



TRANSPOWER



Murihiku Southland Electrification Development Plan

December 2023



Overview

Murihiku Southland has abundant renewable energy resources and there is strong interest in harnessing these for new renewable generation developments to support Aotearoa New Zealand's transition away from high emission fuels. These developments will increase electricity generation capacity across the region, enable Southland businesses and communities to replace fossil fuels with renewable electricity, and contribute to New Zealand's journey toward a low-carbon economy. This decarbonisation activity is already happening, and it is accelerating.

Over the last six months, PowerNet and Transpower have worked together to ensure the electricity infrastructure in the Southland region can support this increasing demand. This report, which identifies the investment requirements in Southland, follows on from earlier consultation papers that sought input from a wide range of stakeholders on their investment ambitions in the region.

Our integrated Murihiku Southland Electrification Development Plan outlines a road map for investment to support the new renewable generation and electricity load growth Southland is planning for, now and into the future.

Location of the possible projects

- TRANSPOWER TACTICAL UPGRADE
- POWERNET MAJOR PROJECTS
- TRANSPOWER MAJOR PROJECTS

Transpower to complete a Tactical Thermal Upgrade of the Invercargill–North Makarewa circuit

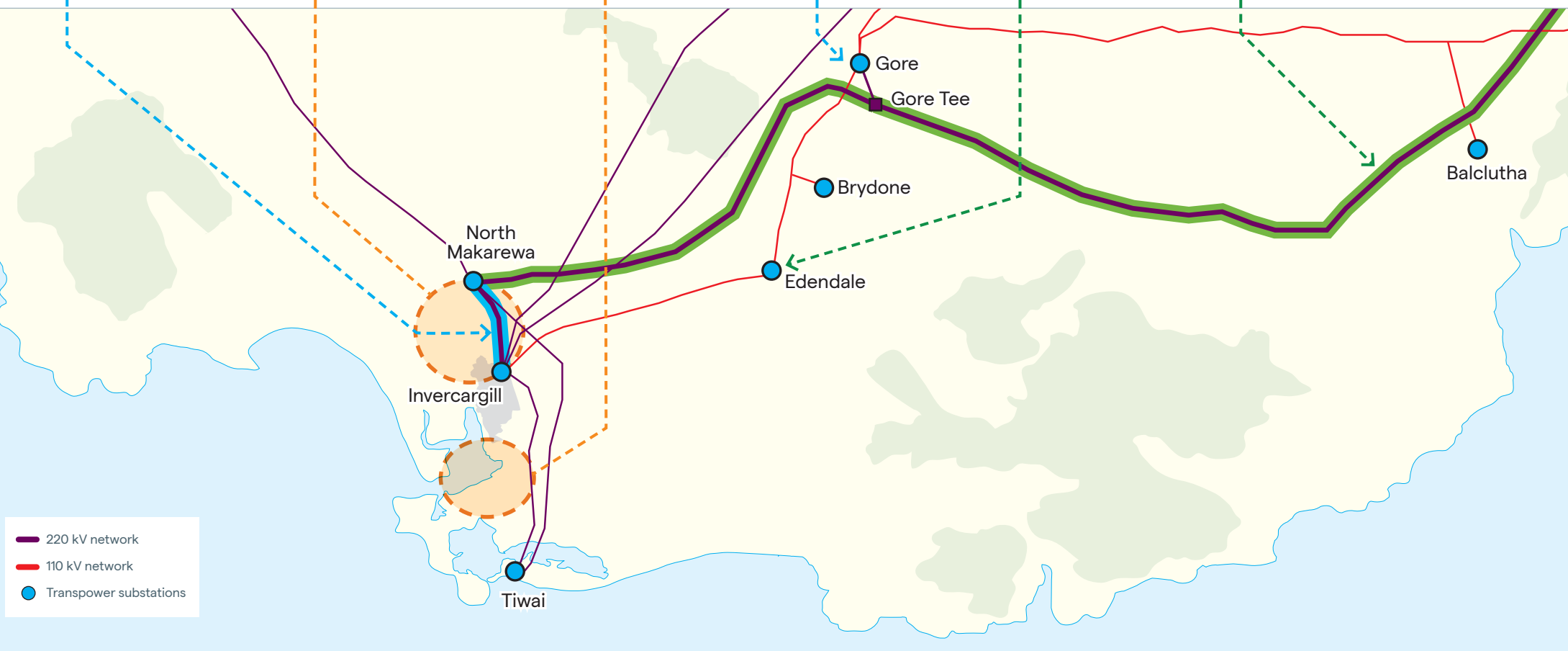
PowerNet to increase transferable load between Invercargill and North Makarewa via the 66 kV network

PowerNet to undertake a 66 kV network development to the Awarua Region

Transpower to implement Special Protection Schemes at regional substations

Upgrade or develop GXP, for example at Edendale

Duplex the 220 kV North Makarewa to Three Mile Hill line



Proposed short-term tactical upgrades



TRANSPOWER
TACTICAL
UPGRADE

- **Transpower to implement Special Protection Schemes at regional substations**
 - **Cost:** up to \$1 million
 - **Need:** Avoid overload of the 110 kV Gore-Roxburgh and Brydone-Gore circuits as new generation and load connects.
 - **Need Date:** End of 2025
- **Transpower to complete a Tactical Thermal Upgrade of the Invercargill–North Makarewa circuit to increase capacity**
 - **Cost:** \$6-9 million (depending on final tower foundation scope)
 - **Need:** Increase transmission network capacity to avoid constraints as new wind generation is developed in the region.
 - **Need Date:** Prior to final commissioning of a second wind farm on the North Makarewa-Three Mile Hill line (expected end 2027).



Proposed major projects



- **PowerNet to undertake a 66 kV network development to the Awarua Region**
 - **Cost:** \$30-50 million
 - **Need:** The significant load growth in the Awarua region expected from decarbonisation in the near term would result in network constraints on the existing 33 kV sub-transmission circuit to Bluff. The 66 kV development would accommodate near-term decarbonisation, relieve 12 megavolt-amperes (MVA) from the existing circuit and provide some additional capacity for regional development.
 - **Need Date:** 2026
- **PowerNet to increase transferable load between Invercargill and North Makarewa via the 66 kV network in a programme of major projects**
 - **Cost:** \$65-100 million
 - **Need:** To transfer approximately 20 MVA of load on the North Makarewa grid exit point (GXP) to the Invercargill GXP and to cater for additional decarbonisation load requirements. This work would relieve capacity constraints in the North Makarewa region, improve resilience to western Southland and defer major investments, such as the GXP upgrade, until firmer plans on major investments are announced by customers. Upgrading to 66 kV will also improve resilience of the network supplying western Southland.
 - **Need Date:** 2028



- **Transpower to duplex the North Makarewa to Three Mile Hill line**
 - **Cost:** \$135-140 million
 - **Need:** To alleviate constraints on the North Makarewa to Three Mile Hill line, which will occur as new generation connects to the network.
 - **Need Date:** For further investigation. Need date to be determined¹.
- **Transpower to upgrade or develop GXPs, for example at Edendale**
 - **Cost:** \$50-60m for a new GXP.
 - **Need:** To provide additional capacity for new or increased demand.
 - **Need Date:** For further investigation. Need date to be determined based on load forecasts.
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While we advance the Transpower tactical upgrades and PowerNet major projects listed, we expect regional investment in new renewable generation developments and electricity demand plans will progress. Transpower and PowerNet can proceed with future investments in the longer-term initiatives outlined in this report once some of the significant potential Southland developments have more certainty.

We encourage new renewable generation developers and organisations seeking additional electricity capacity to continue to engage with Transpower and PowerNet as your plans firm up. Our customer teams are ready to support your decarbonisation goals.

¹ The need is conditional on the connection of a third or subsequent connection to the line, and the need date would match the expected commissioning date of the third connection.

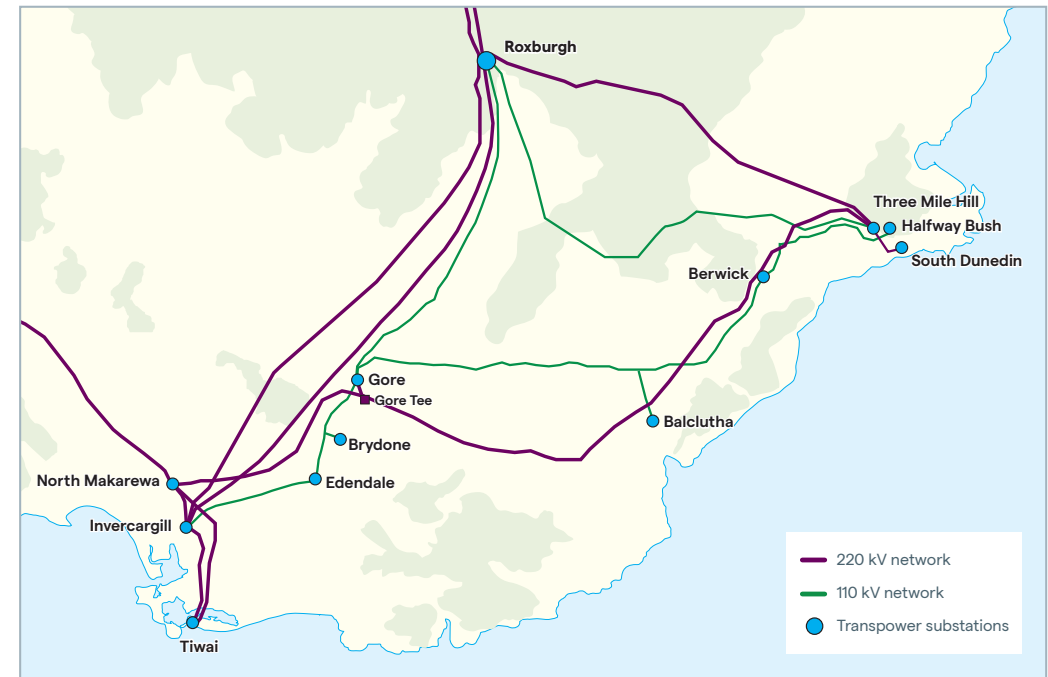
The context for this work

The Southland region is primed for decarbonisation and growth. Various businesses, community groups, iwi, local and central government are looking to capitalise on the region's abundant renewable energy resources, both to increase renewable generation and support the decarbonisation of existing industries, alongside supporting potential new growth.

Given the amount of development expected and the ongoing negotiations by the New Zealand Aluminium Smelter (NZAS) on its longer-term electricity needs, Transpower and PowerNet have scoped a Murihiku Southland Electrification Development Plan for the region.

This approach provides the opportunity for integrated planning and will result in an efficient approach to upgrade investments on the national grid and the distribution network, rather than a reactive or project-by-project approach to network investments.

We have sought to encapsulate the latest demand drivers, forecasts, and potential new generation opportunities in the area, based on input from a broad range of Southland stakeholders.



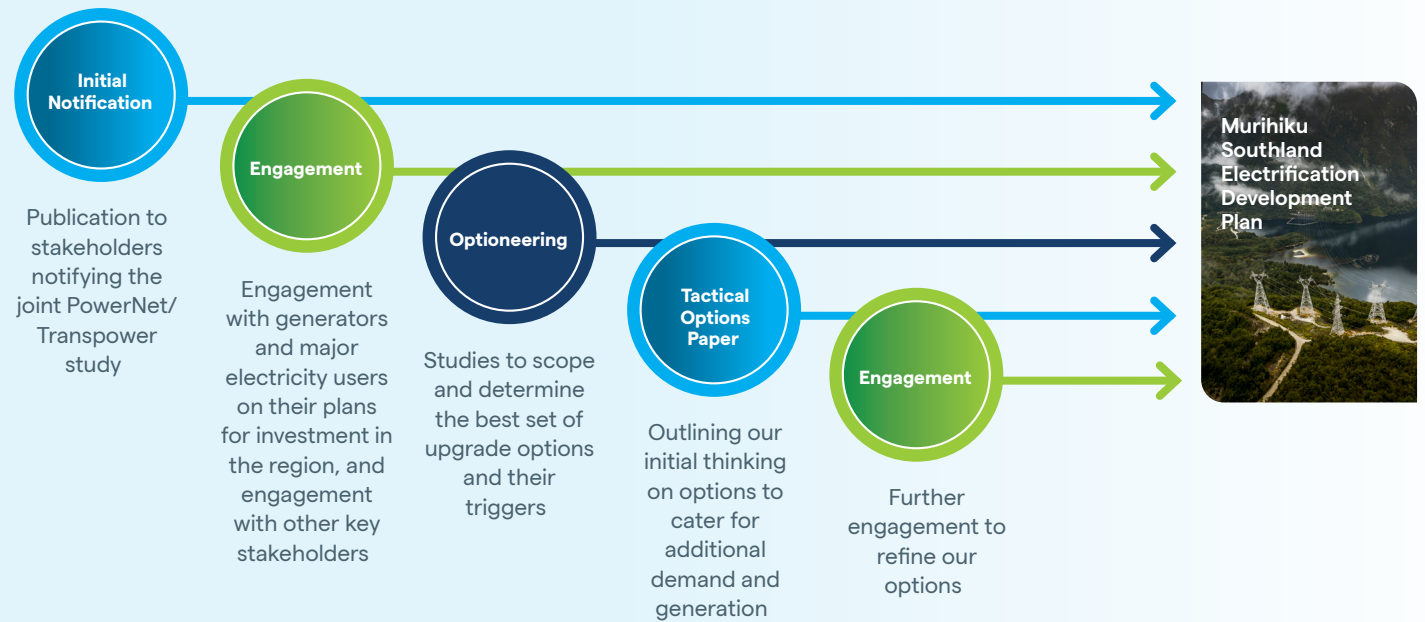
The transmission network in Southland and Southern Otago.

Our process to date

We have engaged extensively with key local stakeholders, generation developers, and large industrial and commercial users of electricity to understand their decarbonisation plans. This approach has given us a broad planning perspective and a road map for an efficient and integrated development plan for the region.

Based on the feedback received, our integrated Murihiku Southland Electrification Development Plan outlines a road map for investment in the transmission and distribution networks to support new renewable generation and electricity load growth now and into the future.

Our process



What we understand about electricity demand growth in Southland

Our July 2023 discussion document highlighted activity underway, such as committed projects as a result of the Energy Efficiency and Conservation Authority's (EECA) work on its Regional Accelerator and Government Investment in Decarbonising Industry (GIDI) Fund, and the Southland Just Transition and Southland Murihiku Regional Energy Strategy.

It also highlighted that Transpower and PowerNet are receiving numerous connection requests and are supporting development activities. Since 2019 Transpower has received 23 enquiries for new generation projects in the Southland and Southern Otago regions, totalling over 4,400 MW. Almost 1,200 MW has progressed beyond the enquiry stage.² We have also received 18 enquiries for potential non-generation connections, such as load connections for new electrified process heat. Ten of these are seeking to connect to PowerNet's network.

² [Connection enquiry information | Transpower.](#)

Our conversations with stakeholders have indicated that there is a large appetite and opportunity for process heat decarbonisation through electrification, increasing residential and commercial loads, and increasing loads from data centres and other emerging technologies. They have also shown that the information that we already hold in our systems is largely accurate in terms of sizing and timing. This has provided clarity on the timings of our investment options and potential future growth and development plans for the region.

The Southern Green Hydrogen project represents a significant step load increase and has the potential to become one of New Zealand's largest load connections to the national grid. However, at this stage, there is insufficient certainty about this project's size, location or timings to inform any current network decisions. While the investment in Transpower tactical upgrades and PowerNet major projects noted in the Murihiku Southland Electrification Development Plan are required in any event, Transpower and PowerNet will continue to monitor this project as it develops.



Process heat electrification

Process heat electrification has been identified as the region's primary driver for network load growth. To further understand the opportunities and needs of our customers and potential electrification projects in the pipeline, PowerNet, in partnership with Transpower and EECA, conducted a process heat stocktake of large customers in 2021/2022. Objectives of the process heat stocktake were to:

- Understand the number of process heat boilers in the Southland region, their capacity, and the fuel used.
- Understand transition intentions, timelines and future capacity requirements to aid in our long-term planning.
- Understand customers' drivers for decarbonisation.
- Understand the support required to enable decarbonisation.

The 44 customers who participated in the stocktake represent around 96 percent of PowerNet's large commercial and industrial customers who currently use fossil fuels for process heating. It was found that 300 MW of electrical capacity equivalent (70 percent of total capacity required) worth of coal was still being used in the region, which will need to be shifted to either electricity or biomass.

While preliminary results in July 2021 showed that biomass was the dominant renewable fuel of choice for decarbonisation, follow-up discussions in March 2022 found many had moved to favour electricity due to cost, operational efficiency and other factors, and that the future electricity capacity required would be 188 MW by 2035, an 85 percent increase compared to the 2021 stocktake. The results indicate that there will likely be significant electricity demand growth in

the Southland region, and the move towards electrification is happening more rapidly than anticipated.

A greater electrification scenario

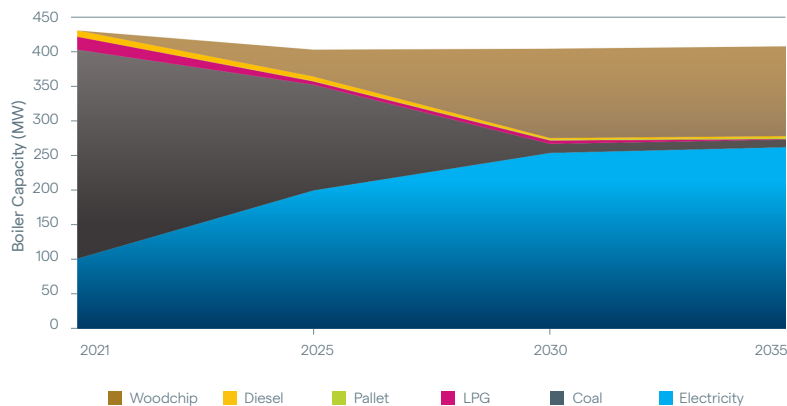
PowerNet believes that there is also potential for a greater electrification scenario in the next ten years. In this scenario, advancements in electrode boiler and high temperature heat pump technology, and better understanding of the benefits of these from early adopters, would see some customers that have indicated a transition to biomass consider electricity instead, as part of their decarbonisation solution. In this greater electrification scenario, which considers a 50:50 conversion to electricity and biomass, the electricity capacity required will more than double in the next 10-15 years, as depicted in Figure 1.

New grid-scale generation

Several parties are also at advanced stages of planning new grid scale generation within the Southland region. Developing local grid scale generation in line with the region's electricity demand growth will help to ensure the electricity supply is affordable and reliable.

As a result of bringing the above information together, PowerNet and Transpower have scoped this plan that identifies a range of cost-effective, short-term upgrades that can be undertaken to support additional capacity on the distribution and transmission networks and enable active new generation and connection requests.

Figure 1: Transition plan to renewable fuel source - Greater Electrification Scenario



Technical work and tactical options

Based on the feedback received to date, we have identified common or no regrets projects that are sensible to construct in a range of future scenarios. Through power flow analysis, we identified which transmission assets will constrain new generation and load projects. These could include everything from the conductors on the lines, to parts of the circuit such as substation assets and protection systems that monitor the circuits and activate in the case of faults.

The most effective and simplest tactical upgrades to remove constraints often include Tactical Thermal Upgrades. This allows existing line conductors to operate at higher temperatures and therefore carry more power. This is achieved through increasing the distance between the conductor and the ground or nearby structures using methods such as reconductoring, earthworks, or raising towers. Equipment within our substations may also need to be upgraded if they become the next constraint following a Tactical Thermal Upgrade.

Larger transmission upgrade investments of more than \$20 million must be approved by the Commerce Commission before Transpower can proceed with these projects. Therefore, it is important that we have confidence in the forecast load increases and the likelihood of new renewable generation developments.

Our analysis shows that demand growth in the short term can be supplied from the existing GXPs in the region with some tactical transmission investments. PowerNet also has the capability to upgrade its distribution network to support more demand growth out of both North Makarewa and Invercargill in the medium term. Opportunities for electrification of large industrial processes within the region remains, for example Fonterra's Edendale plant, which could trigger the need for major transmission upgrades or establishment of a new substation to supply these new loads. We see opportunities for Transpower, PowerNet, Fonterra and other stakeholders to continue to work together on plans to electrify these large industrial processes.

On the generation front, we have analysed what we need to do now to be ready to connect new generation as projects are completed. Our generation connection pipeline identifies three windfarms (totalling over 800 MW) looking to connect in future to the 220 kV North Makarewa–Three Mile Hill line.

Based on this demand and generation information, we identified the following projects to unlock network capacity and support the development of the Southland region.



The projects in our investment roadmap



Special Protection Schemes

Transpower to implement special protection schemes to avoid scenarios that may overload the 110 kV Gore-Roxburgh circuit and the 110 kV Brydone-Gore circuit as new generation and electricity load connects.

A Special Protection Scheme is an automated system that monitors electricity flows through a circuit, and takes action to switch circuits, remove load or remove generation in abnormal or overload conditions.

Demand growth in Southland and new generation connected along the 220 kV North Makarewa-Three Mile Hill circuits may overload the 110 kV Gore-Roxburgh circuit during low generation at Manapouri, and the 110 kV Brydone-Gore circuit during high wind generation scenarios. These 110 kV constraints can be resolved in the short term by Transpower implementing low-cost special protection schemes (SPS) which will automatically reconfigure the 110 kV network to remove overloading. The SPS will push power to flow through the higher capacity 220 kV network, and will be sufficient for the short term, but does not cater for any long-term load growth on the 110 kV network. Should customers need to add additional load to the 110 kV network, further investigation will be required to assess how these circuits could be upgraded further. The specifics of this work will be proportionate with the level of increased demand but could require the installation of a larger conductor on the existing line, or a line re-build (see Major Project 2).



Transpower to complete a Tactical Thermal Upgrade of the Invercargill-North Makarewa circuit to increase capacity.

A Tactical Thermal Upgrade (TTU) increases capacity of a line by increasing the distance between the line and the ground or other obstacles. This allows the line to sag further, which happens as it carries more electricity, without breaching minimum clearance distances. A Tactical Thermal Upgrade is achieved through earthworks, tower raising or decreasing the existing sag in the conductor.

Demand growth in Southland and new generation connected to the 220 kV North Makarewa-Three Mile Hill circuits may overload the 220 kV Invercargill-North Makarewa circuit, rated at 404/457 MVA (summer/winter).

Transpower sees an opportunity to undertake a Tactical Thermal Upgrade of the Invercargill-North Makarewa circuit to increase capacity to 666/717 MVA (summer/winter). Transpower's preliminary investigations show that the cost for this project (and the associated substation components) would be unlikely to exceed our \$20 million major capex threshold.

Transpower will continue investigations into this upgrade, including confirmation of the need to carry more electricity on these lines, as business and developer plans become confirmed. This project is in Transpower's forward work plan to be completed by 2027, dependent on the timing of new generation and demand.





66 kV network development to the Awarua Region

Open Country Dairy received funding³ from the Government Investment in Decarbonising Industry Fund (GIDI) to enable an estimated annual carbon reduction of 41,110 tonnes. This site electrification and decarbonisation project would involve the installation of a high-pressure electrode boiler and high-temperature heat pumps, which will significantly reduce coal use by the site. Enabling the decarbonisation activity would require establishing a 66 kV line to the Awarua region with a target completion date of 2026. This work would enable future development in the region.

An understanding of future load and generation is needed to plan any additional developments to relieve the foreseeable constraints on the existing 33 kV network between the Invercargill GXP and the Colyer Road Substation in Awarua.

³ <https://www.eeca.govt.nz/assets/EECA-Resources/Co-funding/GIDI-Files/Round-5/Round-5-Projects-Map-and-Summaries.pdf>



Increase transferable load between Invercargill and North Makarewa via 66 kV network in a programme of major projects

In the past two years, there have been significant enquiries and applications on the North Makarewa network, particularly in the Makarewa region, which would trigger major network upgrades at both the Transpower GXP level and on PowerNet's sub-transmission network. PowerNet is considering transferring approximately 20 MVA of load from the Makarewa region from North Makarewa GXP to the Invercargill GXP via the new 66 kV connection, triggered by the development in the Awarua region. To supply the additional load requirements, the existing 33 kV network would have to be upgraded to 66 kV. This work would relieve the capacity constraint in the North Makarewa region, improve resilience to western Southland and defer major investments, such as the GXP upgrade, until there is more certainty on the nature and timing of any significant load growth.

Next Steps for Transpower tactical projects and PowerNet major projects

Transpower and PowerNet understand the upgrades needed to support the region in the short term. Our next steps include further investigations to refine the costs and undertake economic analysis to ensure that these projects deliver value for money for our stakeholders and communities. We will provide updates on our websites about these projects when they are finalised and confirmed in workplans.





Duplex the North Makarewa to Three Mile Hill line

Duplexing of electricity lines replaces a single conductor (wire) on a transmission circuit with twin conductors. This is what occurred on Transpower's recent Clutha Upper Waitaki Lines project between Roxburgh and Livingstone.

Given our understanding of the three potential wind generation projects between Transpower's North Makarewa/Gore and Three Mile Hill substations, Transpower has looked at the capacity of the 220 kV line that services this region and concluded that the two North Makarewa-Three Mile Hill circuits could host two wind farms (one on each circuit) with only minor or no generation constraints. However, adding a third or additional wind farms are expected to impose generation constraints to prevent overloading of the circuits limiting the amount of power that can be delivered into the grid from these projects. Duplexing will require a major capital proposal to be approved by the Commerce Commission.



Upgrade or develop grid exit points, for example at Edendale

Edendale supplies the largest dairy processing plant in the Southland region that has the potential to electrify. The Edendale GXP and the 110 kV lines that connect it to the wider grid can supply some additional loads to allow electrification in the short term. However, to fully electrify a site like the Edendale dairy factory, major upgrades to the GXP and 110 kV lines that connect to it are required. Alternative options include establishing GXPs supplied from the nearby high capacity 220 kV lines.

In addition, PowerNet has fielded enquiries for new load and generation connections at Edendale. However, certainty of loads in the area is insufficient to justify major investments now. Transpower sees an opportunity to continue to work with PowerNet, Fonterra and other stakeholders to develop the long-term plans for the Edendale area to ensure there is sufficient transmission and distribution infrastructure in place to support it.

Next steps for Transpower major projects

For Transpower major capital projects that are over \$20 million, Transpower must submit a proposal to the Commerce Commission for approval.

A proposal is usually to enhance or develop the transmission network to meet increasing electricity demand and/or to enable new renewable generation. The proposal must apply the capital expenditure input methodology rules (called the Capex IM) under the Commerce Act 1986. It must also detail the project benefits, consultation with stakeholders, the options considered, and the project costs.

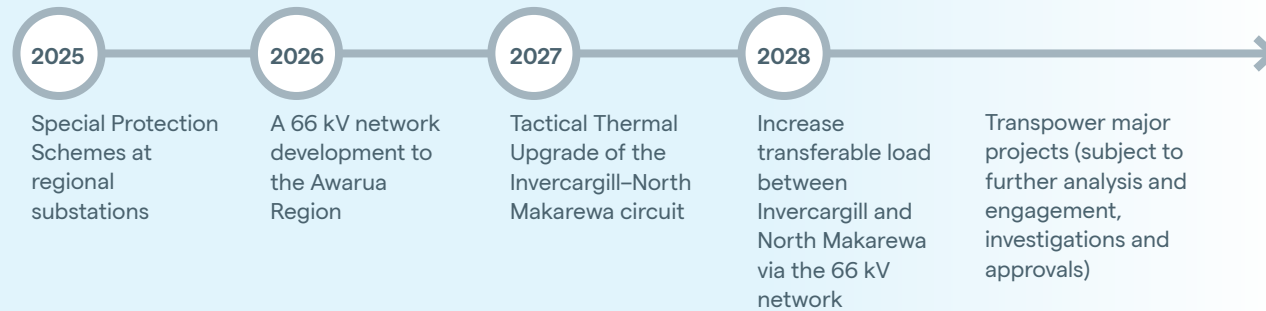
To demonstrate project benefits, Transpower must complete detailed economic analysis to demonstrate to the Commission that the investment is necessary and that the option chosen is cost effective and will be delivered at the right time.

Both major projects highlighted have several uncertainties that need to be confirmed before Transpower can apply to the Commission for approval. Transpower will continue to investigate these projects in 2024 and will continue to engage with generation developers and major users of electricity in the region to ensure investment decisions are timely and based on current information.

Transpower will notify the Commission once we decide to investigate these major projects and will also publish this notification on our website. A longlist of options and formal consultation will be undertaken for each project, which will include information about the underlying assumptions made as part of the investigation.



Timeline for the next steps



Ongoing electrification development

We will continue our work to monitor and understand emerging needs for transmission and distribution upgrades in the region. Please also share this document with others you know who may have an interest.

We value your continued input as our work on the Murihiku Southland Electrification Development Plan progresses. You can contact Southland@transpower.co.nz with further information or queries at any time.

If you have something else to talk about, or just want more information, you can also reach out to Tania Lund at Transpower or Kavi Singh at PowerNet.

Transpower

Tania Lund,
Regional Engagement Manager

Email: tania.lund@transpower.co.nz

Cell: +64 21 394 665

PowerNet

Kavi Singh,
GM New Energy Development & Strategy

Email: kavi.singh@powernet.co.nz

Cell: +64 21 858 684

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About us



As the owner and operator of New Zealand's national grid, part of Transpower's role is to provide a transmission network that can accommodate and enable new large-scale renewable generation and load growth and support electrification at pace, both in the Southland region and across New Zealand.



As the distribution network operator for the region, PowerNet delivers a safe, efficient and reliable supply of electricity to the homes and businesses of Southland. PowerNet needs to understand how its distribution network might need to change to support local communities and businesses as they decarbonise and enable new smaller-scale renewable generation in the region.