TRANSPOWER

A future grid blueprint for Aotearoa

Consultation 2:

Potential Scenarios

October 2025

Te Kanapu
Future Grid Blueprint

Overview

This is the second in a series of consultations we are running, to support us in gathering data, information and feedback on the future of Aotearoa and its energy system.

In this consultation we outline the five potential scenarios we have developed to enable a discussion around Aotearoa's different possible futures and its resulting energy use.

We outline the different inputs we have considered, the methodologies we have used, and the assumptions we are making.

Now we are seeking your input into this work so that we can change, expand and refine our scenarios to reflect your views. Your input will help us understand where we are on track and where we need to do more work.

We'll publish a revised version of these scenarios next year, giving you a second opportunity to give feedback.

Consultation closes at 5pm, Friday 14 November.

There are several questions posed throughout this document. Please keep these in mind as you read through the information. We have provided a separate editable submission form where you can provide your thoughts, feedback and answers to the questions.

Do not feel you have to answer all of them; we welcome all feedback regardless of the level of detail that is provided.

You are also welcome to raise other issues you believe might be relevant. You can:

- Complete and submit the form **here online**, or
- You can download the form, complete it offline, then email the file to **feedback@transpower.co.nz**
- Alternatively, you can email us directly at **feedback@transpower.co.nz** with your thoughts. We welcome all input however it is received.

Everyone is welcome

We're interested in a wide range of views on the future of Aotearoa, how we might grow to realise this future, and the role that electricity will play.

You don't need to be an energy expert to provide valuable insights.

Publishing submissions

We will publish all submissions on **www.transpower.co.nz/our-work/te-kanapu**

Unless requested by you, we will include both your name and your full submission on the website.

Transparency is important in this process. If there is any aspect of your submission that is confidential, please clearly mark the sections you consider confidential and indicate why.

Contact us

If you want to get in contact directly, email **feedback@transpower.co.nz**

For more information

Visit the Te Kanapu section on the Transpower website to read more. There you will find the background to our work, previous and current consultations and additional data and analysis that has been used in our work to date.

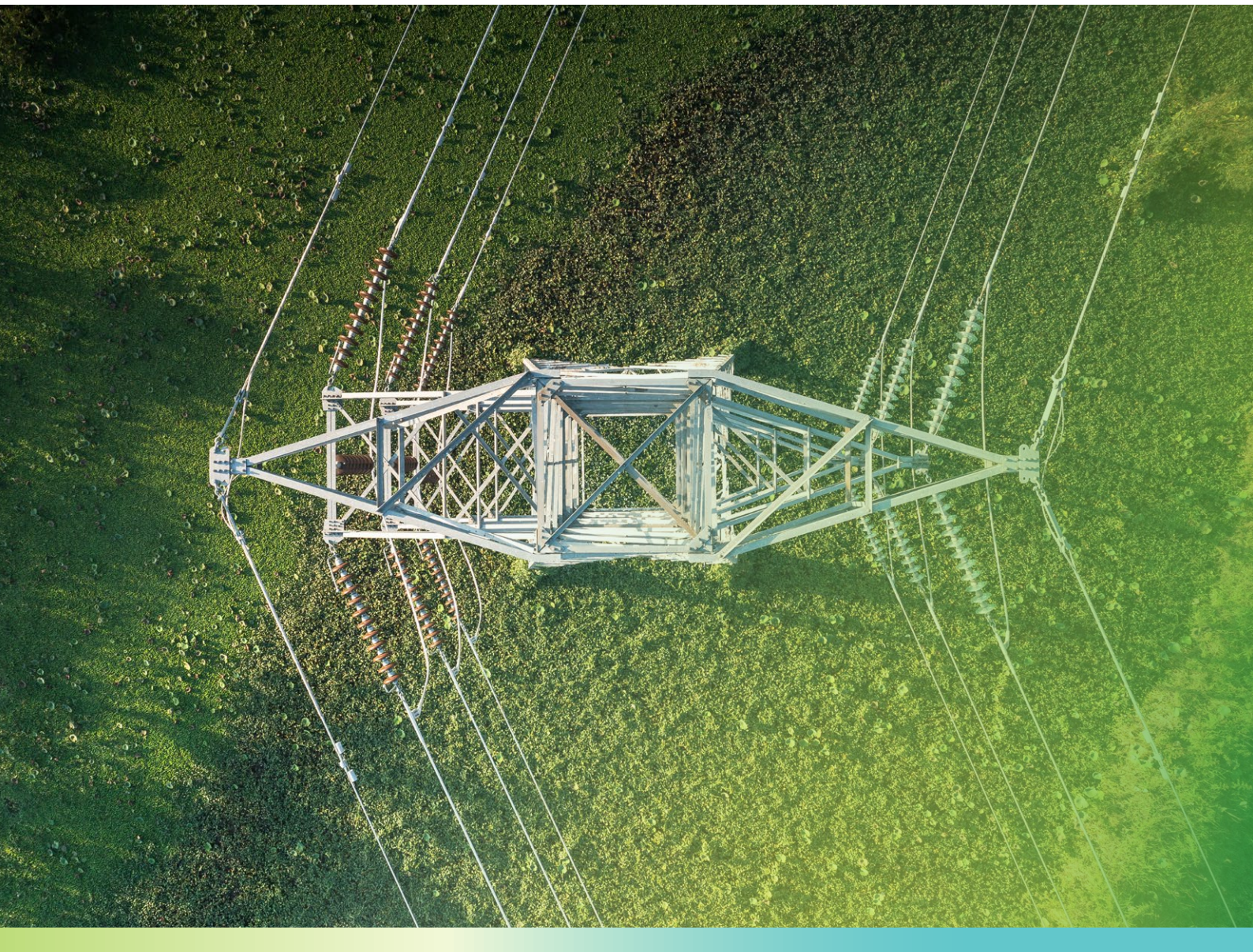
www.transpower.co.nz/our-work/te-kanapu

Introduction: Shaping our energy future together

Transpower has an important role to play in enabling Aotearoa to electrify and grow. We own and operate the national electricity grid; a transmission network consisting of substations, towers, and lines, which moves electricity from where it's made to where it's needed. We also operate the electricity market system, balancing supply and demand 365 days a year, 24 hours a day.

Te Kanapu means both 'lightning' and 'bright', so it speaks to the electrification and the illumination of our country, and Transpower's goals for a bright, energised future.

> Through our Te Kanapu initiative, we are building a future grid blueprint for Aotearoa to guide investments in the grid up to and beyond 2050, supporting the country's future economic growth and net zero aspirations.



> The potential for change is vast and we can't possibly know, or predict, exactly what the future holds. This is why we need your knowledge and insights around how the nation may grow and change, to help us.

We expect that in 2050, the way Aotearoa produces and consumes energy and electricity will be different from today, with more renewables, more distributed energy and more technology.

We also expect that change will play out differently in different regions; with new and evolving industries playing a bigger role in our economy, and more people in more but possibly different places, all needing more electricity.

Work completed for us by economic consultants[1] has highlighted the potential for economic growth out to 2050, that mirrors what we have heard in our conversations with stakeholders; namely that the New Zealand economy could be up to $73b larger than the current trajectory, if certain technologies come to fruition and other aspiration assumptions hold true.

The future grid blueprint will guide Transpower in its 'low regrets' investments in the grid; investments that ensure it is affordable, resilient, adaptive and supports the way we need to manage the electricity system. The blueprint will also support industry and those in the energy sector with their long-term planning.

A key theme we have heard from your feedback to date, is that Transpower and other decision makers, must focus on long-term holistic planning and take a nonpartisan approach to decision making. We believe that the collaborative development of a future grid blueprint will support Transpower and others in achieving exactly this type of operating environment.

Our approach to developing a future grid blueprint

The approach we are taking is collaborative: we are developing this future grid blueprint by gathering views and information from people like you, across Aotearoa.

Since early 2025, we've been having conversations with our customers, industry groups, communities, businesses, iwi and government so we can understand what they think is Aotearoa's economic and energy future out to 2050 and beyond.

By hearing from as many voices as possible, and incorporating the information we gather, we can create a robust future grid blueprint that reflects the ideas and ambitions of the people of New Zealand.

There are four main parts to the work:

1. Finding out as much as we can about the future, such as future economy, energy, technology and megatrends, and using that information to develop our scenarios and test them with you.
2. Developing electricity forecasts for each of those scenarios and looking at how the electricity needed might be generated.
3. Analysing and identifying what the grid needs to look like by 2050 across our scenarios.
4. Confirming any near-term grid upgrades needed in the 2030s that are required in most scenarios.

Our intention is to release a draft grid blueprint in 2026 and gather your feedback on this draft before subsequently releasing the first future grid blueprint, outlining how we would need to invest in the national electricity grid through to 2050 and beyond.

Our first future grid blueprint will not be our last. We will continue to review and revise this work alongside others and update the blueprint every few years to ensure it remains current.

1 Future Grid scenario modelling. Visions of the New Zealand economy to 2050 (2025). Sense Partners. transpower.co.nz/our-work/te-kanapu

Progress to date: what we've heard and what it means

Since early 2025, we've been having conversations across the motu. In July, we issued *Consultation 1: Imagining Aotearoa in 2050*. The feedback we've received to date, has directly informed the work we are presenting here and our potential future scenarios.

Read our first consultation document and a summary of feedback received on our **website**.

Our conversations across the country are ongoing, and we will continue to review the information we receive as part of our process to develop a future grid blueprint.

Key themes

Across all our conversations, and our first consultation, some key themes are emerging. We're being told that:

1. Our primary industries will still be the nation's economic powerhouse in 2050, supported by the new and emerging fields of technology and digital-based industries, next-generation farming and low-carbon fuel production.
2. Accelerating growth is the most important factor for our economy, with affordability and the cost of living coming second.
3. Achieving economic growth will require a focus on delivering the energy trilemma (balancing secure, sustainable and affordable energy), energy independence and productivity gains together with an increase in infrastructure investment and the adoption of new technologies. These are the things the energy sector needs to focus on, together with enabling a diversified supply of renewables.
4. An enduring nonpartisan approach to addressing the future; long-term planning and decision making; a stable operating environment, and streamlined regulations are all needed.
5. People's acceptance of the energy transition remains a critical factor to consider. We must continue to engage with communities and stakeholders to ensure they understand and support the work that will be needed.
6. As communities and regions transition to net zero, energy security, cost, and limiting economic disruption must be top priorities for the sector. Should there be a need for new grid infrastructure, cost should be the number one consideration with resilience, environmental impacts and stakeholder engagement also important.
7. Transpower must focus on optimised, long-term holistic planning for a grid that is more flexible, more decentralised and supports more distributed energy resources. We need to balance all factors in the energy trilemma through increasing investment in new technologies and enabling renewables, while focusing on reliability and resilience at the lowest possible cost. Finally, we cannot afford to ignore the role of thermal generation.

How we've incorporated these themes

By providing five scenarios, we explore a range of possible futures and varying degrees of change from what we see today. The feedback we have heard to date is embracing of ambitious change for the country and our aim is to reflect that here, in a way that you consider plausible and feasible.

We have reflected the factors that you told us are important; sometimes they are strong drivers, other times not, and we've explored the impacts of each. For example, in each scenario, there is a different sector driving our growth, either an existing industry or the new industries you have highlighted. Each scenario discusses how growth will be different, in terms of how much and where it occurs, depending on which sector is leading that growth.

We've explored different degrees of electrification out to 2050, the speed at which this could occur and the resulting impacts, plus how the growth of different industries could impact the demographics of Aotearoa.

Now, we want you to tell us what you think of the potential futures outlined for Aotearoa.

Giving feedback

There are several parts to this consultation where we are seeking your feedback. Click here for the full list of questions and response form.

Scenarios

We want to gather your input on our draft potential future scenarios so we can evolve these scenarios into a suite that are better reflective of what you think is feasible and plausible. Within each scenario we explore the global and local context, what's happening within our economy and society and where we expect to see change. We also outline the potential generation mix for each scenario and the type of energy system this reflects.

We want to hear your feedback on all of these factors.

Regional implications for the power system

We know that each region has distinct resources, needs and potential, driving different potential energy futures. These differences shape how electricity is used today and how demand might grow in the future.

Having first considered our scenarios at a national level, in this section we ask what do you think will be happening at a regional level in 2050?

Drivers of growth in demand

Here we explore data inputs and key assumptions we have made around the drivers of growth in electricity demand and how we have applied these to the different scenarios.

We want to know what you think about the data we are using and the assumptions we are drawing. We also want to know if there is other data you can share, things you know that we should be including in our modelling.

Five potential future scenarios

The following scenarios reflect our thinking to date but they are only draft. They are deliberately based on the premise of economic growth because this is what impacts the decisions we will need to make around investment in the national grid. We want to identify the 'upper limit' of electrification and the broadest possible changes in the system, as ultimately, it is easier for us to scale back, than it is to scale up.

As you read these scenarios, we ask you consider several things:

- Which scenario(s) best reflects your ambition for Aotearoa?
- Do they seem plausible? If not, then why not?
- Do they seem useful for testing the resilience of the future grid blueprint? If not, then why not?

Within each scenario, we ask you to consider:

- Have we outlined the correct drivers and industries that will be directly affecting growth? What have we missed?
- Does the generation mix seem logical?
- Are there other actions we need to consider within the scenarios?

We want to hear any feedback you consider relevant.

Scenario One: Patchwork nation

In a world of sluggish growth and unclear direction set by government, New Zealand makes do with what it has. Communities, businesses, and industries rely on creativity, adaptability, and practicality to keep the economy moving, proving that resilience doesn't always need big investments, it just needs clever thinking.

Global context

The global landscape is one of fragmentation and weak climate action, increasing the likelihood of climate warming significantly exceeding the 2°C target. This would result in more frequent and severe weather events, causing global economic disruption.

Local context

Successive governments struggle to establish a clear, long-term strategic direction. The government takes a hands-off approach, potentially relying on the Emissions Trading Scheme (ETS) to drive decarbonisation without picking winners or providing subsidies for emerging technologies. A lack of direction is evident in the unclear roles of gas and alternative fuels such as sustainable fuels made from biomass and electricity.

The economy

A slow but persistent shift towards a service-based model, accompanied by gradual deindustrialisation. Without a cohesive policy to support their transition, legacy industries decline and it is unlikely that new, large-scale industries emerge to replace them without the attraction of strong government policy support.

Biomass and other liquid fuels persist as an economic alternative in difficult-to-abate sectors, but the overall supply is limited and not prioritised.

Without climate action, New Zealand's clean, green image suffers with the nation becoming less attractive as a destination to live, work, and visit.

Generation mix

Wind, solar and geothermal dominate supply-side development and the system is more decentralised than centralised. Solar is a mix of large grid-scale and rooftop/community scale installations. Thermal plants at Huntly and in Taranaki continue to provide most of the peaking and dry year reserve capability.

Electrification and energy choices

Choices are driven by direct economics and the slow decline of gas supply. Technologies like eFuels and hydrogen remain niche and underdeveloped.

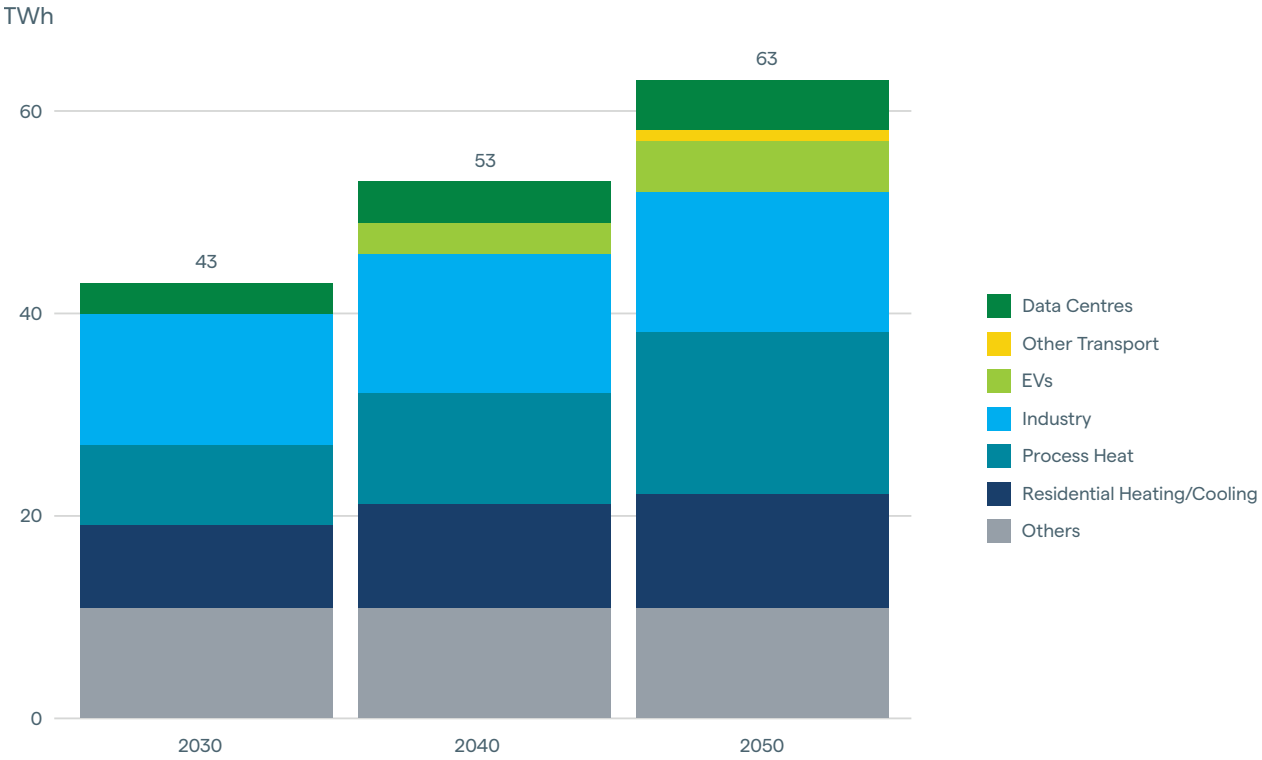
Social and demographic shifts

Low economic growth and a deteriorating environmental image offers little incentive for skilled workers to stay or for new migrants to arrive so the population ages.

Urban centres continue to grow at the expense of regional economies.

Support for decarbonisation is low compared with more pressing issues like the economy, cost of living and healthcare. Adoption of new technologies like EVs is limited.

Figure 1: Electricity demand breakdown – Patchwork nation



Scenario Two: Aotearoa electrified

In a world where global priorities shift with each electoral cycle, Aotearoa chooses a steady, long-term path. By committing to a consistent strategy, we lead by example, reducing emissions where possible and building enduring relationships. Aotearoa demonstrates that small nations can punch above their weight by staying the course and embodying the change they want to see in the world.

Global context

The world is divided into competing geopolitical blocs, climate action is inconsistent, with some regions making strong efforts while others lag. While the global transition away from carbon should still happen, it is at a pace unlikely to avert significant climate damage.

Local context

Aotearoa focuses on its immediate neighbourhood, strengthening trade relationships with APAC and India, and remaining neutral amidst the tensions between larger powers. Government and businesses accept the need to address some decarbonisation challenges to support energy security in an unstable world and we see targeted support for industrial electrification, EV charging networks, and critical electricity infrastructure.

The economy

A slow shift to a service-based economy. Hard to abate industries such as pulp and paper and some chemical production, cease operations as gas supplies diminish. However, with targeted support, many other industrial sectors successfully decarbonise and remain competitive. The dairy industry continues to innovate in carbon and methane reduction, providing high-value products to new and existing trading partners.

Generation mix

Wind, solar and geothermal dominate supply-side development. The electricity system is balanced between centralised and decentralised. Higher uptake of rooftop/community-scale solar and batteries is seen. Batteries and demand response minimise the need for thermal generation.

Electrification and energy choices

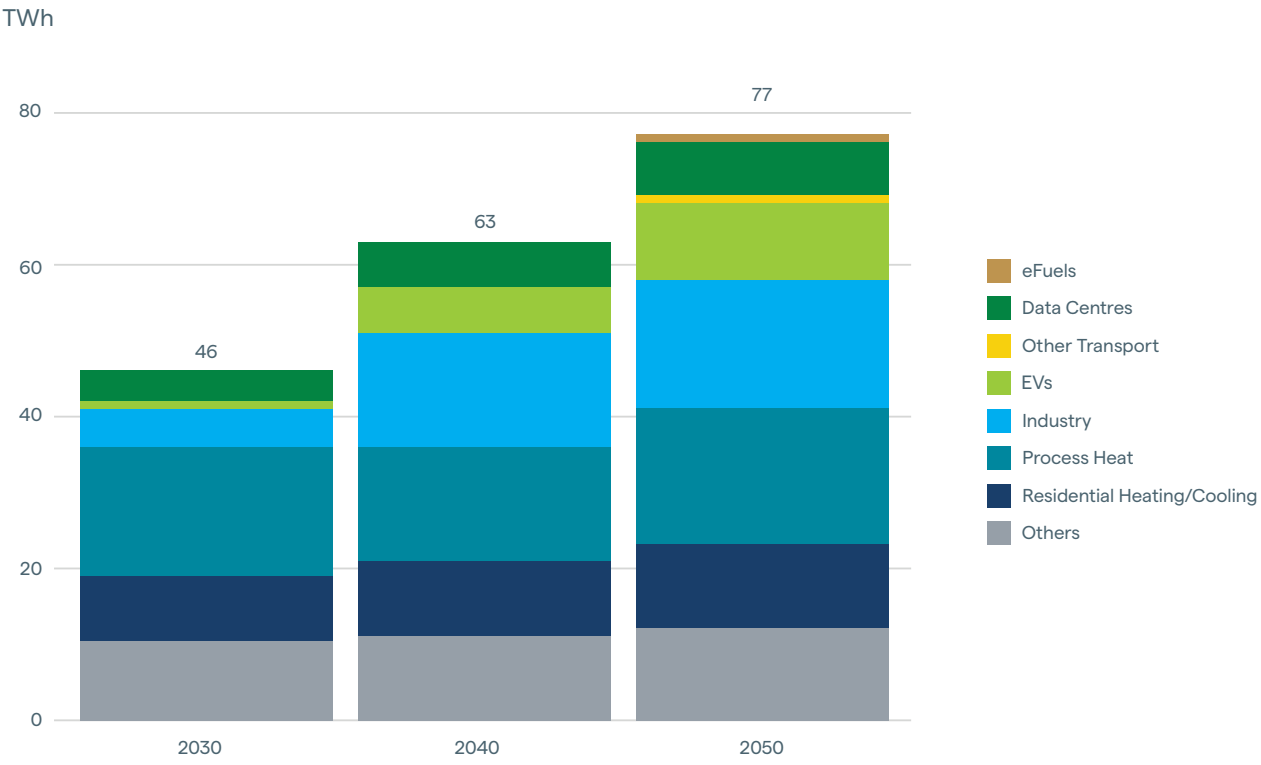
Electrification of transport and process heat is widely seen as the economic and logical choice. Biomass becomes a solid contender as a decarbonisation fuel source.

Social and demographic shifts

Urbanisation continues at a slow but steady pace, although electrification of some regional processing facilities helps to keep the regions active, even if some traditional heavy industry closes.

Migration levels remain low, and the population continues to age. Public opinion regarding electrification varies; while there is general support, resistance to more electricity infrastructure remains a strong and a persistent challenge.

Figure 2: Electricity demand breakdown – Aotearoa electrified



Scenario Three: Global green rush

Global coordination towards reducing emissions accelerates, driving down the costs of clean technologies and improving efficiency worldwide. Aotearoa rides this momentum, finding its path to net zero made cheaper and easier. By leveraging international advances and aligning with global action, the country achieves deep emissions reductions while strengthening key sectors of our economy, such as manufacturing, transport, and farming.

Global context

There are signs of nations taking action to mitigate climate change, such as returning to the Paris Accord with robust commitments, and international carbon markets flourishing. Global investment into decarbonisation technologies, from renewables and EVs to nuclear power and battery energy storage systems (BESS) increase. Things like Carbon Border Adjustment Mechanisms (CBAMs) (where a fee or tariff is levied on imported goods based on the greenhouse gases emitted during their production) emerge and influence how other countries approach their transition.

Local context

The country is motivated to ramp up its transition efforts in the early 2030s. A durable, bipartisan consensus for electrification emerges, with the government shifting its policy focus towards a supply-led approach to make electricity cheaper and more abundant.

Most energy uses switch to electricity because policy shifts have made it more accessible, affordable and reliable.

The economy

The economy evolves to become more insular in a positive way, adopting a ‘back to basics’ approach, focused on meeting its own needs well and becoming a leader in sustainable domestic production. This is a story of value over volume where a thriving ecosystem of decentralised small-to-medium enterprises incubate innovative ideas and succeed in a more virtualised, modern economy.

Generation mix

Wind, solar, and batteries dominate supply-side development, with the global drive to net zero reducing the cost of battery technologies The electricity system is balanced between centralised and decentralised. Solar is a mix of large grid-scale and rooftop/community scale installations. Due to significant reductions in cost, distributed batteries provide most of our peaking capability. Biomass provides dry year reserve and is used to provide renewable fuel for power generation and sustainable aviation fuels, rather than being primarily used for process heat.

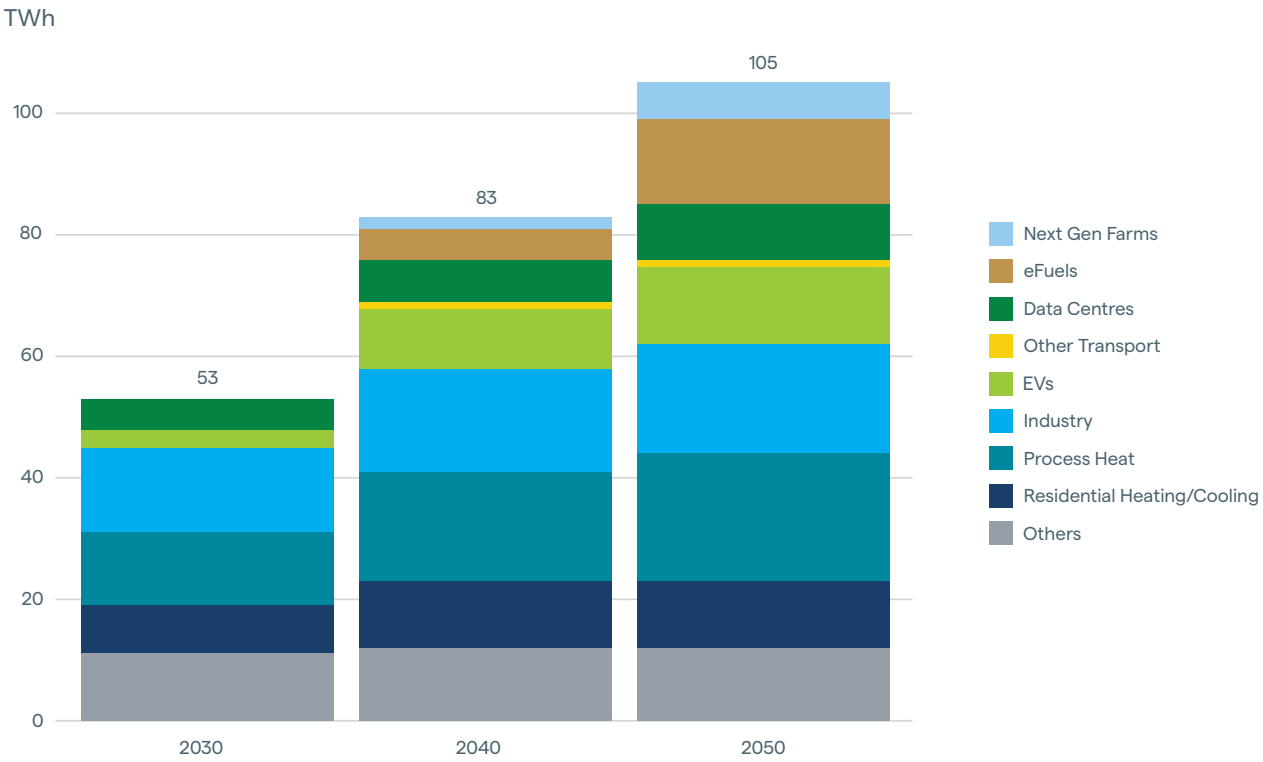
Electrification and energy choices

Electrification becomes the preference where it is technically and economically feasible. eFuels are a small but growing sector, with New Zealand producing some of its own sustainable aviation fuels for domestic needs. We develop next-generation farming techniques to support a vibrant, low carbon farming and food production sector.

Social and demographic shifts

Aotearoa is transformed. The affordability of EVs enables a 'hub-and-spoke' model of living, where people easily live in smaller towns and commute to major urban centres. There is strong public support for the transition, seen as a matter of economic opportunity and social necessity. With the cost-effectiveness of electric alternatives, decarbonisation becomes the status quo. The nation's increasing dependence on electricity also fosters strong public support for the security and reliability of the grid.

Figure 3: Electricity demand breakdown – Global green rush



Scenario Four: Made in Aotearoa

A large expansion of goods production across the primary and manufacturing sectors drives growth. Aotearoa has historically been a strong producer of key products, especially food. This scenario asks, what would happen if we ramped this up and maximised the advantage we have with renewable electricity?

This scenario explores the advantage we would gain from producing more high-value, clean, green products for the world, a future we have heard described by stakeholders, with much enthusiasm.

Global context

Aotearoa takes advantage of uncoordinated global political action on climate change. Wealthier economies and large corporations increasingly demand high-value, green products and are willing to pay a premium for them.

Local context

We capitalise on this by strategically focusing on economic growth underpinned by a highly renewable electricity system. Our 'clean green' image is amplified and becomes a major driver for businesses seeking to access these lucrative export markets.

The economy

We experience a market-driven expansion of existing industries leveraging the country's clean energy to secure a 'green premium' in international markets. Policies designed to create favourable business environments achieve rapid growth and attract international investment. The country makes a strategic entry into new industries, particularly green fuels for both domestic use and export.

Generation mix

Geothermal with a mix of other large, centralised generation sources dominate the supply side development with electricity from geothermal growing the most as we develop our renewable electricity sources.

Grid-connected wind, solar, and batteries also make a sizable contribution to the total overall mix. Natural gas is retained in the mix until the 2040s due to a supportive policy environment and new discoveries. In the 2040s, new hydro is developed, including pumped hydro for long-duration energy storage, eventually displacing gas from the supply mix.

Electrification and energy choices

We see the establishment of 'energy precincts', such as at Marsden Point and Taranaki, to facilitate coordinated industrial development. This lends itself to the development of Renewable Energy Zones (REZ) or strategic energy hubs, with dedicated government policy designed to coordinate and accelerate the supply of clean electricity to centres of industrial demand. This is something we've heard from stakeholders as being a strategic option.

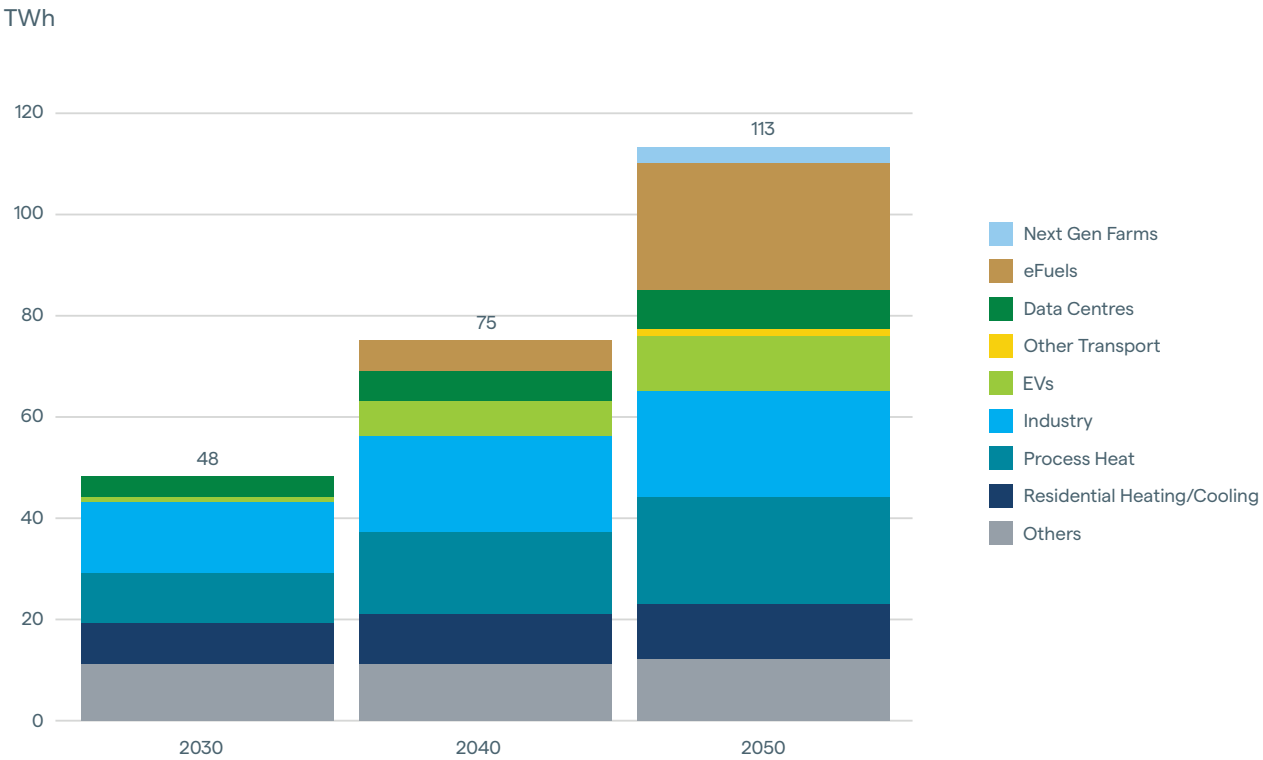
Electrification increases significantly, particularly across trade-exposed sectors as manufacturers and exporters look to capture green premiums for their goods in discerning international markets.

Social and demographic shifts

Regional centres strengthen, particularly those with a strong manufacturing or industrial base. While urbanisation continues, the revitalisation of these industries creates jobs and opportunities outside of the main centres.

Decarbonisation is generally supported, viewed through the lens of economic benefit, with people accepting the transition as a pathway to a higher standard of living. Our population grows thanks to the strength of our image and the emergence of new opportunities.

Figure 4: Electricity demand breakdown – Made in Aotearoa



Scenario Five: Aotearoa intelligence

Our final scenario is a pivot toward digitalisation and Artificial Intelligence (AI). Here we explore what would happen if we targeted growth in high-tech sectors, such as creative industries, healthcare, space, and services.

We also consider the possibility of our population being higher as more people choose to live here, thanks to our reputation as a safe haven.

Greater digitalisation tends to lead to lower relative energy use: it takes a lot less energy to produce accounting software than something like metals or even dairy products. Yet one of the new entrants to large energy consumption is data centres, and Aotearoa has a surprisingly strong advantage for these given our highly renewable electricity system and low air temperatures.

This scenario explores these tensions: lower overall energy intensity is mixed with more people and more data centres.

Global context

An unsettled global environment sees Aotearoa viewed as a protected paradise: a safe haven for those seeking stability and opportunity, particularly attractive to highly skilled professionals. This drives high levels of migration.

Local context

We support the development of a large and vibrant technology industry. The government prioritises investment in digital infrastructure and education, while a national focus on economic growth takes precedence over specific, climate-focused policies.

Complementary policies are enacted to attract and retain high-skilled migrants, with a particular emphasis on the technology sector, helping to fill critical skill gaps in AI, software development, and emerging tech industries, and to foster a dynamic, multicultural workforce that drives innovation and economic growth.

The economy

The focus is on growth in high-value digital services, the establishment of new data centres, and niche industries.

To encourage affordable energy and attract international investment, the government offers renewable energy subsidies, special electricity rates for data infrastructure, and streamlined approvals for energy projects. Tax incentives and grants further lower barriers for global tech companies. These measures make energy more accessible and position Aotearoa as a top destination for digital investment and innovation.

Generation mix

Decentralised energy resources (mainly solar and batteries) located close to consumers dominate the supply side development. Grid scale centralised resources such as geothermal and large wind farms combined with batteries are used to power industry and data centres.

Electrification and energy choices

The shift to less energy-intensive manufacturing and services enables space to utilise our renewable abundance to support large data centre growth instead. Electrification is common, as is energy efficiency, driven primarily by economics and the supply risk of gas.

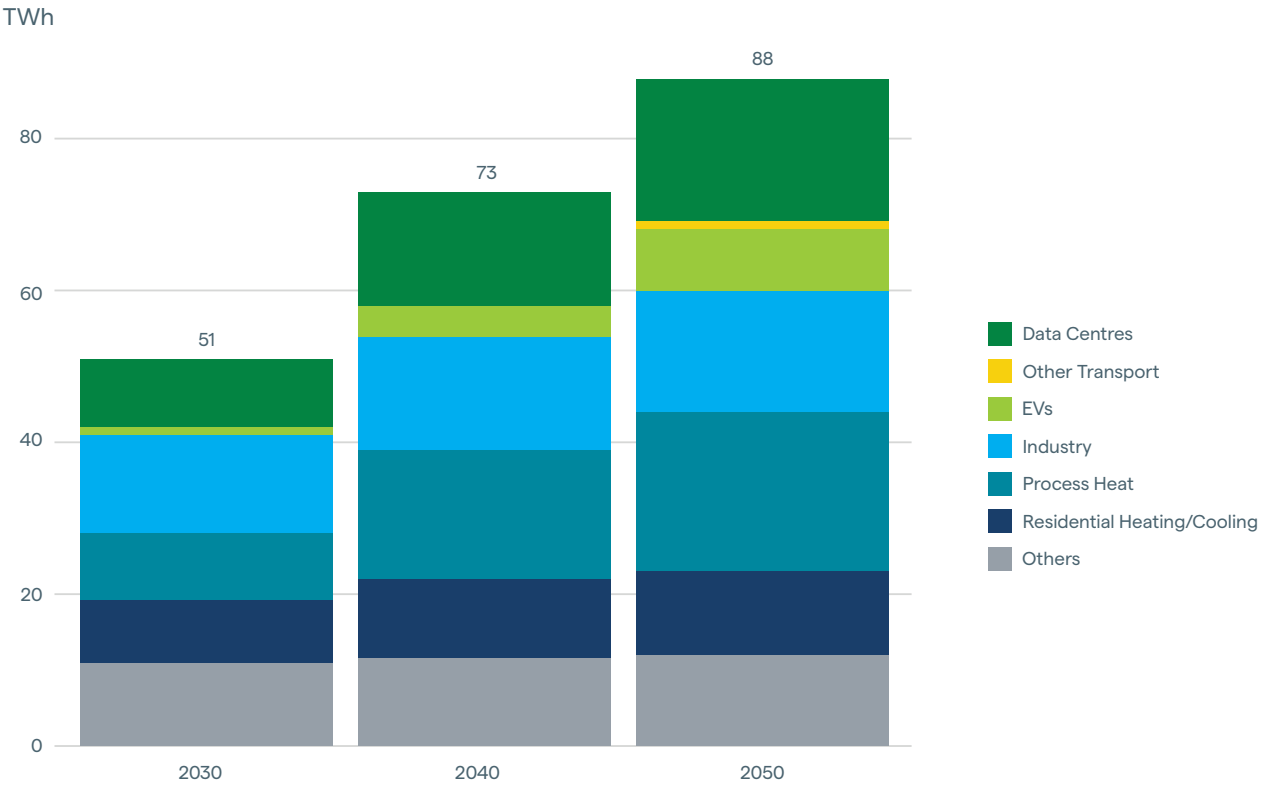
A more concentrated urban population enables some biogas production to help the gas network persist.

Social and demographic shifts

High migration results in a growing and younger population. Urbanisation accelerates and an influx of people, coupled with high density housing and public transport enhancements, boosts system efficiency in residential and commercial sectors.

People value the natural environment and support clean and green initiatives, particularly those related to preserving nature. Decarbonisation is seen as a positive side-effect of a focus on a high-tech, high-quality-of-life economy.

Figure 5: Electricity demand breakdown – Aotearoa intelligence



Comparing potential scenarios

The table below demonstrates the differences between scenarios, across a range of key dimensions.

Table 1: Comparing potential scenarios

Theme	Patchwork nation	Aotearoa electrified	Global green rush	Made in Aotearoa	Aotearoa intelligence
Global context	Fragmented and disrupted	Trade blocs and unclear trade	Coordinated climate action	Uncoordinated climate action	Unsettled; NZ "safe haven"
Local context	ETS-only; unclear path	Pragmatic fixes; get on with electrification	Bipartisan support and coordinated supply policies	Transform industry; target competitive advantage	Tech-led growth; climate secondary
Energy switch and fossil phase-out	Easy wins only; fossil fuels linger	Mix: electrify and biomass. Gas declines.	Rapid electrification; coal exits	Support for electrification; biomass as feedstock to support industry	Electrify easy wins; biogas pockets; gas networks wind down
Shipping and aviation efuels	None	Low	Local SAF (mandates)	Export-led efuels	None
Industry and process heat	Ongoing de-industrialisation	Mixed: some exits, some transform	Viable if electrified; others close	Positive transformation; no net decline	Some legacy declines; pivot to new tech
Land Transport and EVs	Lower EV uptake; cost-sensitive	EVs emerge, but slower pace.	Strong electrification of land transport	Easy wins electrified; alternatives for hard uses	Denser cities; public transport up; fewer car trips
Farming and regional economy	Regions fade; industry shrinks	Dairy innovates; regions mixed	Clean, green NZ next gen farming	Green premium supports regional growth	Lower regional activity due to urbanisation
Data centres	Limited growth; power cost/risk	Modest; grid-limited	Some growth with cheap power	Targeted near green industry hubs	Fast growth; tech-hub focus

Larger increase in demand Medium increase in demand Smaller increase in demand

To illustrate the magnitude of difference across these potential scenarios, figure 7 shows the indicative annual demand (in TWh) for each, illustrating the differences in both the pace and magnitude, of electricity increase.

These are not final forecasts but are used to convey the potential scale and variation between each scenario.

Figure 6: Electricity demand breakdown by driver at 2050

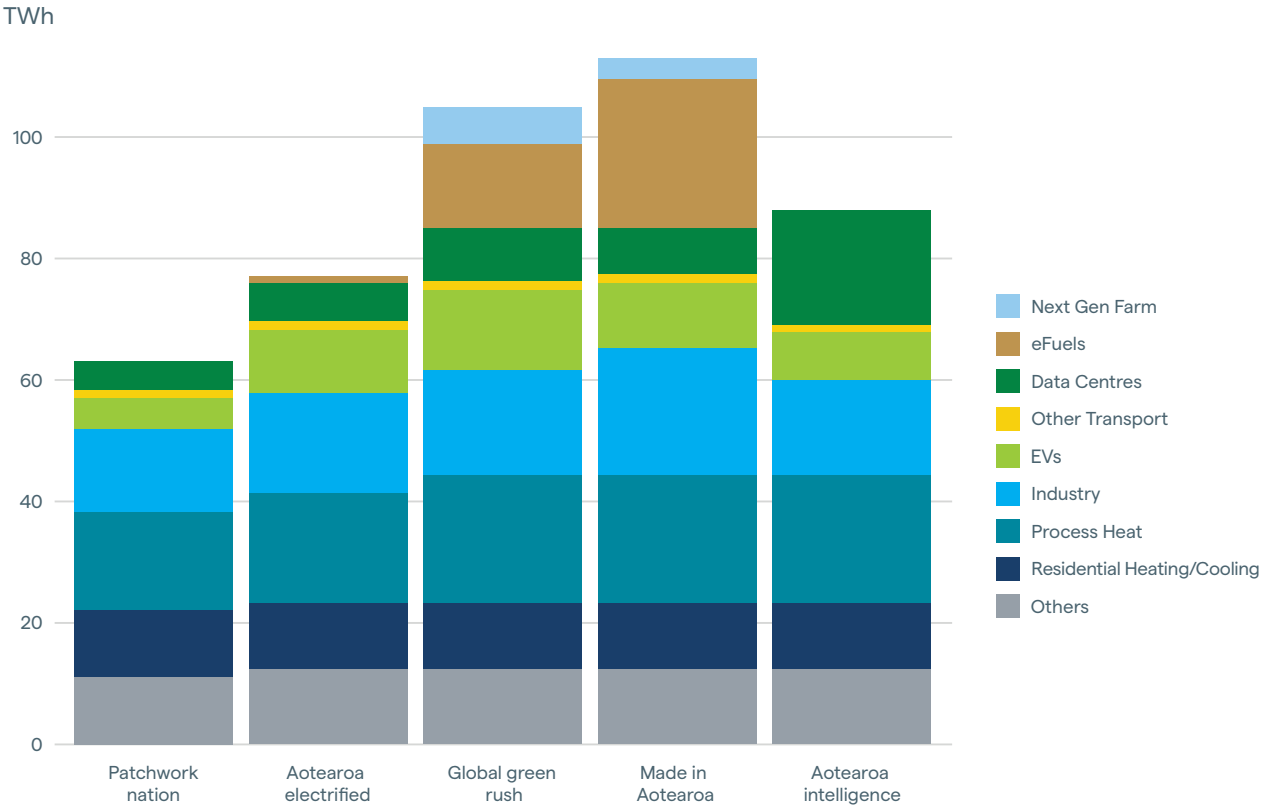
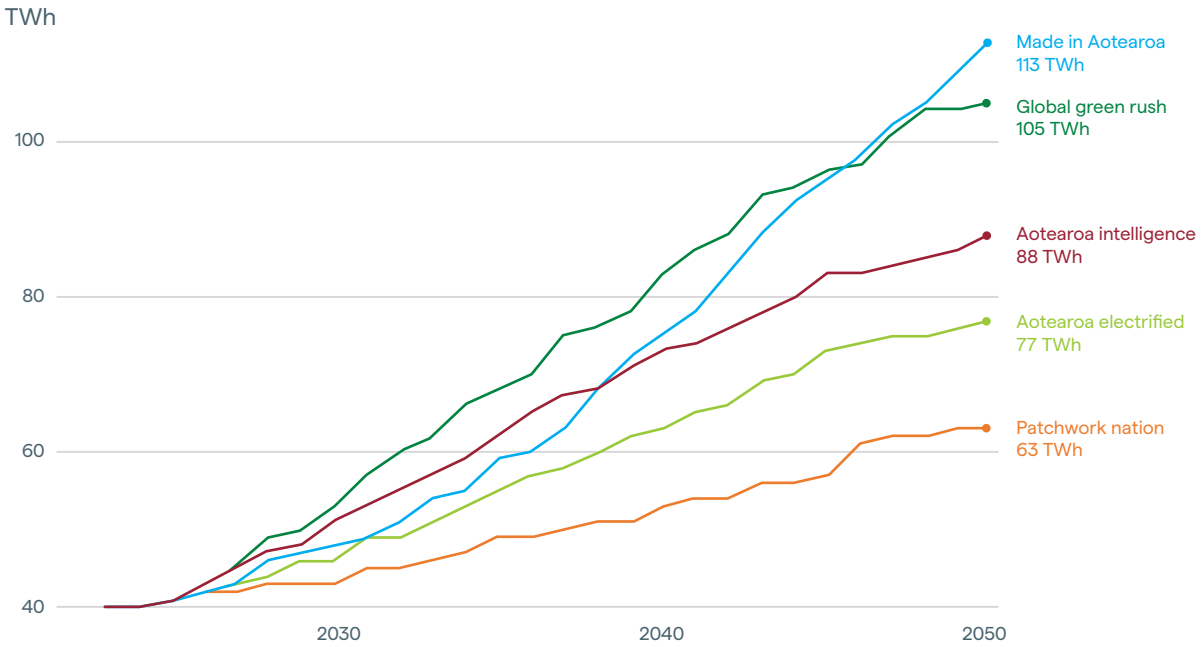


Figure 7: National electricity demand by scenario



Made in Aotearoa ends up the largest by 2050 due to sustained growth in the more energy intensive primary and manufacturing sectors. eFuel production, something you've told us is a potential key industry for growth, also contributes to this.

In contrast, **Global green rush** sees much faster electrification than any other scenario. This is driven by our assumptions around costs falling faster in this scenario, and it provides a good opportunity to test the speed with which investments would need to be made, to keep up. This scenario winds up lower than **Made in Aotearoa** but still represents a significant step up from today.

At the other end of the scale is **Patchwork nation** which indicates that even with very low levels of economic growth and relatively pessimistic assumptions around electrification, there is still growth in electricity use from sectors like transport and process heat.

Aotearoa electrified, is a step up again and includes data centres, which are modelled at 7 TWh by 2050.

Finally, **Aotearoa intelligence** illustrates that a strong shift towards digitalisation can lead to relatively lower energy demand despite high productivity and growth. This scenario results in 88 TWh at 2050; though it grows moderately quickly due to a higher population and faster build out of data centre capacity.

Table 2: National electricity demand by scenario

Scenario	2030	2040	2050	% increase on today
Patchwork nation	43 TWh	53 TWh	63 TWh	+58
Aotearoa electrified	46 TWh	63 TWh	77 TWh	+93
Global green rush	53 TWh	83 TWh	105 TWh	+163
Made in Aotearoa	48 TWh	75 TWh	113 TWh	+180
Aotearoa Intelligence	51 TWh	73 TWh	88 TWh	+120

Background information:

Scenario development, regional implications, inputs, assumptions and key terms

About our future scenarios

Our five scenarios are designed to explore a range of possible futures for the country. All present a future where the economy is growing; the level of growth, what's driving it and where it is occurring are the factors that change with each scenario.

Our scenarios are deliberately based on growth and ambition because of the decisions we have to make around investment in the national grid. We want to identify the 'upper limit' of our potential as it is easier for us to scale back our ambition, than it is to scale up.

While some scenarios might have similar growth trajectories, the key factor to consider about is how and where this growth occurs across Aotearoa. This is critical to the decisions we will need to make around our low-regrets grid investments.

It is important we explore the full potential of Aotearoa's energy future and ensure we are ready to enable all opportunities. That's why we need your input. Based on the insights you share, we'll revise these scenarios and present them again for further review.

> These scenarios discuss potential futures in broad terms and at a national level. What we really want to hear from you about, is what might happen in your city, your sector and in your region. How might these national futures translate at a regional level?

What are future scenarios?

Scenarios provide a way to examine future trends. They are not forecasts; they are plausible, coherent stories about the future, used to test plans against a wide range of uncertainties.

Scenarios seek to enable people to compare different possible versions of the future, and the levers and actions that produce them. They are designed to be used to explore what might happen, not what should happen or what we want to happen.

They help us to consider how our national electricity grid would need to develop to enable or respond to different possible outcomes. Scenarios are widely used internationally by organisations including the World Energy Council and other grid and system operators; and here in Aotearoa by organisations such as the Business Energy Council and EECA (Energy Efficiency and Conservation Authority).

While Aotearoa-specific scenarios exist already, they are not detailed or ambitious enough for our purpose here and they don't reflect some of the key factors that we are exploring such as the potential for new industries to be driving our economy and growth in electricity demand.

How future scenarios have guided our work

Transpower first presented future energy scenarios in *Te Mauri Hiko* (2018) and *Whakamana i Te Mauri Hiko – Empowering our energy future* (2020). Those scenarios served us well as we explored the opportunities available to Aotearoa if we were to electrify our economy.

Today, it is no longer a question of if electrification will occur, this process is now well underway, and our operating context has changed. We need to explore new, potential futures.

This is a process that will be ongoing; as some factors become more certain, new factors will emerge that need to be considered. As some industries fade and others emerge, our country's economic future will change. So too must our potential future scenarios.

Developing our scenarios

Our methodology combines in-depth research, economic modelling, and the feedback we have received so far throughout this process. This ensures our potential scenarios are both technically sound and reflective of a wide range of plausible ways our economy could grow and change and the resulting impacts on the energy system.

Now we need to hear from you to ensure we capture a broad range of views into our potential scenarios. We will continue to engage with stakeholders as these take shape.

1 Research Phase

Worked with specialist economic consultants to establish core assumptions and key drivers.

Used the Treasury's latest macroeconomic forecasts and Long-Term Fiscal Model to project economic growth to 2050.

Drew on historic breakdowns of energy use in Aotearoa, particularly the Energy End Use Database maintained by EECA.

2 Model Development

Modelled critical demand drivers of the country's energy system.

Utilised historic relationships between underlying drivers (e.g. sub-sectoral GDP, population) and energy use.

Projected this forward using research-backed assumptions on how energy use might change; included assumptions about how technology and fuel use could change and what new industries could emerge.

Integrated the country's domestic and international legal obligations for emissions targets:

- Achieving net zero by 2050 for all gases other than biogenic methane, and
- Meeting a 35.5% reduction below 2017 levels for biogenic methane by 2050.

Generation mix

In our recent consultation, you told us that geothermal, grid-connected utility-scale solar and battery energy storage systems are the three forms of supply that will play the greatest role in our energy future. Each of our potential future scenarios explore the possible generation mix and we want to hear your feedback on these assumptions.

Assumptions for generation costs, including grid-scale battery technologies and the potential for long-duration storage deployment, have been developed with the support of external consultants. This includes a major update of the generation stack for all types of generation, ensuring our modelling reflects the most current data and insights available. Summaries of each of the generation types are available on our website: **transpower.co.nz/our-work/te-kanapu**

We know that demand-side flexibility will play an important role in shaping the future of our power system. This flexibility is essential for making the most of our renewable energy, smoothing out periods of high demand, and reducing the overall cost of power for everyone. We want to hear your thoughts on the role of demand-side flexibility in our future electricity supply.

Detailed analysis for the different scenarios will be done once we have completed this consultation, and we will present our findings in our next consultation.

A centralised, balanced or decentralised system?

In our recent consultation you also told us that by 2050, you believe it is more likely that our energy system will be decentralised, than centralised, although a balanced system was the most popular option selected. We want to understand more about your thoughts here.

A decentralised system would see energy generated and supplied from smaller-scale sources, located close to where the energy is used, rather than from large, centralised generators like we do, today. A balanced system will be a mix of small and larger scale sources.

A decentralised system will also include more consumer energy resources (CER), such as rooftop solar, home batteries, EVs, and smart appliances. CER can contribute the flexibility that is needed in our system by balancing supply and demand, storing extra electricity, and even feeding power back into the grid.

We see CER as an inevitable and essential complement to the future power system and based on feedback we are hearing, so do you. We want to hear more from you about the structure of the energy system in 2050 and the role of CER in this system.

Dealing with uncertainty

The country's energy future is marked by significant uncertainty due to a complex interplay of factors such as technological advancements and the pace of adoption; evolving policy landscapes; shifting consumer behaviours, and global economic trends.

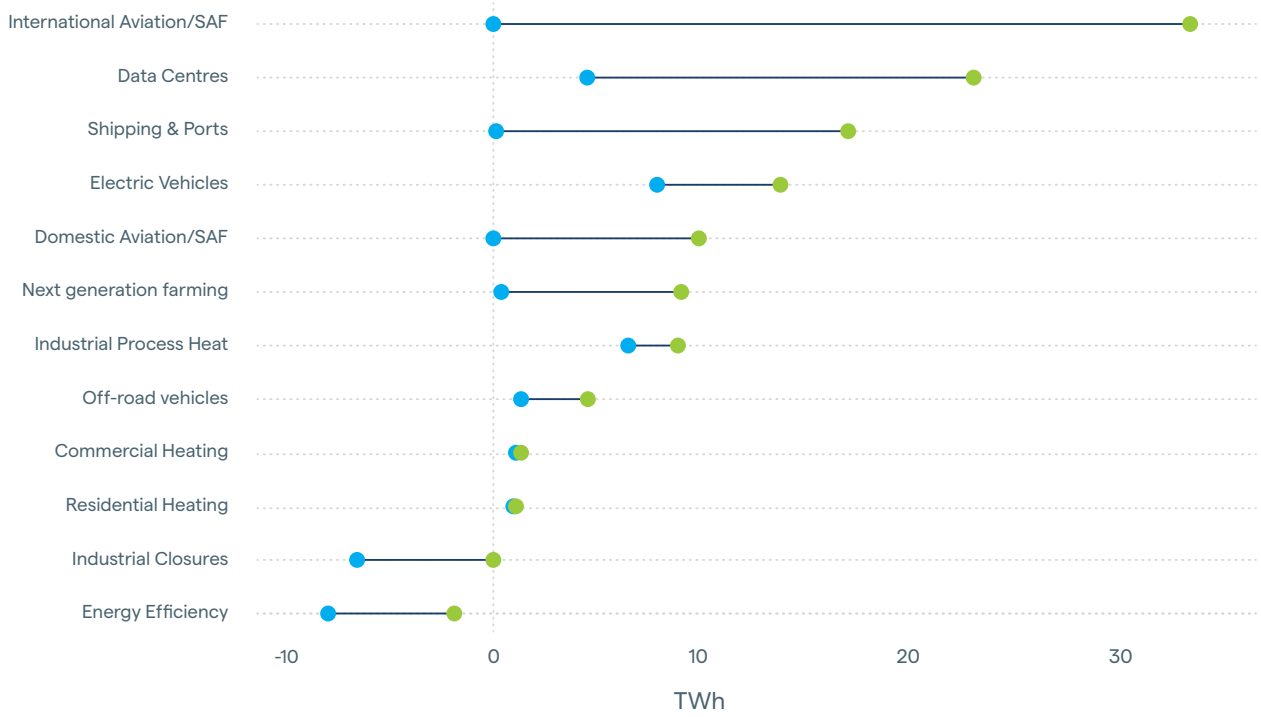
As a result, our scenario planning must remain flexible and responsive to change, without losing sight of the two key assumptions we are working with, which are:

That in 2050, Aotearoa

1. Remains committed to achieving net-zero carbon emissions, and
2. Has a growing and thriving economy.

It's clear that some factors have much larger potential impacts than others, depending on the actions taken to drive economic growth and decarbonisation, and electricity demand will vary accordingly.

Figure 8: Potential electricity growth by demand driver

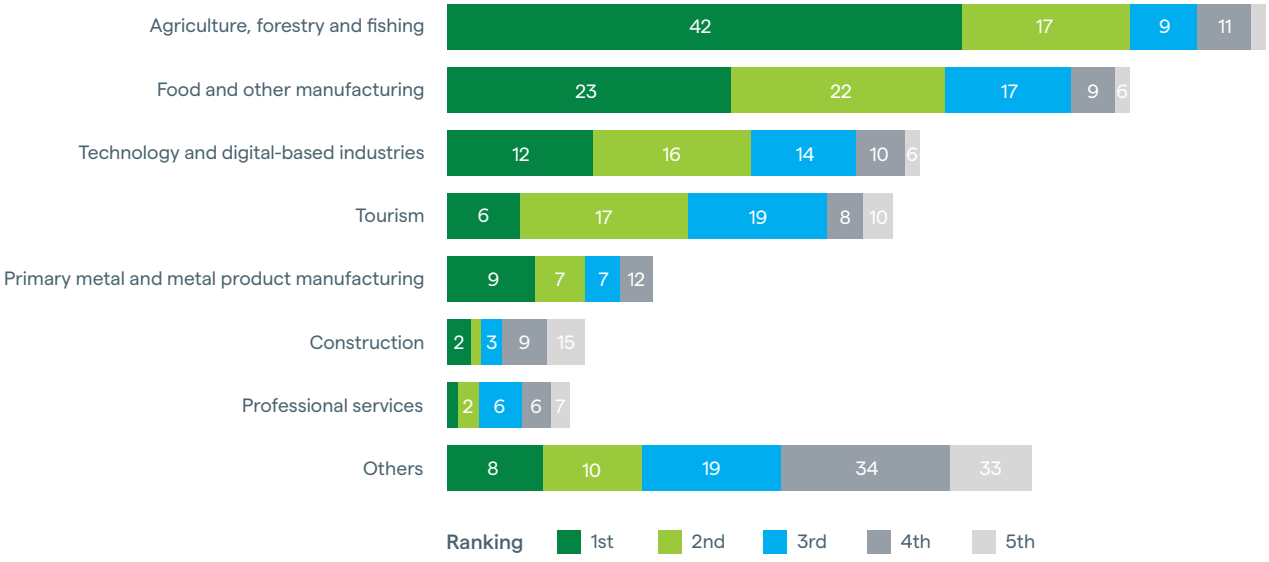


As shown, the level of uncertainty varies depending on the demand driver. For some, we can be reasonably confident; for others, the difference between possible outcomes is significant. This is explored in more detail in the key inputs and assumptions section.

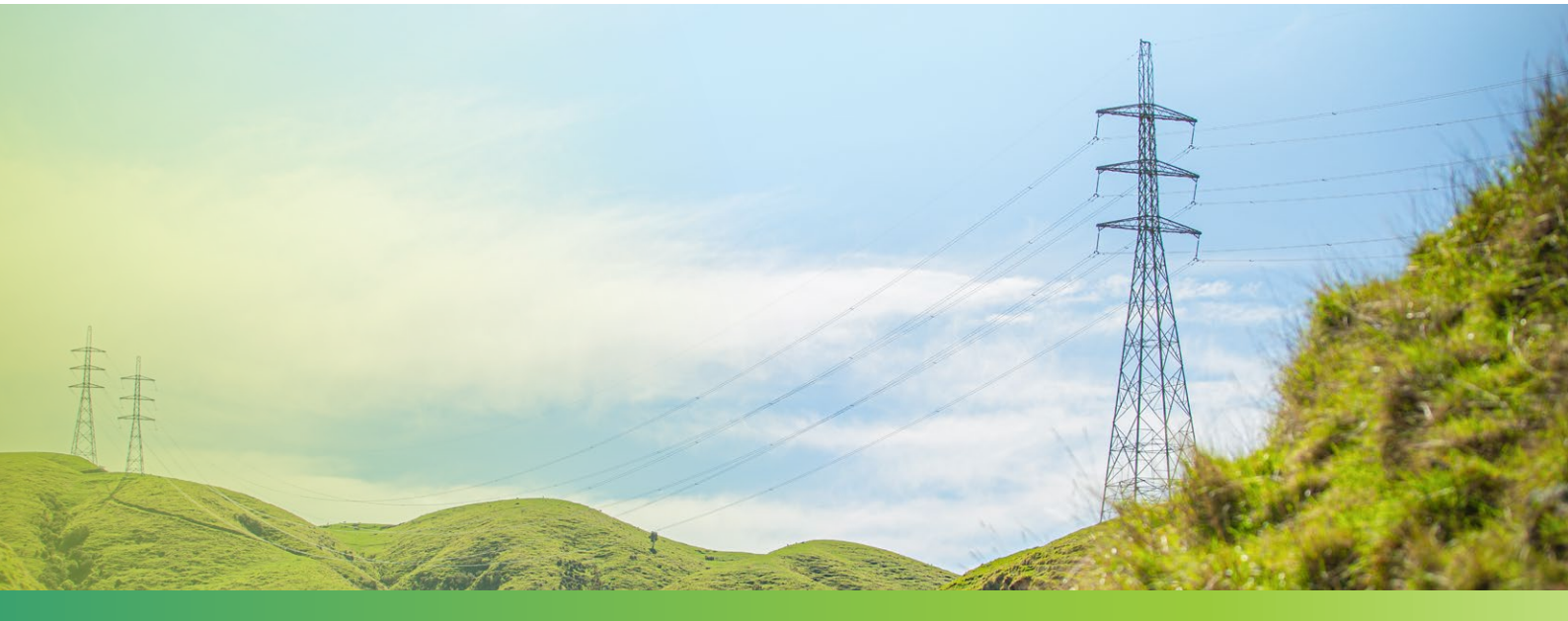
Our conversations to date tell us that these big uncertainties align well with what people in Aotearoa see as the key opportunities for future economic growth.

The responses we received in Consultation 1, when we asked what industries, both new and emerging, will be driving our economy in 2050.

Figure 9: Top ranked existing sectors driving Aotearoa's economic growth by 2050
Count of responses by ranking of sectors (n = 94)

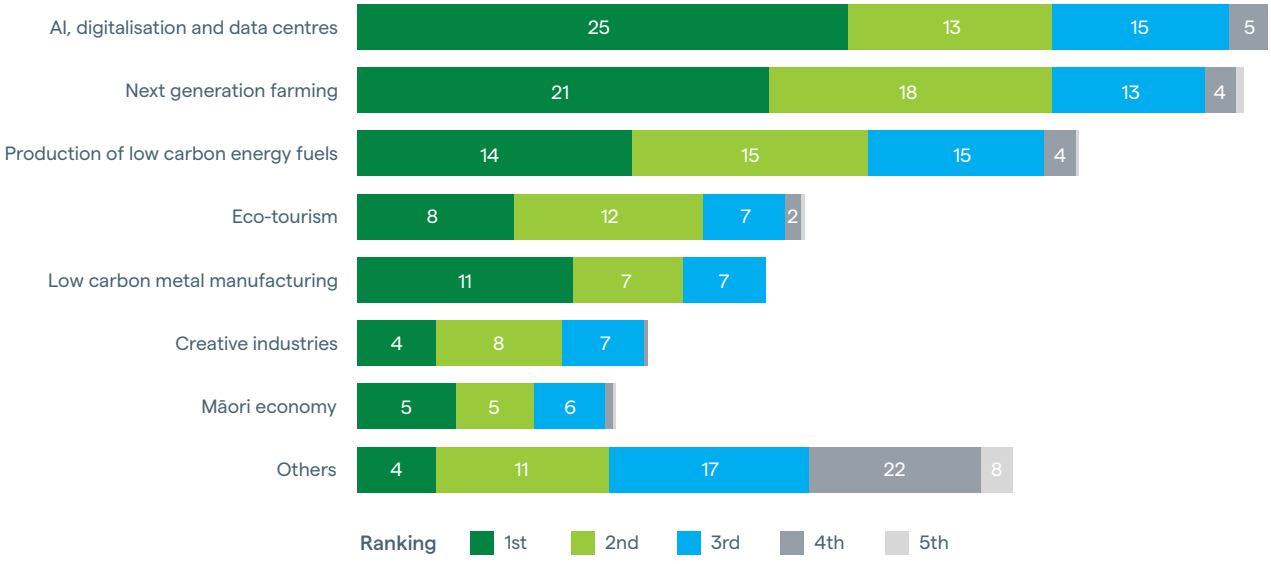


Note: Rankings are weighted (1st = 5 pts to 5th = 1 pt), and the ordering of factors in the chart is based on the total weighted score.



The below chart illustrates the potential range of electricity demand increase across a selection of drivers of electricity use. The below chart illustrates the potential range of electricity demand increase across a selection of drivers of electricity use.

Figure 10: Top ranked new sectors driving Aotearoa's economic growth by 2050
Count of responses by ranking of sectors (n = 93)



Note: The question asked respondents to select and rank their top three factors. Where participants suggested an additional factor that was similar to one already named, it was treated as if the named factor had been selected. Rankings are weighted (1st = 5 pts to 5th = 1 pt), and the ordering of factors in the chart is based on the total weighted score.

These show us the most important levers for potential demand growth to focus on.

Our scenarios deliberately focus on the big things that make the most difference including options for decarbonising shipping and aviation; increasing numbers of data centres and electric vehicles (EVs); the electrification of industry and process heat, and the future of farming.

Regional implications for the power system

In the next stage of our work to revise these scenarios, we will break down the national electricity demand into regional profiles across three time horizons: 2030, 2040 and 2050. Before we commence this work, we would first like to hear your thoughts on the future of your region.

We know that each region has distinct resources, needs and potential, driving different potential energy futures. These differences shape how electricity is used today and how demand might grow in the future.

Having considered our scenarios at a national level, what do you think will be happening at a regional level in 2050?

Figure eleven shows at a high level, what drives economic activity today, in the different regions.

Figure 11: Key drivers of current economic activity at a regional level

1. Northland: agriculture, forestry, fisheries, fuel processing
2. Auckland: urbanisation, services, technology, international migration, manufacturing
3. Waikato: agriculture, dairy, energy infrastructure
4. Bay of Plenty: logistics, horticulture, tourism, energy infrastructure, manufacturing
5. Taranaki: energy (oil & gas, hydrogen), manufacturing
6. Hawkes Bay: agriculture, viticulture, food processing
7. Gisborne: forestry, agriculture
8. Manawatū-Whanganui: agriculture, logistics, education, food and fibre
9. Wellington: public sector, technology, scientific research
10. Nelson: tourism, seafood, horticulture
11. Tasman: tourism, viticulture
12. Marlborough: viticulture, tourism
13. West Coast: mining, tourism
14. Canterbury: agriculture, manufacturing, logistics, energy transition, aerospace
15. Otago: tourism, education, viticulture
16. Southland: agriculture, forestry, energy, manufacturing, seafood

Question: What are your thoughts regarding your region in 2050 including?

- Who will be living in your region and how will they use energy?
- What will be the main drivers of economic growth in your region?
- What will be the main drivers of electricity demand growth in your region?
- What other regional economies will grow and what do you think will be driving that growth?
- Where will the main demand drivers of electricity demand be located?

Please share any feedback you consider relevant.

Key inputs and assumptions

Here we explore data inputs and key assumptions we have made around the drivers of growth in electricity demand and how we have applied these to the different scenarios.

We want to know what you think about the data we are using and the assumptions we are drawing. We also want to know if there is other data you can share, things you know that we should be including in our modelling.

Drivers of growth in electricity demand

In this section we cover the following drivers: aviation, shipping, data centres, land transport, primary industries, and commercial, industrial and residential demand.

Under each, we will be asking: *What are your thoughts regarding the information we have presented including:*

- The opportunities for growth
- The challenges we present
- The locations of potential growth
- The size of potential growth

Please share any feedback you consider relevant.

Aviation

The aviation sector presents unique decarbonisation challenges. Finding cost-effective alternatives to jet fuel is very difficult. Our modelling focused on the three key generally accepted fuel alternatives: direct electrification, direct use of hydrogen, and Sustainable Aviation Fuel (SAF). Each has substantial limitations.

Direct electrification (i.e. battery-powered flight) is limited by the amount of energy that can be packed into a battery, relative to its weight. Whereas jet fuel carries a large amount of energy per unit of weight, batteries are relatively low. This means that battery-powered flight will likely be limited to short flights in small planes.

The direct use of hydrogen has also been proposed, but this will require as yet undeveloped technologies to cool the hydrogen to -253 °C and new ways to store it in completely redesigned aircraft. This is because although hydrogen carries a lot of energy for its weight, it takes up a lot of space per unit of energy.

SAF looks most likely: it can be used in planes that exist now with limited modification and, since it is a drop-in fuel, it can utilise existing supply chains including transport, storage, and delivery. However, scaling up to meet the volume needed to replace all existing jet fuel use would exhaust the easy supply sources we currently use to make it (like waste fats); ultimately, we would need to rely on directly using electricity.

These three pathways for decarbonisation all rely on electricity to reach the scale required. Batteries would require a grid-connection to charge; renewable 'green' hydrogen is made from electricity; and SAF at scale also is made from green hydrogen (and carbon) and therefore also depends on electricity as an input.[2]

Since SAF can 'drop-in' to existing supply chains, it's plausible that we could import all our needs instead of making it within our shores. The big lever in terms of demand, is how much SAF we make here versus how much we import.

Table 3: Electricity demand growth across the scenarios based on variables relating to aviation

	Patchwork nation	Aotearoa electrified	Global green rush	Made in Aotearoa	Aotearoa intelligence
Underlying growth	Low	Moderate	Moderate	Moderate	High
Direct electrification	Low	Moderate	Earlier	Moderate	Moderate
Direct green hydrogen	Not within timeframe	Not within timeframe	Small	Not within timeframe	Not within timeframe
SAF uptake	Low	Moderate	High	Moderate	Moderate
Local SAF production	None	Low	Moderate	Moderate-high	None

Larger increase in demand Medium increase in demand Smaller increase in demand

2 In terms of SAF production, we model two types: Alcohol to Jet (AtJ from woody biomass and Power-to-Liquid (PtL).

> In our conversations to date, we've heard that Taranaki and Northland are well suited to the production of eSAF and eFuels in general, due to existing or historic fuel production plants such as methanol production in Taranaki and petroleum refining, including jet fuel, at Marsden Point.

There is also a proposal to produce eSAF at Marsden Point. In the case of Taranaki, interest in its world-class offshore wind resource fits well with the size and scale of generation that would be required, and with potentially lower transmission implications if the generation could be co-located with its offtake.

It is less clear where SAF based on woody biomass might be made. The central North Island boasts abundant renewable generation and strong transmission availability as well as co-located with woody biomass supply. However, it is far from busy airports and port infrastructure.

Direct electrification of aircraft is likely to occur at all airports, to the extent that these can be upgraded to handle MW-scale charging. We've heard that while progress on direct use of hydrogen remains nascent, it would likely depend upon a hub-and-spoke model with the main refuelling stations being Auckland, Wellington, and Christchurch. Christchurch is the most advanced in its thinking on how this could be integrated close to the Airport through its work on Kōwhai Park.

A key factor with hydrogen supply is the logistics and expense of transporting it, given its cooling and space requirements. It is therefore unlikely that hydrogen would be made far from its end-use; and, for the same reason, we expect that any green hydrogen we use in Aotearoa will be made on our shores rather than imported.

Shipping

The shipping sector today has relatively low electricity use but it is a critical area for future decarbonisation. Like aviation, there are several routes decarbonisation could take.

Direct electrification, although this is subject to limitations given the space taken up by batteries and so it is also most likely applicable to shorter routes and smaller vessels (like ferries). Direct electrification also includes providing electrical power to ships while they are docked to avoid the need to burn fuel. Even with ambitious assumptions, this amounts to relatively small amounts of electricity consumption; though from an infrastructure perspective, the impact may be non-trivial in terms of facilitating megawatt-scale charging at ports and ferry hubs.

New types of low-carbon fuels are more likely for larger ships, including international shipping. Some of these could be made using biomass sources but this is again limited by supply.

Ultimately, to reach the scale required, it's likely that these fuels will also be derived from electricity, such as eMethanol (methanol produced by combining carbon with green hydrogen).

The main large lever is whether we continue to produce methanol in the future and if this production could become 'green'; that is, made from green hydrogen rather than natural gas.

Table 4: Electricity demand growth across the scenarios based on variables relating to shipping

	Patchwork nation	Aotearoa electrified	Global green rush	Made in Aotearoa	Aotearoa intelligence
Underlying growth	Low	Moderate	Moderate	High	Moderate
Direct electrification	Low	Moderate	Earlier	Moderate	Moderate
eMethanol production	None	None	Moderate (NZ use)	High (export)	None

Larger increase in demand Medium increase in demand Smaller increase in demand

In terms of where this growth could happen, direct electrification of shipping could occur right throughout the country. Ferry electrification, in contrast, is more likely to occur in places with existing ferry use, such as Auckland and Wellington. However, MW-scale charging may be a challenge in some regional ports.

The production of eMethanol may be more likely in areas with existing infrastructure; Taranaki and Marsden Point are clear examples for all the same reasons outlined in the context of eSAF production. It could also be possible for a green hydrogen economy to develop in one or both of these locations, supporting multi-fuel production including both eMethanol and eSAF.

Data Centres

The data centre sector has seen significant growth in recent years, and our modelling is designed to capture the potential for this trend to accelerate. Our methodology is based on the idea that the growth of data centres is directly tied to the proliferation of digital technologies and services as well as separate uptake for training of AI models.

Our potential scenarios each contain specific assumptions around technology adoption and the extent to which our economy shifts towards higher use of digitalisation and AI, which in turn, drive the modelled electricity demand.

Unlike other sectors, this one has fewer moving parts. The main driver is how much data centre development we see and how fast this occurs.

> Many of you have told us that digitalisation and AI will be key drivers for future economic growth.

We've also considered the possibility that this growth could be fuelled by a large influx of high-skilled, tech-savvy migrants who perhaps see Aotearoa as a country safe from geopolitical tensions and damage from climate change.

Table 5: Electricity demand growth across the scenarios based on variables relating to data centres

	Patchwork nation	Aotearoa electrified	Global green rush	Made in Aotearoa	Aotearoa intelligence
Underlying growth	Low	Moderate	Moderate	Moderate	High
Data centre capacity	Low	Moderate	Moderate	Moderate	High
Speed of development	Low	Moderate	Moderate	Moderate	High

Larger increase in demand Medium increase in demand Smaller increase in demand

In terms of where data centres appear, present interest has been strongly focused in Auckland and Southland. Auckland, because our current undersea fibre cables connect into the country via the west coast near Auckland. The city is also our major demand centre. Southland is also of interest because of its relatively low ambient temperatures.

Since one of the main costs in data centre operation is cooling, lower temperatures mean lower costs. Southland does not currently have international connectivity via its own direct fibre cable, but this is something that has been proposed and has strong momentum towards.

Primary industries: agriculture, forestry, fishing

Today, this sector is a cornerstone of the economy, something you've told us will still be true in 2050. We model demand based on the sector's underlying economic activity, the potential for electrification of on-farm processes and the production of new energy-intensive products.

The future could include new technologies and changes to the primary sector. An example of this is precision fermentation, a cutting-edge process that uses microorganisms like yeast or bacteria, to produce specific ingredients, such as proteins, enzymes, or fats, typically found in animals or plants.

It's plausible that precision fermentation could become more common in the future because it's sustainable, using less land, water, and energy than traditional farming, and can meet the growing demand for eco-friendly and ethical food options. As costs drop and technology improves, companies could adopt it to produce affordable, high-quality products. Importantly, there are already examples of it in operation at commercial scale today.

> Feedback we've heard is that next generation farming is one of the emerging industries most likely to be driving our economic growth in 2050.

If the country invests and specialises in next generation farming techniques like this, it could lead the world in producing high value, low carbon ingredients and foods, tapping into new markets and supporting a cleaner, greener economy.

Outside of synthetic proteins, there are other ways energy use might change in agriculture, forestry, and fishing. These include:

- off road vehicles, such as diggers, heavy machinery, ATVs, unregistered farm vehicles, etc;
- space and water heating and cooling;
- heat for on-site processing, and
- pumps, including irrigation.

In our scenarios, we kept changes in these technologies consistent across sectors.[3]

The use of irrigation on farms is also subject to assumptions around how our climate and land use may change. Land use change (i.e. from dairy to forestry or the inverse) is captured by the underlying changes in GDP. This is important to consider because dairy farming tends to rely on irrigation in the dry season in some regions.

It also possible that climate change may result in more extensive dry seasons, resulting in more intensive use of irrigation. Historically, irrigation energy use tends to increase by about a third in dry years. Although there is limited evidence on just how often we should expect to experience dry years in the future, we have estimated that these might occur once every three years, up from around once every five years at present.

3 All the fundamental uses of energy in the primary sector have been accounted for by drawing on EECA's Energy End-use Database and projected forward in accordance with each scenario's assumptions around economic growth and the changing characteristics of our economy. To keep the model consistent, we assumed that changes in energy use here was broadly consistent with changes in the other sectors. For example, changes in off road vehicles and machinery matches changes in heavy transport; space and water heating match changes in the commercial and industrial sector, as does process heat.

Table 6: Electricity demand growth across the scenarios based on variables relating to primary industries

	Patchwork nation	Aotearoa electrified	Global green rush	Made in Aotearoa	Aotearoa intelligence
Underlying growth	Low	Moderate	Moderate	High	Low
Electrification of sector	Low	Moderate	High/Early	High/Slow	Moderate
Next generation uptake	None	None	Moderate	Low	None

Larger increase in demand Medium increase in demand Smaller increase in demand

In terms of where this load growth might occur, we expect the current pattern of activity will continue, with strong hubs especially in the Waikato, central North Island, Canterbury, and Southland.

The question of where precision fermentation might occur is more difficult. The industry requires fermentable biomass as an input, so it is likely to be co-located with arable land.

However, it would need to be located where strong infrastructure (especially electricity and transport) and access to high-skilled labour exists; this is not something we have a strong perspective on and are keen to hear what you think.

Commercial, industrial and residential demand

When we look at how commercial and industrial businesses use energy, it helps to break down their needs into a few main categories. One of the biggest uses is process heat; the energy required to create heat for making or processing things.

Another important use is for space and water heating. Energy is used to heat the air in buildings and provide hot water for washing, cleaning, or other daily needs.

Finally, there are lots of smaller but essential uses of energy in these sectors, such as powering electronics, lighting, computers, and machinery. While each individual use might seem minor, together they add up to a significant part of overall energy demand. Understanding these different needs is key to finding ways to make our energy use cleaner and more efficient.[4]

Commercial and industrial

For both the commercial and industrial sectors, our scenarios aim to represent a range of differences in the timing and scale of electrification, as well as identifying which sub-sectors are likely to lead the transition. Our models account for differing energy intensities, operational requirements, and investment cycles. The model is also sensitive to government policy signals, such as the coal boiler phase-out, which influences the timing of electrification across all scenarios.

Table 7: Electricity demand growth across the scenarios based on variables relating to commercial use

	Patchwork nation	Aotearoa electrified	Global green rush	Made in Aotearoa	Aotearoa intelligence
Underlying commercial growth	Low	Moderate	Moderate	Moderate	High
Underlying industrial growth	Low	Moderate	Moderate	High	Low to Moderate
Electrification of sectors	Low Slow	Moderate Steady	High Fast	Moderate Steady	Moderate Steady
Biomass usage	High	High	Low	Moderate	Low

Larger increase in demand Medium increase in demand Smaller increase in demand

Large industrial sites

For large industrial sites, such as New Zealand's aluminium smelter at Tiwai Point and New Zealand Steel's Glenbrook mill, we have modelled their future electricity consumption on a site-specific basis.

This is due to their scale and the impact they have on national electricity demand. Our approach relies on detailed, case-by-case assumptions about the plausible futures of each site.

4 Modelling for the commercial and industrial sectors is a complex process, as it involves a wide range of sub-sectors with very different energy needs. Our approach uses an updated and highly granular dataset that breaks down energy end-use across various sub-industries.

Table 8: Electricity demand growth across the scenarios based on key factors relating to large industrial sites

	Patchwork nation	Aotearoa electrified	Global green rush	Made in Aotearoa	Aotearoa intelligence
Underlying growth	Declining	None	None	Increasing	Declining
Electrification of sector	None	Moderate Slow	Moderate Fast	High Fast	Low Slow

Larger increase in demand Medium increase in demand Smaller increase in demand

Residential

Our modelling for the residential sector is focused on understanding how household electricity consumption will evolve as our population grows, and our homes become more electrified

Population growth and the pace at which new homes are built play a direct role in shaping overall electricity demand. As the number of households increases, so too does the baseline requirement for electric services.

Rapid residential development can amplify this effect, particularly when new builds are equipped with modern electric technologies.

To model changes in residential electricity demand, we use projections for population growth and household formation to establish the baseline number of dwellings. From there, we model the uptake of key electrical appliances, such as electric cooktops, heat pumps for space heating, and electric water heaters.

Table 9: Electricity demand growth across the scenarios based on variables relating to residential use

	Patchwork nation	Aotearoa electrified	Global green rush	Made in Aotearoa	Aotearoa intelligence
Underlying growth	Low	Moderate	Moderate	Moderate	High
Shift to urban density	Moderate	Moderate	Moderate	Low	High
Pace of electrification	Slow	Moderate	Fast	Moderate	Moderate-Fast
Extent of electrification	Low	Moderate	High	Moderate	Moderate

Larger increase in demand Medium increase in demand Smaller increase in demand

In terms of where this will happen, the growth is expected to be in line with where our population centres are today. This changes only to the degree of urbanism/regionalism assumed within the scenario narrative.

Land transport

Our modelling for land transport is driven by a central question: how quickly will our vehicle fleet transition to electricity?

We model this considering different vehicle types, from light passenger cars to heavy-duty trucks. We establish a baseline for energy demand for all vehicles and then model the uptake of EVs over time.[5]

In terms of where this growth occurs, we expect it to be in the places where people are living and working in 20-30 years' time; something that is not immediately obvious.[6] Across all scenarios, we would expect that a large amount of transport demand will occur in our major cities, especially Auckland, Hamilton, Tauranga, Wellington, and Christchurch.

Table 10: Electricity demand growth across the scenarios based on variables relating to land transport

	Patchwork nation	Aotearoa electrified	Global green rush	Made in Aotearoa	Aotearoa intelligence
Underlying growth	Low	Moderate	Moderate	High	Low
Shift to urban density	Moderate	Moderate	Moderate	Low	High
Speed of electrification	Low	Moderate	High	Moderate	Moderate
Extent of electrification	Low	Moderate	High	High	Moderate

Larger increase in demand Medium increase in demand Smaller increase in demand

5 We also included rail but did not explore significant developments in electrification. As rail is a very efficient mode of transport, even significant expansion of an electrified network would not lead to significant electricity demand at a national level.

6 There has been a strong trend in both here and globally towards people increasingly living in cities; this possibility is explored most in our **Aotearoa intelligence** scenario. But it is also possible that Aotearoa could have thriving regions supported by existing and new industries in the future; this is explored in **Made in Aotearoa**.

Terms used in this document

Carbon Border Adjustment Mechanisms (CBAMs): A fee or tariff is levied on imported goods based on the greenhouse gases emitted during their production.

Consumer energy resources (CER): Small scale generation technologies that exist in homes such as solar, EVs, batteries, and heat pumps. See also *Distributed energy resources*.

Demand-side response (DsR): Also referred to as demand response. The ability of businesses and consumers to adjust their electricity use in response to signals from the grid, to help balance supply and demand.

Distributed energy resources (DER): Small scale generation such as solar, EVs/charge point stations, batteries, and heat pumps, located near to where energy is consumed. See also *consumer energy resources*.

Drop-in fuel: An alternative fuel, such as a biofuel or synthetic fuel, that is chemically identical or functionally equivalent to a conventional petroleum-derived fuel like gasoline, diesel, or jet fuel.

eFuels: Synthetic fuels or electro fuels.

Energy precincts: A geographic area or special zone of projects and infrastructure designed to maximise the use of energy assets.

Energy trilemma: Refers to the challenge of balancing three goals within an energy system: energy security, the reliable and stable supply of energy; energy equity, ensuring affordable and accessible energy for all; and environmental sustainability.

Future grid blueprint: A document that maps out, at a high-level, possible strategic investments for the transmission network that will deliver an optimal future grid for the country.

Megawatt (MW): A unit of power equal to one million watts.

Process heat: The energy required to create heat for making or processing things. For example, when steel is melted in a furnace or milk is pasteurised in a dairy plant.

Sustainable aviation fuels (SAF): Non fossil fuel alternatives to conventional jet fuel.

Terawatt hours (TWh): A unit of energy. The current total annual demand of electricity in Aotearoa is around 40 TWh.

Appendices

Appendix A: Detailed deep dive models (downloadable excel workbooks available on **website**).

Appendix B: 2025 Generation Stack - a snapshot (Beca and Concept Consulting report).

Appendix C: Future Grid scenario modelling. Visions of the New Zealand economy to 2050 (Sense Partners report).

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transpower.co.nz/our-work/te-kanapu