabilities and leadership.

The government should establish common capability and development frameworks for agencies that procure and project manage infrastructure projects, as well as the operation of infrastructure. These frameworks should:

- Support the development of capabilities that can be shared across the infrastructure sector.
- Encourage government agencies to be more transparent about the skills they require 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 and project management as career pathways in the public sector.
- Develop capabilities and capacity across the infrastructure system for effective partnership with Māori.
- Accelerate the adoption of open data and common standards for the infrastructure 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[462] and the Institute of Public Works Engineering Australasia's Asset Management Pathway.[463] Complex infrastructure projects require strong 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 18). This should be underpinned by a competencies framework that practitioners would be required to complete before attending the Major Projects Leadership Academy.

CASE STUDY 18

Oxford University hosts the United Kingdom Major Projects Leadership Academy

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 complex projects.[464]

In response, the United Kingdom invested heavily in building the capabilities 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 in 2012 to train senior project leaders for complex major projects.[465] The academy is underpinned by a comprehensive Project Delivery Capability Framework that builds the capacity of civil service project management practitioners throughout their careers and provides guidance for career discussions and promotion decisions.[466] These initiatives provide a common approach for practitioners to gain the knowledge, skills and abilities needed to deliver projects across all areas of government. Over 500 participants have graduated from the programme and it has been highly rated by past participants.[467]

Giving industry the certainty to invest in its people and equipment

A credible infrastructure pipeline is an essential workforce planning tool.

The infrastructure sector will face ongoing workforce pressures in the coming decades. An infrastructure pipeline, a tool that shows all upcoming planned work in the sector, will help the sector to face these challenges. It will provide certainty and:

- Enable more coordinated planning of investment in New Zealand.
- Offer a single, trusted source of information for the infrastructure sector on medium-term investments.
- Enable the construction industry to plan its resource needs accurately, so it can invest in training its people and acquiring equipment and technology.

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 covering different sectors and taking different approaches to the detail they include.[468,469] The Infrastructure Pipeline managed by Te Waihanga currently focuses on committed and/or funded projects from major infrastructure providers, but doesn't yet include investment that has been signalled but not confirmed, as this is more difficult to forecast.[470] There's a need to build on and improve the Infrastructure Pipeline to provide a more credible and transparent infrastructure pipeline tool 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 of planned investment, but there's 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 the people and skills required to meet these needs. An infrastructure priority list can improve how we identify and respond to long-term challenges. It's 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.[471]

Smoothing out boom and bust construction cycles can help us 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. We know that countries experiencing year-to-year swings in public investment tend to be less efficient than others and that New Zealand's swings are more volatile than Australia and many other high-income countries.[472,473] 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 addressing economic downturns. This is because of the long timeframes needed to plan, procure and build major infrastructure projects. By the time construction begins, an economic downturn might be over.[474] Other macroeconomic policies, including the consistent application of monetary policy, automatic stabilisers and prudent counter-cyclical fiscal policy, are typically more effective in economic downturns. However, infrastructure maintenance can be a good way to stimulate the economy as it can be procured and delivered relatively quickly.[475]

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. For example, Case Study 19 highlights some of the barriers women experience when seeking to work in the construction sector.

CASE STUDY 19

Women in Trades, Ministry for Women

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 have 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.[476] For women who worked in the construction sector, or wished to enter it, the most common barriers were:

- A lack of knowledge about opportunities within the trades.
- A lack of direct work experience which often made it difficult to enter the sector.
- Difficulty in finding employers willing to employ women, showing that traditional views on gender roles were still prevalent.
- The male-dominated culture of the trades, which was intimidating and reduced applications from women.
- A lack of flexible work practices, which impacted on the ability of women to both work and undertake parental duties.
- On-site constraints such as poor conditions and the lack of lifting equipment.
- A lack of support for women in the trades.

Interviews with six employers by the Ministry of Women's Affairs in 2011[477] found that, once employed, women were seen as important to their teams. Employers said the key benefits included:

- Improvements in work culture, for example, better behaviour, less competition and more collaboration.
- Competitive advantage. For example, a plumbing firm got more work as its female plumber could work in public women's bathrooms/changing areas without the need to close these temporarily.
- 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 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.[478]

The government and industry have been working to improve the participation, retention and career advancement of women, Māori and Pacific peoples within the infrastructure sector.[479,480,481,482] This work has focused on changing employer perceptions, increasing awareness of jobs through open days, establishing cadetships (see Case Study 20), broadening public sector procurement rules, using ambassadors, building support networks and having events to celebrate success. However, more work needs to be done.

An inclusive workplace environment will improve diversity and increase workforce capacity

If the infrastructure sector is to have a more diverse workforce, it needs to attract people with diverse backgrounds and create an environment that's inclusive and encourages all those with talent to progress to senior and leadership roles. For example, one study found that around three quarters of female engineers in New Zealand thought there would be a time in their career when they'd have to choose between family and career.[483] The provision of work arrangements, such as flexible working hours and part-time work options, was identified by study participants as a way to increase participation of women in the engineering profession.

There's more work to be done to create an infrastructure sector that's welcoming to all. Working to build an inclusive workplace environment will not only improve diversity, but also lift workforce capacity by increasing the total number of people in the sector.

Progress towards greater workforce diversity and inclusion needs to be monitored.

The Construction Sector 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 20

City Rail Link Māori and Pacific peoples cadetships

The Auckland 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 full-time roles on the project at the end of the programme. The intention is for them 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, this lets the young people adapt to the working environment. As well as undertaking real jobs within the project, the young people learn about employment contracts, KiwiSaver and budgeting.

Of the 12 young people who'd completed the programme as at March 2021, 10 are now in stable employment and six with the City Rail Link. Five more young people are currently engaged in the programme.

7.5.4. Recommendations

No.	What	How	Who
64	**Provide certainty to industry to invest in skills and training development** CTP 2022-2031	Strengthen the Te Waihanga Infrastructure Pipeline to provide industry and government with a long-term view on: a. The scale and type of work to be completed. b. The likely resources required to plan, deliver and maintain infrastructure. c. The geographic and sectoral distribution of projects. Use the aggregated data to provide insight into 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
65	**Develop the talent required to deliver New Zealand's future infrastructure** AIP 2022-2031	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 the national infrastructure skills plan so that it: a. Provides information on the likely professional and workforce requirements to deliver the planned and forecast infrastructure supply over the next 15 years and beyond. b. Advises on how our education system can best support our future workforce needs. c. Provides advice on the role of immigration settings to address critical specialist infrastructure skill deficiencies that could delay construction or add to the costs of projects and maintenance. d. Provides advice on skill-development pathways that appeal to a diverse audience and increase 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, Public Service Commission, Te Waihanga, MBIE, Tertiary Education Commission, Treasury, Construction Sector Accord, Ministry of Education
66	**Build New Zealand's competitiveness for international firms and products** AIP 2027-2031	Identify and reduce barriers for international firms and products to enter the New Zealand market by adopting international standards by default unless there is a compelling rationale for the development of a specific New Zealand standard. Strengthen the trans-Tasman procurement market by ensuring a consistent approach in: a. Product and building standards. b. Qualification requirements. c. Contract and procurement processes.	NZ Government Procurement, MBIE

Refer to Section 10 | Time

No.	What	How	Who
67	**Strengthen government client-side capability to plan, design and deliver projects** AIA 2027-2031	Improve project outcomes by increasing public sector capabilities 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 research in infrastructure. d. Aligning remuneration between the public and private sectors to improve competition across infrastructure types.	Public Service Commission, Central Government Delivery Agencies
68	**Recognise major project leadership as a role with comparable complexity to organisational leadership** MPL 2022-2031	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 accountability mechanisms and remuneration are aligned with the complexity and risk project leaders are managing on behalf of the government.	Public Service Commission, Te Waihanga

Refer to Section 10 | Time

Construction of a concrete bridge, West Coast.

8 What happens next

Ka aha ināianei

The Main North Line, Mangamaunu, Kaikōura.

New Zealand's first infrastructure strategy

This strategy demonstrates a need to change how infrastructure is planned and delivered.

It's the first infrastructure strategy for New Zealand. It lays out priorities for New Zealand's infrastructure and it lays a foundation for people, places and business to thrive.

What does the strategy recommend?

The recommendations form a programme of work to address current and future infrastructure challenges quickly and efficiently.

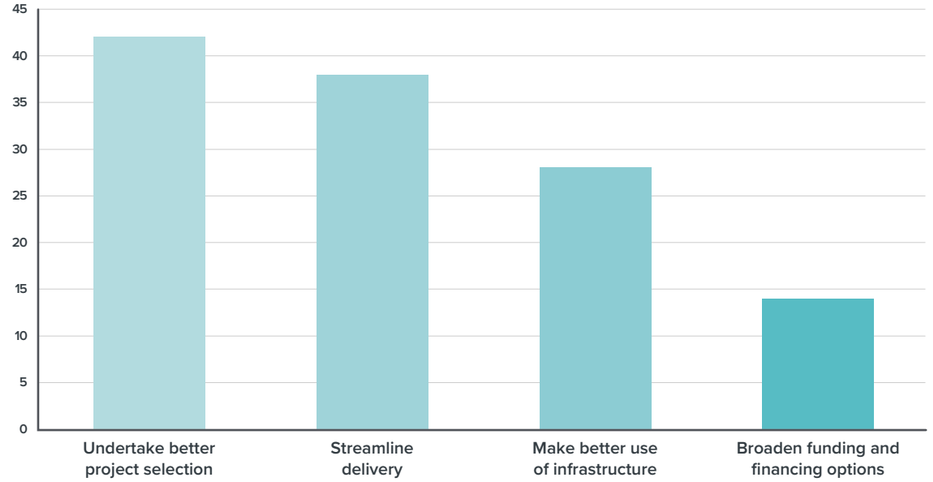
The strategy makes 68 recommendations to central government, local government and the infrastructure sector in general. We've ensured that they're deliverable, are evidence-based and will have lasting impacts in the long-term. Some of the recommendations relate to work that's already planned or underway. Others involve new actions and work programmes.

Recommendations are aimed at:

- Lifting the contribution that infrastructure makes to wellbeing by addressing five strategic objectives.
- Improving the performance of infrastructure planning, funding and financing, and delivery.

Taken together, these recommendations will allow us to respond to the challenges ahead by making better use of infrastructure, broadening funding and financing options, undertaking better project selection and streamlining delivery (see Figure 37). Many recommendations cover more than one infrastructure sector, or relate to more than one strategic objective or cross-cutting theme.

Figure 37: Split of recommendations by change response



Source: Te Waihanga

Together, the recommendations will help to address current and future infrastructure challenges more efficiently and with urgency.

While all the recommendations are important to achieving progress, the strategy identifies three specific areas that will have the greatest positive impact over the next 30 years:

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

Key actions in each area are summarised below (see Table 8).

Table 8: Three areas of greatest positive impact

Area	1. Leveraging our low-emissions energy resources	2. Planning for generations to come	3. Providing better infrastructure through pricing
Potential	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.	We need to overhaul the way we plan infrastructure to keep pace with our growing population, and ensure there's 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.	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 more choice in how we want to live.
Key actions	**The right regulatory settings to enable the 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 the timely development of clean energy generation.	**A resource management system that gives effect to national priorities:** Reform is already underway and the replacement of the RMA must perform the dual roles of protecting the environment and allowing for development. It must enable infrastructure providers to meet policy commitments, which could include decarbonisation, efficient transport networks, adequate competition in the supply chain, universal digital access and the timely provision of social infrastructure.	**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 carriers.
	Reliable supporting infrastructure: This requires an efficient expansion of supporting electricity and telecommunications networks, and the efficient use of our gas and fuel networks.	**A long-term, flexible, 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. It should also reduce uncertainty where possible, such as through the development of a national population plan.	**Better transport alternatives:** Alongside better transport pricing, we need to improve transport alternatives such as public transport and walking and cycling to make it easier for people to change their travel behaviours to avoid prices and move to low-emissions transport options.
	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.	**Protecting areas for infrastructure decades in advance:** Instead of our current 'just-in-time' approach, we can identify and protect strategic infrastructure corridors to provide a pathway for the infrastructure that might be needed in the future, allowing us to deliver more at a lower cost.	**Pricing to pay for water infrastructure:** Charging to match the water we use will reduce costs for low users, encourage more careful use and reduce the need for costly new infrastructure.
		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 to, at a lower cost. Planning rules can empower everyone through improved housing affordability, reduced congestion and support for other social objectives.	**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 straightforward to install rainwater-harvesting systems and promote toilet flushing with grey non-drinking water.
		Ensuring that the costs are fairly spread over time: We need to use funding and financing tools that reflect the periods of time in which infrastructure assets deliver services.	

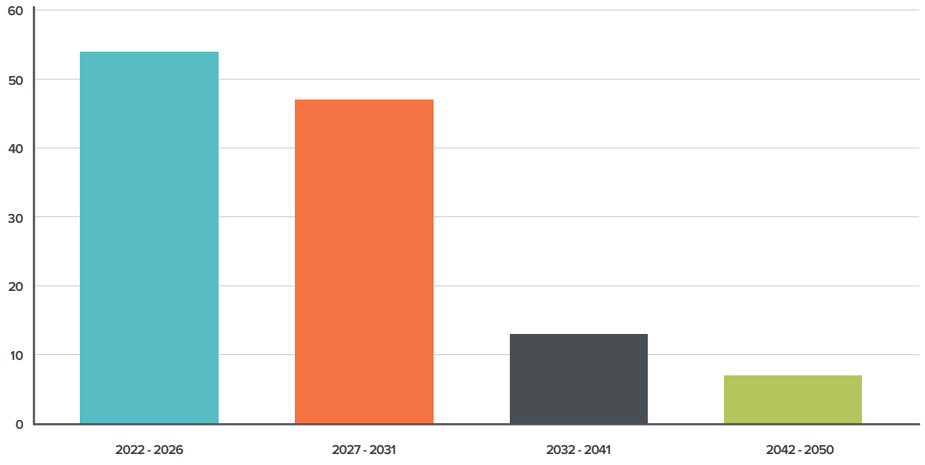
Source: Te Waihanga

When will the strategy be implemented?

The strategy proposes the implementation of recommendations across a 30-year period (see Figure 38). Some recommendations will require ongoing implementation throughout this period, as they relate to planning or project delivery processes. Where this is the case, recommendations have been tagged across the time period when implementation is proposed to occur.

The proposed implementation is front-loaded in the first decade of the strategy period. While this will entail a period of significant change to the infrastructure system, it will also allow the benefits to be delivered early. This is an appropriate approach given the scale of the infrastructure challenge and the fact that we're starting with an existing deficit.

Figure 38: Split of recommendations by time period



Source: Te Waihanga

Who will implement the strategy's recommendations?

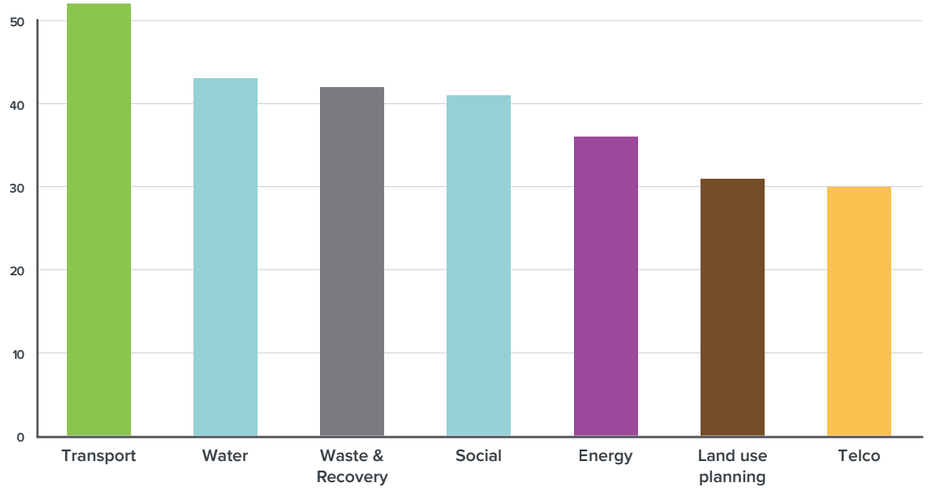
Te Waihanga has proposed that the recommendations in the strategy be implemented by a number of organisations across central government, local government and the infrastructure sector in general.

The recommendations address multiple infrastructure sectors and some recommendations cut across more than one infrastructure sector or relate to system-wide issues (see Figure 39).

The strategy identifies the organisation or group of organisations best placed to implement each recommendation. Where a broad group is identified against a recommendation, this signifies that an infrastructure-wide approach will need to be adopted. We expect that the government response will identify the organisation or group that's best placed to lead implementation. In addition to implementing recommendations, we expect the strategy to inform a range of business-as-usual activities, such as national, regional, sectoral, and organisation level strategies, plans, and programmes.

As the Government's lead advisor on infrastructure, Te Waihanga will support other organisations to deliver recommendations and will monitor and report on progress over time.

Figure 39: Split of recommendations by sector



Source: Te Waihanga

Recommendations that Te Waihanga will lead.

The strategy identifies recommendations where Te Waihanga is best placed to lead implementation or play a significant role in supporting implementation. Progressing these recommendations through our on-going work programme will make a significant contribution to achieving the strategy's objectives.

These actions include:

- Strengthening partnerships with and unlocking opportunities for Māori across the infrastructure system (Recommendations 1 to 3).
- Supporting the development of lead infrastructure policy and supporting guidance and reducing costs through enabling planning for and the protection of infrastructure corridors in advance of growth (Recommendation 16).
- Preparing infrastructure for the impacts of climate change, through supporting the development and implementation of the National Adaptation Plan (Recommendation 27).
- Establishing an independent infrastructure priority list to build consensus on key projects and initiatives that address significant long-term problems (Recommendation 40).
- Improving infrastructure performance reporting and insights (Recommendation 41).
- Undertaking an inquiry into the appropriateness and consistent application of New Zealand's social discount rate policy (Recommendation 44).
- Improving infrastructure cost analysis by undertaking investigations of the cost performance of New Zealand's infrastructure sector (Recommendation 46).
- Delivering an enabling planning and consenting framework for infrastructure through the design of the Natural and Built Environment legislation (Recommendation 60).
- Strengthening Te Waihanga's infrastructure pipeline to provide certainty to industry to invest in skills and training development (Recommendation 64).

How will the Strategy be progressed?

The New Zealand Infrastructure Commission/Te Waihanga Act 2019 sets out the programme for implementing this strategy.

As required by the Act, Te Waihanga has provided this strategy to the Minister for Infrastructure and it has been presented to the House of Representatives (Parliament). Within six months of receiving the strategy, the Government will provide its response.

The Government response will lay out a path to implementation.

The Government will respond to the overall intent of the strategy and will identify the recommendations that it agrees should be implemented, including the organisations to which they'll be allocated. These will be developed into an action plan and each recommendation transitioned to the appropriate agency for implementation. Where the Government doesn't agree with a recommendation, it may choose to put forward an alternative proposal.

Delivering the recommendations will require a mix of policy development, regulation, investment and strategic priority setting. To support the government's response, Te Waihanga will work with relevant agencies to further test implementation requirements, resourcing and the degree to which recommendations can be delivered through existing work programmes.

The work programme of Te Waihanga will support the strategy objectives.

Te Waihanga will support the objectives of the strategy and continue to coordinate, develop and promote an approach that uses infrastructure and the services it delivers to improve the well-being of New Zealanders.

Our wider work programme is aimed at ensuring the delivery of infrastructure for a thriving New Zealand. Key elements include:

- Supporting central and local government to develop as a sophisticated client for infrastructure investment at all levels, by providing support and guidance to agencies involved in the planning, delivery and maintenance of our infrastructure networks.
- Using the strategy as a playbook for providing ongoing advice on infrastructure-related aspects of policy and reform programmes.
- Researching topics identified in the strategy and other emerging issues.
- Evaluating major infrastructure proposals for 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 the government.
- Developing a data-driven evidence base for the analysis of infrastructure issues and to support decision-making.

The Act requires the strategy to be refreshed at least every five years. Insights from the implementation of the strategy and our wider ongoing work programme will inform the development of the 2027 Infrastructure Strategy.

9 List of recommendations

He rārangi tūtohunga

Glenorchy Walkway, Queenstown.

No.	What	How	Who
Section 5 - Strengthening partnerships with and opportunities for Māori			
1	**Strengthen partnerships with Māori across the infrastructure system of Aotearoa New Zealand** CEM 2022-2031	a. Undertake a 'State of Play' of current Māori engagement activity for infrastructure to help inform and educate readers on how infrastructure providers can engage and work with Māori in a way that works for Māori and infrastructure providers. b. Identify a lead government agency that will establish a Māori advisory group to develop a framework for strengthening partnerships with Māori in infrastructure planning and delivery. The framework should be based on Te Tiriti o Waitangi and tikanga Māori and consistent with an all-of-government approach. The advisory group should also consider the evolving role of Māori in the infrastructure system and options for ongoing governance and oversight of the framework.	Iwi, Te Waihanga, Te Arawhiti, Central Government, Local Government, Sector
2	**Develop capabilities and capacity across the infrastructure system for effective partnerships with Māori** CEM 2022-2031	Put in place a programme to develop capabilities and capacity for effective partnership that should: a. Build specialist Māori infrastructure capabilities at the centre of government that can support agencies and Māori. b. Consolidate and enhance specific funding for the 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 for iwi organisations. d. Leverage procurement opportunities for Māori across infrastructure policy, planning, delivery, maintenance and research.	Iwi, Te Waihanga, Te Arawhiti, Central Government, Local Government, Sector
3	**Strengthen the Māori infrastructure evidence base** CEM 2022-2050	A collaborative 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 Māori infrastructure 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 a 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 hapū).	Iwi, Te Waihanga, Te Arawhiti, Central Government, Local Government
		Refer to Section 10	Time

No.	What	How	Who
Section 6.1 - Enabling a net-zero carbon emissions Aotearoa			
4	**Minimise lock-in of future emissions** ITN, SRC, LER 2022-2026	Set a strategic direction in emissions reduction plans that requires public sector investment programmes to be compatible with our international commitments on carbon emissions. Measures to support this direction should: a. Require that infrastructure policies and strategic plans take into account, where feasible, their implications for locking in carbon emissions. b. Include a full consideration of non-built solutions and decarbonising existing infrastructure in all business cases. c. Require assessments of whole-of-life carbon emissions, including embodied, enabled, and operational emissions, in all business cases. d. Require the use of a cost of carbon compatible with international commitments on carbon emissions within all cost benefit analyses, outlined in the Treasury CBAx tool. e. Measure the carbon impacts of different construction materials used in infrastructure projects. f. Set a timetable for reviewing regulations, standards and codes to ensure they don't inhibit the uptake of low-carbon materials. This should be cross-sector and reviewed regularly.	Ministry for the Environment (MfE), Climate Change Commission
5	**Achieve net-zero carbon emissions at minimum cost** ARE, ITN, GIC, BZC, EAN, GTG, LEE, TPM, LER 2022-2031	Develop 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 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, in particular ensuring distributors have reasonable access to the metering data they need to manage their networks safely and efficiently.	MfE, Ministry of Business, Innovation and Employment (MBIE), Commerce Commission, Electricity Authority
6	**Speed the build of low-emissions energy infrastructure to leverage our abundant resources** ARE, OCE, LER 2027-2031	Streamline consenting of low-emissions energy infrastructure while meeting environmental objectives by: a. Strengthening existing Resource Management Act 1991 national direction for renewable energy generation and transmission. b. Developing a streamlined approach to planning and consenting under the Natural and Built Environments legislation, which could include tools such as environmental standards for project consenting and development of renewable energy zones. c. Establishing an offshore regulatory framework to explore and develop low-emissions energy resources in territorial waters.	MfE, MBIE
Refer to Section 10	Time		

No.	What	How	Who
7	**Ensure a fair, inclusive and equitable transition to a low-emissions economy** ITN, LER 2022-2031	Target support to those disproportionately affected in the 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.	Ministry of Social Development, MBIE
Section 6.2 - Supporting towns and regions to flourish			
8	**Improve efficiency and security of freight and the national supply chain** FSE, NFD, NLR, NSC 2022-2026	In developing a long-term National Freight and Supply Chain Strategy, the government should: a. Include airports, ports, road, rail and coastal shipping. b. Ensure it is integrated, resilient and multi-modal. c. Identify infrastructure needs and 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.	Ministry of Transport (MoT)
9	**Reduce barriers to and costs of providing infrastructure services** PTC 2022-2026	In developing a National Digital Strategy, the government should: a. Prepare New Zealand for realising the full benefits of a connected digital society and 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. e. Identify options to improve trust in digital services and address digital privacy concerns. Review standard infrastructure 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.	Department of Internal Affairs (DIA), MBIE
Refer to Section 10	Time		

No.	What	How	Who
10	**Reduce population uncertainties for infrastructure demand, planning and delivery** AIP, GFI 2027-2031	Establish a National Population Plan that: a. Presents a likely population pathway over the next 50 years and identifies requisite supporting policies. b. Provides direction for regional spatial plans. c. Identifies supporting policies required for New Zealand to capitalise on the benefits of a larger 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, medium and low projections.	Productivity Commission, Stats NZ, MBIE
11	**Prepare for zero-emissions commercial electric flights and unmanned aircraft** EAF 2022-2041	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 alternatives 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. f. Upgrade the aviation system and existing airport infrastructure to cater for greater use of unmanned aircraft.	MoT, Civil Aviation Authority, Airports and Airlines
Section 6.3 - Building attractive and inclusive cities			
12	**Improve water infrastructure pricing and provision in cities** WSA, LFF, MHT 2022-2031	The water, wastewater and stormwater sector should be reformed, including by: a. Implementing performance-based economic regulation and water quality regulation to ensure that water providers are incentivised to drive efficiency and deliver excellent customer service. b. Ensuring that there's a clear link between the cost of providing water services and the prices that are charged to users, following the principles in Section 7.2. c. Allowing entities to use their balance sheet capacity to finance infrastructure for growth, as well as funding asset renewals and improvements in water quality. d. Clarifying the interface between water service entities and developer-financed water infrastructure provided under the Infrastructure Funding and Financing Act 2020. e. Ensuring that developers can benefit appropriately from the provision of infrastructure that has spare capacity. f. Developing cost-benefit analysis guidelines to standardise evaluation decisions on water infrastructure against social, environmental and economic benefits.	DIA, Local Government (or New Water Entities), MBIE (or Economic Regulator)

Refer to Section 10 | Time

No.	What	How	Who
13	**Reduce pressure on water infrastructure through better water management and conservation** GIW 2022-2031	Steps that should be taken to reduce pressure on water infrastructure include: a. Using planning rulebooks to encourage on-site solutions. For example, building coverage could be increased in exchange for installation of on-site stormwater-management devices. b. Removing regulatory barriers to water conservation, such as consent requirements to install rainwater harvesting tanks. c. Setting performance standards that improve the water performance of appliances.	Local Government (or New Water Entities), MfE, MBIE, DIA, Taumata Arowai
14	**Realign local government boundaries, where appropriate, to improve coordination of infrastructure and planning outcomes** LMA 2027-2031	Where appropriate, local government boundaries should be redrawn to better align borders with functional labour-market boundaries to enable the coordination of key infrastructure and planning decisions. The realignment of boundaries should be guided by: a. The alignment of borders with wider urban labour markets, commuting and urban growth patterns. b. The costs and benefits of integrating regional planning and infrastructure provision. c. An integration of infrastructure planning, ownership and operation to enable the efficient provision of infrastructure. d. The alignment of funding streams with the infrastructure funding and financing principles outlined in Section 7.2. e. A consideration of mechanisms for local voices to continue to inform decision-making.	DIA, Review into the Future for Local Government
15	**Increase the supply and use of low-emissions transport modes** TCQ, ITN, INH 2022-2041	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 the cost-effective implementation of low-emissions transport modes and streamline costly resource management and local government consultation processes. d. Increase certainty of funding to enable low-emissions transport modes to scale up efficiently. e. Ensure all options considered for investments are subject to appropriate cost-benefit analyses.	MoT, Waka Kotahi NZ Transport Agency (Waka Kotahi), MfE, Local Government

Refer to Section 10 | Time

No.	What	How	Who
16	**Reduce costs by optimising infrastructure corridors** BUP, CPR, ATA, ITA 2022-2031	Enable the 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 and Treasury, supported by Te Waihanga and Infrastructure Providers
17	**Optimise the use of urban land** ULH, CBG 2032-2041	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 Government, Local Government
18	**Improve the efficiency and consistency of urban planning by standardising planning rulebooks** RAN, BUP, JUL 2022-2026	Standardise the 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 a smaller number of combined plans.	MfE, Ministry of Housing and Urban Development (MHUD), Local Government
19	**Improve the delivery of transit-oriented development (TOD)** TSS 2022-2026	Undertake post-implementation reviews of recent transit-oriented development (TOD) opportunities. These reviews should: a. Reflect international best practice, be independent and assess actual performance against appraisal, cost schedule and benefits. b. Recommend changes to practices and policies to increase the effectiveness of TOD delivery.	MoT, Waka Kotahi, MHUD, Kāinga Ora
20	**Improve the efficiency and outcomes of infrastructure through spatial planning** BUP, RAN 2022-2026	Resource management reforms should include requirements for regional spatial plans that: a. Provide clear direction to district plans and funding plans. b. Include mechanisms for participation by relevant central government infrastructure suppliers and Māori. c. Provide for cities to double or triple in population and provide alternative scenarios for the spatial distribution of growth, rather than providing only for a single growth scenario. d. Identify future infrastructure requirements, including future transport networks and other major infrastructure.	MfE, MHUD
Refer to Section 10		Time	

No.	What	How	Who
21	**Reduce congestion and improve urban mobility** TCQ, LGW, LFF 2022-2031	Implement congestion pricing and road tolling in urban centres by: a. Implementing recommendations in the "The Congestion Question" report for congestion charging in Auckland. Stage implementation as appropriate, considering current and future public transport arrangements. b. Immediately removing legislative barriers to implementing congestion charging and road tolling, such as requirements in the Land Transport Management Act 2003 for alternative untolled routes. c. Progressing planning for congestion pricing schemes for Wellington and other cities as appropriate. d. By 2025, identifying other urban areas where congestion pricing may be beneficial. e. Assigning responsibility for setting and adjusting prices to an appropriate independent institution.	MoT, Waka Kotahi, Local Government
22	**Target transport investment to areas of highest need using signals from congestion pricing** LFF, TCQ, LGW 2032-2050	Share and use data and signals from congestion pricing to identify where future multi-modal transport investment is needed.	Waka Kotahi, Local Government
23	**Increase housing development opportunities in areas with good access to infrastructure** BUP, RAN 2022-2031	Improve development opportunities in areas already well served by infrastructure by: a. Accelerating the implementation of the National Policy Statement on Urban Development 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. Prioritising provision of human necessities, such as housing, over preservation of subjective preferences (e.g. heritage, character and amenity). 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. Adopting independent hearings panels to review district plan changes.	Local Government, MfE, MHUD
		Refer to Section 10	Time

No.	What	How	Who
24	**Improve spatial planning through better information on infrastructure capacity and costs to service growth** CBD, WCB 2022-2031	Improve information on the infrastructure cost implications of different growth possibilities by: a. Developing, validating and publishing a spatial model of the long-run average infrastructure costs of servicing growth in different locations, to inform issues like regional spatial planning, local government development contributions policies 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.	MHUD, Te Waihanga, Infrastructure Providers
Section 6.4 - Strengthening resilience to shocks and stresses			
25	**Increase the resilience of critical infrastructure** HGI, BRN, DIV 2022-2026	To increase the resilience of critical infrastructure the government should: a. Develop a principles-based definition of critical infrastructure. b. Apply the definition of critical infrastructure consistently across the policy and legislative framework for resilience. c. Develop the criteria to set infrastructure criticality levels and then identify New Zealand's critical infrastructure. d. Clarify and strengthen requirements to identify minimum service levels for critical infrastructure in the event of an emergency. e. Adequately resource lead resilience agencies to carry out the functions required to support the delivery of critical infrastructure, on a consistent and long-term basis.	National Emergency Management Agency (NEMA), Department of Prime Minister and Cabinet (DPMC), Treasury
26	**Improve infrastructure risk management by making better information available** PRA, RSN 2022-2026	To make better information available to support risk management steps should be taken to: a. Require regular disclosures of information about critical infrastructure preparedness and minimum service levels in an emergency. b. Resource the maintenance, upkeep and availability of research, information, data-sets and tools to support decision-making that enables resilience outcomes.	NEMA, DPMC, LINZ, Central Government
27	**Prepare infrastructure for the impacts of climate change** CAT 2022-2031	To adapt to climate change, actions 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 and robust information on regional and local climate change impacts across the whole country.	MfE, Te Waihanga, Climate Change Commission

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28	**Support the security of supply of essential materials, goods and services to build, operate and maintain infrastructure** PRS 2022-2050	To increase the resilience of supply of essential materials, steps should be taken to: a. Incorporate into all risk-management planning for critical infrastructure a consideration of the security of supply of materials and goods required for the construction, operation and maintenance of infrastructure (including aggregate, bitumen, cement, concrete, steel and processed timber) and other essential goods and services. b. Require that regional councils, in conjunction with territorial authorities, undertake resource scans as part of their long-term planning processes and protect sites suitable for aggregate extraction, including through zoning.	MBIE, Ministry for Primary Industries, Central Government, Local Government
Section 6.5 - Moving to a circular economy			
29	**Establish a clear national direction for circularity in waste management** RRV, WSP 2022-2031	In developing a National Waste Strategy, provide appropriate direction that: a. Sets out a plan for circularity and is consistent with net-zero emissions 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
30	**Prioritise options that minimise waste entering the market to avoid unnecessary infrastructure costs** FOT, ACW 2022-2031	Options should include: a. A ban on products that are hard to recycle. b. The 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 analyses.	MfE, Local Government
31	**Improve recycling infrastructure for priority materials** WSP 2022-2031	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-offs and the 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

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No.	What	How	Who
32	**Use behavioural interventions to address barriers to recycling, reduce waste and avoid contamination** WSP, RRM 2022-2031	This should include: a. Improving the ease of recycling for consumers, with a focus on simplicity and consistency across jurisdictions. b. Funding sustained education campaigns that promote and improve the social licence 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
33	**Reduce landfill emissions resulting from organic waste** WSP 2022-2031	Steps should be taken to: a. Improve the collection of organic waste through more commercial and household food waste collection services. b. Target education and behaviour-change programmes to improve the take-up of organic waste collection. c. Require landfill gas capture for all landfills that accept organic waste.	MfE, Local Government
34	**Develop uses for recycled materials in infrastructure** WSP 2022-2031	Responsible agencies should: a. Identify opportunities for more domestic reprocessing, including for plastics (especially e-waste), metals, fibreglass, plasterboard and aggregate. b. Develop relevant technical specifications and national standards for the re-use of recycled construction materials in infrastructure. c. Support innovation in, and the procurement of, infrastructure design and construction to enable a greater use of recyclable materials in infrastructure.	MfE, MBIE, Local Government
35	**Clarify the strategic role of waste-to-energy** WSP, WTE 2027-2031	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
36	**Improve waste sector data and insight** WSP 2022-2031	Fund improvements in waste data to enable comparisons between volume, performance and processing capacity across waste streams by region and territorial authority. This might be achieved by resourcing the implementation of the National Waste Data Framework.	MfE, Local Government
37	**Encourage public infrastructure waste minimisation and designing for deconstruction** WSP 2022-2031	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 and 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

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No.	What	How	Who
Section 7.1 - Better decision making			
38	**Strengthen government as a sophisticated client of infrastructure** WEF, ROY 2022-2031	Take the following steps to develop the client capabilities 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 in end-to-end delivery, including governance, commissioning, procurement, negotiation, oversight and whole-of-life management systems for major infrastructure.	Treasury, Central Government Delivery Agencies
39	**Increase the clarity of long-term investment intentions for public infrastructure agencies** AIP 2027-2031	Central government requirements for long-term investment planning and asset management planning for all public infrastructure providers should be aligned with standards for local government and regulated infrastructure. Long-term investment planning should be transparent, aligned with agency service-delivery priorities and strategies, and linked with budget allocations and other sources of financing.	Treasury, DIA, Local Government
40	**Strengthen independent advice for infrastructure prioritisation** AIP 2022-2026	Establish an independent infrastructure priority list to build consensus on key projects and initiatives that address significant long-term problems. The development of 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 update the priority list regularly.	Te Waihanga
41	**Improve infrastructure performance reporting and insight** DSA 2022-2050	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

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No.	What	How	Who
42	**Optimise infrastructure investment by considering non-built solutions first** INH, NOF 2022-2031	Consider and prioritise non-built options when choosing how to address infrastructure challenges, including: a. Using pricing to manage demand. b. Making better use of existing infrastructure by adapting or re-using it. c. Using regulation and education to manage infrastructure demands. d. Considering lower-cost options before progressing to higher-cost options.	Treasury, Central Government Delivery Agencies, Local Government
43	**Strengthen project evaluation through cost-benefit analysis** PII 2022-2026	Deliver consistent and transparent project evaluation by requiring: a. Local and central government agencies to undertake and publicly release rigorous social cost-benefit analyses of all public infrastructure investment proposals where the whole-of-life costs of the proposals exceed $150 million. b. Commitments to projects to only be made after the completion of this analysis, rather than prior to undertaking the analysis. c. Analysis to recognise inter-generational choices appropriately and include wider environmental and social impacts.	Treasury, MBIE, Te Waihanga
44	**Ensure an appropriate consideration of future generations in project evaluation** TNT 2027-2031	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
45	**Improve the infrastructure project knowledge base** DSA 2022-2050	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 costs against business case estimates.	Central Government Delivery Agencies
46	**Improve infrastructure cost analysis** BUP 2022-2050	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 every five years to inform ongoing Infrastructure Strategy development.	Te Waihanga

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No.	What	How	Who
Section 7.2 – Improving funding and financing			
47	**Improve equitable funding of local infrastructure** ULH 2027-2031	Investigate options and timing to phase in the removal of existing Crown exemptions from paying rates, recognising when a demand for infrastructure is generated. The approach should avoid creating excessive and unexpected financial liabilities.	DIA
48	**Reform the transport funding system** KCM 2022-2031	Implement a new, fit-for-purpose transport funding system that's sustainable and adequate for meeting future transport investment requirements. The system should incorporate principles for user charges and best-practice funding and include shifting vehicles to time, location, distance and level-of-service-based pricing. Establishing a new system should include: a. Establishing necessary transport funding requirements. b. Introducing necessary complements or replacements to Road User Charges and Petrol Excise Duty. c. Determining how additional funding, if required, should be collected.	MoT
49	**Improve and streamline the application of development contributions** FFI 2027-2031	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
50	**Consolidate existing separate infrastructure capital funds** AIP, FFI, RNS 2022-2031	Fragmented infrastructure capital funding pools should be consolidated and integrated in a transparent infrastructure capital fund, or funds. The consolidation of national capital funding programmes for infrastructure would enable the Government to prioritise investments based on national significance and net benefits and enable greater public transparency of infrastructure capital funding decisions. How funding is held and distributed should: a. Be set out transparently. b. Include a consideration of the use of grants, loans and investments, or some combination of these.	Treasury
51	**Improve the ability to debt fund infrastructure** LFF 2027-2041	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 2020. b. Explore other Special Purpose Vehicles as a mechanism for new infrastructure investments.	Treasury, DIA

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No.	What	How	Who
52	**Improve funding of infrastructure services through targeted funding tools** LFF, FFI, TCQ 2027-2031	Establish targeted funding tools for the following applications: a. Tourism: Ensure that the International Visitor Conservation and Tourism Levy can be used for tourism infrastructure, especially by local authorities with high international visitor numbers that are otherwise struggling to secure funding sources. b. Wastewater: Introduce legislative change that clarifies the ability of local authorities to direct-rate wastewater based on volumes, to create a better link between services and costs to users. c. Waste: Investigate what funding mechanisms will best achieve the objectives of the Waste Minimisation Act 2008 and the National Waste Strategy and incentivise behaviour appropriately.	MBIE, MoT, DIA, MfE
53	**Encourage the use of value capture tools to fund infrastructure for growth** BUP, FFI, LFF, MHT 2022-2031	Enable value capture tools through legislation to ensure that more funding is available for infrastructure that generates value for users and communities.	Treasury
54	**Increase infrastructure funding to meet our infrastructure challenges and boost productivity** FFI, TIC 2027-2050	Given that current expenditure levels are unlikely to be sufficient to provide for infrastructure needs in coming decades, a material increase in infrastructure funding from both public and private sources is required to meet our infrastructure challenges and boost productivity. The government should increase infrastructure funding where there are opportunities to use investment to support productivity growth, resilience and improvements in environmental outcomes. Investments should be made based on rigorous assessments of which projects deliver positive value for money.	Treasury
55	**Ensure that infrastructure charges keep pace with inflation** LFF 2022-2026	Infrastructure related charges, fees and levies that are set out in legislation or regulation should be adjusted for inflation.	Treasury, Local Government
56	**Improve public understanding of how infrastructure is funded** FFI 2022-2026	Improve communication about how infrastructure is priced and funded to build public understanding, including: a. How infrastructure is priced in different infrastructure sectors, and what implications this has for equity and the quality of infrastructure provision. b. The link between how infrastructure is paid for and the quality of services that are provided.	Te Waihanga, Infrastructure Providers

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No.	What	How	Who
Section 7.3 – An enabling planning and consenting framework			
57	**Strengthen the government's mandate to deliver infrastructure** NBE, CCI 2022-2026	Ensure that the Natural and Built Environments legislation 'gives effect' to existing requirements for the government to deliver infrastructure.	MfE
58	**Improve the evidence base for environmental consent applications** NBE, CCI 2022-2031	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 of 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 assessing environmental consent applications.	MfE
59	**Deliver reasonable environmental limits and targets in the Natural and Built Environments legislation** NBE 2022-2026	Steps to achieve this recommendation include: a. Focusing on environmental limits and targets for matters sustaining life (for example air, water, soil and biodiversity) rather than human values and preferences (for example heritage, character and amenity). b. Standardising national minimum environmental limits. Where possible, ensure that environmental limits are measurable, targeted and quantifiable.	MfE
60	**Develop greater certainty for infrastructure providers in the Natural and Built Environments legislation** NBE, CCI 2022-2031	Steps that should be implemented to deliver greater certainty include: a. Standardising and codifying a National Planning Framework for infrastructure in the emerging Natural and Built Environments legislation, which 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. Providing a mechanism for resolving conflicts between multiple outcomes to avoid litigation on the interpretation of the outcomes. c. Narrowing the definition of 'effects' to those relating to the natural and physical environment, so that other matters (like effects on trade competition) aren't unreasonably used to restrict new infrastructure. d. Requiring that externalities unrelated to natural and physical resources are addressed elsewhere, such as in a project business case.	MfE, Te Waihanga

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No.	What	How	Who
Section 7.4 - Accelerating technology use			
61	**Increase the diffusion of existing technologies to increase productivity in the infrastructure sector** PTC 2022-2026	Increase diffusion of existing technologies through the following steps: a. Review approaches to procurement at an agency level and consider whether there are barriers to technology diffusion within current systems and practices. 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 (such as minimum energy performance standards, housing codes, waste and water efficiency) to responsible regulators where there are productivity gains and ensure the standards are reviewed and updated regularly.	DIA, MBIE
62	**Accelerate the adoption of open data and common standards for the infrastructure sector** PTC 2022-2031	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, building on existing government initiatives.	DIA, Stats NZ
63	**Accelerate the digitalisation of infrastructure** PTC 2027-2031	Accelerate digitalisation across the infrastructure lifecycle by implementing the following steps: a. Facilitate the 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

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No.	What	How	Who
Section 7.5 - Building workforce capacity and capability			
64	**Provide certainty to industry to invest in skills and training development** CTP 2022-2031	Strengthen the Te Waihanga Infrastructure Pipeline to provide industry and government with a long-term view on: a. The scale and type of work to be completed. b. The likely resources required to plan, deliver and maintain infrastructure. c. The geographic and sectoral distribution of projects. Use the aggregated data to provide insight into 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
65	**Develop the talent required to deliver New Zealand's future infrastructure** AIP 2022-2031	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 the national infrastructure skills plan so that it: a. Provides information on the likely professional and workforce requirements to deliver the planned and forecast infrastructure supply over the next 15 years and beyond. b. Advises on how our education system can best support our future workforce needs. c. Provides advice on the role of immigration settings to address critical specialist infrastructure skill deficiencies that could delay construction or add to the costs of projects and maintenance. d. Provides advice on skill-development pathways that appeal to a diverse audience and increase 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, Public Service Commission, Te Waihanga, MBIE, Tertiary Education Commission, Treasury, Construction Sector Accord, Ministry of Education
66	**Build New Zealand's competitiveness for international firms and products** AIP 2027-2031	Identify and reduce barriers for international firms and products to enter the New Zealand market by adopting international standards by default unless there is a compelling rationale for the development of a specific New Zealand standard. Strengthen the trans-Tasman procurement market by ensuring a consistent approach in: a. Product and building standards. b. Qualification requirements. c. Contract and procurement processes.	NZ Government Procurement, MBIE

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No.	What	How	Who
67	**Strengthen government client-side capability to plan, design and deliver projects** AIA 2027-2031	Improve project outcomes by increasing public sector capabilities 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 research in infrastructure. d. Aligning remuneration between the public and private sectors to improve competition across infrastructure types.	Public Service Commission, Central Government Delivery Agencies
68	**Recognise major project leadership as a role with comparable complexity to organisational leadership** MPL 2022-2031	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 accountability mechanisms and remuneration are aligned with the complexity and risk project leaders are managing on behalf of the government.	Public Service Commission, Te Waihanga

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Port Chalmers, Dunedin.

10. Want to know more

Hiahia he mōhiohio anō

The following documents are ones that we found particularly useful in the development of the 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 2016**	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
ATA	**Australian Transport Assessment and Planning Guidelines: T8 - Real Options Assessment**	Transport and Infrastructure Council	https://www.atap.gov.au/sites/default/files/documents/atap-t8-real-options-assessment.pdf
BUP	**Better Urban Planning**	The New Zealand Productivity Commission	https://www.productivity.govt.nz/inquiries/better-urban-planning/
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
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	**Ināia tonu nei: a low emissions future for Aotearoa**	He Pou a Rangi, the Climate Change Commission	https://www.climatecommission.govt.nz/our-work/advice-to-government-topic/inaia-tonu-nei-a-low-emissions-future-for-aotearoa/
CCI	**The Cost of Consenting Infrastructure Projects in New Zealand**	Sapere, (a report for the New Zealand Infrastructure Commission, Te Waihanga)	https://www.tewaihanga.govt.nz/assets/The-cost-of-consenting-infrastructure-projects-in-NZ-final-report.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
CTP	**Construction Sector Transformation Plan**	Construction Sector Accord	https://www.constructionaccord.nz/assets/Construction-Accord/files/construction-accord-transformation-plan.pdf
DIV	**30-Year Strategy**	Infrastructure Victoria	https://www.infrastructurevictoria.com.au/wp-content/uploads/2021/08/1.-Victorias-infrastructure-strategy-2021-2051-Vol-1.pdf
EAF	**Washington Electric Aircraft Feasibility Study**	WSDOT, 2020	https://wsdot.wa.gov/sites/default/files/2021-11/WSDOT-Electric-Aircraft-Feasibility-Study.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)	https://www.tewaihanga.govt.nz/assets/Uploads/Financing-and-funding-of-infrastructure-in-New-Zealand.pdf
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://www.tewaihanga.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	https://haveyoursay.climatecommission.govt.nz/comms-and-engagement/future-climate-action-for-aotearoa/consultation/download_public_attachment?sqId=question-2021-01-19-0131576176-publishablefilesubquestion&uuId=488170798
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
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
LER	**Leveraging our energy resources to reduce global emissions and increase our living standards**	New Zealand Infrastructure Commission, Te Waihanga	https://www.tewaihanga.govt.nz/assets/Uploads/Leveraging-our-energy-resources.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/assets/Uploads/Labour-Markets-Report.pdf
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/urban-rural-and-regional-development/municipal-fragmentation-and-economic-performance-of-oecd-tl2-regions_5jrxqs60st5h-en
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
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/sites/default/files/migrated/transport/freight/national-freight-data-hub/files/national-freight-data-hub-options-discussion-paper-august-2020.docx
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://storage.googleapis.com/converlens-au-industry/industry/p/prj1a399c09546fd22c3dd7e/public_assets/offshore-clean-energy-regulatory-framework-discussion-paper.pdf
PII	**Productivity Commission Inquiry Report on Public Infrastructure**	Australian Productivity Commission	https://www.pc.gov.au/inquiries/completed/infrastructure/report

Ref.	Document	Author	Link
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	**Infrastructure Resources Study**	New Zealand Infrastructure Commission, Te Waihanga	https://www.tewaihanga.govt.nz/assets/Infrastructure-Resources-Study-11-Nov-21.pdf
PTC	**Preparing for Technological Change in the Infrastructure Sector**	BECA, Polis (a report for the New Zealand Infrastructure Commission, Te Waihanga)	https://tewaihanga.govt.nz/assets/Uploads/Preparing-for-Technological-Change-in-the-Infrastructure-Sector.pdf
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	**Advice on Recycling and Resource Recovery Infrastructure**	Infrastructure Victoria	https://www.infrastructurevictoria.com.au/wp-content/uploads/2020/03/Advice-on-recycling-and-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)	https://www.infrastructurevictoria.com.au/wp-content/uploads/2019/10/International-and-Australian-comparisons-Alphabeta-September-2019-FINAL-REPORT.pdf
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/assets/Uploads/Infrastructure-Challenge-Report.pdf
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/
ULH	**Using Land for Housing**	New Zealand Productivity Commission	https://www.productivity.govt.nz/inquiries/using-land-for-housing/
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/
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 Public Finance Act. Also referred to as Procuring Agencies.
Aotearoa 2050	The Te Waihanga campaign to collect feedback from New Zealanders to help shape a view of what New Zealand's infrastructure will look like in 2050.
Artificial intelligence – machine learning	Technology that enables digital devices to respond to and learn from their environments. Artificial intelligence is anticipated to streamline tasks, especially those that are repeatable, and continue to learn and develop through completing tasks and receiving feedback.
Augmented reality	An enhanced version of the real physical world that's achieved through the use of digital visual elements, sound or other sensory stimuli delivered via technology.
Better Business Case framework	A five case (or five question) model that provides objective analyses and consistent information to decision-makers, to enable them to make smart investment decisions for public value.
Biomass energy (or bioenergy)	Energy that 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) and gas (such as that produced in wastewater and 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)	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's calculated by multiplying the quantity of a greenhouse gas by the relevant global warming potential.
Circular economy	A model of production and consumption that involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products for as long as possible.
Civil Defence and Emergency Management Act 2002	A framework within which New Zealand can prepare for, deal with, and recover from local, regional and national emergencies.
Congestion pricing	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 the government and industry to transform the construction sector.
Cost-benefit analysis (CBA)	A systematic process that businesses use to analyse the decisions to make and those to forgo. A 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 the Queen which isn't for the time being set aside for any public purpose or held by any person in fee simple.
Cyber security	The practice of protecting critical systems and sensitive information from digital attacks.
Digital consenting	An application of Building Information Modelling (BIM) and digital twins that streamlines the infrastructure consenting and approval process. Traditionally, consenting and approvals of changes to the built environment rely on people checking compliance. Digital consenting removes the human element by integrating the consenting and compliance checks with BIM and digital twin applications.
Digital twins	A virtual model designed to reflect a physical object accurately. 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 and weather conditions and more. This data is then relayed to a processing system and applied to the digital copy.
Disposal emissions	The carbon dioxide emissions generated at the end of life, including emissions from decommissioning, recycling and waste disposal.
Distributed energy resources	The name given to renewable energy units or systems that are commonly located in houses or businesses to provide them with power. Common distributed energy resources include rooftop solar PV units, battery storage, thermal energy storage, electric vehicles and chargers, smart meters, and home energy-management technologies.
Economic infrastructure	Our energy, telecommunications, transport, waste, and water infrastructure.
Economic stimulus	A targeted fiscal and monetary policy intended to elicit an economic response from the private sector.
Electric aircraft	An aircraft powered by electricity, almost always via one or more electric motors that drive propellers. Electricity may be supplied by a variety of methods, the most common being batteries and solar cells.
Electricity generation	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.
Embodied emissions	The carbon dioxide emissions associated with the materials and construction of infrastructure.
Emissions Reduction Plan	A plan that contains policies and strategies to reduce emissions and increase removals to meet an emissions budget.
Emissions Trading Scheme (ETS)	A scheme created through the Climate Change Response Act 2002. The Act was passed in recognition of New Zealand's obligations under the Kyoto Protocol. It's the primary method for the New Zealand government to achieve its long-term commitment to reduce our greenhouse gas emissions.
Enabled emissions	The carbon dioxide emissions generated from third parties using infrastructure.
Energy transition	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 effects of production or consumption of goods and services imposes costs or benefits on others that aren't 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	All the money needed to pay for infrastructure. It comes from the community through users, taxpayers and ratepayers.

Gas-fired generation	A thermal power station that burns natural gas to generate electricity.
Gateway™	An independent project/programme peer review methodology that provides advice and support to the Senior Responsible Owner of a programme or project.
GDP	Gross domestic product.
Geothermal energy	Electrical power generated from geothermal energy.
Gigawatt	A measure equal to one billion (1,000,000,000) watts or one gigawatt = 1000 megawatts. This unit is often used for large power plants and 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's the system by which an organisation or project is directed and controlled.
Information and communications technologies (ICT)	A diverse set of technological tools and resources used to transmit, store, create, share and exchange information. They 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, video-conferencing etc.).
Infrastructure	Fixed, long-lived structures that facilitate economic performance and wellbeing. Infrastructure includes 'horizontal' physical networks (principally transport, water and energy and telecommunications); and 'vertical' infrastructure (buildings such as hospitals, schools and prisons). The latter are also known as social assets.
Infrastructure funds	Entities that consolidate funds for the purpose of acquiring infrastructure assets (the infrastructure assets are defined by the mandate of each fund and can differ substantially for different funds).
Infrastructure pipeline	A tool being published on the Infrastructure Commission website that provides visibility of the timing, sequencing and scale of future infrastructure projects.
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	A non-refundable levy of $35 charged to international visitors. It contributes directly to helping protect the natural environment they enjoy, and the infrastructure they use.
Internet of Things	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.
Joint venture	A strategic alliance between two or more parties to accomplish a specific task or project.
Metadata	Information that describes other information in order to help you understand or use it.
Minimum energy performance standards	Minimum energy efficiency standards that products must meet to be sold in New Zealand.
National Policy Statement on Urban Development	A policy statement that 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	A framework that establishes a set of definitions to act as a common language for collecting and reporting waste data and determines what data is gathered.

Net-zero carbon emissions commitment	A new target for reducing domestic greenhouse gas emissions in New Zealand, set by the Climate Change Response (Zero Carbon) Amendment Act 2019 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'll 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.
Operational emissions	The carbon dioxide emissions generated from operations, maintenance and renewal of infrastructure.
Pumped hydro storage	A hydro storage method that captures and stores water in two places. Using surplus electricity, water can be pumped uphill to a storage lake. When demand for electricity can't be met by other means, that water can be released via a steep drop to power turbines and generate electricity.
Regulatory settings	Laws, ordinances, rules, regulations, orders, codes and other legally enforceable requirements in effect and applicable to the performance of work.
Renewable energy zone	An area that would be suitable for renewable energy infrastructure and where there would be few barriers to gaining resource consent.
Resource exchange mechanism	A mechanism to facilitate the trade of surplus materials, products, components and assets across United Kingdom 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	A Panel appointed by the Minister for the Environment, the Hon David Parker, to undertake a comprehensive review of the resource management system in New Zealand.
Social discount rate	A mechanism used to put a present value on costs and benefits that will occur at a later date.
Social infrastructure	Our hospitals, schools, prisons, parks, libraries, and community buildings.
Spatial planning	Setting a direction and a long-term goal to promote the four well-beings (social, economic, environmental and cultural) through the integration of considerations for land use change, infrastructure development and delivery, environmental management and recognition of cultural values.
Spillover effects	Positive or a negative economic, social or political impact that's experienced due to an independent event occurring from a seemingly unrelated event.
Supply chain	A supply 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	Includes telephone wires, cables (including submarine cables), satellites, microwaves, and mobile technology such as fifth-generation (5G) mobile networks.
Telehealth	A system through which healthcare is provided remotely by means of telecommunications technology.
Terawatt-hour (TWh)	A watt-hour (Wh) is the amount of energy produced by a one-watt source running for one hour. A terawatt-hour (TWh) is one trillion watt-hours, or 1,000 gigawatt-hours (GWh).

Territorial authority	A tier of local government in New Zealand.
Transit-oriented development (TOD)	A development that aims to develop high-density, mixed-use living options in close proximity to local amenities, with links to reliable and frequent public transport.
Value capture	An infrastructure funding mechanism that recovers some or all of the value that public infrastructure generates for private property owners.
Volumetric charge	A charge based on the volume of water used. For metered premises, this is based on the volume of water recorded by the meter.
Waste-to-energy	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.

Glossary of Te Reo Māori Terms

Aotearoa	The te reo name for New Zealand.
Hapū	Kinship group, clan, tribe, subtribe - section of a large kinship group and the primary political unit in traditional Māori society. It consists of a number of whanau 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.
Kaitiaki	Guardian/Steward. Tangata whenua, whānau, hapū, iwi exercising the responsibilities of kaitiakitanga (guardianship) inherited through whakapapa Māori.
Kaitiakitanga	Guardianship/Stewardship.
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.
Maramataka	Māori lunar calendar - a planting and fishing monthly almanac. For most tribes the lunar months began with the new moon and 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.
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’s located on multiply-owned Māori or ancestral land.
Rangatiratanga	Chieftainship, right to exercise authority.
Tangata whenua	People of the land.
Te ao Māori	The Māori world view that acknowledges the interconnectedness and interrelationship of all living and non-living things.
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.

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Transpower New Zealand Limited. *Whakamana I Te Mauri Hiko - Empowering Our Energy Future*. March 2020. Accessed August 24, 2021. https://www.transpower.co.nz/sites/default/files/publications/resources/TP%20Whakamana%20i%20Te%20Mauri%20Hiko.pdf.

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Innovation and Participation Advisory Group. "Submission on Accelerating Renewable Energy and Energy Efficiency." Wellington, New Zealand, February 28, 2020. Accessed February 24, 2022. https://www.ea.govt.nz/assets/dms-assets/26/26595IPAG-MBIE-submission-on-Accelerating-renewable-energy-and-energy-efficiency.pdf

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102. ‘Main cities’ are defined using territorial authority boundaries, including satellite suburbs and towns that are part of the same urban labour market: Auckland (Auckland Council), Wellington urban area (Wellington City, Lower Hutt City, Upper Hutt City, Porirua City, Kapiti Coast District), Christchurch urban area (Christchurch City, Selwyn District, Waimakariri District), Hamilton urban area (Hamilton City, Waikato District, Waipa District), and Tauranga urban area (Tauranga City, Western Bay of Plenty District). This definition includes some rural settlements and excludes some urban places, but it was used to ensure consistency with population projections, which are not yet available below the territorial authority level.
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195. Ministry of Transport. *The Congestion Question: Main Findings*. Wellington: Ministry of Transport. https://www.transport.govt.nz//assets/Uploads/Report/TheCongestionQuestionMainFindings.pdf. This analysis shows that applying a modest peak-time charge will significantly improve road network performance and the quality of travel for users, and that the equity impacts of congestion pricing are modest and manageable with complementary measures.

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320. The OECD Recommendation of the Council on the Governance of Infrastructure recommends that countries develop a long-term strategic vision for infrastructure which is fiscally sustainable, linked with budget allocations and other sources of financing, and aligned with the medium-term expenditure framework. This provides assurance to the relevant stakeholders of the stable, multi-year availability of resources. https://www.oecd.org/gov/infrastructure-governance/recommendation/

321. See Section 93 of the Local Government Act 2002. https://www.legislation.govt.nz/act/public/2002/0084/latest/DLM172344.html

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323. For example, agencies that have projects in the Te Waihanga pipeline starting in 2023 or later are Watercare, Wellington Airport, Transpower and Kainga Ora, all of which have long term funding sources.

324. A potential model is the New South Wales Capital Planning Process, a cyclical process that takes place annually alongside the annual State Budget process. https://www.treasury.nsw.gov.au/information-public-entities/capital-planning

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327. The Office of the Auditor-General has previously highlighted the need for decision-makers to understand the risks in managing physical assets and ensure that these risks are actively managed.
Office of the Auditor-General. *Reflections From Our Audits: Investment and Asset Management*. Wellington, New Zealand: Office of the Auditor-General. 2017. https://oag.parliament.nz/2017/asset-reflections
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328. The Australian infrastructure priority list is available online here: Infrastructure Australia. *Infrastructure Priority List*. Canberra, Australia: Infrastructure Australia. 2021. https://www.infrastructureaustralia.gov.au/infrastructure-priority-list
An infrastructure priority list could draw upon sector-specific long-term planning exercises, such as the Ministry of Transport's "Generational Investment Approach." https://www.transport.govt.nz/area-of-interest/infrastructure-and-investment/generational-investment-approach-gia/

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342. The public sector discount rate encapsulates trade-offs between present and future outcomes. There are several different approaches to selecting a discount rate, which have different implications for how we value the future. For Treasury guidance, see: The Treasury. *Discount Rates*. Wellington, New Zealand: The Treasury. 2020. https://www.treasury.govt.nz/information-and-services/state-sector-leadership/guidance/financial-reporting-policies-and-guidance/discount-rates For a recent discussion of the importance of discount rates for valuing environmental impacts from carbon emissions, see: Vivid Economics. *Carbon Values Literature Review.* BEIS research paper number 2021/049. London, UK: Department for Business, Energy, & Industrial Strategy. 2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1017060/carbon-values-lit-review.pdf

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International Monetary Fund. 2015. *Investment and Capital Stock Dataset (ICSD)*. Accessed 20 September 2021. https://data.imf.org/?sk=1CE8A55F-CFA7-4BC0-BCE2-256EE65AC0E4

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Ramsay, K. 2022. *Financing and Funding of Infrastructure in New Zealand*, https://www.tewaihanga.govt.nz/assets/Uploads/Financing-and-funding-of-infrastructure-in-New-Zealand.pdf

354. 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.

355. 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.

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358. Further details about service-based and cost-reflective pricing are provided in C Hansen, *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 F.A Wolak, *Public Utility Pricing and Finance*. New Palgrave Dictionary of Economics 2nd Edition, 2008:2.

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361. See for instance, how rapid transit affects property values. Auckland Council. *Insights: Topical Commentary on the Auckland Economy.* October 2018. https://www.aucklandcouncil.govt.nz/about-auckland-council/business-in-auckland/docsoccasionalpapers/rapid-transit-access-property-values-oct-2018.pdf

362. 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.

363. Targeted rates are not a pure value capture charge as they cannot be applied to value uplift between two points in time.

364. 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

365. One perceived challenge of using targeted rates to fund infrastructure is that they can be reversed by future decision-makers. However, this is true of infrastructure funding across all sectors. Decision-makers are always required to carefully consider the implications of any change from original intentions. This is dictated through the obligations placed on board directors and elected members through various legislation.

366. Public transport is partly subsidised from rates and fuel taxes. This reflects the fact that public transport provision helps reduce road congestion. For empirical evidence, see:
Adler, Martin, and Jos N. van Ommeren. *Does Public Transit Reduce Car Travel Externalities?* Netherlands: Tinberg Institute. 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. *The Transport Impacts of the 20 June 2013 Storm*. Wellington, New Zealand: Ministry of Transport. 2013. Accessed September 21, 2021. https://web.archive.org/web/20180202160530/https://www.transport.govt.nz/assets/Uploads/News/Documents/Transport-impacts-in-Wellington-storm-June-2013.pdf

367. Work and Income New Zealand. *Winter Energy Payment*. 2019. Accessed September 22, 2021. https://www.workandincome.govt.nz/products/a-z-benefits/winter-energy-payment.html

368. Kline P. and E Moretti. "People, Places and Public Policy: Some Simple Welfare Economics of Local Economic Development Programs." *IZA Discussion Papers* No. 7735. 2013. http://hdl.handle.net/10419/89941

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371. Caldera Sánchez, Aida and Dan Andrews "Residential Mobility and Public Policy in OECD Countries." *OECD Journal: Economic Studies*, Vol. 2011/1. 2011: 199. http://dx.doi.org/10.1787/eco_studies-2011-5kg0vswqt240

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375. Ministry of Business, Innovation and Employment. "Broadband and Mobile Programmes." https://www.mbie.govt.nz/science-and-technology/it-communications-and-broadband/fast-broadband/broadband-and-mobile-programmes/

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377. Carter, D. “Lifting Investment in Irrigation.” *New Zealand Government Release: Budget 2011*. May 10, 2015. https://www.beehive.govt.nz/release/budget-2011-lifting-investment-irrigation

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381. Hon Shane Jones. “The Provincial Growth Fund.” *New Zealand Government Release*. December 2017. 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.

382. Ministry of Business, Innovation and Employment. “Tourism Infrastructure Fund.” https://www.mbie.govt.nz/immigration-and-tourism/tourism/tourism-funding/tourism-infrastructure-fund/.
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383. New Zealand Government Release. “The New Zealand Upgrade Programme.” January 29, 2020. https://www.beehive.govt.nz/feature/new-zealand-upgrade-programme

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392. Hon James Shaw. “Foundations Laid for Strong Climate Action.” *Press release.* May 20, 2021. 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.

393. Waka Kotahi. “Allocation of Funds to Activity Class” https://www.beehive.govt.nz/release/government-provide-support-water-reforms-jobs-and-growth

394. Infrastructure New South Wales. “Restart NSW.” https://www.infrastructure.nsw.gov.au/restart-nsw/

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396. Productivity Commission. *Local Government Funding and Financing: Final Report*. Wellington, New Zealand: Productivity Commission. 2019. https://www.productivity.govt.nz/assets/Documents/a40d80048d/Final-report_Local-government-funding-and-financing.pdf

397. 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.

398. 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.

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402. This includes three Ministry of Education projects, delivering 11 new primary and secondary schools in Auckland, Christchurch, Hamilton and Queenstown; three Department of Corrections projects, delivering 2060 additional prison beds at Auckland Prison, the Auckland South Correctional Facility and Waikeria Prison; and two Waka Kotahi, NZ Transport Agency projects, Transmission Gully and Pūhoi to Warkworth, delivering c.45km of Motorway.

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405. Adversarial consenting processes have been shown to increase costs to review and consent projects, and potentially also reduce environmental outcomes due to delays.
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Te Āpiti wind farm in the Manawatū can generate up to 90.75 megawatts of electricity.

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