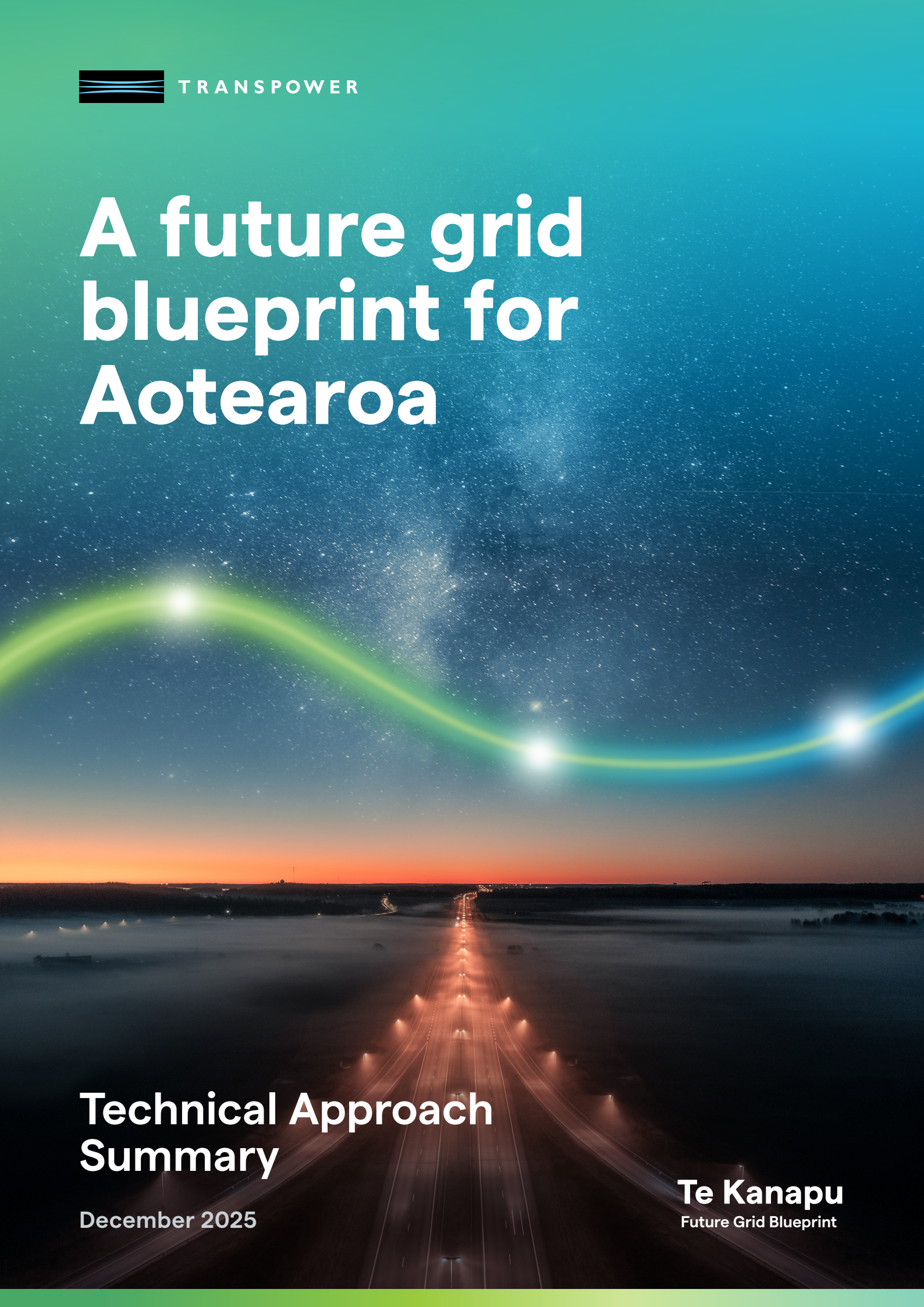
TRANSPOWER

A future grid blueprint for Aotearoa



Technical Approach Summary

December 2025

Te Kanapu
Future Grid Blueprint

Overview

The Te Kanapu Technical Approach suite of documents outline how Transpower is working to develop its draft future grid blueprint. By publishing these documents, we are sharing all the data, inputs and information being used in this process, for review and feedback.

Most documents have been written by Transpower subject matter experts while others were commissioned from external consultants who are experts in the relevant field. A few will be further developed or are still to be written as our technical work progresses.

The technical approach to building a future grid blueprint is supported by the feedback we have heard during ongoing conversations we are having with industry, businesses and consumers, and via our two recent consultations.

In this summary, we outline in more detail our approach to developing the future grid blueprint and provide an overview of the various publications that are supporting our technical work.

A note on our detail

Despite the level of detail presented, nothing should be seen as an implied decision on an outcome. Nor should it be considered an expression of any commitment from Transpower regarding investment.

This level of detail is required to help us identify the optimal grid blueprint for the future of Aotearoa. It is presented here to ensure we maintain a transparent and consultative approach to our work.

While every effort has been made to ensure this information is of the highest possible quality, many assumptions are made across our work. This information should not be used for any purpose other than to inform discussions on a future grid blueprint.

We want to hear from you

The approach we are taking is collaborative: we are developing this future grid blueprint by gathering feedback and we welcome your input into this work. Unlike with our earlier consultations, there is no formal feedback questionnaire or close off date. Given the technical nature of this material we will host at least two webinars between December and February.

Please get in touch by emailing **feedback@transpower.co.nz**.

Publishing feedback

We will publish a summary of the feedback we receive throughout this process on **www.transpower.co.nz/our-work/te-kanapu**; initially later in February. We will publish updates where we change our approach because of the feedback we hear.

Transparency is important in this process. Unless requested by you, we will include both your name and any information you provide as part of your feedback, on our website.

If there is any aspect of your feedback that is confidential, please make this clear to us.

For more information

Visit the Te Kanapu section on the Transpower website to find out 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

You can also **sign up** to receive email updates on Te Kanapu as our work progresses.

Introduction: Shaping our energy future together

Transpower has an important role to play in enabling Aotearoa to electrify and grow.

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.

When complete, Transpower's grid blueprint will make the case for what investments are needed now to meet demand and unlock growth; and it will help the industry plan across a longer time frame.

The grid blueprint will contain future potential scenarios and the 'low regrets' investment options for the 2030s. These are options that address the features that are common across scenarios and will deliver an optimal future grid for everyone.

Addressing uncertainty

In focusing on 2050, we know that the potential for change is vast and no one individual can possibly know, or predict, exactly what the future holds. This is why we need knowledge and insights from others to help us.

Our work is grounded in two main assumptions, which are that in 2050, Aotearoa:

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

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

Developing a future grid blueprint

To produce the future grid blueprint, we need to understand what the most common features across all our potential futures are, to guide our investments. This relies on two key factors:

1. what the future could bring; potential scenarios that explore different possible futures for Aotearoa and the electricity generation and demand assumptions that come with them, for 2050, and
2. how we will model that future; extensive power system and market modelling.

In our engagement and consultations to date, we've sought views on the first factor.

Now, we are addressing the second factor, diving deep into the details of how we intend to model the future electricity system and the investment that will be needed in transmission, so we can determine the best possible outcome for Aotearoa.

Our technical approach

In this document we provide a high-level overview of our methodology.

This includes:

- how we developed the demand profiles for the potential scenarios,
- our proposed generation stack and how this was developed,
- how we will develop the mix of generation and supply to meet the total electricity demand in each scenario, and
- the options we have identified and costed, that could add the transmission capacity needed for each scenario.

Completing the draft and first grid blueprint

Our intention is to release a draft grid blueprint later in 2026 and gather feedback 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 as we gather feedback from stakeholders and will update the blueprint every few years to ensure it remains current.

Our approach to developing a future grid blueprint

In this section we outline 'how' we are developing our future grid blueprint; our process and an overview of the elements that come together to create the final product. We then outline where we are at in our development process.

The programme is an intensive one, drawing on the expertise, knowledge and feedback of many people across Aotearoa. It is a complex and technical process that involves many moving parts, a lot of data, many assumptions and much uncertainty.

Most importantly, it is an iterative and evolutionary process; where we need to change our approach, we will. When we receive feedback, we adapt.

Finally, this process of producing a future grid blueprint does not circumvent nor supersede any of the existing regulatory requirements in place regarding Transpower's investment. Any grid investment proposals or decisions will continue according to the regulatory requirements current at that time, as set by the Commerce Commission and the Electricity Authority.

Figure one illustrates our process for creating a future grid blueprint and the elements that go into its development.

Figure two builds on Figure one and illustrates where we are at in this process including the different documents we have published, or will publish, in our development of a future grid blueprint. It illustrates which have been authored by Transpower, and which have been commissioned from external experts.

Figure 1: Our process for creating a future grid blueprint

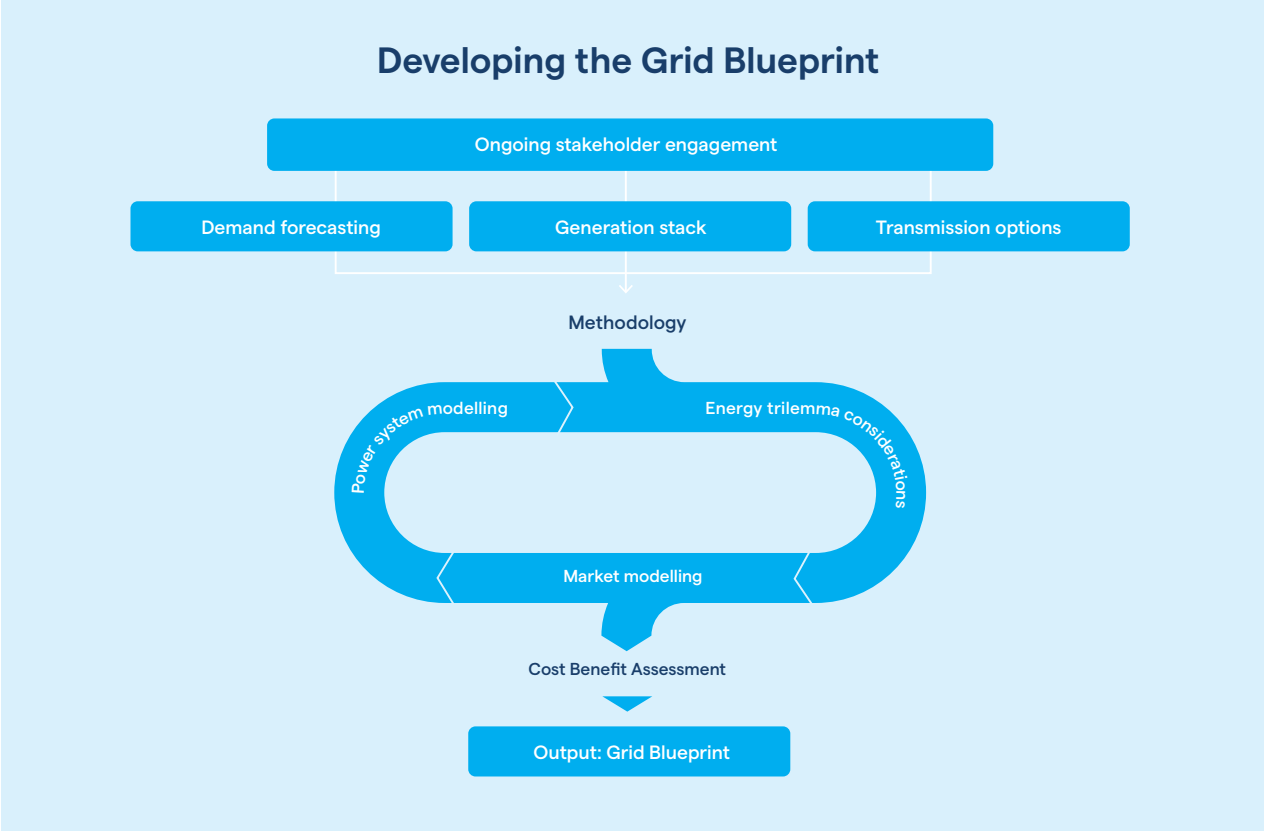
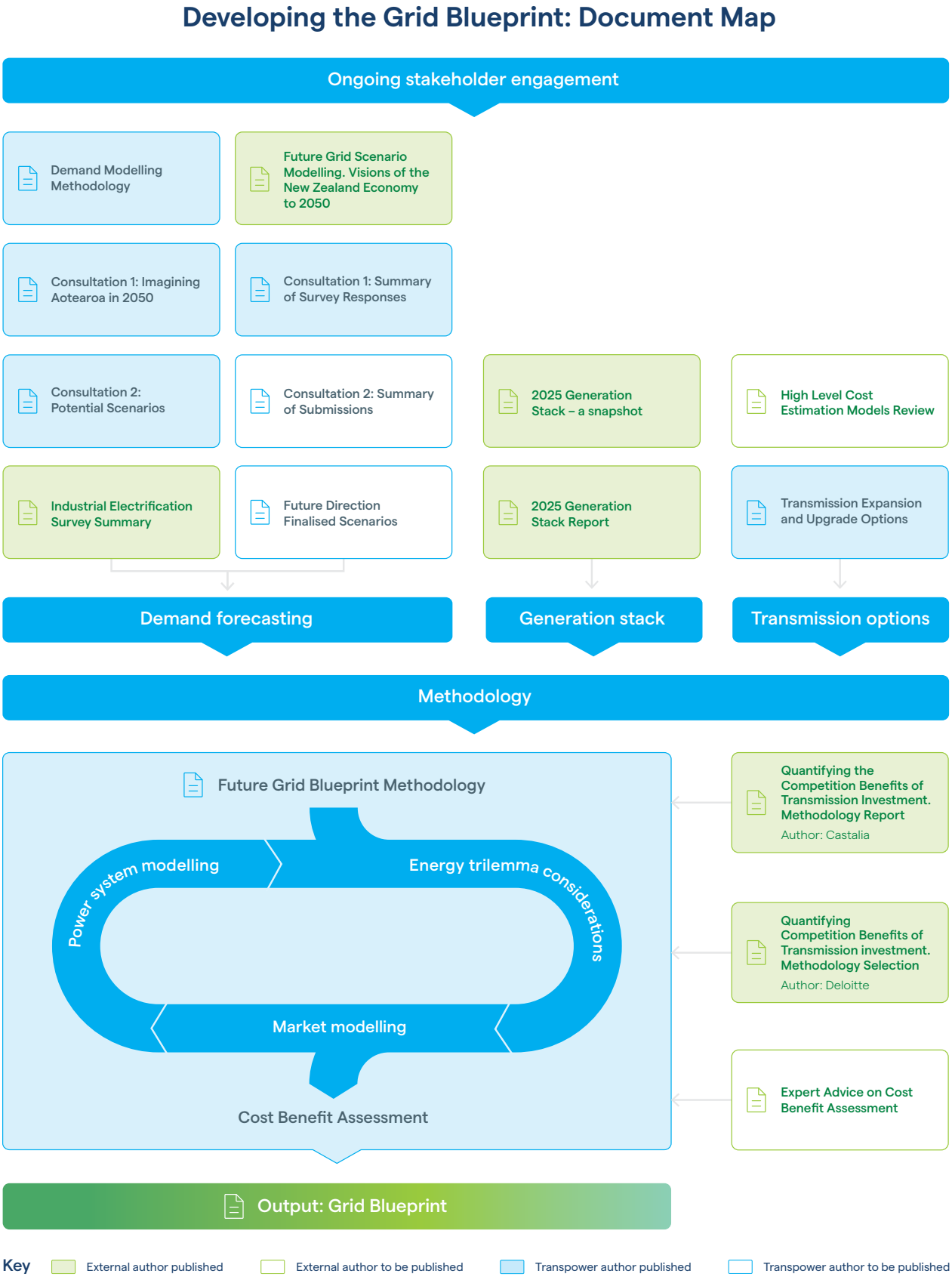


Figure 2: Our publications across each stage of the process



Input one: Ongoing stakeholder enagement

Extensive stakeholder engagement is fundamental to this work and an ongoing focus for us.

Transpower is one part of a wider energy system that exists to serve the people of Aotearoa. We know that partnership and collaboration are core to the success of long-term planning.

We cannot possibly know all there is to know about the future growth and decarbonisation of Aotearoa; the shape of our economy, our population, how we will live, work and play.

This is why widespread engagement is critical to the success of our work.

Where we are at in the process

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.

We have engaged one-on-one with stakeholders, presented at conferences and forums, held workshops with special interest groups and worked with Consumer NZ on a targeted consumer engagement campaign.

All the feedback we have gathered, and continue to gather, is being considered and included in our work. This is an ongoing process, and we will continue to seek feedback at every step of the way.

In July 2025 we published our first consultation, and the subsequent summary of survey responses was published in September 2025.

- ***A future grid blueprint for Aotearoa. Consultation 1: Imagining Aotearoa in 2050*** *(Transpower)*
- ***A future grid blueprint for Aotearoa. Consultation 1: Summary of survey responses*** *(Transpower)*

Then in October 2025, we published our second consultation.

- ***A future grid blueprint for Aotearoa. Consultation 2: Potential Scenarios*** *(Transpower)*

In 2026 we will publish and seek further feedback on our draft future grid blueprint - including our final scenarios - and then our first future grid blueprint.

At the time of writing, feedback from consultation tells us that there is a strong appetite for clean energy innovation in Aotearoa. Stakeholders support the country's transition and see genuine opportunities for the nation if we lean into it.

People expect that our primary industries will still be the nation's economic powerhouse in 2050, and these will be supported by the new and emerging fields of technology and digital-based industries, and low-carbon fuel production.

Of importance to many is an enduring, bipartisan approach to addressing the future, long-term planning and decision making, a stable operating environment and streamlined regulations are needed.

For Transpower and our development of a future grid blueprint, feedback is that we need to 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 the energy trilemma through increasing investment in new technologies and enabling renewables, while focusing on reliability and resilience at the lowest possible cost.

Our engagement is ongoing. We hope to hear from as many people as possible and welcome your views and feedback on the future of Aotearoa in 2050.

Input two: Demand forecasting

Here we seek to understand how the use of electricity will grow, out to 2050.

The output is the development of potential future scenarios. Scenarios enable people to compare different possible versions of the future, and the levers and actions that produce them. They help us to consider how our national electricity grid would need to develop to enable or respond to different possible outcomes.

Where we are at in the process

While there are a range of forecasts for our sector already, we have taken a fresh look linked to how Aotearoa's economy and regions will grow, where new businesses will be located, and how our economy will change over time.

EDGS[1] will continue to be used for our regulated grid upgrades, however, for this work, we sought a longer-term view. Our approach is comparable to that used overseas by other agencies such as AEMO (Australia) and NESO (Great Britain).

The first piece of demand forecasting work was completed in July 2025 by consultants Sense Partners in considering how our economy might respond to different choices about how it could grow.

- ***Future Grid scenario modelling. Visions of the New Zealand economy to 2050*** *(Sense Partners)*

This work helped shape our thinking around how the economy may grow and the trade-offs required. Our demand modelling methodology was published in December 2025.

- ***Demand Modelling Methodology. Te Kanapu Technical Approach*** *(Transpower)*

Here we outline the methodology and approach for modelling national demand using deep dive models to complete specific forecasts for some emerging drivers of electricity demand, such as datacentres and sustainable aviation fuels, and generic economic growth for existing sectors using the Low Emissions Analysis Platform (LEAP) models.

We then disaggregate demand to regional and grid exit point (GXP) levels and apply demand profiles to determine peaks.

Our demand forecasting approach has been used to generate new potential future scenarios, published as Consultation 2 in October 2025.

- ***A future grid blueprint for Aotearoa. Consultation 2: Potential Scenarios*** *(Transpower)*

Our five scenarios explore a range of possible futures for the country. They are deliberately based on growth and ambition because of the decisions we must 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, than it is to scale up.

The five scenarios have electricity demand reaching between 63 TWh to 113 TWh by 2050.

While some scenarios might have similar growth trajectories, the key factor to consider is how and where this growth occurs across Aotearoa.

There is one more document in the demand forecasting set, written by DETA and published in September 2025.

- ***Industrial Electrification Survey Summary*** *(DETA)*

The aim of this work was to understand the impact of industrial electrification on load growth. Selected industrial electricity customers were surveyed regarding primarily the electrification of their process heat infrastructure and decarbonisation transition plans. Survey findings will contribute to the development of our final potential future scenarios for Aotearoa.

Please note that all commercially sensitive content has been removed from this report prior to its publication.

We continue to seek feedback on our scenarios as they are revised and refined. Our intention is to publish our updated scenarios early in 2026. These will include additional content around how demand is allocated within regions, and more information on the growth in consumer energy resources.

We welcome your feedback on our process and methodology in developing these scenarios.

1 Electricity Demand and Generation Scenarios as published by MBIE

Our demand forecasting includes a whole-of-energy model that outputs New Zealand's pathway through the energy transition, such as this example from the Made in Aotearoa scenario. To find out more, read *Demand Modelling Methodology: Te Kanapu Technical Approach*.

Figure 3: Useful energy in petajoules by fuel grouping

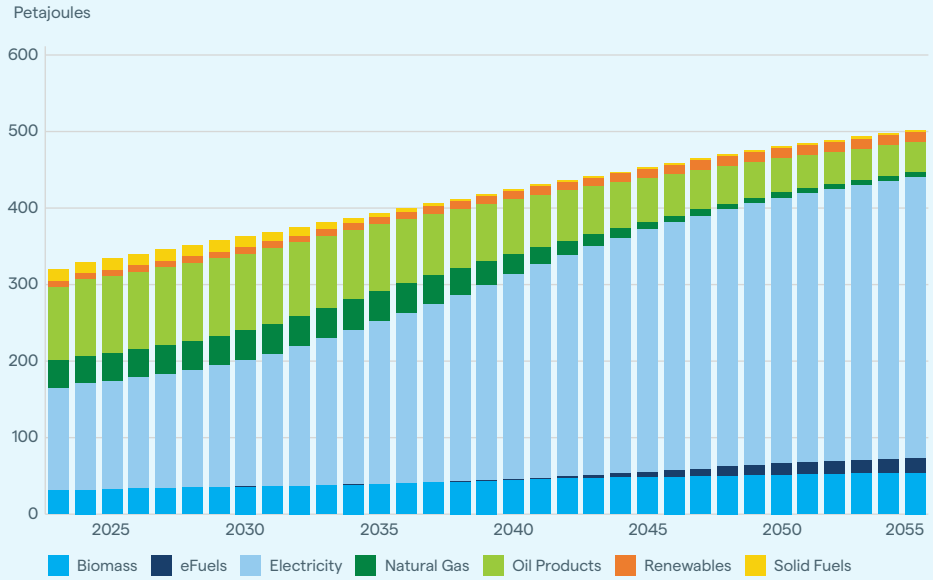
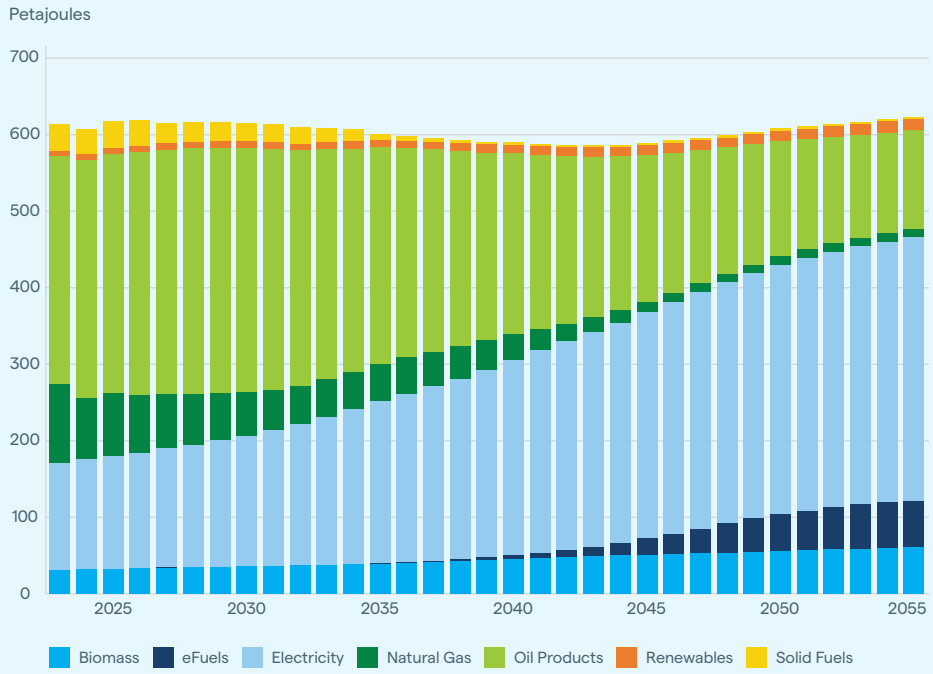


Figure 4: Consumed energy in petajoules by fuel grouping



Input three: Generation stack

The generation stack is a snapshot of the current cost of developing generation in New Zealand and an associated forecast for where costs might trend in the future.

It is used to assist with understanding and determining what electricity generation capacity is required to be built and when, to meet forecast electricity demand. It is a key input to modelling performed by the Ministry of Business, Innovation and Employment; Transpower, and the wider electricity industry.

Where we are at in the process

In October 2025, we published work commissioned from Beca and Concept Consulting on the generation stack. There are two documents you can access.

- ***2025 Generation Stack Report***
  (Beca and Concept Consulting)
- ***2025 Generation Stack – a snapshot***
  (Beca and Concept Consulting)

> The work presents a comprehensive set of cost estimates and critical performance parameters for a range of electricity generation technologies.

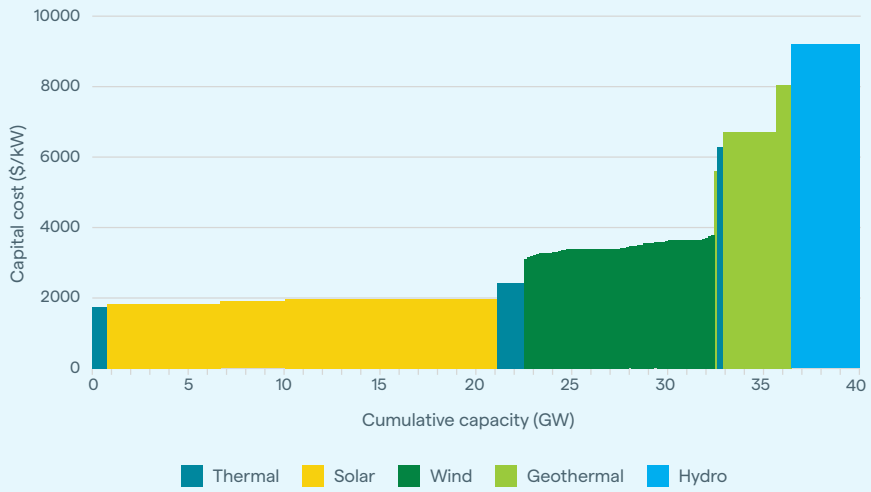
Covering a range of proven, potential, and speculative generation sources, the report consolidates capital expenditure, operational costs, technical parameters, and scalability to facilitate informed decision-making in energy planning.

In developing the generation stack, the Beca and Concept Consulting team have drawn on published information about current projects in Aotearoa, including previous stack reports, and international forecasts. They also consulted with some of the major developers in New Zealand as part of this process.

There is nothing further we expect to publish regarding the generation stack. We welcome your feedback on the work by Beca and Concept Consulting.

The generation stack highlights the abundance of renewable resource potential in New Zealand. To find out more, read *2025 Generation Stack Report*.

Figure 5: The generation stack



Input four: Transmission options

We need to understand the options that are available to feasibly increase the capacity of our transmission network, maximise existing capacity or how new and emerging technologies can be used to achieve a similar outcome.

Options are considered at both a regional and national level.

Where we are at in the process

In December 2025 we published our work on options to expand or upgrade the transmission network.

- ***Transmission Expansion and Upgrade Options. Te Kanapu Technical Approach*** *(Transpower)*

This document outlines a range of options available to us, to feasibly increase transmission capacity across Aotearoa, both at an inter regional level and a national level. Where it is possible, we have also provided indicative costs.

> These options include ways to add transmission capacity; ways to maximise existing capacity and, emerging new solutions that add capacity.

As we run our methodology for each scenario, we will select transmission options to address regional and inter regional constraints that emerge in meeting demand or enabling generation in a region.

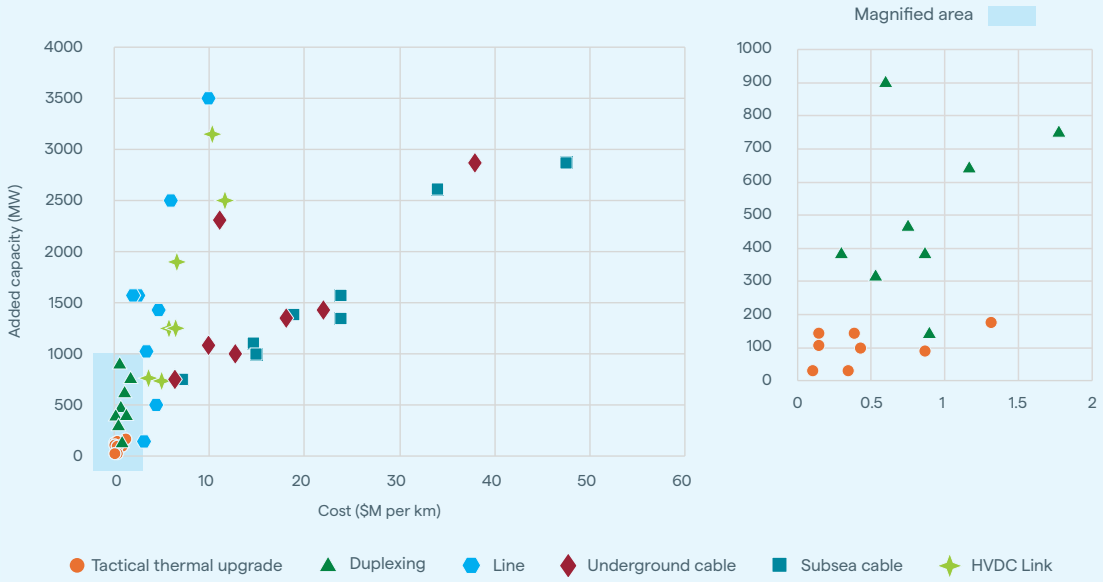
The methodology will identify the solution that carries the lowest total system cost for addressing each constraint.

This will be a "first pass" at what might be needed. In later stages we will look holistically at the individual regional and inter regional transmission options for each scenario and assess the implications of each such as resilience and the overall grid backbone. This may result in other transmission options being selected.

The review of our cost estimation models is ongoing and we will publish this in due course. We welcome your feedback on this work so far.

Options to upgrade and expand transmission offer a different balance between cost and capacity. To find out more about the transmission options we are considering, read *Transmission Expansion and Upgrade Options: Te Kanapu Technical Approach*.

Figure 6: Cost per kilometre for transmission upgrade options with potential capacity gains



Methodology

All the information gathered from across inputs are used within our technical approach for developing a future grid blueprint, published in December 2025.

- ***Future Grid Blueprint Methodology. Te Kanapu Technical Approach*** *(Transpower)*

Our methodology iterates each scenario in a loop between market modelling and power system modelling. The loop terminates once a realistic scenario is found.

Viewing the outcomes of a scenario through the lens of the energy trilemma provides a useful gauge as to how realistic the scenario is. Balancing the energy trilemma is the perennial problem in energy policy so we consider a well-balanced scenario to be more realistic.

Our analysis considers the different dimensions of the trilemma throughout the process; during demand forecasting as decarbonisation and electrification is modelled; during generation modelling as least-cost optimisation is used, incorporating the carbon price of emissions; during resource adequacy checks in the market models to check for dry winters and peak demand, and when ensuring regulatory requirements around resilience and reliability are being met.

Electricity market modelling

Electricity market models are economic models which represent the least-cost dispatch of generation against a specific demand forecast. The models optimise the addition of new capacity to cover demand growth and plant retirements.

> We apply these models to calculate the total system cost of delivering electricity. Through market modelling, we assess the cost of each network development plan, in each scenario.

In our methodology we outline our use of market models which forecast the electricity market, including participants' investment and generation dispatch decisions. The models have rich detail around transmission constraints, renewable generation (intermittency and hydro inflow uncertainty), and thermal fuel costs. This means the models can provide an estimate of the total system cost under different scenarios.

We use generation expansion models to determine the least-cost build out of new generation to meet expected demand. This generation build then becomes the inputs into generation dispatch models which simulate the operation of the electricity system in high levels of detail.

We have tested several representations of the transmission network and quantified the cost of constraints on the existing network. There is a trade-off between the representation of network constraints and computational run times, and we explore finding workable solutions.

Power system modelling

Power system modelling assesses the physics and engineering of each network development plan, in each scenario. It is required to ensure our solution meets both physical requirements and meets, or exceeds, minimum security requirements under the current settings in the Electricity Industry Participation Code 2010 (the Code).

> While power system modelling checks the system obeys physical laws, the market modelling checks the system against economics. The two models work together to ensure, as a minimum, they are meeting today's power system security criteria as defined by the Code.

The section also has further details about how the thermal, steady-state static voltage stability and dynamic limits are defined and assessed; the process of creating region-to-region transfer limits, and how they will be fed back to the market model as

constraint equations which then can be refined as we progress with transmission development options.

Competition effects

Transpower commissioned two reports to identify a robust methodology for quantifying the competition benefits of transmission investments.

- ***Quantifying Competition Benefits of Transmission Investment. Methodology Selection*** *(Deloitte)*
- ***Quantifying the Competition Benefits of Transmission Investment. Methodology Report*** *(Castalia)*

We are now working alongside Deloitte to develop an Agent-Based Machine Learning model to simulate competitive bidding behaviour in the presence of transmission constraints for the New Zealand electricity market.

Cost benefit assessment

Here we compare the different total system costs across different development plans and different scenarios to determine the first grid blueprint.

This section outlines the key considerations, guiding principles, and some general details of our approach to cost benefit assessment.

Our intention is to seek external specialist advice on this work, to be completed and available in March 2026, when results from market modelling for our scenarios start being produced.

We intend to publish expert advice on our cost benefit assessment in 2026. We welcome your feedback on this or other aspects of our methodology.

Modelling the electricity system can be complicated. Designing models that capture the relevant physics and economics within a reasonable solve time is key. To find out more about our model design decisions and rationale, read *Future Grid Blueprint Methodology: Te Kanapu Technical Approach*.

Figure 7: Three-stage funnelling approach for power systems analysis

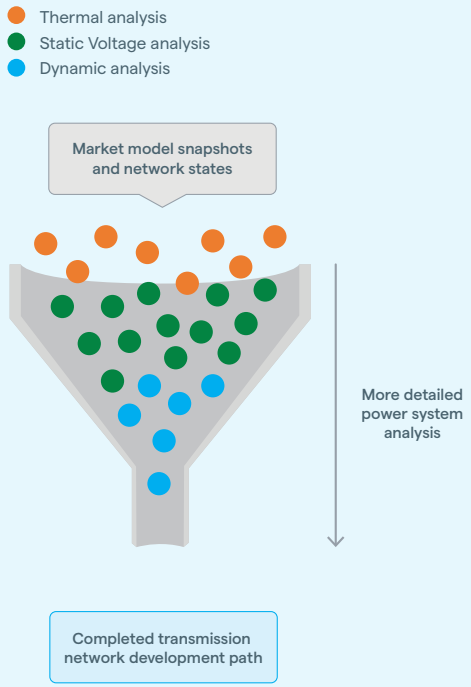
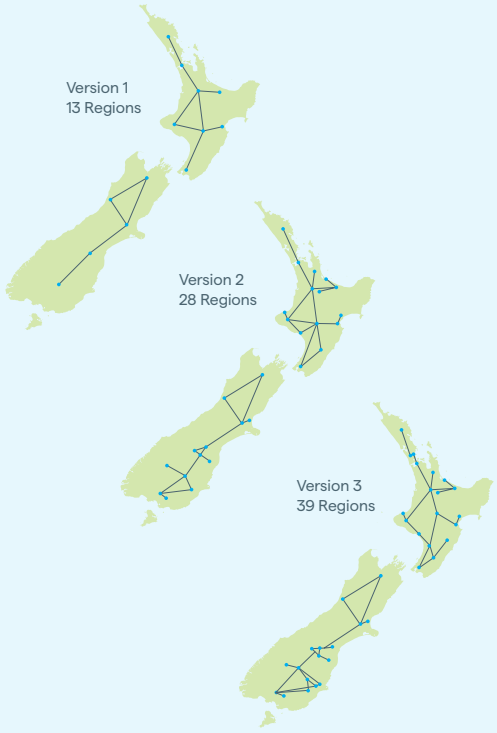


Figure 8: Regional market model representation and regional interfaces



Feedback

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However, unlike with our earlier consultations, there is no formal feedback questionnaire or close off date, rather we invite you to please get in touch by emailing **feedback@transpower.co.nz**.

We would be happy to set up a time to hear your feedback directly and to discuss our approach in more detail.

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