Bay of Plenty

Spare Capacity and Load Characteristics Report

EECA

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Document History & Status

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Revision	Details
A	Draft for client review/comment
B	Update with EECA load sites
C	Updated to include Transpower, Powerco and Unison feedback
D	Updated to include WMA feedback

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1. Executive Summary

Transpower maintains/manages the transmission network in New Zealand and supplies the Bay of Plenty region (as described in this report) via ten GXP's (three supplying Horizon Energy's network, four supplying the Tauranga and Mount Maunganui areas of Powerco's Eastern network, and three supplying Unison's Rotorua region).

The three Electrical Distribution Businesses (EDBs), Horizon, Powerco, and Unison then take supply from Transpower and distribute the electricity to end customers in the various regions. In this region, some large customers take supply directly from Transpower.

The Energy Efficiency & Conservation Authority (EECA) is running a flagship program that is called Regional Energy Transition Accelerator (RETA)[1]. The program is targeted at large energy-using businesses and public sector organisations that are committed to reducing carbon emissions, and seeks to identify the barriers involved and opportunities available.

As part of the ETA program, EECA has developed a set of Load Sites for the Bay of Plenty region. The Load Sites involve existing consumers/plant that use fossil fuel, and which could potentially be converted to using electricity, resulting in an overall lower carbon footprint.

EECA contracted Ergo to determine the following for the Bay of Plenty region:

- The current supply demand characteristics (peak & average supply and seasonality information) at the major electrical substations.
- The (N) and (N-1) capacity available for each grid exit point and substations.
- A capital cost estimate to supply electricity to each of the Load Sites.

The purpose of the Load Site cost analysis is to provide options for investment that will provide significant reduction in the use of fossil fuels.

1.1 Network Spare Capacity

The following Figure 1 illustrates the (N) and (N-1) spare capacity at the Transpower GXP substations in the Bay of Plenty region. This figure is based on historical maximum loadings and the Transpower planning report 2022 and does not incorporate any future load growth. It is important to note that these spare capacities also do not include any voltage constraints or upstream transmission constraints (which would have to be confirmed by Transpower or the relevant EDB) As such, it is highly likely that those constraints would prevent all the spare capacity shown below being utilised.

Bay of Plenty: GXP Substations: Spare (N) and (N-1) Capacity

[1] https://www.eeca.govt.nz/co-funding-and-support/products/about-reta/

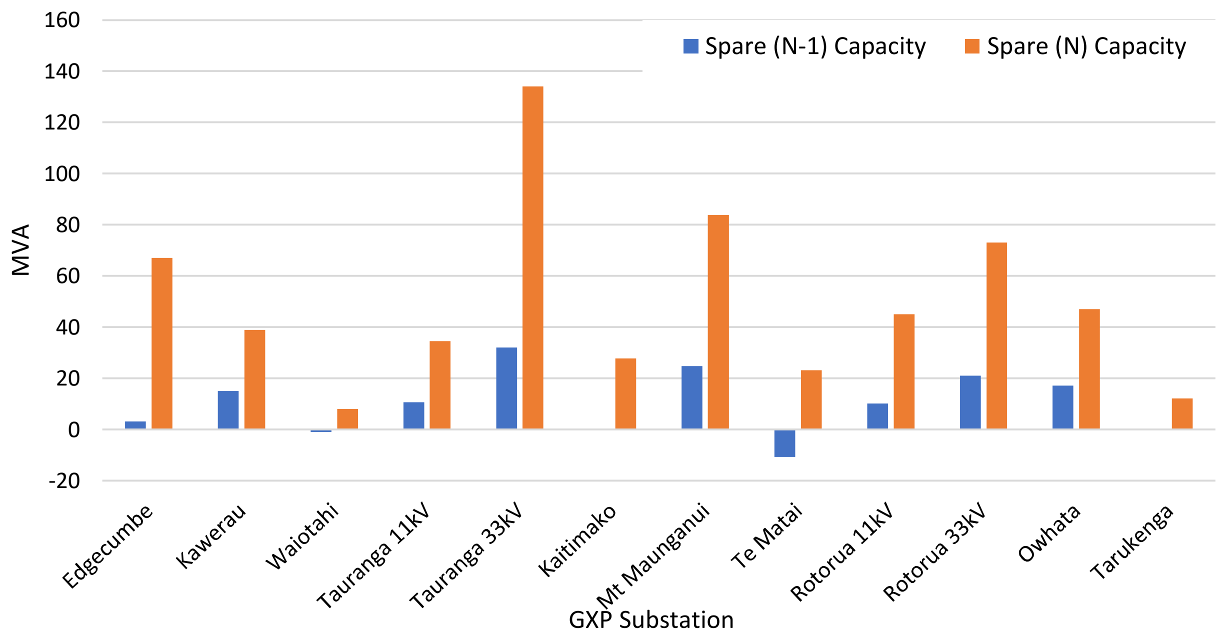


Figure 1 Summary: Approximate N and N-1 spare capacity at GXP substations.

The following Figure 2, Figure 3, Figure 4 illustrate the (N) and (N-1) spare capacity at the three EDB's (Horizon Energy, Powerco, and Unison respectively) zone substations in the Bay of Plenty region. These figures are based on the maximum loadings and the EDB 2023 disclosures. Negative numbers for (N-1) capacity indicate zone substations where the load has exceeded the (N-1) capacity in the past.

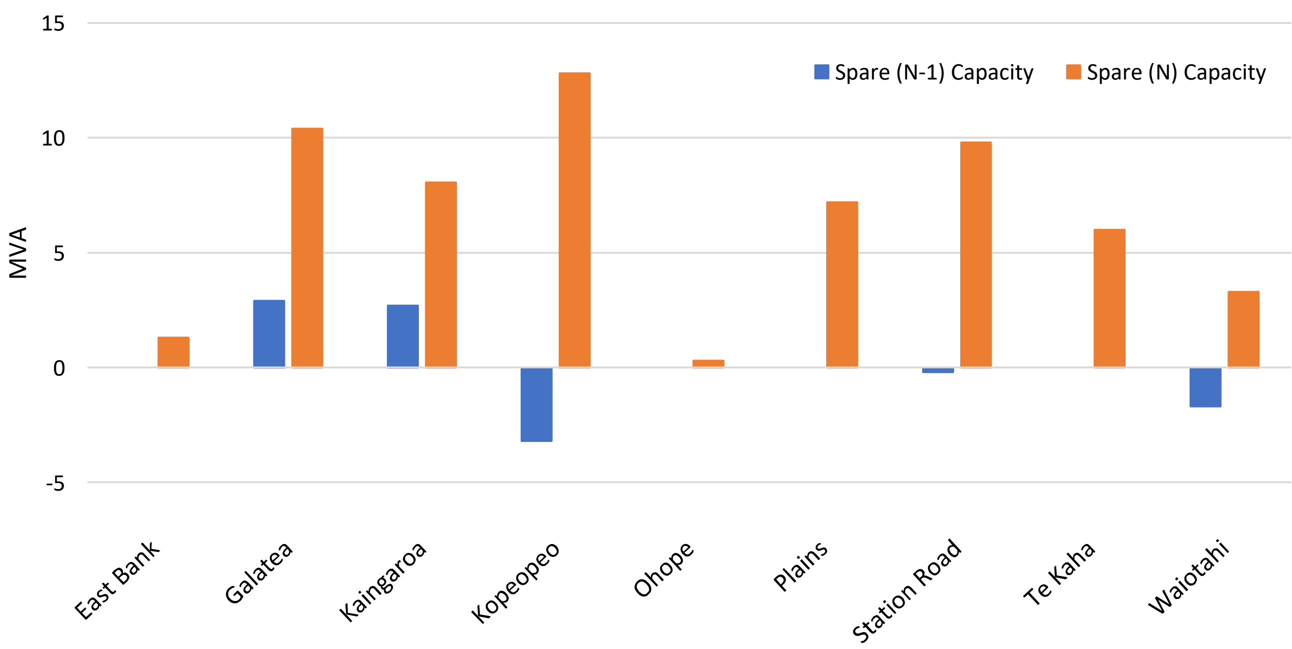


Figure 2. Summary: Approximate (N) and (N-1) spare capacity at Horizon Energy's zone substations.

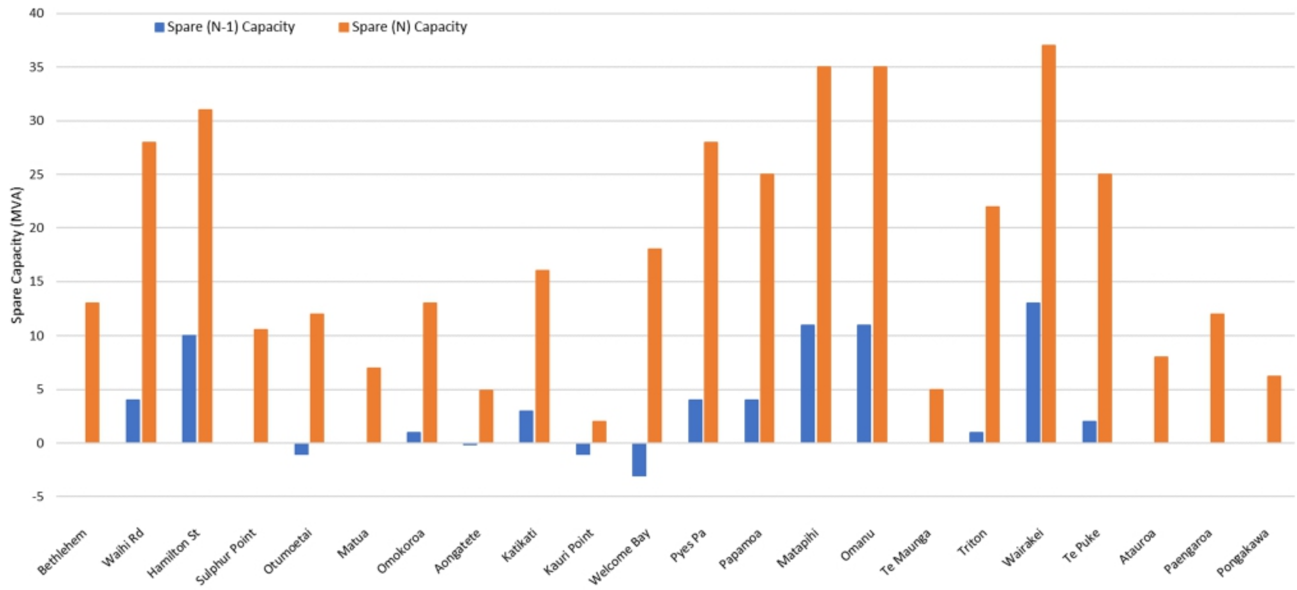


Figure 3 Summary: Approximate (N) and (N-1) spare capacity at Powerco's zone substations

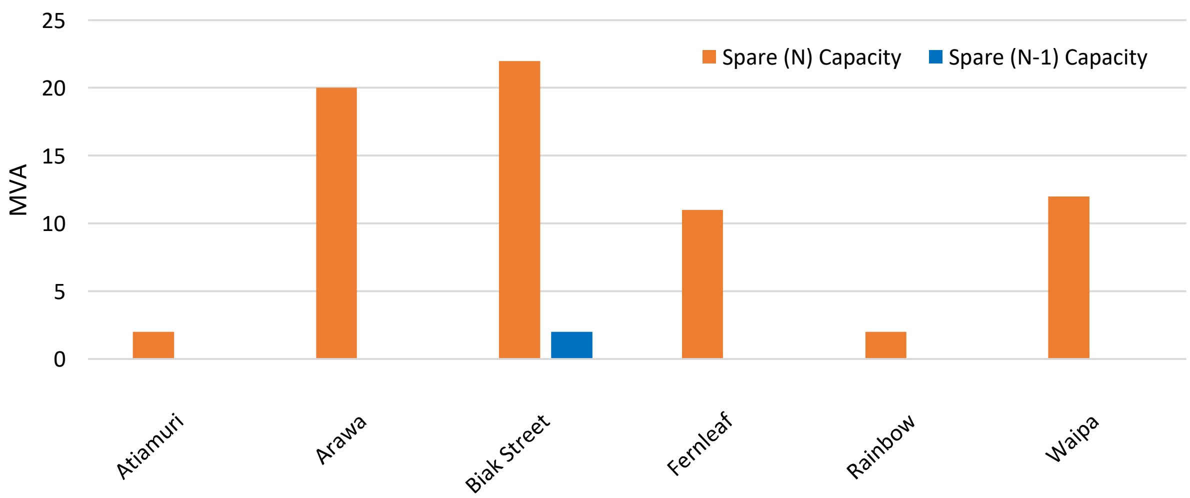


Figure 4. Summary: Approximate (N) and (N-1) spare capacity at Unison's zone substations.

1.2 Load Characteristics

The substation load characteristics are documented in detail in the main body of the report (and the supplementary document 23019-RPT-005) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Edgecumbe GXP* – – Mix of residential, commercial, and industrial loads. Winter peaking, and appears to have intermittent generation supporting the load.
- *Kawerau GXP* – Mix of residential, commercial, and industrial loads. Winter peaking with a traditional daily morning and evening peak.
- *Waiotahe GXP* – Mix of residential and commercial. Winter peaking with a traditional daily morning and evening peak.
- *Tauranga GXP* – Tauranga is a rapidly developing coastal region, with horticultural industries, a port, and a large regional centre at Tauranga. Mix of residential, commercial, port, and light industrial loads. The Tauranga 11 kV is winter peaking with a traditional daily morning and evening peak. Summer daily profiles are almost flat. The Tauranga 33 kV supply has a fairly typical load profile with no marked seasonal difference. It is influenced by the tendency of the Kaimai generation to offset peak load.
- *Kaitemako GXP* – Pyes Pā and Welcome Bay zone substations supply the major subdivisions in these areas. The Pyes Pā substation has offloaded Tauranga GXP supplying the large industrial and residential developments in this area. Winter peaking with a traditional daily morning and evening peak.
- *Mount Maunganui GXP* – The Mt Maunganui area covers the urban parts of Mt Maunganui, the developing area of Papamoa, and the Wairakei coastal strip. Mix of residential, rural, commercial and industrial loads. Winter peaking with a relatively flat daytime load profile.
- *Te Matai GXP* – Mix of residential, rural and lifestyle block loads in and around Te Puke. Winter peaking with a traditional daily morning and evening peak especially in winter. Peaks are less pronounced in summer and the load is approximately 50% of the winter load.
- *Rotorua GXP* – Mix of residential and commercial load since it supplies most of the Rotorua township and central business district. Winter peaking with a traditional daily morning and evening peak especially in winter for the Rotorua 11 kV GXP. The 33 kV GXP load is also winter peaking but has a flat daily profile.
- *Ōwhata GXP* – Mainly residential load with some industrial load. Winter peaking with a traditional daily morning and evening peak especially in winter. Evening peaks are less pronounced in summer and approximately 60% lower than in winter.
- *Tarukenga GXP* – Mix of residential and rural lifestyle block loads. Winter peaking with a traditional daily morning and evening peak especially in winter. Evening peaks are less pronounced in summer and approximately 50% lower than in winter.

Zone Substations:

- The load characteristics of the zone substations vary widely depending on the connected consumers/generators.

1.3 EECA Load Sites

The following table shows EECA's Load Sites together with:

- The peak electrical power requirements of the Load Site.
- The distribution zone substation to which the Load Site would connect.
- The transmission substation/GXP which supplies the relevant zone substation.
- Ergo's estimate of the capital cost to increase the capacity of the relevant transmission assets (lines and substations).
- Ergo's estimate of the capital cost to install the necessary distribution assets to supply the Load Site.
- The cost efficiency associated with the Load Site in terms of $M/MW.
- The 'complexity of connection' based on the level of upgrades required.

The costs are preliminary and Ergo is of the view that they have an accuracy of Class 5[2], which is only suitable for concept screening. (Refer to the assumptions outlined in Section 8.2 for more details)

Summary: Load Sites vs transmission/distribution capital cost estimates

Table 1 Summary of Load Sites and estimated capital costs

No.	Load Site Name	Load (MW)	Transmission Details		Distribution		TOTAL	Cost Efficiency ($M/MW)	Complexity of Connection	Refer to notes
			GXP/Transmission Substation	Upgrade Costs ($M)	Zone Substation	Upgrade Costs ($M)	Upgrade Costs ($M)			
1	Fonterra, Edgecumbe (N-1) Security Option Total Cost	28.55	Edgecumbe	$4.75	East Bank	$15.40	$20.15	$0.71	Major	1
2	Whakatane Growers, Whakatane (N) Security Supply	2.32	Edgecumbe	$0.00	Station Road	$0.25	$0.25	$0.11	Minor	1
3	Ministry of Health, Whakatane Hospital	0.59	Edgecumbe	$0.00	Kopeopeo	$0.00	$0.00	$0.00	Minor	1
4	Whakatane Mill (N-1) Security Supply	35.00	Edgecumbe	$14.00	N/A	$6.20	$20.20	$0.58	Major	1
4	Dominion Salt, Mt. Maunganui (N-1) Security Supply	10.25	Mt Maunganui	$0.50	Triton	$19.06	$19.56	$1.91	Moderate	1
5	Bakels Edible Oils, Mt. Maunganui	2.61	Mt Maunganui	$0.00	Omanu	$1.30	$1.30	$0.50	Moderate	1
6	Lawter, Tauranga	2.23	Mt Maunganui	$0.00	Triton	$0.70	$0.70	$0.31	Moderate	1
7	Fulton Hogan, Mt Maunganui	1.77	Mt Maunganui	$0.00	Omanu	$0.46	$0.46	$0.26	Moderate	1
8	Ingham, Mt Maunganui	1.02	Mt Maunganui	$0.00	Triton	$0.00	$0.00	$0.00	Minor	1
9	Downer, Mount Maunganui	0.72	Mt Maunganui	$0.00	Omanu	$0.00	$0.00	$0.00	Minor	1
10	Ballance Agri-Nutrients Ltd, Mt. Maunganui	0.44	Mt Maunganui	$0.00	Triton	$0.00	$0.00	$0.00	Minor	1
11	Fonterra, Reporoa (N) Security Supply	16.80	Rotorua	$0.00	Fernleaf	$18.19	$18.19	$1.08	Major	1
12	Alsco, Rotorua (N) Security Supply	2.16	Rotorua	$0.00	Biak Street	$2.45	$2.45	$1.13	Moderate	1
13	Ministry of Health, Rotorua Hospital	0.10	Rotorua	$0.00	Biak Street	$0.00	$0.00	$0.00	Minor	1
14	Ministry of Education, Malfroy School	0.30	Rotorua	$0.00	Rotorua	$0.00	$0.00	$0.00	Minor	1
15	Pure Bottling	0.75	Tauranga	$0.00	Tauranga	$0.00	$0.00	$0.00	Minor	1
16	Winstone Wallboards GIB, Tauranga (Overall Cost)	49.38	Tauranga	$70.00	New sub	$33.00	$103.00	$2.09	Major	1,2
17	Ministry of Health, Tauranga Hospital	1.18	Tauranga	$0.00	Waihi Rd	$0.82	$0.82	$0.70	Moderate	1
18	Mt. Eliza Cheese, Tauranga	0.67	Tauranga	$0.00	Aongatete	$0.00	$0.00	$0.00	Minor	1
19	Ministry of Education, Tauranga Boys' College	0.42	Tauranga	$0.00	Waihi Rd	$0.00	$0.00	$0.00	Minor	1
20	Ministry of Education, Otumoetai College	0.30	Tauranga	$0.00	Otumoetai	$0.00	$0.00	$0.00	Minor	1
21	Ministry of Education, Tauranga Girls' College	0.17	Tauranga	$0.00	Waihi Rd	$0.00	$0.00	$0.00	Minor	1
22	AFFCO, Rangiuru	2.51	Te Matai	$4.00	Rangiuru (Future Sub)	$12.60	$16.60	$6.60	Major	1,2,3
23	Ministry of Education, Opotiki College	0.30	Waiotahe	$0.00	Opotiki	$0.00	$0.00	$0.00	Minor	1
	TOTAL =>	160.5	TOTAL =>	$93.3	TOTAL =>	$110.43	$203.68			

Notes

1 Doesn't include distribution transformer or switchgear costs for Load Sites (details provided in body of report). Estimated between $50k - $350k depending on size.

2 Transmission upgrade cost obtained from Transpower 2022 TPR. No indication is given around how this cost may be distributed.

3 Includes cost of new Powerco substation. No indication of how this cost is to be distributed has been provided.

2 Cost Estimate Classification System - As Applied in Engineering, Procurement, and Construction for the Process Industries, AACE International Recommended Practice No. 18R-97.

Disclaimer: The Load Site supply investigations and capital cost estimates outlined in this report are preliminary and are only suitable for screening purposes. The capital cost estimates should not be used for final budgeting purposes in order to connect the respective Load Sites.

2. Introduction

The consumers in the Bay of Plenty region are supplied with electricity via electrical networks that are owned by the following EDBs:

- Horizon Networks (Horizon) – 8 zone substations
- Powerco Ltd (Tauranga and Mt Manganui areas only) - 22 zone substations, and
- Unison Networks Ltd (Rotorua area only) - 5 zone substations

The franchise areas of the EDBs are shown in Figure 5 for the three EDBs respectively.

The Energy Efficiency & Conservation Authority (EECA) is running a flagship program that is called Regional Energy Transition Accelerator (RETA)[3]. The program is targeted at large energy-using businesses and public sector organisations that are committed to reducing carbon emissions, and seeks to identify the barriers involved and opportunities available.

As part of the ETA program, EECA contracted Ergo to determine the existing spare supply capacity and the load characteristics at the major electrical substations within the Bay of Plenty region.

Ergo previously developed similar reports for Southland, South Canterbury, West Coast, North Canterbury, and more regions.

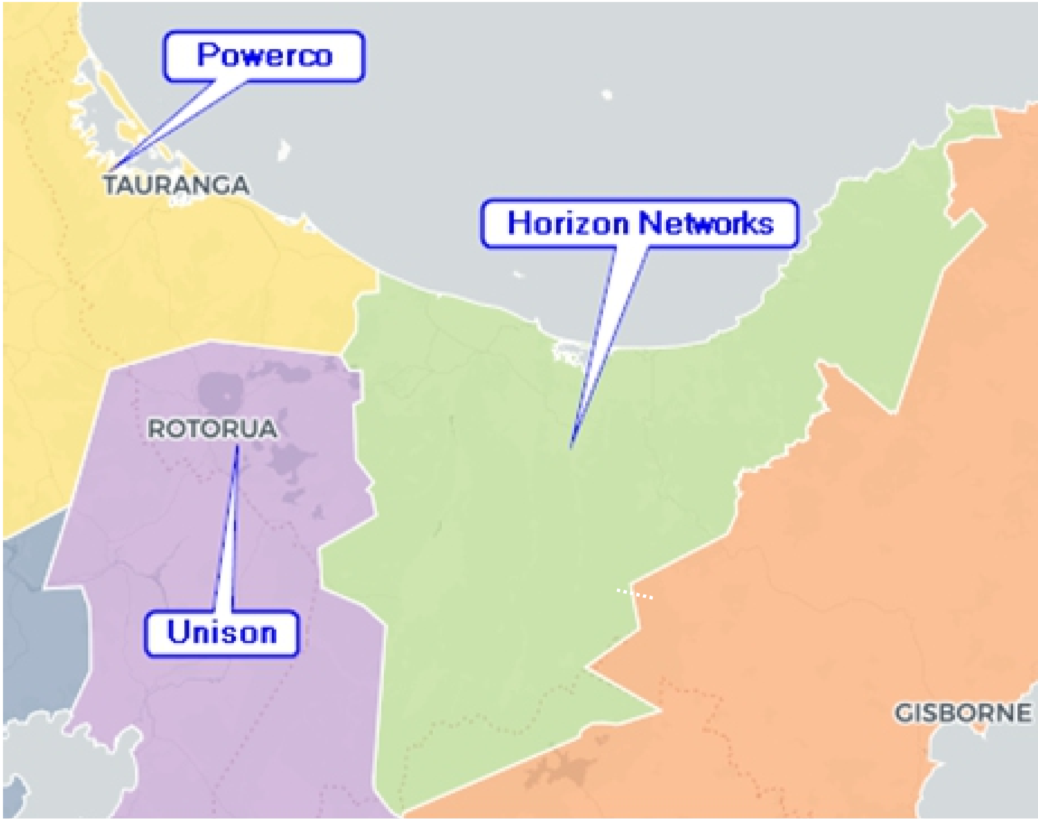


Figure 5 EDB franchise areas[4]

[3] https://www.eeca.govt.nz/co-funding-and-support/products/about-reta/

[4] https://www.ena.org.nz/lines-company-map/

3. Scope of Work

The scope requested of Ergo was to assess the existing capacity (both (N) and (N-1) security) and supply characteristics (peak and average supply and seasonality information) for the major electrical infrastructure in the Bay of Plenty region. This included reviewing both the GXP's and local distribution zone substations along with their associated lines/cables within the Bay of Plenty region.

Ergo's assessments and analysis were based on the following information sources:

- Transpower's Transmission Planning Report 2022.
- Horizon Networks' 2023 regulatory information disclosures[5] and Asset Management Plan (AMP).
- Powerco's 2023 regulatory information disclosures[9] and AMP.
- Unison's 2023 regulatory information disclosures[9] and AMP.
- SCADA substation loading data provided by Horizon, Powerco, and Unison.
- GXP metering data extracted from the Electricity Authority's website[6].
- Network diagrams provided by Horizon, Powerco, and Unison.
- Geographic Information System (GIS) asset and location data provided by Horizon, Powerco, and Unison. This was mostly supplied in the form of *.kmz files.

[5] These disclosures are the schedules included in the Asset Management Plan.

[6] https://www.emi.ea.govt.nz/Wholesale/Datasets

4. Bay of Plenty Network

The following sections describe (at a high level), the locations of the relevant substations and lines. For the purposes of this document the franchise areas defined above and supplied by Horizon, Powerco, and Unison are referred to as the Bay of Plenty region.

4.1 Transmission/GXP Substations

The following Figure 6 illustrates the relevant transmission substations (GXPs) within the Bay of Plenty region, which include the following:

- Horizon Networks:
  - Edgecumbe GXP.
  - Kawerau GXP(Horizon)[7].
  - Waiotahe GXP.
- Powerco:
  - Tauranga GXP.
  - Kaitemako GXP.
  - Mt Maunganui GXP.
  - Te Matai GXP
- Unison:
  - Rotorua GXP
  - Ōwhata GXP
  - Tarukenga GXP

The transmission network in the Bay of Plenty region is also shown schematically in Figure 7. As generation capacity in the Bay of Plenty region is lower than its maximum demand, the deficit is imported through the National Grid during peak load conditions. The 220 kV Ātiamuri–Whakamaru and Ohakuri–Wairakei circuits connect the region to the rest of the National Grid. The Bay of Plenty load is predominantly supplied through these two circuits, and the region will be on N security whenever one of these circuits is out of service.

The transmission network in the Bay of Plenty region comprises high capacity 220 kV and low capacity 110 kV circuits, with interconnecting transformers located at Tarukenga, Kaitemako, Edgecumbe and Kawerau. In normal operation the interconnecting transformer at Edgecumbe is open on the 110 kV side.

[7] Kawerau is a large GXP that supplies Horizon as well as other customers including large scale generators. For the purposes of this report, the Kawerau GXP specifically refers to the Kawerau (Horizon) part of the GXP.

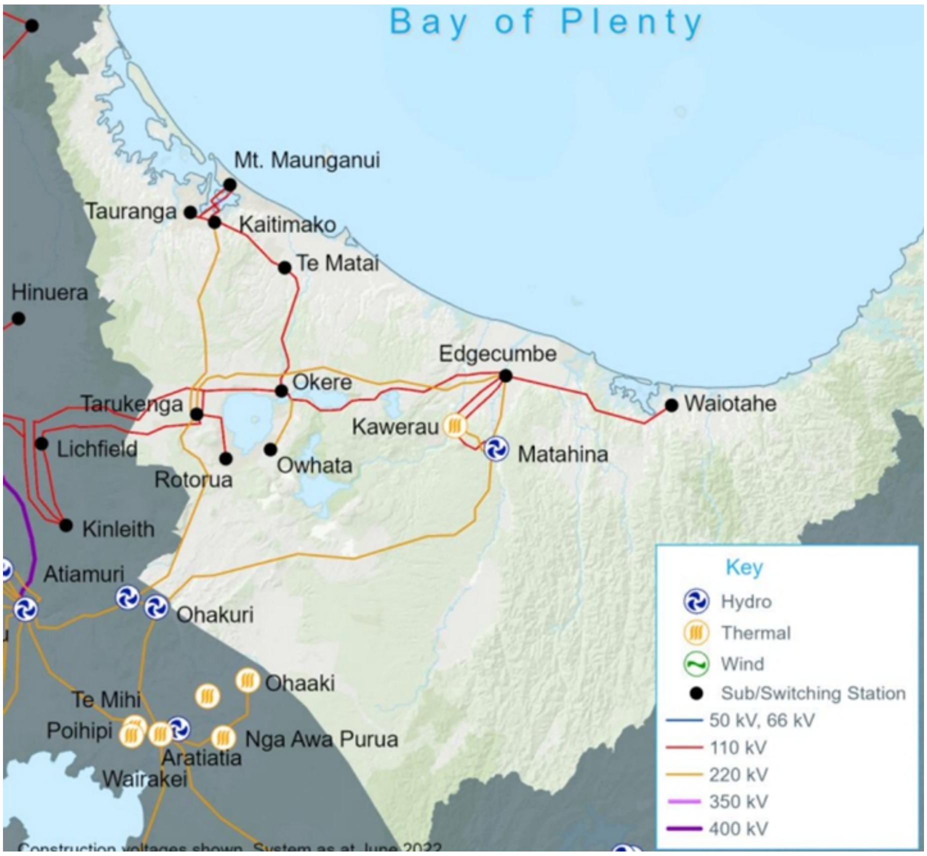


Figure 6 Transmission/GXP substations[8]

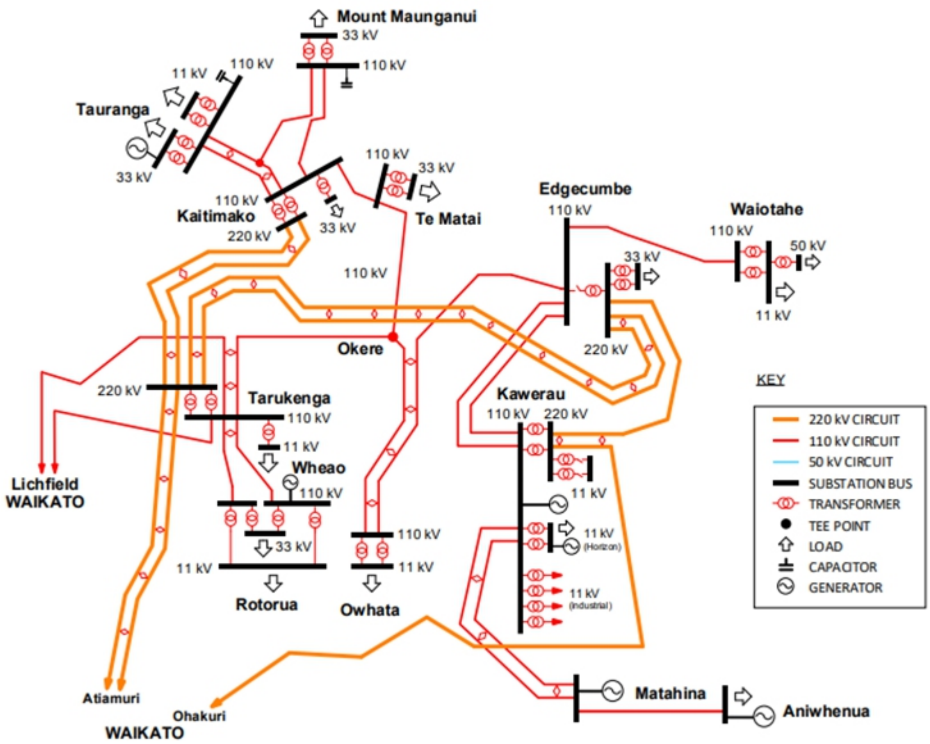


Figure 7 Existing transmission/GXP substations[7]

[8] *Transmission Planning Report 2022*.

4.2 Zone Substations

Zone substations are categorised by the EDB that owns and operates the network. As mentioned earlier, in the Bay of Plenty area, there are three relevant EDB's – Horizon Networks, Powerco, and Unison. Table 2 below gives an overview of the number of zone substations managed by each EDB, and the number of Transpower GXPs they take power from.

Table 2 Overview of substation numbers for each EDB under review.

EDB Name	Number of zone substations	Number of GXPs
Horizon	8	3
Powerco (Tauranga & Mt Maunganui areas)	22	4
Unison (Rotorua area)	5	3[9]

4.2.1 Horizon Networks

The following Figure 8 shows the GXPs and zone substations on Horizon's network. The zone substations include:

- East Bank Road 33/11kV zone substation
- Galatea 33/11kV zone substation
- Kaingaroa 33/11kV zone substation[10]
- Kopeopeo 33/11kV zone substation
- Ōhope 33/11kV zone substation
- Plains 33/11kV zone substation
- Station Road 33/11kV zone substation
- Te Kaha 50/11kV zone substation

[9] The Rotorua GXP is split between the 11 kV and 33 kV supplies.

[10] Galatea and Kaingaroa ZSSs are supplied from the Pioneer owned Aniwhenua switchyard, with a long 33kV feeder backup from the Edgecumbe GXP

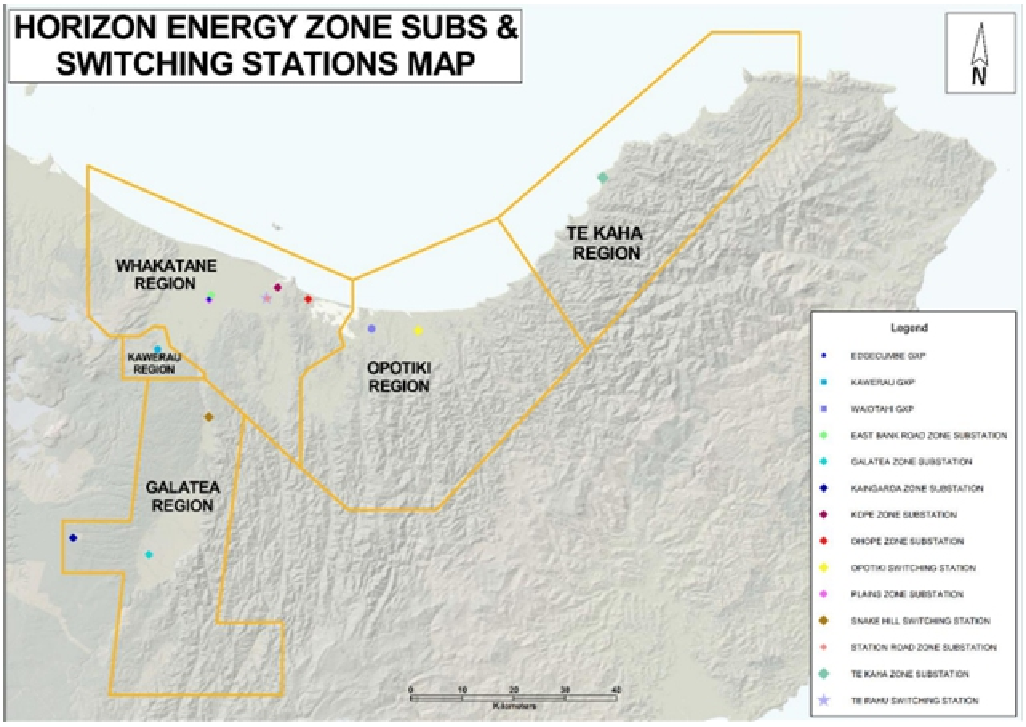


Figure 8 Horizon Energy: Northern Zone Substation Geospatial Sub-transmission and Distribution Diagram[11]

4.2.2 Powerco

The following Figure 9 and Figure 10 show the subtransmission networks, zone substations, and GXPs for Powerco's Tauranga and Mt Maunganui regions respectively. The substations include:

- Tauranga GXP:
  - Bethlehem 33/11kV zone substation
  - Tauranga 11 kV & Tauranga 33 kV[12]
  - Waihi Road 33/11kV zone substation
  - Hamilton Street 33/11kV zone substation
  - Sulphur Point 33/11kV zone substation
  - Otūmoetai 33/11kV zone substation
  - Matua 33/11kV zone substation
  - Ōmokoroa 33/11kV zone substation
  - Aongatete 33/11kV zone substation
  - Katikati 33/11kV zone substation
  - Kauri Point 33/11kV zone substation
- Kaitemako GXP:
  - Welcome Bay 33/11kV zone substation
  - Pyes Pa 33/11kV zone substation
- Mt Maunganui GXP:
  - Papamoa 33/11kV zone substation
  - Matapihi 33/11kV zone substation

[11] Horizon's 2023 Asset Management Plan can be found here: https://www.horizonnetworks.nz/information-disclosure-regulation

[12] This substation belongs to Transpower and is covered in the GXP sections of this report.

- Omanu 33/11kV zone substation
- Te Maunga 33/11kV zone substation
- Triton 33/11 kV zone substation
- Te Matai GXP:
  - Wairakei 33/11kV zone substation
  - Te Puke 33/11kV zone substation
  - Atauroa Avenue 33/11kV zone substation
  - Paengaroa 33/11kV zone substation
  - Pongakawa 33/11kV zone substation

	
Figure 9 Powerco's Tauranga region zone substations and interconnecting subtransmission circuits [13]	Figure 10 Powerco's Mt Maunganui region zone substations and interconnecting subtransmission circuits [13]

[13] Powerco's 2023 Asset Management Plan found here: https://www.powerco.co.nz/who-we-are/disclosures-and-submissions/electricity-disclosures

4.2.3 Unison

The following Figure 11 shows the GXPs and zone substations on Unison's network. The zone substations include:

- Ātiamuri 11 kV supply[14]
- Arawa 33/11kV zone substation
- Biak Street 33/11kV zone substation
- Fernleaf 33/11kV zone substation
- Rainbow 33/11kV zone substation
- Waipa 33/11kV zone substation

Figure 11 Unison: Rotorua sub-transmission network[15]

[14] This is a supply from Mercury's generating station, there is no subtransmission system.
[15] Unison's 2023 Asset Management Plan can be found here: https://www.unison.co.nz/tell-me-about/unison-group/publications-disclosures

5. (N) and (N-1) Security Classifications

Both Transpower and the EDB's develop and operate their networks in accordance with a set of reliability standards. In the context of Transpower it is required to meet the grid reliability standards that are outlined in the *Electricity Industry Participation Code* (EIPC)[16]. In contrast, EDBs are required to publish an annual AMP which often details a network specific security standard, which is used to plan/develop its network.

In both cases, these standards are usually quantified in terms of the following terminology:

- (N) security: The network is designed and operates such that it will be unable to supply load in the event of a single asset failure (i.e., a line, transformer or other primary asset). This is equivalent to a single-engine airplane, which in the event of engine failure will result in the aircraft crashing.
- (N-1) security: The network is designed and operates such that it can continue to supply load uninterrupted in the event of a single asset failure. This scenario can be compared with to an aircraft, but in this case with two engines, which in the event of single engine failure will not crash.

The decision around whether to develop/operate a network supply with (N) or (N-1) security is typically driven by the size and criticality of the load versus the investment costs.

Typically, in New Zealand, this results in the following:

- Transmission GXP substations and lines being designed and operated with (N-1) security of supply.
- Distribution zone substations are designed and operated as follows:
  - Loads ≥ 12MW designed and operated with (N-1) security of supply.
  - Loads < 12MW designed and operate with (N) security of supply.

Transpower is required to provide (N-1) for "core grid" (i.e. 220kV and >150MVA loads) interconnected assets (i.e. transmission lines that supply multiple GXP substations). For "non-core grid" assets (i.e. <220kV and <150MVA loads), the decision to supply (N-1) is still made by Transpower but must be economically justified.

For connection assets that are dedicated to a single consumer the decision regarding security is made by the consumer/customer. The customer can be an industrial consumer, but in most cases is an EDB and usually (N-1) security of supply is specified. However, for GXPs that supply small consumer load or where a large industrial customer does not want to pay for (N-1) security, an N security connection is not uncommon.

The Transpower GXPs discussed in this report are considered connection assets and therefore decisions around their security classifications lie with their end customers (i.e., Horizon, Powerco, or

[16] https://www.ea.govt.nz/code-and-compliance/the-code/

Unison). For those substations that are supplied via dedicated incoming lines, the lines are also considered to be connection assets. The remaining lines that are not dedicated to a single substation are interconnection assets.

The distribution networks owned/operated by EDBs generally supply multiple consumers and thus, in most cases, EDBs have to make security of supply decisions on behalf of their consumers. These decisions are based on the EDB's disclosed network security criteria, that have been ratified by their respective boards of directors.

Both Transpower and EDBs have taken advantage of technology to make the above-mentioned standards more flexible, by managing consumer demand where possible. Initially this involved the use of mains borne ripple injection equipment to manage the load drawn by consumer's hot water cylinders. But more recently this has involved, for example, special protection systems (SPS) that, in the event of the loss of specific network equipment will shed specific consumer loads. More recently, the development of a market for interruptible load[17] has been initiated. There are examples of this at both transmission and distribution levels. This has allowed Transpower and EDB's to operate some sections of their networks well beyond their (N-1) limits, whilst still maintaining sufficient security of supply to the majority of their consumers.

There is potential to significantly reduce the costs associated with electrical network upgrades if load sites can be designed to:

- Operate during times of minimum network loading (typically late in the evening and early in the morning) such that they do not significantly increase existing peak network loading.
- Swiftly and safely disconnect from the relevant electrical network during periods of peak loading.

[17] Demand side participation | Transpower

6. Spare Capacity – Transmission Substations (GXPs)

The following sections document the spare capacity that is available at the GXP's that supply the Bay of Plenty region.

Transpower has identified the following "*grid issues*" that result from increasing electrical demand and generation in the Bay of Plenty region including:

- The Edgecumbe peak load is forecast to exceed the N-1 capacity of T7 from winter 2024 and the N-1 capacity of T4 from winter 2035.
- Peak load at Te Matai is forecast to exceed the (N-1) 110 kV transmission capacity into Te Matai from winter 2025. Peak load at Te Matai GXP first exceeded the (N-1) supply capacity in winter 2019, when only supplied through T1. When only supplied through T2, peak load will exceed the transformer capacity in 2023. T1 also exceeded its continuous rating (when both transformers are in service) in 2019.
- Since 2020, with low generation at Kaimai, the combined peak load of Tauranga 11 kV and 33 kV has exceeded the (N-1) capacity of the two circuits 110 kV Kaitemako-Tauranga circuits. Peak load at Tauranga 33 kV is forecast to exceed the (N-1) capacity of the supply transformers from winter 2024 with low (14 MW) Kaimai generation, and from winter 2031 with maximum (42 MW) generation.
- The (N-1) capacity of the Kaitemako 220/110 kV interconnecting transformers (223/225 MVA summer/winter) may be exceeded from winter 2024/25, and the N capacity of the interconnection (300 MVA) may be exceeded from winter 2026/27. Furthermore, an outage on one of the interconnecting transformers may cause an overload on the Okere-Te Matai 110 kV circuit section.
- The (N-1) capacity of the two Rotorua-Takurenga 110 kV circuits is forecast to be exceeded from winter 2025. If the circuit that has the Wheao generator connected has an outage, then the other circuit is also overloaded due to the loss of generation offset.
- Very high loading on the Kaitemako interconnecting transformers and transmission lines in the Western Bay of Plenty area to cause low voltages/regional voltage collapse during 220kV circuit, interconnecting transformer, or bus outages from around 2030 onwards. Low voltages in the Western Bay of Plenty also expected outside of contingency conditions.

Overall, there are extensive supply capacity issues affecting Tauranga, Kaitemako and Rotorua. These are being addressed by Transpower, in consultation with other stakeholders such as Powerco and Unison. Consultation and development of a plan is underway, as a Major Capex Proposal (MCP)[18].

[18] Western Bay of Plenty Development Plan: Major Capex Proposal long-list consultation | Transpower

Figure 12 below illustrates Transpower's view of a possible 2037 configuration for the Bay of Plenty region's transmission network. It includes:

- Replacement of the 11 kV switchboard at the Waiotahe GXP with a 33 kV switchboard.
- Addition of a 110 kV Kaitemako–Tauranga cable.
- Adding a second 110/33 kV transformer at Kaitemako GXP.
- Install a third 220/110 kV transformer and a third 220 kV bus section at Kaitemako.
- Install 100 MVAr capacitor support in the Western Bay of Plenty area.
- Replace the two Tauranga 110/11 kV transformers with two 33/11 kV transformers.
- Add a third Tauranga 110/33 kV supply transformer and reconfigure the Tauranga 110 kV and 33 kV substation.
- Replace Kawerau–T13 with a 250 MVA transformer.
- Open Edgecumbe–Kawerau 110 kV circuits and replace the Edgecumbe 220/110 kV transformer with higher rated unit.
- Reconductor Kaitemako–Te Matai 110 kV circuit.
- Reconductor Ta Matai-Okere-Tarukenga 110 kV circuit.

While Transpower's MCP (mentioned above) is still under development, the plan is subject to change. At present, Transpower is considering the creation of a new GXP, Tauriko, South of Tauranga, which may alter the plans above.

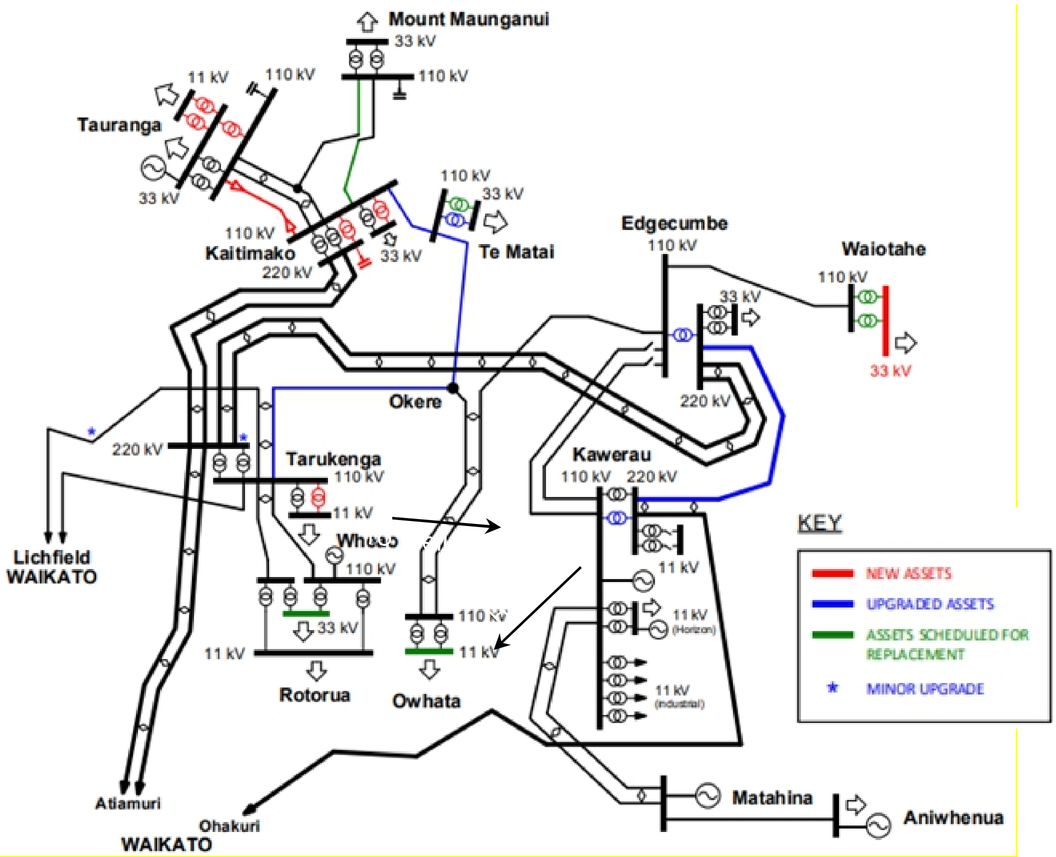


Figure 12 Existing transmission/GXP substations together with future possible upgraded/new assets[7]

6.1 Demand Forecast

The following Table 3 illustrates Transpower's forecast demand at the transmission substations in the Bay of Plenty region from its annual *Transmission Planning Report 2022*[7]. The forecast predicts the demand growing at an average of 3.6% per annum over the next fifteen years which is greater than the national average of 2.1%.

Table 3 Forecast prudent annual peak demand (MW) at Bay of Plenty grid exit points to 2037.

GXP	Power factor	Peak demand (MW)											
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2037
Edgecumbe	0.97	63	64	65	67	68	69	71	72	74	76	78	91
Kawerau	0.88	26	26	27	27	28	28	28	29	29	30	30	32
Waiotahe	0.99	15	16	17	18	18	19	20	21	22	24	25	30
Tauranga 11kV[1]	1.00	27	28	28	29	30	30	31	32	26	26	27	28
Tauranga 33kV[2]	1.00	111	115	119	123	127	130	124	137	140	143	144	146
Kaitemako[1,3]	1.00	48	54	56	60	96	99	103	107	117	120	121	124
Mt Maunganui[4]	0.99	70	72	73	61	63	64	65	66	67	68	69	71
Te Matai[4,5]	1.00	47	55	61	84	90	96	106	111	117	119	120	123
Rotorua 11 kV	1.00	26	27	27	29	30	31	32	32	33	34	35	38
Rotorua 33 kV	0.98	44	46	49	49	50	50	50	50	50	50	51	51
Ōwhata	1.00	13	16	17	18	18	19	19	19	20	20	20	21
Tarukenga 11 kV	1.00	8	8	9	9	9	10	10	10	10	11	11	12

Notes:

1. Load shift of approximately 6 MW from Tauranga 11 kV to Kaitemako in 2030.
2. Load increase expected from the Port of Tauranga – 20 MW between 2022 and 2030.
3. Ongoing demand growth expected in the southern part of Tauranga from residential and commercial developments including Tauriko West and Winstone Wallboards. Transpower discussions with Powerco indicate that a large part of the load increase reported on the Kaitemako grid exit point might instead appear on the Tauranga 33 kV grid exit point.
4. Load shift of Papamoa zone substation load from Mount Maunganui to Te Matai in 2025 (12 MW).
5. Ongoing demand growth expected at Te Matai from residential and commercial developments including cool stores, packing houses, Rangiuru Business Park and Golden Sands Town Centre.

6.1.1 Edgecumbe GXP

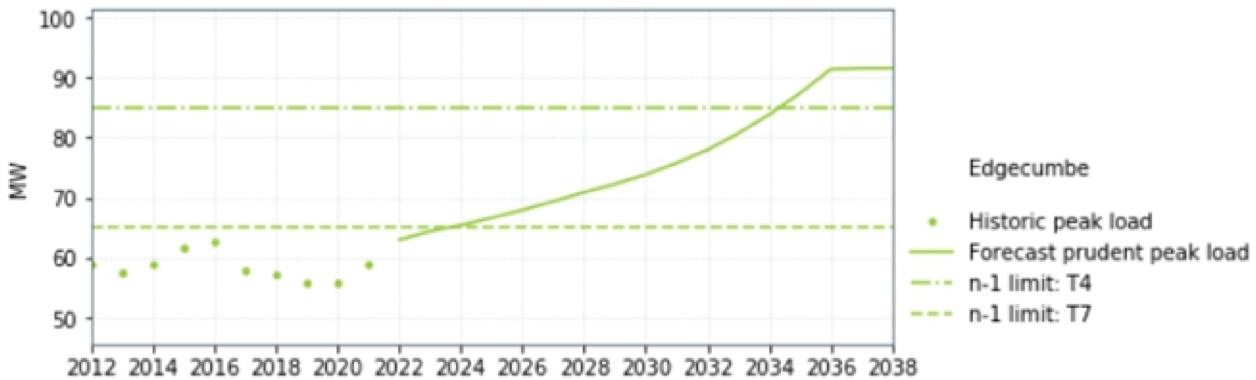
Transpower's demand forecast indicates that the Edgecumbe GXP is expected to have a 2023 peak demand of 64 MW at 0.97pf. This aligns with the historical SCADA data that indicates that, in 2022 the Edgecumbe GXP experienced a peak load of 63 MVA. However, this peak occurred for only one half-hour period at 07H30 on 25 July 2022. Prior peaks were just below 60 MVA.

The Edgecumbe GXP is equipped with two 220/33 kV transformers providing:

- (N) secure capacity of 130 MVA and
- (N-1) capacity of 66/70 MVA (summer/winter).

The Edgecumbe T7 transformer has a planned replacement for 2030-2032, with the replacement likely to match the capacity of the T4 transformer. This replacement will increase the GXP (N-1) capacity, and additionally enable connection of additional solar generation in the area (connecting to the 33 kV network), beyond the presently committed 139 MW.

The peak load is forecast to exceed the (N-1) capacity of T7 from winter 2024 and the (N-1) capacity of T4 from winter 2035. The following graph[19] compares Edgecumbe GXP's supply capacity with the historical loading and Transpower's demand forecast.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

Horizon Networks take supply at 33 kV from the Edgecumbe GXP and supply the Whakatāne region with five-zone substations. This region represents the largest load on Horizon's network, with a mix of urban, rural, heavy industrial, commercial, and dairy loads. Horizon Networks forecast a generic load growth of 0.7% on the Edgecumbe GXP 33 kV supply.

The following Figure 13 illustrates Edgecumbe's 2022 loading in comparison to its substation capacity.

[19] Sourced from Transpower's *Transmission Planning Report 2022*.

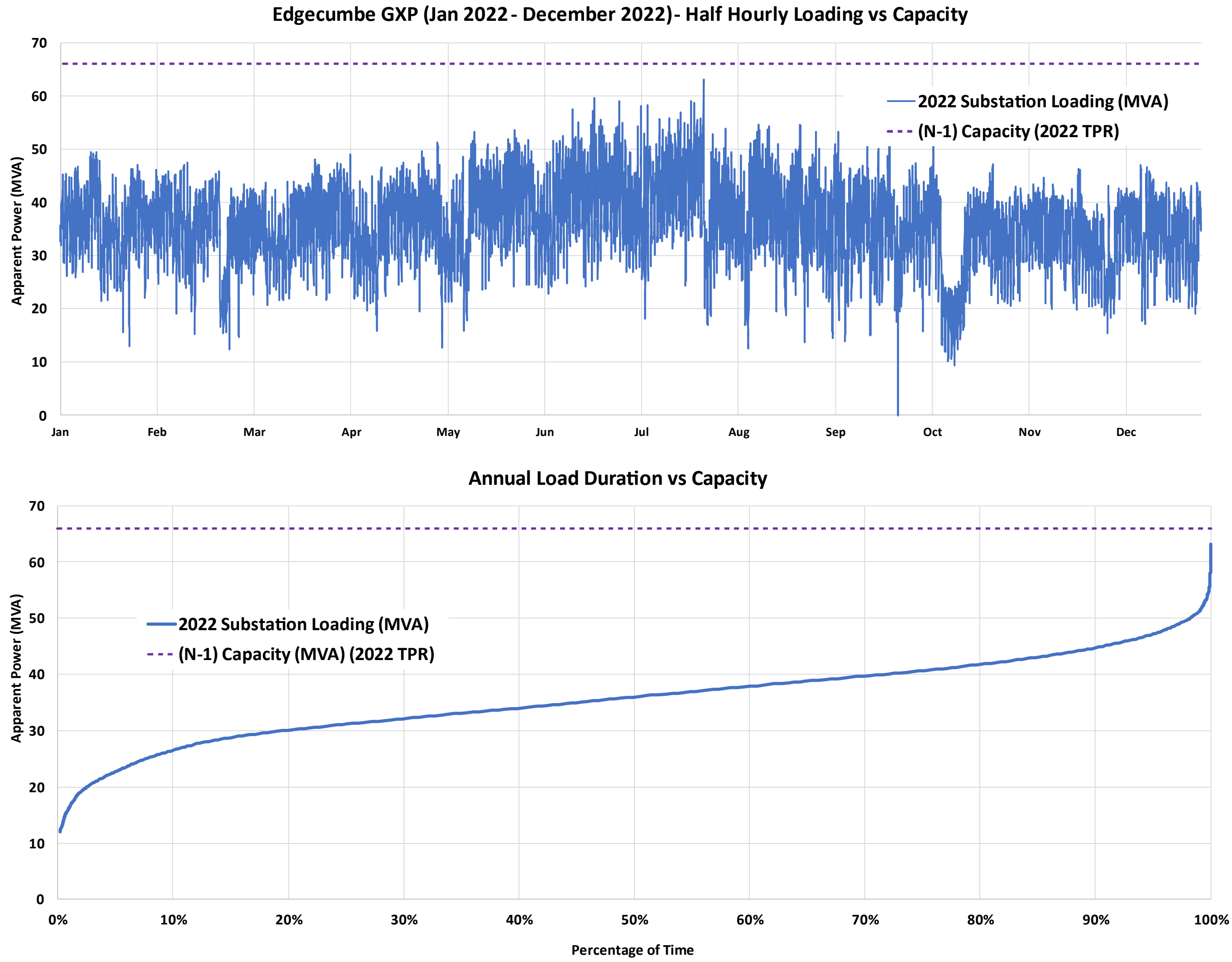


Figure 13 Edgecumbe GXP: 2021 Loading: Substation capacity

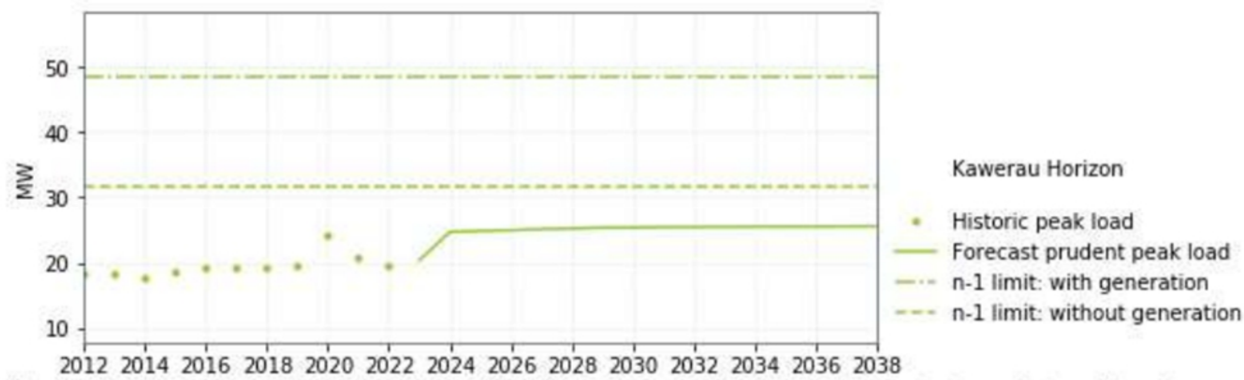
6.1.2 Kawerau GXP

Transpower's demand forecast indicates that the Kawerau GXP is expected to have a 2023 peak demand of 26 MW at 0.88 power factor. This value compares to the historical SCADA data that indicates the 11 kV supply at the Kawerau GXP recorded a peak load of 21.1 MVA during the 2022 year.

Two 110/11 kV transformers supply Horizon's load, providing:

- Total nominal installed capacity of 60 MVA
- (N-1) capacity of 36/36 MVA (summer/winter).

The Te Ahi O Maui geothermal generator is connected within Horizon's 11 kV distribution network. Peak load is forecast to stay within the (N-1) capacity of the supply transformers for the forecast period with Te Ahi O Maui connected. Without this generation, the peak load is forecast to exceed the (N-1) capacity of the supply transformers from winter 2031. As Te Ahi O Maui is base load generator with extremely high availability, it is not considered that there is a supply capacity issue at Kawerau within the forecast period. The following graph[20] compares Kawerau GXP's supply capacity with the historical loading and Transpower's demand forecast.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following Figure 14 illustrates Kawerau GXP 2022 11 kV loading in comparison to its substation capacity as well as the load duration curve in relation to capacity. Note that the load plotted below is gross load, so the net loading on the transformer is low in practice due to the near permanent generation from Te Ahi O Maui. However, in the future Eastland generation may disconnect Te Ahi O Maui from Kawerua 11 kV if the TOPP2 geothermal project goes ahead.

[20] Sourced from Transpower's interim 2023 TPR

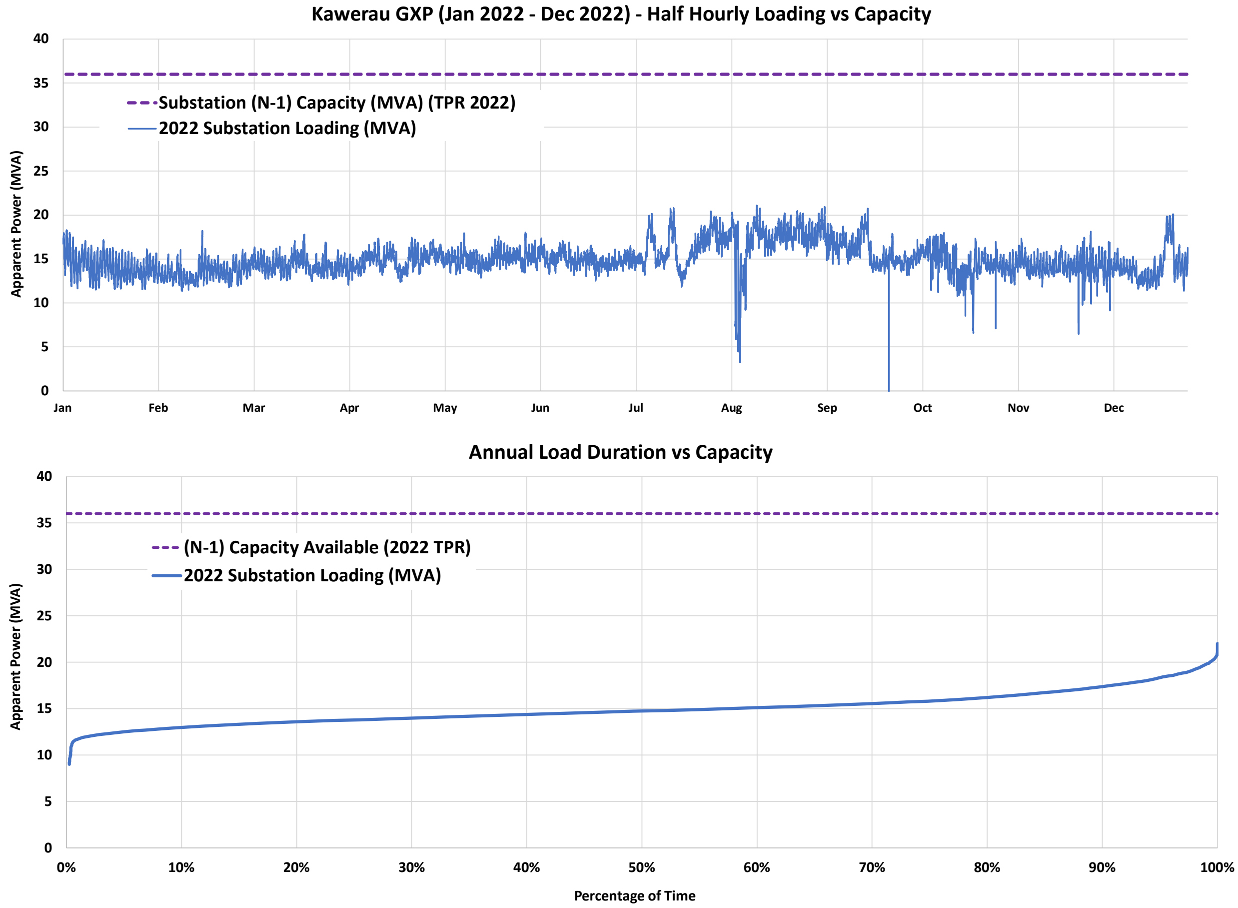


Figure 14 Kawerau GXP: 2022 Loading, capacity, and load duration.

6.1.3 Waiotahe GXP

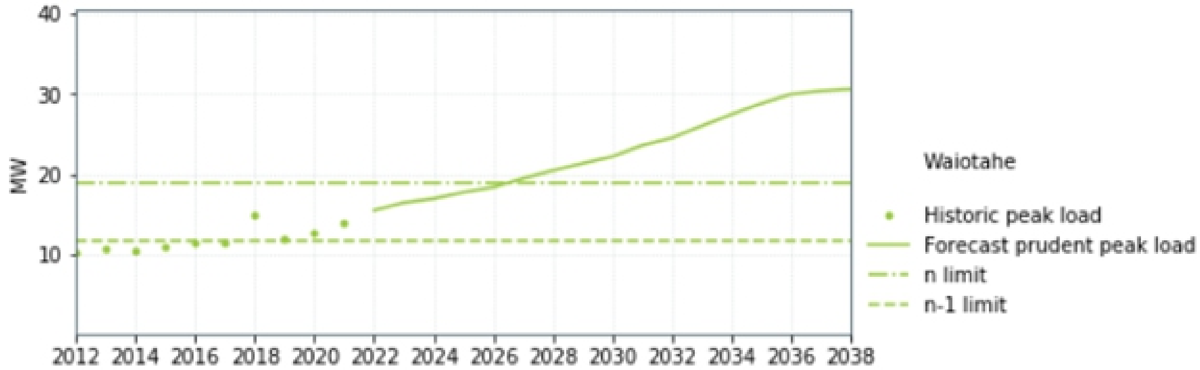
Transpower's demand forecast indicates that the Waiotahe GXP is expected to have a 2023 peak demand of 16 MW at 0.99 power factor. This contrasts with the historical SCADA data that indicates that during 2022 the Waiotahe GXP experienced a peak load of 12.1 MVA.

The Waiotahe load is supplied by:

- Two 110/11 kV supply transformers rated at 75 MVA each, providing:
  - A total nominal installed capacity of 20 MVA.
  - An (N-1) capacity of 11/12 MVA (summer/winter).

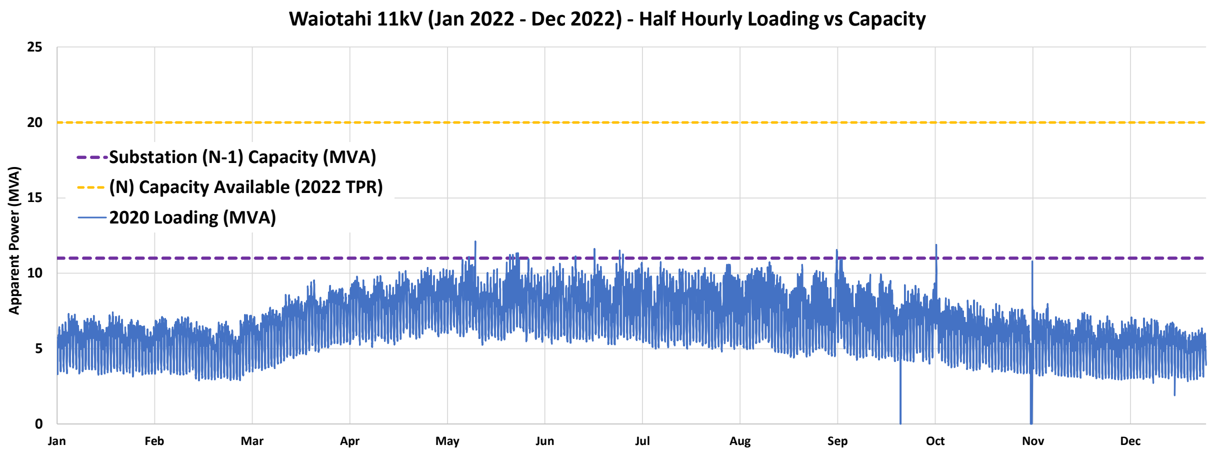
The transformers also supply a 50 kV feeder via an 11/50 kV step-up transformer. The combined 11 kV and 50 kV peak load first exceeded the (N-1) capacity of the 110/11 kV supply transformers in the winter of 2018. Both the 110/11 kV transformers will overload pre-contingency at peak from winter 2027. The following graph[19] compares Waiotahe GXP's supply capacity with the historical loading and Transpower's demand forecast.

Ergo notes that Transpower has decided, in conjunction with Horizon and solar farm developers who plan to connect to the network, to replace the existing 110/11 kV transformers with larger, three-winding, 110/33/11 kV transformers. This replacement will mitigate the capacity and voltage issues at the GXP.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following Figure 15 illustrates Waiotahe GXP's 2022 loading in comparison to its substation capacity.



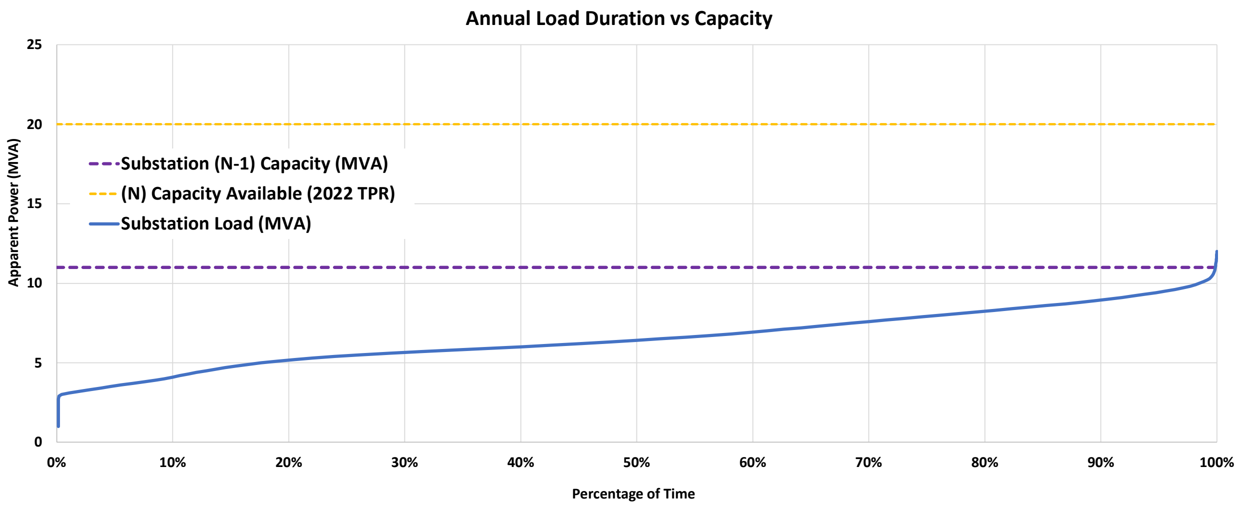


Figure 15 Waiotahe GXP: 2021 Loading: Substation capacity:

6.1.4 Tauranga 11 kV GXP

Transpower's demand forecast indicates that the Tauranga 11 kV GXP is expected to have a 2023 peak demand of 28 MVA (28 MW at unity power factor). This aligns with the historical SCADA data that indicates that, during 2022, the Tauranga 11 kV GXP experienced a peak load of 25.4 MVA.

The Tauranga 11 kV GXP is equipped with two 110/11 kV transformers rated at 36/33 MVA each, that provide:

- A total nominal installed capacity of 60 MVA.
- An (N-1) capacity of 36/36 MVA (summer/winter)

The total Tauranga load (on the 11 kV and 33 kV GXPs) is constrained by the capacity of the two 110 kV circuits that supply Tauranga from Kaitemako (one of which is shared with Mt Maunganui).

The 11 kV system at the Tauranga GXP supplies the major subdivisions in the Tauranga south area in and around Greerton.

Peak load at Tauranga 11 kV is within the n-1 capacity of the supply transformers for the forecast period. The following graph[19] compares Tauranga 11 kV GXP's supply capacity with the historical loading and Transpower's demand forecast. It is noted that there is a large decrease in load shown on this graph between 2028 and 2030 which is assumed to be due to load shifting between GXPs.

Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following Figure 16 illustrates Tauranga 11 kV GXP's 2022 loading in comparison to its substation capacity.

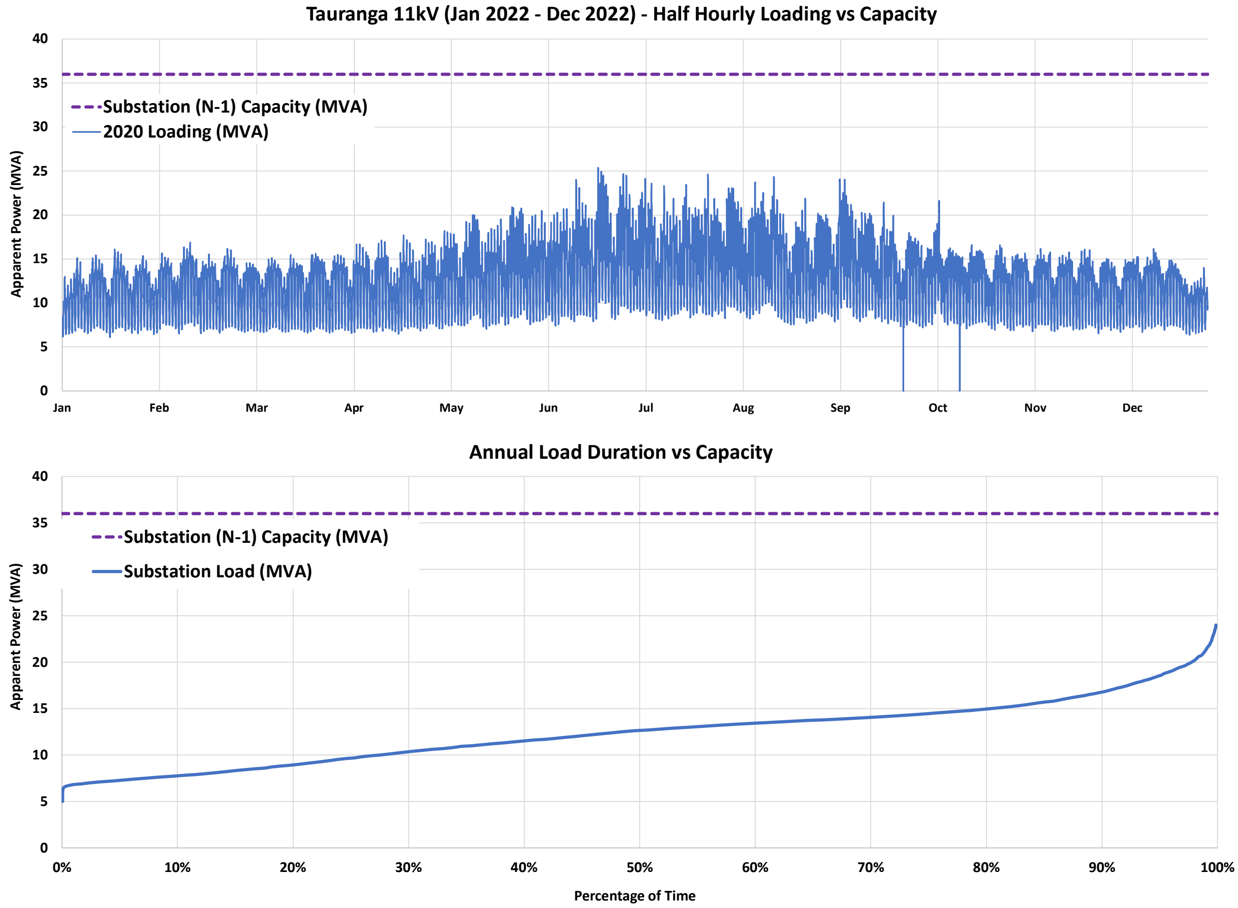


Figure 16 Tauranga 11 kV GXP: 2022 Loading: Substation capacity

6.1.5 Tauranga 33 kV GXP

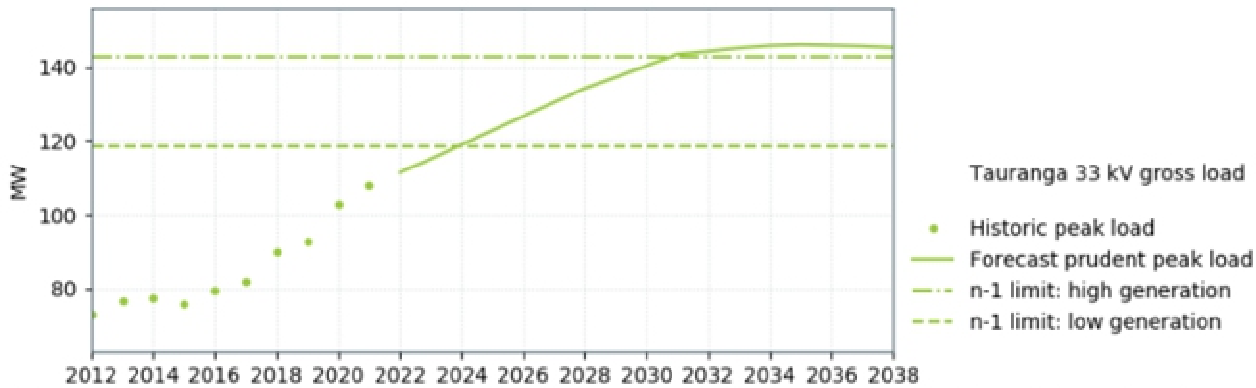
Transpower's demand forecast indicates that the Tauranga 33 kV GXP is expected to have a 2023 peak demand of 115 MVA (115 MW at unity power factor). This contrasts with the historical SCADA data that indicates that, during 2022, the Tauranga 33 kV GXP experienced a peak load of 76 MVA. This discrepancy is due to the SCADA data representing net load (that is, load including the offset caused by Kaimai generation).

The Tauranga 33 kV GXP is equipped with two 110/33 kV transformers rated at 36/33 MVA (summer/winter) each, that provide:

- A total nominal installed capacity of 210 MVA.
- An (N-1) capacity of 108/108 MVA (summer/winter)

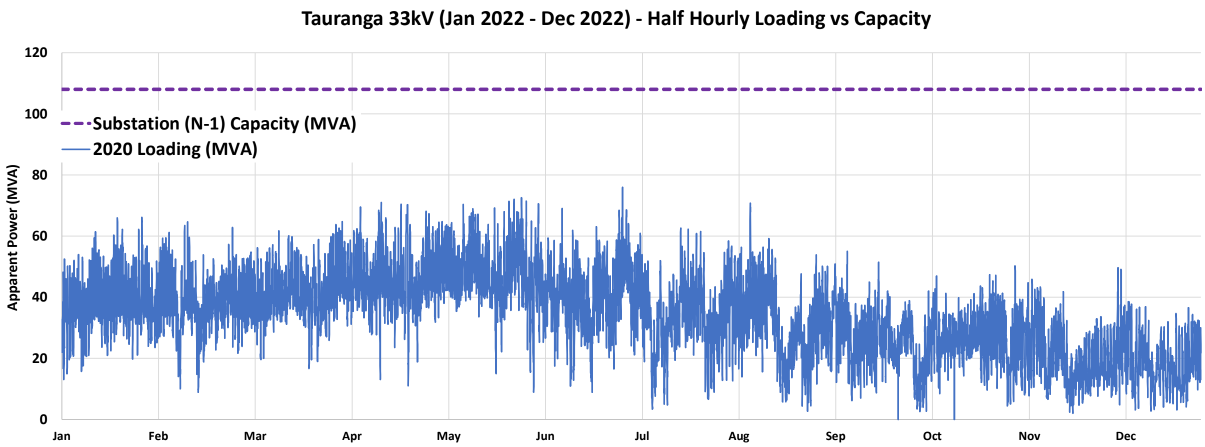
The 33 kV system at the Tauranga GXP supplies the subtransmission network and ten of Powerco's zone substations namely Bethlehem, Waihi Road, Hamilton Street, Sulphur Point, Otūmoetai, Matua, Ōmokoroa, Aongatete, Katikati and Kauri Point.

Peak load at Tauranga 33 kV is forecast to exceed the (N-1) capacity of the supply transformers from winter 2024 with low (14 MW) Kaimai generation, and from winter 2031 with maximum (42 MW) generation. The following graph[19] compares Tauranga 33 kV GXP's supply capacity with the historical loading and Transpower's demand forecast.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following Figure 17 illustrates Tauranga 33 kV GXP's 2022 loading in comparison to its substation capacity. Note that difference in Kaimai generation between peak and reasonable minimum (during poor hydrology conditions) is 26 MW – so the load duration curve below could shift up by up to 26 MW.



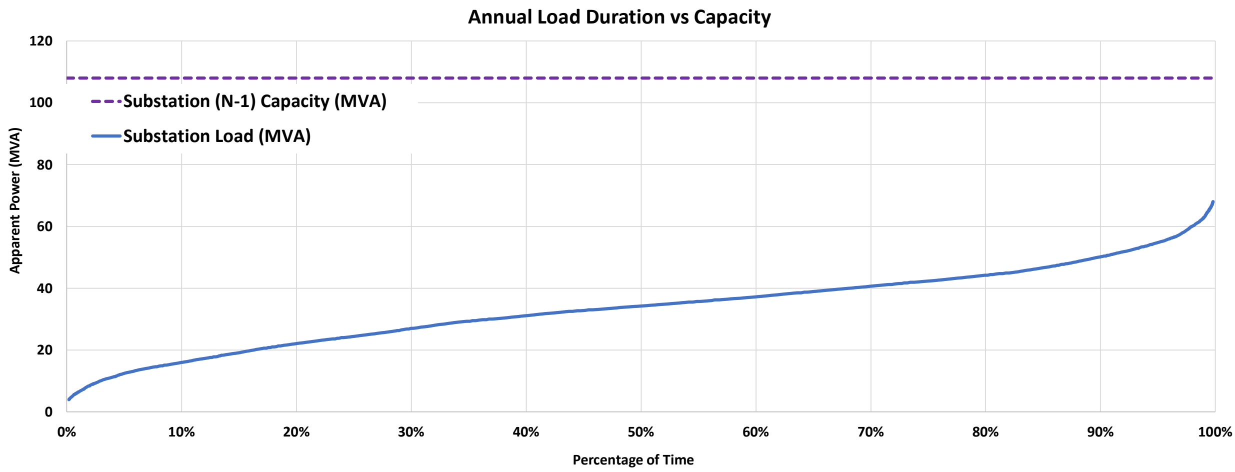
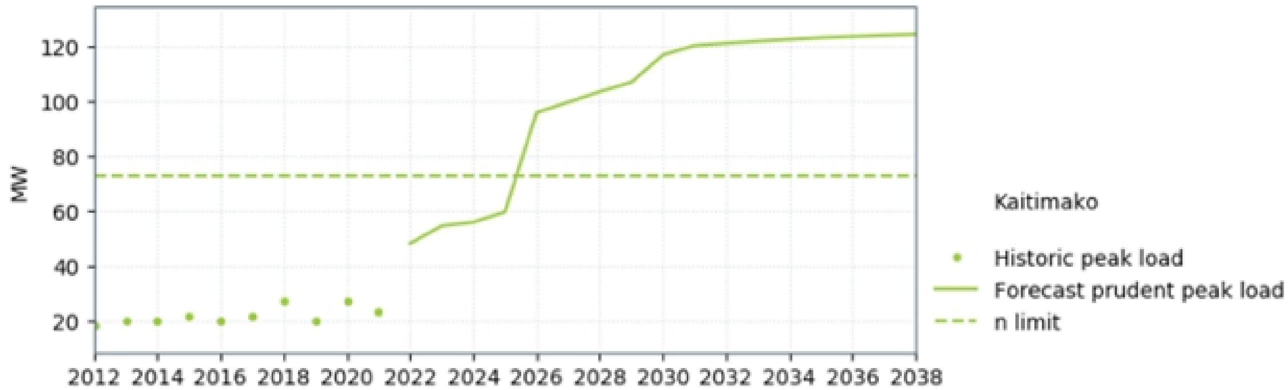


Figure 17 Tauranga 33 kV GXP: 2022 Loading: Substation capacity

6.1.6 Kaitemako GXP

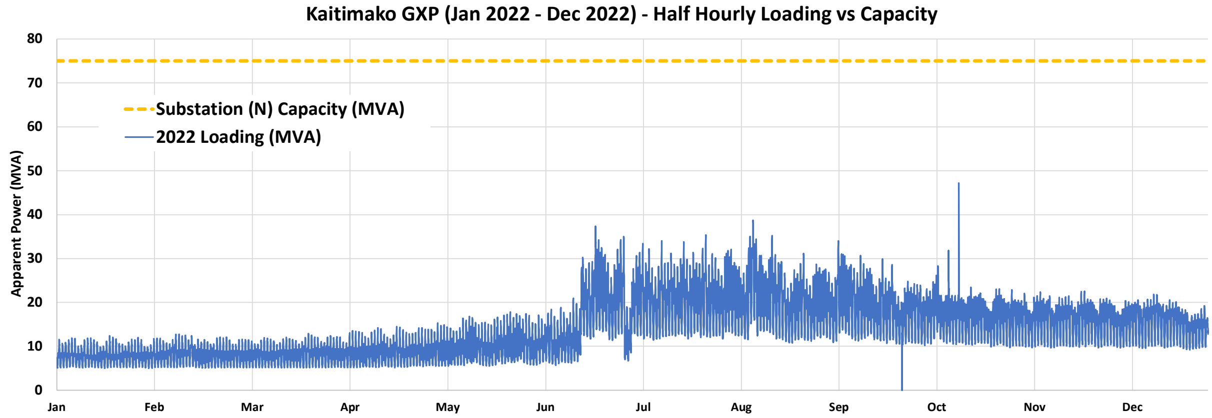
Transpower's demand forecast indicates that the Kaitemako GXP is expected to have a 2023 peak demand of 54 MVA (54 MW at unity power factor). This contrasts with the historical SCADA data that indicates that, during 2022, the Kaitemako GXP experienced a peak load of 47.2 MVA.

The Kaitemako GXP is equipped with a single 110/33 kV transformer rated at 75 MVA. Peak load at Kaitemako GXP is forecast to exceed the continuous capacity of the GXP from winter 2026. The following graph[19] compares Kaitemako GXP's supply capacity with the historical loading and Transpower's demand forecast. It is noted that there is a large increase in load shown on this graph between 2024 and 2026 which is assumed to be due to load shifting between GXPs, and/or due to increases in the industrial loads at the GXP.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following Figure 18 illustrates Kaitemako GXP's 2022 loading in comparison to its substation capacity.



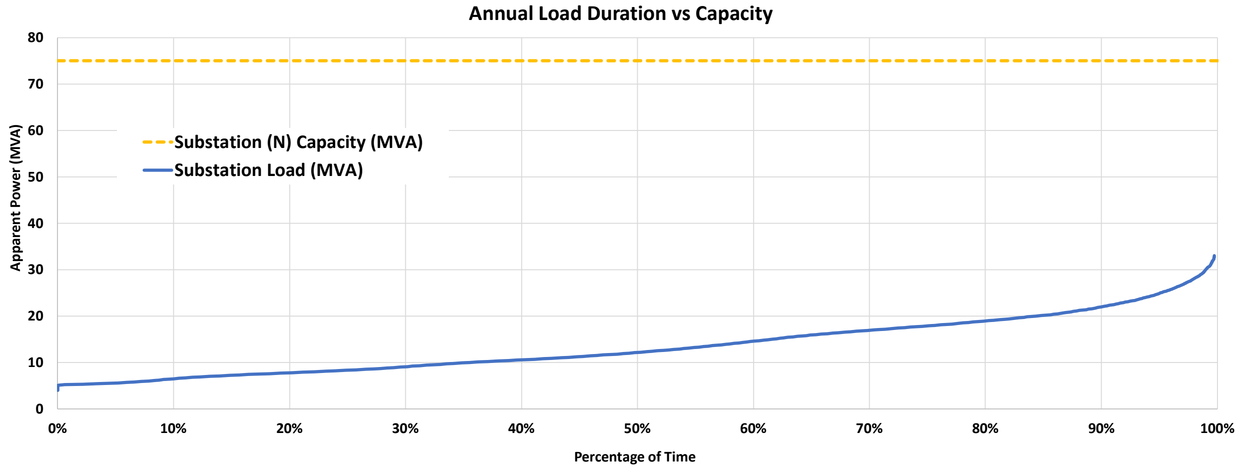


Figure 18 Kaitemako GXP: 2022 Loading: Substation capacity

6.1.7 Mt Maunganui GXP

Transpower's demand forecast indicates that the Mt Maunganui GXP is expected to have a 2023 peak demand of 72 MW at 0.99 power factor. This contrasts with the historical SCADA data that indicates that, during 2022, the Mt Maunganui GXP recorded a peak load of 66.2 MVA.

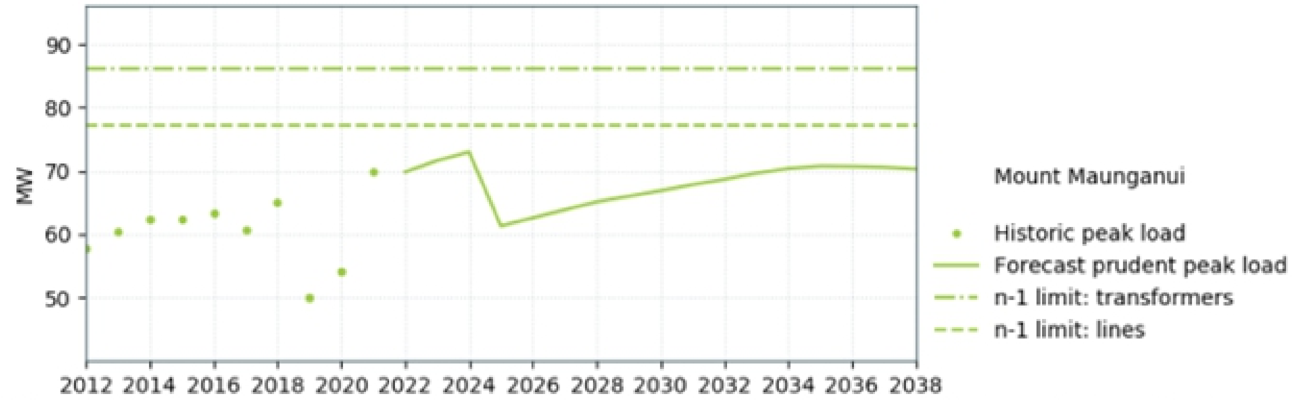
The Mount Maunganui load is supplied by:

- Two 110 kV circuits from Kaitemako:
  - a direct Kaitemako–Mount Maunganui circuit rated at 63/77 MVA (summer/winter)
  - a shared Kaitemako–Tauranga–Mount Maunganui circuit with Kaitemako–Poike and Poike–Mount Maunganui sections rated at 96/105 MVA and 63/77 MVA (summer/winter), respectively.
- Two 110/33 kV transformers providing:
  - total nominal installed capacity of 150 MVA
  - (N-1) capacity of 91/91 MVA[21] (summer/winter).

The forecast peak load at Mount Maunganui is within the (N-1) capacity of the supply transformers and 110 kV circuits for the forecast period. The following graph[19] compares Mt Maunganui GXP's

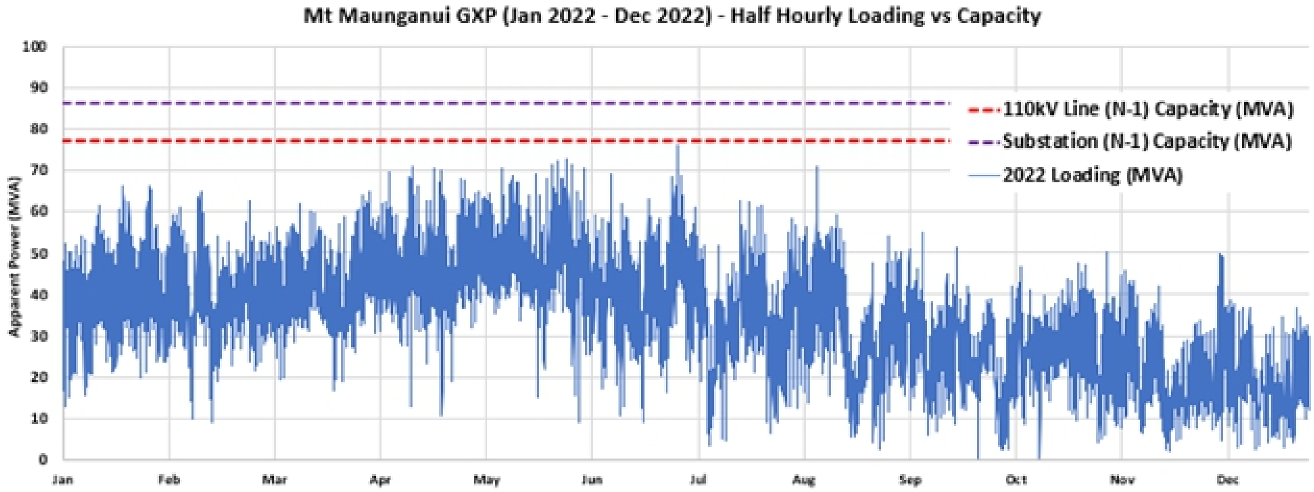
[21] The transformers' capacity is limited by the current rating of the 33 kV switchgear; with this limit resolved, the n-1 capacity will be 94/98 MVA (summer/winter)

supply capacity with the historical loading and Transpower's demand forecast. It is noted that there is a large decrease in load shown on this graph between 2024 and 2026 which is assumed to be due to load shifting between GXPs.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following



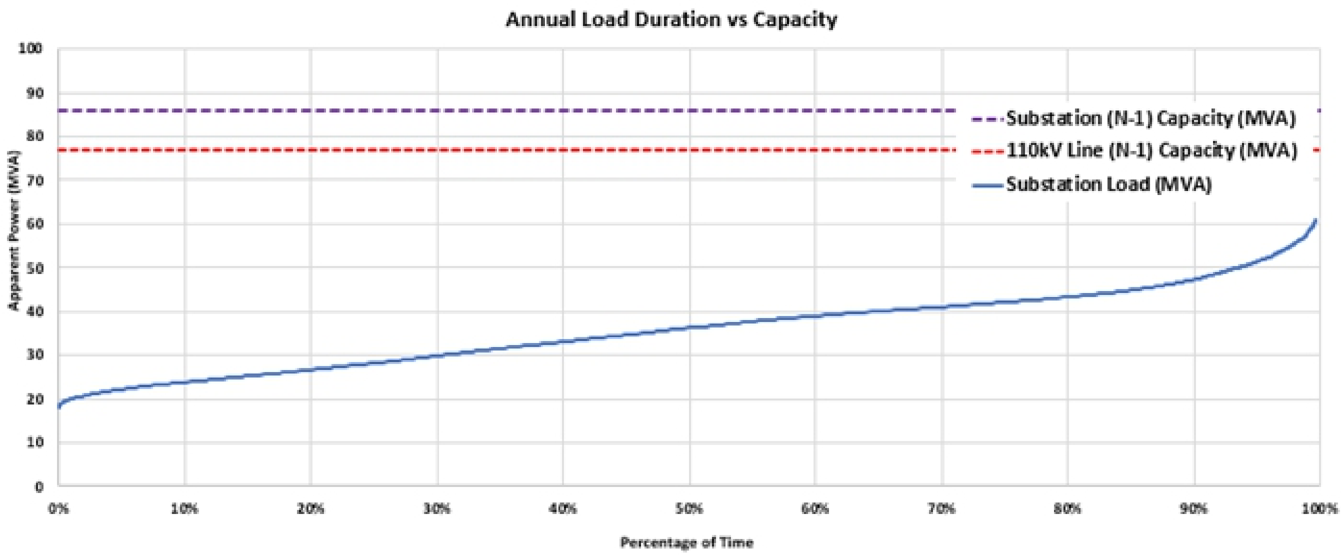


Figure 19 illustrates Mt Maunganui GXP's 2022 loading in comparison to its substation capacity.

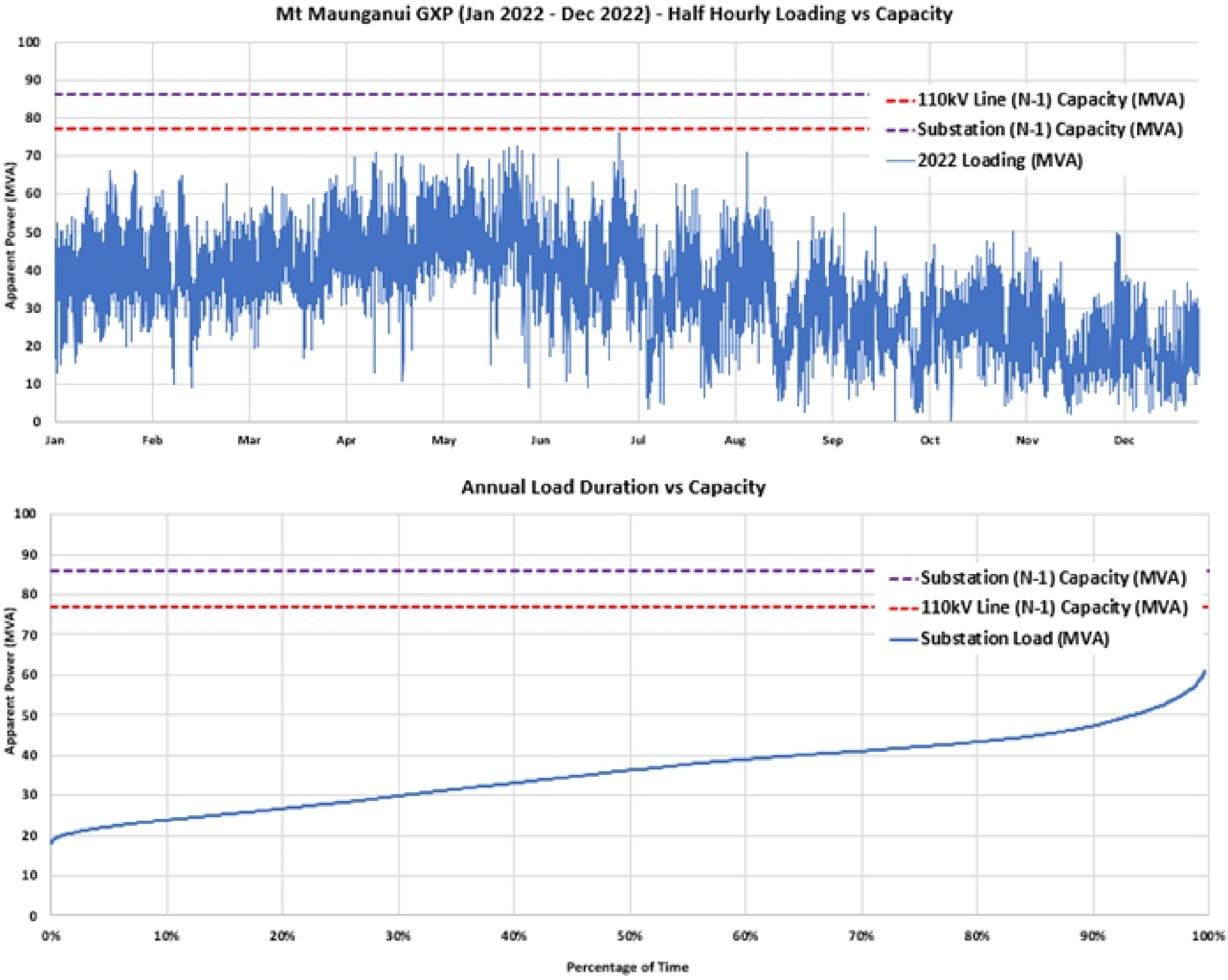


Figure 19 Mt Maunganui GXP: 2022 Loading: Substation capacity

6.1.8 Te Matai GXP

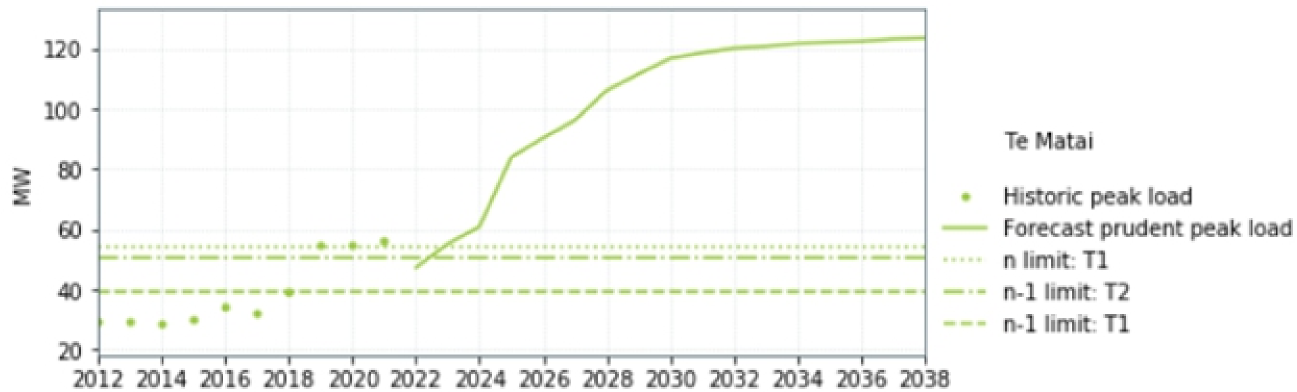
Transpower's demand forecast indicates that the Te Matai GXP is expected to have a 2023 peak demand of 55 MVA (55 MW at unity power factor). This contrasts with the historical SCADA data that indicates that, during 2022, the Te Matai GXP recorded a peak load of 46.8 MVA.

Two 110/33 kV transformers (T1 rated at 30 MVA and T2 rated at 40 MVA) supply Te Matai's load, providing:

- Total nominal installed capacity of 70 MVA
- (N-1) capacity of 36/39 MVA (summer/winter).

Ergo notes that Transpower plans to replace the T1 transformer with a new 80 MVA unit by winter of 2025, at which point, the total installed capacity at Te Matai will increase to 120 MVA, and (N-1) capacity to ~61 MVA.

The graph[19] below shows that peak load at Te Matai first exceeded the (N-1) supply capacity in winter 2019, when only supplied through T1. When only supplied through T2, peak load will exceed the transformer capacity in 2023. T1 also exceeded its continuous rating (when both transformers were in service) in 2019.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

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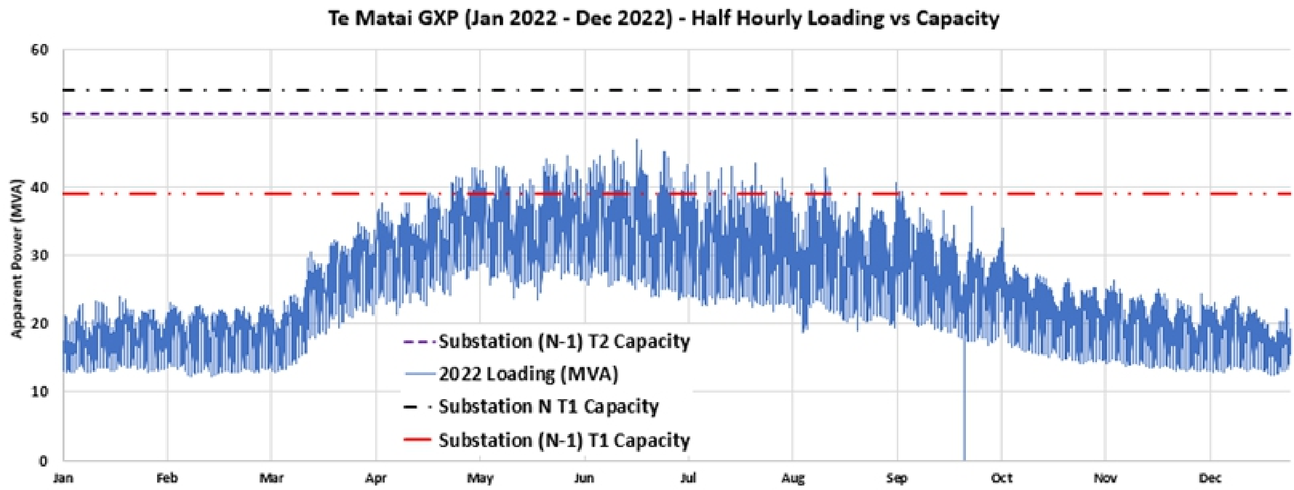


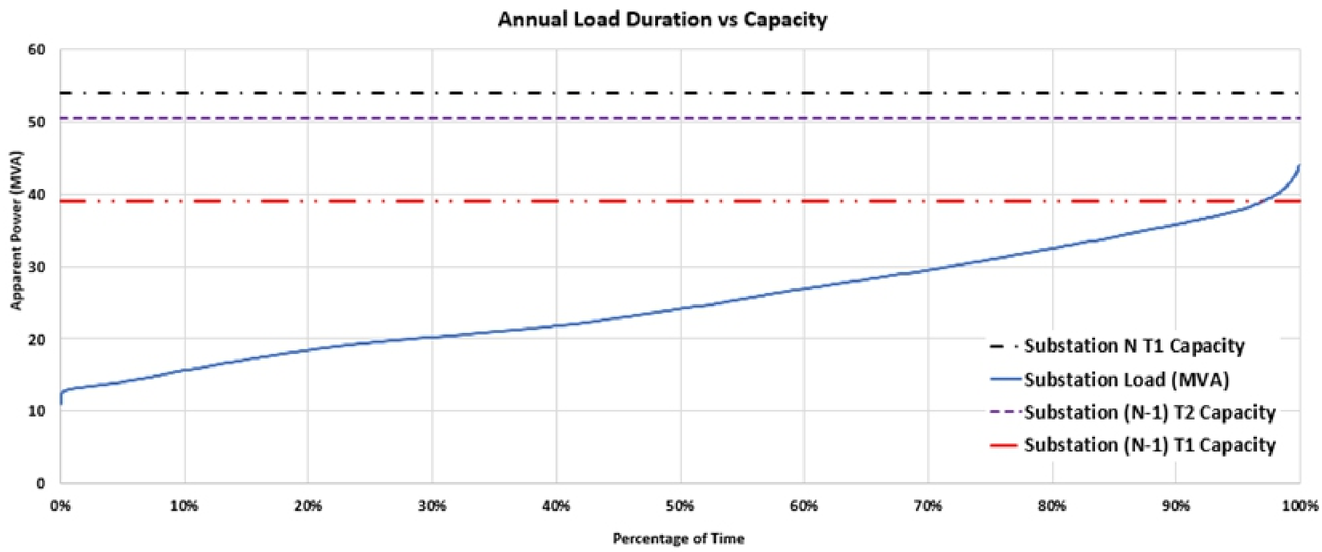


Figure 20 illustrates Te Matai GXP's 2022 loading in comparison to its substation capacity.

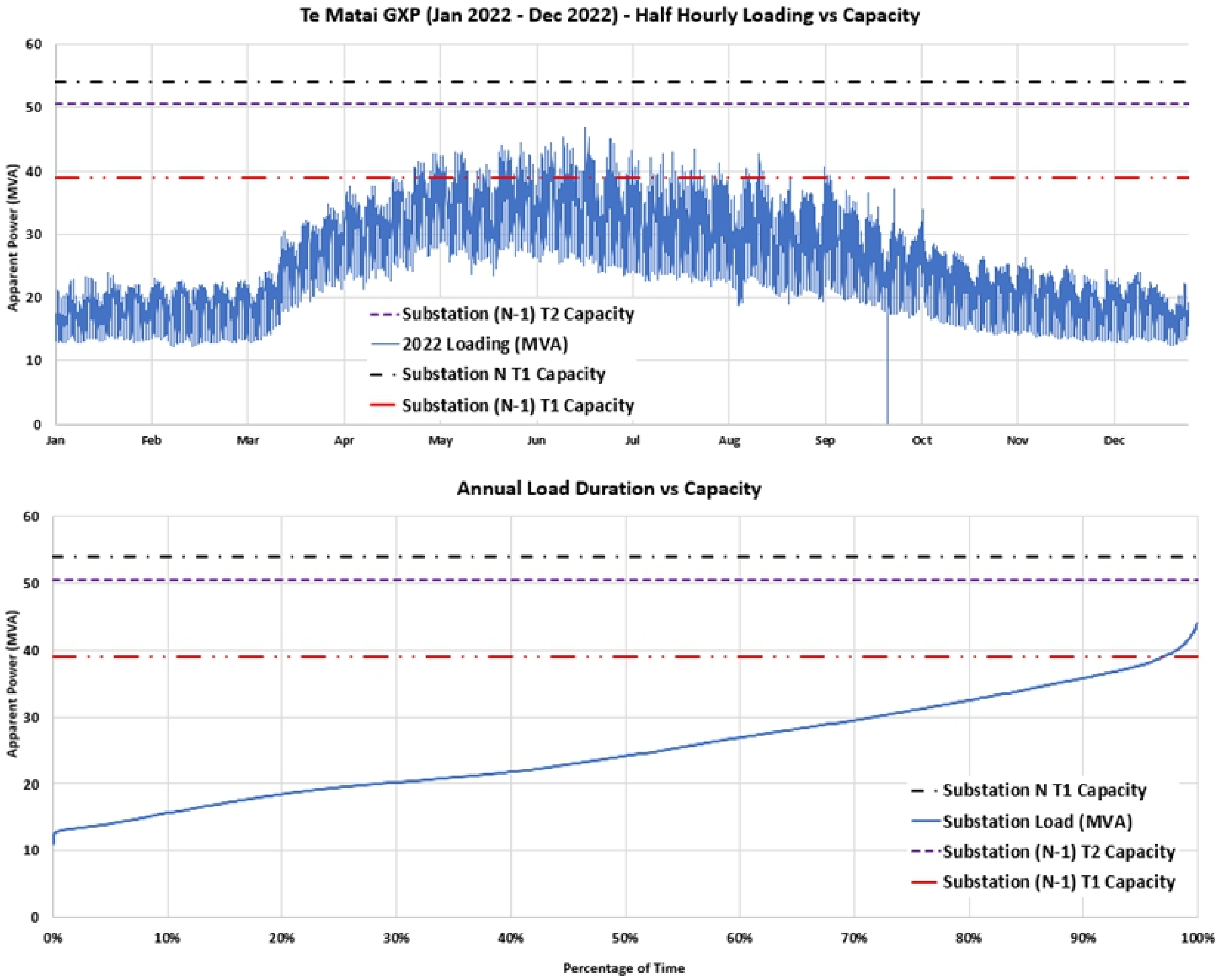


Figure 20 Te Matai GXP: 2022 Loading: Substation capacity

6.1.9 Rotorua 11 kV GXP

Transpower's demand forecast indicates that the Rotorua 11 kV GXP is expected to have a 2023 peak demand of 27 MVA at unity power factor. This aligns well with the historical SCADA data that indicates that, during 2022, the Tauranga 11 kV GXP experienced a peak load of 27.4 MVA.

Rotorua is supplied by two 110 kV Rotorua–Tarukenga circuits. The Rotorua 110 kV bus is split to give two bus sections, each supplied by one Rotorua–Tarukenga circuit. Two 110/33 kV and two 110/11 kV supply transformers are distributed across the two bus sections. One bus section has a single 110 kV connection to the Wheao hydro generator.

The total Rotorua load (11 kV and 33 kV GXPs) is constrained by the two 110 kV circuits that provide supply from Tarukenga, with an (N-1) capacity of 63/77 MVA (summer/winter). The Transpower 2022 TPR forecasts the peak combined load of Rotorua 11 kV and 33 kV to exceed this constraint from winter 2023.

Transpower is discussing options with Unison to increase the spare capacity of these lines, including load transfers to other GXPs, implementing variable line ratings or reconductoring the lines, or reconfiguring the 110 kV bus (e.g. closing the bus section circuit breaker).

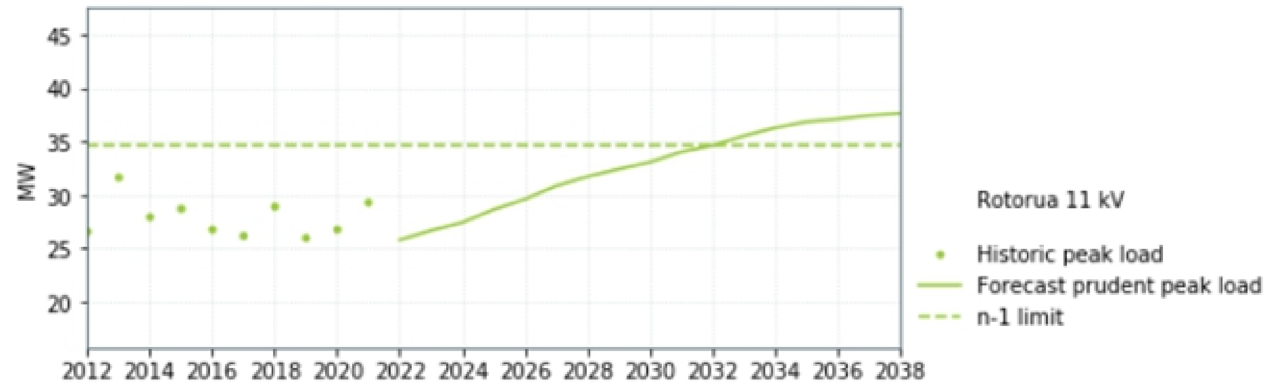
The Rotorua 11 kV GXP is equipped with two 110/11 kV transformers rated at 36/36 MVA each, that provide:

- A total nominal installed capacity of 70 MVA.
- An (N-1) capacity of 36/36 MVA (summer/winter)

With the 11 kV load increasing at Rotorua 11 kV, Transpower is considering either transferring some of the load at Rotorua 11 kV to Tarukenga or Ōwhata, or upgrading the circuit breakers connected to the 110/11 kV transformers. These options would both increase the spare capacity of the Rotorua 11 kV GXP.

The 11 kV system at the Rotorua GXP supplies the Rotorua township and immediate surrounding areas.

Peak load at Rotorua 11 kV is forecast to exceed the (N-1) capacity of the supply transformers from winter 2033. The following graph[19] compares Rotorua 11 kV GXP's supply capacity with the historical loading and Transpower's demand forecast.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following

Figure 21 illustrates Rotorua 11 kV GXP's 2022 loading in comparison to its substation capacity.

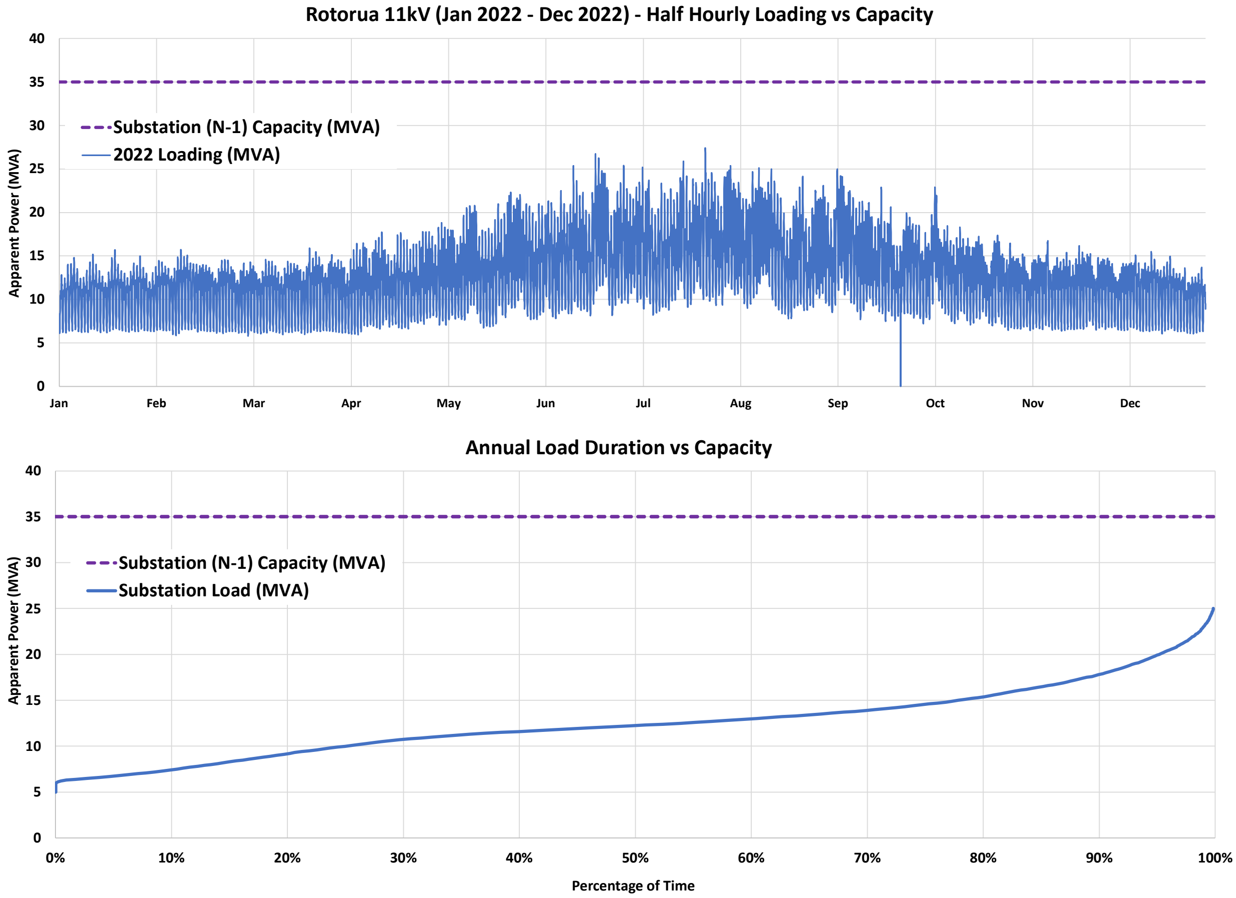


Figure 21 Rotorua 11 kV GXP: 2022 Loading: Substation capacity

6.1.10 Rotorua 33 kV GXP

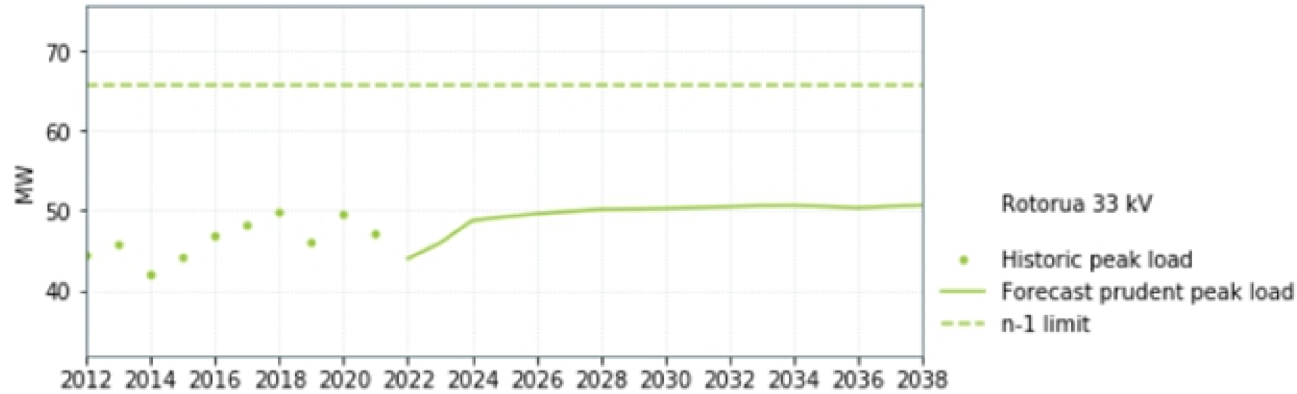
Transpower's demand forecast indicates that the Rotorua 33 kV GXP is expected to have a 2023 peak demand of 46 MVA at 0.98 power factor. This aligns well with the historical SCADA data that indicates that, during 2022, the Rotorua 33 kV GXP experienced a peak load of 46.9 MVA.

The Rotorua 33 kV GXP is equipped with two 110/33 kV transformers rated at 68/71 MVA each, that provide:

- A total nominal installed capacity of 120 MVA.
- An (N-1) capacity of 68/71 MVA (summer/winter)

The 33 kV system at the Rotorua GXP supplies five zone substations namely Arawa, Biak Street, Fernleaf, Raionbow, and Waipa as shown in Figure 11.

Peak load at Rotorua 33 kV is within the (N-1) capacity of the supply transformers for the forecast period. The following graph[19] compares Rotorua 33 kV GXP's supply capacity with the historical loading and Transpower's demand forecast.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following Figure 22 illustrates Rotorua 33 kV GXP's 2022 loading in comparison to its substation capacity.

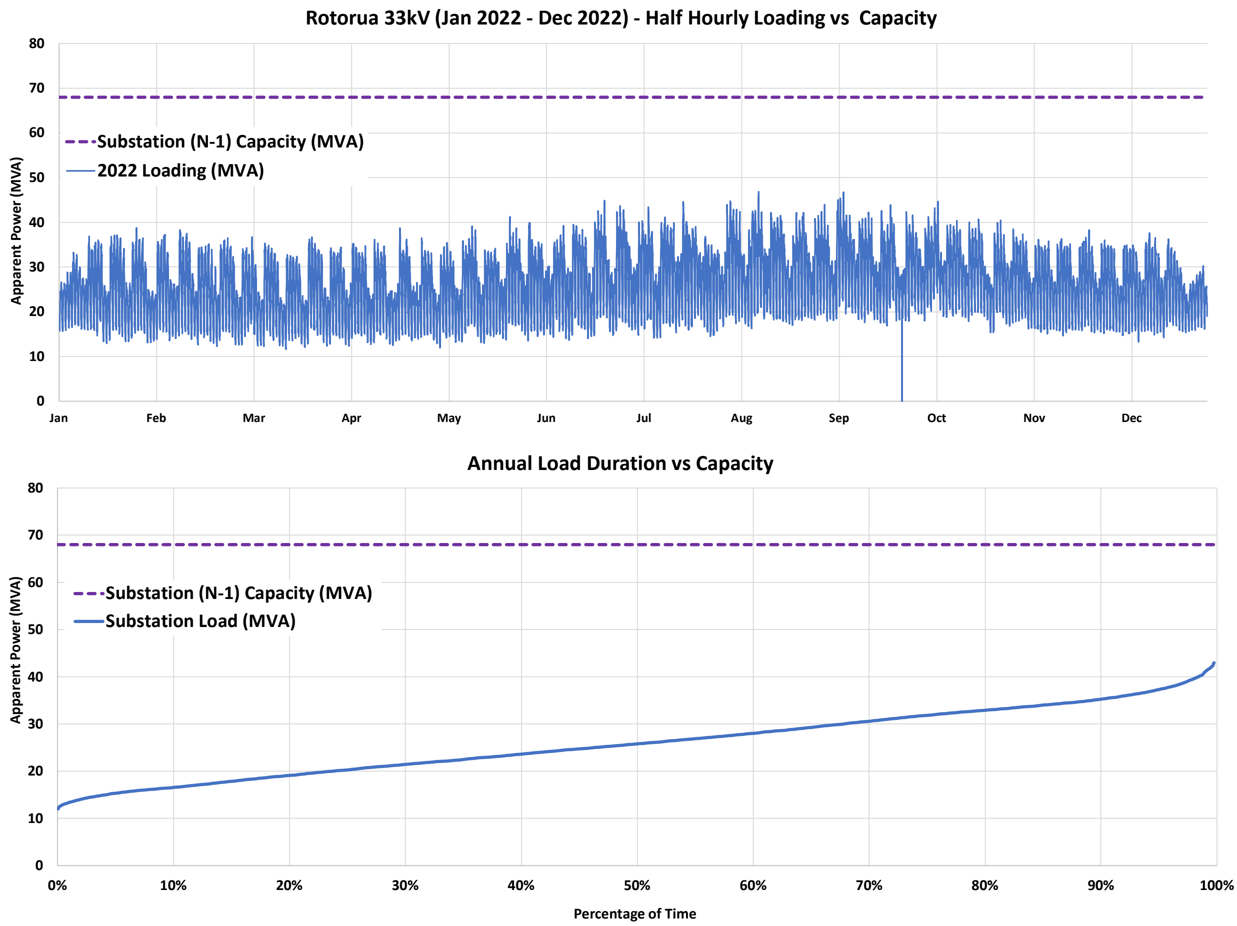


Figure 22 Rotorua 33 kV GXP: 2022 Loading: Substation capacity

6.1.11 Ōwhata GXP

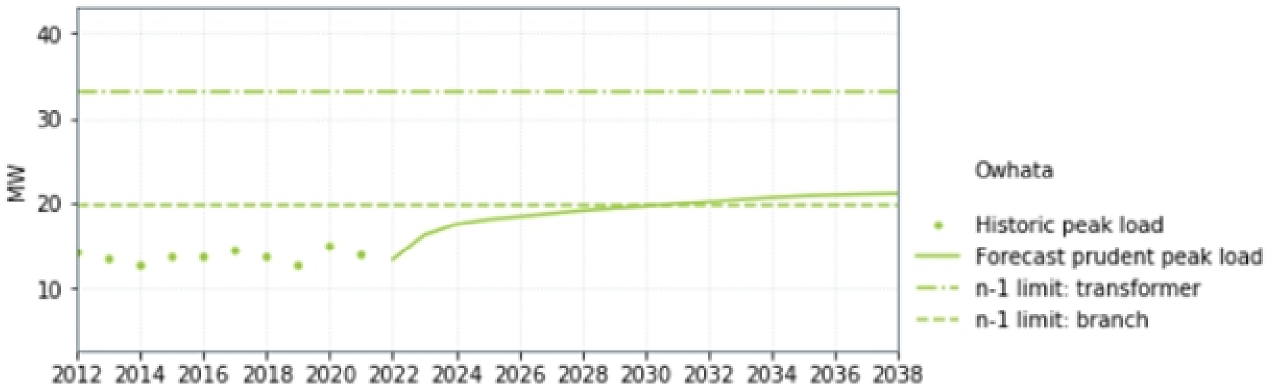
Transpower's demand forecast indicates that the Ōwhata GXP is expected to have a 2023 peak demand of 16 MVA at unity power factor. This is slightly higher than the historical SCADA data that indicates that, during 2022, the Ōwhata GXP experienced a peak load of 13.5 MVA.

Two 110/11 kV transformers supply Ōwhata's load, providing:

- A total nominal installed capacity of 68 MVA.
- An (N-1) capacity of 34/34 MVA (summer/winter)

The 11 kV system at the Ōwhata GXP supplies residential, commercial, industrial, and agricultural loads in and around the Ōwhata area.

The peak load is forecast to exceed the (N-1) capacity of the supply transformers from the winter of 2031. The Ōwhata 11 kV switchgear replacement project, completed in 2022, now allow the full (N-1) capacity of the supply transformers to be utilised, resolving the (N-1) supply capacity issue for the forecast period. The following graph[19] compares Ōwhata GXP's supply capacity with the historical loading and Transpower's demand forecast.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following Figure 23 illustrates Ōwhata GXP's 2022 loading in comparison to its substation capacity.

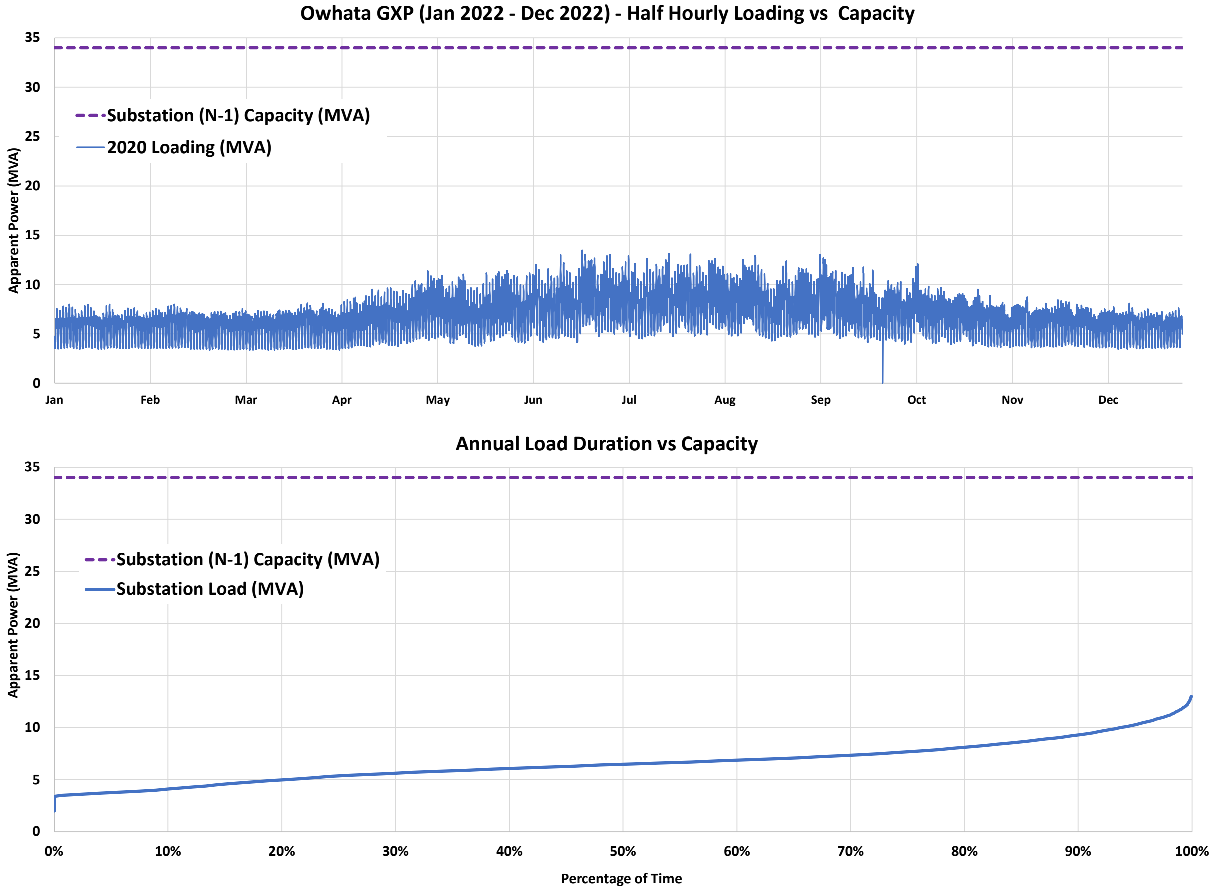


Figure 23 Ōwhata GXP: 2022 Loading: Substation capacity.

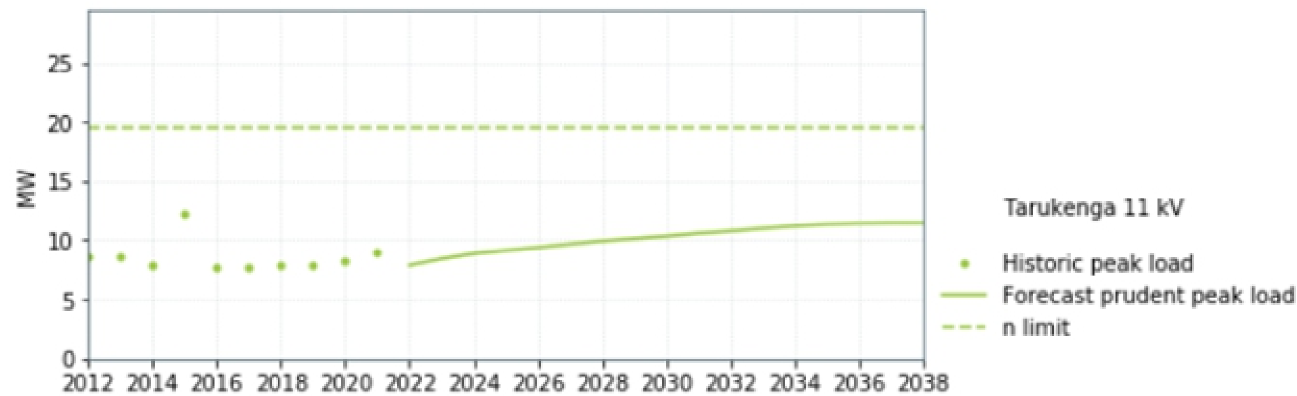
6.1.12 Tarukenga GXP

Transpower's demand forecast indicates that the Tarukenga GXP is expected to have a 2023 peak demand of 8 MVA at unity power factor. This is slightly lower than the historical SCADA data that indicates that, during 2022, the Tarukenga GXP experienced a peak load of 8.6 MVA during winter.

A single 110/11 kV transformers supply Tarukenga's load, providing a nominal (N-security) installed capacity of 20 MVA.

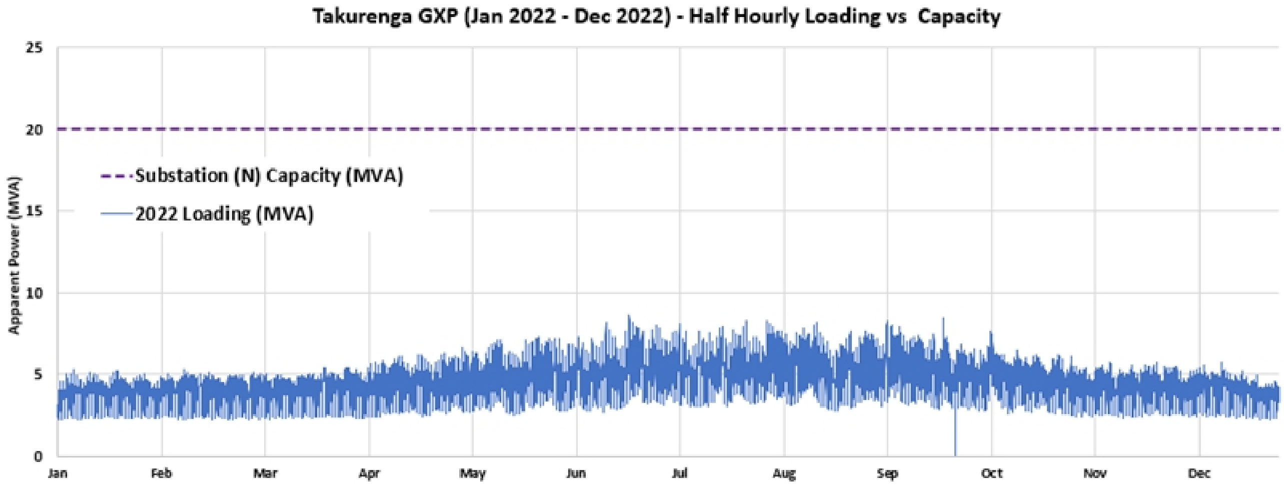
The 11 kV system at the Tarukenga GXP supplies residential (lifestyle blocks) and agricultural loads in the area.

The peak load is forecast out to 2038 is well below the (N) capacity of 20 MVA. The following graph[19] compares Tarukenga 11 kV GXP's supply capacity with the historical loading and Transpower's demand forecast.



Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following



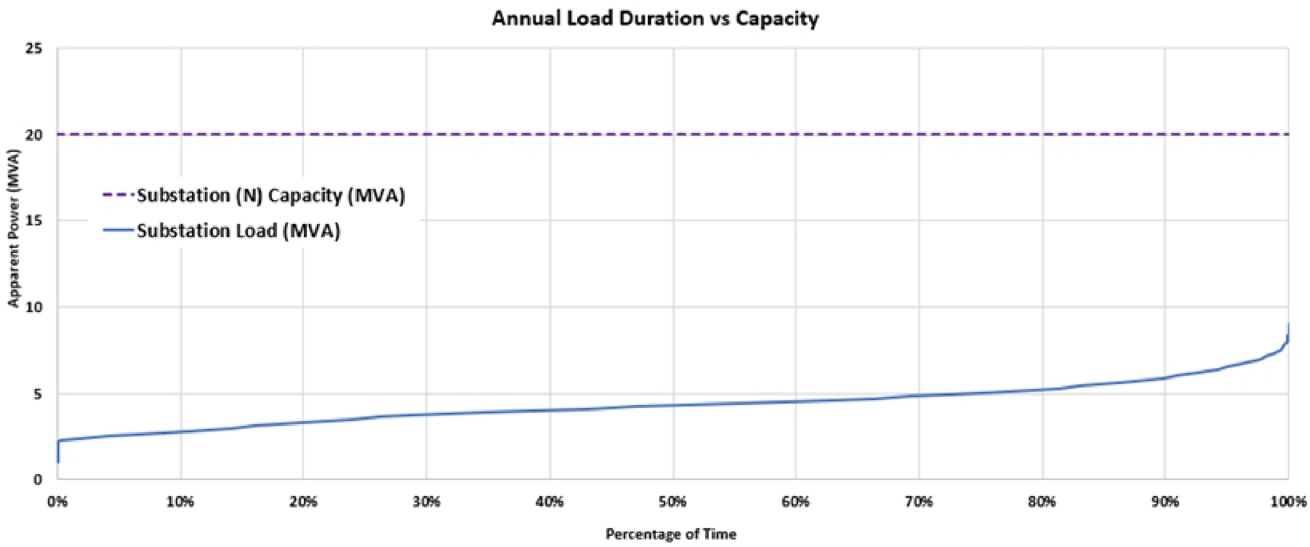


Figure 24 illustrates Tarukenga GXP's 2022 loading in comparison to its substation capacity.

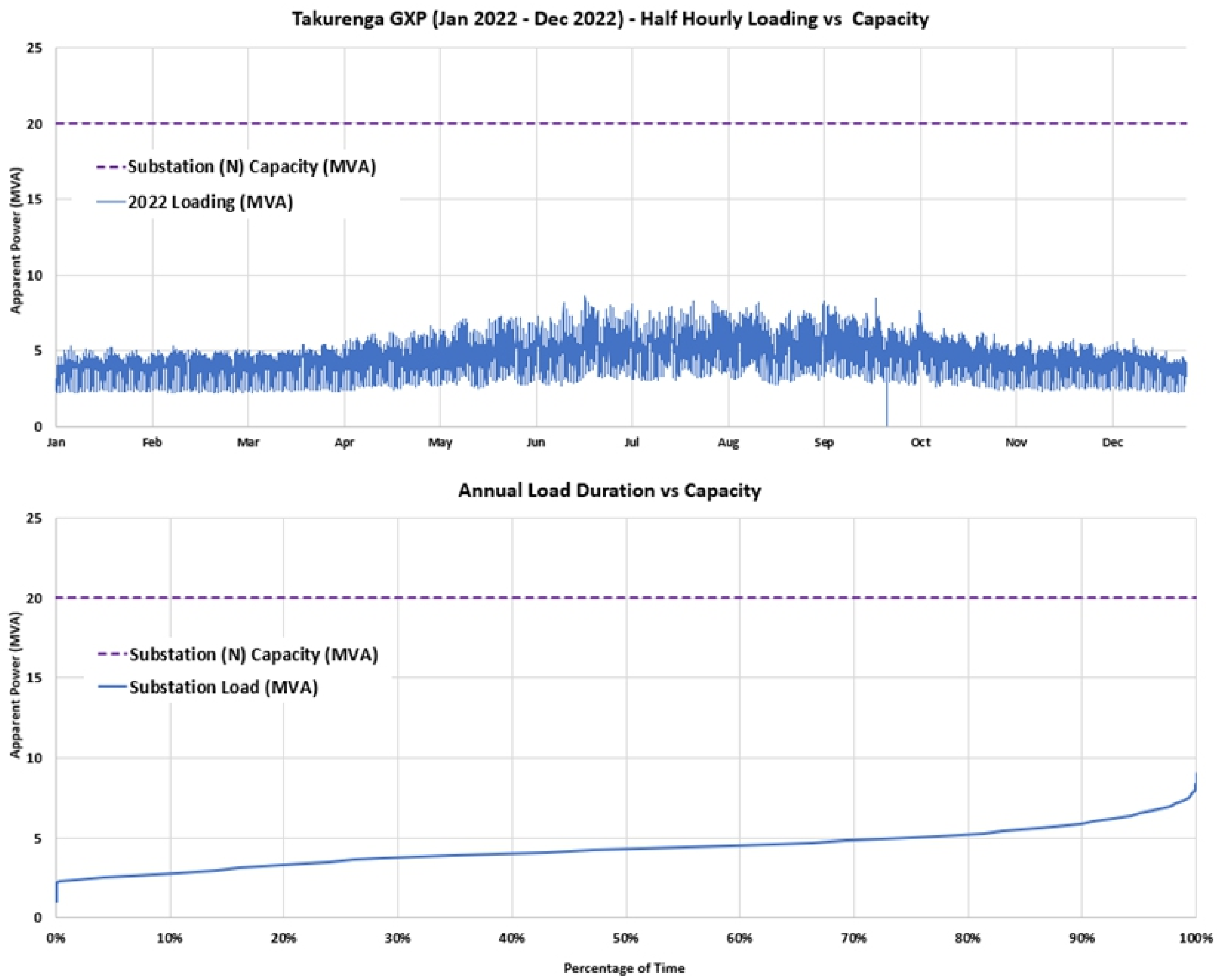


Figure 24 Tarukenga GXP: 2022 Loading: Substation capacity.

6.2 Spare Capacity based on Transpower's 2022 Forecast

The following Figure 25 summarises the approximate, all year, (N-1) and (N) spare capacities at each GXP based on:

- The substation capacity disclosed in Transpower's *Transmission Planning Report 2022*
- The 2022 forecast load provided in Transpower's *Transmission Planning Report 2022* (refer to Table 3).
- Half hourly load data from Electricity Market Information website.
- The 2023 Horizon Networks *Asset Management Plan*.
- The 2023 Powerco *Asset Management Plan.*
- The 2023 Unison *Asset Management Plan.*

Negative values are only possible for (N-1) capacities and indicate that there is no spare (N-1) capacity. The negative amount indicates the capacity increase that is required to achieve a secure firm capacity at the substation.

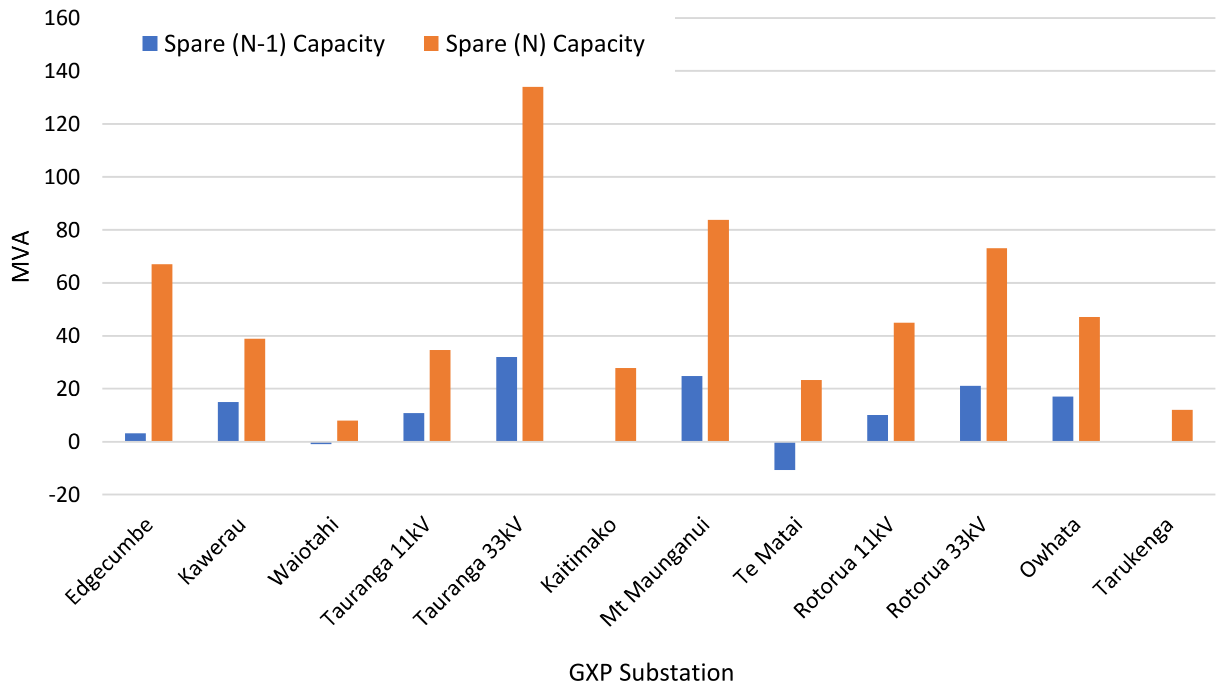


Figure 25 Summary: GXP Spare Capacity based on GXP 2022 EMI loading data.

It should be noted that the spare capacities are based on the asset rating values disclosed by Transpower, and the actual 2022 load data as recorded and presented on The Electricity Market Information website. Also, the spare (N) capacities do not include any voltage constraints or upstream transmission constraints, which would need to be confirmed by Transpower or the relevant EDB. These are however considered in the individual load assessments in Section 8, particularly for larger loads. We note the following:

- The negative values in Figure 25 indicate that there is no capacity and consumer load cannot be supplied for (N-1) conditions.
- Figure 25 infers that there are relatively high levels of spare (N-1) capacity at Kawerau, Tauranga 11 kV, Tauranga 33 kV, Rotorua 33 kV, and Ōwhata GXPs, but we note that these values do not consider the transmission line constraints and voltage constraints.
- All of the GXPs in this region have (N-1) security at present, except for Kaitemako and Tarukenga, which have (N) security.

7. Spare Capacity – Zone Substations

In determining the (N) and (N-1) spare capacities for the zone substation, Ergo reviewed the EDB 2023 disclosure data and the historical substation loading data for 2022. Actual historical loading data was provided by Horizon Networks, Powerco, and Unison and all data is shown in Table 4, Table 5, and Table 6 respectively.

7.1 Horizon Network

Table 4 Horizon: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity[22]	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	East Bank Road	1.30	0.12	N/A	N/A
2	Galatea	10.40	10.49	2.9	3.0
3	Kaingaroa	8.06	7.41	2.7	2.1
4	Kopeopeo	12.80	13.03	-3.2	-3.0
5	Ōhope	0.30	0.47	N/A	N/A
6	Plains	7.20	8.61	N/A	N/A
7	Station Road	9.80	10.07	-0.2	0.1
8	Te Kaha	6.00	5.95	N/A	N/A
9	Waiotahe	3.30	3.30	-1.7	-1.7

Note: The negative (N-1) ratings represent a zone substation where the (N-1) rating is already exceeded at times throughout the year.

7.2 Powerco

Table 5 Powerco: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Bethlehem	13	12.5	N/A	N/A
2	Waihi Rd	28	29.4	4.0	5.4
3	Hamilton St	31	30.4	10.0	9.4
4	Sulphur Point	10.6	10.6	N/A	N/A
5	Otūmoetai	12	13.3	-1.0	0.3
6	Matua	7	8.3	N/A	N/A
7	Ōmokoroa	13	13.2	1.0	1.2
8	Aongatete	4.9	4.6	-0.1	-0.4
9	Katikati	16	16.6	3.0	3.6
10	Kauri Point	2	2.4	-1.0	-0.6
11	Welcome Bay	18	17.4	-3.0	-3.6

[22] N/A represents zone substations with N security.

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
12	Pyes Pa	28	33.9	4.0	9.9
13	Papamoa	25	25.9	4.0	4.9
14	Matapihi	35	34.3	11.0	10.3
15	Omanu	35	36.3	11.0	12.3
16	Te Maunga	5	5.4	N/A	N/A
17	Triton	22	27.2	1.0	6.2
18	Wairakei	37	38.3	13.0	14.3
19	Te Puke	25	26.3	2.0	3.3
20	Atauroa	8	6.0	N/A	N/A
21	Paengaroa	12	10.1	N/A	-2.9
22	Pongakawa	6	5.8	0.0	-0.4

Note: The negative (N-1) ratings represent a zone substation where the (N-1) rating is already exceeded at times throughout the year.

7.3 Unison (Rotorua network)

Table 6 Unison: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Ātiamuri[23]	2.0	1.6	0.0	-0.4
2	Arawa	20.0	19.3	0.0	-0.7
3	Biak Street	22.0	20.8	2.0	0.8
4	Fernleaf	11.0	10.2	N/A	N/A
5	Rainbow	2.0	1.4	N/A	N/A
6	Waipa	12.0	13.1	N/A	N/A

[23] No sub-transmission system. Fed directly from Mighty River Power (MRP) generating station.

7.4 Summary

7.4.1 Horizon Networks

(N-1) Capacity Summary

The following Figure 26 illustrates the approximate (N-1) spare capacities at Horizon Network's zone substations, for the disclosed 2022 peak demand estimates[24]. It should be noted that these have been calculated based on the transformer ratings disclosed by Horizon Networks.

The spare capacities shown do not include any upstream or downstream lines, cables or other equipment thermal constraints, which may be discussed for specific zone substations in Section 8.

The negative (N-1) ratings represent a zone substation where the (N-1) rating is already exceeded at times throughout the year. This means there is no spare (N-1) capacity left and the red graph indicates the extent that the (N-1) secure capacity has been exceeded in the past. Zone substation with (N) security have been omitted from this graph. This means that four of the nine zone substations (East Bank, Ohope, Plains, and Te Kaha) do not have (N-1) security with respect to the supply transformers.

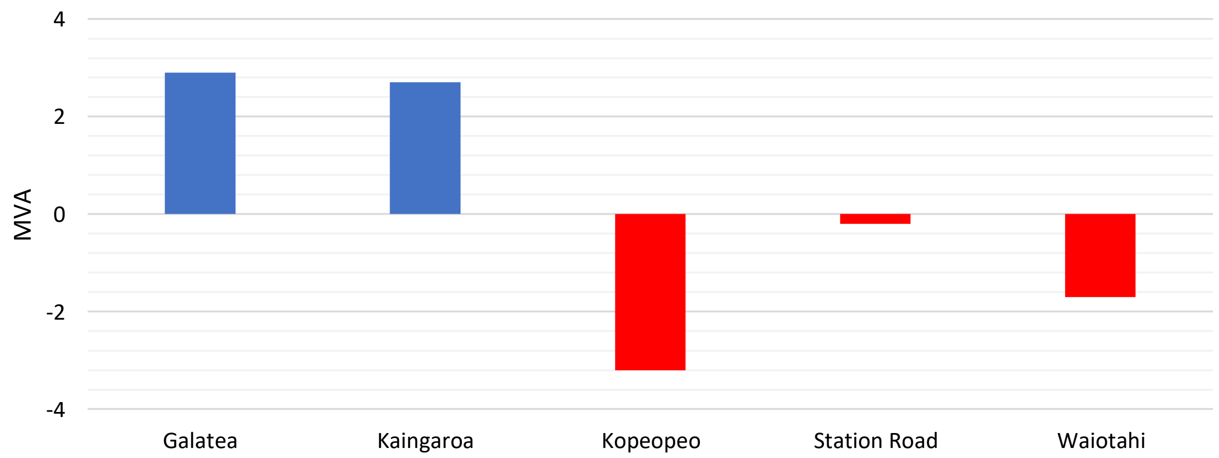


Figure 26 Summary: Approximate (N-1) spare capacity at Horizon Network's zone substations.

(N) Capacity Summary

The following Figure 27 illustrates the approximate (N) spare capacities at Horizon Network's zone substations, for the disclosed peak demand estimates. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Horizon Networks. The spare capacities shown do not include any upstream or downstream conductor or other equipment thermal constraints, which may be discussed for specific zone substations in Section 8.

[24] Horizon Network's 2023 AMP available here: https://www.horizonnetworks.nz/information-disclosure-regulation.

Figure 27 indicates that most the zone substations have moderate to significant spare (N) capacity (between 22% and 80% across all zone substations), except for East Bank and Ōhope zone substation which only has 6% and 17% spare capacity left respectively.

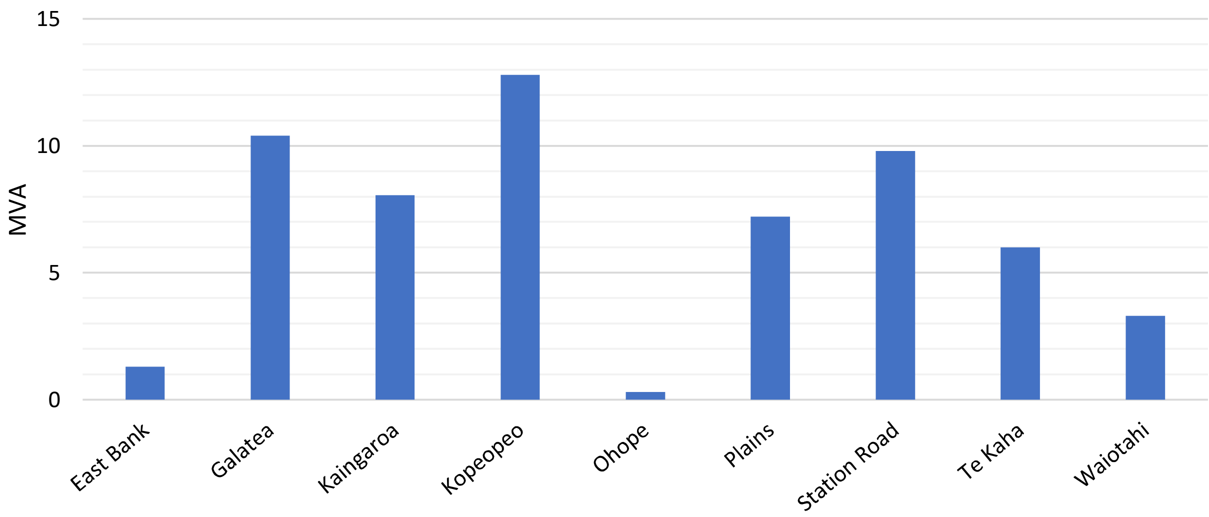


Figure 27 Summary: Approximate (N) spare capacity at Horizon Network's zone substations

7.4.2 Powerco

(N-1) Capacity Summary

The following Figure 28 illustrates the approximate (N-1) spare capacities at Powerco's zone substations, for the disclosed peak demand estimates. It should be noted that these have been calculated based on the transformer ratings disclosed by Powerco.

The spare capacities shown do not include any upstream or downstream conductor or other equipment thermal constraints, which may be discussed for selected zone substations in Section 8.

The negative (N-1) ratings represent a zone substation where the (N-1) rating is already exceeded at times throughout the year. This means there is no spare (N-1) capacity left and the red graph indicates the extent that the (N-1) secure capacity has been exceeded in the past. Zone substation with (N) security have been omitted from this graph. This means that six of the twenty two zone substations (Bethlehem, Sulphur Point, Matua, Te Maunga, Atauroa and Paengaroa) do not have (N-1) security with respect to the supply transformers. At five of the zone substations, the (N-1) supply capacity has been exceeded in 2022.

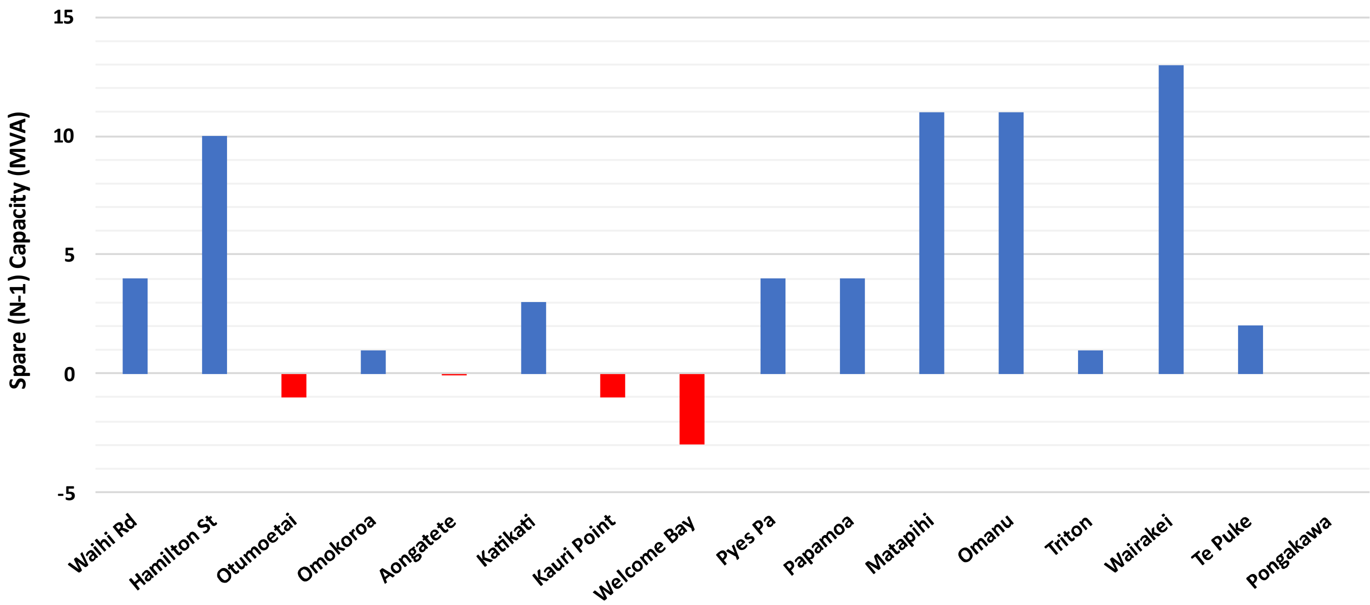


Figure 28. Summary: Approximate (N-1) spare capacity at Powerco's zone substations

The zone substations with spare (N-1) capacity left vary from 8% (for Ōmokoroa) to 48% (for Hamilton St) available capacity.

(N) Capacity Summary

The following Figure 29 illustrates the approximate (N) spare capacities at Powerco 's zone substations, for the disclosed peak demand estimates[25]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Powerco.

The spare capacities shown do not include any upstream or downstream lines, cables or other equipment thermal constraints, which may be discussed for selected zone substations in Section 8. Figure 29 indicates that there is a significant volume of spare (N) capacity, more than 40%, at Powerco's substations, although we note that many of them are in urban/CBD locations where (N-1) security of supply would be a standard requirement.

[25] Powerco 's 2023 AMP available here: https://www.Powerco.co.nz/who-we-are/disclosures-and-submissions/electricity-disclosures.

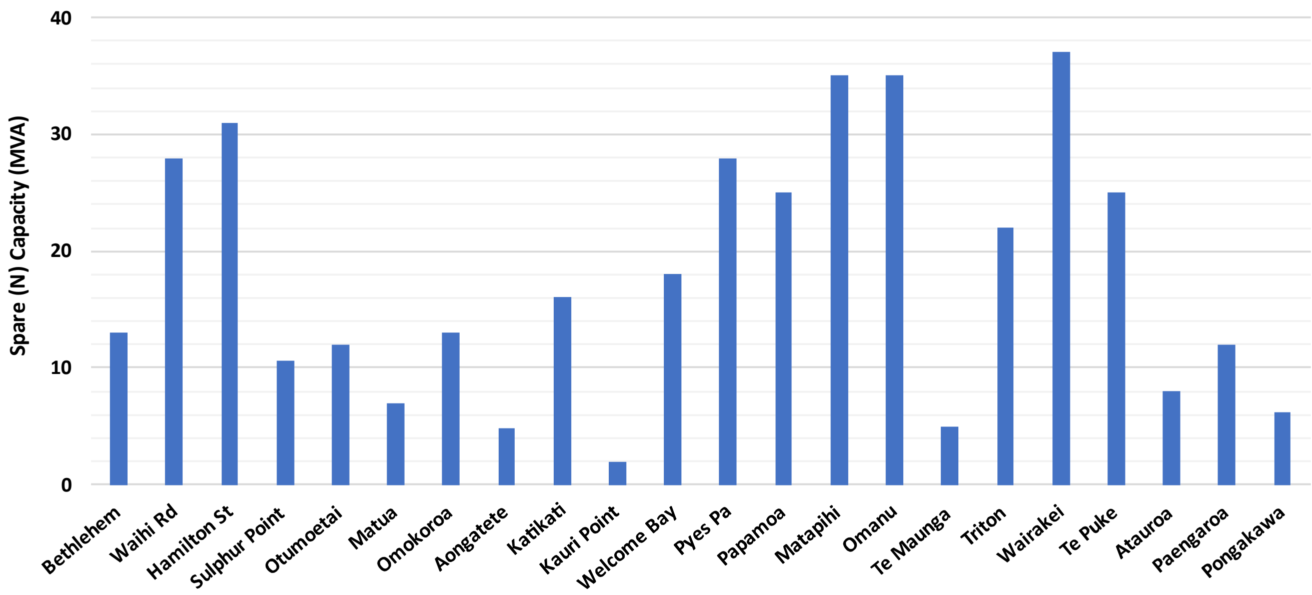


Figure 29. Summary: Approximate (N) spare capacity at Powerco's zone substations

7.4.3 Unison (Rotorua Network)

(N-1) Capacity Summary

The following Figure 30 illustrates the approximate (N-1) spare capacities at Unison's zone substations, for the disclosed peak demand estimates. It should be noted that these have been calculated based on the transformer ratings disclosed by Unison.

The spare capacities shown do not include any upstream or downstream conductor or other equipment thermal constraints, which may be discussed for selected zone substations in Section 8.

The negative or approximately zero (N-1) ratings represent a zone substation where there is no (N-1) capacity. Zone substations with (N) security have been omitted from this graph. This means that three of the six two zone substations (Fernleaf, Rainbow, and Waipa) do not have (N-1) security with respect to the supply transformers. Based on recent historical loads, of the three substations with (N-1) security, only Biak Street has spare (N-1) supply capacity available.

The Biak Street zone substations only has 10% spare (N-1) capacity left.

Figure 30 Summary: Approximate (N-1) spare capacity at Unison's zone substations.

(N) Capacity Summary

The following Figure 31 illustrates the approximate (N) spare capacities at Unison 's zone substations, for the disclosed peak demand estimates[26]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Unison.

The spare capacities shown do not include any upstream or downstream lines, cables, or other equipment thermal constraints, which may be discussed for selected zone substations in Section 8. Figure 31 indicates that there is between 39% and 60% spare (N) security capacity available at the respective zone substations.

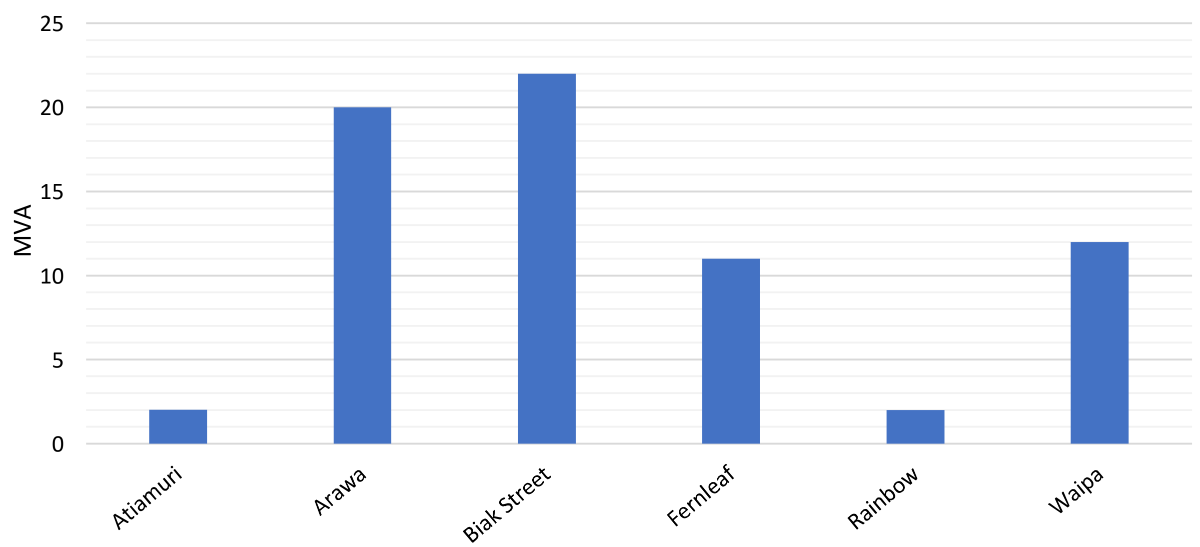


Figure 31 Summary: Approximate (N) spare capacity at Unison's zone substations.

[26] Unison's 2023 AMP available here: https://www.unison.co.nz/tell-me-about/unison-group/publications-disclosures/asset-management-plan.

8. Connection Options

The following sections describe the potential connection options for EECA's Load Sites. For simplicity Ergo has categorised (and discusses) the connection options for the Load Site's in terms of the local substations, as follows:

- Transpower GXP substations (shaded blue colour in diagrams).
- The Horizon Networks, Powerco, and Unison zone substations (shaded yellow in diagrams).

The purpose of this section is to provide a high-level assessment regarding the feasibility of connecting the Load Sites to the existing electrical infrastructure (both transmission and distribution) and where upgrades would be needed, provide an indication of potential scope, capital costs and timeframes.

The assessments made have involved a desk-based assessment using the various information provided to Ergo. Where information was not available, we have used engineering judgement. If the Load Sites are progressed further, Ergo recommends more detailed engineering assessments are undertaken in consultation with Transpower, Horizon Networks, Powerco, and Unison as the case may be. This would likely entail powerflow modelling, optioneering and concept designs to provide more refined cost estimates.

8.1 Assessment Methodology

The assessment of each individual Load Sites uses a top-down approach where the Load Site peak load is used to determine whether there appears to be spare capacity at:

- The incoming transmission lines.
- The GXP substation.
- The sub-transmission lines feeding the nearby zone substation.
- The nearby zone substation.
- The adjacent 11kV or 22kV feeder.

The spare capacity across each asset type has been determined using the information provided by Transpower and the relevant EDB or in the absence of information, assumptions made based on the asset type/voltage and typical capacity expectations.

Once the load implications across the supply network are understood, Ergo has been able to determine the implications of connecting that load i.e. the necessary infrastructure upgrades. Ergo has used a building block approach to the costing of the necessary upgrades where typical assets have a unit rate associated with them.

In terms of upgrades, these can typically be classified as:

- Minor – The "as designed" electrical system can likely connect the Load Site with minor distribution level changes and without the need for substantial infrastructure upgrades costs.

- Moderate – The "as designed" electrical system requires some infrastructure upgrades including new connections into the local zone substation and/or upgrades at the local zone substation or sub-transmission network.
- Major – The "as designed" electrical system requires substantial upgrades at both the transmission and distribution level, likely requiring significant investment.

8.2 Engineering Assumptions:

Specific engineering assumptions in this section include:

- We have used the spare capacities of both the GXP, and zone substations based on the publicly disclosed loading and capacity data (instead of the 2022 loading data provided by Transpower, Horizon Energy, Powerco, and Unison). Ergo's view is that these are typically more conservative than the actual loading and are therefore appropriate for this sort of high-level assessment.
- We have assumed the existing site security should be maintained (unless otherwise stated). For example, if the site currently presently has (N-1) security, we have recommended infrastructure upgrades to maintain this.
- The upgrades and costs of individual Load Sites are considered in isolation of the adjacent Load Sites. We have not considered the scope and costs associated with connecting multiple Load Sites at this stage.
- The Load Site loads will have unity power factor which is reasonable considering the preliminary nature of the assessment.
- Unless otherwise stated, we have assumed the existing incoming sub-transmission line/cable capacities exceed the capacity of the existing zone substation(s) they supply.
- Unless capacity information is available, we assumed existing 33 kV and 11 kV feeders are capable of supplying up to 12 MVA and 4.5 MVA respectively which is generally accepted as a conservative capacity limit in the absence of detailed information.
- Cost estimates have a Class 5[27] accuracy - suitable for concept screening. Appendix 2: outlines accuracy of the cost estimates and the general assumptions.
- Cost estimates exclude land purchase, easements and consenting. These costs are difficult to estimate without undertaking a detailed review of the available land (including a site visit) and the local council rules in relation to electrical infrastructure. For example, the upgrade of existing overhead lines or new lines/cables across private land does require utilities to secure easements to protect their assets. Securing easements can be a very time consuming and costly process. For this reason, Ergo's estimates for new electrical circuits are generally based on assuming they are installed in road reserve and involve underground cables in urban locations and overhead lines in rural locations. We note that, as a general rule, 110 kV and 220 kV lines cannot be installed in road reserve due to wide corridor requirements. In some locations the width of the road reserve is such that 66 kV and 33 kV lines cannot be installed. This issue only becomes transparent after a preliminary line design has been undertaken.
- Cost estimates only include the incumbent network operator's distribution/transmission equipment and do not include onsite equipment that may be required to supply the Load Sites

[27] Cost Estimate Classification System - As Applied in Engineering, Procurement, and Construction for the Process Industries, AACE International Recommended Practice No. 18R-97.

(for example, MV switchboards/cabling and LV switchboards/cables within the respective Load Site sites are not included).

- The time estimates provided are based on Ergo's experience. These can vary significantly depending on the scope of the project and the appetite for expediting. These should be used as a guide only.

Disclaimer: The Load Site supply investigations and capital cost estimates outlined in this report are preliminary and are only suitable for screening purposes. The capital cost estimates should not be used for final budgeting purposes in order to connect the respective Load Sites. For the larger Load Sites Ergo recommend proceeding with a Concept Design Report (CDR) to improve the accuracy of the respective cost estimate.

8.3 Edgecumbe GXP

The "Large" EECA Load Sites connecting to the Edgecumbe GXP include:

- Fonterra Edgecumbe (28.55 MVA)
- Whakatāne Growers (2.32 MVA)

The "Small" Load Site connecting to the Edgecumbe GXP is (refer to section 8.3.5):

- Whakatāne Hospital (0.59 MVA)

The geographic locations of the Load Sites are shown on the following map in relation to the local transmission and distribution substations.

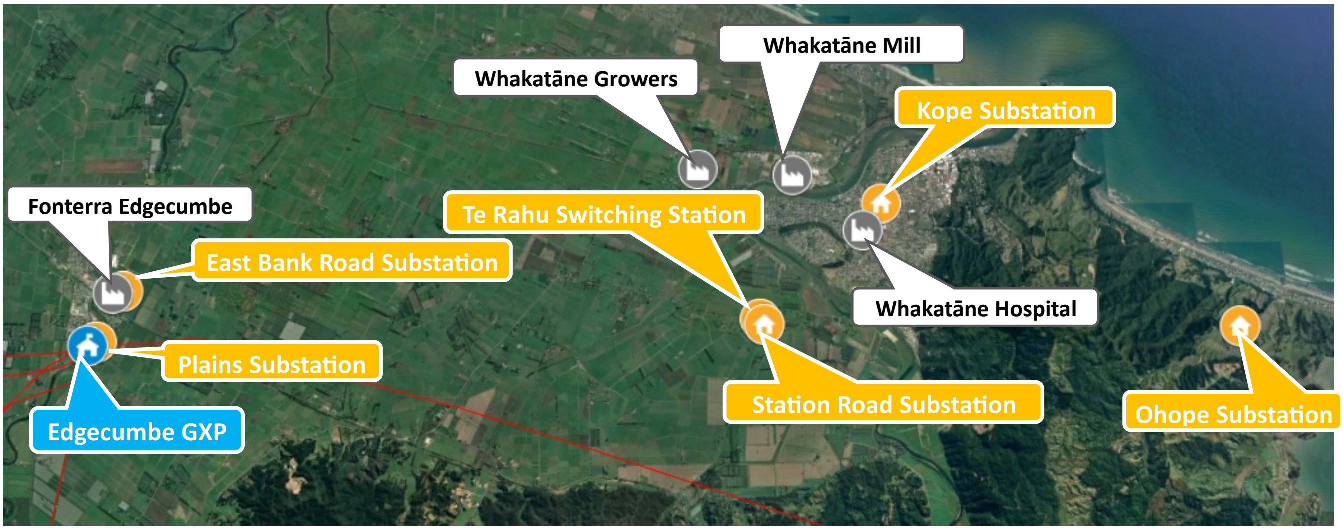


Figure 32 Edgecumbe GXP: EECA Load Sites vs local substations

8.3.1 Edgecumbe GXP Upgrade

The Edgecumbe GXP power transformers presently have 3 MVA of spare (N-1) capacity and 67 MVA of spare (N) capacity. Excluding the proposed Fonterra Edgecumbe load, all other proposed loads can be individually connected to the GXP without causing capacity issues. However, if all the proposed loads, including Fonterra, are to be connected the (N-1) capacity will be exceeded.

Transpower has identified a potential issue with supply capacity at this site; however, it has stated that future investment in capacity at this site will be customer driven.

Ergo expects an upgrade to the transformers at Edgecumbe GXP will be necessary to connect these loads. Transpower has not given an indicative cost in their 2022 TPR, however, Ergo expects an upgrade of T7 initially to be in the order of $7 million depending on the rating of the transformer replacing T7. Upgrading both T7 and T4 will come at a higher cost.

8.3.2 Fonterra Edgecumbe

		FONTERRA EDGECUMBE
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	28.55	Edgecumbe
Existing Electrical Supply to the Plant		
Fonterra Edgecumbe presently has two 11 kV cable feeders. Supply from the East Bank Zone substation is delivered over a ≈0.3 km cable with 485 A (9.3 MW) capacity, while supply from Plains Zone substation is delivered over a ≈1.2 km cable with 330 A (6.3 MW) capacity. As per Horizon Group disclosure data, only the East Bank feeder is loaded by the Fonterra site, with a maximum load of 246 A (4.69 MW). There is no load data for the incoming feeder from the Plains zone substation. East Bank zone substation has one transformer installed providing an (N) capacity of 7.5 MVA. Presently this substation has a peak load of 6.2 MVA, leaving 1.3 MVA spare capacity. Plains zone substation has a single transformer installed, providing a total (N) capacity of 16 MVA. Present maximum loading is 8.8 MVA, leaving 7.2 MVA spare capacity. Both the Plains zone substation, and the East Bank zone substation are supplied by the Edgecumbe GXP. Plains zone substation is supplied by an underground cable with a maximum capacity of 625 A (35.7 MW). East Bank zone substation is supplied by an underground cable with a maximum capacity of 330 A (18.9 MW). Edgecumbe GXP has an (N-1) capacity of 66 MVA (Summer capacity). Transpower forecasts a maximum loading of 67 MW by 2025, increasing to 91 MW by 2037. The GXP has an (N) capacity of 130 MVA. Presently, Edgecumbe GXP has 67 MVA of spare (N) capacity, and 3 MVA of spare (N-1) capacity. This limit is imposed by the capacity of T7 (67 MVA), while T4 is larger at a maximum capacity of 88MVA.		

FONTERRA EDGECUMBE

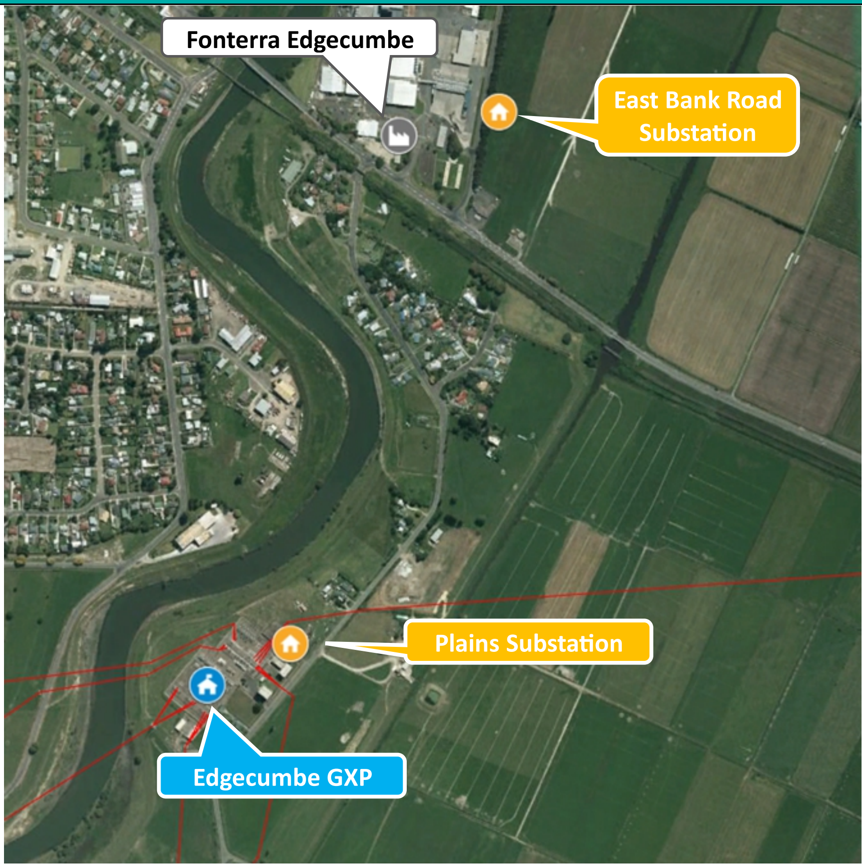


Figure 33 Fonterra Edgecumbe geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Ergo has analysed the connection of this load in a staged approach, at both (N) and (N-1) sub transmission supply security. Three stages are analysed, with each stage introducing an additional ~9.51 MVA at the Fonterra site.

<u>(N) Security Supply</u>

Stage 1: In order to connect the initial stage of 9.51 MVA, a capacity upgrade at East Bank substation is required. Ergo proposes that a secondary transformer is installed with at least 20 MVA capacity. In addition to this, a new 11 kV feeder to the site from East Bank zone substation will be required.

Stage 2: Once the second 9.51 MVA is connected (for a total of 19.02 MVA connected), the capacity of the 33 kV feeder between Edgecumbe GXP and Plains zone substation will be exceeded. Therefore, a new 33 kV feeder will be required. As with the previous stage, an additional 11 kV feeder will need to be installed.

Stage 3: Finally, in order to connect the final 9.53 MVA load (for a total of 28.55 MVA connected), further transformer upgrades at East Bank zone substation will be required. Ergo proposes that the original 7.5 MVA transformer is replaced with a new unit that can deliver at least 20 MVA. As with previous stages, an additional 11 kV feeder will be installed for this stage.

FONTERRA EDGECUMBE

(N-1) Subtransmission Supply Security

Stage 1: Presently, the (N-1) capacity is limited by supply transformers at East Bank zone substation and the T7 power transformer at Edgecumbe GXP. In order to supply an initial 9.51 MVA with (N-1) sub transmission security, Ergo proposes that two new supply transformers are installed at the zone substation. These should have at least 40 MVA capacity each, to avoid future replacements for the stage 2 and 3 loads. This would involve a replacement of the existing 7.5 MVA transformer, and the installation of a second transformer. At the GXP, Ergo proposes an upgrade of Edgecumbe GXP T7 which should be designed to accommodate the expected stage 3 load. This will increase spare (N-1) capacity at the GXP by 21 MVA, limited by the T4 transformer. Ergo notes that, depending on the timing of this project, upgrades may bring forward or alter the capacity required for Transpower's already planned replacement of the T7 transformer at Edgecumbe, and so a cost for this has been included.

In order to ensure (N-1) security on the sub transmission lines, an additional 33 kV feeder would be installed between Edgecumbe GXP and East Bank zone substation. Finally, an 11 kV feeder is to be installed from the zone substation into the Fonterra site to accommodate new load.

Stage 2: To connect the stage 2 load of 9.51 MVA (for a total of 19.02 MVA), an additional 33 kV feeder will be required between Edgecumbe GXP and East Bank zone substation. This will be in addition to the 33 kV feeder installed in stage 1 and will ensure suitable (N-1) capacity in the sub transmission lines. Additionally, an additional 11 kV feeder should be installed.

Stage 3: Finally, once final 9.53 MVA stage is connected (for a total of 28.55 MVA connected), the (N-1) capacity at Edgecumbe GXP will be exceeded. Therefore, Ergo proposes that the T4 transformer is upgraded to match the size of the T7 upgrade performed as part of stage 1 works. This should be designed such that (N-1) capacity supports a total of 28.55 MVA (N-1) load from Fonterra as a minimum. Ergo notes that the T4 transformer at Edgecumbe is relatively new, so Transpower may prefer to install a third transformer, which, for the purposes of this investigation, poses similar costs.

As with previous stages, an additional 11 kV feeder is to be installed as part of stage 3 works to accommodate the added 9.53 MVA.

Capital Cost Estimate

(N) Supply

Table 7 Fonterra Edgecumbe: Costing for stage 1 of an (N) security supply.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Medium supply transformer (ZSS)	1.00	$1.90
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	0.50	$0.30
		TOTAL	**$2.30**

Table 8 Fonterra Edgecumbe: Costing for stage 2 of an (N) security supply.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Single underground 33kV cable	2.00	$1.80
Subtransmission	33kV circuit breaker bay	1.00	$0.25
Distribution	Single underground 11kV cable	0.50	$0.30
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
		TOTAL	**$2.45**

Table 9 Fonterra Edgecumbe: Costing for stage 3 of an (N) security supply.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Medium supply transformer (ZSS)	1.00	$1.90
Distribution	11kV circuit breaker (ZSS)	0.50	$0.05
Distribution	Single underground 11kV cable	0.50	$0.30
		TOTAL	**$2.25**

(N-1) Subtransmission Security Supply

Table 10 Fonterra Edgecumbe: Costing for stage 1 of an (N-1) subtransmission security supply.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	Equipment	Number and Capital Cost ($M)	
Transmission	Large supply transformer (GXP)	1.00	$4.50
Subtransmission	Single underground 33kV cable	2.00	$1.80
Subtransmission	33kV circuit breaker bay	1.00	$0.25
Distribution	Single underground 11kV cable	0.50	$0.30
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Large supply transformer (ZSS)	2.00	$4.60
		TOTAL	**$11.55**

Table 11 Fonterra Edgecumbe: Costing for stage 2 of an (N-1) subtransmission security supply.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	Equipment	Number and Capital Cost ($M)	
Subtransmission	Double underground 33kV cable	2.00	$2.80
Subtransmission	33kV circuit breaker bay	2.00	$0.50
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	0.50	$0.30
		TOTAL	**$3.70**

Table 12 Fonterra Edgecumbe: Costing for stage 3 of an (N-1) subtransmission security supply.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	Equipment	Number and Capital Cost ($M)	
Distribution	Large supply transformer (GXP)	1.00	$4.50
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	0.50	$0.30
		TOTAL	**$4.90**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Time estimates to plan, design, procure, construct, and commission the works are as follows:

- (N) security:
  - Stage 1: 12 - 24 months.
  - Stage 2: 24 – 48 months.
  - Stage 3: 12 – 24 months.
- (N-1) Security:
  - Stage 1: 36 – 48 months.
  - Stage 2: 24 – 36 months.
  - Stage 3: 36 – 48 months.

Excluded is any work required to establish the Load Site, and any land acquisition and consenting, if required.

8.3.3 Whakatāne Mill

		WHAKATĀNE MILL
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	35	Edgecumbe
Existing Electrical Supply to the Plant		

Whakatāne Mill has two 33 kV predominately overhead line feeders that provide supply directly from the Edgecumbe GXP. Both lines ('WBM North' and 'WBM South') are about 12.8 km. According to Horizon Group disclosure data, the North line has a capacity of 24 MVA (420 A), whereas the South line has a capacity of 17 MVA (300 A). The maximum load currently supplied to the Whakatāne Mill site is 23 MW (400A). This peak load can be supplied solely by the North line, but not by the South line.

As mentioned previously, Edgecumbe GXP has two transformers installed giving an (N-1) capacity of 66/70 MVA (summer/winter). The peak load at the GXP in 2022 was 63 MVA, which leaves 3 MVA in spare (N-1) capacity. This limit is imposed by the capacity of T7 (67 MVA), while the T4 (N-1) limit is larger at 88MVA. The GXP also has an (N) capacity of 130 MVA, which leaves has 67 MVA of spare (N) capacity currently.

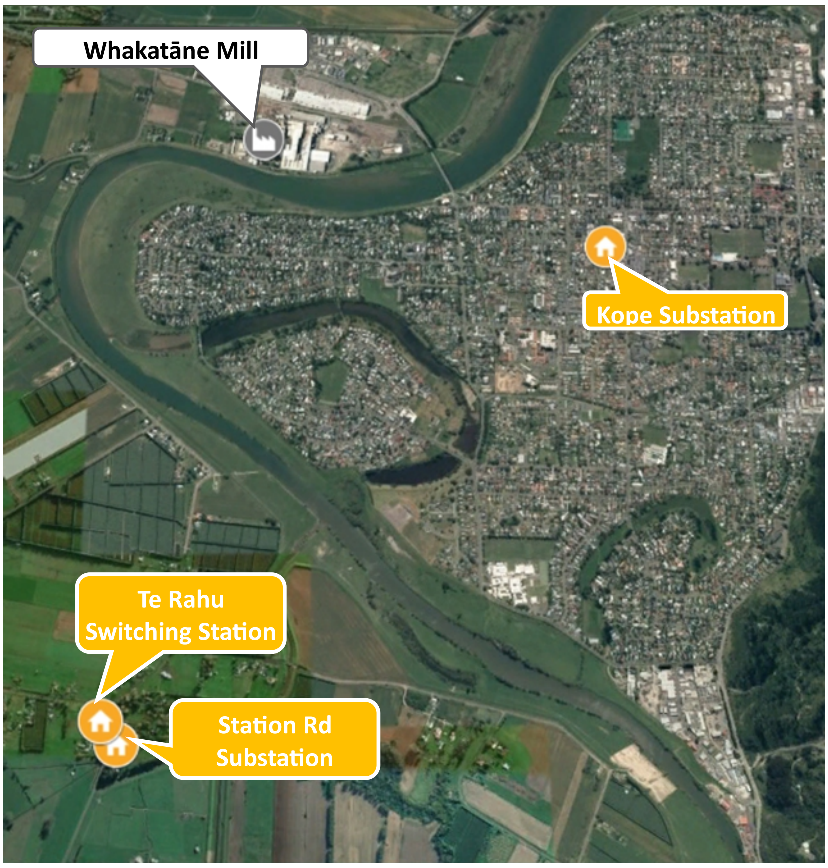


Figure 34 Whakatāne Mill geographic location in relation to the surrounding zone substations

WHAKATĀNE MILL

Supply Option(s) for New Load

Ergo has approached the connection of this load in a staged approach to reduce upfront investment costs. Additionally, options for an (N-1) or (N) security of supply at the Edgecumbe GXP are presented. For both security options, three stages are analysed, with the first two stage introducing an additional 11 MVA load each, and the third introducing an additional 13 MVA load at the Whakatāne Mill site.

Ergo notes that as the site is presently supplied at 33 kV, Ergo has not considered the 11 kV or lower voltage reticulation around the site. Additional costs will apply for these upgrades, however Ergo does not have visibility on the existing systems at the site or the upgrades required.

(N) Security Supply

Stage 1: For stage 1, no network upgrades are expected.

Stage 2: Once the second 11 MVA is connected (for a total of 22 MVA connected), the capacity of the two 33 kV feeders from Edgecumbe GXP will be exceeded. Ergo recommends reconductoring the South line to achieve a capacity of ~30 MVA. This would increase the total supply capacity to at least 54 MVA (assuming even load sharing between the North and South lines), which is enough for the combined original load and load from the first two stages (45 MVA).

Stage 3: To connect the final 13 MVA (for a total of 35 MVA connected plus the existing 23 MVA = 58 MVA total), the North 33 kV line which supplies the site should also be reconductored, to match the new South line (at least 30 MVA capacity).
Additionally, due to the size of the load connecting, it is likely that a Special Protection Scheme (SPS, protection scheme that sheds load after a transformer outage to prevent overloading the other transformer) may be required to prevent all Edgecumbe GXP load being disconnected when an outage coincides with peak loading.

(N-1) Security Supply

Stage 1: A capacity upgrade is required at the Edgecumbe GXP to accommodate the first 11 MVA load stage. Ergo proposes that the T7 transformer that is currently limiting the (N-1) capacity be replaced, to at least accommodate the potential 35 MVA additional load, other load growth in the area should be considered as well. Ergo notes that, depending on the timing of this project, upgrades may bring forward or alter the capacity required for Transpower's already planned replacement of the T7 transformer at Edgecumbe, and so a cost for this has been included.

Stage 2: Once the second 11 MVA is connected (for a total of 22 MVA connected), the capacity of the two 33 kV feeders from Edgecumbe GXP will be exceeded. Ergo recommends reconductoring the South and North lines to achieve a capacity of ~30 MVA each. This would increase the total supply capacity to at least 60 MVA (assuming even load sharing between the North and South lines), which is enough for the combined original load and load from the first two stages (45 MVA). A third 33 kV line should also be installed between Edgecumbe GXP and the Mill, with a similar rating to the North and South lines, to give the load (N-1) security of supply.

WHAKATĀNE MILL
Stage 3: To connect the final 13 MVA of load, a further upgrade to the Edgecumbe GXP transformers is necessary. Therefore, Ergo proposes that the T4 transformer is upgraded to match the size of the T7 upgrade performed as part of stage 1 works. As mentioned previously, the (N-1) capacity would likely be larger to accommodate load growth on the GXP. Ergo notes that the T4 transformer at Edgecumbe is relatively new, so Transpower may prefer to install a third transformer, which, for the purposes of this investigation, poses similar costs.

Capital Cost Estimate

(N) Supply

Ergo notes that the cost for reconductoring/uprating the North and South lines supplying the Mill is based on the Horizon AMP stated cost for one of these lines.

Table 13 Whakatāne Mill: Costing for stage 1 of an (N) security supply.

No network upgrades are expected for stage 1 with an (N) security supply.

Table 14 Whakatāne Mill: Costing for stage 2 of an (N) security supply.

Transmission => (N)	**Subtransmission =>**	**(N)**	**Distribution => (N)**
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Reconductor/uprate single overhead 33kV line thermal	1.00	$0.60
		TOTAL	**$0.60**

Table 15 Fonterra Edgecumbe: Costing for stage 3 of an (N) security supply.

Transmission => (N)	**Subtransmission =>**	**(N)**	**Distribution => (N)**
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Special protection scheme (GXP)	1.00	$0.50
Distribution	Reconductor/uprate single overhead 33kV line thermal	1.00	$0.60
		TOTAL	**$1.10**

(N-1) Subtransmission Security Supply

Ergo notes that the cost for reconductoring/uprating the North and South lines supplying the Mill is based on the Horizon AMP stated cost for one of these lines.

Table 16 Whakatāne Mill: Costing for stage 1 of an (N-1) security supply.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	Equipment	Number and Capital Cost ($M)	
Transmission	Large supply transformer (GXP)	1.00	$7.00
		TOTAL	$7.00

Table 17 Whakatāne Mill: Costing for stage 2 of an (N-1) security supply.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	Equipment	Number and Capital Cost ($M)	
Subtransmission	Reconductor/uprate single overhead 33kV line thermal	1.00	$0.60
Subtransmission	Single overhead 33kV line	16.00	$5.60
		TOTAL	$6.20

Table 18 Whakatāne Mill: Costing for stage 3 of an (N-1) security supply.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	Equipment	Number and Capital Cost ($M)	
Transmission	Large supply transformer (GXP)	1.00	$7.00
		TOTAL	$7.00

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Time estimates to plan, design, procure, construct, and commission the works are as follows:

- (N) security:
  - Stage 1: N/A.
  - Stage 2: 12 -24 months.
  - Stage 3: 24 – 36 months.
- (N-1) Security:
  - Stage 1: 36 – 48 months.
  - Stage 2: 12 – 24 months.
  - Stage 3: 36 – 48 months.

Excluded is any work required to establish the Load Site, and any land acquisition and consenting, if required.

8.3.4 Whakatāne Growers

WHAKATĀNE GROWERS		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	2.32	Edgecumbe
Existing Electrical Supply to the Plant		

Whakatāne Growers is supplied by Horizon Group's Station Road substation, which is supplied at 33 kV by Edgecumbe GXP via Te Rahu switching station (2 x predominantly overhead circuits, with short underground sections between Te Rahu switching station and Station Road substation). These circuits are presently loaded to a maximum of 173.8 A (9.93 MW), with a maximum capacity of 519 A (30 MW).

The site is supplied by a 3.4 km, 11 kV feeder from the Station Road substation. This feeder is presently loaded at a maximum of 160 A (3.05 MW), with a maximum capacity of 330 A (6.3 MW).

Figure 34 Whakatāne Growers geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

The Edgecumbe GXP has 3 MW of spare (N-1) capacity at the Edgecumbe GXP, which is sufficient for this additional load. However, this would accelerate the supply capacity issue at Edgecumbe. Station Rd zone substation does not have sufficient (N-1) capacity to accommodate the additional 2.3 MW load, however there is sufficient (N) capacity available.

WHAKATĀNE GROWERS
The two 33 kV circuits between Edgecumbe and Station Road (via Te Rahu) are not expected to be overloaded by the addition of this load, with the remaining capacity post load addition being 214 A (12.23 MW). In order to connect the proposed load, Ergo proposes that the existing 11 kV feeder between Station Road and the Whakatāne Growers site is utilised, leaving this feeder with 48.2 A (0.92 MW) spare capacity remaining. Due to the limited (N-1) capacity available at the Station Road substation, an upgrade of the 33 kV/11 kV transformers would be necessary if (N-1) security was desired. However, this transformer upgrade is not required if (N) security is acceptable. If Whakatāne Growers were to opt for the (N) security subtransmission option, a Special Protection system would be required at the Station Road zone substation to protect supply security for other customers.
Capital Cost Estimate

Table 19 Whakatāne Growers: Capital cost estimate to supply the Load Site ((N) security of supply)

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Special protection system (ZSS)	1.00	$0.25
		TOTAL	**$0.25**

Table 20 Whakatāne Growers: Capital cost estimate to supply the Load Site with (N-1) sub transmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Medium supply transformer (ZSS)	2.00	$3.80
		TOTAL	**$3.80**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure
It is estimated to take 3-6 months to plan, design, procure, construct, and commission the works required for the (N) security option. However, due to the transformer replacement the (N-1) option is estimated to take 12-24 months. Excluded are any works required to establish the Load Site. Any land acquisition and consenting, if required, is excluded.

8.3.5 Small Opportunities

Below is a summary of the "small" Load Sites that were provided by EECA but due to their size, are unlikely to have a material effect on the distribution or transmission network. The costs provided are estimates to provide RMUs and appropriately sized distribution transformers to supply the site.

Table 21 Summary of the "small" Load Sites that are unlikely to have a material effect on the MV/HV network.

Opportunity name	Zone sub	Zone sub (N-1) spare capacity (MVA)	Zone sub (N) spare capacity (MVA)	Current Feeder loading (MW)	Opportunity Load (MW)	Estimate cost ($k)
Whakatāne Hospital	Kope	-3.2	12.8	3.74	0.59	200

Each Load Site is estimated to take 3 - 6 months to plan, design, procure, construct and commission the works.

Estimates exclude:

- The work required to establish the Load Site.
- Land acquisition and consenting, if required.

8.3.6 Effect of all Load Sites Connecting to Edgecumbe GXP

The following Figure 35 illustrates the Edgecumbe GXP 33 kV load profile together with the load profiles of all the Load Sites within the Edgecumbe GXP region. Also shown in Figure 35 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Edgecumbe GXP would increase to 98.5 MVA, an increase of 35 MVA on the 2022 maximum demand. Given that the independent sum of the individual load peaks is 129.5 MVA there is a diversity factor of 0.76 between the loads.
- Based on Ergo's analysis, the Edgecumbe GXP's (N-1) limit is expected to be exceeded. Transpower upgrades will be required to support load growth in this area. Further detail can be found in the discussion in section 8.3.1.

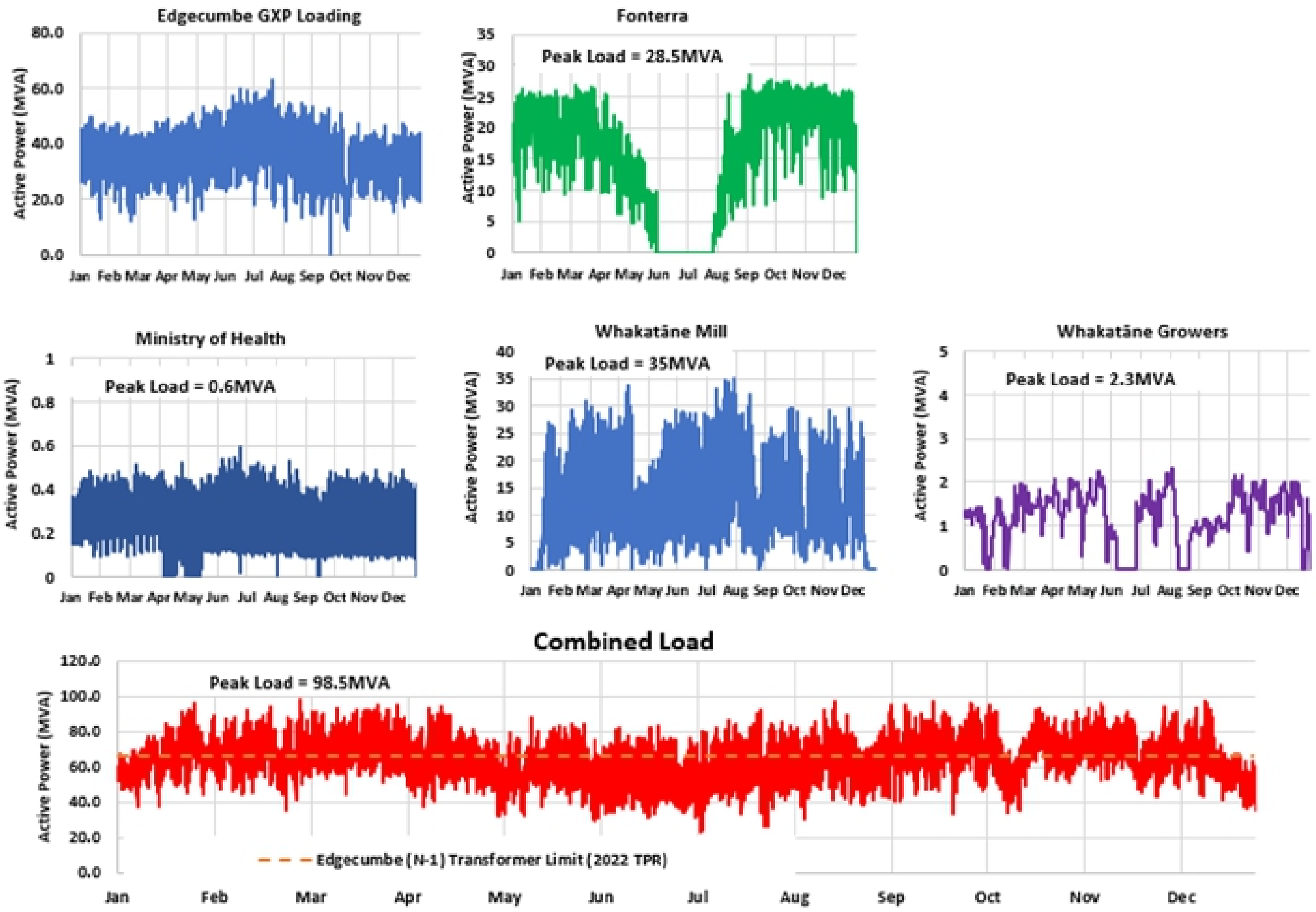


Figure 35 Loading Profiles: Edgecumbe GXP 2022 33 kV historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.4 Kaitemako GXP

The "Large" EECA Load Site connecting to the Kaitemako GXP is:

- Winstone Wallboards GIB Tauranga (49.38 MVA)

There are no "Small" Load Sites connecting to the Kaitemako GXP.

The geographic locations of the Load Sites are shown on the following map in relation to the local transmission and distribution substations.

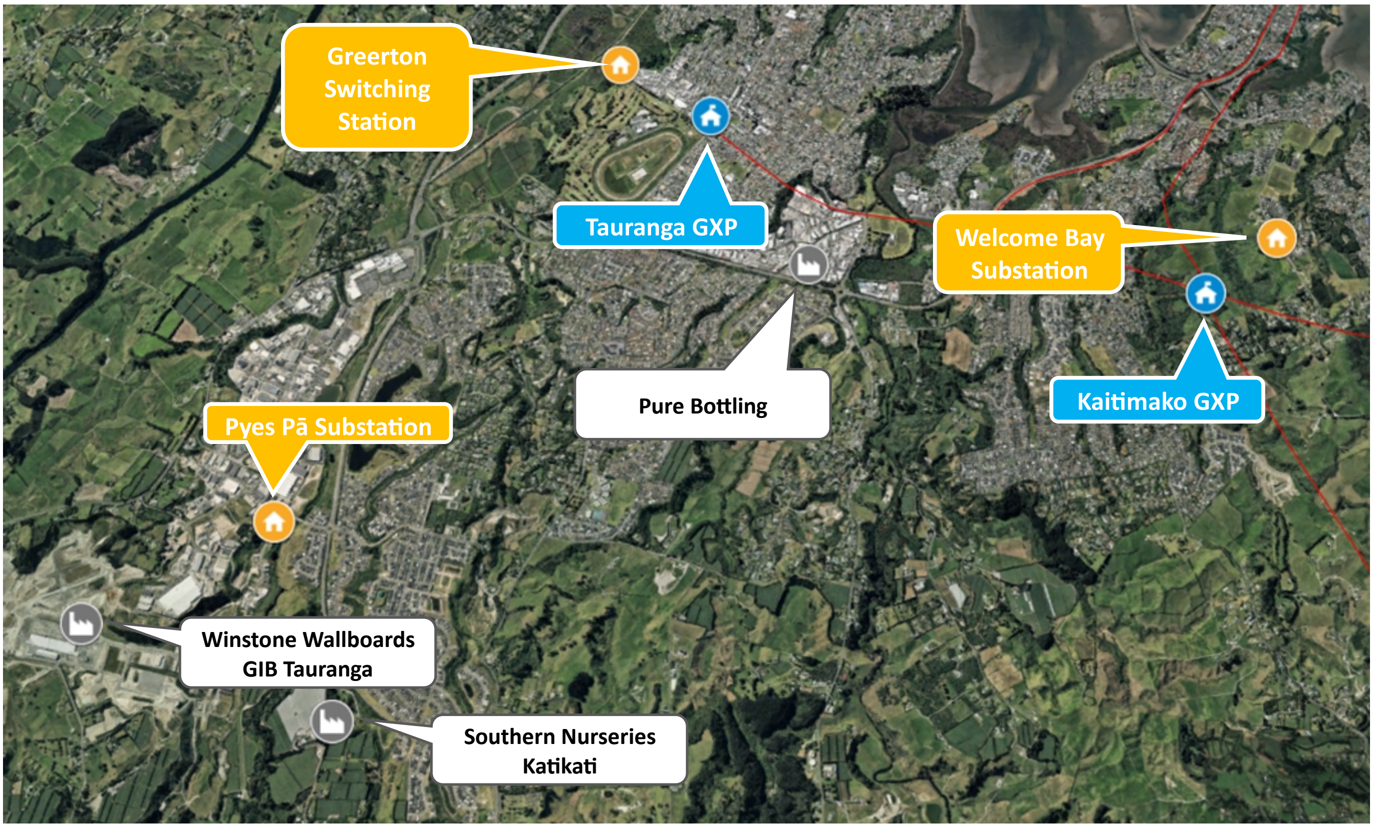


Figure 36 Kaitemako GXP: EECA Load Sites vs local substations

8.4.1 Kaitemako GXP Upgrade

Ergo has suggested to connect the only load site presently supplied by Kaitemako, Winstone Wallboards, to the Tauranga GXP. As such, no load increase is expected at Kaitemako GXP, with no GXP upgrades considered.

8.4.2 Winstone Wallboards GIB Tauranga

WINSTONE WALLBOARDS GIB TAURANGA		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	49.38	Kaitemako
Existing Electrical Supply to the Plant		

Winstone Wallboards is presently supplied at 11 kV by Powerco's Pye's Pā zone substation, which is supplied at 33 kV from Kaitemako GXP. Previously supply was from Tauranga GXP, however load was switched to Kaitemako due to constraints on Transpower's 110 kV transmission lines between Kaitemako and Tauranga.

Transpower is investigating options to resolve these constraints in collaboration with Powerco, with the objective of reconnecting Pyes Pā to Tauranga GXP. These options look to increase transmission capacity by adding a new Kaitemako – Tauranga line, and installing a third supply transformer at Tauranga GXP. Transpower has slated the upgrades as customer investments.

Pyes Pā zone substation presently has a peak load of 20 MVA, with 0 MVA of spare (N-1) capacity and 20 MVA of spare (N) capacity. Pye's Pā is supplied by 2x 20 MVA rated feeders from Kaitemako GXP.

Winston Wallboards is approximately 2 km from Pyes Pā, with a further 5.5 km to Tauranga GXP.

Figure 37 Winstone Wallboards GIB Tauranga geographic location in relation to the surrounding zone substations

WINSTONE WALLBOARDS GIB TAURANGA
Supply Option(s) for New Load
Ergo has analysed connection options as a staged approach, reducing upfront investment costs. Due to the size of the proposed load and lack of spare capacity at the zone substation, it is expected that the final outcome will be a new zone substation installed locally to the Winstone Wallboards site. Without a nearby zone substation it would be necessary to install a significant number of 11 kV feeders. Stages leading up to this new zone substation can be designed to minimise cost duplication when transitioning the site from Pyes Pā zone substation. <u>Stage 1</u> Ergo proposes that as an intermediary stage Winstone Wallboards can connect 20 MVA to Pyes Pā zone substation at (N) security (for a total of 20 MVA connected). Beyond this point the supply transformers at Pyes Pā become a constraint. This load would be supplied by a new 33 kV feeder, establishing a 33 kV supply to, and new zone substation at, the site. <u>Stage 3</u> In order to connect the remaining 29.38 MVA, Ergo proposes that the load takes supply directly from Tauranga GXP, and given the size of the proposed load this connection may initiate Transpower upgrades beyond those being investigated. New 33 kV feeders would be run from Tauranga GXP, with a proposed 7.2 km underground route along Kopurererua Stream and into the Pyes Pā industrial park. This route would go via the Pyes Pā zone substation, and utilise cables installed as part of Stage 1 for the final stretch. It is expected that for an (N-1) supply of 49.38 MVA, four 33 kV feeders would be required. There are presently two spare 33 kV circuit breakers at Tauranga GXP, and as such a further two 33 kV circuit breakers would be required. It is unclear whether there is space at Tauranga GXP for these additional breakers, and therefore installing these breakers may initiate further significant Transpower upgrades. It is assumed that 11 kV feeders will be reticulated around the Winstone Wallboards site from the proposed new zone substation.

Capital Cost Estimate

Stage 1

Table 22 Winstone Wallboards GIB Tauranga: Capital cost estimate for proposed stage 2.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	Equipment	Number and Capital Cost ($M)	
Distribution	Single underground 33kV cable	2.00	$1.80
Distribution	33kV circuit breaker (ZSS)	1.00	$0.30
Distribution	Medium zone substation	1.00	$8.00
		TOTAL	**$10.10**

Stage 2

Table 23 Winstone Wallboards GIB Tauranga: Capital cost estimate for proposed stage 3.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	Equipment	Number and Capital Cost ($M)	
Distribution	Double underground 33kV cable	16.00	$22.40
Distribution	33kV circuit breaker bay	2.00	$0.50
		TOTAL	**$22.90**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Does not include any costs that may be associated with accelerating Transpower work to increase capacity at Tauranga GXP. Transpower has indicated that the cost to upgrade these assets would be approximately $70 million.

Timeframe to Establish New Electrical Infrastructure
It is estimated that each stage will take the following time periods to plan, design, procure, and commission: • Stage 1: 6-12 months. • Stage 2: No infrastructure upgrades, so no time associated. • Stage 3: 36-48 months. Excluded are any work required to establish the Load Site. Any land acquisition and consenting, if required, is excluded.

8.4.3 Effect of all Load Sites Connecting to Kaitemako GXP

As Ergo expects Winstone Wallboards to connect into Tauranga GXP, no impacts are expected on Kaitemako GXP.

8.5 Mt Maunganui GXP

The "Large" EECA Load Sites connecting to the Mt Maunganui GXP include:

- Dominion Salt (10.25 MVA)
- Bakels Edible Oils (2.61 MVA)
- Lawter (2.23 MVA)
- Fulton Hogan Mt Maunganui (1.77 MVA)
- Ingham Mt Maunganui (1.02 MVA)

The "Small" Load Sites connecting to the Mt Maunganui GXP include (refer to sections 8.5.7 and 8.5.9):

- Downer Mt Maunganui (0.72 MVA)
- Ballance Agri-Nutrients Ltd (0.44 MVA)

The geographic locations of the Load Sites are shown on the following map in relation to the local transmission and distribution substations.

Figure 38 Mt Maunganui GXP: EECA Load Sites vs local substations

8.5.1 Mt Maunganui GXP Upgrade

The Mt Maunganui GXP presently has 25 MVA of spare (N-1) capacity and 84 MVA of spare (N) capacity, based on the transformer ratings. Based on the line ratings, for winter (as the GXP load peaks in winter), the GXP has approximately 11 MVA of spare (N-1) capacity and 88 MVA of spare (N) capacity.

The transformer and line (N-1) spare capacity are adequate for any given single Load Site to connect to the network, however if multiple or all of the Load Sites connect, the (N-1) line supply capacity to the GXP may be exceeded. In this case the lines suppling the GXP may need to be upgraded, at a cost of approximately $11.7 M (total 17 km of overhead line and 1 km of underground cable). Alternatively, depending on the load growth prior to the Load Sites connecting, an SPS may be required at the GXP.

Ergo understands that there is a planned load shift of the Papamoa zone substation from the Mt Maunganui GXP to the Te Matai GXP which will mitigate the supply issues, but not eliminate them.

Ergo notes that the Mt Maunganui GXP may be impacted by Transpower's MCP for the area. Once agreed upon, the plan for the area should ease some of the constraints affecting this GXP. However, while the solution is unknown, the total cost associated with these upgrades is also unknown. Ergo expects that the associated costs will be shared among all customers affected (e.g. via electricity bill Transmission Charges). However, it is possible that if connection of the Load Sites brings upgrades forward, that a portion of the cost would fall to the Load Sites.

8.5.2 Dominion Salt

DOMINION SALT		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	10.25	Mt Maunganui
Existing Electrical Supply to the Plant		
Dominion Salt is presently supplied by Powerco's Triton substation via an underground 11 kV feeder, which is in turn supplied from Mt Maunganui GXP by two 33 kV sub transmission circuits. These circuits have a maximum capacity of 330 A (18.8 MVA) and 404 A (23 MVA). This site is located approximately 0.6 km from Triton. In turn, Triton zone substation is approximately 4.6 km from Mt Maunganui GXP. Triton zone substation is currently being redeveloped, with an outdoor to indoor (ODID) conversion and transformer replacement scheduled for this year in the Powerco Asset Management Plan. These projects will leave Triton with an (N-1) capacity of 24 MVA, and space for three future feeders. There is currently a maximum loading of 20 MVA on Triton zone substation. This would leave the substation with 28 MVA of spare (N) capacity, and 4 MVA of spare (N-1) capacity after these upgrades.		

Figure 39 Dominion Salt geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

DOMINION SALT
For (N) security two new underground 11 kV feeders would be required to the site from Triton zone substation. 11 kV circuit breakers can be installed in two of the three spaces earmarked for future feeders. In this case, both the zone sub and GXP have suitable spare (N) capacity, so no transformer upgrades are required. However, Ergo notes that due to the size of the load and existing constraints on the transmission lines, an SPS would likely be required, on both 110 kV lines connecting to the GXP. Additionally, there is suitable capacity in the 33 kV sub transmission lines to supply the additional load at (N) security. Therefore no upgrades to the sub transmission lines would be required. If Dominion Salt were to opt for an (N) security supply solution, a Special Protection System is likely to be required at Triton zone substation to protect supply security for other customers. Ergo notes that due to the load growth in the area, and nature of the other loads supplied by the Triton zone substation (i.e. the local port, as well as numerous industrial loads), an (N) supply connection may not be suitable for Powerco's needs in the area. For an (N-1) security case, the current 33 kV sub transmission lines to Triton zone sub do not have sufficient capacity for (N-1) security to supply this load. Therefore, Ergo expects an extra 33 kV line would be required, along with a new 33 kV switchboard at Triton. Powerco has estimated these upgrades at $12-16M (CAPEX). Triton zone substation does not have suitable (N-1) capacity to supply this load, and therefore an upgrade of the supply transformers would be required. Powerco has provisioned space for a future transformer, so it is likely that a third transformer would be installed to increase (N-1) capacity. There is existing (N-1) capacity at the Mt Maunganui GXP, and therefore no upgrades to the power transformers are expected. However, Ergo notes that due to the size of the load and existing constraints on the transmission lines, an SPS would likely be required, on both 110 kV lines connecting to the GXP.

Capital Cost Estimate

Table 24 Dominion Salt: Capital cost estimate to supply the Load Site with (N) security.

Transmission => (N-1)	Subtransmission => (N)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Distribution	Special protection system (ZSS)	1.00	$0.25
Distribution	Double underground 11kV cable	1.20	$0.96
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
		TOTAL	**$1.91**

Table 25 Dominion Salt: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Subtransmission	Triton substation upgrade 33 kV supply	1.00	$16.00
Distribution	Double underground 11kV cable	1.20	$0.96
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Medium supply transformer (ZSS)	1.00	$1.90
		TOTAL	**$19.56**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

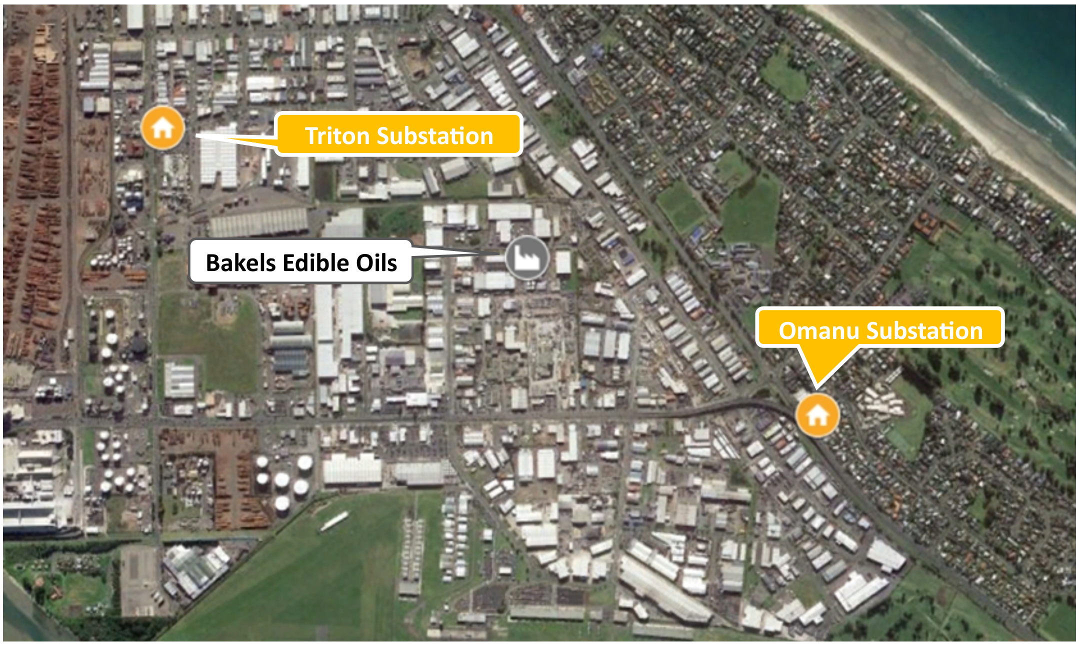
For the (N) security case, it is estimated to take 12-24 months to plan, design, procure, construct, and commission the works.

For the (N-1) security case, it is estimated to take 24-36 months to plan, design, procure, construct, and commission the works.

Excluded are any work required to establish the Load Site.

Any land acquisition and consenting, if required, is excluded.

8.5.3 Bakels Edible Oils

BAKELS EDIBLE OILS		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	2.61	Mt Maunganui
Existing Electrical Supply to the Plant		
Bakels Edible Oils is presently supplied at 11 kV by Powerco's Triton zone substation, which is supplied at 33 kV by Mt Maunganui GXP. The plant is located approximately 2.5 km from Triton zone substation, which in turn is located approximately 5.3 km from the GXP. However, this site is potentially closer to Omanu zone substation. With approximately 2 km between the load site and Omanu substation, and a further 2.5 km from Omanu to the GXP.  Figure 40 Bakels Edible Oils geographic location in relation to the surrounding zone substations		
Supply Option(s) for New Load		
Triton zone substation has 28 MVA of spare (N) capacity, and 4 MVA of spare (N-1) capacity. However, Omanu zone substation has spare (N) capacity of 35 MVA, and spare (N-1) capacity of 11 MVA. Mt Maunganui has more than enough spare (N) and (N-1) capacity to supply the proposed load. Therefore, to supply this load, only an additional new 11 kV feeder is required with an associated circuit breaker. Based on proximity and capacity, Ergo suggest this feeder would come from one of the spare spaces at Omanu zone substation. Ergo proposes that this site shares a feeder with the proposed Fulton Hogan load. As Omanu has spare (N-1) capacity, this would provide (N-1) subtransmission security.		

Capital Cost Estimate

Table 26 Bakels Edible Oils: Capital cost estimate to supply the Load Site for (N-1) security at subtransmission.

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single underground 11 kV cable	2.00	$1.20
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
		TOTAL	**$1.30**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 6-12 months to plan, design, procure, construct, and commission the works.

Excluded are any work required to establish the Load Site.

Any land acquisition and consenting, if required, is excluded.

8.5.4 Lawter

LAWTER		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	2.23	Mt Maunganui
Existing Electrical Supply to the Plant		

The Lawter site is presently supplied by Powerco's Triton zone substation. Triton substation is fed at 33 kV by Mt Maunganui GXP. The load site is approximately 1 km away from Triton.

As discussed, Triton zone substation has 28 MVA of spare (N) capacity, and 4 MVA of spare (N-1) capacity.

Figure 41 Lawter geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

For both an (N) security and (N-1) security supply, a new 11 kV feeder would be required from Triton zone substation.

Lawter is in close proximity to Balance Agri-Nutrients, and therefore Ergo suggests that both sites are fed by this 11 kV feeder.

Capital Cost Estimate

Table 27 Lawter: Capital cost estimate to supply the Load Site from Triton zone substation with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single underground 11 kV cable	1.00	$0.60
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
		TOTAL	**$0.70**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 6-12 months to plan, design, procure, construct, and commission the works.

Excluded are any work required to establish the Load Site.

Any land acquisition and consenting, if required, is excluded.

8.5.5 Fulton Hogan Mt Maunganui

		FULTON HOGAN MT MAUNGANUI
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	1.77	Mt Maunganui

Existing Electrical Supply to the Plant

Fulton Hogan Mt Maunganui is presently supplied by Powerco's Triton zone substation. Triton substation is fed at 33 kV by Mt Maunganui GXP. The load site is approximately 1 km away from Triton.

However, Omanu substation presently has more capacity and is closer than Triton. Therefore, Ergo expects that a large load at Fulton Hogan may be connected to this supply. The Fulton Hogan site is 0.6 km from Omanu zone substation.

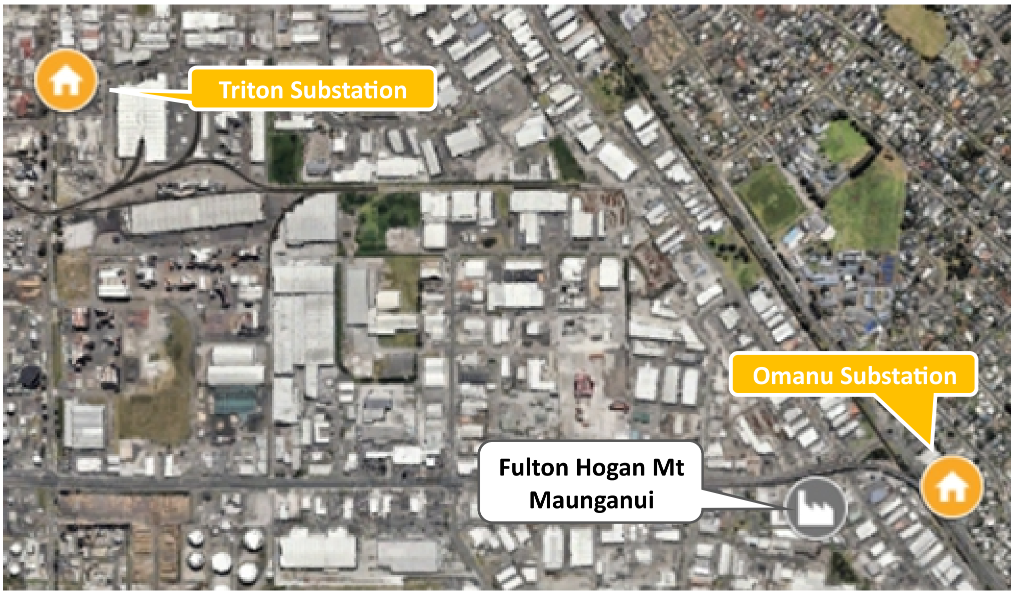


Figure 42 Fulton Hogan Mt Maunganui geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

For both an (N) and (N-1) security supply case, Ergo would propose a new 11 kV feeder from Omanu zone substation, as there is suitable capacity and space for an additional 11 kV feeder.

Further upstream, there is suitable capacity on the 33 kV sub transmission lines, and sufficient (N-1) capacity at Mt Maunganui GXP.

Capital Cost Estimate

Table 28 Fulton Hogan Mt Maunganui: Capital cost estimate to supply the Load Site from Omanu zone substation with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single underground 11 kV cable	0.60	$0.36
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
		TOTAL	**$0.46**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 6-12 months to plan, design, procure, construct, and commission the works.

Excluded are any work required to establish the Load Site.

Any land acquisition and consenting, if required, is excluded.

8.5.6 Ingham Mt Maunganui

INGHAM MT MAUNGANUI		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	1.02	Mt Maunganui
Existing Electrical Supply to the Plant		
Ingham Mt Maunganui is presently supplied by Powerco's Triton zone substation. Triton substation is fed at 33 kV by Mt Maunganui GXP. The load site is approximately 1.2 km away from Triton.		

Figure 43 Ingham Mt Maunganui geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load
For both an (N) and (N-1) security supply case, a new 11 kV feeder from Triton zone substation is required. No further works would be required, as there is sufficient (N) capacity at Triton, Mt Maunganui GXP, and on the sub transmission lines. Ergo proposes that Ingham connects to one of the feeders that have been proposed for the Dominion Salt site, as Triton zone substation has limited spaced for additional 11 kV feeders. Alternatively, the load could connect to the existing, nearby, Totara St North feeder.

Capital Cost Estimate
Approximate cost of an RMU and distribution transformer to supply the load is $0.26M. Does not include the costs of any switchgear on the plant site.
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 6-12 months to plan, design, procure, construct, and commission the works. Excluded are any work required to establish the Load Site. Any land acquisition and consenting, if required, is excluded.

8.5.7 Small Opportunities

Below is a summary of the "small" Load Sites that were provided by EECA but due to their size, are unlikely to have a material effect on the distribution or transmission network. The costs provided are estimates to provide RMUs and appropriately sized distribution transformers to supply the site.

Table 29 Summary of the "small" Load Sites that are unlikely to have a material effect on the MV/HV network

Opportunity name	Zone sub	Zone sub (N-1) spare capacity (MVA)	Zone sub (N) spare capacity (MVA)	Current Feeder loading (MW)	Opportunity Load (MW)	Estimate cost ($k)
Downer Mt Maunganui	Omanu	11	35	4	0.72	200
Balance Agri-nutrients Ltd.	Triton	4	22	3.5	0.44	130

Each Load Site is estimated to take 3 - 6 months to plan, design, procure, construct and commission the works.

Estimates exclude:

- The work required to establish the Load Site.
- Land acquisition and consenting, if required.

8.5.8 Combined Load on Zone Substations

8.5.8.1 Triton

Five of the loads on Mt Maunganui GXP are expected to connect to Triton zone substation. The loads are Dominion Salt, Ingham Mt Maunganui, Ballance Agri-nutrients Ltd Mt Maunganui, Fulton Hogan Mt Maunganui, and Lawter. The sum of peaks of these loads is 15.71 MVA, which the zone substation does not have (N-1) capacity for. However, the upgrades discussed in the dedicated sections for each load above are considered adequate to support all three loads. Further upgrades of Triton zone substation are not considered.

Note that all estimations for connections to Triton zone substation are subject to completion of ODID conversion and transformer upgrades outlined in Powerco's Asset Management Plan.

8.5.9 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Mt Maunganui GXP gives a combined load of 1.16 MVA. When the load shapes are combined, they result in the following load shape (Figure 44), with a maximum load of 1.16 MVA, with a diversity factor of 1.

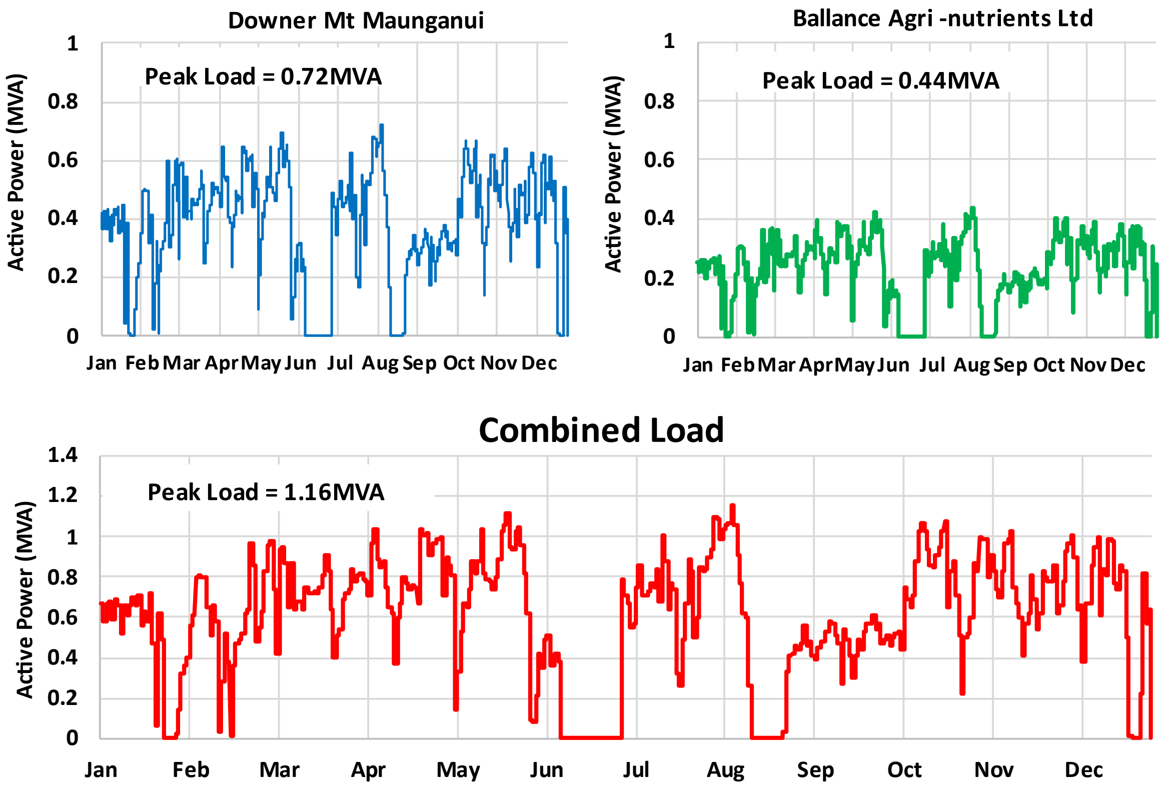


Figure 44 Loading Profiles: Mt Maunganui GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.5.10 Effect of all Load Sites Connecting to Mt Maunganui GXP

The following Figure 45 illustrates the Mt Maunganui GXP 33 kV load profile together with the load profiles of all the Load Sites within the Mt Maunganui GXP region. Also shown in Figure 45 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Mt Maunganui GXP would increase to 80.8 MVA, an increase of 14.6 MVA on the 2022 maximum demand. Given that the independent sum of the individual load peaks is 85.2 MVA there is a diversity factor of 0.95 between the loads.
- Based on Ergo's analysis, the Mt Maunganui GXP's (N-1) line limit is expected to be exceeded. Ergo has discussed mitigation for this in Section 8.5.1.

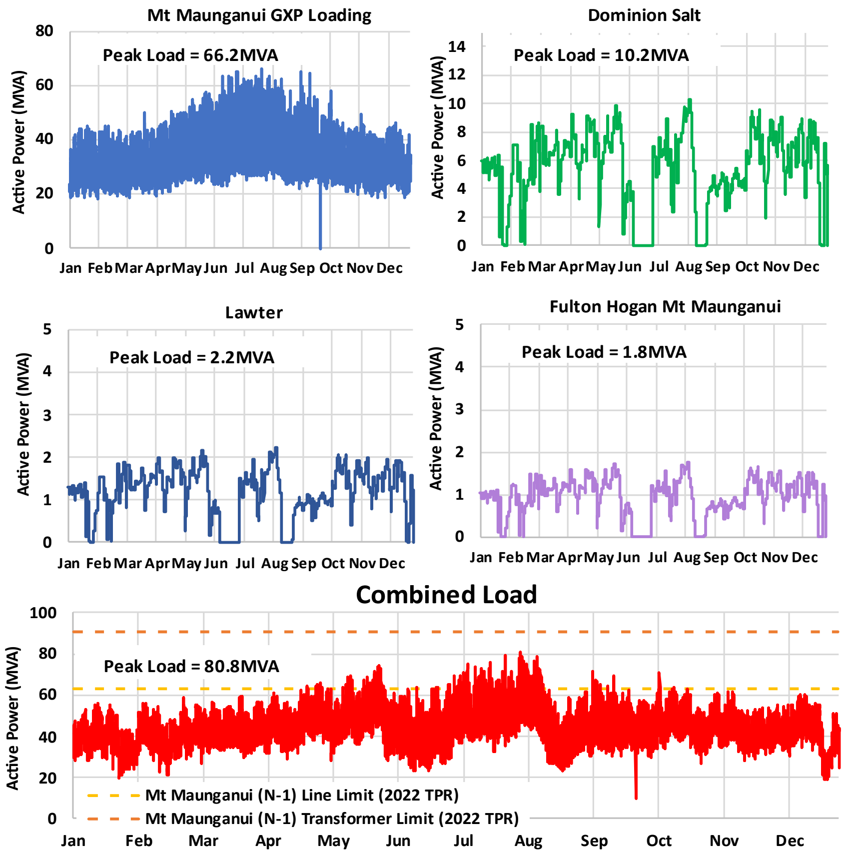


Figure 45 Loading Profiles: Mt Maunganui GXP 2022 33 kV historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.6 Rotorua GXP

The "Large" EECA Load Sites connecting to the Rotorua 33 kV GXP include:

- Fonterra Reporoa (16.80 MVA)
- Alsco Rotorua (2.16 MVA)

None of the "Large" EECA Load Sites are expected to connect to the Rotorua 11 kV GXP.

The "Small" Load Sites connecting to the Rotorua GXP include (refer to section 8.6.4):

- Malfroy School (0.30 MVA) (connecting to the 11 kV GXP)
- Rotorua Hospital (0.10 MVA) (connecting to the 33 kV GXP)

The geographic locations of the Load Sites are shown on the following map in relation to the local transmission and distribution substations.

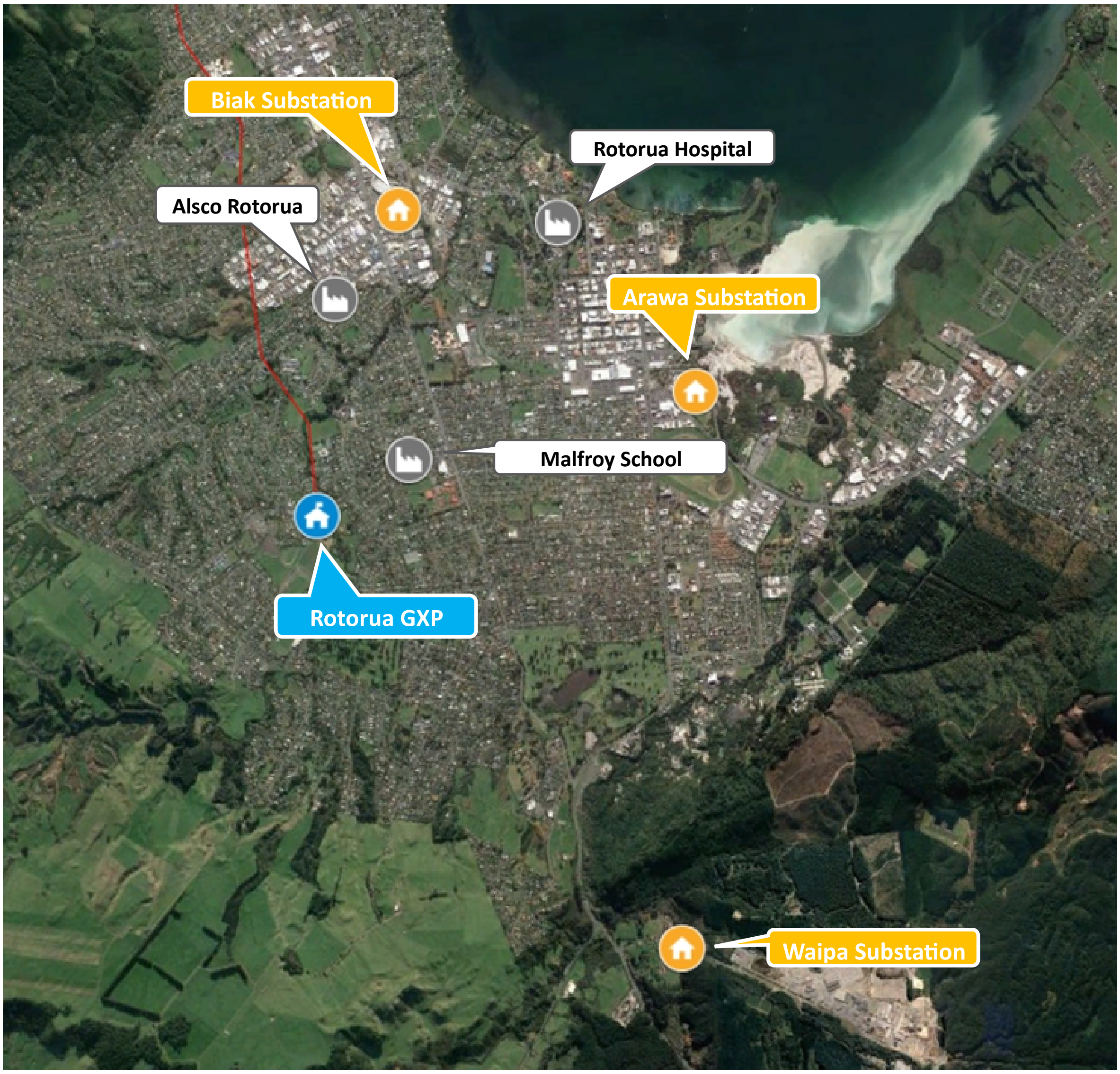


Figure 46 Rotorua GXP: EECA Load Sites vs local substations (Rotorua Enlargement)

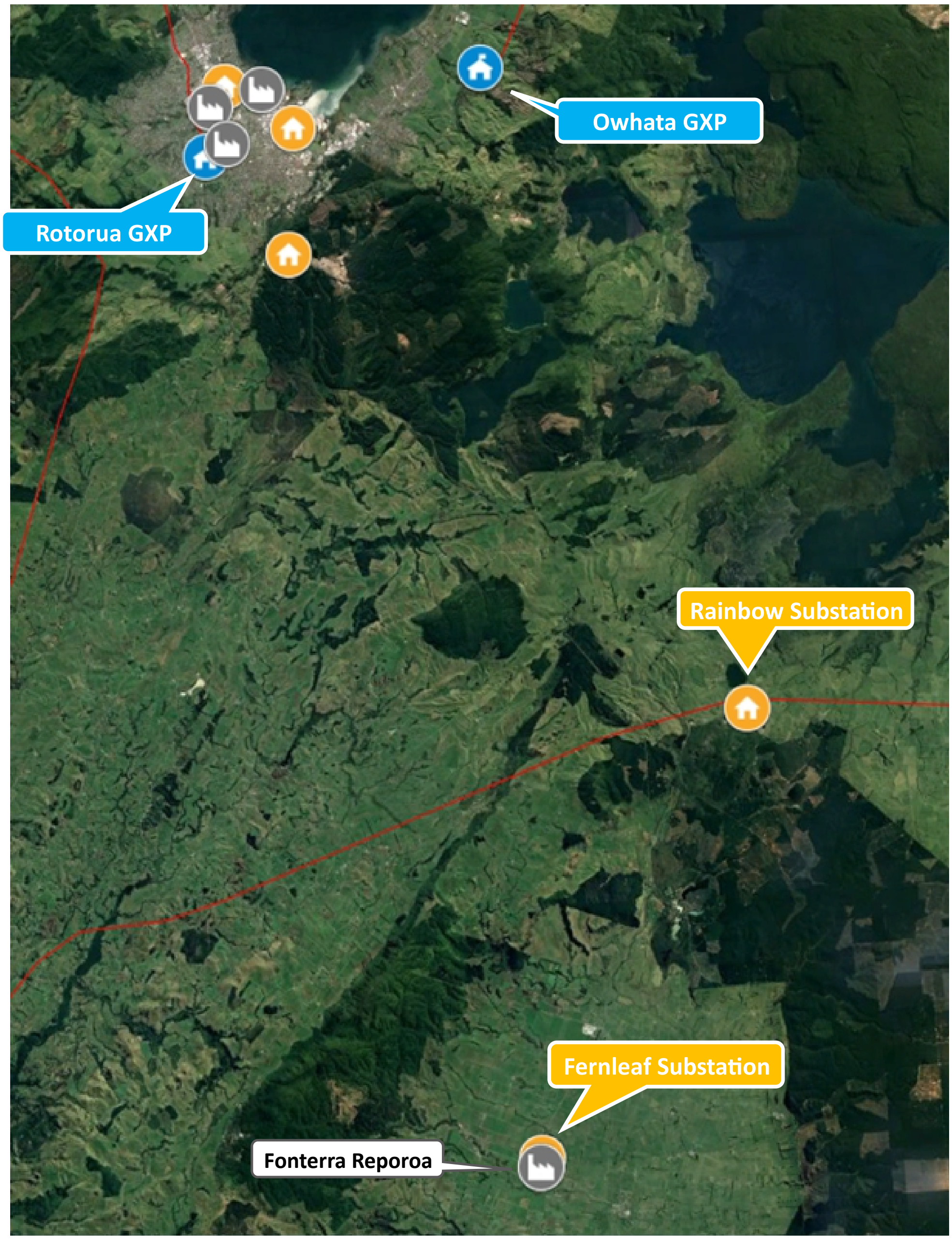


Figure 47 Rotorua GXP: EECA Load Sites vs local substations

8.6.1 Rotorua GXP Upgrade

The Rotorua 33 kV GXP presently has 21 MVA of spare (N-1) capacity and 73 MVA of spare (N) capacity, while the Rotorua 11 kV GXP presently has 10 MVA of spare (N-1) capacity and 45 MVA of spare (N) capacity. Connection of the proposed load sites to the GXPs is not expected to exceed these spare capacities. However, the Rotorua-Tarukenga 110 kV transmission circuit (N-1) capacity will be exceeded (this is forecast to happen even in the absence of the proposed load connections as mentioned above). Transpower and Unison are investigating possible solutions that can facilitate decarbonisation such as transferring 11 kV load to the Ōwhata or Tarukenga GXPs, upgrading/reconfiguring the Rotorua GXP, and reconductoring/variably rating the 110 kV circuits[20].

8.6.2 Fonterra Reporoa

FONTERRA REPOROA		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	16.80	Rotorua 33 kV
Existing Electrical Supply to the Plant		

Fonterra Reporoa is presently supplied at 11 kV by Fernleaf zone substation. Fernleaf is in turn supplied at 33 kV by Rotorua GXP.

There is a single 33 kV feeder supplying Fernleaf zone substation, however this feeder is presently fully loaded at 409 A. Fernleaf zone substation presently has 2x transformers, operated in an open 11 kV bus configuration, to reduce the voltage impact to Fonterra from 11 kV faults.

Fernleaf zone sub presently only provides (N) security and has 11 MVA of spare capacity. Rotorua GXP currently has 21 MVA of (N-1) capacity, and 71 MVA of (N) capacity.

The Fonterra site is located approximately 0.3 km from Fernleaf zone substation, which in turn is located 38 km from Rotorua GXP.

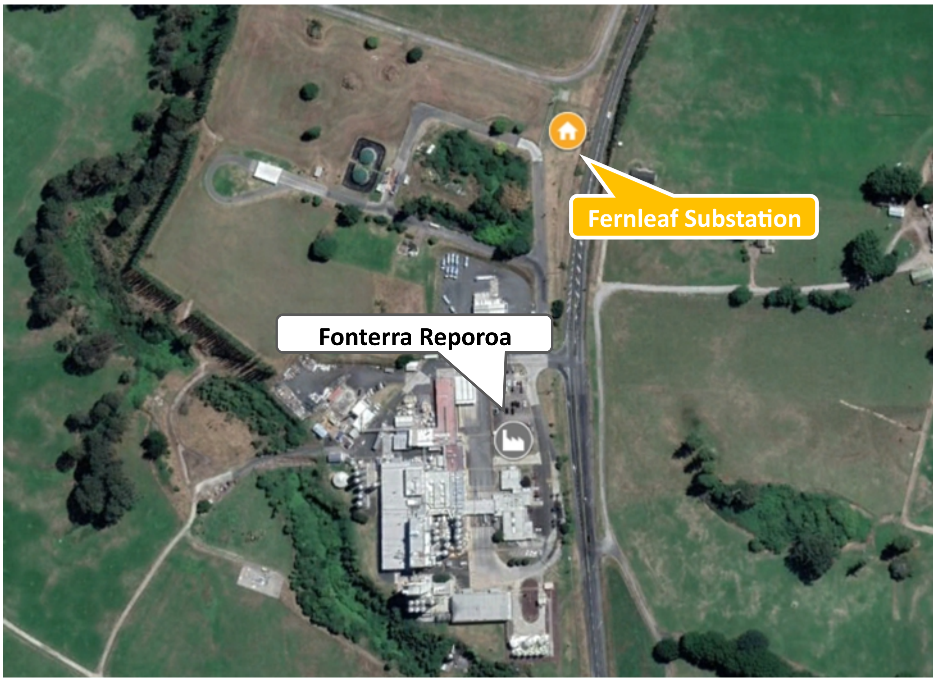


Figure 48 Fonterra Reporoa geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

If the current (N) supply security is to be maintained, two new 11 kV feeders are required between Fernleaf zone sub and the Fonterra site. The zone substation supply transformers must be upgraded, as the present (N) capacity is not sufficient to support the proposed load. In addition, due to the current load on the existing feeder, a new 33 kV feeder between Rotorua GXP and Fernleaf zone substation will be required. Ergo expects this feeder to follow a similar route as the existing overhead lines, a distance of 38 km. At this distance, voltage drop becomes significant and voltage regulator or voltage supporting solution at the load would be required.

For (N-1) supply security, a new third 33 kV feeder from Rotorua GXP to Fernleaf zone substation would be required.

Capital Cost Estimate

Table 30 Fonterra Reporoa: Capital cost estimate to supply the Load Site at (N) security.

Transmission => (N-1)	Subtransmission =>	(N)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Single overhead 33kV line	38.00	$13.30
Subtransmission	33kV circuit breaker bay	1.00	$0.25
Distribution	11kV Voltage Regulator	1.00	$0.40
Distribution	Double underground 11kV cable	0.30	$0.24
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Medium supply transformer (ZSS)	2.00	$3.80
		TOTAL	**$18.19**

Table 31 Fonterra Reporoa: Capital cost estimate to supply the Load Site at (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission =>	(N-1)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	33kV circuit breaker bay	2.00	$0.50
Subtransmission	Double overhead 33kV line	38.00	$15.20
Distribution	11kV Voltage Regulator	1.00	$0.40
Distribution	Double underground 11kV cable	0.30	$0.24
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
		TOTAL	**$16.54**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 36-48 months to plan, design, procure, construct, and commission the works.

Excluded are any works required to establish the Load Site.

Any land acquisition and consenting, if required, is excluded.

8.6.3 Alsco Rotorua

ALSCO ROTORUA		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	2.16	Rotorua 33 kV
Existing Electrical Supply to the Plant		

Presently Alsco Rotorua is fed at 11 kV by Biak St zone substation, which is in turn fed at 33 kV from Rotorua GXP.

There are two 33 kV feeders from Rotorua GXP to Biak St substation, each with a maximum capacity of 700 A (for a total of 1400 A capacity). With maximum loading at Biak Street reaching 18 MVA, this leaves a spare capacity of 1085 A between the two existing feeders.

The Alsco site is located approximately 1 km from Biak St zone substation, with a further ~3.5 km between the zone substation and Rotorua GXP.

Figure 49 Alsco Rotorua geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

For an (N) security supply, a new 11 kV feeder is required from Biak Street substation. This feeder would likely follow the route of existing feeders and be reticulated underground.

If Alsco were to opt for an (N) security solution, a Special Protection Scheme would be required at Biak Street zone substation to protect the supply security of other customers.

ALSCO ROTORUA

In a case where Alsco desired an (N-1) security supply, an upgrade of the Biak Street supply transformers is required. There is no requirement for upgrades to the 33 kV sub transmission lines or the distribution transformers, as both of these assets have suitable excess capacity.

Capital Cost Estimate

Table 32 Fonterra Rotorua: Capital cost estimate to supply the Load Site with (N) security.

Transmission => (N-1)	Subtransmission => (N)	Distribution => (N)	
Network Asset	Equipment	Number and Capital Cost ($M)	
Distribution	Special protection system (ZSS)	1.00	$0.25
Distribution	Single underground 11kV cable	3.50	$2.10
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
		TOTAL	**$2.45**

Table 33 Fonterra Rotorua: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	Equipment	Number and Capital Cost ($M)	
Distribution	Single underground 11kV cable	3.50	$2.10
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Small supply transformer (ZSS)	2.00	$3.00
		TOTAL	**$5.20**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 6-12 months to plan, design, procure, construct, and commission the works for the (N) supply case.

It is estimated to take 12-24 months to plan, design, procure, construct, and commission the works for the (N-1) supply case.

Excluded are any work required to establish the Load Site.

Any land acquisition and consenting, if required, is excluded.

8.6.4 Small Opportunities

Below is a summary of the “small” Load Sites that were provided by EECA but due to their size, are unlikely to have a material effect on the distribution or transmission network. The costs provided are estimates to provide RMUs and appropriately sized distribution transformers to supply the site.

Table 34 Summary of the "small" Load Sites that are unlikely to have a material effect on the MV/HV network

Opportunity name	Zone sub	Zone sub (N-1) spare capacity (MVA)	Zone sub (N) spare capacity (MVA)	Current Feeder loading (MW)	Opportunity Load (MW)	Estimate cost ($k)
Malfroy School	Rotorua*	10	45	Unknown	0.30	130
Rotorua Hospital	Biak Street	2	22	Unknown	0.10	50

* Direct supply from Rotorua 11 kV GXP

Each Load Site is estimated to take 3 - 6 months to plan, design, procure, construct and commission the works.

Estimates exclude:

- The work required to establish the Load Site.
- Land acquisition and consenting, if required.

8.6.5 Combined Load on Zone Substations

8.6.5.1 Biak

Two of the loads on Rotorua GXP are expected to connect to Biak zone substation. The loads are Alsco Rotorua and Rotorua Hospital. The sum of peaks of these loads is 2.26 MVA, which the zone substation does have (N-1) capacity for. Therefore, upgrades of Biak zone substation are not considered.

8.6.6 Effect of all Load Sites Connecting to Rotorua GXP

The following Figure 50 illustrates the Rotorua GXP 33 kV load profile together with the load profiles of all the Load Sites within the Rotorua GXP region. Also shown in Figure 50 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Rotorua GXP would increase to 60.3 MVA, an increase of 13.4 MVA on the 2022 maximum demand. Given that the independent sum of the individual load peaks is 66.3 MVA there is a diversity factor of 0.91 between the loads.
- Based on Ergo's analysis, the Rotorua GXP's (N-1) limit is not expected to be exceeded. However, coupled with load growth in the area, the (N-1) limit may be exceeded, which may be addressed in the short-term with an SPS (at a cost of ~$0.5M), or in the long-term with further grid upgrades.

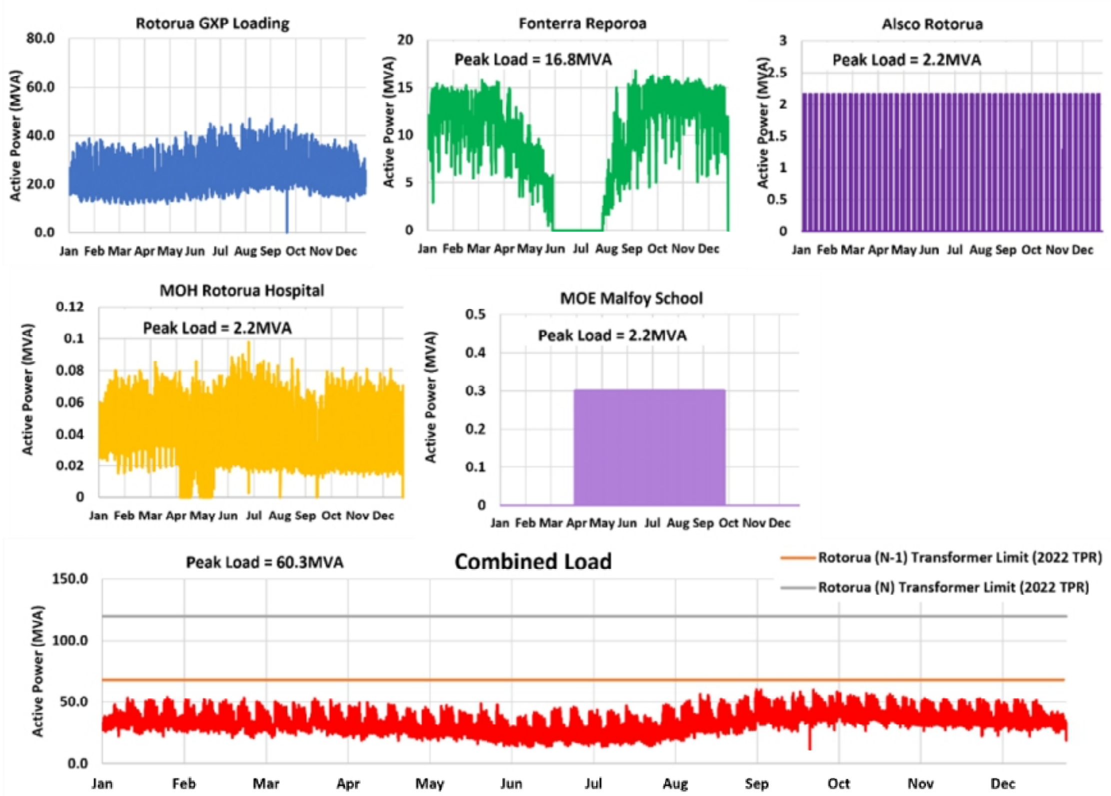


Figure 50 Loading Profiles: Rotorua GXP 2022 33 kV historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.7 Tauranga GXP

The “Large” EECA Load Sites connecting to the Tauranga 33 kV GXP include:

- Tauranga Hospital (1.18 MVA)
- Winstone Wallboards (49.38 MVA)
    - Note: Winstone Wallboards is currently connected to Kaitemako GXP. Based on projected network upgrades, Ergo suggests this load is connected to Tauranga GXP instead.

The “Small” Load Sites connecting to the Tauranga 33 kV GXP include (refer to sections 8.7.3 and 8.7.5):

- Mt Eliza Cheese (0.67 MVA)
- Tauranga Boys’ College (0.42 MVA)
- Otūmoetai College (0.30 MVA)
- Tauranga Girls’ College (0.17 MVA)

Additionally, one “Small” Load Site connects to the Tauranga 11 kV GXP (refer to section 8.7.3):

- Pure Bottling (0.75 MVA)

The Port of Tauranga is considering electrification, with a load on the order of 10-20 MVA. They are independently dealing with PowerCo, and this load is not included in the EECA Load Sites.

The geographic locations of the Load Sites are shown on the following map in relation to the local transmission and distribution substations.

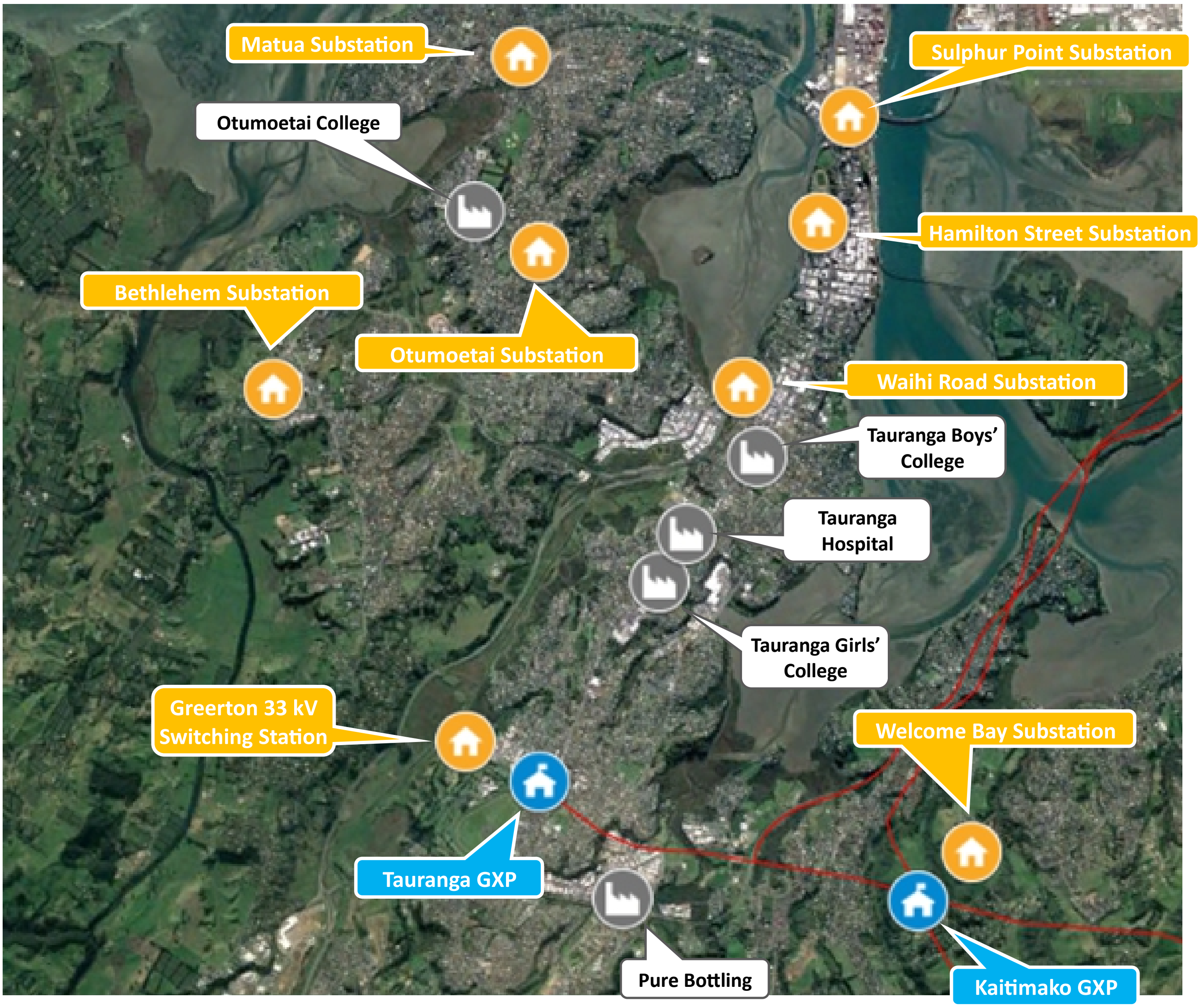


Figure 51 Tauranga GXP: EECA Load Sites vs local substations

8.7.1 Tauranga GXP Upgrade

The Tauranga 33 kV GXP presently has 32 MVA of spare (N-1) capacity and 134 MVA of spare (N) capacity; while the Tauranga 11 kV GXP presently has 11 MVA of spare (N-1) capacity and 35 MVA of spare (N) capacity.

The spare (N-1) capacity of the Tauranga 33 kV GXP (with low/no Kaimai generation) is expected to be exceeded. Network upgrades to manage the Tauranga 33 kV future capacity constraint are being investigated jointly by Transpower and Powerco, and include:

- Short-term: implement variable line ratings on the two 110 kV circuits which supply Tauranga; upgrade the existing Kaitemako SPS (special protection scheme which sheds load if required upon loss of an asset); install an SPS on the two 110 kV circuits which supply Tauranga. Expected cost $0.75M.
- Long-term: install a cable between Tauranga and Kaitemako (110 kV) (so that there are three circuits supplying Tauranga); Replace the 110/11 kV transformers at Tauranga with 33/11 kV

transformers; add a third 110/33 kV transformer at Tauranga; and other reconfigurations of the Tauranga GXP. Expected cost $70M.

Ergo expects that the costs of these upgrades will mostly be paid via transmission charges to all network customers. However, it is possible that if connection of the Load Sites (specifically Winstone Wallboards) brings upgrades forward, that a portion of the cost would fall to the Load Sites. The expected cost to the Load Sites of this is unknown to Ergo at this time.

Ergo notes that the Tauranga GXP will be impacted by Transpower's MCP for the area. Once agreed upon, the plan for the area should ease some of the constraints affecting this GXP. However, while the solution is unknown, the total cost associated with these upgrades is also unknown. Ergo expects that the associated costs will be shared among all customers affected (e.g. via electricity bill Transmission Charges). However, it is possible that if connection of the Load Sites brings upgrades forward, that a portion of the cost would fall to the Load Sites.

8.7.2 Tauranga Hospital

TAURANGA HOSPITAL		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	1.18	Tauranga 33 kV
Existing Electrical Supply to the Plant		

Tauranga Hospital is presently supplied at 11 kV by Powerco's Waihi Road zone substation, which is in turn supplied at 33 kV by Tauranga GXP.

The load site is 2.3 km from Waihi Road zone substation, with a further 4.6 km to Tauranga GXP.

Figure 52 Tauranga Hospital geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Waihi Road zone substation has 28 MVA of spare (N) capacity, with 4 MVA of spare (N-1) capacity.

TAURANGA HOSPITAL

Currently, hospital load is supplied by the WRD4 feeder. In order to supply the proposed load, a new 11 kV feeder would need to be installed from Waihi Road zone substation. There is sufficient capacity in the 33 kV sub transmission infrastructure to accommodate this load at (N-1) security.

Capital Cost Estimate

Table 35 Tauranga Hospital: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single underground 11kV cable	1.20	$0.72
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
		TOTAL	**$0.82**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 6-12 months to plan, design, procure, construct, and commission the works.

Excluded are any work required to establish the Load Site.

Any land acquisition and consenting, if required, is excluded.

8.7.3 Small Opportunities

Below is a summary of the “small” Load Sites that were provided by EECA but due to their size, are unlikely to have a material effect on the distribution or transmission network. The costs provided are estimates to provide RMUs and appropriately sized distribution transformers to supply the site.

Table 36 Summary of the "small" Load Sites that are unlikely to have a material effect on the MV/HV network

Opportunity name	Zone sub	Zone sub (N-1) spare capacity (MVA)	Zone sub (N) spare capacity (MVA)	Current Feeder loading (MW)	Opportunity Load (MW)	Estimate cost ($k)
Pure Bottling	Tauranga*	10.6	34.6	Unknown	0.75	200
Mt. Eliza Cheese, Tauranga	Aongatete	-0.1	4.9	Unknown	0.67	200
Ministry of Education, Tauranga Boys' College	Waihi Rd	4	28	Unknown	0.42	130
Ministry of Education, Otūmoetai College	Otūmoetai	-1	12	Unknown	0.30	130
Ministry of Education, Tauranga Girls' College	Waihi Rd	4	28	Unknown	0.17	80

*Direct supply from Tauranga 11 kV GXP.

Each Load Site is estimated to take 3 - 6 months to plan, design, procure, construct and commission the works.

Estimates exclude:

- The work required to establish the Load Site.
- Land acquisition and consenting, if required.

8.7.4 Combined Load on Zone Substations

8.7.4.1 Waihi Road

Three of the loads on Tauranga GXP are expected to connect to Waihi Road zone substation. The loads are Tauranga Hospital, Tauranga Boy’s College, and Tauranga Girl’s College. The sum of peaks of these loads is 1.77 MVA, which the zone substation does have (N-1) capacity for. Therefore, upgrades of Waihi Road zone substation are not considered.

8.7.5 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Tauranga GXP gives a combined load of 2.44 MVA. However, when the load shapes are combined, they result in the following load shape (Figure 53), with a maximum load of 1.87 MVA, with a diversity factor of 0.76.

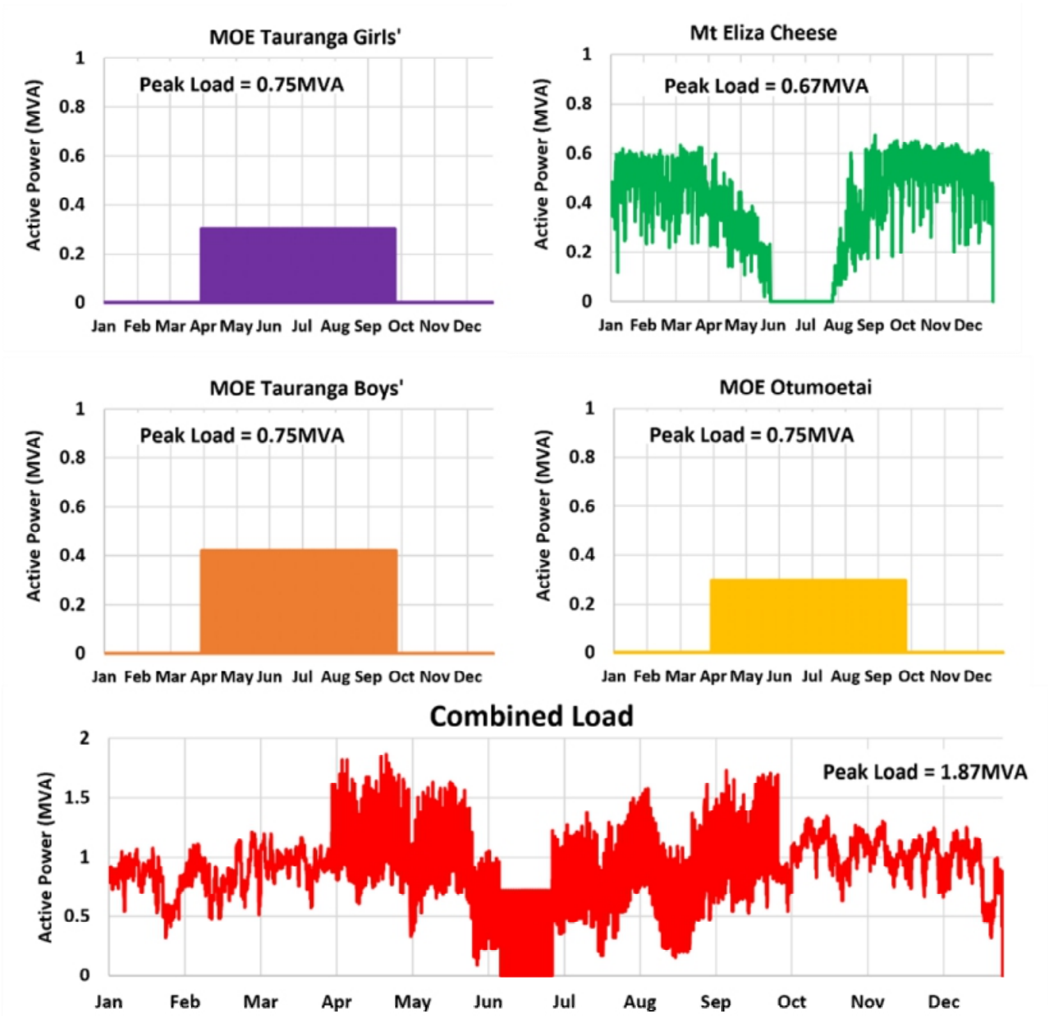


Figure 53 Loading Profiles: Tauranga GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.7.6 Effect of all Load Sites Connecting to Tauranga GXP

The following Figure 54 illustrates the Tauranga GXP 33 kV load profile together with the load profiles of all the Load Sites within the Tauranga GXP region. Also shown in Figure 54 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Tauranga GXP would increase to 76.8 MVA, an increase of 0.9 MVA on the 2022 maximum demand. Given that the independent sum of the individual load peaks is 78.94 MVA there is a diversity factor of 0.97 between the loads.
- Based on Ergo's analysis, connection of the Load Sites would cause the peak load to exceed the (N-1) transformer limit, particularly where periods of low Kaimai generation are considered. Refer to section 8.7.1 for details on future upgrades to mitigate this issue.

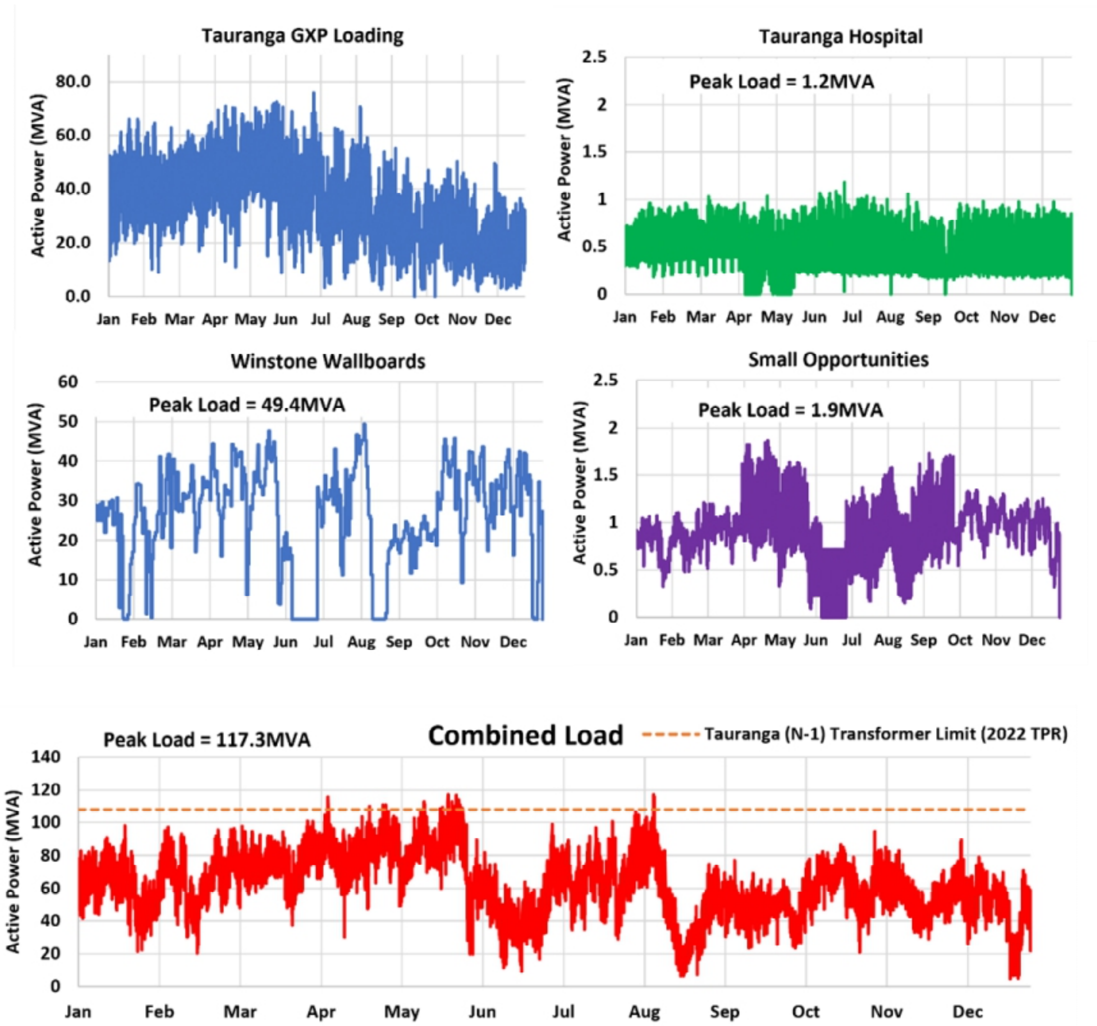


Figure 54 Loading Profiles: Tauranga GXP 2022 33 kV historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.8 Te Matai GXP

The "Large" EECA Load Site connecting to the Te Matai GXP is:

- AFFCO Rangiuru (2.51 MVA)

No "Small" Load Sites connect to the Te Matai GXP.

The geographic location of the Load Site is shown on the following map in relation to the local transmission and distribution substations.

Figure 55 Te Matai GXP: EECA Load Sites vs local substations

8.8.1 Te Matai GXP Upgrade

The Te Matai 33 kV GXP presently has no spare (N-1) capacity and 23 MVA of spare (N) capacity.

Transpower has identified in their 2022 Transmission Planning Report that there is a 110 kV supply capacity issue at Te Matai GXP, with (N-1) capacity having been exceeded since 2019. Both Transpower and Powerco project significant load growth in this area, with the Rangiuru Business Park playing a large role in this.

Transpower has identified that the T1 transformer at Te Matai is to be upgraded as part of a risk-based policy replacement, and has proposed that Te Matai T2 could be upgraded as a customer-initiated project. Transpower has suggested this work will need to take place by 2025/2026.

8.8.2 AFFCO Rangiuru

AFFCO RANGIURU		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	2.51	Te Matai
Existing Electrical Supply to the Plant		

Presently, AFFCO Rangiuru is supplied at 11 kV by Te Puke zone substation. Te Puke is in turn supplied at 33 kV by Te Matai GXP.

There are two 33 kV feeders supplying Te Puke. These feeders are dual 33 kV Te Matai – Te Puke circuits.

AFFCO is located ~6 km from Te Puke zone substation, with a further ~5 km from the zone substation to Te Matai GXP.

It has been identified in Transpower's 2022 Transmission Planning Report that significant load growth is expected at Te Matai GXP. Te Matai T1 transformer is due for risk-based replacement in 2025, and will be replaced with a unit suitable to accommodate expected load growth. Replacement of the T2 transformer is to be customer driven, shared among various network users.

Additionally, the Powerco Asset Management Plan discusses the Rangiuru Business Park as an area of significant load growth. Powerco has indicated that a new zone substation will be required at Rangiuru to supply this load, and projects it being constructed before 2030.

Figure 56 AFFCO Rangiuru geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

As Powerco has discussed the installation of a new zone substation at Rangiuru to support this business park, Ergo would expect the AFFCO site to connect to this substation.

As such, Ergo expects that the only additional infrastructure requirement would be for a new 11 kV feeder, reticulated underground to the AFFCO site. Rangiuru zone substation is listed in the Powerco AMP as "Customer Driven" project, however Ergo has not estimated any costs associated with this substation installation.

If Powerco goes ahead with this proposed substation as outlined in their AMP, it will be built with (N-1) security of supply.

Additionally, there is not currently sufficient (N-1) capacity at Te Matai GXP to support any additional load. This is an issue that has been identified in Transpower's TPR, and replacement of Te Matai T2 transformer is to be done as a customer initiated project.

Ergo expects that AFFCO will be part of a larger number of customers connecting load in this business park, and therefore costs associated with Transpower upgrades are difficult to estimate.

Capital Cost Estimate

Table 37 AFFCO Rangiuru: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security. Note that cost for Rangiuru zone substation is the total cost quoted by Powerco. Cost to AFFCO is likely to only be a portion of this.

Transmission => (N-1)	**Subtransmission => (N-1)**	**Distribution => (N)**	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single underground 11kV cable	1.00	$0.60
Distribution	Rangiuru Zone Substation	1.00	$12.00
		TOTAL	**$12.60**

Does not include the costs of any distribution transformers/switchgear on the plant site.

Does not include costs to upgrade Transpower infrastructure at Te Matai zone substation. Transpower has indicated in their TRP that these upgrades will be customer initiated, and on the order of $4 million.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 24-36 months to plan, design, procure, construct, and commission the works.

Excluded are any work required to establish the Load Site.

Any land acquisition and consenting, if required, is excluded.

8.8.3 Effect of all Load Sites Connecting to Te Matai GXP

The following Figure 54 illustrates the Te Matai GXP 33 kV load profile together with the load profiles of all the Load Sites within the Tauranga GXP region. Also shown in Figure 54 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Te Matai GXP would increase to 47.6 MVA, an increase of 0.7 MVA on the 2022 maximum demand. Given that the independent sum of the individual load peaks is 49.4 MVA there is a diversity factor of 0.96 between the loads.
- As discussed in section 8.8.1, Te Matai GXP has exceeded (N-1) capacity. Due to large projected load growth in this area, Transpower is working in conjunction with Powerco to increase capacity.

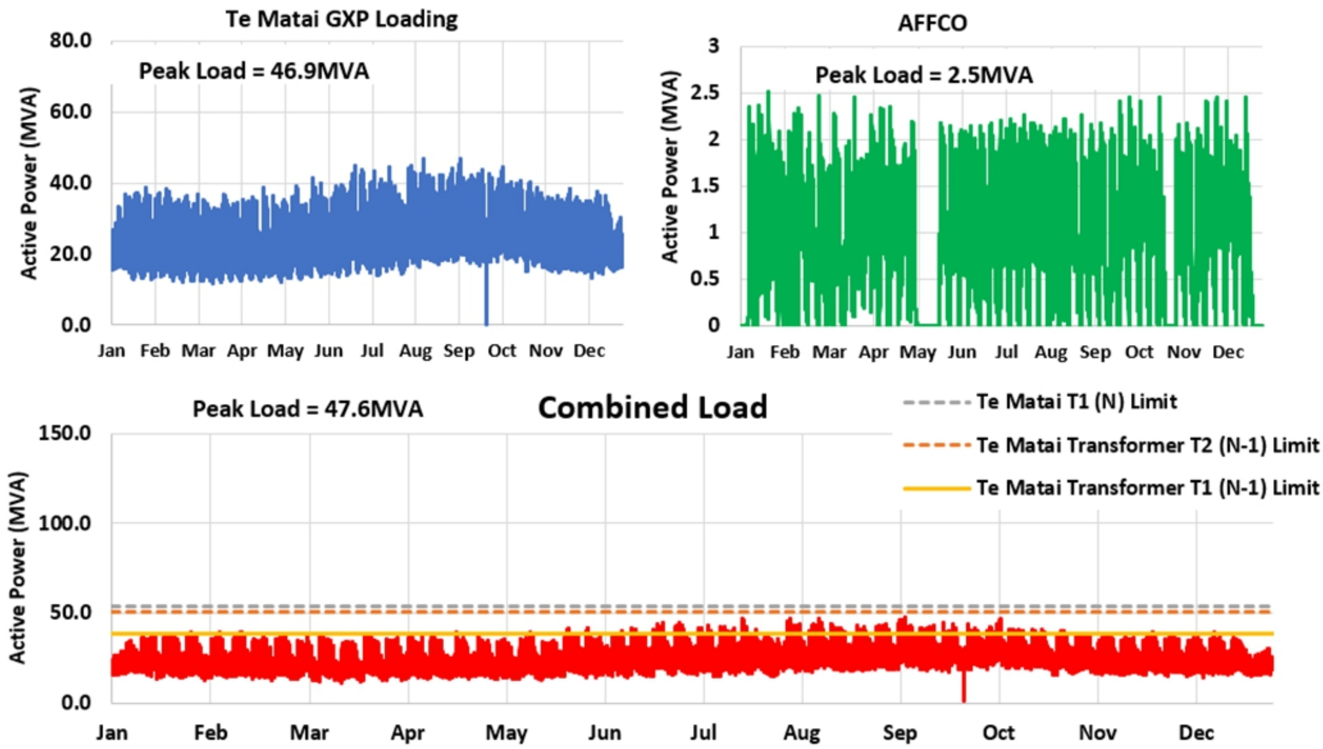


Figure 57 Loading Profiles: Te Matai GXP 2022 33 kV historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.9 Waiotahe GXP

No "Large" EECA Load Sites are connecting to the Waiotahe GXP.

The "Small" Load Site connecting to the Waiotahe GXP is (refer to section 8.9.2):

- Ōpōtiki College (0.30 MVA)

The geographic locations of the Load Sites are shown on the following map in relation to the local transmission and distribution substations.

Figure 58 Waiotahe GXP: EECA Load Sites vs local substations

8.9.1 Waiotahe GXP Upgrade

Due to the size of the load connecting, upgrades at Waiotahe GXP are not considered.

8.9.2 Small Opportunities

Below is a summary of the "small" Load Sites that were provided by EECA but due to their size, are unlikely to have a material effect on the distribution or transmission network. The costs provided are estimates to provide RMUs and appropriately sized distribution transformers to supply the site.

Table 38 Summary of the "small" Load Sites that are unlikely to have a material effect on the MV/HV network

Opportunity name	Zone sub	Zone sub (N-1) spare capacity (MVA)	Zone sub (N) spare capacity (MVA)	Current Feeder loading (MW)	Opportunity Load (MW)	Estimate cost ($k)
Ōpōtiki College	Ōpōtiki (switching station)	N/A	N/A	4.64	0.30	130

Each Load Site is estimated to take 3 - 6 months to plan, design, procure, construct and commission the works.

Estimates exclude:

- The work required to establish the Load Site.
- Land acquisition and consenting, if required.

8.9.3 Effect of all Load Sites Connecting to Waiotahe GXP

As the only Load Site expected to connect to Waiotahe is small, and not expected to make a material impact on the GXP, the effect of the load connecting on the Waiotahe load characteristic has not been investigated.

9. Conclusions

9.1 Network Spare Capacity

The following Figure 59 illustrates the (N) and (N-1) spare capacity at the Transpower GXP substations in the Bay of Plenty region.

Bay of Plenty region: GXP Substations: Spare (N) and (N-1) Capacity

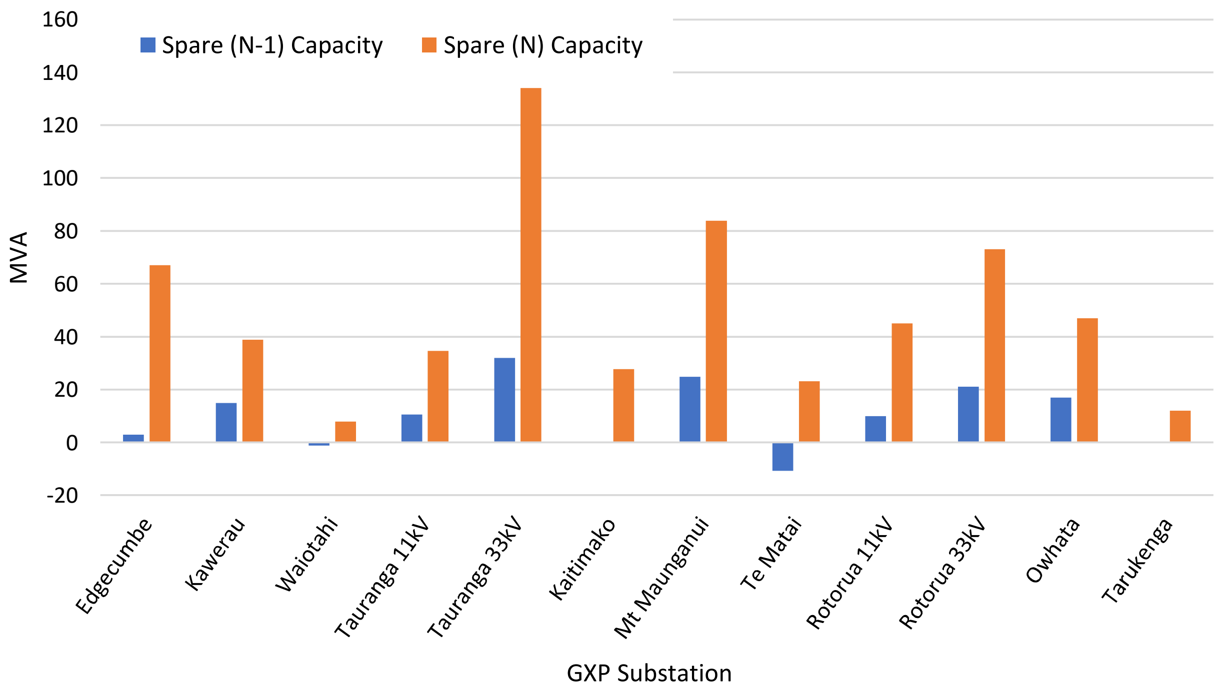


Figure 59 Summary: Approximate (N) and (N-1) spare capacity at GXP substations.

The following figures illustrate the (N) and (N-1) spare capacity at the EDB Zone Substations in the Bay of Plenty region. These figures are based on the maximum loadings and the EDB 2023 disclosures.

Horizon Networks Zone Substations: Spare (N) and (N-1) Capacity

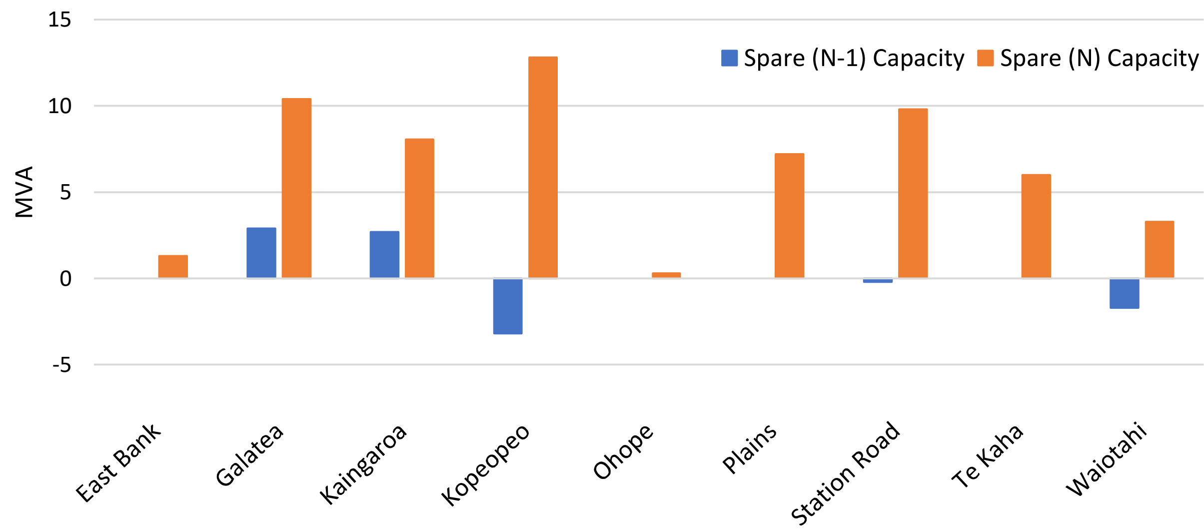


Figure 60 Summary: Approximate (N) and (N-1) spare capacity at Horizon Network's zone substations

Powerco Zone Substations: Spare (N) and (N-1) Capacity

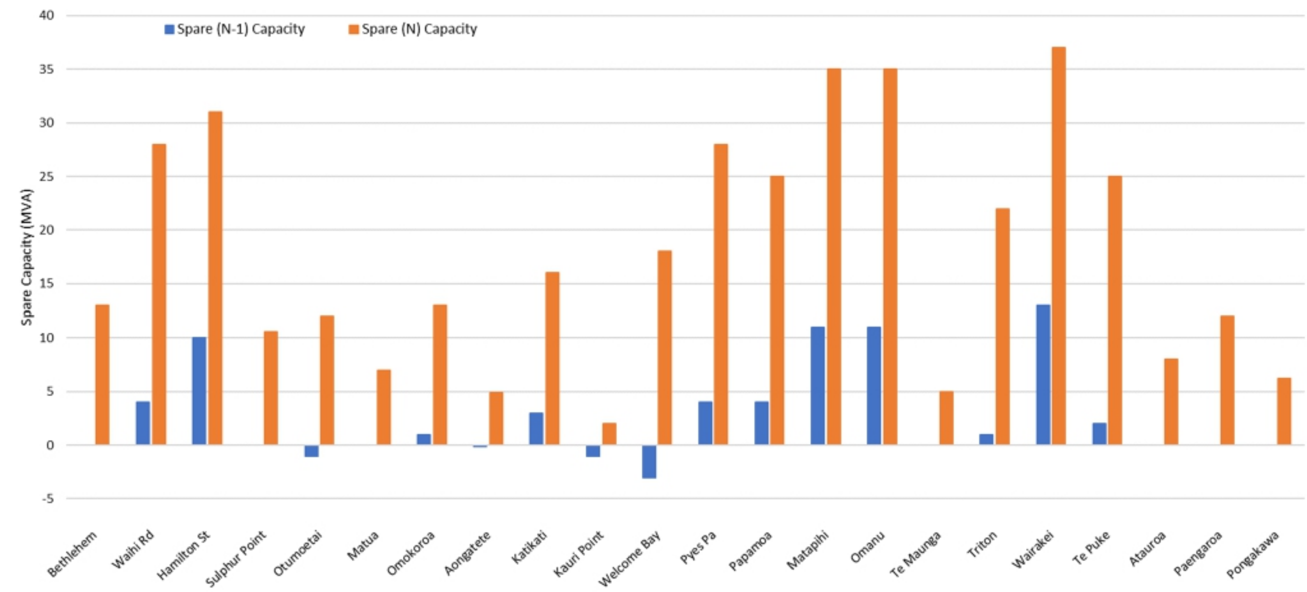


Figure 61 Summary: Approximate (N) and (N-1) spare capacity at Powerco's zone substations.

Unison Zone Substations: Spare (N) and (N-1) Capacity

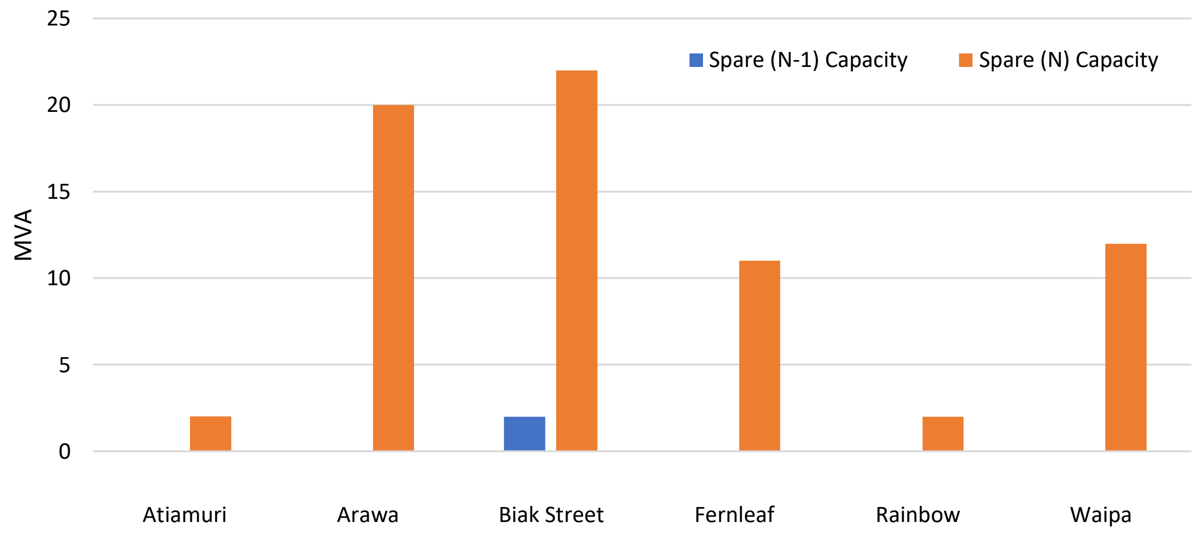


Figure 62 Summary: Approximate (N) and (N-1) spare capacity at Unison's zone substations.

9.2 Load Characteristics

The substation load characteristics are documented in detail in the main body of the report (and the supplementary document 22132-RPT-0006) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Edgecumbe GXP* – – Mix of residential, commercial, and industrial loads. Winter peaking, and appears to have intermittent generation supporting the load.
- *Kawerau GXP* – Mix of residential, commercial, and industrial loads. Winter peaking with a traditional daily morning and evening peak.
- *Waiotahe GXP* – Mix of residential and commercial. Winter peaking with a traditional daily morning and evening peak.
- *Tauranga GXP* – Tauranga is a rapidly developing coastal region, with horticultural industries, a port, and a large regional centre at Tauranga. Mix of residential, commercial, port, and light industrial loads. The Tauranga 11 kV is winter peaking with a traditional daily morning and evening peak. Summer daily profiles are almost flat. The Tauranga 33 kV supply has a fairly typical load profile with no marked seasonal difference. It is influenced by the tendency of the Kaimai generation to offset peak load.
- *Kaitemako GXP* – Pyes Pā and Welcome Bay zone substations supply the major subdivisions in these areas. The Pyes Pā substation has offloaded Tauranga GXP supplying the large industrial and residential developments in this area. Winter peaking with a traditional daily morning and evening peak.

- *Mount Maunganui GXP* – The Mt Maunganui area covers the urban parts of Mt Maunganui, the developing area of Papamoa, and the Wairakei coastal strip. Mix of residential, rural, commercial and industrial loads. Winter peaking with a relatively flat daytime load profile.
- *Te Matai GXP* – Mix of residential, rural and lifestyle block loads in and around Te Puke. Winter peaking with a traditional daily morning and evening peak especially in winter. Peaks are less pronounced in summer and the load is approximately 50% of the winter load.
- *Rotorua GXP* – Mix of residential and commercial load since it supplies most of the Rotorua township and central business district. Winter peaking with a traditional daily morning and evening peak especially in winter for the Rotorua 11 kV GXP. The 33 kV GXP load is also winter peaking but has a flat daily profile.
- *Ōwhata GXP* – Mainly residential load with some industrial load. Winter peaking with a traditional daily morning and evening peak especially in winter. Evening peaks are less pronounced in summer and approximately 60% lower than in winter.
- *Tarukenga GXP* – Mix of residential and rural lifestyle block loads. Winter peaking with a traditional daily morning and evening peak especially in winter. Evening peaks are less pronounced in summer and approximately 50% lower than in winter.

Zone Substations:

- The load characteristics of the zone substations vary widely depending on the connected consumers/generators.

9.3 EECA Load Sites

The following table shows EECA's Load Sites together with:

- The peak electrical power requirements of the Load Site.
- The distribution zone substation to which the Load Site would connect.
- The transmission substation/GXP which supplies the relevant zone substation.
- Ergo's estimate of the capital cost to increase the capacity of the relevant transmission assets (lines and substations).
- Ergo's estimate of the capital cost to install the necessary distribution assets to supply the Load Site.
- The cost efficiency associated with the Load Site in terms of $M/MW.
- The 'complexity of connection' based on the level of upgrades required.

The costs are preliminary and Ergo is of the view that they have an accuracy of Class 5[28], which is only suitable for concept screening. (Refer to the assumptions outlined in Section 8.2 for more details)

[28] Cost Estimate Classification System - As Applied in Engineering, Procurement, and Construction for the Process Industries, AACE International Recommended Practice No. 18R-97.

Summary: Load Site's vs transmission/distribution capital cost estimates

Table 39 Summary of Load Sites and estimated capital costs

No.	Load Site Name	Load (MW)	Transmission Details		Distribution		TOTAL	Cost Efficiency ($M/MW)	Complexity of Connection	Refer to notes
			GXP/Transmission Substation	Upgrade Costs ($M)	Zone Substation	Upgrade Costs ($M)	Upgrade Costs ($M)			
1	Fonterra, Edgecumbe (N-1) Security Option Total Cost	28.55	Edgecumbe	$4.75	East Bank	$15.40	$20.15	$0.71	Major	1
2	Whakatane Growers, Whakatane (N) Security Supply	2.32	Edgecumbe	$0.00	Station Road	$0.25	$0.25	$0.11	Minor	1
3	Ministry of Health, Whakatane Hospital	0.59	Edgecumbe	$0.00	Kopeopeo	$0.00	$0.00	$0.00	Minor	1
4	Whakatane Mill (N-1) Security Supply	35.00	Edgecumbe	$14.00	N/A	$6.20	$20.20	$0.58	Major	1
4	Dominion Salt, Mt. Maunganui (N-1) Security Supply	10.25	Mt Maunganui	$0.50	Triton	$19.06	$19.56	$1.91	Moderate	1
5	Bakels Edible Oils, Mt. Maunganui	2.61	Mt Maunganui	$0.00	Omanu	$1.30	$1.30	$0.50	Moderate	1
6	Lawter, Tauranga	2.23	Mt Maunganui	$0.00	Triton	$0.70	$0.70	$0.31	Moderate	1
7	Fulton Hogan, Mt Maunganui	1.77	Mt Maunganui	$0.00	Omanu	$0.46	$0.46	$0.26	Moderate	1
8	Ingham, Mt Maunganui	1.02	Mt Maunganui	$0.00	Triton	$0.00	$0.00	$0.00	Minor	1
9	Downer, Mount Maunganui	0.72	Mt Maunganui	$0.00	Omanu	$0.00	$0.00	$0.00	Minor	1
10	Ballance Agri-Nutrients Ltd, Mt. Maunganui	0.44	Mt Maunganui	$0.00	Triton	$0.00	$0.00	$0.00	Minor	1
11	Fonterra, Reporoa (N) Security Supply	16.80	Rotorua	$0.00	Fernleaf	$18.19	$18.19	$1.08	Major	1
12	Alsco, Rotorua (N) Security Supply	2.16	Rotorua	$0.00	Biak Street	$2.45	$2.45	$1.13	Moderate	1
13	Ministry of Health, Rotorua Hospital	0.10	Rotorua	$0.00	Biak Street	$0.00	$0.00	$0.00	Minor	1
14	Ministry of Education, Malfroy School	0.30	Rotorua	$0.00	Rotorua	$0.00	$0.00	$0.00	Minor	1
15	Pure Bottling	0.75	Tauranga	$0.00	Tauranga	$0.00	$0.00	$0.00	Minor	1
16	Winstone Wallboards GIB, Tauranga (Overall Cost)	49.38	Tauranga	$70.00	New sub	$33.00	$103.00	$2.09	Major	1,2
17	Ministry of Health, Tauranga Hospital	1.18	Tauranga	$0.00	Waihi Rd	$0.82	$0.82	$0.70	Moderate	1
18	Mt. Eliza Cheese, Tauranga	0.67	Tauranga	$0.00	Aongatete	$0.00	$0.00	$0.00	Minor	1
19	Ministry of Education, Tauranga Boys' College	0.42	Tauranga	$0.00	Waihi Rd	$0.00	$0.00	$0.00	Minor	1
20	Ministry of Education, Otumoetai College	0.30	Tauranga	$0.00	Otumoetai	$0.00	$0.00	$0.00	Minor	1
21	Ministry of Education, Tauranga Girls' College	0.17	Tauranga	$0.00	Waihi Rd	$0.00	$0.00	$0.00	Minor	1
22	AFFCO, Rangiuru	2.51	Te Matai	$4.00	Rangiuru (Future Sub)	$12.60	$16.60	$6.60	Major	1,2,3
23	Ministry of Education, Opotiki College	0.30	Waiotahe	$0.00	Opotiki	$0.00	$0.00	$0.00	Minor	1
	TOTAL =>	160.5	TOTAL =>	$93.3	TOTAL =>	$110.43	$203.68			

Notes

1 Doesn't include distribution transformer or switchgear costs for Load Sites (details provided in body of report). Estimated between $50k - $350k depending on size.

2 Transmission upgrade cost obtained from Transpower 2022 TPR. No indication is given around how this cost may be distributed.

3 Includes cost of new Powerco substation. No indication of how this cost is to be distributed has been provided.

Disclaimer: The Load Site supply investigations and capital cost estimates outlined in this report are preliminary and are only suitable for screening purposes. The capital cost estimates should not be used for final budgeting purposes in order to connect the respective Load Sites. For the larger Load Sites Ergo recommend proceeding with a Concept Design Report (CDR) to improve the accuracy of the respective cost estimate.

Appendix 1: Glossary

CT	Current transformer
DG	Distributed generator
EDB	Electrical Distribution Business
EDG	Edgecumbe GXP
EIPC	Electricity Industry Participation Code
ODID	Outdoor to Indoor (typically for substation upgrade/conversion projects)
ENA	Electricity Network Association
ESA	Electricity Supply Authority
GXP	Grid exit point substation
KAW	Kawerau GXP
KMO	Kaitemako GXP
kV	Kilovolts
MTM	Mount Maunganui GXP
MW	Megawatts
MVArs	Mega volt amps reactive
MVA	Mega volt amps
ONAN	Oil natural air natural (the methods used to cool the windings and body of the transformer)
ONAF	Oil natural air forced (the methods used to cool the windings and body of the transformer)
OWH	Ōwhata GXP
ROT	Rotorua GXP
SCADA	Supervisory control and data acquisition
TGA	Tauranga GXP
TMI	Te Matai GXP
WAI	Waiotahe GXP

Appendix 2: Accuracy of Cost Estimates and Assumptions

The amount of time available and effort expended to prepare a capital cost estimate has a significant bearing on the expected accuracy range. Accordingly the accuracy of capital cost estimates should be based on the amount and quality of information available at the time the estimate is developed. The Association for the Advancement of Cost Engineering (AACE) has developed a framework for the accuracy of cost estimates as a project progresses, which is illustrated below.

Table 40 Cost estimate classification matrix[29]

ESTIMATE CLASS	*Primary Characteristics*	*Secondary Characteristic*		
	MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges at an 80% confidence level
Class 5 (Order of Magnitude)	***0% to 2%***	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	**L: -20% to -50%** **H: +30% to +100%**
Class 4 (Preliminary)	***1% to 15%***	Study or Feasibility	Equipment Factored or Parametric Models	**L: -15% to -30%** **H: +20% to +50%**
Class 3 (Early Budget)	***10% to 40%***	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	**L: -10% to -20%** **H: +10% to +30%**
Class 2 (Budget/Control)	***30% to 70%***	Control or Bid / Tender	Detailed Unit Cost With Forced Detailed Take-off	**L: -5% to -15%** **H: +5% to +20%**
Class 1 (Definitive/Construction)	***50% to 100%***	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	**L: -3% to -10%** **H: +3% to +15%**

Assumptions

Ergo is of the view that the capital cost estimates developed in this report are Class 5 and we note the following:

- Costs exclude land and/or land easements.
- Costs exclude planning/consenting.
- It is assumed there is sufficient space/land in switchrooms/switchyards to accommodate the new equipment.
- The estimates are based on the connection of Load Sites and do not consider the connection of multiple Load Sites.

29 Cost Estimate Classification System - As Applied in Engineering, Procurement, and Construction for the Process Industries, AACE International Recommended Practice No. 18R-97.