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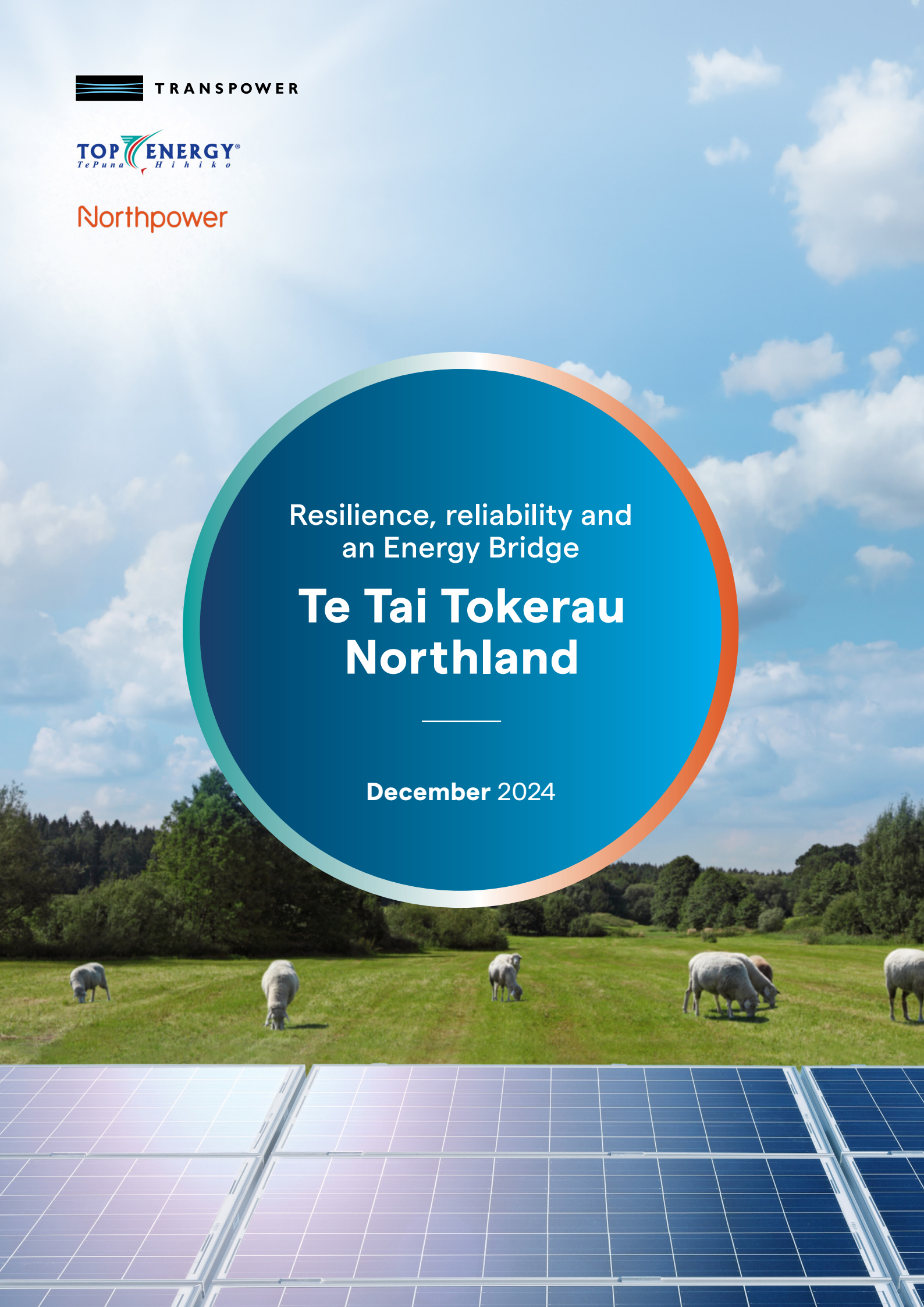
TePuna Hihiko

Northpower



Resilience, reliability and an Energy Bridge

Te Tai Tokerau Northland

December 2024

Overview

There's been a spotlight on the electricity network in Te Tai Tokerau Northland.

In June, a tower fall on Transpower's network took out power to the region. While power was back on for most consumers later that day, it took some time for larger businesses and seven days for full reliability to be restored.

This, coming after the extreme weather events of the last few years, left Northlanders highly aware of the limitations of their infrastructure and the constraints to their businesses and way of life.

In response, Transpower, Northpower and Top Energy have each explored how to deliver additional network resilience and reliability to the people of Northland in the immediate future.

We are also working together to plan for what we're calling an "Energy Bridge".

The Energy Bridge is a game-changing set of infrastructure investments that can pave the way for an energy future where Northland benefits from its abundant natural resources – sun, wind, and geothermal energy. It would support the strong interest from generation developers and new commercial and industrial electricity consumers seeking renewable electricity sources to meet their decarbonisation goals and it is an evolution of our collective work in 2022 to consider a Renewable Energy Zone. The Energy Bridge would also take advantage of the significant network capacity already available on the national grid between Marsden and Auckland, providing the ability to export electricity southwards.

This document explains what is being done now on each network for resilience and reliability, including considering whether operating Northland's networks as a series of "islands" is feasible.

It also explains more about the Energy Bridge, and what the process will be from here.

We are aiming to use this document as a basis for a discussion with Te Tai Tokerau stakeholders, government, the electricity industry, generation and user developers, and to determine a long-term direction for Northland's electricity infrastructure. We want to collaborate with others who have an interest in Northland's energy future to jointly establish a preferred pathway for future investment.

We also want to reassure locals that we have each continued our focus on delivering additional regional resilience and reliability, the need for which has been highlighted not only by the tower fall, but major weather events.

Transpower, Top Energy and Northpower all want to see Te Tai Tokerau flourish and grow, meeting its aspirations and goals. Ensuring it has the electricity network it needs is how we contribute.

Who we are – electricity transmission and distribution

As the owners and operators of the distribution networks for the region, Northpower and Top Energy deliver a safe, efficient, and reliable supply of electricity to homes and businesses. Northpower and Top Energy need to understand how their distribution networks might need to change to remain resilient while supporting local communities and businesses as they decarbonise; and enable new smaller-scale renewable generation and load growth.

As the owner and operator of New Zealand's national grid, Transpower transmits electricity over 12,000 kilometres of transmission lines and through 170 substations around New Zealand, linking generators with communities and businesses. As part of its role to deliver a national electricity grid for Aotearoa, Transpower needs to understand how the transmission network in Northland might need to change to accommodate growth and support users of electricity by providing a reliable and appropriately sized network, at the right time.

Together, we supply the region with the electricity needed to power homes, businesses, and communities, ensuring that households have the energy they need, businesses can operate efficiently, and communities have reliable and sustainable power sources.

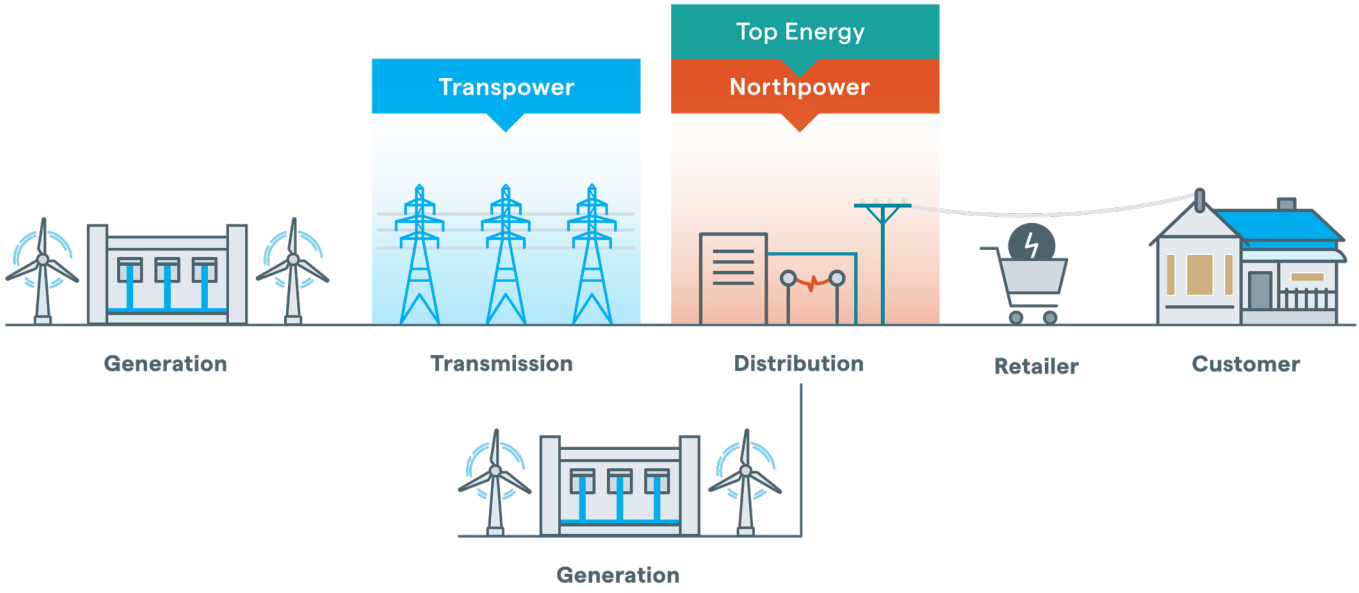


Figure 1: Illustration of electricity network infrastructure

Northland's electricity network

Northland relies on two main Transpower transmission lines to bring electricity to the region from generation sources in the central North Island, complementing local solar farms and Top Energy's Ngāwhā geothermal power station.

Northland has great solar and wind resources for renewable electricity. These types of generation can be developed quickly and cost effectively. However, both are intermittent and not always available when people want to use power, so an alternative supply is sometimes needed, such as that provided by Transpower from other generation sources to the south. Geothermal generation is renewable, reliable and in general low cost, but its steady reliability means it can't adjust its output quickly to match the changes in electricity users' needs throughout each day. While the geothermal power plant at Ngāwhā can fully supply the Far North, it can't do that alone without being connected to the electricity transmission network to support these rapid increases and decreases in power use through the day.

Figure 2: Transmission and distribution network ownership in Northland

What we are doing now

Top Energy initiatives underway

Top Energy has conducted a review to understand how climate change could affect the electricity network and the risk of fires. They have created a five-year plan focused on improving the reliability, safety, and strength of the network. This plan aims to reduce the amount of time there are power outages, their impact and how often they occur. This includes:

Distribution security
Top Energy has started a program to make the network more resilient, including building new connections to improve security for areas that currently don't have backup power options.

Distribution reliability initiatives
This program focuses on reducing the number and impact of power interruptions. It includes increased tree management, better fault detection, reviews of protection systems, group fusing, and automation.

Transmission refurbishment programme
A ten-year plan to update and maintain the 110 kV transmission assets.

Review of physical and transitional risk in sustainability reporting
Top Energy's sustainability reporting has been updated to better reflect current climate risks and ways to manage them. This includes new categories like landslips and more detailed timeframes for impacts from vegetation growth and temperature changes.

Vegetation managment near distribution lines

Northpower initiatives underway

Northpower has several projects underway to enhance network resilience, while also adapting long-term investment plans to address the challenges posed by severe weather and other high-impact events. These include:

Transformer upgrades
Upgrading 110/33 kV transformers at Kensington and Maungatapere to increase transfer capacity and redundancy.

Switchgear replacement
Replacing Kensington 33 kV switchgear and converting Maungatapere OD/ID as part of the Asset Management Plan.

Interlink cable upgrade
Upgrading the 33 kV interlink cable to boost Whangarei CBD's resilience.

Land stability monitoring
A recent investigation of land stability around 110 kV towers supplying Kensington regional substation indicated a very low risk of land movement and ongoing monitoring will continue to provide assurance.

Asset replacement and network upgrades
To reduce network risk, Northpower has expanded its asset replacement and network upgrade programmes, optimising spending to improve resilience.

Vegetation management
Prioritising initiatives that address vegetation that poses the greatest risk to the network.

Communication network enhancements
Incorporating several improvements to the communication network into the capital expenditure program.

Fault response strategy
Implementing a new strategy to improve fault location and isolation, increase automation on the distribution network, and restore power quickly to unaffected customers.

Transpower initiatives underway

Transpower has several key obligations and targets to ensure the resilience and reliability of the electricity transmission system.

Major initiatives include:

Future Security and Resilience
Transpower is engaged in a project with the Electricity Authority to develop a shared understanding of the opportunities and challenges for the future security and resilience of New Zealand's power system. This includes a 10-year roadmap outlining the necessary actions.

Climate Adaptation Plan
Transpower has developed a Climate Adaptation Plan to enhance the resilience of the electricity transmission system in response to climate change. This plan includes integrating climate adaptation into asset management, understanding climate-related risks, and implementing adaptive responses.

Regional Initiatives
Specific initiatives are also being implemented to improve regional energy resilience in conjunction with different electricity distributors. This helps us take and share learnings from one region to another as we identify the priority areas to work on. Our regional initiatives so far will inform aspects of our resilience planning for the Northland region.

These efforts are part of Transpower's broader strategy to ensure a reliable and resilient electricity supply as New Zealand transitions to a low-carbon future.

Other Transpower work programmes:

- Following the Auckland Anniversary Day floods in 2023, several slips were observed close to transmission towers in Northland. Geotechnical surveys were completed for towers on these lines to determine the level of risk. Those requiring intervention or further investigation were identified. Work is currently underway to complete investigation and design of corrective actions. Further on-site work has been scheduled for 2025.
- The Bream Bay and Marsden substations are vulnerable to a tsunami event >4-6m and may be vulnerable to flooding in a one-in- 100-year flood event (Bream Bay) and one-in-250-year event (Marsden). As we replace equipment at these sites, we will continue to monitor the risk and ensure equipment is replaced to modern design standards to mitigate these risks.
- Transpower is working with the Northland Regional Council to develop a critical infrastructure resilience tool - Resilience Explorer - Urban Intelligence, which facilitates enhanced risk-based decision making through a centralised risk analysis platform.
- Transpower will continue to investigate how further improvements can be made to the 110 kV Henderson to Maungatapere line to reduce or avoid having to disconnect it during maintenance of the 220 kV circuits.
- Transpower is reviewing its internal operating procedures for improved industry coordination forums during major events, with the aim of maximising the amount of electricity supplied during major events.
- Transpower will continue to work with Ngāwhā Generation and Top Energy to explore whether it is possible for Ngāwhā to continue to operate during unexpected events.
- Transpower will investigate the development of a regional special protection scheme (SPS) that potentially uses grid scale batteries and controllable load to reduce the risk of supply loss during planned or unplanned outages of the 220 kV circuits.

Transpower activities following the Glorit tower fall

Following the Glorit tower fall in June 2024 there has been an even greater focus on Northland's electricity resilience and reliability. Transpower has reviewed its processes and accepted recommendations from several investigations to ensure something like the Glorit tower fall never happens again. Many of the recommendations looked at resilience and reliability in a broad sense, and Transpower has taken the following actions to further strengthen work in this area:

- Reviewing equipment outages in Northland to see if any can be combined, reduced, or cancelled if possible. Some of this work has already been done and will continue as more projects are planned.
- To prevent bird nests from causing power issues, Transpower has increased inspections from every two months to every two weeks at sites known for bird activity.
- Reviewed several maintenance methodologies and workshopped these with subject matter experts within service provider organisations.
- Transpower's reviewed training methodologies for crews working on Transpower assets.
- Increased the scope of auditing systems, for the work service providers complete in the field to further improve how Transpower gathers information and shares learnings on work practices.

New generation

New renewable generation projects are being planned for Northland, with a total of 2.7 GW of additional electricity that could enter the network, this is around 11 times more than Northland presently uses at peak times.

Although these projects are being considered and promoted by their respective developers, it is unlikely that all will proceed through to construction for various reasons. However, it is evident that interest in constructing renewable generation projects in Northland is increasing.

While challenges may arise during the planning and approval stages, the overall trend suggests a positive outlook for the renewable energy sector in the region. Continued collaboration between Transpower, Northpower, Top Energy, government bodies, connecting parties, and local communities will be crucial in overcoming obstacles and ensuring the successful implementation of these projects.

Network	Location/Closest Substation	Type	Aggregated MW
Northpower	Maungatapere (Incl. Dargaville)	Wind	175
		Solar	175
	Maungaturoto	Solar	68
	Bream Bay	Solar	20
Top Energy	Kaitaia	Solar	43
	Kaikohe	Geothermal	32
Transpower – National Grid connected	Regionwide[3]	Wind	1800
		Solar	400
		TOTAL	**2.7 GW**

[3] Excludes projects in delivery

Is “islanding” an option to enhance resilience?

What is islanding?

Islanding is the division of an interconnected power grid into individual disconnected regions with their own power generation or supply.

In the event of an outage on the transmission network, operating as an island would mean that part of the network could operate independently, maintaining the power supply for that part of the community while repairs are made to reconnect it to the wider transmission network.

For an island to work, it must have sufficient local generation with flexibility to increase and decrease the power supply to meet local demand. It must also be able to maintain voltage and frequency stability and have the capability to reconnect the island back onto the grid once transmission service is restored.

Is islanding feasible for Northland?

Northland does have multiple areas that depend on single transmission lines for power supply, so an island would help address the risk that one of these fails.

To create an all-of-Northland-island, a 30 MW/120 MWh grid-scale battery energy storage system could be installed at Kaitaia.

It would need to be specified such that it could operate alongside solar farms in the far north. This – along with existing and new solar farms and Top Energy’s geothermal power stations – would mean Northland could operate independently for at least three days (the typical restoration time for a tower failure), should a transmission line fail. This would mean Northland is immune to power supply interruptions due to the failure of a single transmission line, year-round.

Based on high-level information provided by a reputable grid-scale battery energy storage system supplier, this solution would cost around $70 million.

In addition, Transpower would have to invest in the capability for reconnecting islanded areas back onto the grid once transmission services are restored. This is a complex technical issue, which would require detailed study to further evaluate viability. It would also need to work with generator owners within the region to ensure their equipment can operate stably and safely in an island, which may also require further additional investment from them.

Islanding is theoretically viable, but other resilience and reliability options are more cost-effective

Islanding for the region may be a theoretically viable option, however the time and cost of investing in the additional technology involved means that the likelihood of this proceeding is not high when compared to other options for investment into resilience, reliability and enabling additional capacity in the region at this time. Due to the way costs are allocated, a significant proportion of this investment would fall on local consumers.

The Energy Bridge

A significant increase in new renewable electricity generation in Northland would provide both energy resilience and economic development benefits directly to the region.

It could also mean that Northland may generate far more electricity than it consumes, and the excess electricity could be exported south to the larger load centre of Tāmaki Makarau Auckland. It could boost local economic development by creating jobs as well as enhance regional energy security.

However, the costs to unlock this future are significant, and the current regulations require local consumers to pay a high proportion of the costs.

Northland needs a "bridge" - a plan for the infrastructure investments needed to unlock the potential of its electricity resources.

The issues we need to bridge

New renewable electricity generation will need to connect

Northland has significant wind, solar and geothermal potential in a range of locations. However, the major electricity lines travel mostly through the centre of the region. The existing electricity network does not necessarily reach the locations that developers consider best for new generation. Investment in transmission and/or distribution lines will be needed to connect some of the potential new projects to the central backbone.

There is limited spare capacity in network infrastructure

Some of Northland's existing electricity infrastructure doesn't have enough capacity to transfer large amounts of electricity south to Maungatapere, Marsden, Auckland and beyond.

Limited capacity increases the risk of outages during routine maintenance

One of the transmission lines has limited capacity to import electricity and has a risk of overloading when Transpower is undertaking maintenance on the other line. Transpower typically manages this through reducing security to the region when the maintenance is happening. Increasing capacity is one way to help reduce this risk.

Under current regulations, Northland households and businesses would pay a high proportion of the costs of major upgrades

The investments to enable the benefits of new generation are significant, and current regulatory settings and arrangements identify Northland consumers (through Northpower and Top Energy) as a primary beneficiary. In reality, the main beneficiaries may be generation developers and the broader population that benefits from the electricity produced, much of which would be used in Auckland. This creates a prospective situation where Northland consumers may bear a sizeable portion of the investment costs (until new generation is connected).

Developing a bridge

In 2022, Transpower, Northpower and Top Energy consulted Northland communities and stakeholders about the potential for developing a Renewable Energy Zone. This is where multiple electricity generators and/or businesses that use a lot of electricity agree to co-locate and share the costs of a single connection to the electricity grid and any required network upgrades. Most respondents supported the concept and the development of a pilot REZ in Northland.

The key benefits the consultation process identified included unlocking Northland's renewable energy resources, lifting local economic development, creating jobs, and enhancing energy security and resilience. However, concerns were raised about the potential for higher costs to consumers, and environmental impacts. The feedback also highlighted the need for strong community and iwi engagement. Respondents emphasised the importance of transparent processes, fair cost distribution, and considering non-network alternatives. There was also support for using existing infrastructure where possible and ensuring that any additional costs do not fall on local consumers, particularly given the high levels of energy poverty in the region. Overall, the feedback highlighted a strong interest in the project but underscored the need for careful planning and collaboration.

The current regulatory settings for the allocation of costs to load customers, especially in the context of investing in new lines and infrastructure in advance of committed generation coming forward, led us to delay the next stages of the REZ. This has allowed us time to work with regulators and policy makers to explore potential solutions.

Following that foundational work, we are clear on what the key upgrades are that can form an Energy Bridge, enabling new generation to connect and be moved around and out of Northland. The Energy Bridge work also includes considering options with government agencies to get investment underway, unlocking the potential of a new energy future for Northland, including exploring what funding models might be possible.

Detail about the existing electricity infrastructure

220 kV interconnection Auckland / Northland

The existing 220 kV grid backbone interconnection lines from Auckland to Marsden, which form part of the transmission backbone, are underutilised.

110 kV between Bream Bay and Maungatapere

The existing grid can accommodate up to 270 MW of generation at Maungatapere 110 kV with no generation added on the 220 kV. Adding generation to the 220 kV will reduce the capacity to connect generation on the 110 kV.

110 kV and 50 kV Northland / Far North

The western region of Northpower's distribution network from Dargaville to Maungatapere is fully committed to planned projects. However, the area has significant potential for further wind and solar generation.

Transpower's line from Maungatapere to Kaikohe is fully committed in terms of available n-1 capacity. A generation runback scheme could unlock more generation within Top Energy's network (adding around 60 MW more capacity). This is currently in our investigation pipeline.

Top Energy's network from Kaikohe to Kaitaia is fully committed.

[1] N-1 transmission is a standard used in power systems to ensure reliability. It means that the power grid should be able to handle the failure of any single component, such as a transmission line, transformer, or generator, without causing a widespread power outage. In simpler terms, if one part of the system fails, the rest of the system should still function properly to prevent blackouts. This helps maintain a stable and reliable electricity supply even when unexpected issues occur.

[2] The Transmission Pricing Methodology (TPM) details how Transpower must allocate and recover costs from connected parties. The TPM is a regulatory process set by the Electricity Authority which Transpower must follow.

Detail about the potential major projects

The potential projects listed below are the key infrastructure upgrade projects that form the Energy Bridge. These upgrades will support new load growth and provide capacity to both import electricity and to move bulk electricity south.

While all these projects are technically feasible, there are opportunities and challenges associated with each. These are highlighted here to support discussions on options to move these projects forward, including alternative funding and cost recovery arrangements.

Project	Network	Opportunities	Considerations	Potential Solution
Increase capacity between Maungatapere and Dargaville – upgrade to 110 kV	**Distribution**	Unlocks new wind and solar generation in the Dargaville area	First mover disadvantage[1]	Alternative frameworks for initial investment, including possible centralised funding – similar to the ultra fast broadband. These are being explored under the Energy Bridge concept
Increase capacity between Kaikohe and Kaitaia by building an additional line	**Distribution**	Unlocks new generation in the far north while providing additional resilience	First mover disadvantage[1]	As above
Increase 110 kV capacity between Maungatapere and Kaikohe	**Transmission**	Unlocks new wind, solar and geothermal generation in Top Energy's network	Pricing allocations[2]	
Upgrade the low capacity 110 kV Henderson-Maungatapere line	**Transmission**	Provides resilience to the Northland region Unlocks new generation in the Northland regional 110 kV network	Pricing allocations[2]	
Upgrade the low capacity 220 kV circuit from Huapai	**Transmission**	Providing more capacity to export generation on the 220 kV network towards Auckland	Pricing allocations[2]	
Regional special protection scheme (SPS)	**Transmission**	A SPS monitoring the post contingent overload on 110 kV circuits between HEN and MPE. If the circuits are overloaded, the SPS automatically ramps up injection from grid level storage sources and/or reduced load. This could minimise the amount of time that pre-contingent operational splits would be required, reducing risk of total loss of supply to the region	Would require multi company agreement and protection coordination This does not guarantee security of supply to all loads in the region following a loss of both 220 kV circuits from Huapai	Staged partial SPS could be adopted if agreement from all parties not possible
Far North Runback Scheme		Special protection runback scheme unlocks up to 60 MW of additional capacity to connect generation in the far north		Engineering investigation is currently underway which may lead to implementation if viable

[1] The first mover disadvantage happens when the first customer to connect at a particular location pays all the costs for a large asset and risks carrying the cost of that asset if no other customers follow, or for several years until other customers connect to that asset. While the Transmission Pricing Methodology (TPM) has a mechanism to address this, the issue may not be addressed for distribution projects. As a result, new generation developments will generally connect where there are both existing assets nearby, and where there is plenty of existing capacity, to minimise the cost of a new connection and the risk of first mover disadvantage.

[2] The Transmission Pricing Methodology (TPM) details how Transpower must allocate and recover costs from connected parties. The TPM is a regulatory process set by the Electricity Authority which Transpower must follow.

Next steps and how to create a plan for Northland's electricity future with us

Top Energy, Northpower and Transpower will continue to engage with stakeholders in the region to talk through what the opportunities and challenges for electricity infrastructure mean, and how these options could support new renewable generation and load growth in the region.

To register your interest in being part of these discussions please email us at: **feedback@transpower.co.nz.**

Please also share this document with others you know who may have an interest.

We would like to hear from you to understand:

a. Your goals and aspirations for Northland and how electricity could support them

b. Your views on the options we have identified and how they align with or may affect your decision-making on investments, and

c. Any further plans we are not aware of that would increase electricity demand or increase electricity generation in the region.

Later in 2025, we will publish an electricity development plan for Te Tai Tokerau Northland that incorporates the views of community, iwi, government, regulatory and industry stakeholders.

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