ERGO CONSULTING

Manawatū-Whanganui

Spare Capacity and Load Characteristics Report

EECA

23163 | 23163-RPT-005

Rev B | 27 FEB 25

Document History & Status

Revision	Date	Author	Reviewed by	Approved by	Status
A	13-09-2024	Caitlin Bergervoet, Seff Figgins	Willem Rawlins	Kane Morison	Draft
B	02-12-2024	Caitlin Bergervoet, Seff Figgins	Willem Rawlins	Kane Morison	Draft
C	02-12-2024	Caitlin Bergervoet, Seff Figgins	Kane Morison	Kane Morison	Final

Revision	Details
A	Stage 2 Draft for client review/comment
B	Re-issued following feedback from EDBs and TP
C	Final Issue following feedback from Sapere

Table of Contents

List of Tables

List of Figures

1. Executive Summary

Transpower maintains/manages the transmission network in New Zealand and supplies the Manawatū-Whanganui region (as described in this report) via fourteen GXP's (supplying Electra, The Lines Company, Powerco, and Scanpower).

The four Electrical Distribution Businesses (EDBs), Electra, The Lines Company, Powerco, and Scanpower, then take supply from Transpower and distribute the electricity to end customers in the various regions.

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 RETA program, EECA has developed a set of Load Sites for the Manawatū-Whanganui 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 Manawatū-Whanganui 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 Manawatū-Whanganui region. This figure is based on historical maximum loadings and Transpower's *Transmission Planning Report 2023* and does not incorporate any future load growth. It is important to note that these spare capacities do not include any voltage constraints or upstream transmission constraints (which would have to be confirmed by Transpower or the relevant EDB), other than those already identified in the *Transmission Planning Report 2023*. As such, it is highly likely that those constraints would prevent all the spare capacity shown below being utilised.

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

Manawatū-Whanganui: GXP Substations: Spare (N) and (N-1) Capacity

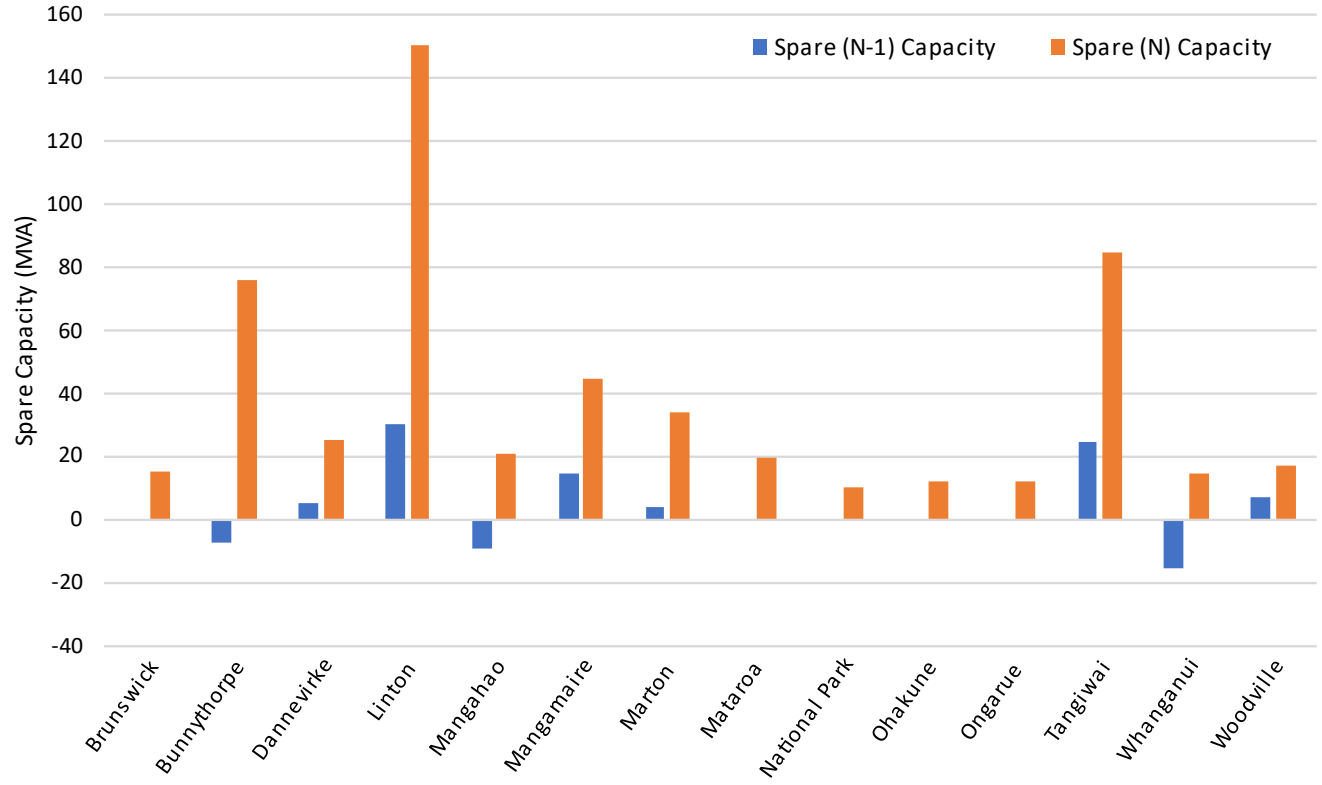


Figure 1 Summary: Approximate N and N-1 spare capacity at GXP substations.

The following Figure 2, Figure 3, and Figure 4 illustrate the (N) and (N-1) spare capacity at the four EDB's (Electra, The Lines Company, Powerco, and Scanpower respectively) zone substations in the Manawatū-Whanganui 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.

It is noted that the fourth EDB in the region, Scanpower, presently has no zone substations and so is excluded from these graphs.

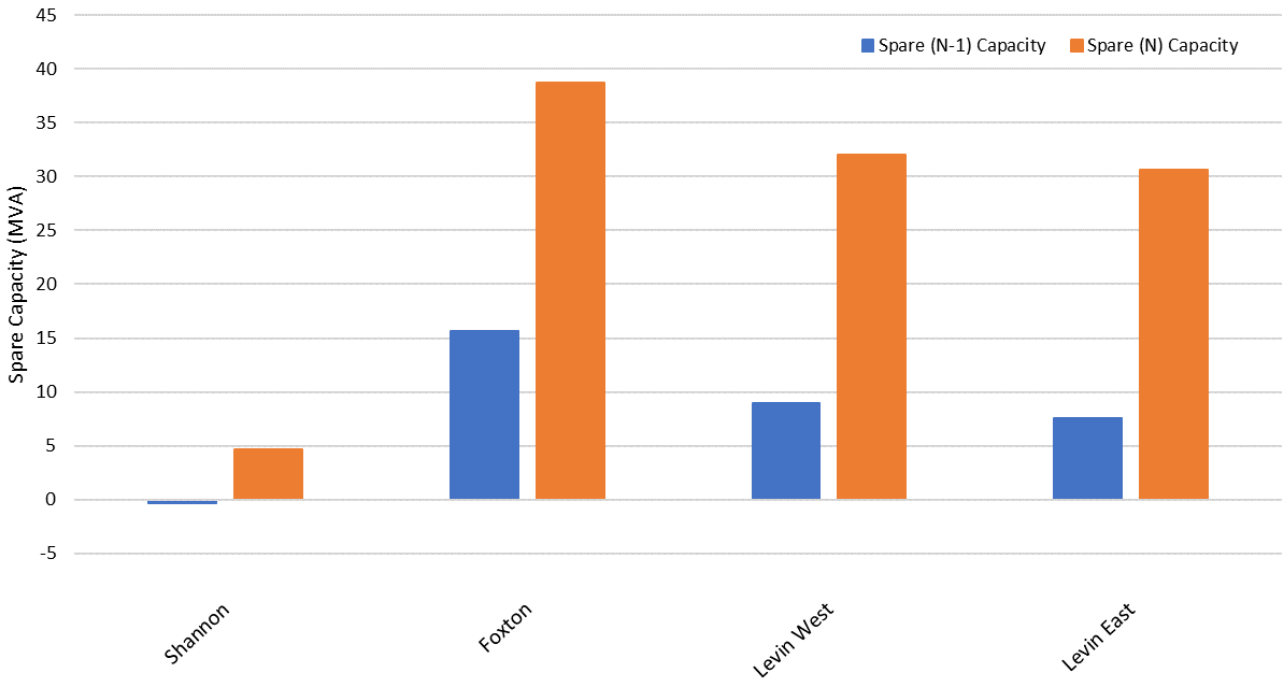


Figure 2. Summary: Approximate (N) and (N-1) spare capacity at Electra's zone substations.

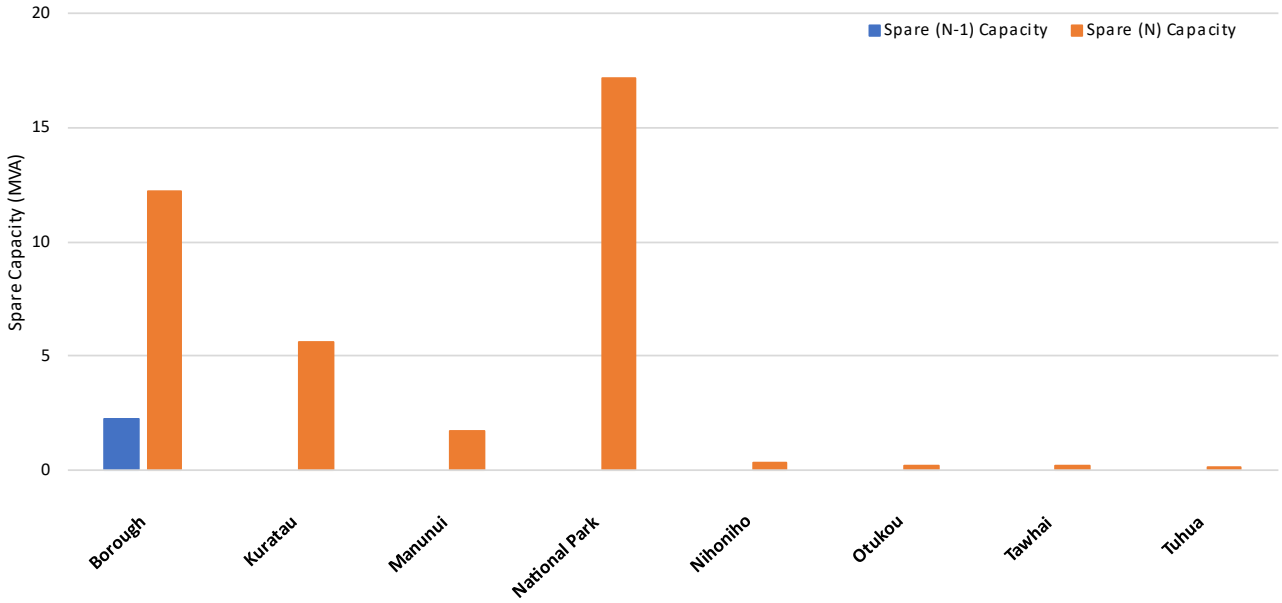


Figure 3 Summary: Approximate (N) and (N-1) spare capacity at The Lines Company's zone substations.

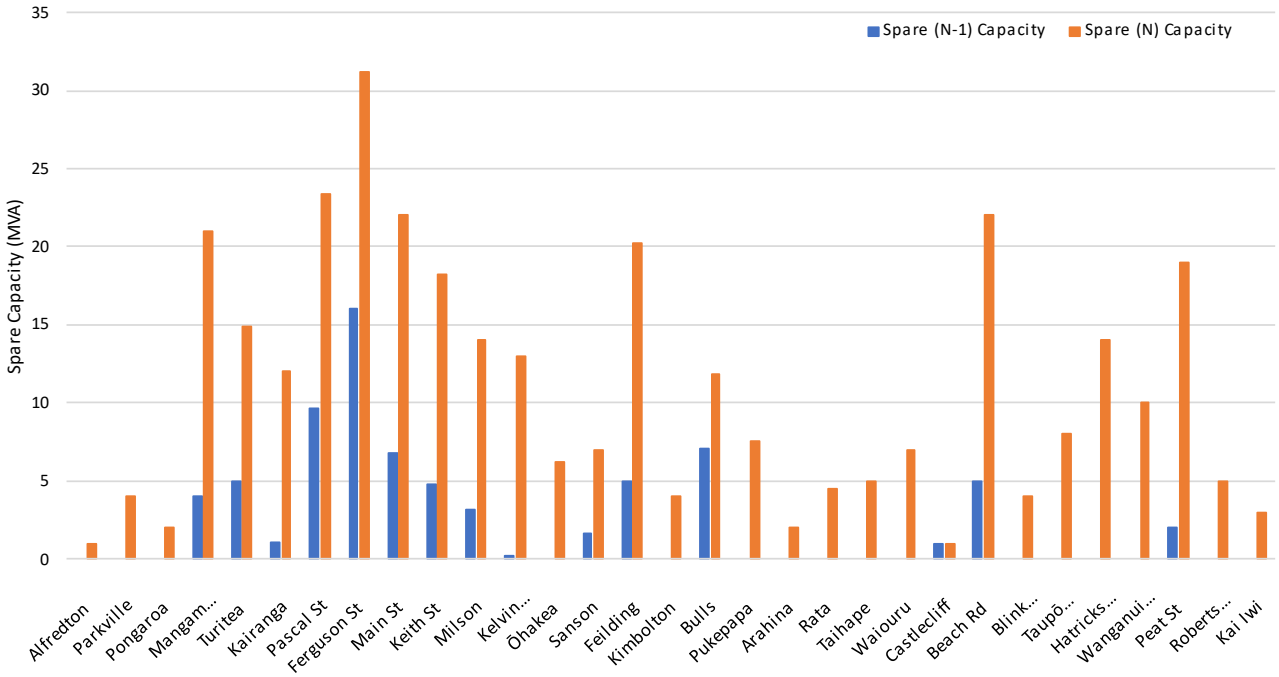


Figure 4. Summary: Approximate (N) and (N-1) spare capacity at Powerco's zone substations.

1.2 Load Characteristics

The substation load characteristics are documented in detail in the main body of the report (and the supplementary document 23163-RPT-008) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Brunswick GXP* – Along with Whanganui GXP, supplies Whanganui, with loads related to agriculture, forestry, and fishing in the nearby areas, along with a mix of other industrial, commercial, and residential loads. Load is winter peaking, with typical daily morning and evening peaks.
- *Bunnythorpe GXP* – Along with Linton GXP, supplies Palmerston North, with a mix of industrial, commercial, and residential loads. Load is reasonably flat throughout the year with a slight winter peak, and typical daily morning and evening peaks. A 34 MW wind farm (Mercury's Tararua Wind Stage 1) is connected within the distribution network connected to this GXP.
- *Dannevirke GXP* – Supplies Dannevirke town and the surrounding rural area, with a significant amount of agricultural (beef and sheep farming) loads, along with some industrial, commercial, and residential loads within Dannevirke. Load is reasonably flat throughout the year, with typical daily morning and evening peaks.
- *Linton GXP* – Along with Bunnythorpe GXP, supplies Palmerston North, with a mix of industrial, commercial, and residential loads. Load is winter peaking, with typical daily morning and evening peaks. Load is winter peaking, with typical daily morning and evening peaks. A 34 MW wind farm (Mercury's Tararua Wind Stage 2) is connected within the distribution network connected to this GXP.
- *Mangahao GXP* – Supplies Levin, Foxton, and Shannon, and provides connection of the embedded Mangahao generation. Mixture of agriculture/horticulture loads, along with some residential and commercial. Typical daily morning and evening peaks. The operation of the Mangahao generation is clear in the load profile of this GXP.
- *Mangamaire GXP* – Supplies some small towns including Pahiatua, Eketāhuna, Alfredton, and Pongaroa. Reasonably rural loading with some residential and industry (e.g. a dairy factory). Load peaks in winter-spring, with a reasonably flat daily load with slight morning and evening peaks.
- *Marton GXP* – Supplies the towns of Bulls and Marton, with significant portions of primary processing and downstream processing. Load is reasonably flat throughout the year, with typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *Mataroa GXP* – Supplies the towns of Taihape and Waiouru, resulting in a reasonably rural agricultural and residential load characteristic. Winter peaking. Typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *National Park GXP* – Supplies the town adjacent to the Tongariro National Park, with the load dominated by a winter ski-season tourist peak from the Whakapapa ski field. Throughout the day the load is reasonably flat.
- *Tangiwai GXP* – Supplies Winstone Pulp International. The load is reasonably flat throughout the year and throughout the day, which is typical of a large industrial load.
- *Ohakune GXP* – Supplies Ohakune town and the surrounding rural area, along with the Tūroa ski field. There is a mix of rural agricultural and residential loads with a prominent increase in load due to tourism/ski season through the winter. Load has a typical daily morning and evening peak, though load is flatter in the summer.

- *Ongarue GXP* – Supplies Taumaranui town, Ongarue village, and the surrounding rural areas. Load is peaky throughout the year. Typical daily morning and evening peaks with a slightly flatter profile through the summer. Operation of the 7.5 MW of connected embedded generation is clear in the load profile.
- *Whanganui GXP* – Along with Brunswick GXP, supplies Whanganui, with loads related to agriculture, forestry, and fishing in the nearby areas, along with a mix of other industrial, commercial, and residential loads. Load is winter peaking, with typical daily morning and evening peaks.
- *Woodville GXP* – Supplies Woodville town and the surrounding rural area, with a significant amount of agricultural (beef and sheep farming) loads, along with some industrial, commercial, and residential loads within Dannevirke. Load is winter peaking, with typical daily morning and evening peaks.

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)

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

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)			
MAWH8	AFFCO New Zealand Limited Castlecliff	2.59	Brunswick	$7.00	Castlecliff	$4.02	$11.02	$4.25	Major	1, 2
MAWH40	Alsco NZ Palmerston North	2.67	Bunnythorpe	$12.00	Keith St	$0.16	$12.16	$4.56	Major	1, 2
MAWH41	Kakariki Proteins	2.50	Bunnythorpe	$12.00	Sanson	$5.38	$17.38	$6.95	Major	1, 2
MAWH10	AFFCO New Zealand Limited Manawatu	1.26	Bunnythorpe	$12.00	Fielding	$8.28	$20.28	$16.04	Major	1, 2
MAWH27	NZ Defence Force Ohakea Air Base	1.14	Bunnythorpe	$12.25	Ohakea	$6.28	$18.53	$16.21	Major	1, 2
MAWH43	Moana New Zealand	0.51	Bunnythorpe	$0.00	Keith St	$0.00	$0.00	$0.00	Minor	1
MAWH17	Fonterra Brands Limited Palmerston North	0.21	Bunnythorpe	$0.00	Keith St	$0.00	$0.00	$0.00	Minor	1
MAWH32	Ovation New Zealand Limited Feilding	0.20	Bunnythorpe	$0.00	Fielding	$0.00	$0.00	$0.00	Minor	1
MAWH37	Godfrey Hirst NZ Limited Dannevirke	2.38	Dannevirke	$0.00	N/A	$3.08	$3.08	$1.29	Minor	1
MAWH36	Alliance Group Limited Dannevirke	0.35	Dannevirke	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
MAWH23	Higgins Palmerston North Asphalt Plant	10.70	Linton	$0.00	Kairanga	$6.70	$6.70	$0.63	Moderate	1, 2
MAWH25	Massey University Manawatu	5.70	Linton	$0.00	Turitea	$6.99	$6.99	$1.23	Moderate	1, 2
MAWH20	Fonterra Limited Research and Development Centre	3.96	Linton	$0.00	Turitea	$7.09	$7.09	$1.79	Moderate	1, 2
MAWH42	NZ Pharmaceuticals	3.75	Linton	$0.00	Turitea	$12.84	$12.84	$3.42	Moderate	1, 2
MAWH29	Ministry of Health Palmerston North Hospital	3.49	Linton	$0.00	Main St	$12.30	$12.30	$3.53	Moderate	1, 2
MAWH21	Goodman Fielder Longburn	3.25	Linton	$0.00	Kairanga	$4.58	$4.58	$1.41	Moderate	1, 2
MAWH18	Fonterra Limited Longburn	1.80	Linton	$0.00	Kairanga	$4.58	$4.58	$2.55	Moderate	1, 2
MAWH15	Goodman Fielder Ernest Adams	1.70	Linton	$0.00	Pascal St	$0.00	$0.00	$0.00	Minor	1
MAWH26	NZ Defence Force Linton	0.55	Linton	$0.00	Turitea	$0.00	$0.00	$0.00	Minor	1
MAWH11	AgResearch Grasslands Research Centre	0.44	Linton	$0.00	Turitea	$0.00	$0.00	$0.00	Minor	1
MAWH3	Horowhenua District Council Levin Aquatic Centre	3.87	Mangahao	$9.00	Levin West	$2.20	$11.20	$2.89	Major	1, 2
MAWH5	Oji Fibre Solutions Packaging NZ Central	3.75	Mangahao	$9.00	Levin East	$0.58	$9.58	$2.56	Major	1, 2
MAWH7	Turk's Poultry	2.31	Mangahao	$9.00	Foxton	$0.52	$9.52	$4.12	Major	1, 2
MAWH2	Health New Zealand Horowhenua Health Centre	1.50	Mangahao	$9.00	Levin East	$1.12	$10.12	$6.75	Major	1, 2
MAWH6	RJs Confectionery Levin	1.08	Mangahao	$9.00	Levin West	$2.20	$11.20	$10.40	Major	1, 2
MAWH4	Mitchpine Limited Levin	0.49	Mangahao	$0.00	Levin West	$0.00	$0.00	$0.00	Minor	1
MAWH19	Fonterra Limited Pahiatua - Stage 1	13.00	Mangamaire	$0.00	Mangamutu	$8.88	$8.88	$0.68	Moderate	1, 2
MAWH19	Fonterra Limited Pahiatua - Stage 2	25.00	Mangamaire	$50.40	Mangamutu	$14.75	$65.15	$2.61	Major	1, 2
MAWH24	Malteurop Marton	14.40	Marton	$10.00	Arahina	$23.90	$33.90	$2.35	Major	1, 2
MAWH30	Nestle Purina Petcare Marton	2.40	Marton	$0.00	Arahina	$10.46	$10.46	$4.37	Moderate	1, 2
MAWH13	ANZCO Foods Rangitikei	1.61	Marton	$0.00	Arahina	$1.41	$1.41	$0.88	Moderate	1, 2
MAWH12	ANZCO Foods Manawatū	1.56	Marton	$0.00	Bulls	$1.55	$1.55	$0.99	Moderate	1, 2
MAWH16	Farmland Foods Bulls	0.72	Marton	$0.00	Pukepapa	$0.00	$0.00	$0.00	Minor	1
MAWH38	King Country Pet Food Taumarunui	7.04	Ongarue	$6.00	Manunui	$14.43	$20.43	$2.90	Major	1, 2
MAWH39	Ministry of Health Taumarunui Hospital	0.90	Ongarue	$0.00	Borough	$0.00	$0.00	$0.00	Minor	1
MAWH31	Open Country Dairy Limited Whanganui - Stage 1	6.00	Whanganui	$10.00	Beach Rd	$0.46	$10.46	$1.74	Major	1, 2
MAWH31	Open Country Dairy Limited Whanganui - Stage 2	9.00	Whanganui	$0.00	Beach Rd	$16.90	$16.90	$1.88	Major	1, 2
MAWH31	Open Country Dairy Limited Whanganui - Stage 3	13.43	Whanganui	$0.00	Beach Rd	$10.50	$10.50	$0.78	Major	1, 2
MAWH9	AFFCO New Zealand Limited Imlay	7.09	Whanganui	$10.00	Beach Rd	$14.04	$24.04	$3.39	Major	1, 2
MAWH14	Department of Corrections Whanganui Prison	3.31	Whanganui	$10.00	Whanganui East	$9.88	$19.88	$6.01	Major	1, 2
MAWH34	Tasman Tanning Castlecliff	1.79	Whanganui	$5.66	Beach Rd	$0.00	$5.66	$3.15	Major	1, 2
	TOTAL =>	169.43	TOTAL =>	$202.31	TOTAL =>	$216.05	$418.36			

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 (N-1) scenario cost shown

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 Manawatū-Whanganui region are supplied with electricity via electrical networks that are owned by the following EDBs:

- Electra - 4 zone substations
- The Lines Company (Northern and Manawatū-Whanganui River areas only) – 8 zone substations
- Powerco (Manawatū-Whanganui regions of the network) – 30 zone substations
- Scanpower –No zone substations

The regional areas of the EDBs are shown in Figure 5 for the four 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 RETA program, EECA contracted Ergo to determine the existing spare supply capacity and the load characteristics at the major electrical substations within the Manawatū-Whanganui region.

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

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

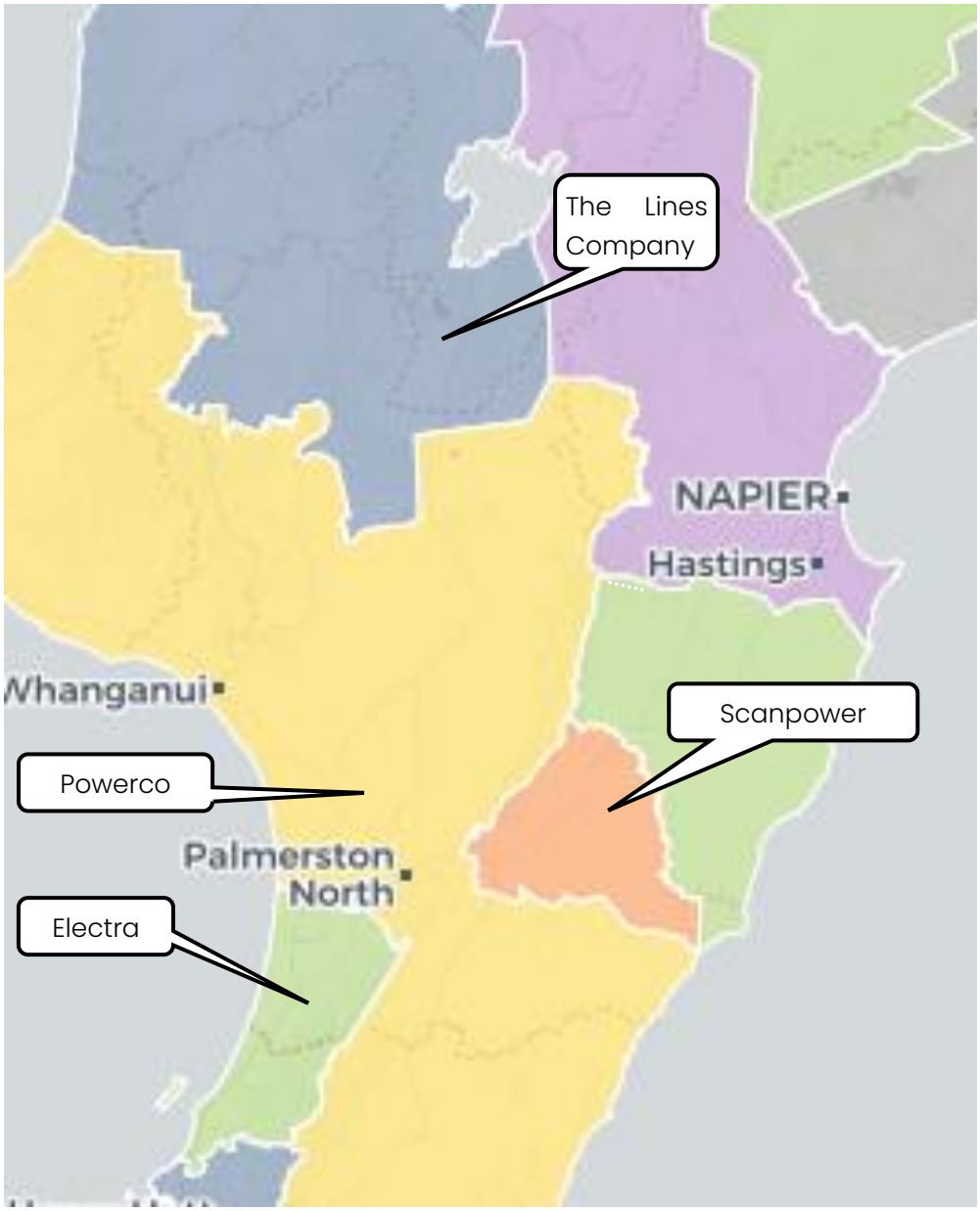


Figure 5 EDB regional areas[4]

[4] ENA Lines Company Map: 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 Manawatū-Whanganui region. This included reviewing both the GXP's and local distribution zone substations along with their associated lines/cables within the Manawatū-Whanganui region.

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

- Transpower's *Transmission Planning Report 2023*.
- Electra's 2023 regulatory information disclosures[5] and AMP.
- The Lines Company's 2023 regulatory information disclosures[6] and AMP.
- Powerco's 2023 regulatory information disclosures[7] and AMP.
- Scanpower's 2023 regulatory information disclosures[8] and AMP.
- SCADA substation loading data provided by Electra, The Lines Company, Powerco, and Scanpower.
- GXP metering data extracted from the Electricity Authority's website[9].
- Network diagrams provided by Electra, The Lines Company, Powerco, and Scanpower.
- Geographic Information System (GIS) asset and location data provided by Electra, The Lines Company, Powerco, and Scanpower.
- Powerco's Demand Capacity Map[10].

[5] https://electra.co.nz/our-company/disclosures/
[6] https://www.thelinescompany.co.nz/disclosures/
[7] https://www.Powerco.co.nz/who-we-are/disclosures-and-submissions/electricity-disclosures
[8] https://scanpower.co.nz/disclosures/
[9] https://www.emi.ea.govt.nz/Wholesale/Datasets
[10] https://experience.arcgis.com/experience/3e5c53d1cc6c4ab0955675bdb0df408e

4. Manawatū-Whanganui Network

The following sections describe (at a high level), the locations of the relevant substations and lines. For the purposes of this document the EDB regional areas defined above and supplied by Electra, The Lines Company, Powerco, and Scanpower, are referred to as the Manawatū-Whanganui region.

4.1 Transmission/GXP Substations

The following Figure 6 illustrates the relevant transmission substations (GXPs) within the Manawatū-Whanganui region, which include the following (linked here to the EDB they supply and the name of the EDB network area if applicable):

- Electra:
    - Mangahao GXP.
- The Lines Company:
    - Ongarue GXP ("Southern" network).
    - National Park GXP ("Southern" network).
    - Ohakune GXP ("Southern" network).
- Powerco:
    - Brunswick GXP ("Whanganui" network).
    - Whanganui GXP ("Whanganui" network).
    - Ohakune ("Rangitīkei" network).
    - Mataroa ("Rangitīkei" network).
    - Marton GXP ("Rangitīkei" network).
    - Bunnythorpe GXP ("Manuwatū" network).
    - Linton GXP ("Manuwatū" network).
    - Mangamaire GXP ("Tararua" network).
- Scanpower:
    - Dannevirke GXP.
    - Woodville GXP.
- Direct supply to industrial loads:
    - Tangiwai GXP.

The Manawatū-Whanganui region includes a significant portion of the North Island generation capacity, with generators connected at dedicated GIPs (Grid Injection Points), or at the GXPs listed above. Generation in the region includes several large wind farms as well as a range of hydroelectric power stations. The generation plants in the region include:

- Tararua Wind (North) (wind generation) (34 MW) – connects at Bunnythorpe GXP.
- Tararua Wind (South) (wind generation) (34 MW) – connects at Linton GXP.
- Turitea Wind (wind generation) (221 MW) – connects at Transpower's 220 kV Linton Substation.
- Mangahao (hydroelectric generation) (30 MW[11]) – connects at Mangahao GXP.
- Hydroelectric generation connected at Ongarue GXP:

[11] Ergo notes that the site has a full capacity of 38 MW, but only the G1 unit is presently being utilised, which limits output to 26 MW at present.

    - Mokauiti (1.6 MW)
    - Kuratau (6 MW)
    - Wairere Falls (4.6 MW)
- Rangipo (hydroelectric generation) (120 MW) – dedicated GIP.
- Tararua Wind (wind generation) (Stage 3: 93 MW; Te Rere Hau: 49 MW) – dedicated GIP.
- Tokaanu (hydroelectric generation) (240 MW) – connects at Transpower's 220 kV Tokaanu Substation.
- Te Apiti (wind generation) (90 MW) – connects at Transpower's 110 kV Woodville Substation.

The transmission network in the Manawatū-Whanganui region is also shown schematically in Figure 7. Generally, generation capacity in the Manawatū-Whanganui region is higher than its maximum demand, with the excess exported to the National Grid.

The region is reasonably interconnected with the National Grid, with connections to Wellington, Hawke's Bay, Waikato, and Taranaki. Four 220 kV circuits and one 110 kV circuit run south to Wellington (220 kV to Haywards and 110 kV to Masterton) from Bunnythorpe (220 kV) and Mangamaire (110 kV) respectively. Two 110 kV circuits run north to the Hawke's Bay (Waipawa) from Dannevirke[12]. One 220 kV Rangipo-Wairakei, two 220 kV Tokaanu-Whakamaru, and one 110 kV Ongarue-Hangatiki circuit connect the region to Waikato. Three 220 kV Brunswick-Stratford and one 110 kV Whanganui-Waverley circuit connect the region to Taranaki.

Two 220/110 kV interconnecting transformers are located at Bunnythorpe.

[12] Ergo notes that there is an open point between Waipawa and the Hawke's Bay region, at present.

Figure 6. Transmission/GXP substations (note that while the Wairakei and Waipawa GXPs are present in Transpower's "Central North Island" region, they are discussed as part of the Waikato and Hawke's Bay regions, respectively, for this EECA RETA project, and so are not discussed in this report) [13]

[13] *Transmission Planning Report 2023*.

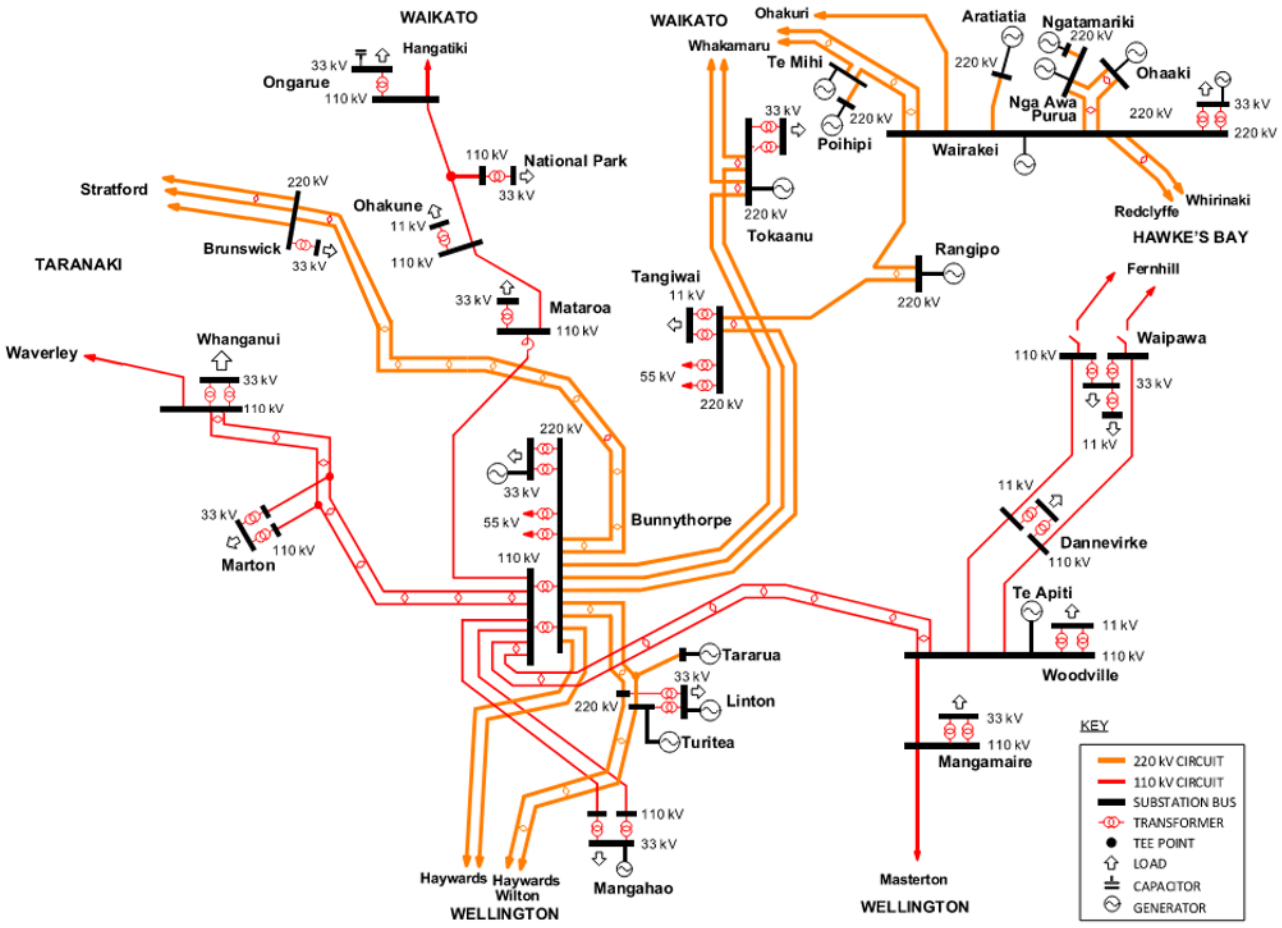


Figure 7 Existing transmission/GXP substations (note that while the Wairakei and Waipawa GXPs are in Transpower's "Central North Island" region, they are discussed as part of the Waikato and Hawke's Bay regions, respectively, for this EECA RETA project, and so are not discussed in this report)[13]

4.2 Zone Substations

Zone substations are categorised by the EDB that owns and operates the network. As mentioned earlier, in the Manawatū-Whanganui area, there are four relevant EDB's – Electra, The Lines Company, Powerco, and Scanpower. 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
Electra	4	1
The Lines Company (Southern area)	14	4
Powerco (Whanganui, Rangitīkei, Manuwatū, and Tararua network areas)	31	8
Scanpower	0	2

4.2.1 Electra

The following Figure 8 shows the subtransmission network, zone substations, and GXPs for Electra's region. The substations include:

- Mangahao GXP ("Northern" Network):
    - Shannon 33/11 kV zone substation
    - Foxton 33/11 kV zone substation
    - Levin West 33/11 kV zone substation
    - Levin East 33/11 kV zone substation
    - Ergo notes that Electra have indicated that another substation is required in the area, which is being called Manakau zone substation.

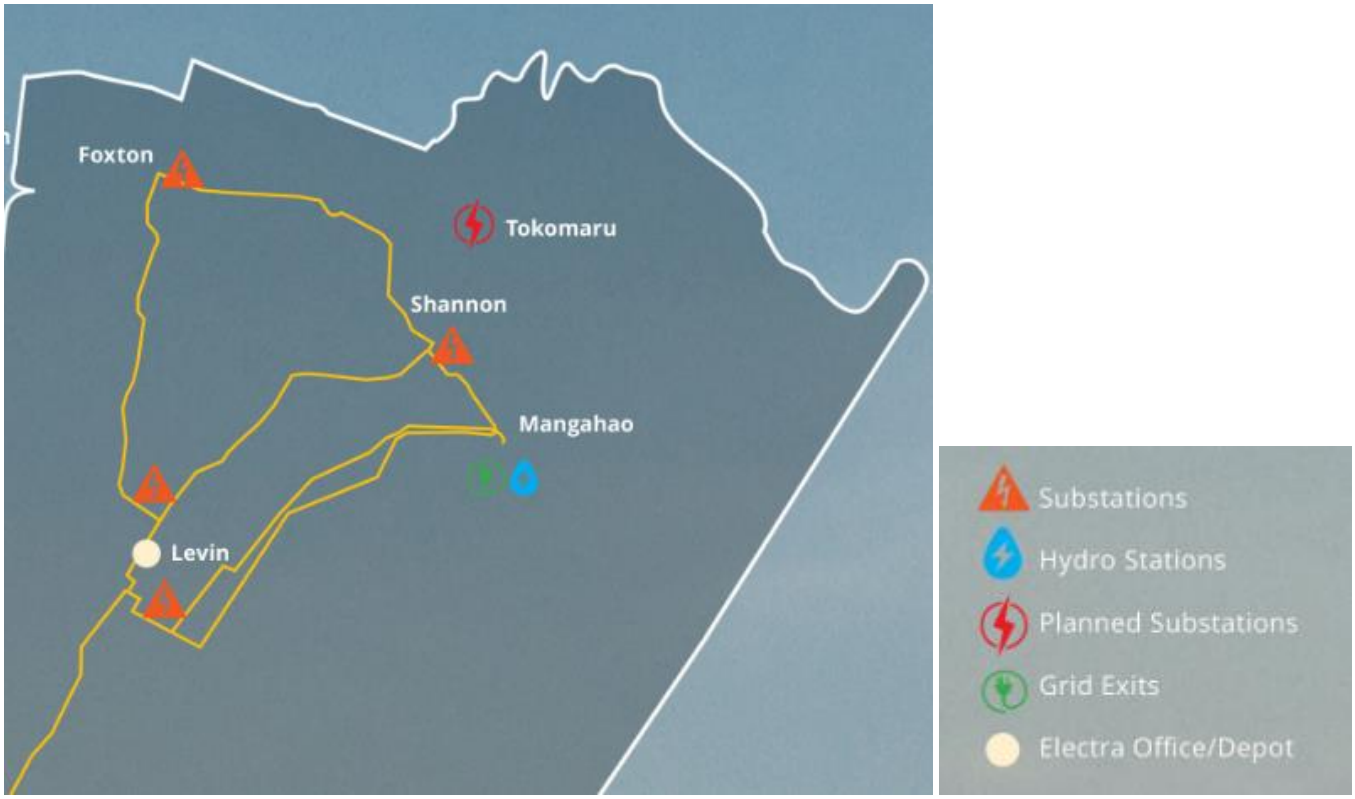


Figure 8. Electra zone substations and interconnecting subtransmission circuits [14]

4.2.2 The Lines Company

The following Figure 9 shows the subtransmission network, zone substations, and GXPs for the relevant regions of The Lines Company's network. The Manawatū-Whanganui substations include:

- Ongarue, Tokaanu, National Park, and Ohakune GXPs (Southern network area):
    - Nihoniho 33/11 kV zone substation
    - Borough 33/11 kV zone substation
    - Manunui 33/11 kV zone substation
    - Kuratau 33/11 kV zone substation
    - Otukou 33/11 kV zone substation
    - Tawhai 33/11 kV zone substation
    - National Park 33/11 kV zone substation

[14] Electra's 2023 Asset Management Plan found here: https://electra.co.nz/our-company/disclosures/

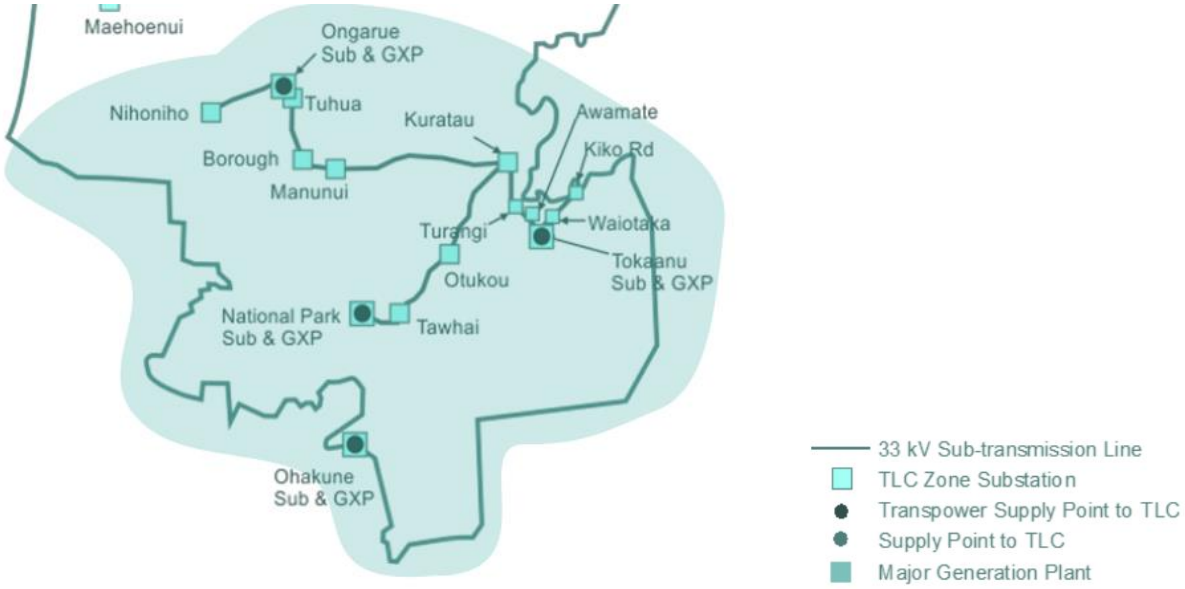


Figure 9. The Lines Company zone substations and interconnecting subtransmission circuits[15]

4.2.3 Powerco

The following Figure 10, Figure 11, Figure 12, and Figure 13 show the subtransmission network, zone substations, and GXPs for Powerco's Valley region (includes the Whanganui, Rangitīkei, Manawatū, and Tararua subareas). The substations include:

- Brunswick and Wanganui GXPs (Whanganui network area):
    - Kai Iwi 33/11 kV zone substation
    - Peat St 33/11 kV zone substation
    - Roberts Ave 33/11 kV zone substation
    - Taupō Quay 33/11 kV zone substation
    - Blink Bonnie 33/11 kV zone substation
    - Castlecliff 33/11 kV zone substation
    - Beach Rd 33/11 kV zone substation
    - Hatricks Wharf 33/11 kV zone substation
    - Wanganui East 33/11 kV zone substation
- Ohakune, Mataroa, and Marton GXPs (Rangitīkei network area):
    - Waiouru 33/11 kV zone substation
    - Taihape 33/11 kV zone substation
    - Rata 33/11 kV zone substation
    - Arahina 33/11 kV zone substation
    - Pukepapa 33/11 kV zone substation
    - Bulls 33/11 kV zone substation
- Bunnythorpe and Linton GXPs (Manuwatū network area):
    - Feilding 33/11 kV zone substation
    - Ferguson Street 33/11 kV zone substation

[15] The Lines Company's 2023 Asset Management Plan found here: https://www.thelinescompany.co.nz/disclosures/

    - Kairanga 33/11 kV zone substation
    - Keith Street 33/11 kV zone substation
    - Kelvin Grove 33/11 kV zone substation
    - Kimbolton 33/11 kV zone substation
    - Main Street 33/11 kV zone substation
    - Milson 33/11 kV zone substation
    - Ōhakea 33/11 kV zone substation
    - Pascal Street 33/11 kV zone substation
    - Sanson 33/11 kV zone substation
    - Turitea 33/11 kV zone substation
- Mangamaire GXP (Tararua network area):
    - Mangamutu 33/11 kV zone substation
    - Parkville 33/11 kV zone substation
    - Alfredton 33/11 kV zone substation
    - Pongaroa 33/11 kV zone substation

Figure 10. Powerco's Whangaui region zone substations and interconnecting subtransmission circuits [16]

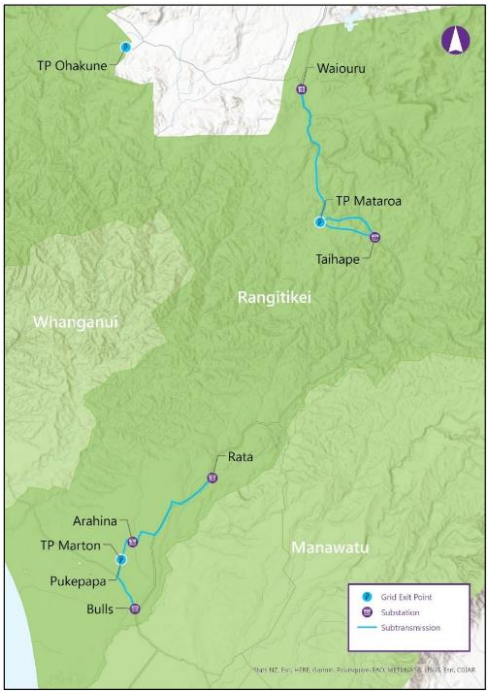


Figure 11. Powerco's Rangitīkei region zone substations and interconnecting subtransmission circuits [16]

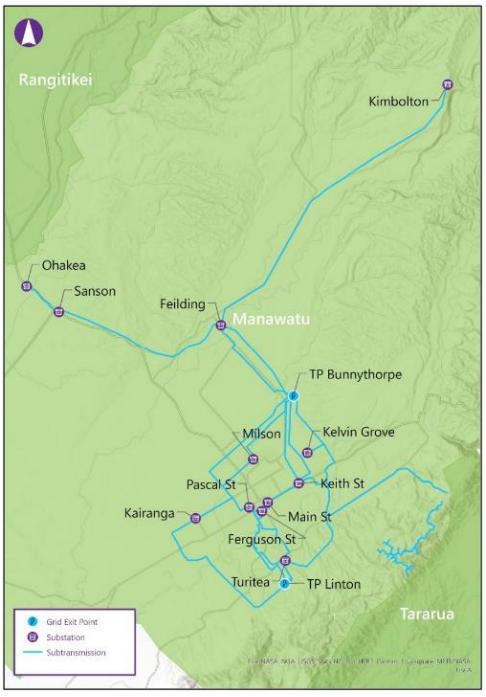


Figure 12. Powerco's Manawatū region zone substations and interconnecting subtransmission circuits [16]

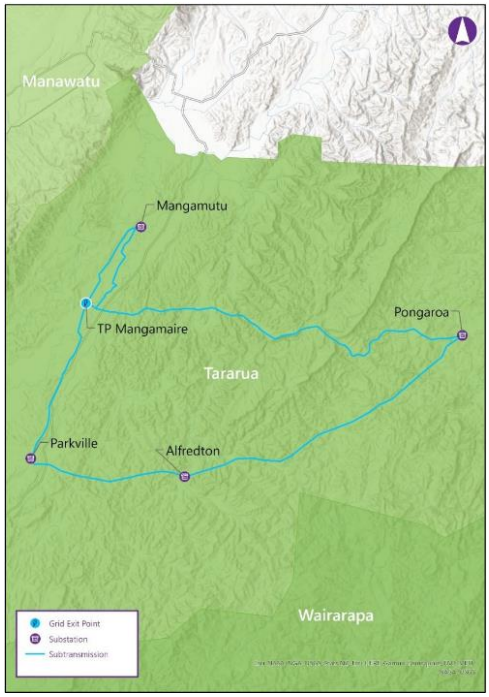


Figure 13. Powerco's Tararua region zone substations and interconnecting subtransmission circuits [16]

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

4.2.4 Scanpower

Scanpower does not presently own subtransmission assets or zone substations, and it takes supply at 11 kV from the two GXPs in the area (Dannevirke and Woodville). Scanpower's 11 kV network is shown in Figure 14 below.

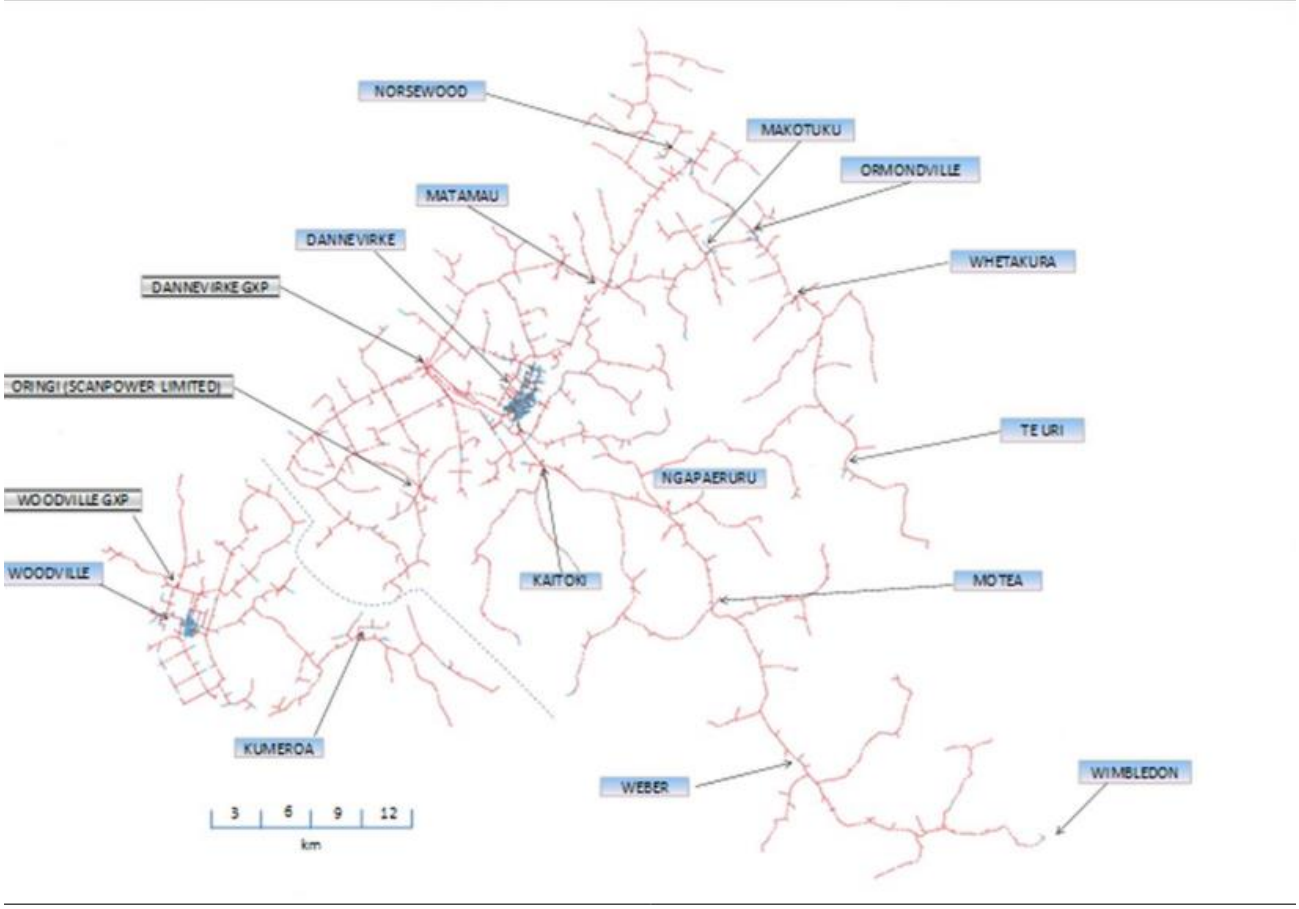


Figure 14. Scanpower's region 11 kV network [17]

[17] Scanpower's 2023 Asset Management Plan found here: https://scanpower.co.nz/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)[18]. 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. More remote or small GXPs may be designed for (N) security.
- Distribution zone substations are designed and operated as follows:
    - Loads ≥ 12 MW designed and operated with (N-1) security of supply.
    - Loads < 12 MW designed and operate with (N) security of supply.

Transpower is required to provide (N-1) for "core grid" (typically, 220 kV and >150 MVA loads) interconnected assets (i.e. transmission lines that supply multiple GXP substations). For "non-core grid" assets (typically, <220 kV and <150 MVA 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., Electra, The Lines Company, Powerco, or Scanpower). For those substations that are supplied via dedicated incoming lines, the lines are also

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

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[19] 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.

[19] 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 Manawatū-Whanganui region.

Transpower has identified the following "*grid issues*" that result from increasing electrical demand and generation in the Manawatū-Whanganui region including:

- During periods of low wind generation, low HVDC North transfer, and high regional load, an outage of one of the two 220/110 kV interconnecting transformers at Bunnythorpe can overload the 110 kV disconnectors and bus conductor associated with the transformer remaining online, towards the end of the forecast period.
- The 110 kV Bunnythorpe-Mataroa circuit can overload during some generation dispatch scenarios, and for an outage on a number of the 220 kV circuits in the region. The frequency and magnitude of this overload increases with: increasing load supplied from the 110 kV system (Bunnythorpe-Ongarue-Hamilton-Bombay corridor; increasing levels of generation injection at Bunnythorpe; decreasing levels of generation at Arapuni or Karapiro.
- One or both of the 110 kV Bunnythorpe-Woodville circuits may overload for an outage of: one 110 kV Bunnythorpe-Woodville circuit; one 220 kV Bunnythorpe-Paraparaumu-Haywards, or Bunnythorpe-Linton, or Haywards-Wilton-Linton circuit during high HVDC south flow; a 220 kV bus at Bunnythorpe, Linton, or Tararua Central during high HVDC south flow; or both 110 kV Haywards-Greytown circuits.
- With the present configuration of Powerco's network, when there is low wind generation at Bunnythorpe, the (N-1) capacity of the Bunnythorpe 220/33 kV transformers may be exceeded. Powerco is planning load shifts off Bunnythorpe (to Linton and Marton) over the forecast period, which will largely relieve the issue at Bunnythorpe. However, these load transfers will mean the peak load at Marton will exceed the (N) transformer capacity, and will result in the following issues during an outage of one 110 kV Bunnythorpe-Marton-Whanganui circuit:
    - The Bunnythorpe-Marton section of the remaining Bunnythorpe-Marton-Whanganui circuit will overload during periods of low Taranaki generation,
    - The Bunnythorpe-Marton section of the remaining Bunnythorpe-Marton-Whanganui circuit will overload during periods of high Taranaki generation, and
    - The supply bus at Marton will fall below 0.95 p.u. This issue is worsened as the transformers at Marton are not equipped with on-load tap changers (OLTC).
- An outage of the 110 kV Hāwera-Stratford circuit (within the Taranaki region) can result in low voltages, or a voltage drop greater than 5% at Whanganui, when there is no generation available at Hāwera.

Figure 15 below illustrates Transpower's view of a possible 2038 configuration for the Manawatū-Whanganui region's transmission network. Ergo notes that this is only one possible view, and we expect that the plan for upgrades may change over time. It includes:

- Upgrades of the 220 kV Bunnythorpe-Tokaanu, Tokaanu-Whakamaru, and Brunswick-Stratford lines.
- Upgrades of the 110 kV Bunnythorpe-Marton-Whanganui lines.
- Replacement of the 220 kV bus at Rangipo.

- Replacements of the 110/33 kV transformers at Mangamaire, Mangahao, Whanganui, Ongarue, Mataroa, and Brunswick (including installation of an additional new 110/33 kV transformer at Brunswick).
- Replacement of the 220/33 kV transformers at Bunnythorpe (note these are bushing replacements and not full transformer replacements) and 220/11 kV transformers at Tangiwai.
- Investigation and potential implementation of a system split on the Ongarue-Hangatiki 110 kV line.

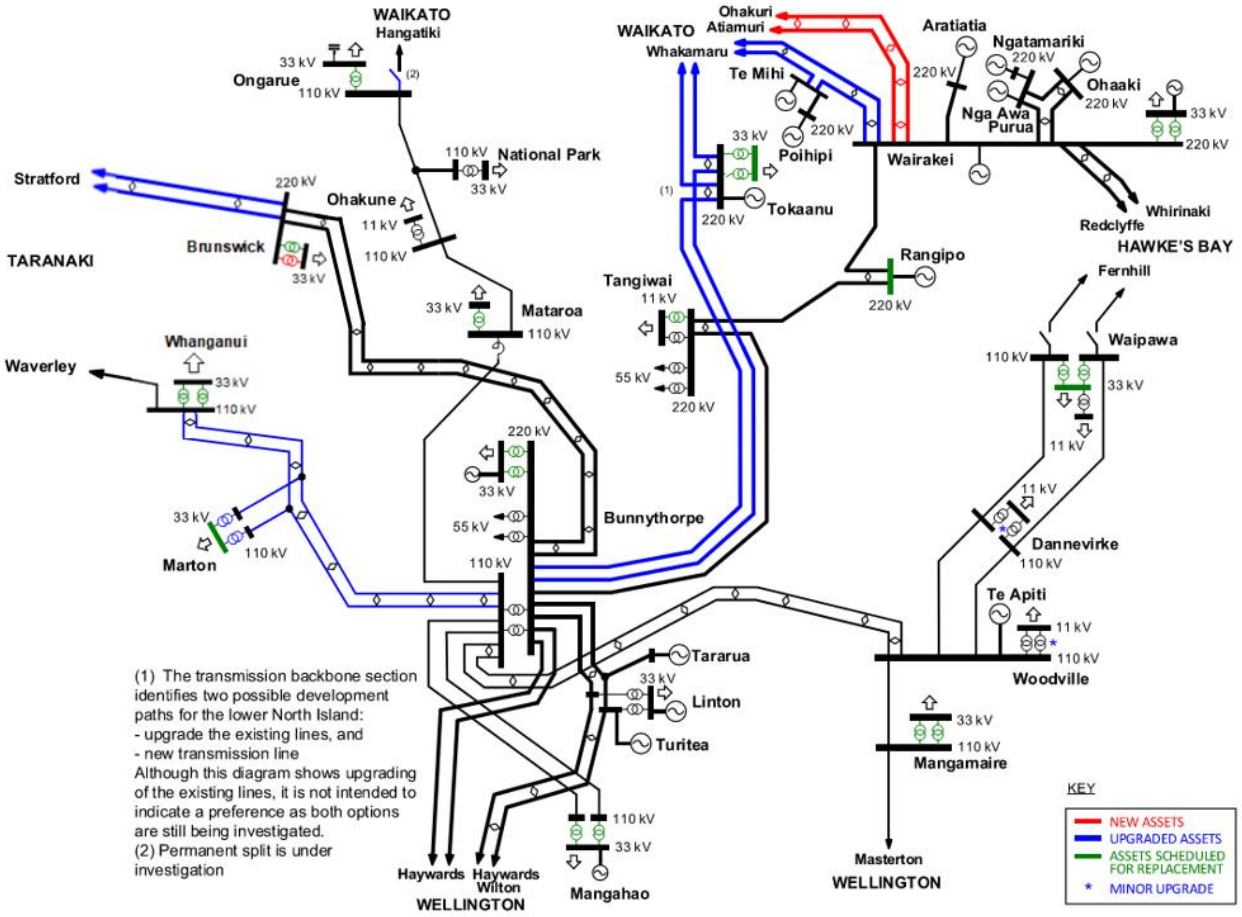


Figure 15 Existing transmission/GXP substations together with future possible upgraded/new assets[20]

[20] Transmission Planning Report 2023

6.1 Demand Forecast

The following Table 3 illustrates Transpower's forecast demand at the transmission substations in the Manawatū-Whanganui region from its annual *Transmission Planning Report 2023*[21]. The forecast predicts the demand growing at an average of 3.0% per annum over the next fifteen years which is greater than the national average of 2.0%.

Table 3 Forecast prudent annual peak demand (MW) at Manawatū-Whanganui grid exit points to 2038.

GXP	Power factor	Peak demand (MW)											
		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2038
Brunswick	0.99	32	33	33	34	34	35	35	35	36	36	37	38
Bunnythorpe[1, 2, 3]	0.99	104	105	103	106	108	110	112	113	115	116	118	122
Dannevirke	0.99	16	16	17	17	21	21	22	23	23	26	26	28
Linton[1]	1.00	64	79	84	85	87	88	89	90	91	92	93	95
Mangahao	0.99	47	47	48	49	50	51	52	52	53	54	55	57
Mangamaire	0.98	16	16	16	17	17	17	17	17	17	17	17	18
Marton[2, 4]	0.99	23	31	52	58	64	64	65	65	65	66	66	67
Mataroa	1.00	7	7	8	8	8	8	8	8	8	8	9	9
National Park	0.99	6	6	6	6	6	6	7	7	7	7	7	7
Ohakune	0.98	9	10	10	10	10	10	11	11	11	11	11	12
Ongarue	1.00	17	18	18	18	18	19	19	19	19	20	20	20
Tokaanu	1.00	12	12	12	13	13	13	14	14	15	15	16	17
Whanganui	0.98	34	34	35	36	37	37	38	38	38	38	39	39
Woodville[5]	-0.98	4	4	4	4	4	4	4	5	5	5	5	5

Notes:

1. Powerco has advised of a load shift from Bunnythorpe to Linton in 2024 (Main St Substation is being shifted from Bunnythorpe to Linton).
2. Powerco has advised of a load shift from Bunnythorpe to Marton in 2025 (this is dependent on the Marton GXP transformer upgrades).
3. Powerco has advised of industrial load increases at Bunnythorpe of 11 MW across 2030-2031 (following a transformer replacement). The expected load increases are customer dependent.
4. Powerco has advised of industrial load increases at Marton of up to 32 MW across 2023-2027. The expected load increases are customer dependent.
5. Leading power factor.

[21] Transmission Planning Report 2023

6.1.1 Brunswick GXP

Transpower's demand forecast indicates that the Brunswick GXP was expected to have a 2023 peak demand of 32 MW at 0.99 power factor (32.32 MVA). This value aligns with the historical SCADA data that indicates the Brunswick GXP recorded a peak load of 34.83 MVA during the 2023 year.

The Brunswick GXP is equipped with a single 220/33 kV transformer providing:

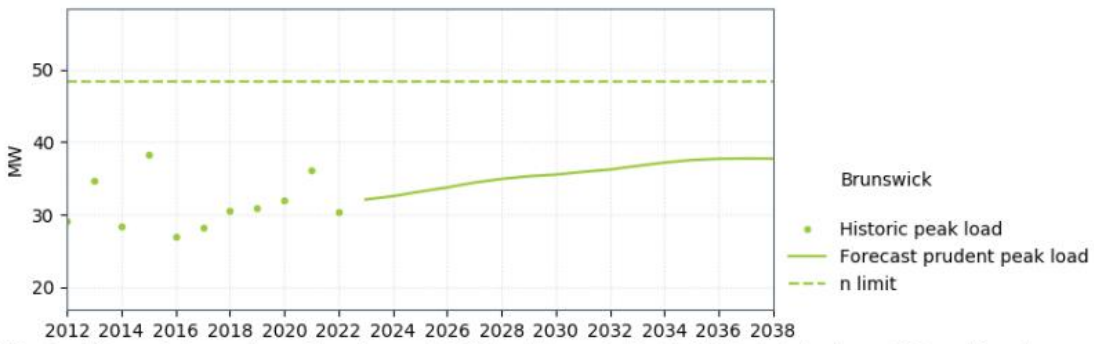
- (N) capacity of 50 MVA and
- (N-1) capacity of 0 MVA.

Brunswick is supplied at 220 kV by two lines from Bunnythorpe, rated at 694/764 MVA and 694/712 MVA (summer/winter). Three 220 kV lines connect Brunswick to Stratford in Taranaki, each rated at 232/287 MVA (summer/winter).

The 220/33 kV transformer at Brunswick is due for risk-based condition replacement around 2023-2026. At present, a failure of the single Brunswick transformer is managed by transferring load to the Whangaui GXP by switching in Powerco's network. However, particularly during higher loading periods, Powerco's network may not have capacity to transfer the entire load, so this may still require some load curtailment.

There is a non-contracted spare transformer on-site at Brunswick, and it is estimated that the spare transformer could be installed to restore supply in the case of a failure of the Brunswick 220/33 kV transformer within 8-14 hours. Transpower and Powerco are investigating a business case for installing a second 220/33 kV transformer at Brunswick.

The following graph[22] shows Brunswick GXP's 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 16 illustrates Brunswick's 2023 loading in comparison to its substation capacity.

[22] Sourced from Transpower's *Transmission Planning Report 2023*.

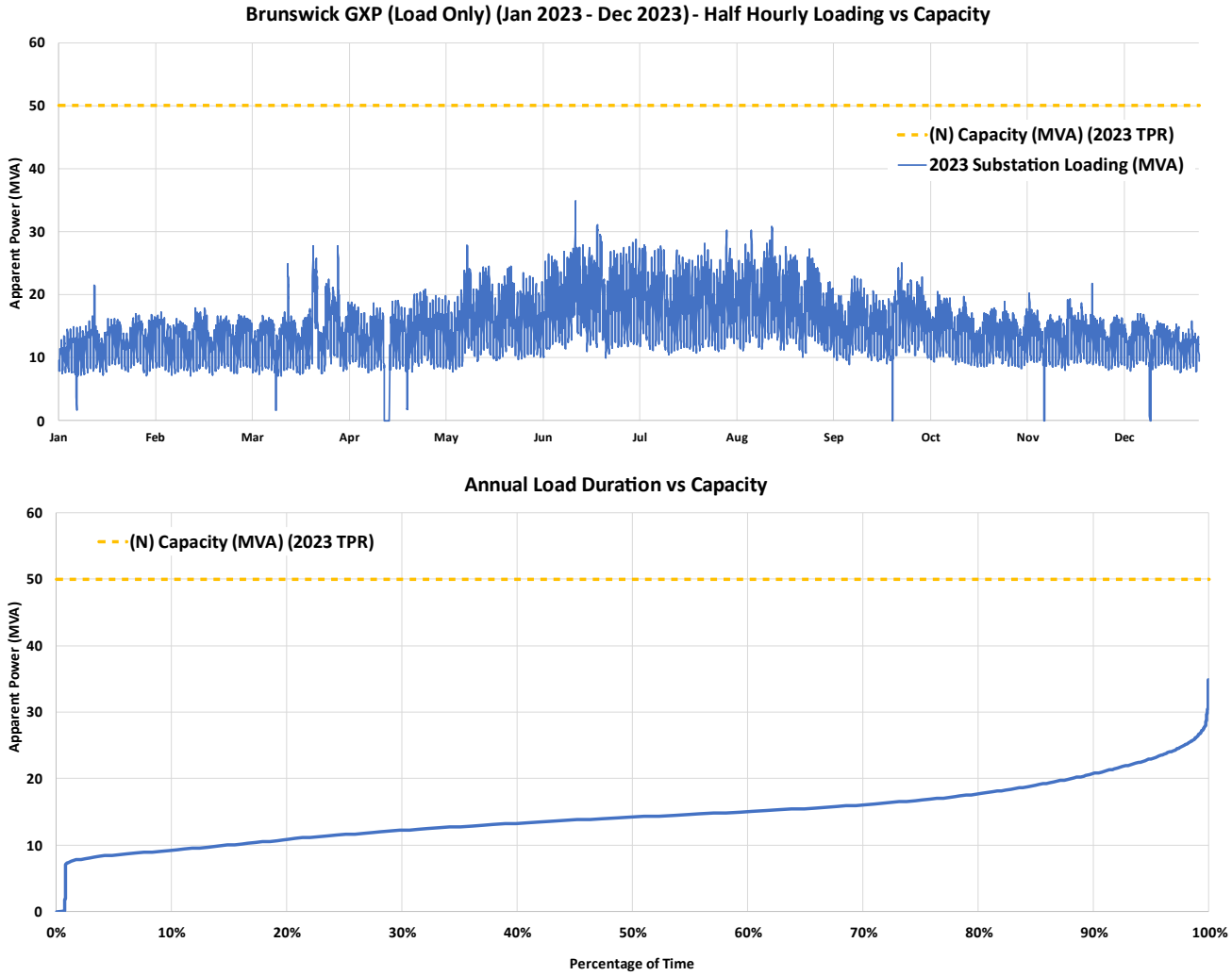


Figure 16. Brunswick GXP: 2023 Loading: Substation capacity.

6.1.2 Bunnythorpe GXP

Bunnythorpe GXP has two separate supplies from Transpower. One at 55 kV, which supplies Kiwirail, and the other at 33 kV, which supplies the other connected customers, including Powerco's network. Discussion in this report focusses on the non-Kiwirail supply.

Transpower's demand forecast indicates that the Bunnythorpe GXP was expected to have a 2023 peak demand of 104 MW at 0.99 power factor (~105.1 MVA). This value compares to the historical SCADA data that indicates the Bunnythorpe GXP recorded a peak load of 90.1 MVA during the 2023 year. The difference is likely due to Powerco shifting load from Bunnythorpe to Linton GXP during the year.

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

- (N) capacity of 166 MVA and
- (N-1) capacity of 101.6 MVA.

The transformer capacity at Bunnythorpe is limited by a 33 kV cable limit on T9.

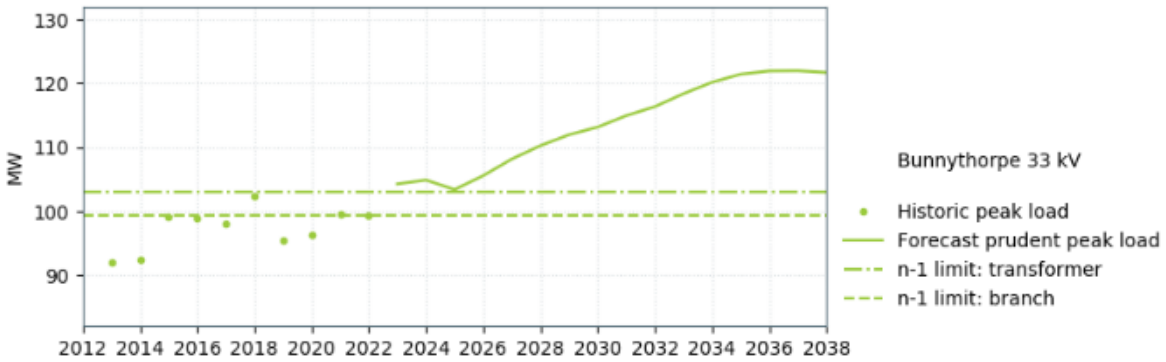
Bunnythorpe is connected at 220 kV to: Brunswick via two lines rated at 694/764 MVA and 694/712 MVA (summer/winter); Tangiwai via one line rated at 239/292 MVA (summer/winter); Tokaanu via two lines rated at 308/335 MVA (summer/winter); and Haywards via four lines, two of which are rated at 694/764 MVA (summer/winter), the other two being rated at 355/391 MVA (summer/winter).

Two 220/110 kV interconnecting transformers supply the region's 110 kV loads (and some load outside the region). The interconnecting transformers have an (N) capacity of 300 MVA, and (N-1) capacity of 178 MVA.

Peak load at Bunnythorpe was expected to exceed the transformer (N-1) capacity from winter of 2023. This does not include any contribution from the Tararua North wind generation, which connects at the GXP's 33 kV bus. At present, Transpower plans to manage the expected overload operationally, and through switching in Powerco's network to move load to the Linton GXP post-contingency.

The following graph[23] compares Bunnythorpe GXP's supply capacity with the historical loading and Transpower's demand forecast.

[23] Sourced from Transpower's *Transmission Planning Report 2023*.



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 Bunnythorpe's 2023 loading in comparison to its substation capacity.

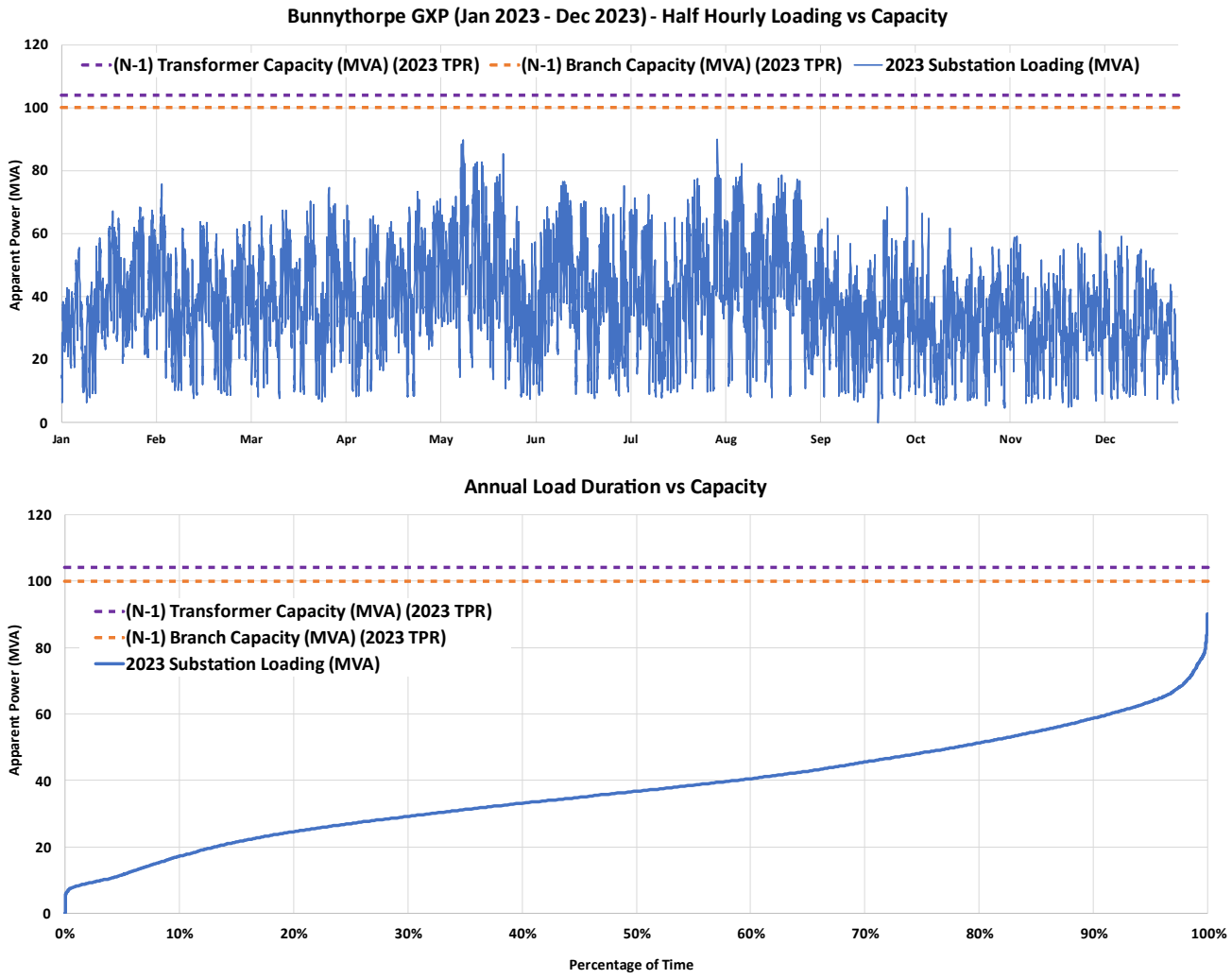


Figure 17. Bunnythorpe GXP: 2023 Loading: Substation capacity.

6.1.3 Dannevirke GXP

Transpower's demand forecast indicates that the Dannevirke GXP was expected to have a 2023 peak demand of 16 MW at 0.99 power factor (~16.16 MVA). This aligns well with the historical SCADA data that indicates that during 2023 the Dannevirke GXP experienced a peak load of 14.4 MVA.

The Dannevirke GXP is equipped with two 110/11 kV transformers providing:

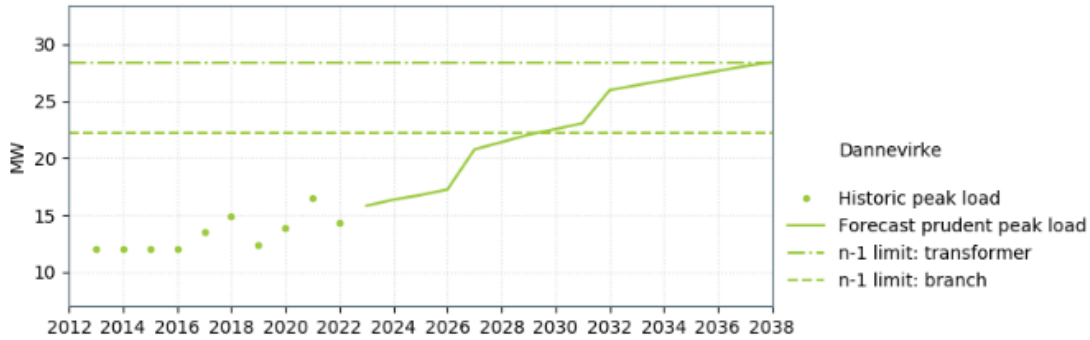
- (N) capacity of 40 MVA and
- (N-1) capacity of 23 MVA.

The transformer capacity is limited by a metering limit.

Dannevirke is supplied by the two 110 kV Woodville-Dannevirke-Waipawa circuits which are each rated at 51/62 MVA (summer/winter). Woodville is in turn supplied by Bunnythorpe at 110 kV by two lines rated at 57/70 MVA (summer/winter) each.

Peak load at Dannevirke is forecast to exceed the (N-1) capacity of the transformers from winter of 2030. Transpower plans to resolve the metering limit at the GXP (at an estimated cost of $0.1M), which will relieve this issue for the forecast period.

The following graph[24] compares Dannevirke 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 18 illustrates Dannevirke's 2023 loading in comparison to its substation capacity.

[24] Sourced from Transpower's *Transmission Planning Report 2023*.

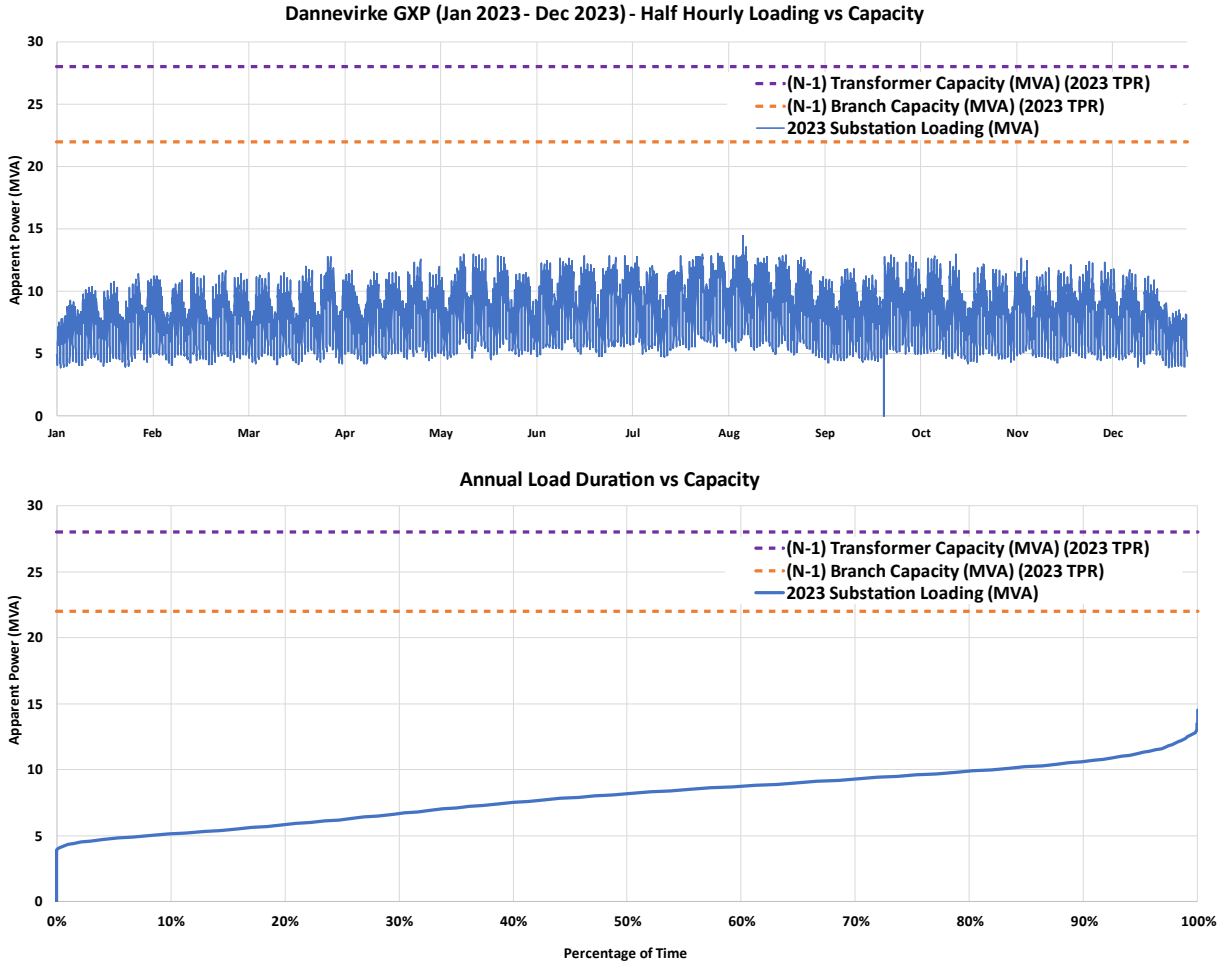


Figure 18. Dannevirke GXP: 2023 Loading: Substation capacity

6.1.4 Linton GXP

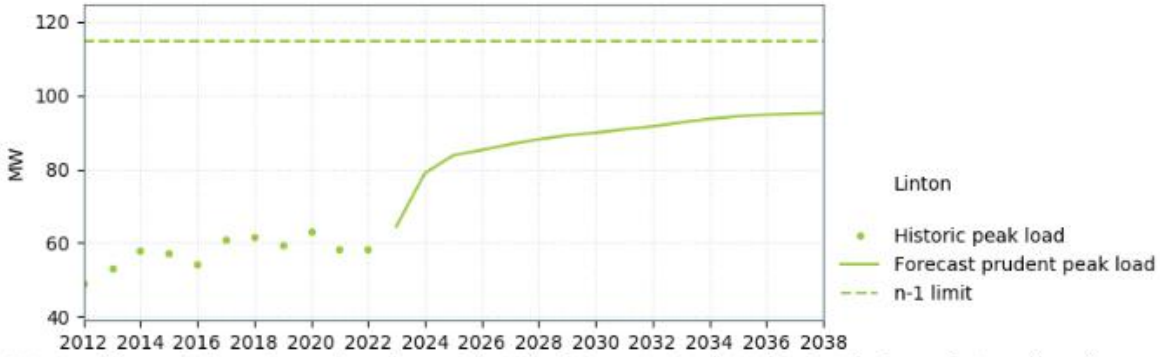
Transpower's demand forecast indicates that the Linton GXP was expected to have a 2023 peak demand of 64 MW at 1.00 power factor (64 MVA). This aligns with the historical SCADA data that indicates that during 2023 the Linton GXP experienced a peak load of 69.6 MVA. The difference is likely due to Powerco shifting load from Bunnythorpe to Linton GXP during the year.

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

- (N) capacity of 220 MVA and
- (N-1) capacity of 103.3 MVA.

Linton tees off two of the 220 kV lines between Bunnythorpe and Haywards, which are each rated at 694/764 MVA (summer/winter).

The following graph[25] compares Linton 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 19 illustrates Linton's 2023 loading in comparison to its substation capacity.

[25] Sourced from Transpower's *Transmission Planning Report 2023*.

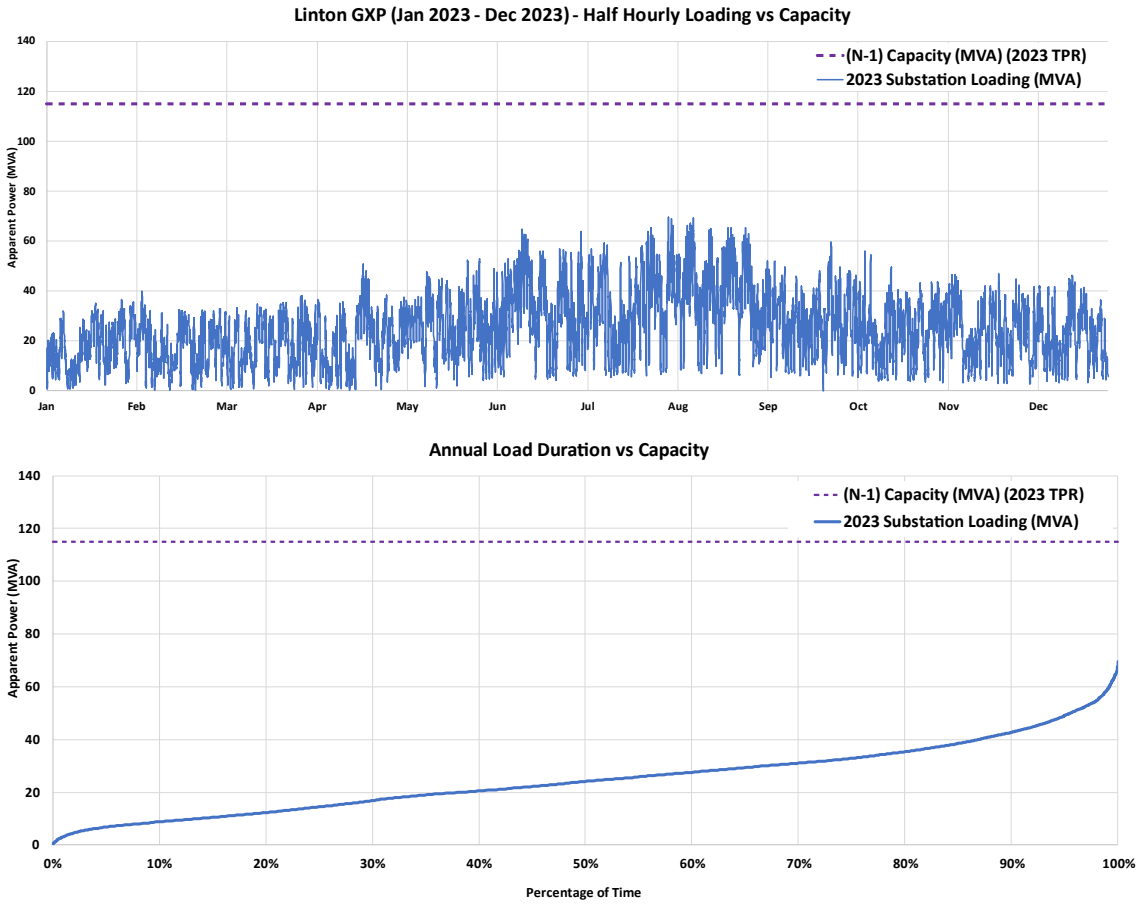


Figure 19. Linton GXP: 2023 Loading: Substation capacity

6.1.5 Mangahao GXP

Transpower's demand forecast indicates that the Mangahao GXP was expected to have a 2023 peak demand of 47 MW at 0.99 power factor (47.5 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Mangahao GXP experienced a peak load of 39.1 MVA (18% lower than forecasted). The difference is because of the effects of the embedded hydrogeneration at Mangahao (i.e. if the hydrogeneration were excluded from the load shown below, the load would be closer to forecasted).

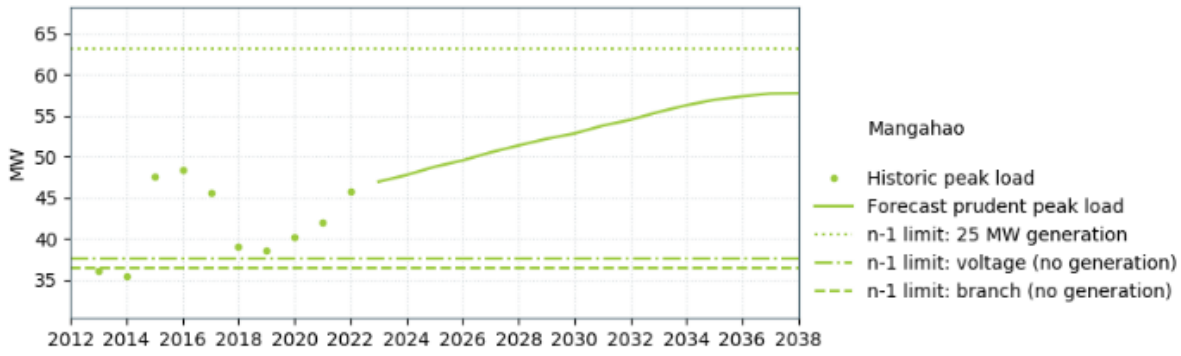
The Mangahao GXP is equipped with two 110/33 kV transformers providing:

- (N) secure capacity of 60 MVA and
- (N-1) capacity of 38.7 MVA.

Mangahao is supplied at 110 kV by two circuits from Bunnythorpe, each rated at 48/59 MVA (summer/winter). There is no bus coupler or connection between the two transformers at the site at 110 kV, so loss of one transmission line to the site also results in a loss of the associated transformer.

Mangahao's load already exceeds the (N-1) capacity of the site (assuming no generation from the 33 kV-connected Mangahao power station). When Mangahao is not generating, low 33 kV voltages occur following an outage of either 110 kV circuit or transformer, which further limits the supply capacity. The low voltages occur as the supply transformers at the site are not equipped with on-load tap-changers (OLTC). The transformer overload and voltage issues are presently managed operationally, by constraining on the Mangahao power station. Additionally, the supply transformers are due for replacement in 2026-2028, and at the time of replacement, the required transformer sizing will be investigated by Transpower and Electra.

The following graph[26] compares Mangahao 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 20 illustrates Mangahao 2023 loading in comparison to its substation capacity.

[26] Sourced from Transpower's *Transmission Planning Report 2023*.

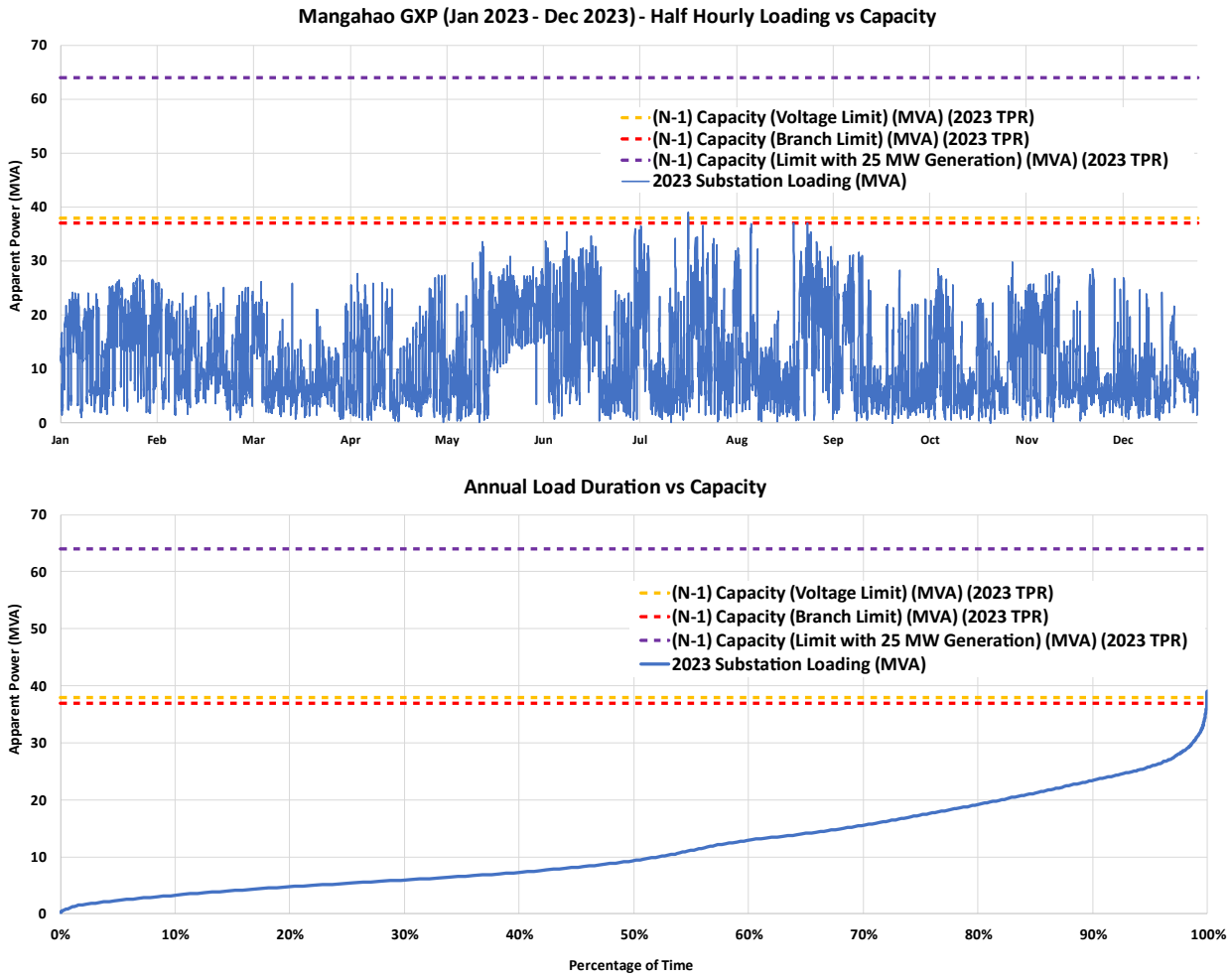


Figure 20. Mangahao GXP: 2023 Loading: Substation capacity

6.1.6 Mangamaire GXP

Transpower's demand forecast indicates that the Mangamaire GXP was expected to have a 2023 peak demand of 16 MW at 0.98 power factor (16.3 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Mangamaire GXP experienced a peak load of 15.4 MVA.

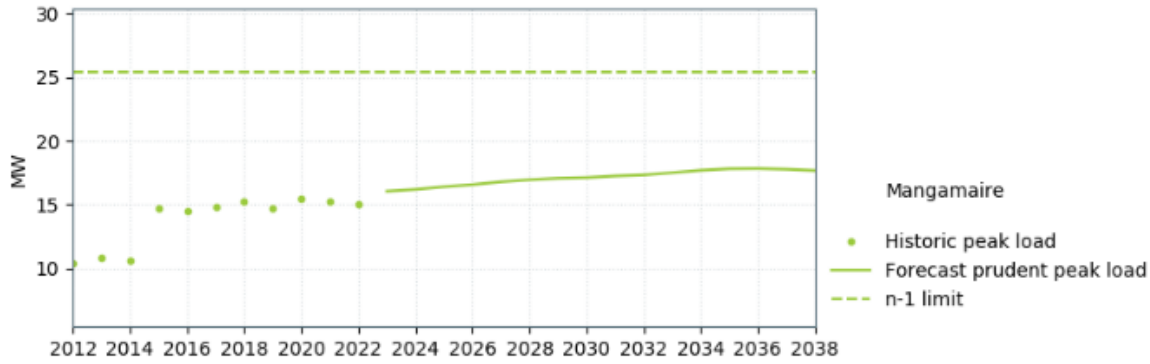
The Mangamaire GXP is equipped with two 110/33 kV transformers providing:

- (N) secure capacity of 60 MVA and
- (N-1) capacity of 27 MVA.

The transformer (N-1) capacity is limited by a metering limit.

Mangamaire is supplied by one 110 kV circuit from Woodville which is rated to 135/149 MVA (summer/winter) and connects to Masterton in the Wellington by a single circuit with the same rating. Woodville is in turn supplied by Bunnythorpe at 110 kV by two lines rated at 57/70 MVA (summer/winter) each.

The following graph[27] compares Mangamaire 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 Mangamaire's 2023 loading in comparison to its substation capacity.

[27] Sourced from Transpower's *Transmission Planning Report 2023*.

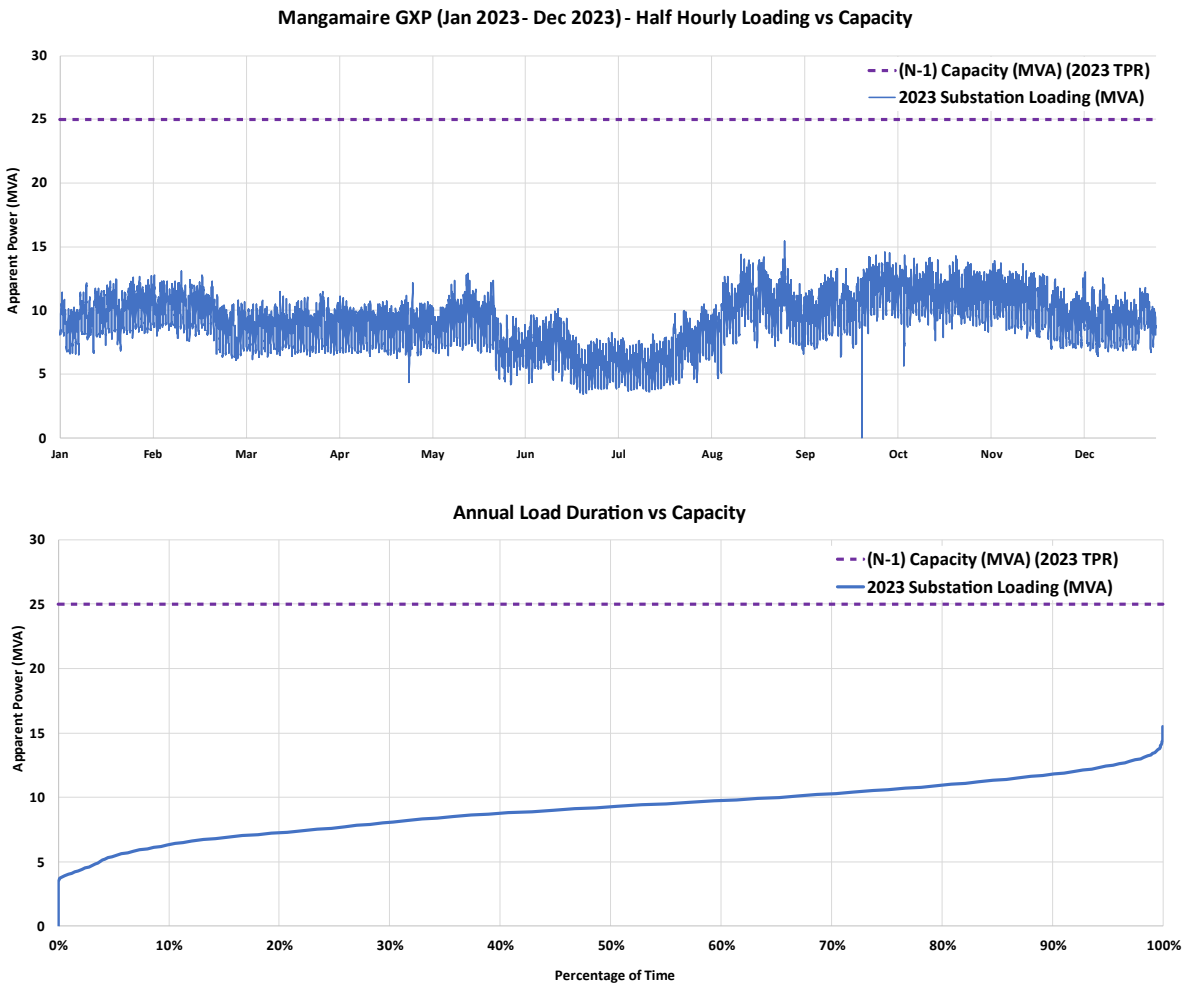


Figure 21. Mangamaire GXP: 2023 Loading: Substation capacity

6.1.7 Marton GXP

Transpower's demand forecast indicates that the Marton GXP was expected to have a 2023 peak demand of 23 MW at 0.99 power factor (~23.2 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Marton GXP experienced a peak load of 16.2 MVA (30% lower than forecasted). Ergo understands that this difference between forecast and actual peak may be due to an expected 7 MVA industrial load (a factory) not materialising.

The Marton GXP is equipped with two 110/33 kV transformers providing:

- (N) secure capacity of 50 MVA and
- (N-1) capacity of 24.4 MVA.

The transformer capacity is limited by protection limits.

The Marton transformers are tee-connected off the two 110 kV Bunnythorpe-Marton-Whanganui lines, each rated to 66/80 MVA (summer/winter). There is no bus coupler or connection between the two transformers at the site at 110 kV, so loss of one transmission line to the site also results in a loss of the associated transformer. Overloads on the remaining Bunnythorpe-Marton-Whanganui line may occur when the other circuit is offline, as discussed at the top of Section 6.

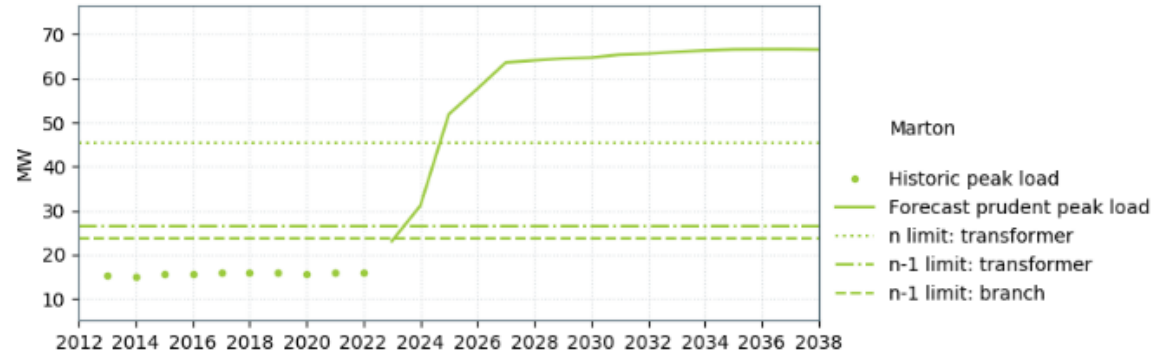
Peak load at Marton was forecast to exceed the (N-1) supply capacity from winter of 2023. Additionally, the Marton 11 kV bus voltage is expected to drop below 0.95 p.u. for an outage of one of the transformers at peak load.

The transformer protection constraint will be removed as part of the proposed Marton 33 kV outdoor to indoor conversion (ODID) and protection project. Transpower has discussed options to manage the Marton low voltage and supply issues with Powerco and presents the following solution:

- The Marton supply transformers do not have OLTC. As such, the fixed tap position of the transformers will be changed as load grows.
- A special protection scheme will be implemented which will manage the transformer overload and low voltage issue by tripping load and transferring load back to Bunnythorpe post-contingency. Estimated cost of $0.5M.
- The planned (risk-based) replacement of the smaller transformer at the site may be brought forward, if this is the case, both transformers will be replaced with higher capacity units. Estimated cost $10M.
- The issues regarding the 110 kV Bunnythorpe-Marton-Whanganui circuits will be managed by a special protection scheme (estimated cost $0.5M) and/or thermal upgrade of the circuits (estimated cost $10.2M).

The following graph[28] compares Marton GXP's supply capacity with the historical loading and Transpower's demand forecast.

[28] Sourced from Transpower's *Transmission Planning Report 2023*.



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 Marton's 2023 loading in comparison to its substation capacity.

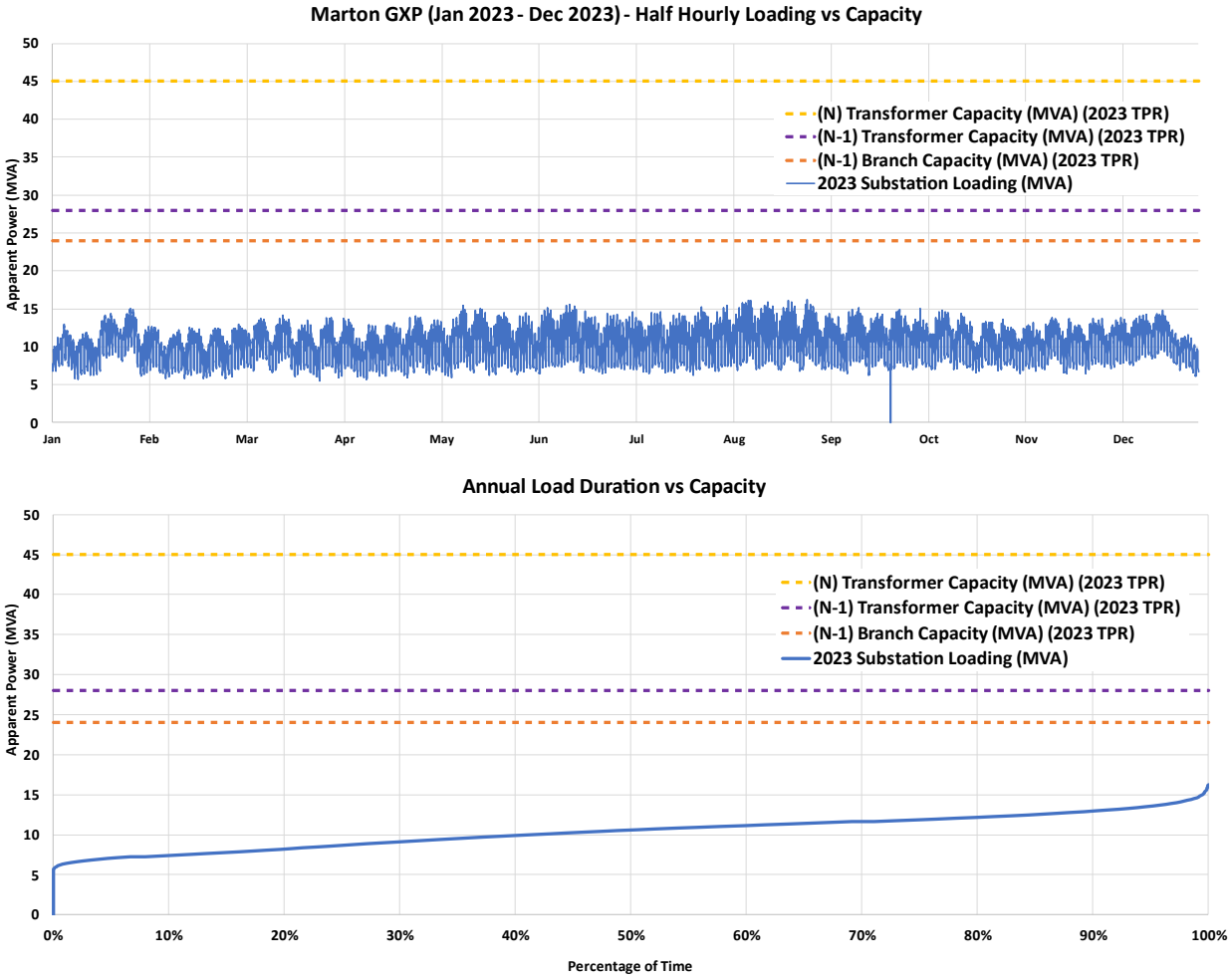


Figure 22. Marton GXP: 2023 Loading: Substation capacity

6.1.8 Mataroa GXP

Transpower's demand forecast indicates that the Mataroa GXP was expected to have a 2023 peak demand of 7 MW at 1.00 power factor (7 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Mataroa GXP experienced a peak load of 6.6 MVA.

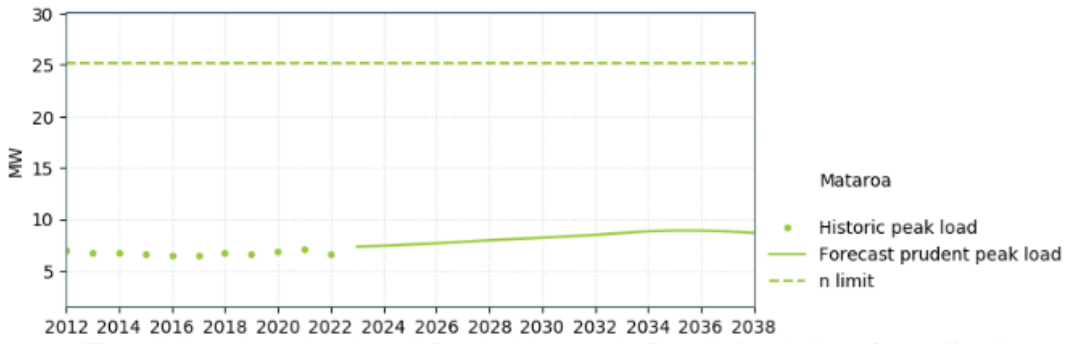
Mataroa GXP is equipped with a single 110/33 kV transformer rated at 30 MVA. This means the site has (N) security, with an (N) capacity of 26 MVA (limited by other branch components). There is a spare on-site unit which may be able to provide backup of the transformer following a unit failure, with the replacement estimated to take 8-14 hours; however, this spare transformer is uncontracted and therefore may be unavailable.

Mataroa takes supply at 110 kV from Bunnythorpe via a single line which is rated at 57/70 MVA (summer/winter). Mataroa also connects to Ohakune via a single 110 kV line rated at 57/70 MVA (summer/winter).

The 33 kV bus voltage at Mataroa is forecast to fall below 0.95 p.u. following an outage of the Bunnythorpe-Mataroa circuit towards the end of the forecast period. This issue is worsened by the transformer at Mataroa not being equipped with OLTC, and will be worsened by load increasing at Ohakune, National Park, Ongarue, Hangatiki, and Te Awamutu.

The lack of (N-1) security will be managed operationally by Powerco through the planning period. The Mataroa transformer is due for replacement toward the end of the forecast period, and the new transformer will be equipped with OLTC. Until the transformer replacement, the low voltage issue is managed by constraining on generation at Arapuni.

The following graph[29] shows Mataroa GXP's 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 Mataroa's 2023 loading.

[29] Sourced from Transpower's *Transmission Planning Report 2023*.

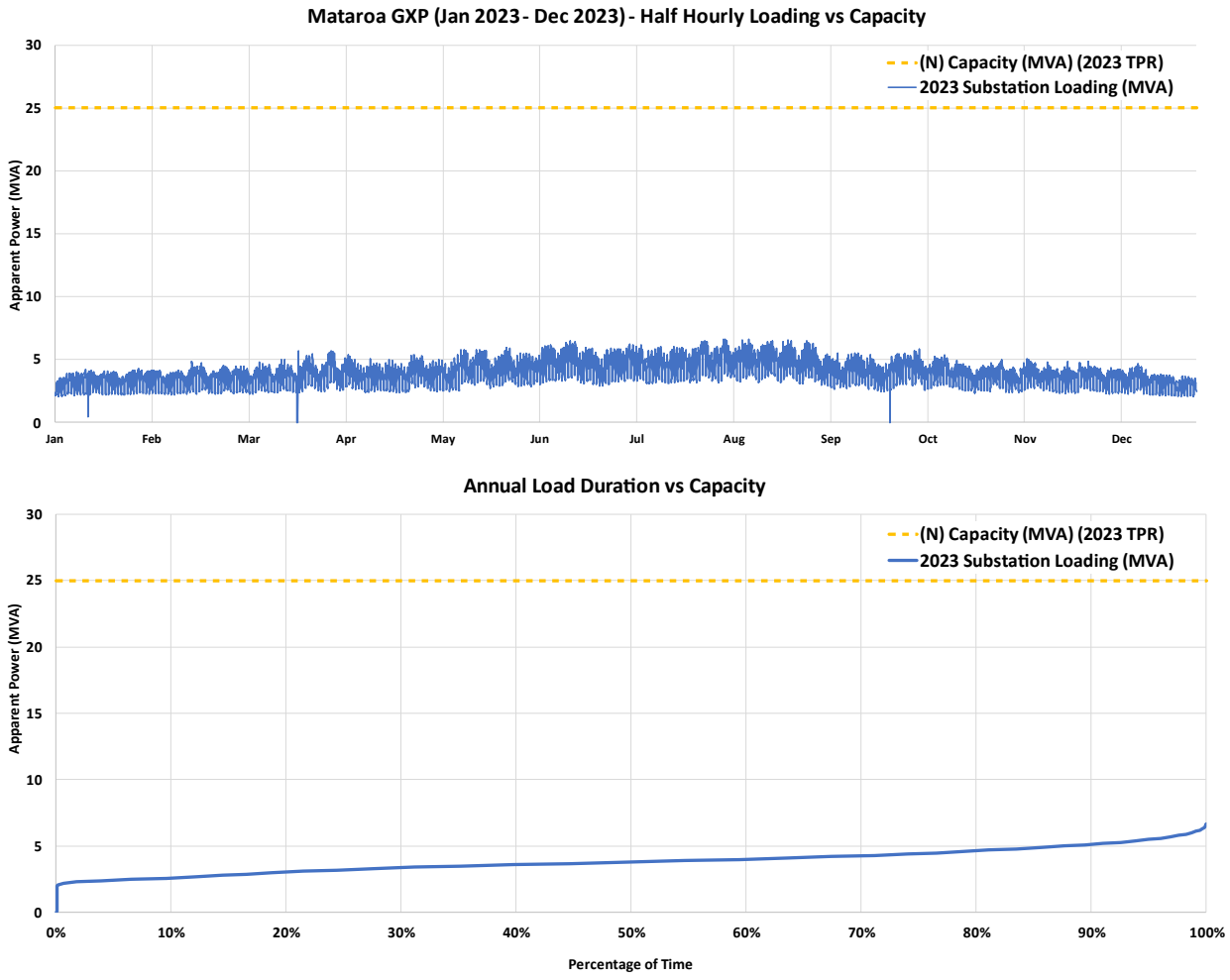


Figure 23. Mataroa GXP: 2023 Loading: Substation capacity

6.1.9 National Park GXP

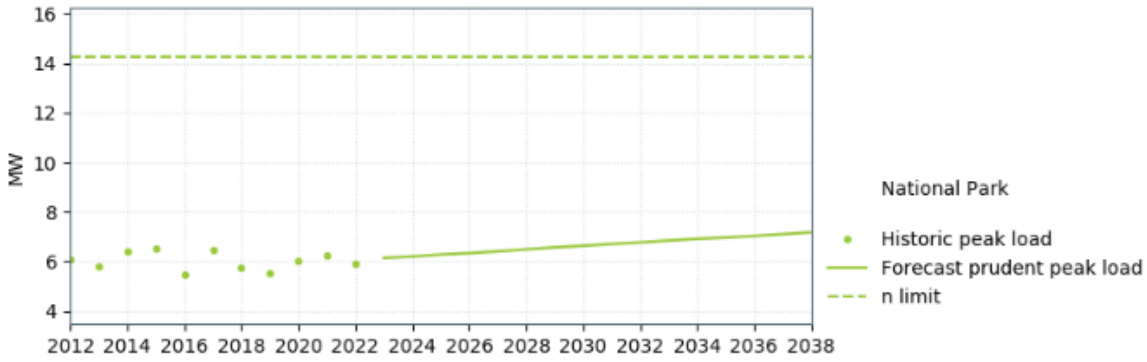
Transpower's demand forecast indicates that the National Park GXP was expected to have a 2023 peak demand of 6 MW at 0.99 power factor (~6.1 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the National Park GXP experienced a peak load of 4.9 MVA (19% lower than the forecast). It is expected that the lower-than-expected peak load at this GXP is due to reduced activity at the Whakapapa ski field.

National Park GXP is equipped with a single 110/33 kV transformer rated at 15 MVA. This means the site has (N) security, with an (N) capacity of 15 MVA. The site has connection facilities for Transpower's mobile substation which may be used during major works or contingent events, depending on the mobile substation's availability and location.

National Park tees off the single 110 kV Ohakune-National Park-Ongarue circuit, which is rated to 57/70 MVA (summer/winter). The line connecting to National Park to the tee point is rated to 49/60 MVA (summer/winter).

The lack of (N-1) security will be managed operationally by The Lines Company through the planning period.

The following graph[30] compares National Park 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 National Park's 2023 loading in comparison to its substation capacity.

[30] Sourced from Transpower's *Transmission Planning Report 2023*.

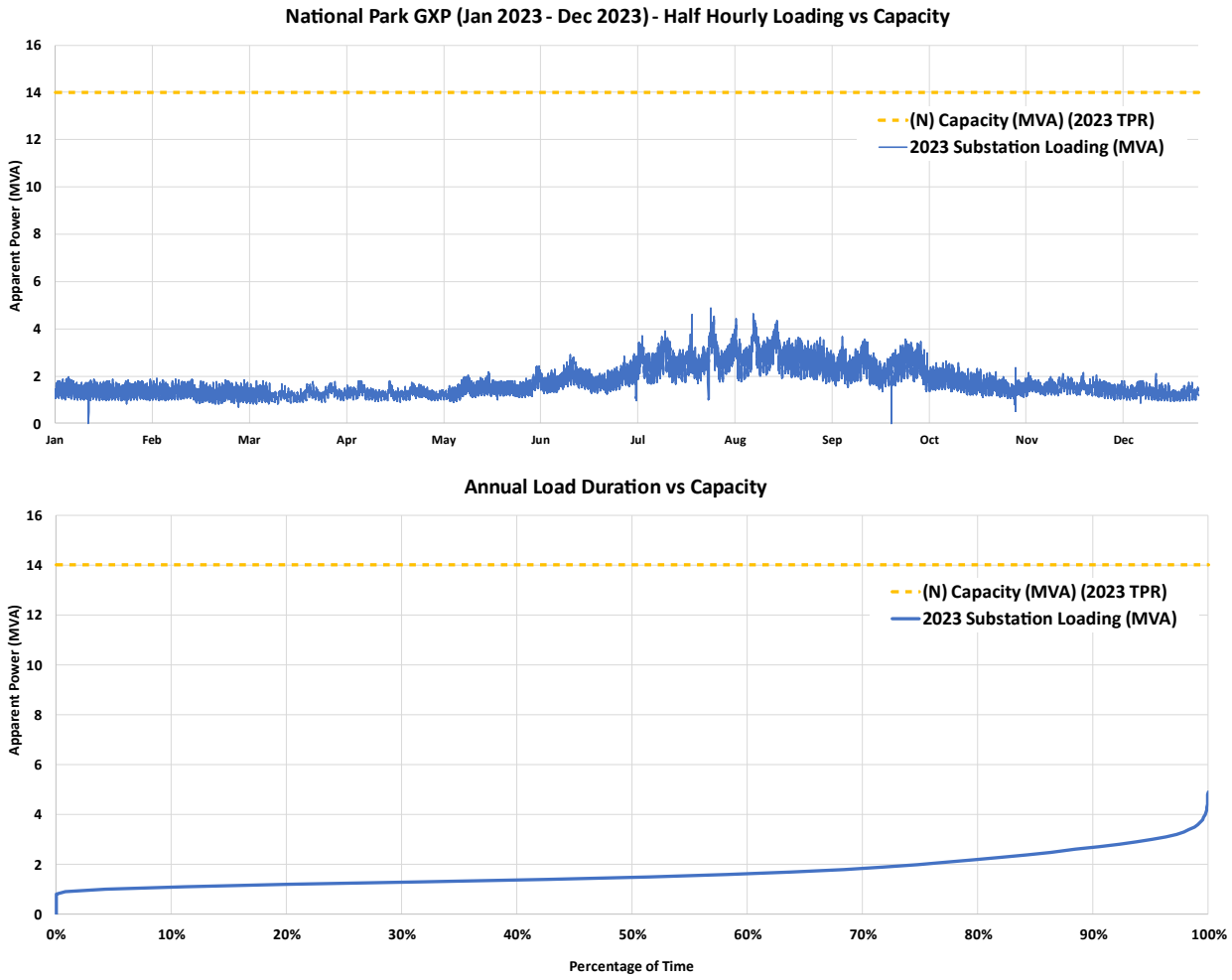


Figure 24. National Park GXP: 2023 Loading: Substation capacity

6.1.10 Ohakune GXP

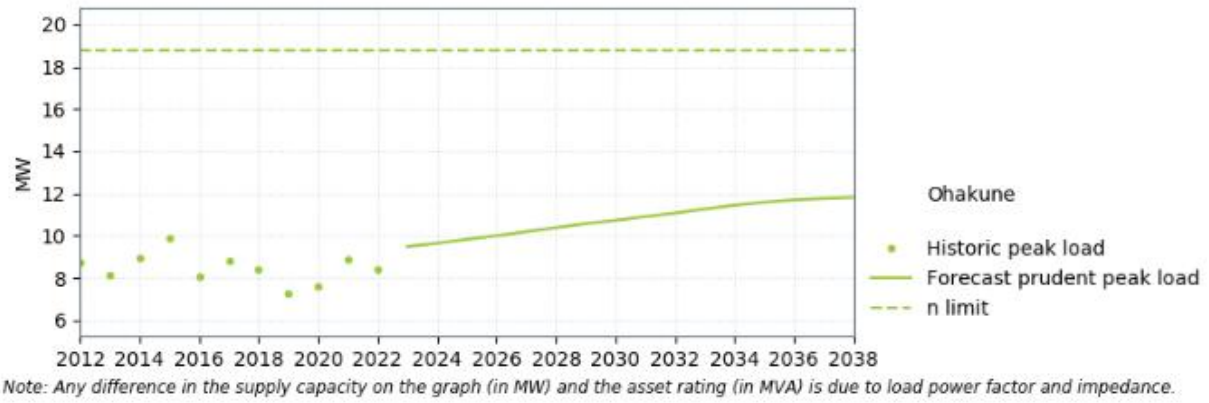
Transpower's demand forecast indicates that the Ohakune GXP was expected to have a 2023 peak demand of 9 MW at 0.98 power factor (~9.2 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Ohakune GXP experienced a peak load of 8.1 MVA.

Ohakune GXP is equipped with a single 110/11 kV transformer rated at 20 MVA. This means the site has (N) security, with an (N) capacity of 20 MVA. The site has connection facilities for Transpower's mobile substation which may be used during major works or contingent events, depending on the mobile substation's availability and location.

Ohakune connects to Ongarue via the single 110 kV Ohakune-National Park-Ongarue circuit, which is rated to 57/70 MVA (summer/winter). Ohakune is also connected to Bunnythorpe via Marton via a single line rated to 57/70 MVA (summer/winter).

The lack of (N-1) security will be managed operationally by The Lines Company and Powerco through the planning period.

The following graph[31] compares Ohakune 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 25 illustrates Ohakune's 2023 loading in comparison to its substation capacity.

[31] Sourced from Transpower's *Transmission Planning Report 2023*.

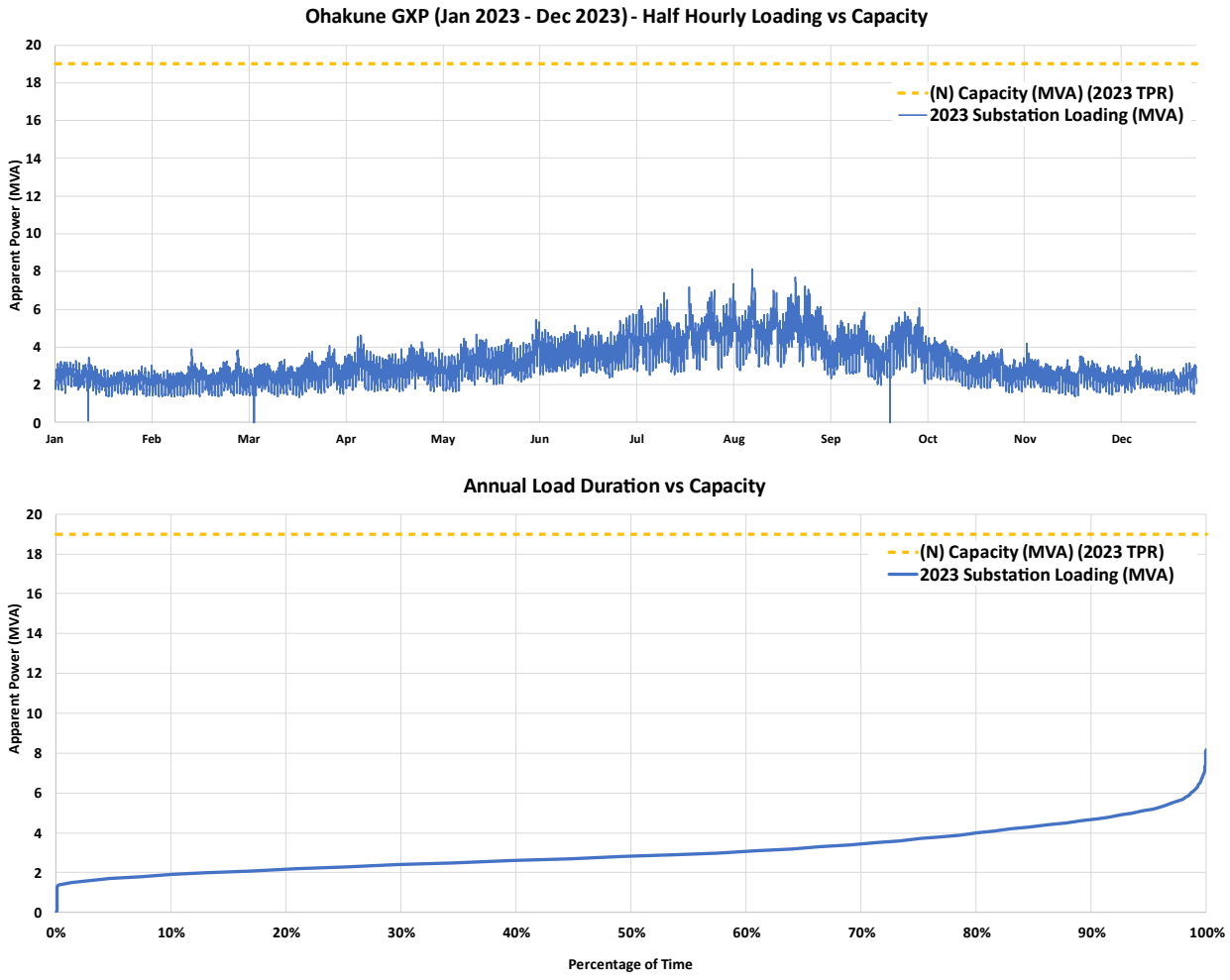


Figure 25 Ohakune GXP: 2023 Loading: Substation capacity

6.1.11 Ongarue GXP

Transpower's demand forecast indicates that the Ongarue GXP was expected to have a 2023 peak demand of 17 MW at 1.00 power factor (17 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Ongarue GXP experienced a peak load of 8.0 MVA. The difference is because of the effects of the embedded hydrogeneration at Ongarue (i.e. if the hydrogeneration were excluded from the load shown below, the load would be closer to forecasted).

Ongarue GXP is equipped with a single 110/33 kV transformer rated at 20 MVA. This means the site has (N) security, with an (N) capacity of 20 MVA.

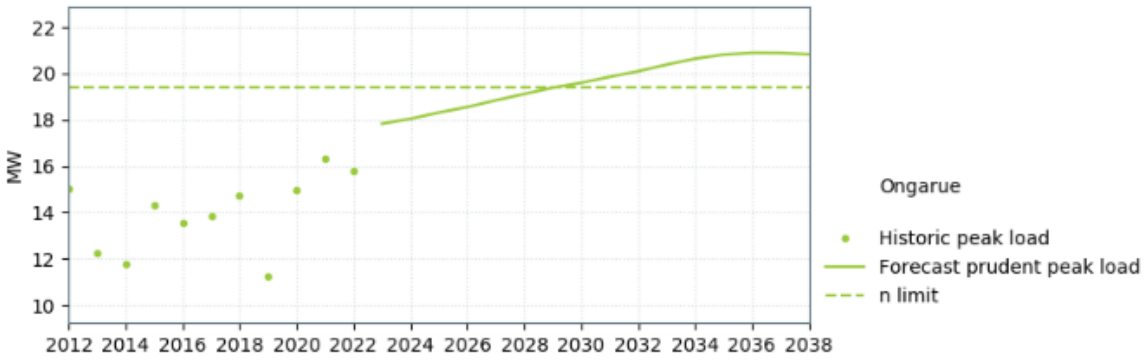
Ongarue connects to Bunnythorpe at 110 kV via single circuit lines through Ohakune and Marton, rated at 57/70 MVA (summer/winter). Ongarue also connects to Hangatiki (in the Waikato region) via a single 110 kV line rated at 57/70 MVA (summer/winter).

Loss of the Karapiro-Te Awamutu 110 kV circuit causes low voltages at Ongarue, particularly at times of high load and low Arapuni generation. This is worsened by the transformer at Ongarue not being equipped with OLTC. This low voltage issue is expected to be resolved by the planned upgrades to the transmission capacity at Hangatiki.

The supply transformer is due for condition-based replacement towards the end of the forecast period, which may be brought forward depending on the load growth in the area. The replacement transformer will be equipped with OLTC.

The lack of (N-1) security will be managed operationally by The Lines Company presently.

The following graph[32] compares Ongarue 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 26 illustrates Ongarue's 2023 loading in comparison to its substation capacity.

[32] Sourced from Transpower's *Transmission Planning Report 2023*.

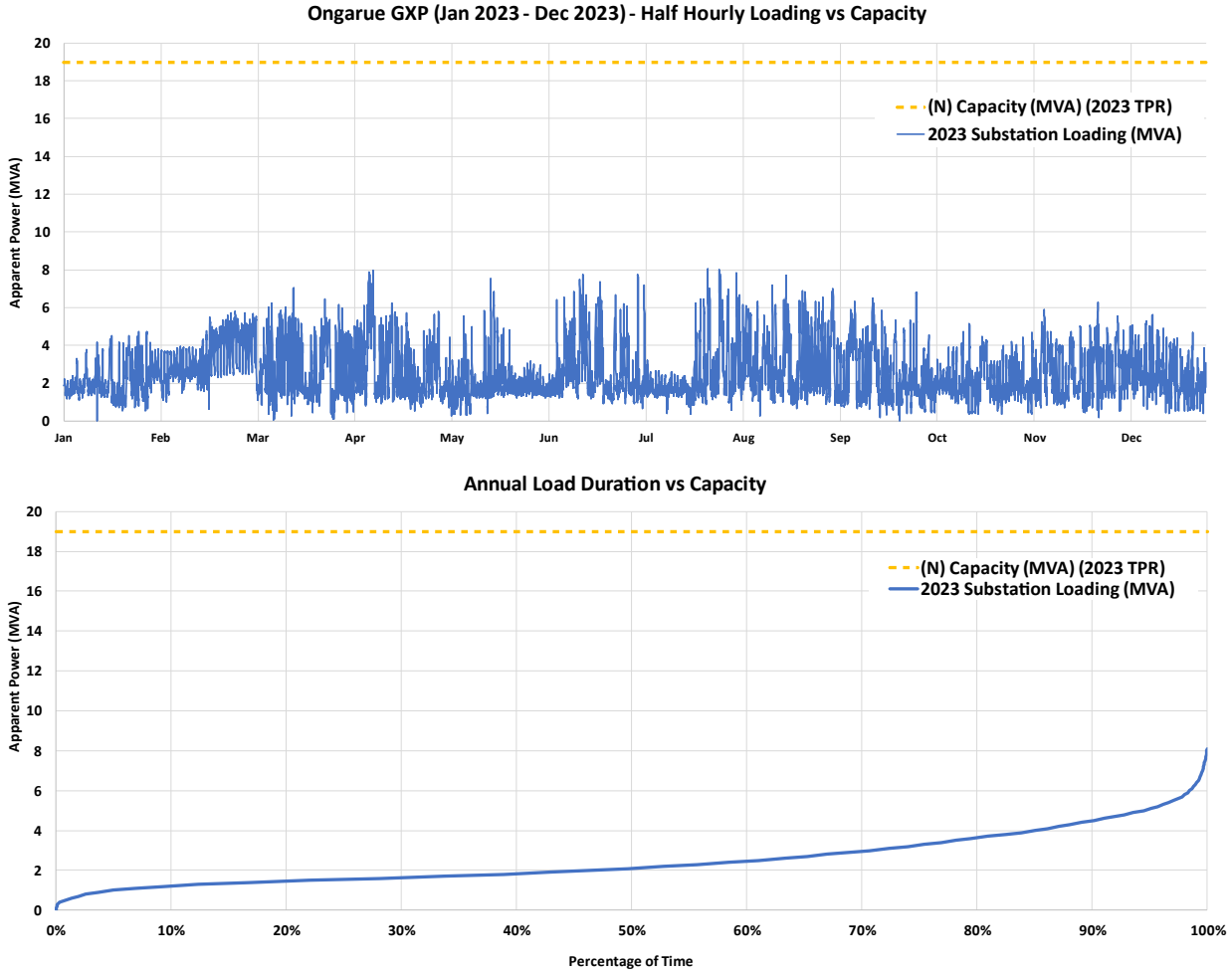


Figure 26 Ongarue GXP: 2023 Loading: Substation capacity

6.1.12 Tangiwai (11 kV) GXP

Tangiwai GXP has two separate supplies – one at 55 kV, which supplies Kiwirail, and another at 11 kV, which supplies Winstone Pulp International. Discussion in this report focusses on the non-Kiwirail supply.

Transpower's demand forecast indicates that the Tangiwai 11 kV GXP was expected to have a 2023 peak demand of 36 MW at 1.00 power factor (36 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Tangiwai GXP experienced a peak load of 35.3 MVA.

Ergo notes that with the closure of Winstone Pulp International, the load at this GXP is now 0 MW, and the GXP's future is uncertain.

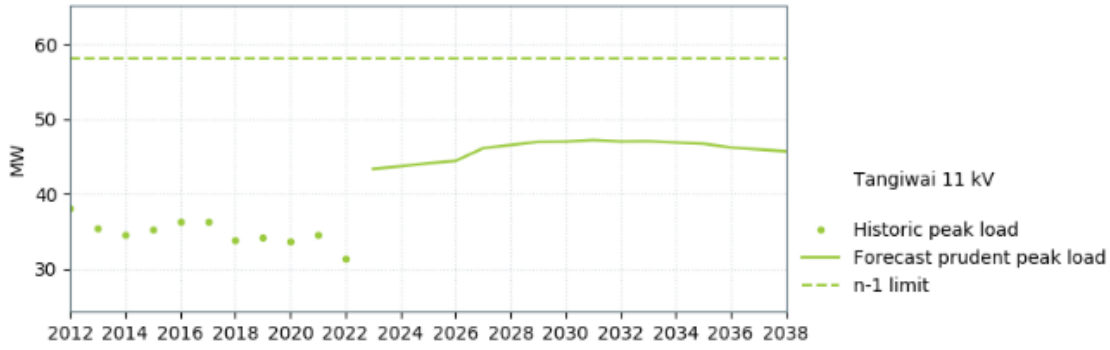
The Tangiwai GXP is equipped with two 220/11 kV transformers providing:

- (N) secure capacity of 120 MVA and
- (N-1) capacity of 60 MVA.

The transformer capacity at Tangiwai GXP is limited by LV circuit breaker and cable ratings at present.

Tangiwai connects to Bunnythorpe at 220 kV via a single circuit rated at 239/292 MVA (summer/winter). Tangiwai also connects to Wairakei via Rangipō through a single 110 kV circuit rated at 239/292 MVA (summer/winter).

The following graph[33] compares Tangiwai 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 26 illustrates Tangiwai's 2023 loading in comparison to its substation capacity.

[33] Sourced from Transpower's *Transmission Planning Report 2023*.

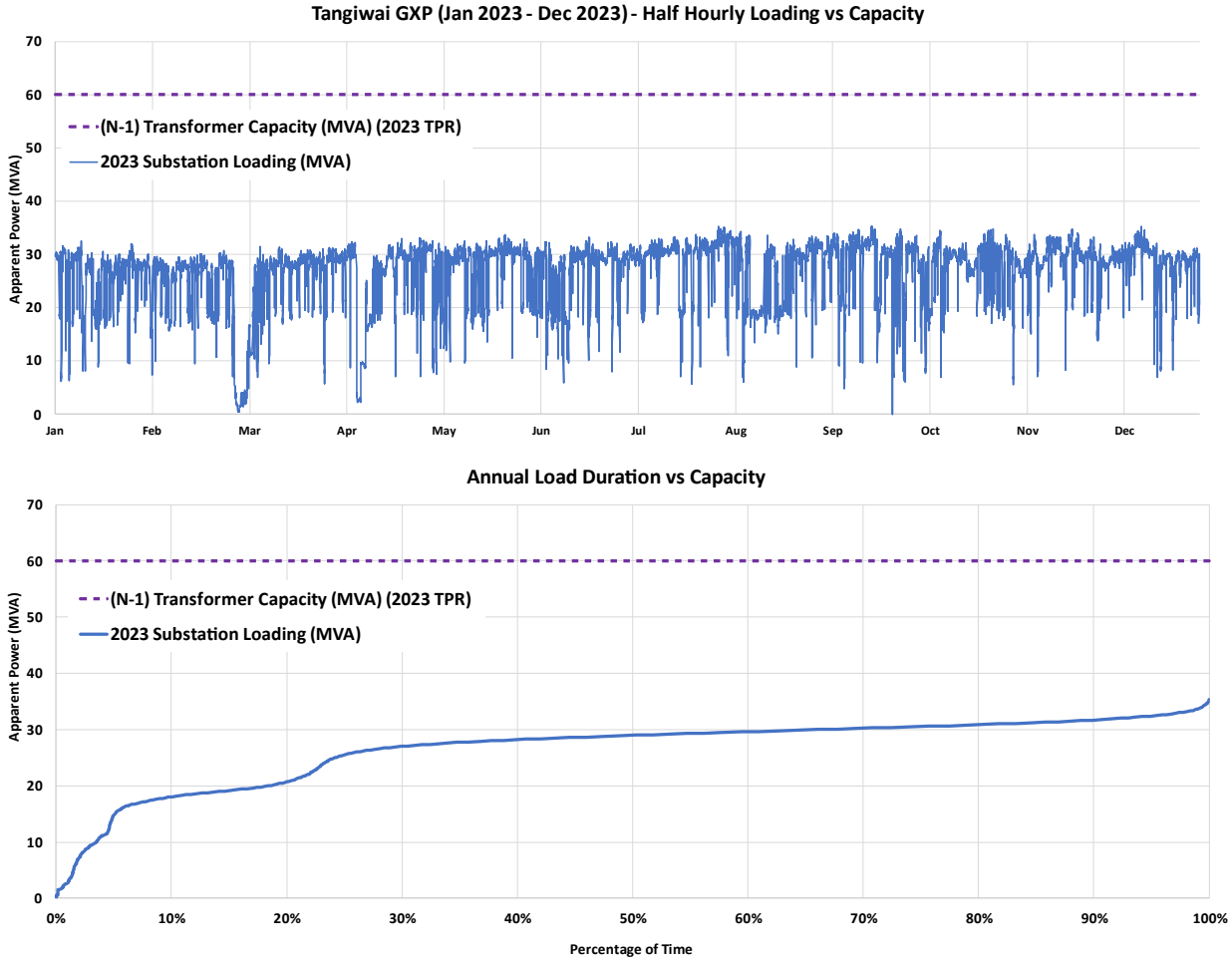


Figure 27 Tangiwai GXP: 2023 Loading: Substation capacity

6.1.13 Whanganui GXP

Transpower's demand forecast indicates that the Whanganui GXP was expected to have a 2023 peak demand of 34 MW at 0.98 power factor (~34.7 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Whanganui GXP experienced a peak load of 35.2 MVA.

The Whanganui GXP is equipped with two 110/33 kV transformers providing:

- (N) secure capacity of 50 MVA and
- (N-1) capacity of 24 MVA.

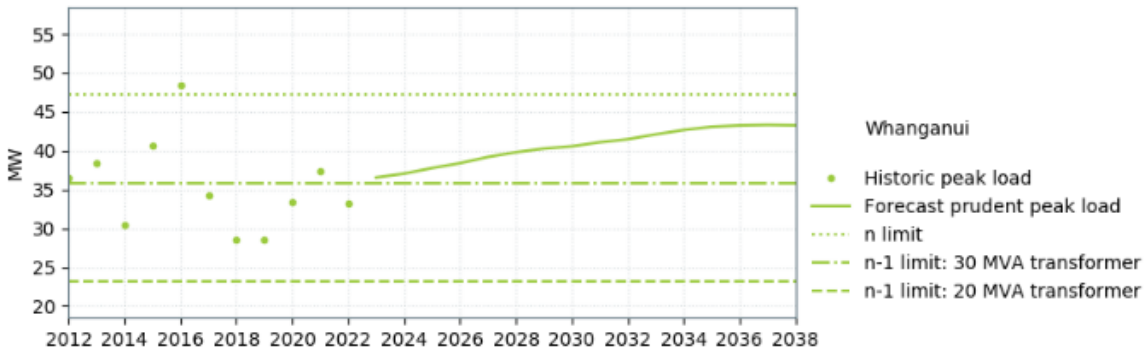
The transformer capacity is limited by the 33 kV bushings.

Whanganui is supplied by two 110 kV Bunnythorpe-Whanganui lines rated at 66/80 MVA (summer/winter); this line has a tee which supplies Marton. Whanganui also connects to Waverley (in the Taranaki region) via a single 110 kV line rated at 153/165 MVA (summer/winter).

Loss of one of the supply transformers at Whanganui or of a Bunnythorpe-Marton-Whanganui 110 kV circuit causes low voltages at Whanganui, when load is at its peak. This is worsened by the transformers at Whanganui not being equipped with OLTC.

Load already exceeds the (N-1) limit of the GXP, which is presently managed by Powerco by using switching within the subtransmission network to shift load onto Brunswick GXP when required. Transpower is planning to replace the smaller of the two transformers at Whanganui and is investigating the possibility of replacing the other transformer at the same time.

The following graph[34] compares Whanganui 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 28 illustrates Whanganui's 2023 loading in comparison to its substation capacity.

[34] Sourced from Transpower's *Transmission Planning Report 2023*.

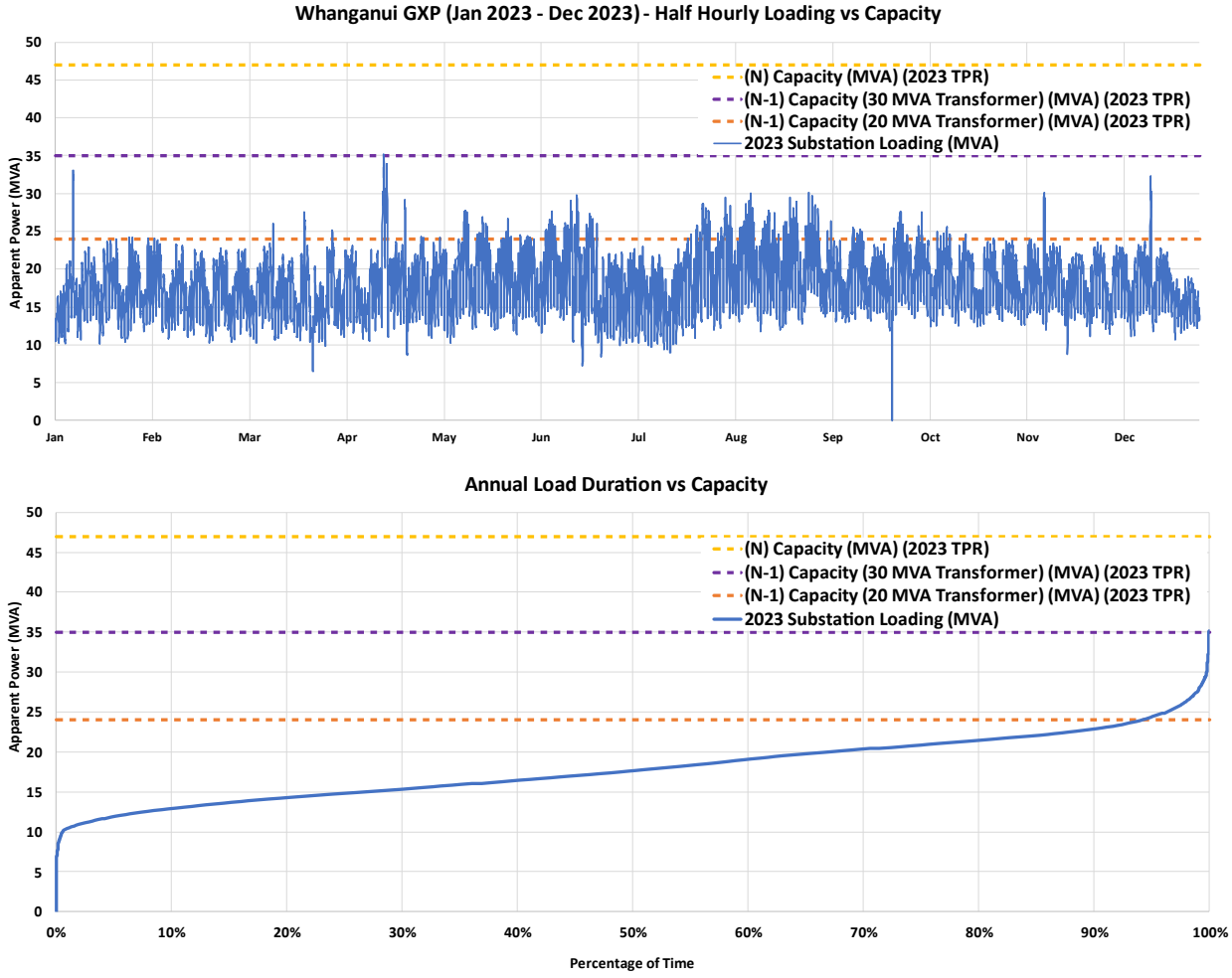


Figure 28 Whanganui GXP: 2023 Loading: Substation capacity

6.1.14 Woodville GXP

Transpower's demand forecast indicates that the Woodville GXP was expected to have a 2023 peak demand of 4 MW at -0.98 (leading) power factor (~4.1 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Woodville GXP experienced a peak load of 3.0 MVA (27% lower than forecast, however, Ergo understands that this is largely due to rounding of the Transpower forecast in the *Transmission Planning Report 2023*).

The Woodville GXP is equipped with two 110/11 kV transformers providing:

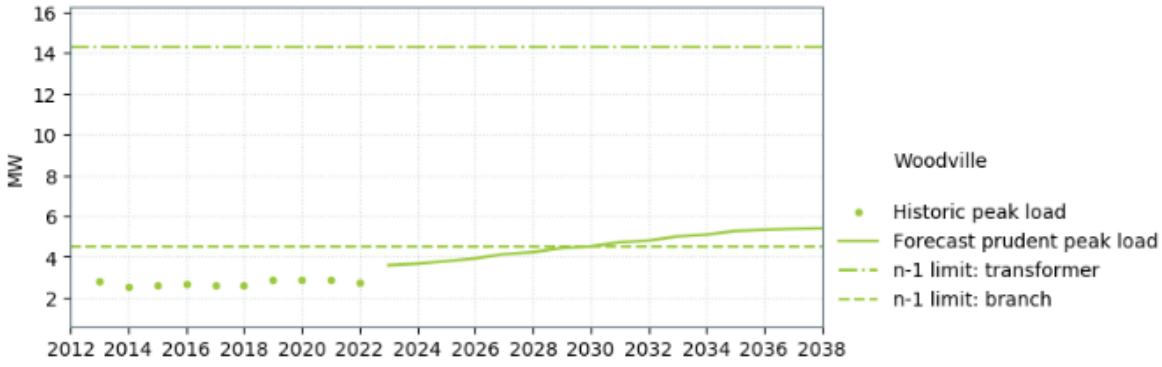
- (N) secure capacity of 20 MVA and
- (N-1) capacity of 4.5 MVA.

The transformer (N-1) capacity is presently limited by a metering limit.

Woodville is supplied by Bunnythorpe at 110 kV by two lines rated at 57/70 MVA (summer/winter) each. Woodville also connects to Dannevirke via the two 110 kV Woodville-Dannevirke-Waipawa circuits which are each rated at 51/62 MVA (summer/winter).

Peak load at Woodville is expected to exceed the transformer (N-1) capacity from winter of 2031. Transpower plans to remove the metering limit (at an estimated cost of $100 k), which will resolve this issue.

The following graph[35] compares Woodville 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 29 illustrates Woodville's 2023 loading in comparison to its substation capacity.

[35] Sourced from Transpower's *Transmission Planning Report 2023*.

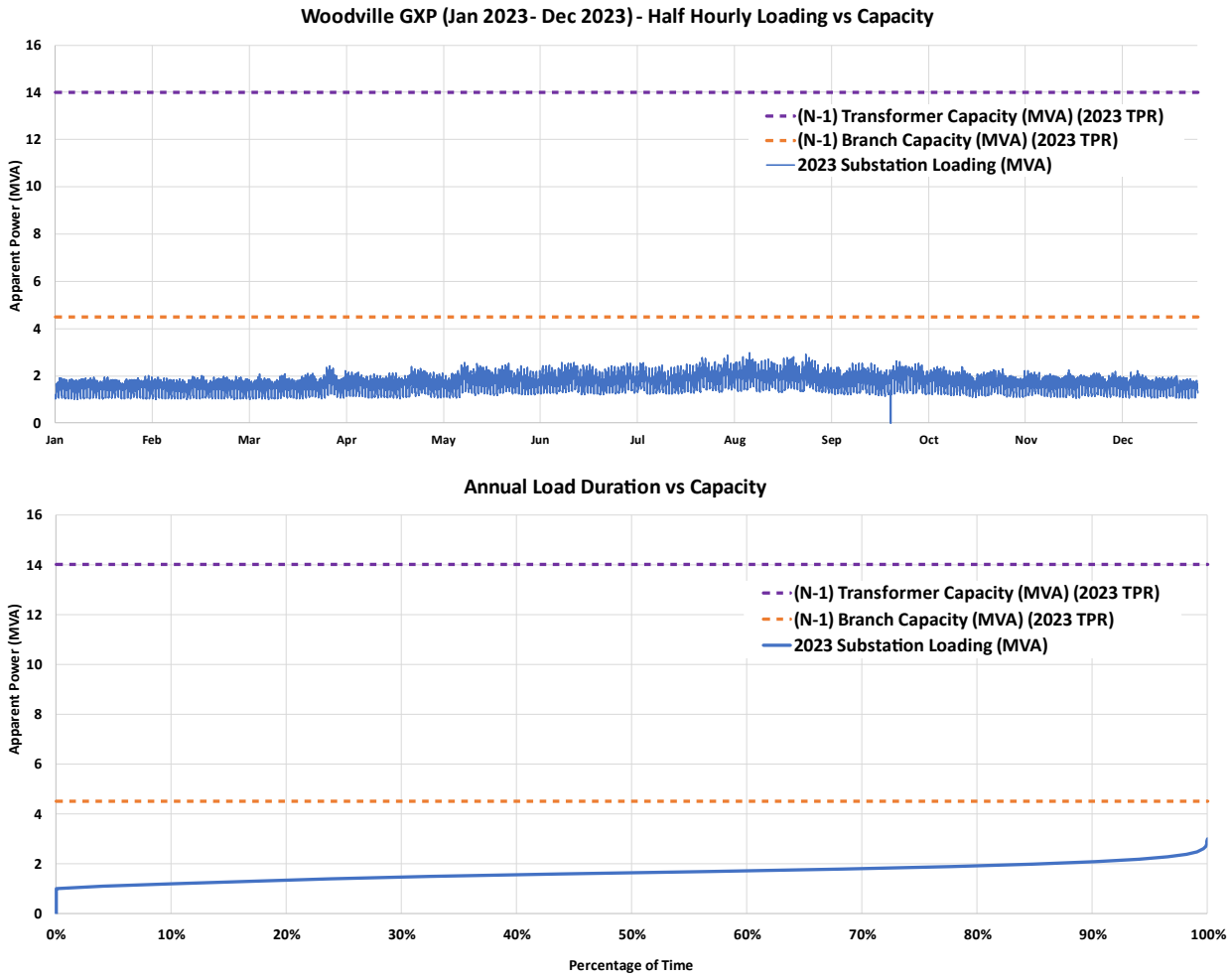


Figure 29 Woodville GXP: 2023 Loading: Substation capacity

6.2 Spare Capacity based on Transpower's 2023 Forecast

The following Figure 30 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 2023*
- The 2023 forecast load provided in Transpower's *Transmission Planning Report 2023* (refer to Table 3).
- Half hourly load data from Electricity Market Information website.
- The 2023 Electra, The Lines Company, Powerco, and Scanpower *Asset Management Plans*.

Negative values are only possible for (N-1) capacities and indicate that there is no spare (N-1) capacity, and that consumer load cannot be supplied for (N-1) conditions. The negative amount indicates the capacity increase that is required to achieve a secure firm capacity at the substation.

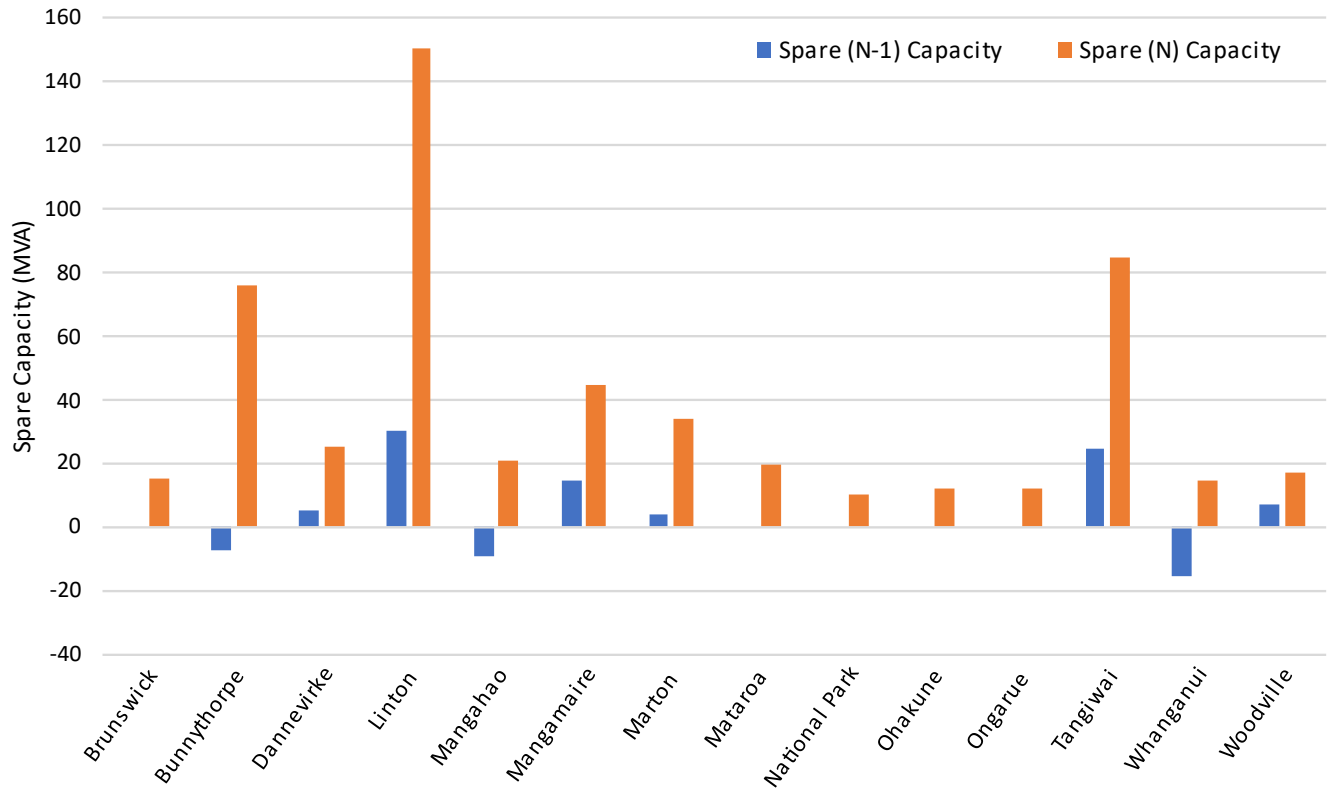


Figure 30 Summary: GXP Spare Capacity based on GXP 2023 EMI loading data.

It should be noted that the spare capacities are based on the asset rating values disclosed by Transpower, and the actual 2023 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.

Ergo notes that for many of the GXPs which have two transformers, the (N) capacity cannot be fully utilised, even with a special protection system (SPS), due to risk of transformer damage in the period between an outage occurring, and the SPS curtailing load. Instead, an SPS may be used to utilise some of the (N) capacity at a given GXP, but not all.

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 2023. Actual historical loading data was provided by Electra, The Lines Company, Powerco, and Scanpower, and all data is shown in Table 4, Table 5, and Table 6 respectively.

7.1 Electra

Table 4 Electra: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity (MVA)		Spare (N-1) Capacity (MVA)	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Shannon	4.7	-3.5	-0.3	-8.5
2	Foxton	38.7	33.4	15.7	10.4
3	Levin West	32.0	21.7	9.0	-1.3
4	Levin East	30.6	18.4	7.6	-4.6

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 The Lines Company

Table 5 The Lines Company: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity (MVA)		Spare (N-1) Capacity (MVA)	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Borough	12.2	13.4	2.2	3.4
2	Kuratau	5.6	5.6	N/A	N/A
3	Manunui	1.7	3.3	N/A	N/A
4	National Park	17.2	0.5	N/A	N/A
5	Nihoniho	0.3	1.0	N/A	N/A
6	Otukou	0.2	0.4	N/A	N/A
7	Tawhai	0.2	1.9	N/A	N/A
8	Tuhua	0.1	1.5	N/A	N/A

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 Powerco

Table 6 Powerco: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity (MVA)		Spare (N-1) Capacity (MVA)	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Alfredton	1.00	Unknown	N/A	Unknown
2	Parkville	4.00	Unknown	N/A	Unknown
3	Pongaroa	2.00	Unknown	N/A	Unknown
4	Mangamutu	21.00	Unknown	4.0	Unknown
5	Turitea	14.90	15.4	5.0	0.4
6	Kairanga	12.00	7.3	1.1	-3.7
7	Pascal St	23.40	19.7	9.6	2.7
8	Ferguson St	31.20	35.0	16.0	11.0
9	Main St	22.00	14.2	6.8	-2.8
10	Keith St	18.20	24.9	4.8	2.9
11	Milson	14.00	14.2	3.2	-0.8
12	Kelvin Grove	13.00	30.7	0.2	6.7
13	Ōhakea	6.20	6.9	N/A	N/A
14	Sanson	7.00	-0.5	1.6	-4.0
15	Feilding	20.20	19.2	5.0	1.2
16	Kimbolton	4.00	0.1	N/A	N/A
17	Bulls	11.80	14.5	7.1	4.9
18	Pukepapa	7.50	-5.2	N/A	N/A
19	Arahina	2.00	2.4	N/A	N/A
20	Rata	4.50	5.6	N/A	N/A
21	Taihape	5.00	4.2	N/A	N/A
22	Waiouru	7.00	7.6	N/A	N/A

No.	Substation Name	Spare (N) Capacity (MVA)		Spare (N-1) Capacity (MVA)	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
23	Castlecliff	1.00	1.1	1.0	0.1
24	Beach Rd	22.00	6.1	5.0	5.1
25	Blink Bonnie	4.00	-0.7	N/A	N/A
26	Taupō Quay	8.00	2.6	0.0	-9.9
27	Hatricks Wharf	14.00	14.4	N/A	N/A
28	Wanganui East	10.00	10.4	N/A	N/A
29	Peat St	19.00	25.3	2.0	5.3
30	Roberts Ave	5.00	4.0	N/A	N/A
31	Kai Iwi	3.00	2.4	N/A	N/A

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

7.4 Scanpower

Scanpower presently has no zone substations and therefore no zone substation capacity information is available.

7.5 Summary

7.5.1 Electra

(N-1) Capacity Summary

The following Figure 31 illustrates the approximate (N-1) spare capacities at Electra'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 Electra.

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 substations with (N) security have been omitted from this graph. This means that all of Electra's four zone substations have (N-1) security with respect to the supply transformers. At one of the zone substations (Shannon), the (N-1) supply capacity was exceeded in 2023.

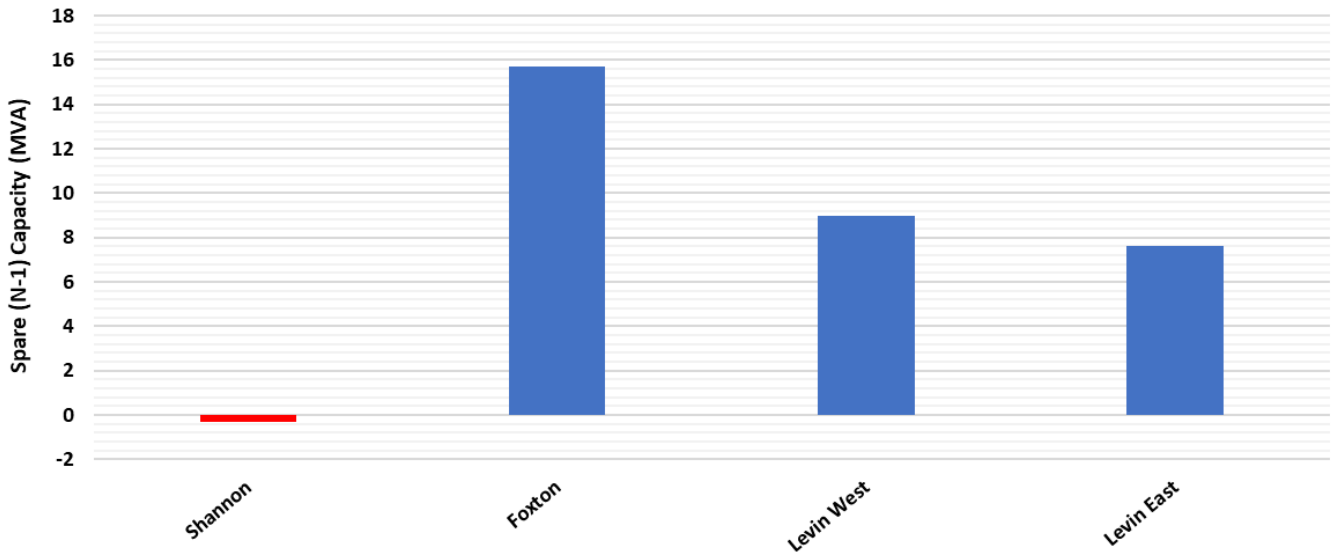


Figure 31. Summary: Approximate (N-1) spare capacity at Electra's zone substations

The zone substations with spare (N-1) capacity left vary from 33% (for Levin East) to 68% (for Foxton) available capacity.

(N) Capacity Summary

The following Figure 32 illustrates the approximate (N) spare capacities at Electra's zone substations, for the disclosed peak demand estimates[36]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Electra.

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 32 indicates that there is a moderate volume of spare (N) capacity at Electra's substations, with spare capacity ranging from 47% (for Shannon) to 84% (for Foxton), although we note that these may be in locations where (N-1) security of supply would be a standard requirement.

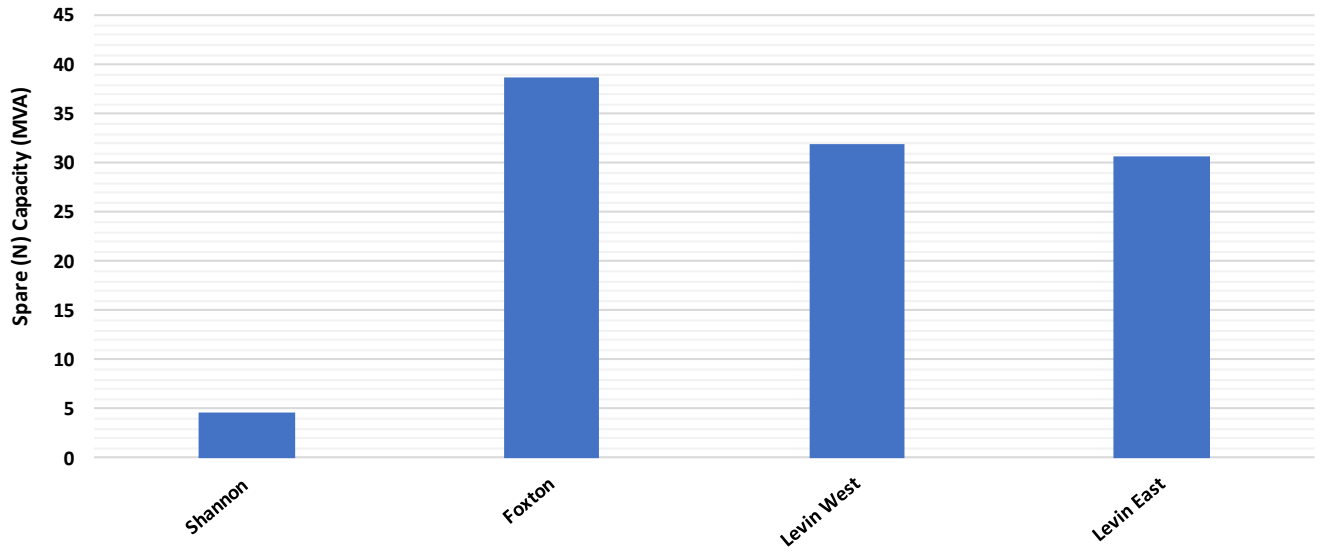


Figure 32. Summary: Approximate (N) spare capacity at Electra's zone substations

7.5.2 The Lines Company

(N-1) Capacity Summary

The following Figure 31 illustrates the approximate (N-1) spare capacities at The Lines Company'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 The Lines Company.

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.

Zone substations with (N) security have been omitted from this graph. Only one of The Lines Company's eight zone substations in the region (Borough) has (N-1) security with respect to the supply transformers.

[36] Electra' 2023 AMP available here: https://Electraenergy.co.nz/about-us/regulatory-disclosures/

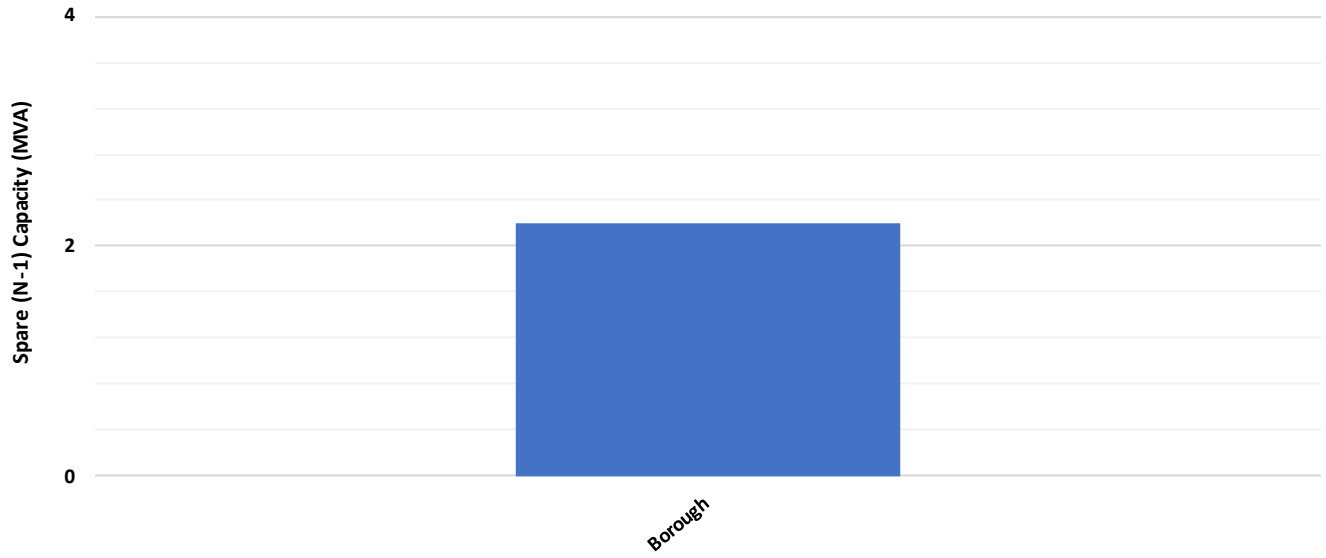


Figure 33. Summary: Approximate (N-1) spare capacity at The Lines Company's zone substations

The zone substation with spare (N-1) capacity left (Borough) has 22% available capacity.

(N) Capacity Summary

The following Figure 34 illustrates the approximate (N) spare capacities at The Lines Company's zone substations, for the disclosed peak demand estimates[37]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by The Lines Company.

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 34 indicates that there is a wide range of spare (N) capacity, from 4% to 86%, although we note that where there is (N) capacity, may be in locations where (N-1) security of supply would be a standard requirement.

[37] The Lines Company's 2023 AMP available here: https://www.thelinescompany.co.nz/disclosures/

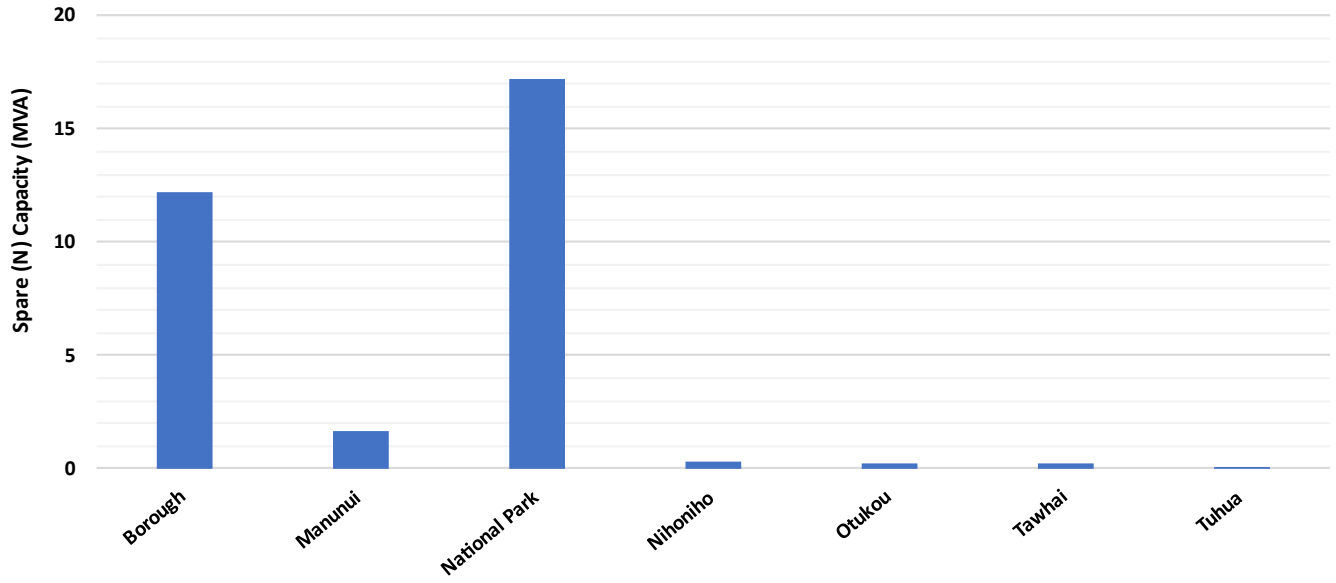


Figure 34. Summary: Approximate (N) spare capacity at The Lines Company's zone substations

7.5.3 Powerco

Nine of Powerco's zone substations in the region (Kairanga, Kai Iwi, Hatrick's Wharf, Blink Bonnie, Whanganui East, Sanson, Castlecliff, Taupō Quay, and Roberts Ave) have (N-1 switched) security rather than full (N-1) security. These substations each have one transformer only, however, backfeed is available through the local network in the case that the transformer is out of service. For these substations, the total (N) capacity is typically taken as the transformer capacity, while the total (N-1) capacity is taken as the backfeed capability (also called "transfer capacity") for that substation's load.

(N-1) Capacity Summary

The following Figure 35 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 substations with (N) security have been omitted from this graph. This means that sixteen of the thirty zone substations (Alfredton, Parkville, Pongaroa, Ōhakea, Taupō Quay, Kimbolton, Bulls, Pukepapa, Arahina, Rata, Taihape, Waiouru, Blink Bonnie, Hatricks Wharf, Wanganui East, and Kai Iwi) do not have (N-1) security with respect to the supply transformers. At six of the zone substations, the (N-1) supply capacity has been met or exceeded in 2023.

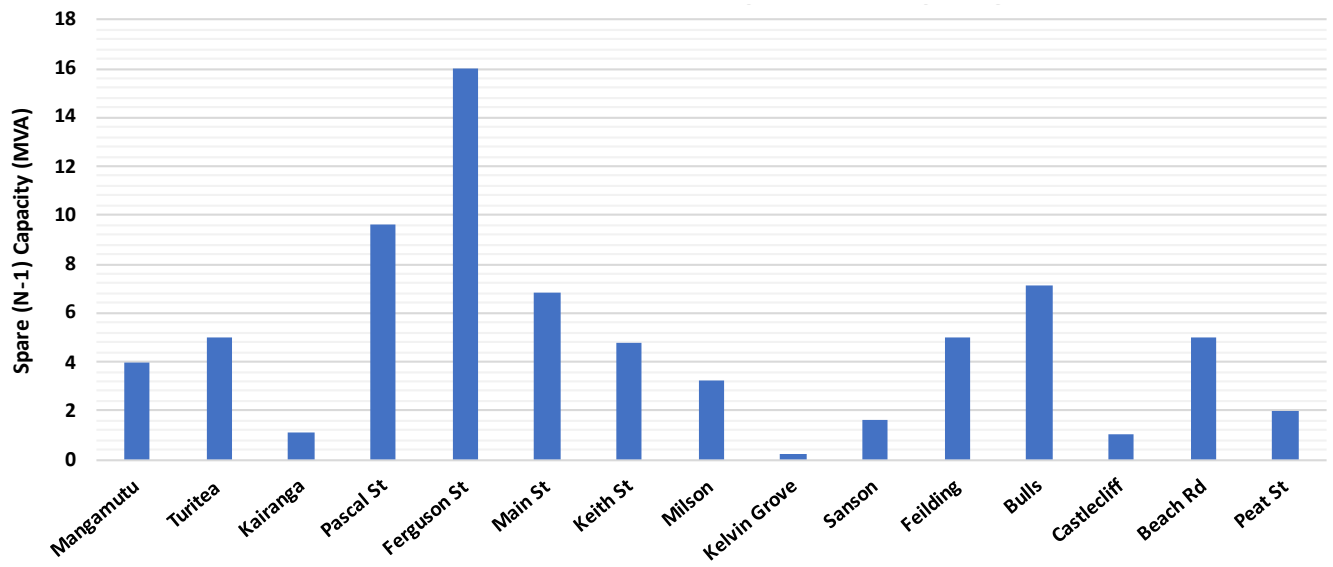


Figure 35. Summary: Approximate (N-1) spare capacity at Powerco's zone substations

The zone substations with spare (N-1) capacity left vary from 4% (for Feilding) to 54% (for Ferguson St) available capacity.

(N) Capacity Summary

The following Figure 36 illustrates the approximate (N) spare capacities at Powerco's zone substations, for the disclosed peak demand estimates[38]. 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 36 indicates that there is a wide range of spare (N) capacity, with spare (N) capacity ranging from 100% to 80%. We note that where substations have spare (N) capacity may be in locations where (N-1) security of supply would be a standard requirement.

Ergo notes that Sanson, which presently exceeds its (N) capacity, is supported via backfeed through the 33 kV network, when required at present.

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

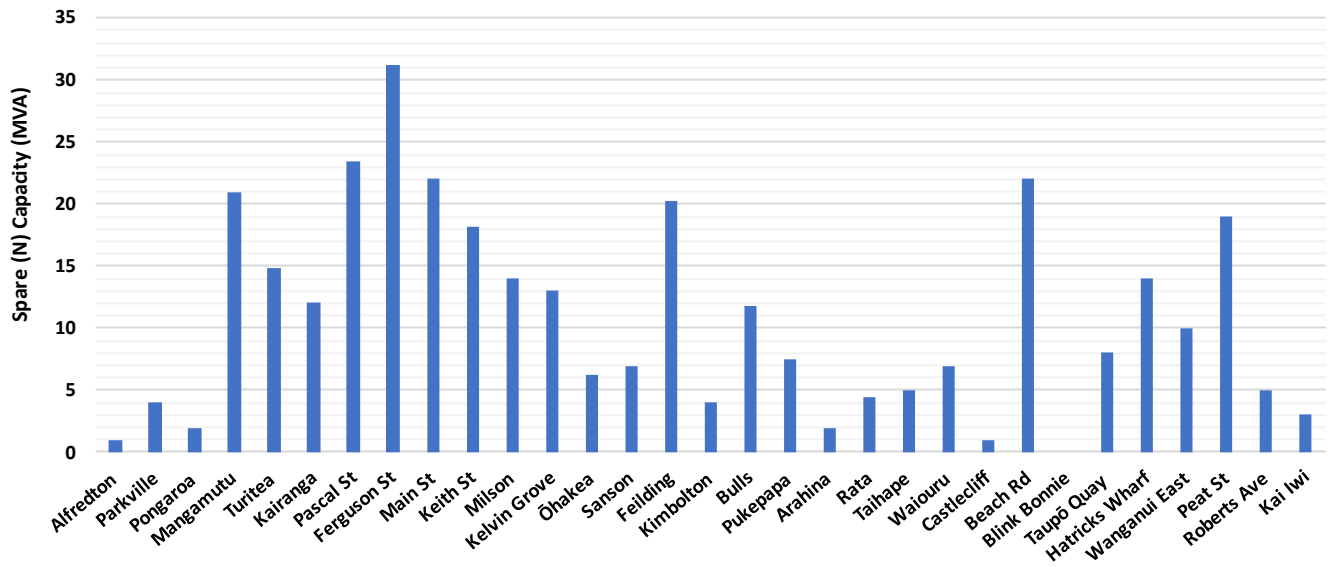


Figure 36. Summary: Approximate (N) spare capacity at Powerco's zone substations

7.5.4 Scanpower

Scanpower presently has no zone substations and therefore no zone substation capacity information is available.

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 EDB 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 and the relevant EDB. 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 11 kV or 22 kV 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 2023 loading data provided by Transpower, Electra, The Lines Company, Powerco, and Scanpower). 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 or improved (unless otherwise stated). For example, if the site currently presently has (N-1) security, we have recommended infrastructure upgrades to maintain this. If the site presently has (N) security, infrastructure upgrades are suggested both to maintain this, and to increase the security to (N-1).
- 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, 22 kV and 11 kV feeders are capable of supplying up to 12 MVA, 9 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[39] 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 (for example, MV switchboards/cabling and LV switchboards/cables within the respective Load Site sites are not included).

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

- 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.
- Where Load Site analysis is presented in stages, it is assumed that the upgrades progress along either the (N-1) security path or the (N) security path, and do not mix the two.

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 Brunswick GXP

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

- AFFCO New Zealand Limited Castlecliff (2.6 MW)

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

Figure 37. Brunswick GXP: EECA Load Site vs local substations

8.3.1 Brunswick GXP Upgrade

Given there is only a single load connected to the Brunswick GXP, the outline of upgrades to the GXP can be found in section 8.3.2.

8.3.2 AFFCO New Zealand Limited Castlecliff

AFFCO NEW ZEALAND LIMITED CASTLECLIFF		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	2.59	Brunswick

Existing Electrical Supply to the Plant

AFFCO New Zealand Limited Castlecliff is presently supplied by Powerco's CastleCliff zone substation. The site is supplied via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Castlecliff is in turn supplied from Brunswick GXP by one 33 kV subtransmission circuit. The subtransmission circuit is rated to approximately 430 A (24 MVA) via Peat St Substation. A second subtransmission circuit is connected to Castlecliff from Beach Road substation (which is supplied by Whanganui GXP). The second subtransmission circuit affords the site (N-1 switched) security.

This site is located approximately 0.2 km from Castlecliff zone substation, which is approximately 11.4 km from Brunswick GXP.

There is currently a maximum loading of 9 MW on Castlecliff zone substation, with 1 MVA of spare (N) capacity and no spare (N-1) capacity. Brunswick GXP presently has no spare (N-1) capacity (as it is a single transformer GXP at present) and 15 MVA of spare (N) capacity.

Figure 38. AFFCO New Zealand Limited Castlecliff geographic location in relation to the surrounding zone substations

AFFCO NEW ZEALAND LIMITED CASTLECLIFF

Supply Option(s) for New Load

Both the zone substation and GXP have insufficient (N-1) capacity. The zone substation also lacks adequate (N) capacity for the increased site load.

For Castlecliff zone substation to provide adequate (N) or (N-1) capacity, the transformers at Castlecliff zone substation would need be replaced (one replaced for an (N) condition, or both for an (N-1) condition).

For Brunswick 33 kV GXP to reach the required spare (N-1) capacity, a second 220/33 kV transformer would need to be installed at the GXP.

The existing 11 kV feeder is estimated to have 1.6 MVA of spare capacity. Therefore, due to the size of the load, a new 11 kV feeder and associated circuit breaker are required. Due to the urban/industrial topography of the area, this would likely be an underground cable of 0.2 km in length.

Capital Cost Estimate

Table 7. AFFCO New Zealand Limited Castlecliff: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	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	0.20	$0.12
		TOTAL	**$2.12**

Table 8. AFFCO New Zealand Limited Castlecliff: 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	Brunswick GXP Transformer upgrades	1.00	$7.00
Distribution	Medium supply transformer (ZSS)	2.00	$3.80
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	0.20	$0.12
		TOTAL	**$11.02**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

AFFCO NEW ZEALAND LIMITED CASTLECLIFF
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 12-18 months for an (N) security supply, and 36-48 months for an (N-1) security supply, 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.

8.3.3 Effect of all Load Sites Connecting to Brunswick GXP

The following Figure 39 illustrates the Brunswick GXP load profile together with the load profile of the Load Site within the Brunswick GXP region. Also shown in Figure 39 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Brunswick GXP would increase to 34.4 MW, an increase of 0.04 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 36.96 MW there is a diversity factor of 0.93 between the loads.
- Based on Ergo's analysis, the Brunswick GXP's (N-1) limit is expected to be exceeded. Ergo has discussed mitigation for this in Section 8.3.1.

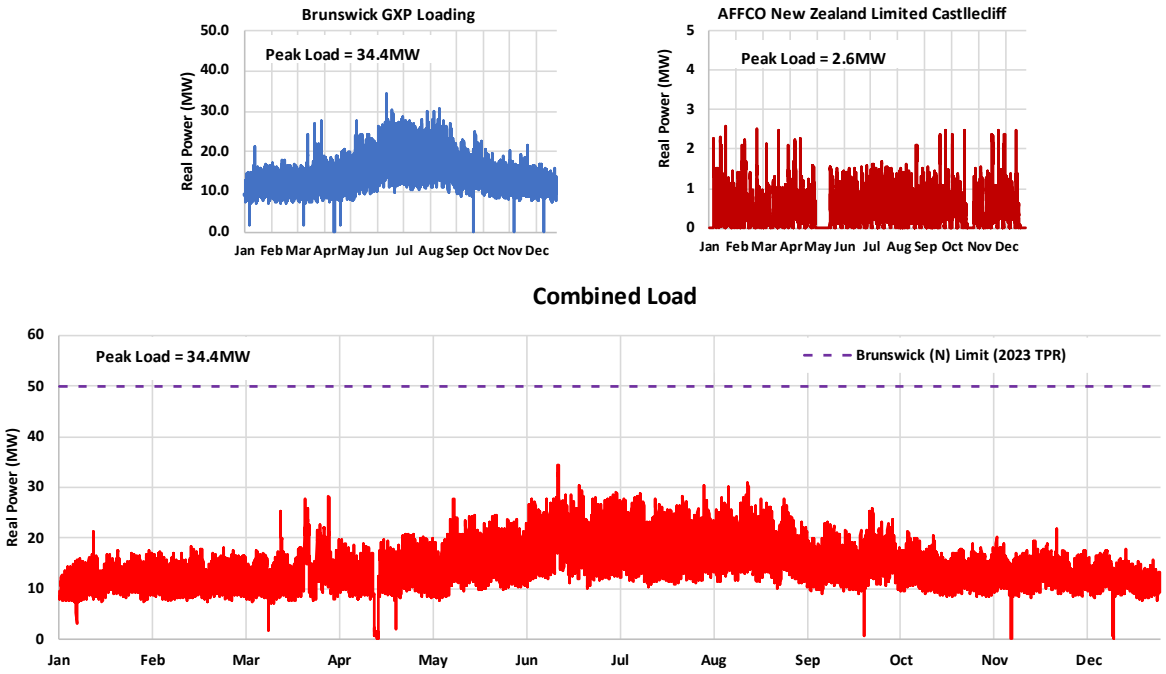


Figure 39. Loading Profiles: Brunswick GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.4 Bunnythorpe GXP

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

- Alsco NZ Palmerston North (2.67 MW)
- Kakariki Proteins (2.50 MW)
- AFFCO New Zealand Limited Manawatū (1.26 MW)
- NZ Defence Force Ōhakea Air Base (1.14 MW)

The "Small" Load Sites connecting to the Bunnythorpe GXP include (refer to Sections 8.4.6 and 8.4.8):

- Moana New Zealand (0.51 MW)
- Fonterra Brands Limited Palmerston North (0.21 MW)
- Ovation New Zealand Limited Feilding (0.20 MW)

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

Figure 40. Bunnythorpe GXP: EECA Load Sites vs local substations – Feilding & Sanson

Figure 41. Bunnythorpe GXP: EECA Load Sites vs local substations – Palmerston North

8.4.1 Bunnythorpe GXP Upgrade

The Bunnythorpe GXP presently has 12 MVA of spare (N-1) capacity and 76 MVA of spare (N) capacity, based on the transformer ratings.

Based on analysis in Section 8.4.9, if all of the proposed Load Sites were to connect, the (N-1) capacity of the GXP is expected to be exceeded. Additionally, considering the other load growth expected in the region, Ergo has taken that GXP upgrades would be required for any single site to connect.

To accommodate an (N) capacity condition, it is expected that a special protection scheme may be required for the transformers at Bunnythorpe GXP, to avoid overloading the remaining transformer in the event of a single transformer outage. This upgrade is expected to cost $0.5 M.

To accommodate an (N-1) capacity condition, it is expected that the existing transformers may need to be upgraded/replaced. To be considered sufficient to supply all the connected loads, the expected cost is $9.0 M. This value is included in the costs for all of the connecting large loads, and may be shared should multiple of the loads connect.

8.4.2 Alsco NZ Palmerston North

		ALSCO NZ PALMERSTON NORTH
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	2.67	Bunnythorpe

Existing Electrical Supply to the Plant

Alsco NZ Palmerston North is presently supplied by Powerco's Kelvin Grove Zone substation. The site is supplied via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Kelvin Grove is in turn supplied from Bunnythorpe GXP by two 33 kV subtransmission circuits, one direct from the GXP, and one via Keith St substation.

This site is located approximately 1.5 km from Kelvin Grove zone substation. In turn, Kelvin Grove zone substation is approximately 4.5 km from Bunnythorpe GXP.

There is currently a maximum loading of 17 MVA on Kelvin Grove zone substation, with 31 MVA of spare (N) capacity and 7 MVA of spare (N-1) capacity. Bunnythorpe GXP presently has 12 MVA of spare (N-1) capacity and 76 MVA of spare (N) capacity. However, as mentioned in Section 8.4.1, it is expected that due to load growth in the area, for any of the Load Sites to connect with (N-1) security, GXP upgrades would be required.

Figure 42. Alsco NZ Palmerston North geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

ALSCO NZ PALMERSTON NORTH

Both the zone substation and the GXP have adequate spare (N) capacity. However, the GXP lacks adequate spare (N-1) capacity.

For Bunnythorpe GXP to accommodate an (N) capacity condition, it is expected that a special protection scheme would be required for the GXP transformers to avoid overloading the remaining transformer in the event of a single transformer outage.

For Bunnythorpe GXP to reach the required spare (N-1) capacity, the existing supply transformers may need to be upgraded/replaced.

The existing 11 kV feeder is estimated to have adequate spare capacity in most of its conductors. It is expected that 100 m of underground cable would have to be replaced to supply the Load Site.

Capital Cost Estimate

Table 9. Alsco NZ Palmerston North: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**
Transmission	Special protection system (GXP)	1.00	$0.50
Distribution	Single underground 11kV cable	0.10	$0.06
	TOTAL	**$0.56**

Table 10. Alsco NZ Palmerston North: 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	Bunnythorpe GXP transformer replacements	1.00	$12.00
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	0.10	$0.06
	TOTAL	**$12.16**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N) security supply, or 36-48 months for an (N-1) security supply 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.

8.4.3 Kakariki Proteins

KAKARIKI PROTEINS		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	2.50	Bunnythorpe

Existing Electrical Supply to the Plant

Kakariki Proteins is presently supplied by Powerco's Sanson substation. It supplied via an overhead 11 kV feeder. Sanson is in turn supplied from Bunnythorpe GXP by one 33 kV subtransmission circuit via Feilding zone substation. The subtransmission circuit current rating is approximately 485 A (27.7 MVA) each.

This site is located approximately 15.7 km from Sanson zone substation. In turn, Sanson zone substation is approximately 20.8 km from Bunnythorpe GXP.

There is currently a maximum loading of 9 MVA on Sanson zone substation, with -1.5 MVA of spare (N) capacity and -5 MVA spare (N-1) capacity. Bunnythorpe GXP presently has 12 MVA of spare (N-1) capacity and 76 MVA of spare (N) capacity. However, as mentioned in Section 8.4.1, it is expected that due to load growth in the area, for any of the Load Sites to connect with (N-1) security, GXP upgrades would be required.

Figure 43. Kakariki Proteins geographic location in relation to the surrounding zone substations

KAKARIKI PROTEINS

Supply Option(s) for New Load

The zone substation does not have adequate spare (N) or (N-1) capacity for the new load. The GXP has adequate (N) capacity, but insufficient (N-1) capacity.

For Sanson zone substation to achieve the required spare (N) capacity, the transformer at Sanson zone substation would need be replaced/upgraded, which according to the Powerco AMP, is expected to cost ~$1.356 M. This replacement is presently planned for 2028-2029.

Additionally, Powerco has a number of planned subtransmission feeder upgrades between Sanson, Bulls, and Feilding zone substations which will provide (N-1) security to these zone substations. Some of these were planned to be completed in 2024 and therefore are not included in the costings here, however, the Feilding-Sanson 33 kV line, which is planned for 2025-2027 has an expected cost of ~$1.406 M, is included in the costings below for an (N-1) supply.

The upgrades already planned by Powerco (mentioned above) have been included in the costings on the basis that this Load Site project may bring the upgrades forward, in which case, the Load Site would likely be required to contribute to the project costs, even though they are already planned.

For Bunnythorpe GXP to accommodate an (N) capacity condition, it is expected that a special protection scheme would be required for the transformers to avoid overloading the remaining transformer in the event of a single transformer outage.

For Bunnythorpe GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced.

The existing 11kV feeder has approximately 0.1 MVA spare capacity. However, due to the size of the load, reconductoring the existing feeder overhead line may be required. It is expected that approximately 3.6 km of overhead line may need to be upgraded.

Capital Cost Estimate

Table 11. Kakariki Proteins: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Subtransmission	Medium supply transformer (ZSS) (Sanson TX replacement)	1.00	$1.36
Distribution	Reconductor 11 kV line (larger)	3.60	$0.72
		TOTAL	**$2.58**

KAKARIKI PROTEINS

Table 12. Kakariki Proteins: 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	Bunnythorpe GXP transformer replacements	1.00 $12.00
Subtransmission	Sanson-Fielding 33 kV line	1.00 $1.41
Subtransmission	Medium supply transformer (ZSS) (Sanson TX replacement)	1.00 $1.36
Subtransmission	Medium supply transformer (ZSS)	1.00 $1.90
Distribution	Reconductor 11kV line (larger)	3.60 $0.72
	TOTAL	**$17.38**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N) security supply, or 36-48 months for an (N-1) security supply 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.

8.4.4 AFFCO New Zealand Limited Manawatū

AFFCO NEW ZEALAND LIMITED MANAWATŪ		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	1.26	Bunnythorpe

Existing Electrical Supply to the Plant

AFFCO New Zealand Limited Manawatū is presently supplied by Powerco's Feilding Zone substation. The site is supplied via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Feilding is in turn supplied from Bunnythorpe GXP by two 33 kV subtransmission circuits. The subtransmission circuits are rated to approximately 485 A (27.7 MVA) each.

This site is located approximately 1.7 km from Feilding zone substation. In turn, Feilding zone substation is approximately 7.8 km from Bunnythorpe GXP.

There is currently a maximum loading of 23 MVA on Feilding zone substation, with 19 MVA of spare (N) capacity and 1 MVA of spare (N-1) capacity. Bunnythorpe GXP presently has 12 MVA of spare (N-1) capacity and 76 MVA of spare (N) capacity. However, as mentioned in Section 8.4.1, it is expected that due to load growth in the area, for any of the Load Sites to connect with (N-1) security, GXP upgrades would be required.

Figure 44. AFFCO New Zealand Limited Manawatū geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity. However, both the zone substation and GXP lack adequate spare (N-1) capacity.

To accommodate an (N) capacity condition, it is expected that a special protection scheme would be implemented for the zone substation supply transformers.

Ergo understands that Powerco is planning to install a new substation in the area, which is assumed to supply this load. The new substation is estimated to cost $7.756 M. This project has been included in the costings on the basis that this Load Site project may bring the upgrades forward, in which case, the Load Site would likely be required to contribute to the project costs, even though they are already planned.

For Bunnythorpe GXP to accommodate an (N) capacity condition, it is expected that a special protection scheme would be required for the GXP transformers to avoid overloading the remaining transformer in the event of a single transformer outage.

For Bunnythorpe GXP to reach the required spare (N-1) capacity, the existing supply transformers may need to be upgraded/replaced.

The existing 11 kV feeder is estimated to have 0.1 MVA of spare capacity. Due to the size of the load and the high loading of the existing feeder, 1x new 11 kV feeder and associated circuit breaker may be required. Due to the urban / industrial topography of the area, this would likely be an underground cable, at a length of 1.7 km.

Capital Cost Estimate

Table 13. AFFCO New Zealand Limited Manawatū: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Subtransmission	Special protection system (ZSS)	1.00	$0.25
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single overhead 11 kV line	1.70	$0.43
		TOTAL	**$1.28**

Table 14. AFFCO New Zealand Limited Manawatū: 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	Bunnythorpe GXP transformer replacements	1.00	$12.00
Subtransmission	Feilding new zone substation	1.00	$7.76
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single overhead 11kV line	1.70	$0.43
		TOTAL	**$20.28**

AFFCO NEW ZEALAND LIMITED MANAWATŪ
Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 12-18 months for an (N) security supply, or 36-48 months for an (N-1) security supply 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.

8.4.5 NZ Defence Force Ōhakea Air Base

NZ DEFENCE FORCE ŌHAKEA AIR BASE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	1.14	Bunnythorpe

Existing Electrical Supply to the Plant

NZ Defence Force Ōhakea Air Base is presently supplied by Powerco's Ōhakea Zone substation. The site is supplied via two underground 11 kV feeders. Ōhakea zone substation is in turn supplied from Bunnythorpe GXP by one 33 kV subtransmission circuit via Feilding and Sanson substations. The subtransmission circuit is rated to 12.6/15.7 MVA (summer/winter), and it is estimated that the line between Ōhakea zone substation and Sanson zone substation has 4 MVA spare capacity.

This site is located approximately 0.8 km from Ōhakea zone substation. In turn, Ōhakea zone substation is approximately 23.6 km from Bunnythorpe GXP.

There is currently a maximum loading of 2 MVA on Ōhakea zone substation, with 8 MVA of spare (N) capacity and no spare (N-1) capacity (the substation operates on (N) security at present). Bunnythorpe GXP presently has 12 MVA of spare (N-1) capacity and 76 MVA of spare (N) capacity. However, as mentioned in Section 8.4.1, it is expected that due to load growth in the area, for any of the Load Sites to connect with (N-1) security, GXP upgrades would be required.

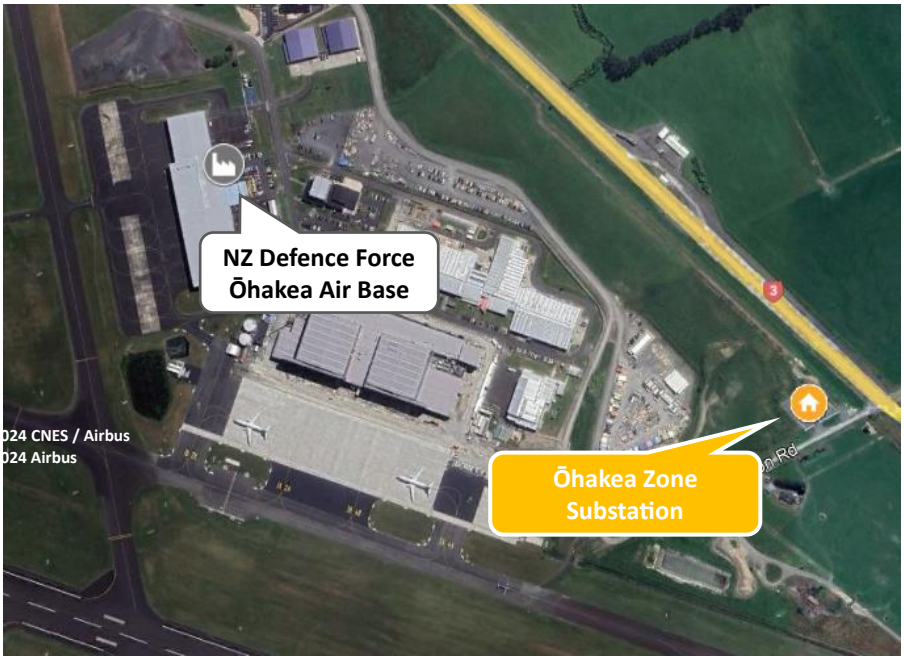


Figure 45. NZ Defence Force Ōhakea Air Base geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity. However, they're both lacking in spare (N-1) capacity.

For Ōhakea zone substation to achieve the required spare (N-1) capacity, an additional supply transformer would need to be installed. Additionally, a second 33 kV circuit (approximately 3.5 km long, and cabled, due to the urban topography in Sanson town and space constraints along the route) from Sanson zone substation and accompanying circuit breakers would be required.

For Bunnythorpe GXP to accommodate an (N) capacity condition, it is expected that a special protection scheme would be required for the GXP transformers to avoid overloading the remaining transformer in the event of a single transformer outage.

For Bunnythorpe GXP to reach the required spare (N-1) capacity, the existing supply transformers may need to be upgraded/replaced.

There is approximately 0.1 MW of spare capacity on the existing 11 kV feeder supplying the Load Site. Therefore, due to the size of the load, one new 11 kV feeder and associated circuit breaker would be required. Due to the industrial topography of the area, this would likely be an underground cable, at a length of 0.8 km.

Capital Cost Estimate

Table 15. NZ Defence Force Ōhakea Air Base: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**
Transmission	Special protection system (GXP)	1.00	$0.50
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	0.80	$0.48
		TOTAL	**$1.08**

Table 16. NZ Defence Force Ōhakea Air Base: 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	Bunnythorpe GXP transformer replacements	1.00	$12.00
Transmission	33kV circuit breaker bay	1.00	$0.25
Subtransmission	Single underground 33kV cable	3.50	$3.15
Subtransmission	33kV circuit breaker (ZSS)	2.00	$0.60
Subtransmission	Medium supply transformer (ZSS)	1.00	$1.90
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Single overhead 11kV line	1.70	$0.43
		TOTAL	**$18.53**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

NZ DEFENCE FORCE ŌHAKEA AIR BASE
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 12-18 months for an (N) security connection, or 36-48 months for an (N-1) security connection, 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.

8.4.6 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 17. 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)	Feeder Spare Capacity (MW)	Opportunity Load (MW)	Estimate cost ($k)
Moana New Zealand	Keith St	3	25	3.1	0.51	$130
Fonterra Brands Limited Palmerston North	Keith St	3	625	3.1	0.21	$80
Ovation New Zealand Limited Feilding*	Feilding	1	19	0.1	0.20	$80

*Ergo has calculated the impact of the Ovation load on the feeder which presently supplies it, and the load increase after diversity is 0.08 MW, so it is taken that the feeder has capacity.

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.

8.4.7 Combined Load on Zone Substations

While individual Load Site assessments in the sections above focus on upgrades required if only one Load Site were to connect, this section details where multiple Load Sites are proposed to connect to the same zone substation and whether the proposed upgrades in the sections above are sufficient or if further upgrades are required.

It is noted that any costs in this section are additional to those stated in the preceding sections assessing individual loads.

8.4.7.1 Keith St

Two of the loads on Bunnythorpe GXP are expected to connect to Keith St zone substation. The loads are Moana New Zealand, and Fonterra Brands Limited Palmerston North. The sum of peaks of these loads is 0.73 MW, which the zone substation does have (N-1) spare capacity for. Therefore, no further upgrades are expected at Keith St.

8.4.7.2 Feilding

Two of the loads on Bunnythorpe GXP are expected to connect to Feilding zone substation. The loads are AFFCO New Zealand Limited Manawatū and Ovation New Zealand Limited Feilding. The sum of peaks of these loads is 1.47 MW, which the zone substation does have (N-1) capacity for. Therefore, no further upgrades are expected at Feilding zone substation.

8.4.7.3 Feilding, Sanson, and Ōhakea subtransmission

Several loads on the Bunnythorpe GXP are expected to connect to the Feilding, Sanson, and Ōhakea substations, which share a subtransmission network. The loads are Kakariki Proteins, AFFCO New Zealand Limited Manawatū, NZ Defence Force Ohakea Air Base, and Ovation New Zealand Limited Feilding. The sum of the peaks of these loads is 5.1 MW. The subtransmission network in the area is constrained at present, however, Powerco has several projects underway and planned which are expected to relieve these issues. The upgrades underway/completed, along with the upgrades mentioned in the initial Load Site analysis are considered to be adequate for all of the connecting loads.

8.4.8 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Bunnythorpe GXP gives a combed load of 0.93 MW. When the load shapes are combined, they result in the following load shape (Figure 46), with a maximum load of 0.93 MW, with a diversity factor of 1.00.

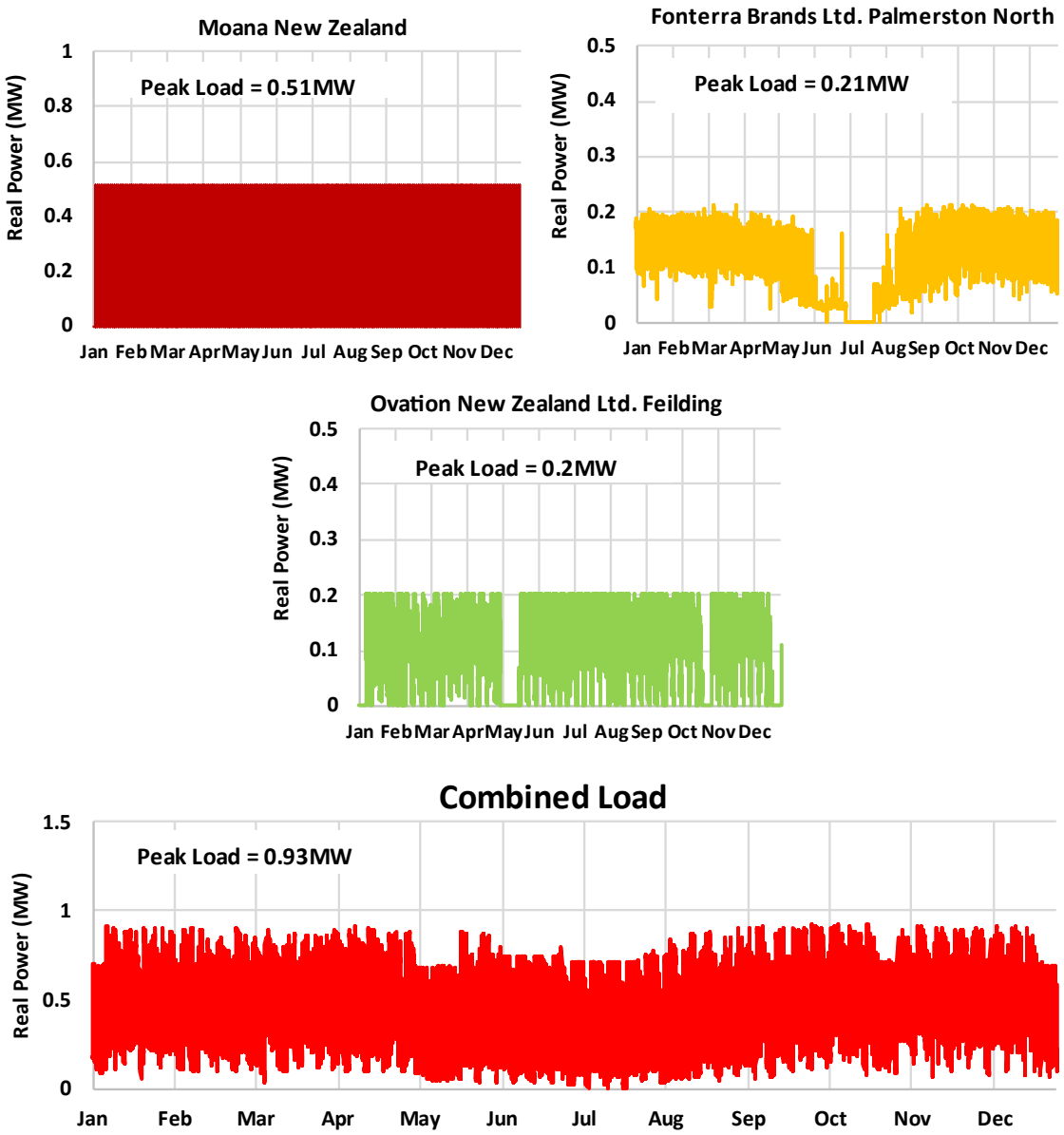


Figure 46. Loading Profiles: Bunnythorpe GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.4.9 Effect of all Load Sites Connecting to Bunnythorpe GXP

The following Figure 47 illustrates the Bunnythorpe GXP load profile together with the load profiles of all the Load Sites within the Bunnythorpe GXP region. Also shown in Figure 47 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Bunnythorpe GXP would increase to 92.8 MW, an increase of 3.5 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 97.8 MW there is a diversity factor of 0.95 between the loads.
- Based on Ergo's analysis, the Bunnythorpe GXP's (N-1) limit is expected to be exceeded. Ergo has discussed mitigation for this in Section 8.4.1.

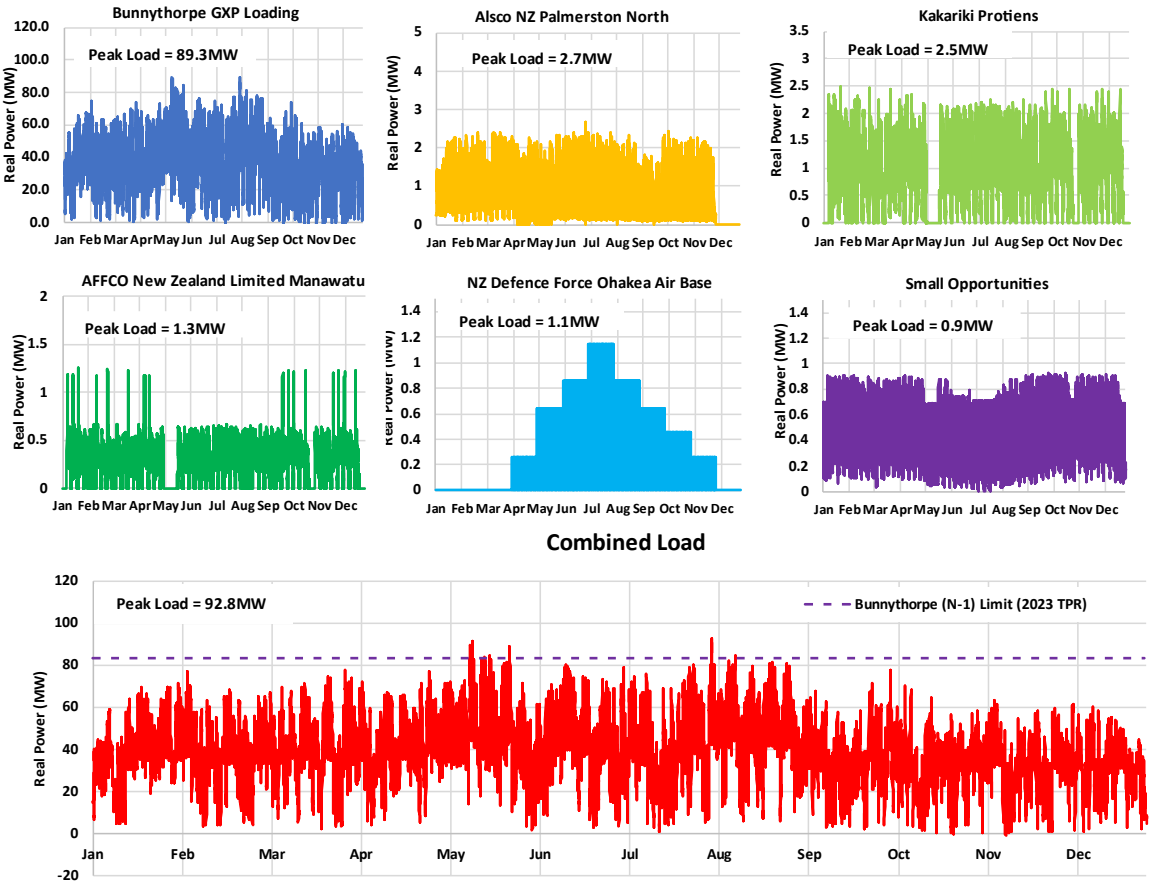


Figure 47. Loading Profiles: Bunnythorpe GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.5 Dannevirke GXP

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

- Godfrey Hirst NZ Limited Dannevirke (2.38 MW)

The "Small" Load Site connecting to the Dannevirke GXP include (refer to Section 8.5.3):

- Alliance Group Limited Dannevirke (0.35 MW)

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

Figure 48. Dannevirke GXP: EECA Load Sites vs local substations

8.5.1 Dannevirke GXP Upgrade

The Dannyvirke GXP presently has 9 MVA of spare (N-1) capacity and 26 MVA of spare (N) capacity, based on the transformer ratings.

Given the size of the new loads added to the Dannevirke GXP, no upgrades are expected at the GXP.

8.5.2 Godfrey Hirst NZ Limited Dannevirke

GODFREY HIRST NZ LIMITED DANNEVIRKE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	2.38	Dannevirke
Existing Electrical Supply to the Plant		
Godfrey Hirst NZ Limited Dannevirke is presently supplied by Transpower's Dannyvirke GXP. It is assumed that the site is supplied by the Weber 11kV feeder, which is expected be a mixture of underground cable and overhead line. This site is located approximately 6.5 km from Dannyvirke GXP. Dannevirke GXP presently has 26 MVA of spare (N) capacity and 9 MVA of spare (N-1) capacity.  Figure 49. Godfrey Hirst NZ Limited Dannevirke geographic location in relation to the surrounding zone substations		
Supply Option(s) for New Load		
The GXP has adequate (N) and (N-1) capacity to supply the new load. The existing 11 kV feeder loading is estimated to 2.4 MW with a maximum capacity of 4.4 MW. Due to the size of the load, it is expected that the conductors would require upgrading to accommodate the load. Due to the rural topography of the main run with urban topography near the load site, this would likely be a mixture of overhead line and underground cable, at a total length of approximately 6.3 km and 2.5 km respectively.		

GODFREY HIRST NZ LIMITED DANNEVIRKE

Capital Cost Estimate

Table 18. Godfrey Hirst NZ Limited Dannevirke: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)		Subtransmission => N/A	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single overhead 11 kV line	6.30	$1.58
Distribution	Single underground 11 kV cable	2.50	$1.50
		TOTAL	**$3.08**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N-1) security connection 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 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 19. 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)
Alliance Group Limited Dannevirke	N/A	N/A	N/A	2.1	0.35	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.

8.5.4 Effect of all Load Sites Connecting to Dannevirke GXP

The following Figure 50 illustrates the Dannevirke GXP load profile together with the load profiles of all the Load Sites within the Dannevirke 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 Dannevirke GXP would increase to 16.5 MW, an increase of 2.2 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 18.2 MW there is a diversity factor of 0.91 between the loads.
- Based on Ergo's analysis, the Dannevirke GXP's (N-1) limit is not expected to be exceeded.

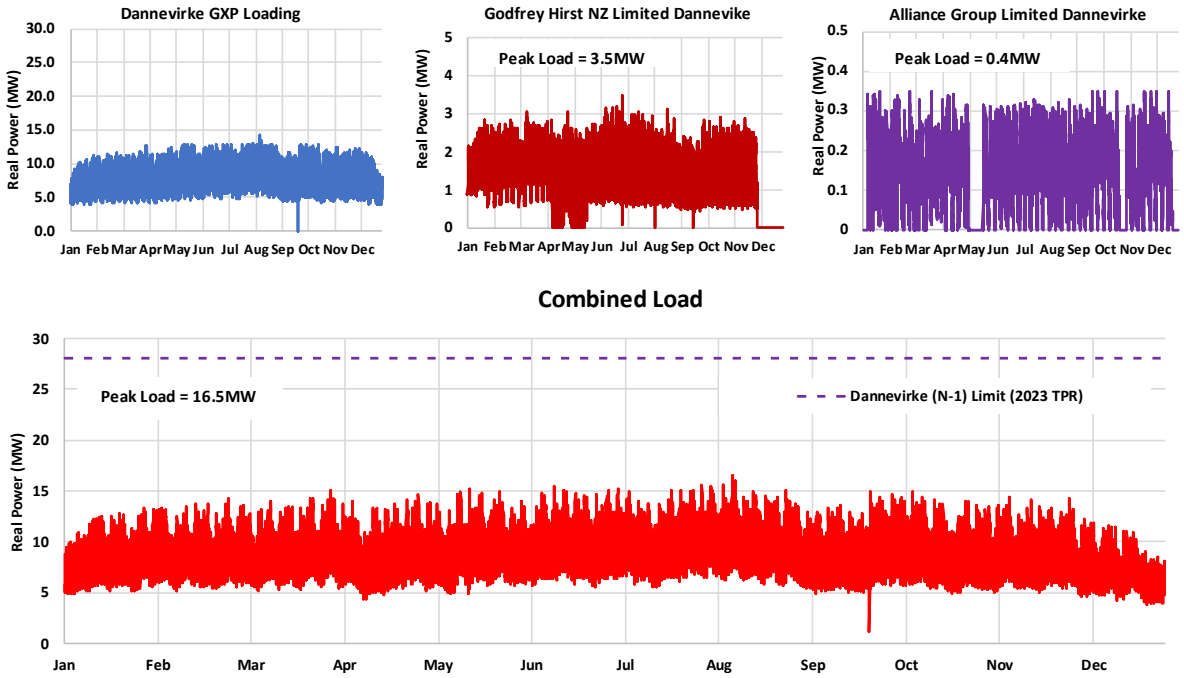


Figure 50. Loading Profiles: Dannevirke GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.6 Linton GXP

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

- Higgins Palmerston North Asphalt Plant (10.70 MW)
- Massy University Manawatū (5.70 MW)
- Fonterra Limited Research and Development Centre (3.96 MW)
- NZ Pharmaceuticals (3.75 MW)
- Ministry of Health Palmerston North Hospital (3.49 MW)
- Goodman Fielder Longburn (3.25 MW)
- Fonterra Limited Longburn (1.80 MW)
- Goodman Fielder Ernest Adams (1.70 MW)

The "Small" Load Sites connecting to the Linton GXP include (refer to Sections 8.6.10 and 8.6.12):

- NZ Defence Force Linton (0.55 MW)
- AgResearch Grasslands Research Centre (0.44 MW)

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

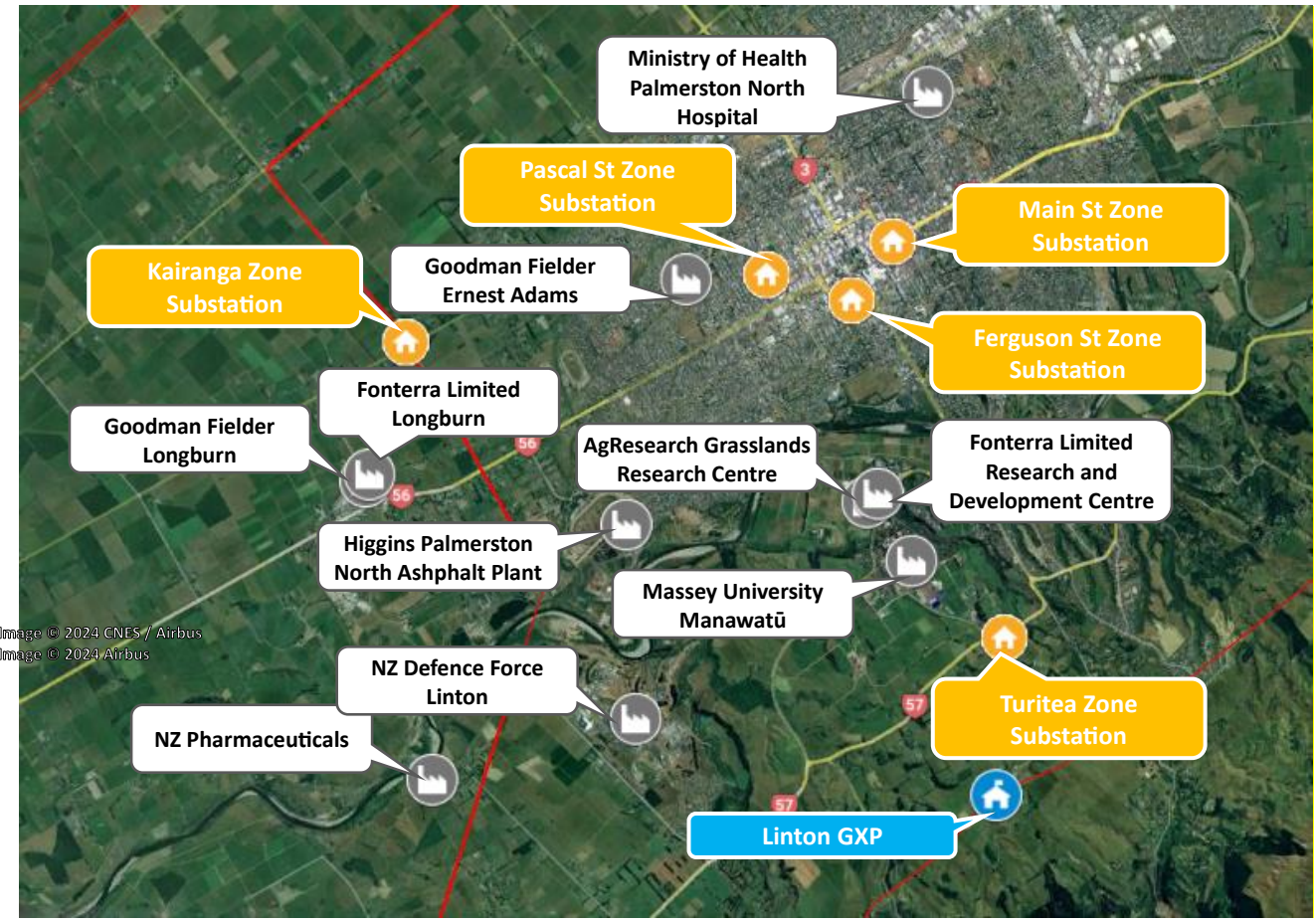


Figure 51. Linton GXP: EECA Load Sites vs local substations

8.6.1 Linton GXP Upgrade

The Linton GXP presently has 34 MVA of spare (N-1) capacity and 150 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in section 8.6.13 indicates that the spare (N-1) capacity of the Linton GXP is not expected to be exceeded if all the Load Sites are connected. Therefore, no upgrades at the Linton GXP are expected.

8.6.2 Higgins Palmerston North Asphalt Plant

HIGGINS PALMERSTON NORTH ASPHALT PLANT		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	10.70	Linton
Existing Electrical Supply to the Plant		

Higgins Palmerston North Asphalt Plant is presently supplied by Powerco's Kairanga substation. It supplied via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Kairanga is in turn supplied from Linton GXP by two 33 kV subtransmission circuits, one of which is shared with Pascal St substation. The subtransmission circuits' current ratings are approximately 800 A (45.7 MVA) each.

This site is located approximately 5.0 km from Kairanga zone substation. In turn, Kairanga zone substation is approximately 8.6 km from Linton GXP.

There is currently a maximum loading of 18 MVA on Kairanga zone substation, with 12 MVA of spare (N) capacity and 1 MVA of spare (N-1) capacity. Linton GXP presently has 130 MVA of spare (N) capacity and 34 MVA of spare (N-1) capacity.

Figure 52. Higgins Palmerston North Asphalt Plant geographic location in relation to the surrounding zone substations

HIGGINS PALMERSTON NORTH ASPHALT PLANT

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity. However, the zone substation does not have adequate (N-1) capacity.

For an (N-1) security supply, it is expected that the transformers at Kairanga substation would be replaced. Ergo notes that Powerco have presently planned for transformer upgrades at Kairanga, at an expected cost of $2.504 M, with upgrades scheduled for 2025-2026. It has been assumed that this new load would bring these upgrades forward and so the costs have been included in the costings below.

Due to the size of the load, it is expected that two 11 kV feeders from the Kairanga substation would be required to supply the load. Due to space constraints and urban topography in the area, these would likely be underground cables, at a length of ~5.0 km.

Capital Cost Estimate

Table 20. Higgins Palmerston North Asphalt Plant: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**
Distribution	11 kV circuit breaker (ZSS)	2.00 $0.20
Distribution	Double underground 11 kV cable	5.00 $4.00
	TOTAL	**$4.20**

Table 21. Higgins Palmerston North Asphalt Plant: 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)**
Subtransmission	Kairanga substation transformer upgrades	1.00 $2.50
Distribution	11 kV circuit breaker (ZSS)	2.00 $0.20
Distribution	Double underground 11 kV cable	5.00 $4.00
	TOTAL	**$6.70**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

HIGGINS PALMERSTON NORTH ASPHALT PLANT
It is estimated to take 12-18 months for an (N) or 24-36 months for an (N-1) security connection 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.

8.6.3 Massey University Manawatū

MASSEY UNIVERSITY MANAWATŪ		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	5.70	Linton

Existing Electrical Supply to the Plant

Massey University Manawatū is presently supplied by Powerco's Turitea zone substation. It supplied via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Turitea is in turn supplied from Linton GXP by one 33 kV subtransmission circuit. The subtransmission circuit current rating is approximately 800 A (45.7 MVA).

This site is located approximately 2.0 km from Turitea zone substation. In turn, Turitea zone substation is approximately 2.3 km from Linton GXP.

There is currently a maximum loading of 14 MVA on Turitea zone substation, with 16 MVA of spare (N) capacity and 1 MVA of spare (N-1) capacity. Linton GXP presently has 130 MVA of spare (N) capacity and 34 MVA of spare (N-1) capacity.

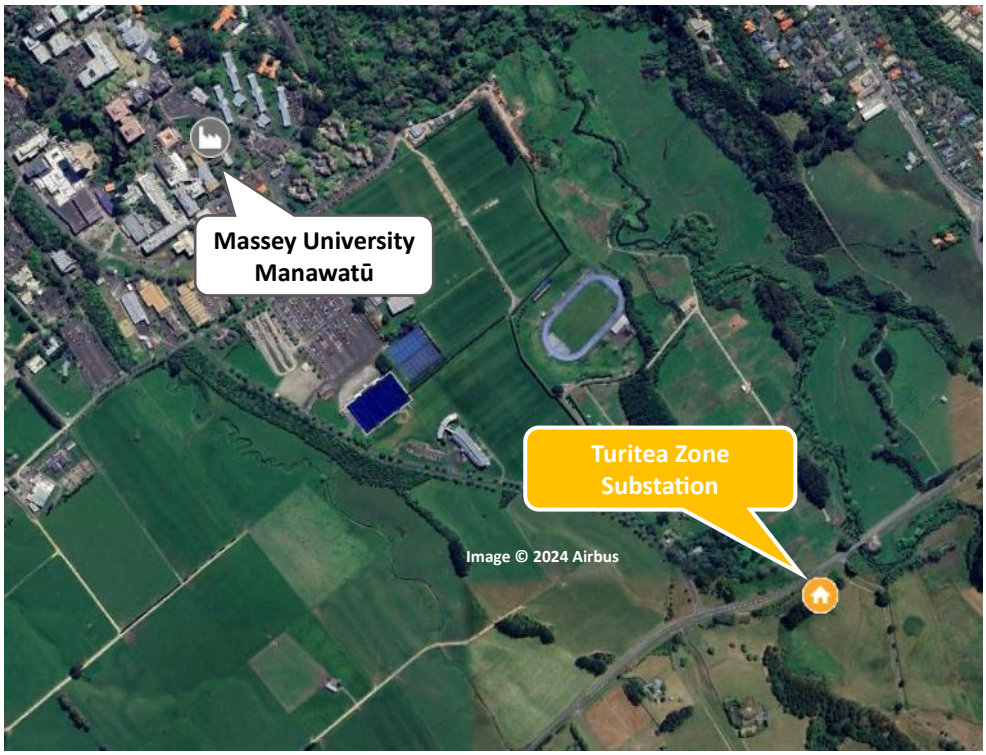


Figure 53. Massey University Manawatū geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity. However, the zone substation lacks spare (N-1) capacity.

MASSEY UNIVERSITY MANAWATŪ

Ergo understands from the Powerco AMP that Powerco is aware of this Load Site's plan to decarbonise. To supply this load Powerco has planned to install a second 33 kV circuit from Linton GXP to Turitea zone substation, upgrading the 33 kV switchboard at Turitea, and replacing the transformers at Turitea. The new 33 kV line is expected to cost $2.068 M (planned for 2024-2025); with the transformer replacements expected to cost $2.884 M (planned for 2024-2025). Because these upgrades have been triggered at least partly due to this Load Site, the costs are included in the costing for this site. These upgrades would afford the site with (N-1) security.

Ergo understands that Powerco plans to split the load of Massey University across the two 11 kV feeders from Turitea substation. Due to the urban/industrial topography of the area, Ergo has assumed these to be underground cables, at a length of 2.3 km each.

Capital Cost Estimate

Table 22. Massey University Manawatū: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)		Subtransmission => (N)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	2.30	$1.84
		TOTAL	**$2.04**

Table 23. Massey University Manawatū: 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)**	
Subtransmission	Turitea substation second 33 kV line	1.00	$2.07
Subtransmission	Turitea substation transformer replacements	1.00	$2.88
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	2.30	$1.84
		TOTAL	**$6.99**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

MASSEY UNIVERSITY MANAWATŪ
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 12-18 months for an (N) security connection or 24-36 months for an (N-1) security connection 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.

8.6.4 Fonterra Limited Research and Development Centre

FONTERRA LIMITED RESEARCH AND DEVELOPMENT CENTRE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	3.96	Linton

Existing Electrical Supply to the Plant

Fonterra Limited Research and Development Centre is presently supplied by Powerco's Turitea zone substation. It supplied via an underground 11 kV feeder. Turitea is in turn supplied from Linton GXP by one 33 kV subtransmission circuit. The subtransmission circuit current rating is approximately 800 A (45.7 MVA).

This site is located approximately 3.5 km from Turitea zone substation. In turn, Turitea zone substation is approximately 2.3 km from Linton GXP.

There is currently a maximum loading of 14 MVA on Turitea zone substation, with 16 MVA of spare (N) capacity and 1 MVA of spare (N-1) capacity. Linton GXP presently has 130 MVA of spare (N) capacity and 34 MVA of spare (N-1) capacity.

Figure 54. Fonterra Limited Research and Development Centre geographic location in relation to the surrounding zone substations

FONTERRA LIMITED RESEARCH AND DEVELOPMENT CENTRE

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity. However, the zone substation lacks spare (N-1) capacity.

Powerco has planned to install a second 33 kV circuit from Linton GXP to Turitea zone substation, upgrading the 33 kV switchboard at Turitea, and replacing the transformers at Turitea. The new 33 kV line is expected to cost $2.068 M (planned for 2024-2025); with the transformer replacements expected to cost $2.884 M (planned for 2024-2025). These costs have been included against this Load Site as it may impact them. These upgrades would afford the site with (N-1) security.

The existing 11 kV feeder is estimated to have 3.2 MVA of spare capacity. Due to the size of the load and the high loading of the existing feeder, one new 11 kV feeder and associated circuit breaker may be required. Due to the urban/industrial topography of the area, this would likely be an underground cable, at a length of ~3.4 km. Given the proximity of AgResearch Grasslands Research Centre, it is possible that the cost of this upgrade could be shared between sites.

Capital Cost Estimate

Table 24. Fonterra Limited Research and Development Centre: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.40	$2.04
		TOTAL	**$2.14**

Table 25. Fonterra Limited Research and Development Centre: 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)**	
Subtransmission	Turitea substation second 33 kV line	1.00	$2.07
Subtransmission	Turitea substation transformer replacements	1.00	$2.88
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.40	$2.04
		TOTAL	**$7.09**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

FONTERRA LIMITED RESEARCH AND DEVELOPMENT CENTRE
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 12-18 months for an (N) security connection or 24-36 months for an (N-1) security connection 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.

8.6.5 NZ Pharmaceuticals

NZ PHARMACEUTICALS		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	3.75	Linton

Existing Electrical Supply to the Plant

NZ Pharmaceuticals is presently supplied by Powerco's Turitea zone substation. It supplied via an underground 11 kV feeder. Turitea is in turn supplied from Linton GXP by one 33 kV subtransmission circuit. The subtransmission circuit current rating is approximately 800 A (45.7 MVA).

This site is located approximately 8.7 km from Turitea zone substation. In turn, Turitea zone substation is approximately 2.3 km from Linton GXP.

There is currently a maximum loading of 14 MVA on Turitea zone substation, with 16 MVA of spare (N) capacity and 1 MVA of spare (N-1) capacity. Linton GXP presently has 130 MVA of spare (N) capacity and 34 MVA of spare (N-1) capacity.

Figure 55. NZ Pharmaceuticals geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity. However, the zone substation lacks spare (N-1) capacity.

Ergo understands that Powerco plan to supply this Load Site via the new substation proposed at the Linton Army Camp. This substation will have (N) subtransmission security to begin with, with a second 33 kV circuit planned to connect the substation to Linton GXP in the future, providing the substation (N-1) capacity. Expected costs from the Powerco AMP are $5.643M for the substation, and $5.396M for the additional 33 kV circuit. These costs have been included against this Load Site as it may impact

them. The upgrades are presently planned for 2030-2033, however they may be brought forward if customers require it.

Due to the size of the load, it is expected that one new 11 kV feeder and associated circuit breaker would be required to supply this site. Due to the rural topography of the area, this would likely be an overhead line, at a length of 6.8 km.

Capital Cost Estimate

Table 26. NZ Pharmaceuticals: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)		Subtransmission => (N)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Linton Army Camp Substation	1.00	$5.64
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single overhead 11kV line	6.80	$1.70
		TOTAL	**$7.44**

Table 27. NZ Pharmaceuticals: 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)**	
Subtransmission	Linton Army Camp Substation	1.00	$5.64
Subtransmission	Linton Army Camp Substation Second 33 kV circuit	1.00	$5.40
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single overhead 11kV line	6.80	$1.70
		TOTAL	**$12.84**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

If connection of the Load Site were to bring plans forward, it is estimated to take 24-36 months for either an (N) or (N-1) security connection 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.

8.6.6 Ministry of Health Palmerston North Hospital

MINISTRY OF HEALTH PALMERSTON NORTH HOSPITAL		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	3.49	Linton
Existing Electrical Supply to the Plant		

Ministry of Health Palmerston North Hospital is presently supplied by Powerco's Keith St Zone substation. The site is supplied via an underground 11 kV feeder. Keith St is in turn supplied from Brunswick GXP by two 33 kV subtransmission circuits. The subtransmission circuits are rated to approximately 625 A (35.7 MVA) each. The Hospital is also supplied by an 11 kV feeder from Powerco's Main St substation. Main St is in turn supplied from Linton GXP by two 33 kV subtransmission circuits via Ferguson St zone substation. The subtransmission circuit current rating is approximately 800 A (45.7 MVA) each.

This site is located approximately 2.8 km from Keith St ZS. In turn, Keith St zone substation is approximately 6.7 km from Bunnythorpe GXP. The site is located approximately 1.8 km from Main St ZS. Main St ZS is approximately 8.5 km from Linton GXP.

There is currently a maximum loading of 19 MVA on Keith St zone substation, with 25 MVA of spare (N) capacity and 3 MVA of spare (N-1) capacity. However, as mentioned in Section 8.4.1, it is expected that due to load growth in the area, for any of the Load Sites to connect with (N-1) security, GXP upgrades would be required at Bunnythorpe. There is currently a maximum loading of 18 MVA on Main St zone substation, with 16 MVA of spare (N) capacity and -1 MVA of spare (N-1) capacity. Linton GXP presently has 130 MVA of spare (N) capacity and 34 MVA of spare (N-1) capacity.

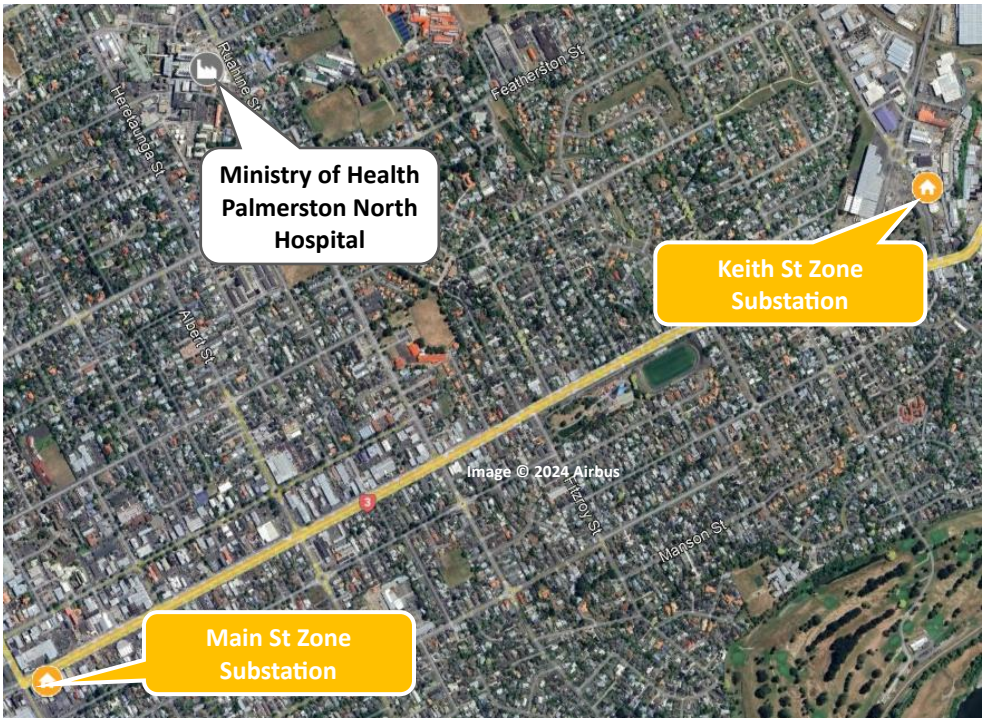


Figure 56. Ministry of Health Palmerston North Hospital geographic location in relation to the surrounding zone substations.

MINISTRY OF HEALTH PALMERSTON NORTH HOSPITAL

Supply Option(s) for New Load

Linton GXP has adequate (N) and (N-1) spare capacity for this load. Main St substation has adequate (N) but not (N-1) spare capacity for this load.

Ergo understands that Powerco is aware of the hospital's increasing energy needs. Powerco has planned for a new feeder (33 kV rated, operating at 11 kV in the short-term, approximately 3 km long) to the site from one of its substations (Main St), and has indicated that in the long-term, a substation would be built at the end of the new feeder.

Ergo has assumed that for either an (N) or an (N-1) security solution, the new substation would be required, with the new 11 kV feeder from Main St providing supply in the short-term.

To accommodate an (N) capacity condition, it is expected that a single-transformer substation would be established at the new substation site.

For an (N-1) security supply, it is expected that a dual-transformer substation would be established at the new substation site, which would also include establishing a second new 33 kV feeder from Main St to the new substation site.

Along with the new substation, it is expected that a new 11 kV feeder from the new substation would be required for this load. Due to the urban/industrial topography of the area, this would likely be an underground cable, at a length of ~0.5 km for connection (assumed) to the new zone substation.

Capital Cost Estimate

Table 28. Ministry of Health Palmerston North Hospital: Capital cost estimate to supply the Load Site with supply in the short-term.

Transmission => (N-1)		Subtransmission => (N)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 33kV cable	3.00	$2.70
		TOTAL	**$2.80**

Table 29. Ministry of Health Palmerston North Hospital: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)		Subtransmission => (N)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	33kV circuit breaker bay	2.00	$0.50
Subtransmission	Small zone substation	1.00	$5.00
Distribution	11kV circuit breaker (ZSS)	3.00	$0.30
Distribution	Single underground 11kV cable	0.50	$0.30
		TOTAL	**$6.10**

MINISTRY OF HEALTH PALMERSTON NORTH HOSPITAL

Table 30. Ministry of Health Palmerston North 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)**	
Subtransmission	33kV circuit breaker bay	4.00	$1.00
Subtransmission	Single underground 33kV cable	3.00	$2.70
Subtransmission	Medium zone substation	1.00	$8.00
Distribution	11kV circuit breaker (ZSS)	3.00	$0.30
Distribution	Single underground 11kV cable	0.50	$0.30
		TOTAL	**$12.30**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 24-36 months for either an (N) or (N-1) security supply 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.

8.6.7 Goodman Fielder Longburn

		GOODMAN FIELDER LONGBURN
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	3.25	Linton
Existing Electrical Supply to the Plant		

Goodman Fielder Longburn is presently supplied by Powerco's Kairanga substation. It supplied via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Kairanga is in turn supplied from Linton GXP by two 33 kV subtransmission circuits: one direct circuit from Linton GXP and one circuit via Pascal St zone substation. The subtransmission circuits' current ratings are approximately 415 A (23.7 MVA) each.

This site is located approximately 2.3 km from Kairanga zone substation. In turn, Kairanga zone substation is approximately 8.6 km from Linton GXP.

There is currently a maximum loading of 18 MVA on Kairanga zone substation, with 12 MVA of spare (N) capacity and 1 MVA of spare (N-1) capacity. Linton GXP presently has 130 MVA of spare (N) capacity and 34 MVA of spare (N-1) capacity.

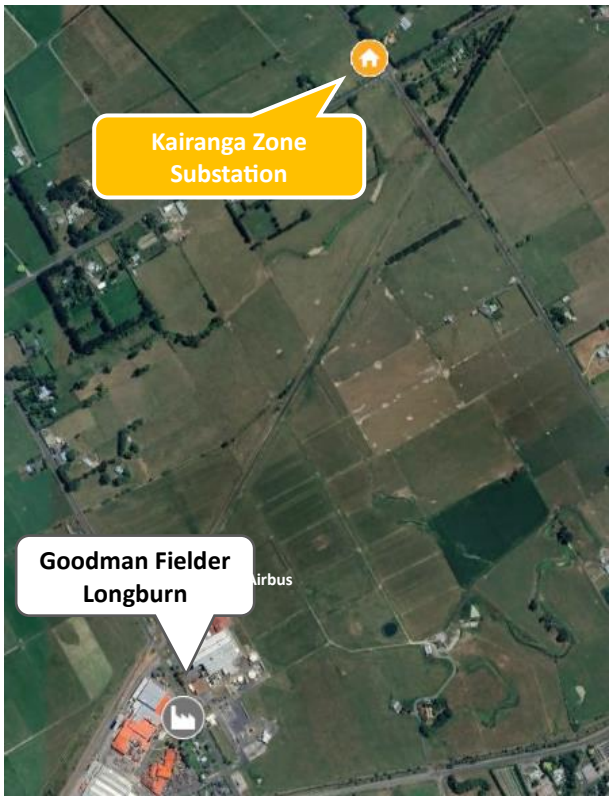


Figure 57. Goodman Fielder Longburn geographic location in relation to the surrounding zone substations

GOODMAN FIELDER LONGBURN

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity. However, the zone substation does not have adequate (N-1) capacity.

For an (N-1) security supply, it is expected that the transformers at Kairanga substation would be replaced. Ergo notes that Powerco have presently planned for transformer upgrades at Kairanga, at an expected cost of $2.504 M, with upgrades scheduled for 2025-2026. It has been assumed that this load side would bring these upgrades forward and so the costs have been included in the costings below.

The existing 11 kV feeder is estimated to have 0.1 MVA of spare capacity. Due to the size of the load and the high loading of the existing feeder, one new 11 kV feeder and associated circuit breaker would be required. Due to space constraints in the road reserves, this would likely be an underground cable, at a length of 3.3 km. Given the proximity between this site and Fonterra Limited Longburn, the cost of the new feeder may be shared between sites.

Capital Cost Estimate

Table 31. Goodman Fielder Longburn: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.30	$1.98
		TOTAL	**$2.08**

Table 32. Goodman Fielder Longburn: 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)**	
Subtransmission	Kairanga substation transformer upgrades	1.00	$2.50
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.30	$1.98
		TOTAL	**$4.58**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

GOODMAN FIELDER LONGBURN
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 12-18 months for an (N) or 24-36 months for an (N-1) security connection 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.

8.6.8 Fonterra Limited Longburn

		FONTERRA LIMITED LONGBURN
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	1.80	Linton
Existing Electrical Supply to the Plant		

Fonterra Limited Longburn is presently supplied by Powerco's Kairanga substation. It supplied via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Kairanga is in turn supplied from Linton GXP by two 33 kV subtransmission circuits: one direct circuit from Linton GXP and one circuit via Pascal St zone substation. The subtransmission circuits' current ratings are approximately 415 A (23.7 MVA) each.

This site is located approximately 2.3 km from Kairanga zone substation. In turn, Kairanga zone substation is approximately 8.6 km from Linton GXP.

There is currently a maximum loading of 18 MVA on Kairanga zone substation, with 12 MVA of spare (N) capacity and 1 MVA of spare (N-1) capacity. Linton GXP presently has 130 MVA of spare (N) capacity and 34 MVA of spare (N-1) capacity.

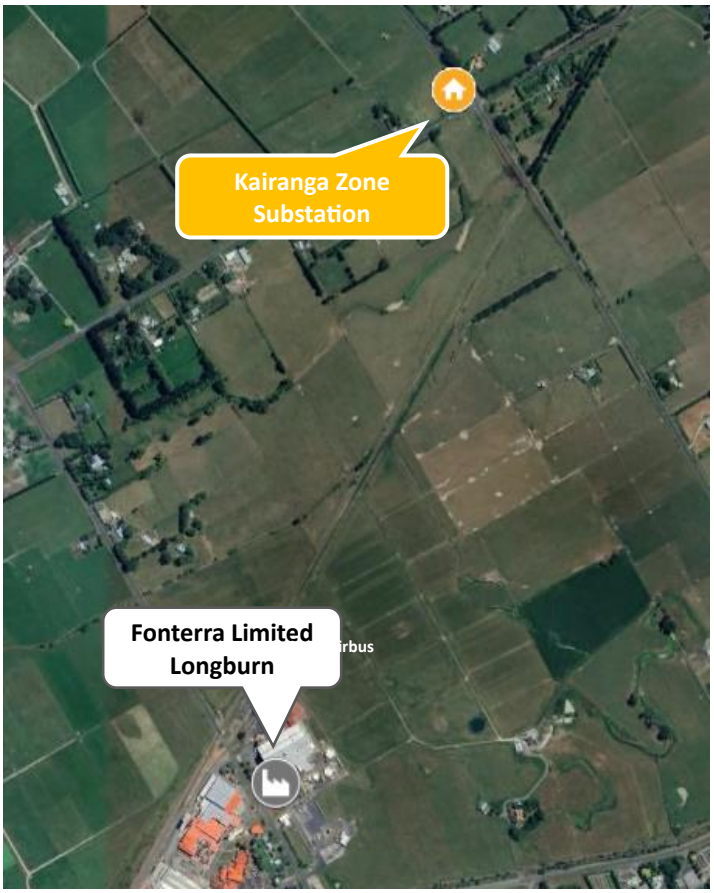


Figure 58. Fonterra Limited Longburn geographic location in relation to the surrounding zone substations

FONTERRA LIMITED LONGBURN

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity. However, the zone substation does not have adequate (N-1) capacity.

For an (N-1) security supply, it is expected that the transformers at Kairanga substation would be replaced. Ergo notes that Powerco have presently planned for transformer upgrades at Kairanga, at an expected cost of $2.504 M, with upgrades scheduled for 2025-2026. It has been assumed that this load side would bring these upgrades forward and so the costs have been included in the costings below.

The existing 11 kV feeder is estimated to have 0.1 MVA of spare capacity. Due to the size of the load and the high loading of the existing feeder, one new 11 kV feeder and associated circuit breaker may be required. Due to space constraints in the road reserves, this would likely be an underground cable, at a length of 3.3 km. Given the proximity between this site and Fonterra Limited Longburn, it is possible for the cost of the new feeder to be shared between sites.

Capital Cost Estimate

Table 33. Fonterra Limited Longburn: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.30	$1.98
		TOTAL	**$2.08**

Table 34. Fonterra Limited Longburn: 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)**	
Subtransmission	Kairanga substation transformer upgrades	1.00	$2.50
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.30	$1.98
		TOTAL	**$4.58**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

FONTERRA LIMITED LONGBURN
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 12-18 months for an (N) or 24-36 months for an (N-1) security connection 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.

8.6.9 Goodman Fielder Ernest Adams

GOODMAN FIELDER ERNEST ADAMS		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	1.70	Linton

Existing Electrical Supply to the Plant

Goodman Fielder Ernest Adams is presently supplied by Powerco's Pascal St zone substation. It supplied via an underground 11 kV feeder. Pascal St is in turn supplied from Linton GXP by two 33 kV subtransmission circuits. The subtransmission circuits' current ratings are approximately 393 A (22.5 MVA) and 415 A (23.7 MVA) respectively.

This site is located approximately 1.2 km from Pascal St zone substation. In turn, Pascal St zone substation is approximately 8.0 km from Linton GXP.

There is currently a maximum loading of 15 MVA on Pascal St zone substation, with 19 MVA of spare (N) capacity and 2 MVA of spare (N-1) capacity. Linton GXP presently has 130 MVA of spare (N) capacity and 34 MVA of spare (N-1) capacity.

Figure 59. Goodman Fielder Ernest Adams geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) and (N-1) capacity to supply this load.

The existing 11 kV feeder has an approximate spare capacity of 2.7 MVA. It is expected that this is sufficient to supply the new site load.

GOODMAN FIELDER ERNEST ADAMS
Given the existing infrastructure is sufficient to provide (N-1) capacity, no investigation has been provided for an (N) security condition.
Capital Cost Estimate
Indicatively, it is expected that a distribution transformer to supply this load would cost approximately $350 k. Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) 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. Excluded are any work required to establish the Load Site. Any land acquisition and consenting, if required, is excluded.

8.6.10 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 35. 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)	Expected Feeder Capacity (MW)	Opportunity Load (MW)	Estimate cost ($k)
NZ Defence Force Linton*	Turitea	1	16	1.2	0.55	200
AgResearch Grasslands Research Centre	Turitea	1	16	0.8	0.44	130

*Ergo notes that Powerco is expecting further load growth at NZDF Linton other than that expected in this report. Powerco is proposing to install a new substation at Linton Army Camp, utilising the existing subtransmission lines in the area, to supply this load.

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.

8.6.11 Combined Load on Zone Substations

While individual Load Site assessments in the sections above focus on upgrades required if only one Load Site were to connect, this section details where multiple Load Sites are proposed to connect to the same zone substation and whether the proposed upgrades in the sections above are sufficient or if further upgrades are required.

It is noted that any costs in this section are additional to those stated in the preceding sections assessing individual loads.

8.6.11.1 Kairanga

Three of the loads on Linton GXP are expected to connect to Kairanga zone substation. The loads are Higgins Palmerston North Asphalt Plant, Goodman Fielder Longburn, and Fonterra Limited Longburn. The sum of peaks of these loads is 15.75 MW, which the zone substation does not have (N-1) capacity for. However, the upgrades specified for the individual Load Sites are expected to be adequate for all the loads connecting, and should multiple of the loads connect, there may be an opportunity to share the costs of the upgrades. This relates to the substation itself and not the subtransmission lines, which are discussed below.

8.6.11.2 Kairanga and Pascal St subtransmission

Three of the loads on Linton GXP are expected to connect to Kairanga zone substation, and one to Pascal St zone substation. The loads are Higgins Palmerston North Asphalt Plant, Goodman Fielder Longburn, Fonterra Limited Longburn, and Goodman Fielder Ernest Adams. The sum of peaks of these loads is 17.45 MW, which the shared subtransmission lines do not have (N-1) capacity for. With the majority of the loads connecting to Kairanga, a second line from Linton GXP to Kairanga may be required. Due to the urban topography and growth in the area, it is expected that this would be underground cabled at an approximate length of 14 km. The route involves a river crossing, which is accounted for in costing by an extra 1 km of cabling. An indicative cost for this is $14.1 M.

8.6.11.3 Turitea

Five of the loads on Linton GXP are expected to connect to Turitea zone substation. The loads are Massey University Manawatū, Fonterra Limited Research and Development Centre, NZ Pharmaceuticals, NZ Defence Force Linton, and AgResearch Grasslands Research Centre. The sum of peaks of these loads is 14.41 MW, which the zone substation does not have (N-1) capacity for.

Additional to the upgrades specified for the individual Load Sites, a number of the connecting sites require installation of additional circuit breakers at the substation. While some of these may be shared feeders, it is expected that the existing 11 kV switchroom will not have room for all of the proposed connecting circuit breakers. An indicative cost for a switchroom/switchboard replacement to accommodate the required additional circuit breakers is $5.5 M.

8.6.12 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Linton GXP gives a combed load of 0.99 MW. When the load shapes are combined, they result in the following load shape (Figure 60), with a maximum load of 0.97 MW, with a diversity factor of 0.97.

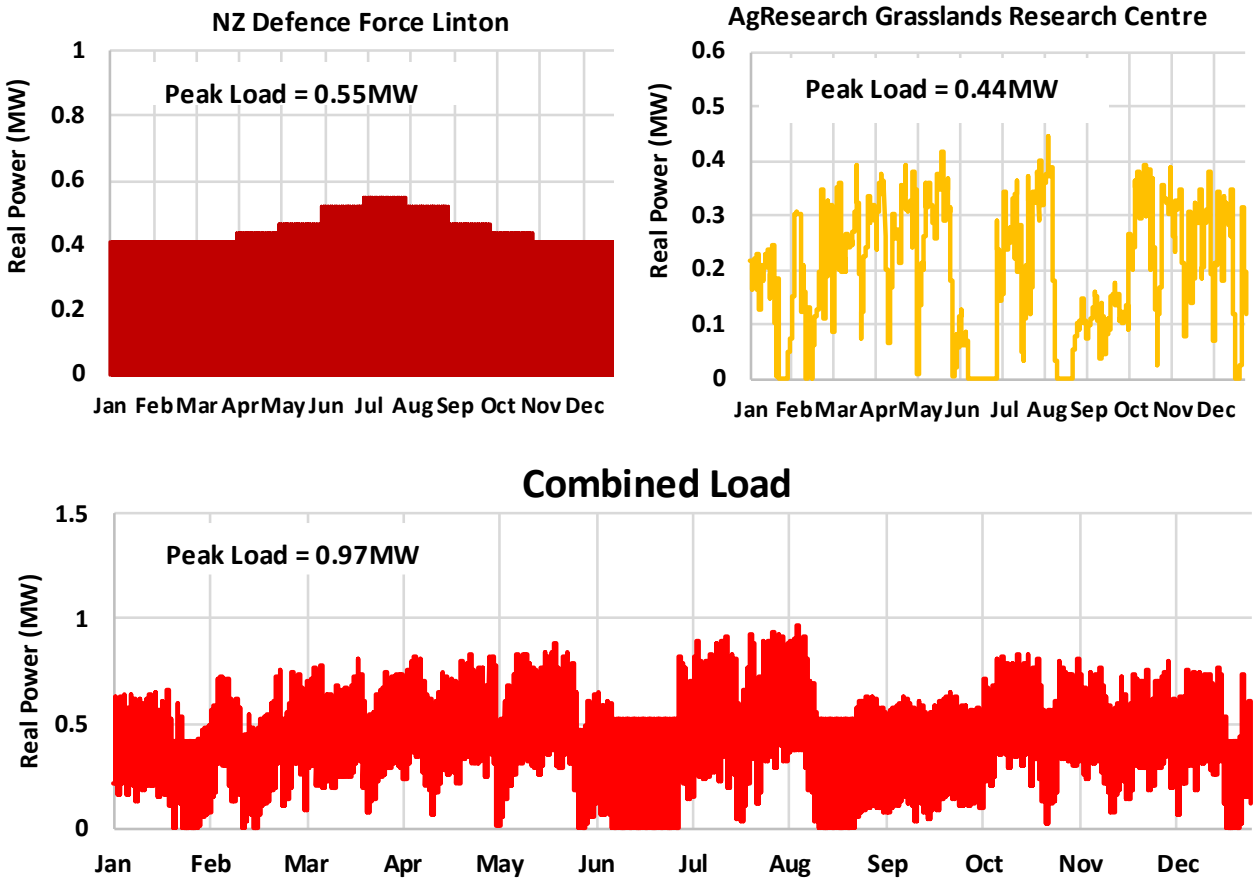


Figure 60. Loading Profiles: Linton GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.6.13 Effect of all Load Sites Connecting to Linton GXP

The following Figure 61 illustrates the Linton GXP load profile together with the load profiles of all the Load Sites within the Linton GXP region. Also shown in Figure 61 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Linton GXP would increase to 80.8 MW, an increase of 11.2 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 104.9 MW there is a diversity factor of 0.77 between the loads.
- Based on Ergo's analysis, the Linton GXP's (N-1) limit not expected to be exceeded.

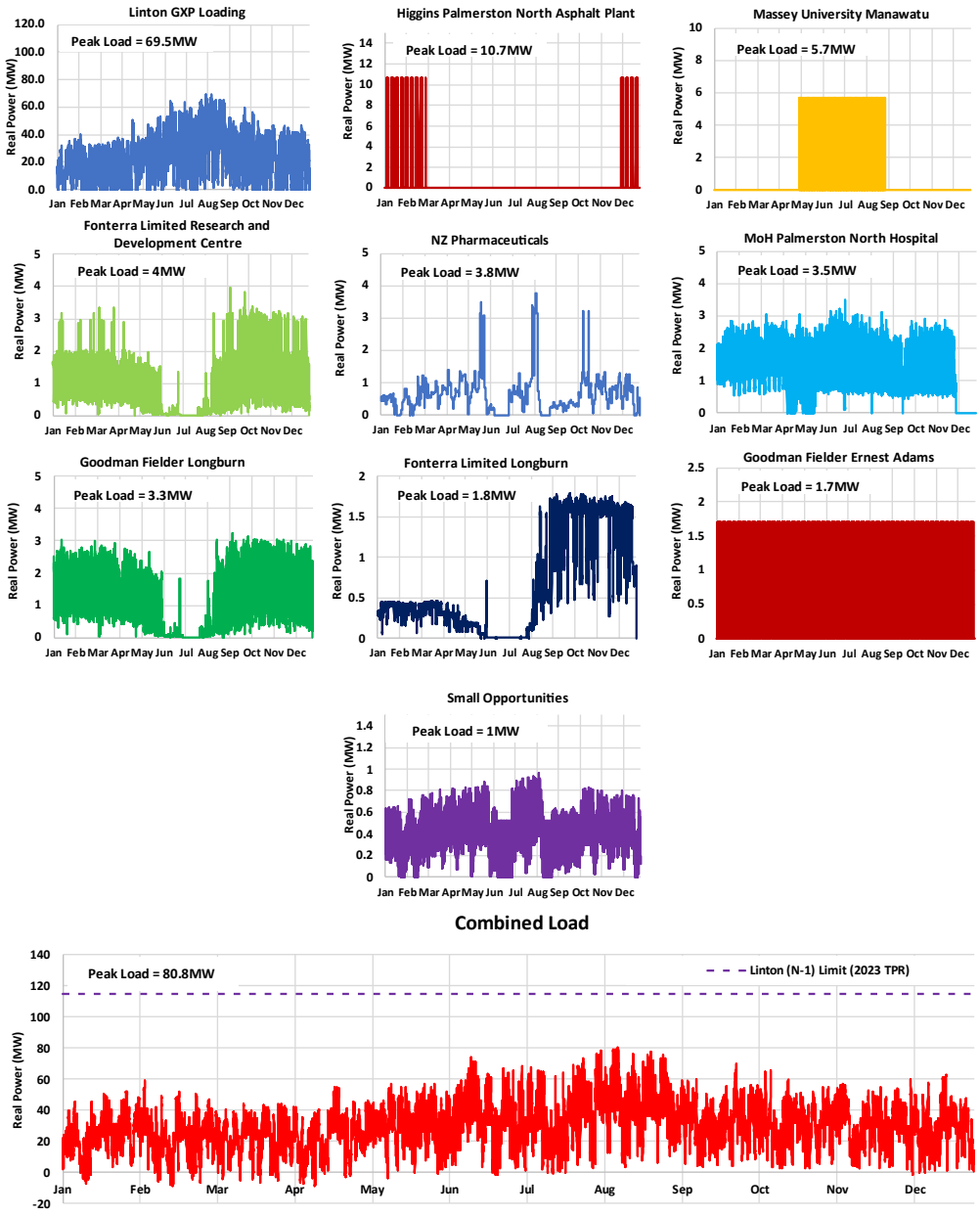


Figure 61. Loading Profiles: Linton GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.7 Mangahao GXP

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

- Horowhenua District Council Levin Aquatic Centre (3.87 MW)
- Oji Fibre Solutions Packaging NZ Central (3.75 MW)
- Turk's Poultry (2.31 MW)
- Health New Zealand Horowhenua Health Centre (1.50 MW)
- RJs Confectionery Levin (1.08 MW)

The "Small" Load Site connecting to the Mangahao GXP is (refer to Section 8.7.7):

- Mitchpine Limited Levin (0.49 MW)

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

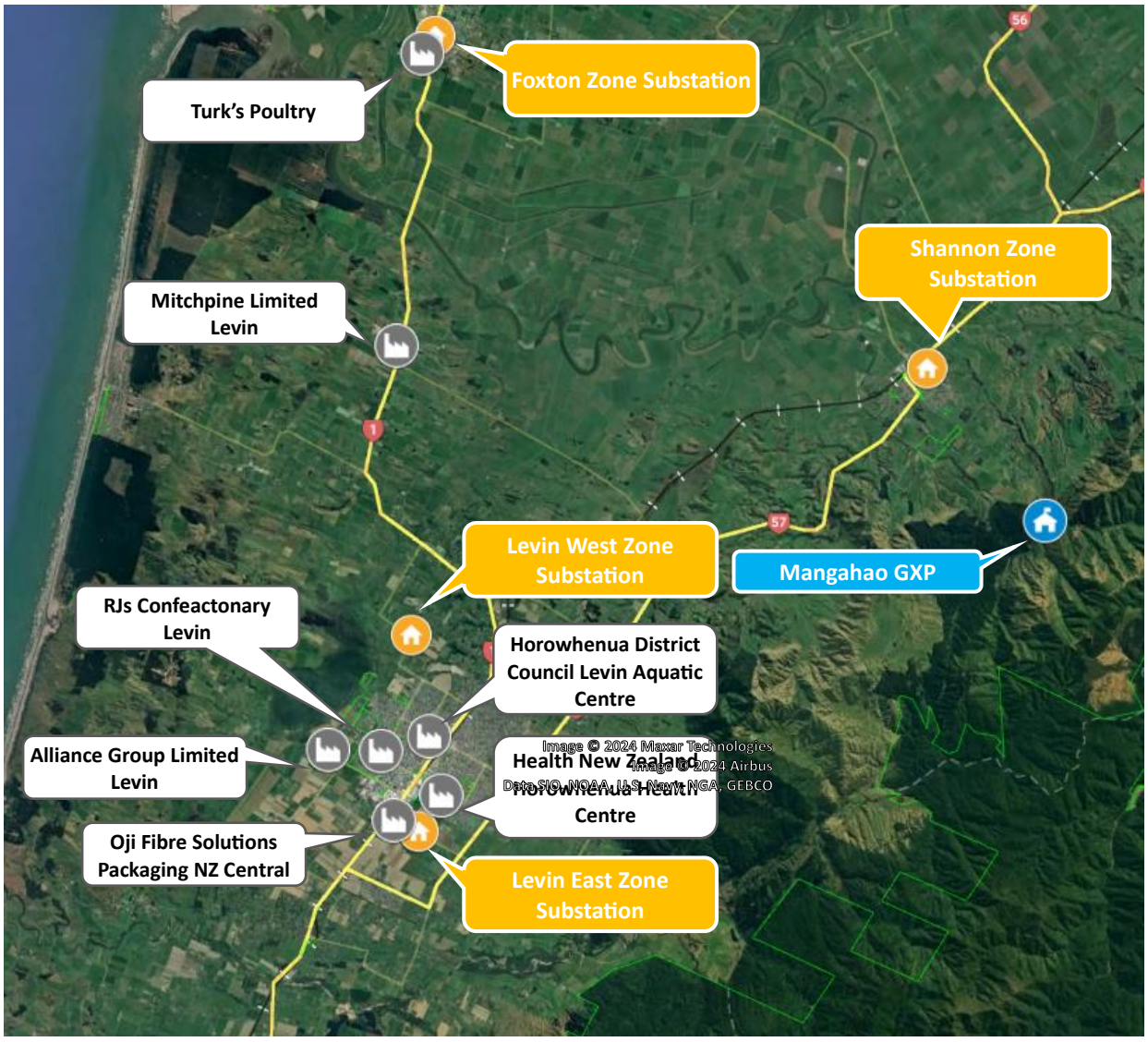


Figure 62. Mangahao GXP: EECA Load Sites vs local substations

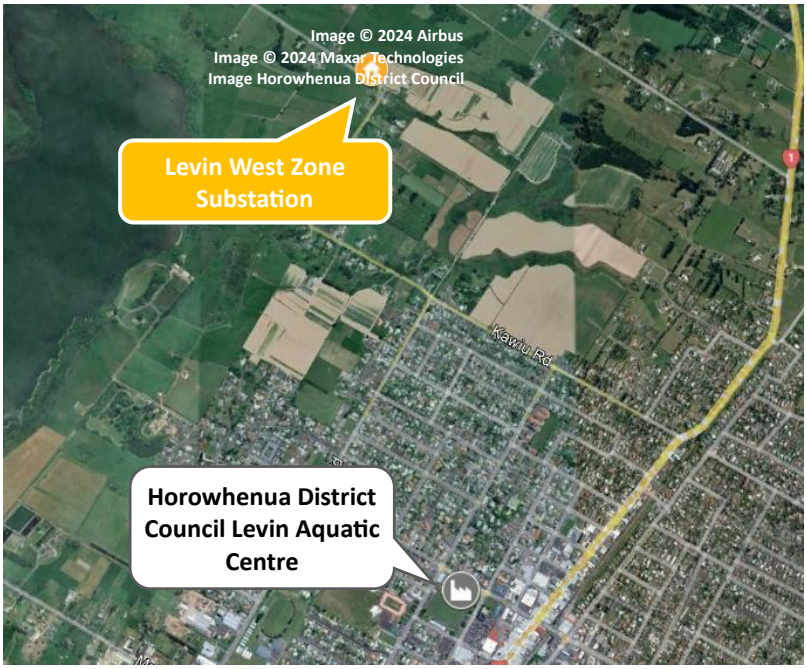
8.7.1 Mangahao GXP Upgrade

The Mangahao GXP presently has no spare (N-1) capacity and 21 MVA of spare (N) capacity, based on the transformer ratings.

The GXP already exceeds its (N-1) capacity and therefore, for any of the proposed Load Sites to be afforded (N-1) transmission security, the transformers at the GXP require replacements. These transformer replacements are included in the individual Load Site analyses below. It is noted that should multiple Load Sites connect, the costs of upgrading the GXP to provide (N-1) supply could be shared.

Analysis in Section 8.7.9 suggests that if all of the load sites connect, the maximum load on the GXP would increase to 50.6 MW. This peak occurs during winter, with the summer peak being closer to 33 MW. Given that the transmission lines supplying the GXP are rated to 48/59 MVA (summer/winter), the transmission line (N-1) capacity is not expected to be exceeded by the addition of the Load Sites. However, Ergo notes that the Transmission Planning Report forecasts significant load increases over the planning period at Mangahao. At present, heavy loading periods are managed by constraining on the embedded generation within Electra's Network connected to Mangahao. If line replacements are required, Ergo estimates that this will cost ~$75 M.

8.7.2 Horowhenua District Council Levin Aquatic Centre

HOROWHENUA DISTRICT COUNCIL LEVIN AQUATIC CENTRE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	3.87	Mangahao
Existing Electrical Supply to the Plant		
Horowhenua District Council Levin Aquatic Centre is presently supplied by Electra's Levin West zone substation. It is supplied via an 11 kV feeder (E154, King's Drive) which consists of a mixture of underground cable and overhead line, rated to approximately 6.3 MVA. Levin West zone substation is supplied via a ring network of single subtransmission circuits from Foxton (rated to ~26.5 MVA), Shannon (rated to ~30.8 MVA), and Levin East (rated to ~26.5 MVA) substations, however it does not have a direct link to Mangahao substation. This site is located approximately 5.0 km from Levin West zone substation. In turn, Levin West zone substation is approximately 18.6 km from Mangahao GXP. There is currently a maximum loading of 14 MVA on Levin West zone substation, with 32 MVA of spare (N) capacity and 9 MVA of spare (N-1) capacity. Mangahao GXP presently has no spare (N) capacity and 21 MVA of spare (N-1) capacity.  Figure 63. Horowhenua District Council Levin Aquatic Centre geographic location in relation to the surrounding zone substations		
Supply Option(s) for New Load		
Levin West substation has adequate (N) and (N-1) spare capacity for this load, and the GXP has adequate (N) but not (N-1) spare capacity.		

For the Mangahao GXP to achieve the required spare (N-1) capacity, upgrades/replacements of the existing transformers at the GXP would be required.

The existing feeder to the site is already loaded at ~5.6 MVA, so it is expected that for this load to connect, that a new 11 kV feeder from Levin West substation to the site would be required. Due to the urban topography of the area, this would likely be underground cables, at a length of ~3.5 km.

Capital Cost Estimate

Table 36. Horowhenua District Council Levin Aquatic Centre: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.50	$2.10
		TOTAL	**$2.20**

Table 37. Horowhenua District Council Levin Aquatic Centre: 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	Large supply transformer (GXP)	2.00	$9.00
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.50	$2.10
		TOTAL	**$11.20**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N) security connection, or 36-48 months for an (N-1) security connection, 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 Oji Fibre Solutions Packaging NZ Central

OJI FIBRE SOLUTIONS PACKAGING NZ CENTRAL		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	3.75	Mangahao

Existing Electrical Supply to the Plant

Oji Fibre Solutions Packaging NZ Central is presently supplied by Electra's Levin East substation. It is supplied via an 11 kV feeder (G311, Tararua) which is overhead lines, with an underground cable supplying the site on a tee off the main feeder conductors. The main conductors of the feeder are rated to ~6.4 MVA, while the cable from the tee into the site is rated to ~3.7 MVA. Levin East zone substation is supplied by two circuits from Mangahao GXP, both rated at ~30.9 MVA. The other substations in Electra's Northern network are connected in a mesh, with another line connecting to Levin East from Levin West (which is in turn also connected to Shannon and Foxton substations).

This site is located approximately 0.6 km from Levin East ZS. In turn, Levin East ZS is approximately 16 km from Mangahao GXP.

There is currently a maximum loading of 15.4 MVA on Levin East zone substation, with 30.6 MVA of spare (N) capacity and 7.6 MVA of spare (N-1) capacity. Mangahao GXP presently has no spare (N) capacity and 21 MVA of spare (N-1) capacity.

Figure 64. Oji Fibre Solutions Packaging NZ Central geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Levin East substation has adequate (N) and (N-1) spare capacity for this load, and the GXP has adequate (N) but not (N-1) spare capacity.

For the Mangahao GXP to achieve the required spare (N-1) capacity, upgrades/replacements of the existing transformers at the GXP would be required.

The existing feeder to the site is already loaded at ~6 MVA, so it is expected that for this load to connect, that a new 11 kV feeder from Levin East substation to the site would be required. Due to the urban topography of the area, this would likely be underground cables, at a length of ~0.8 km.

Capital Cost Estimate

Table 38. Oji Fibre Solutions Packaging NZ Central: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	0.80	$0.48
		TOTAL	**$0.58**

Table 39. Oji Fibre Solutions Packaging NZ Central: 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	Large supply transformer (GXP)	2.00	$9.00
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	0.80	$0.48
		TOTAL	**$9.58**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N) security connection, or 36-48 months for an (N-1) security connection, 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.

8.7.4 Turk's Poultry

TURK'S POULTRY		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	2.31	Mangahao

Existing Electrical Supply to the Plant

Turk's Poultry is presently supplied by Electra's Foxton substation. It is supplied via an 11 kV feeder (C1, South) which consists of a mixture of underground cable and overhead line, rated to approximately 4.4 MVA. Foxton zone substation is supplied via a ring network of single subtransmission circuits including one circuit from Mangahao GXP (rated to ~34.6 MVA), and a circuit from Levin West (rated to ~26.5 MVA) via Shannon and Levin East.

This site is located approximately 0.5 km from Foxton ZS. In turn, Takapau ZS is approximately 18 km from Mangahao GXP.

There is currently a maximum loading of 7.3 MVA on Foxton zone substation, with 38.7 MVA of spare (N) capacity and 15.7 MVA of spare (N-1) capacity. Mangahao GXP presently has no spare (N) capacity and 21 MVA of spare (N-1) capacity.

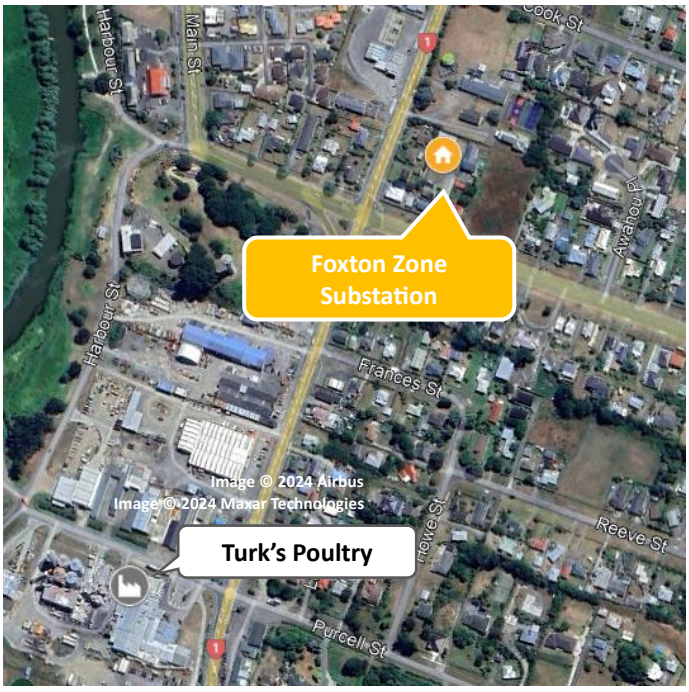


Figure 65. Turk's Poultry geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Foxton substation has adequate (N) and (N-1) spare capacity for this load, and the GXP has adequate (N) but not (N-1) spare capacity.

TURK'S POULTRY

For the Mangahao GXP to achieve the required spare (N-1) capacity, upgrades/replacements of the existing transformers at the GXP would be required.

The existing feeder to the site is already loaded at ~4.5 MVA, so it is expected that for this load to connect, that a new 11 kV feeder from Levin East substation to the site would be required. Due to the urban topography of the area, this would likely be underground cables, at a length of ~0.7 km.

Capital Cost Estimate

Table 40. Turk's Poultry: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N-1)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**
Distribution	11 kV circuit breaker (ZSS)	1.00 $0.10
Distribution	Single underground 11 kV cable	0.70 $0.42
	TOTAL	**$0.52**

Table 41. Turk's Poultry: 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	Large supply transformer (GXP)	2.00 $9.00
Distribution	11 kV circuit breaker (ZSS)	1.00 $0.10
Distribution	Single underground 11 kV cable	0.70 $0.42
	TOTAL	**$9.52**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N) security connection, or 36-48 months for an (N-1) security connection, 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.

8.7.5 Health New Zealand Horowhenua Health Centre

HEALTH NEW ZEALAND HOROWHENUA HEALTH CENTRE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	1.50	Mangahao
Existing Electrical Supply to the Plant		
Health New Zealand Horowhenua Health Centre is presently supplied by Electra's Levin East substation. It is supplied via an 11 kV feeder (G311, Tararua) which is a mixture of overhead lines and underground cables, and is rated to ~3.7 MVA (constrained by a short length of undersized cable). Levin East zone substation is supplied by two circuits from Mangahao GXP, both rated at ~30.9 MVA. The other substations in Electra's Northern network are connected in a mesh, with another line connecting to Levin East from Levin West (which is in turn also connected to Shannon and Foxton substations). This site is located approximately 1.0 km from Levin East ZS. In turn, Levin East ZS is approximately 16 km from Mangahao GXP. There is currently a maximum loading of 15.4 MVA on Levin East zone substation, with 30.6 MVA of spare (N) capacity and 7.6 MVA of spare (N-1) capacity. Mangahao GXP presently has no spare (N) capacity and 21 MVA of spare (N-1) capacity.  Figure 66. Health New Zealand Horowhenua Health Centre geographic location in relation to the surrounding zone substations		
Supply Option(s) for New Load		

HEALTH NEW ZEALAND HOROWHENUA HEALTH CENTRE

Levin East substation has adequate (N) and (N-1) spare capacity for this load, and the GXP has adequate (N) but not (N-1) spare capacity.

For the Mangahao GXP to achieve the required spare (N-1) capacity, upgrades/replacements of the existing transformers at the GXP would be required.

The existing feeder to the site is already heavily loaded, so it is expected that for this load to connect, that a new 11 kV feeder from Levin East substation to the site would be required. Due to the urban topography of the area, this would likely be underground cables, at a length of ~1.7 km.

Capital Cost Estimate

Table 42. Health New Zealand Horowhenua Health Centre: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)		Subtransmission => (N-1)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	1.70	$1.02
		TOTAL	**$1.12**

Table 43. Health New Zealand Horowhenua Health Centre: 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	Large supply transformer (GXP)	2.00	$9.00
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	1.70	$1.02
		TOTAL	**$10.12**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N) security connection, or 36-48 months for an (N-1) security connection, 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.

8.7.6 RJs Confectionery Levin

RJS CONFECTIONERY LEVIN		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	1.08	Mangahao

Existing Electrical Supply to the Plant

RJs Confectionery Levin is presently supplied by Levin West substation. It is supplied via an 11 kV feeder (E153, Queen West) which consists of a mixture of underground cable and overhead line, rated to approximately 4.4 MVA. Levin West zone substation is supplied via a ring network of single subtransmission circuits from Foxton (rated to ~26.5 MVA), Shannon (rated to ~30.8 MVA), and Levin East (rated to ~26.5 MVA) substations, however it does not have a direct link to Mangahao substation.

This site is located approximately 2.8 km from Levin West zone substation. In turn, Levin West zone substation is approximately 18.6 km from Mangahao GXP.

There is currently a maximum loading of 14 MVA on Levin West zone substation, with 32 MVA of spare (N) capacity and 9 MVA of spare (N-1) capacity. Mangahao GXP presently has no spare (N) capacity and 21 MVA of spare (N-1) capacity.

Figure 67. RJs Confectionery Levin geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

RJS CONFECTIONERY LEVIN

Levin West substation has adequate (N) and (N-1) spare capacity for this load, and the GXP has adequate (N) but not (N-1) spare capacity.

For the Mangahao GXP to achieve the required spare (N-1) capacity, upgrades/replacements of the existing transformers at the GXP would be required.

The existing feeder to the site is already heavily loaded, so it is expected that for this load to connect, that a new 11 kV feeder from Levin West substation to the site would be required. Due to the urban topography of the area, this would likely be underground cables, at a length of ~3.5 km.

Capital Cost Estimate

Table 44. RJs Confectionery Levin: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)		Subtransmission => (N-1)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.50	$2.10
		TOTAL	**$2.20**

Table 45. RJs Confectionery Levin: 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	Large supply transformer (GXP)	2.00	$9.00
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	3.50	$2.10
		TOTAL	**$11.20**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N) security connection, or 36-48 months for an (N-1) security connection, 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.

8.7.7 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 46. 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)
Mitchpine Limited Levin*	Levin West	9	32	4.417	0.49	130

*Ergo has calculated the impact of the Mitchpine load on the feeder which presently supplies it, and the load increase after diversity is 0 MW, so it is taken that the feeder has capacity for this load.

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.

8.7.8 Combined Load on Zone Substations

While individual Load Site assessments in the sections above focus on upgrades required if only one Load Site were to connect, this section details where multiple Load Sites are proposed to connect to the same zone substation and whether the proposed upgrades in the sections above are sufficient or if further upgrades are required.

It is noted that any costs in this section are additional to those stated in the preceding sections assessing individual loads.

8.7.8.1 Levin West

Three of the loads on Mangahao GXP are expected to connect to Levin West zone substation. The loads are Horowhenua District Council Levin Aquatic Centre, RJs Confectionery Levin, and Mitchpine Ltd Levin. The sum of peaks of these loads is 5.44 MW, which the zone substation does have (N-1) capacity for. Beyond those stipulated in the individual load analyses, no further upgrades are expected at Levin West.

8.7.8.2 Levin East

Two of the loads on Mangahao GXP are expected to connect to Levin East zone substation. The loads are Oji Fibre Solutions Packaging NZ Central, and Health New Zealand Horowhenua Health Centre. The sum of peaks of these loads is 5.25 MW, which the zone substation does have (N-1) capacity for. Beyond those stipulated in the individual load analyses, no further upgrades are expected at Levin East.

8.7.9 Effect of all Load Sites Connecting to Mangahao GXP

The following Figure 68 illustrates the Mangahao GXP load profile together with the load profiles of all the Load Sites within the Mangahao GXP region. Also shown in Figure 68 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Mangahao GXP would increase to 50.6 MW, an increase of 8.7 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 55.0 MW there is a diversity factor of 0.92 between the loads.
- Based on Ergo's analysis, the Mangahao GXP's (N-1) limit is expected to be exceeded. Ergo has discussed mitigation for this in Section 8.7.1.
- Ergo notes that the embedded generation connected within Electra's network connected to Mangahao as been excluded from the calculations shown (i.e. the plant has been assumed offline).

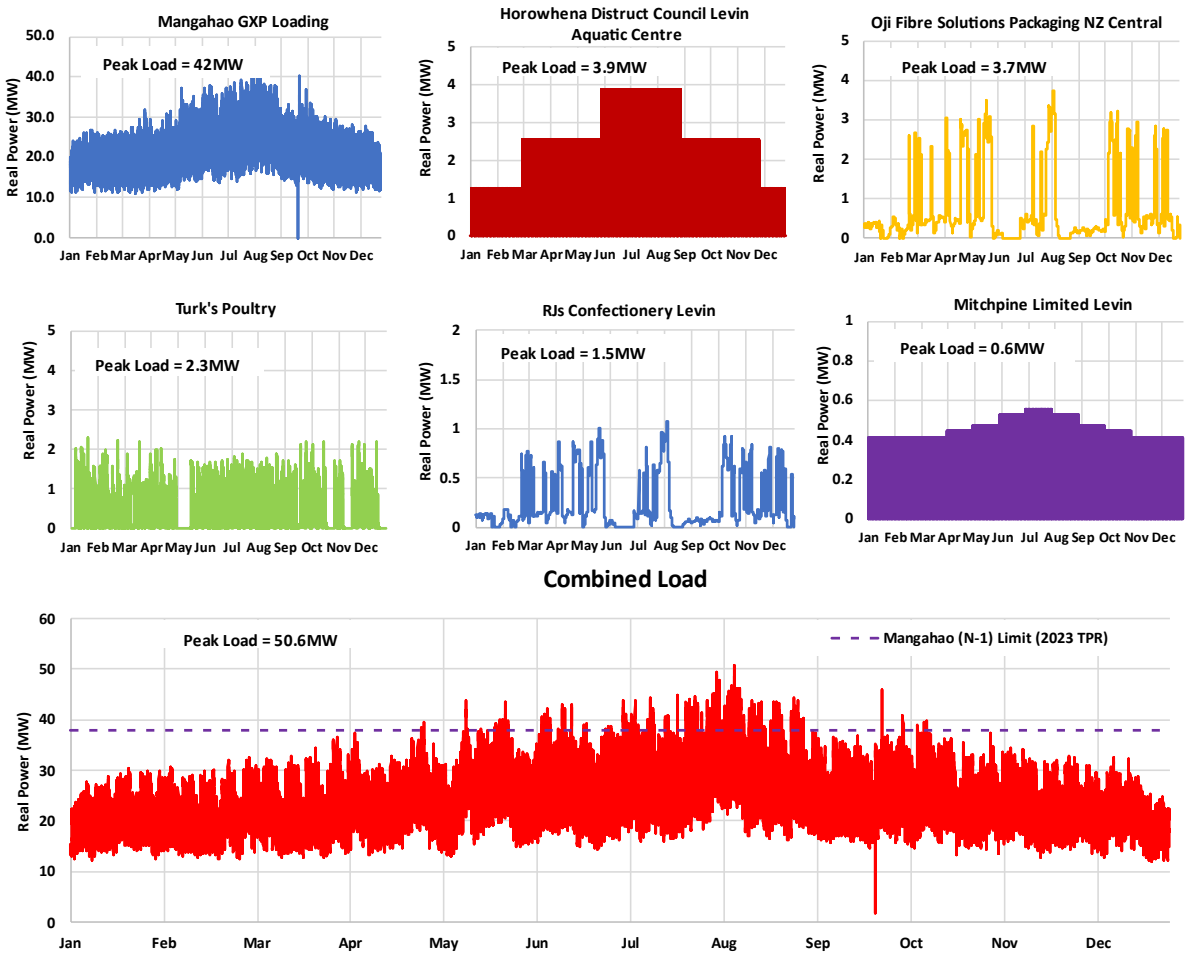


Figure 68. Loading Profiles: Mangahao GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.8 Mangamaire GXP

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

- Fonterra Limited Pahiatua (38.00 MW)

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

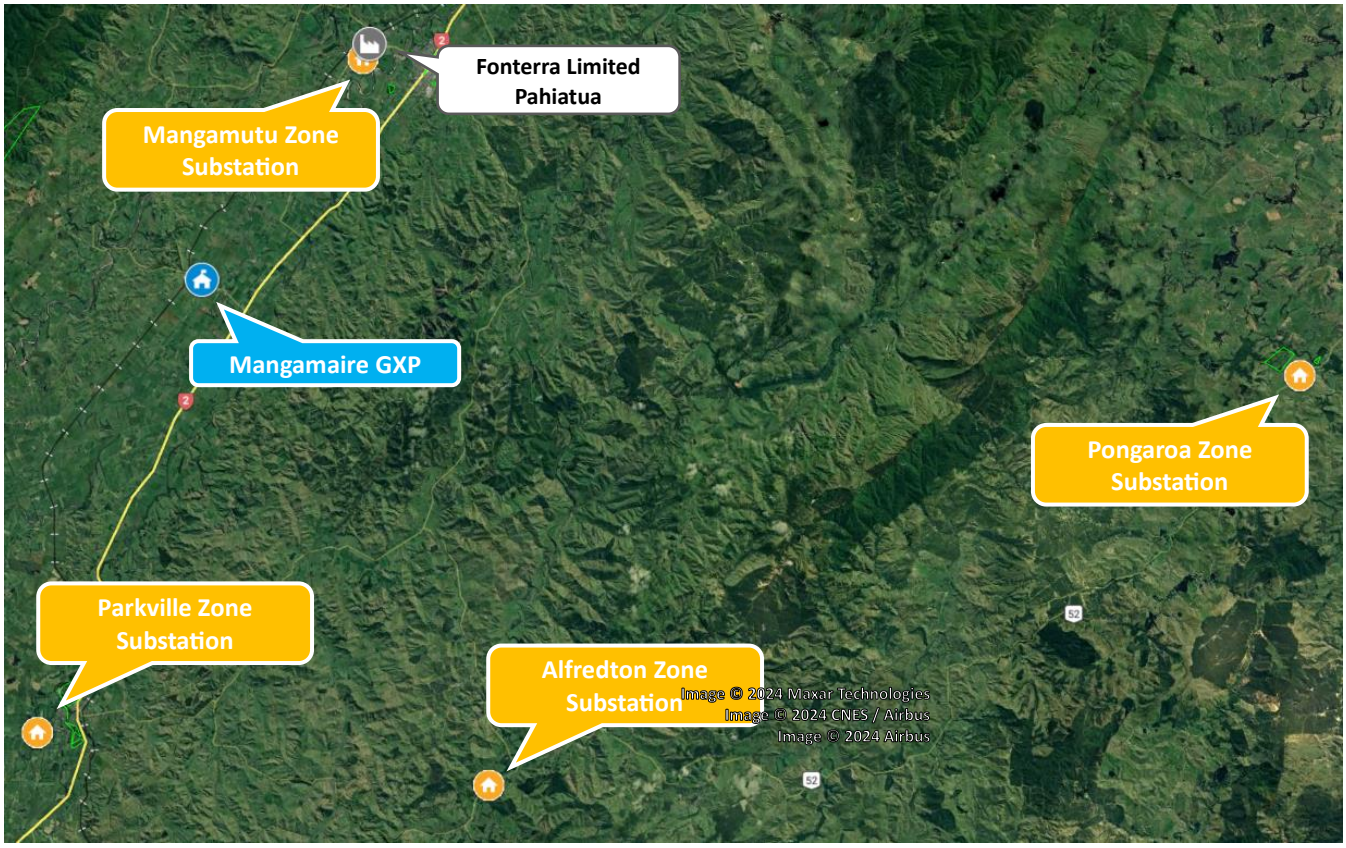


Figure 69. Mangamaire GXP: EECA Load Sites vs local substations

8.8.1 Mangamaire GXP Upgrade

Given there is only a single load connected to the Mangamaire GXP, the outline of upgrades to the GXP can be found in section 8.8.2.

8.8.2 Fonterra Limited Pahiatua

FONTERRA LIMITED PAHIATUA		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	38.00	Mangamaire

Existing Electrical Supply to the Plant

Fonterra Limited Pahiatua is presently supplied by Powerco's Mangamutu zone substation. It supplied via an underground 11 kV feeder. Mangamutu is in turn supplied from Mangamaire GXP by two 33 kV subtransmission circuits. The subtransmission circuit current ratings are approximately 17.8 MVA each.

This site is located approximately 0.7 km from Mangamutu zone substation. In turn, Mangamutu zone substation is approximately 9.1 km from Mangamaire GXP.

There is currently a maximum loading of 13 MVA on Mangamutu zone substation, with 13 MVA of spare (N) capacity and 0 MVA of spare (N-1) capacity. Mangamaire GXP presently has 45 MVA of spare (N) capacity and 12 MVA of spare (N-1) capacity.

Figure 70. Fonterra Limited Pahiatua geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Due to the size of the proposed load, a staged approach has been developed. Ergo has determined stages based on the network constraints (i.e. capacity levels at which additional upgrades would be triggered).

FONTERRA LIMITED PAHIATUA

Ergo understands, based on Powerco's AMP, that Powerco are aware of this Load Site's plan to decarbonise, and that Powerco plan to work with the Load Site to develop a solution.

Stage 1 – 13 MW

The first stage of Fonterra Limited Pahiatua adds an additional 13 MVA onto the existing load.

Mangamaire GXP has adequate (N) and (N-1) capacity for this load.

Powerco has advised that for this increase, the Mangamutu substation transformers would require replacements for an (N) supply. For an (N-1) supply, along with the replacements required for an (N) supply, a third transformer would be required at Mangamutu.

It is taken that due to the size of the load, two large new 11 kV feeders would be required to supply the load. These 11 kV feeders would be rated to 33 kV, to account for the future load growth in Stage 2. Due to the urban/industrial topography of the area, it is expected these feeders would be underground, and would approximately 0.7 km long.

For Mangamutu to provide adequate (N-1) capacity, it is expected that the transformers would need to be replaced/upgraded. If Mangamutu is to provide (N) security to the load, it is expected a special protection scheme would be implemented to avoid overloading the remaining transformer in the event of a single transformer outage.

Stage 2 – 38 MVA

The second stage of Fonterra Limited Pahiatua adds an additional 25 MVA, bringing the proposed load to 38 MVA.

The incoming subtransmission circuits to the Mangamutu zone substation do not have adequate (N-1) capacity to supply the final load to the site. To provide (N-1) security, an additional subtransmission line would need to be installed between the zone substation (or upgrades to the existing two lines supplying the zone substation) and the Mangamaire GXP. Due to space constraints in the road reserve due to the existing overhead lines, it is assumed that this additional feeder would be underground and would be approximately 10.5 km long. It is expected that the route would include a minimum of two river crossings, for which an additional km of cabling has been allowed, each, in the costings.

Mangamaire GXP has adequate (N) but does not have adequate (N-1) capacity to supply the load. For Mangamaire GXP to provide (N-1) security to the site, it is expected that the existing supply transformers would need to be upgraded/replaced. If Mangamaire is to provide (N) security to the load, it is expected a special protection scheme would be implemented to avoid overloading the remaining transformer in the event of a single transformer outage.

At this Stage, the 11 kV (33 kV rated) feeders installed to the site in Stage 1 would be switched to 33 kV operating, which would require reconfiguration of the feeders to new 33 kV switchgear at Mangamutu zone substation. It is taken that at this stage the load would take supply at 33 kV. It is assumed that this upgrade would also involve establishing an indoor 33 kV switchboard at Mangamutu.

This stage would also trigger upgrades of the 110 kV circuits between Bunnythorpe and Woodville. Ergo expects that this may involve line reconductoring/upgrades along the length of the Bunnythorpe-Woodville double circuits.

Capital Cost Estimate

Table 47. Fonterra Limited Pahiatua Stage 1: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Large supply transformer (ZSS)	2.00	$4.60
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 33kV cable	0.70	$0.98
		TOTAL	**$5.78**

Table 48. Fonterra Limited Pahiatua Stage 1: 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)**	
Subtransmission	Large supply transformer (ZSS)	3.00	$6.90
Distribution	33kV circuit breaker (ZSS)	2.00	$0.60
Distribution	11kV circuit breaker (ZSS)	4.00	$0.40
Distribution	Double underground 33kV cable	0.70	$0.98
		TOTAL	**$8.88**

Table 49. Fonterra Limited Pahiatua Stage 2: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Transmission	110kV double cct line	23.00	$41.40
Distribution	Small switchroom (ZSS)	1.00	$1.50
Distribution	33kV circuit breaker (ZSS)	5.00	$1.50
		TOTAL	**$44.90**

FONTERRA LIMITED PAHIATUA

Table 50. Fonterra Limited Pahiatua Stage 2: 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	Large supply transformer (GXP)	2.00	$9.00
Transmission	110kV double cct line	23.00	$41.40
Subtransmission	33kV circuit breaker bay	2.00	$0.50
Subtransmission	Single underground 33kV cable	12.50	$11.25
Distribution	Small switchroom (ZSS)	1.00	$1.50
Distribution	33kV circuit breaker (ZSS)	5.00	$1.50
		TOTAL	**$65.15**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

For stage 1, it is estimated to take 24-36 months for either an (N) or an (N-1) security connection to plan, design, procure, construct, and commission the works.

For stage 2, it is estimated to take 36-48 months for either an (N) or an (N-1) security connection.

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 Mangamaire GXP

The following Figure 71 illustrates the Mangamaire GXP load profile together with the load profiles of all the Load Sites within the Mangamaire GXP region. Also shown in Figure 71 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Mangamaire GXP would increase to 50.6 MW, an increase of 35.5 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 53.1 MW there is a diversity factor of 0.95 between the loads.
- Based on Ergo's analysis, the Mangamaire GXP's (N-1) limit is expected to be exceeded. Ergo has discussed mitigation for this in Section 8.8.2.

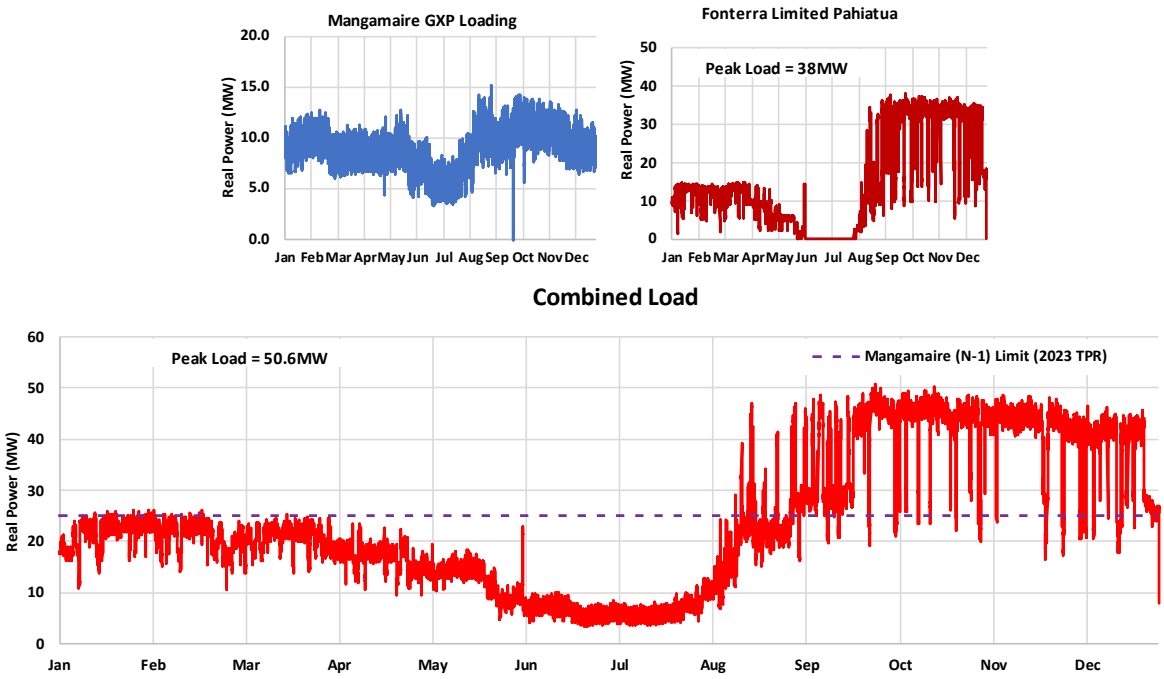


Figure 71. Loading Profiles: Mangamaire GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.9 Marton GXP

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

- Malteurop Marton (14.4 MW)
- Nestle Purina Petcare Marton (2.40 MW)
- ANZCO Foods Rangitikei (1.6 MW)
- ANZCO Foods Manawatū (1.6 MW)

The "Small" Load Sites connecting to the Marton GXP include (refer to Section 8.9.6):

- Farmland Food Bulls (0.7 MW)

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

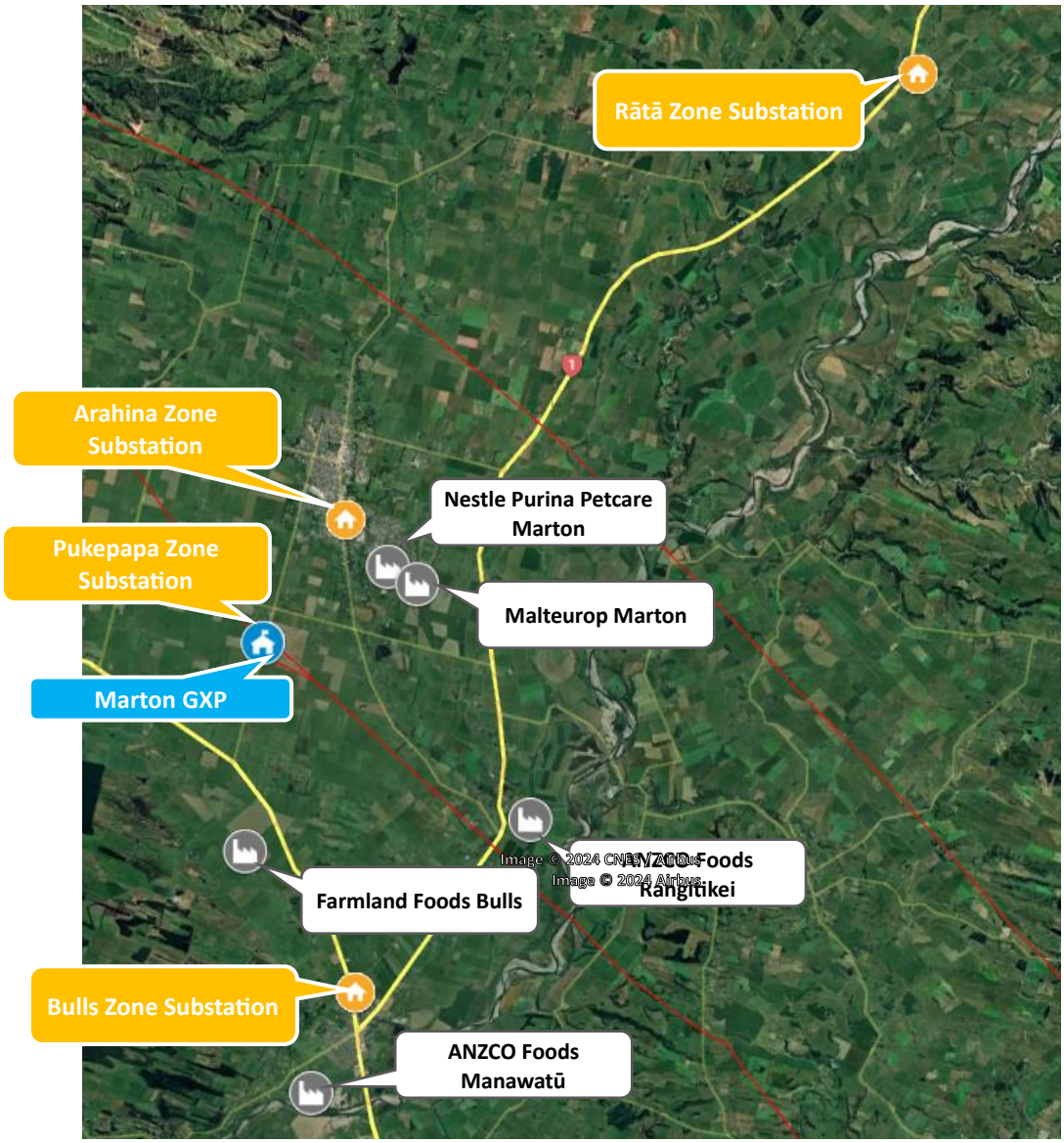


Figure 72. Marton GXP: EECA Load Sites vs local substations

8.9.1 Marton GXP Upgrade

The Marton GXP presently has 8 MVA of spare (N-1) capacity and 34 MVA of spare (N) capacity, based on the transformer ratings.

The upgrades expected for the connection of Malteurop include installation of a special protection scheme at the GXP for an (N) security supply, or upgrades/replacements of the GXP transformers for an (N-1) security supply. If this site connects along with the other Load Sites, it is possible that an SPS would be an unacceptable solution, at which point the (N-1) upgrades would be required. Additionally, reconductoring of the Bunnythorpe-Marton-Whanganui circuits may be required, at an expected cost of $48M.

If any combination of the other three loads connects, then no upgrades are expected at the GXP.

8.9.2 Malteurop Marton

		MALTEUROP MARTON
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	14.40	Marton
Existing Electrical Supply to the Plant		

Malteurop Marton is presently supplied by Powerco's Arahina substation. It supplied via an overhead 11 kV feeder. Arahina is in turn supplied from Marton GXP by one 33 kV subtransmission circuit. This circuit tees off to Pukepapa zone substation (however the tee to Pukepapa is normally open). The subtransmission circuit current rating is approximately 372/477 A (21.2/27.2 MVA), summer/winter. The Rātā zone substation is fed from the Arahina zone substation 33 kV bus.

This site is located approximately 2.1 km from Arahina zone substation. In turn, Arahina zone substation is approximately 3.9 km from Marton GXP.

There is currently a maximum loading of 8 MVA on Arahina zone substation, with 2 MVA of spare (N) capacity and no spare (N-1) capacity (it is an (N) security site at present). Marton GXP presently has 34 MVA of spare (N) capacity and 8 MVA of spare (N-1) capacity.

There is presently a loading of 3 MVA on the Rātā zone substation. Combined with the 8 MVA peak loading on Arahina zone substation at present, the subtransmission line supplying Arahina has ~10 MVA of spare (N) capacity.

Figure 73. Malteurop Marton geographic location in relation to the surrounding zone substations

MALTEUROP MARTON

Supply Option(s) for New Load

The zone substation does not have adequate (N) capacity to supply the increase of site load. The GXP has adequate (N) capacity, but lacks (N-1) capacity.

Given the size of the new load and the lack of capacity of the Arahina zone substation, it is assumed that the Load Site would be supplied at 33 kV from Arahina zone substation. This would require one new 33 kV feeder for an (N) supply and two new 33 kV feeders for an (N-1) supply, along with the associated circuit breaker/s at the Arahina zone substation. Due to the urban topography of the area, this would likely be an underground cable, at a length of ~3 km. This route would include rail crossings, for which an additional 1 km of cabling has been allowed for in the costing.

To provide (N) security to the site, an additional 33 kV subtransmission line would need to be installed between Marton GXP and Arahina zone substation. Ergo understands that Powerco has a project underway to install a second 33 kV subtransmission circuit from Marton GXP to Arahina zone substation, with an expected cost of $8.85 M. The cost for this has been included in the costings below. Based on the capacity of the existing subtransmission circuit to Arahina (21.2 MVA in summer) and the expected capacity of the new subtransmission circuit (~23.3 MVA), to provide this site with (N-1) security, a third subtransmission circuit would need to be installed.

For Marton GXP to accommodate a (N) capacity condition, it is expected that a special protection scheme would be required for the transformers at Marton GXP, to avoid overloading the remaining transformer in the event of a single transformer outage.

For Marton GXP to accommodate an (N-1) capacity condition, the existing transformers would need to be upgraded/replaced. Transpower has provided a costing estimate of $10 M for this in their Transmission Planning Report.

Ergo understands that Transpower and Powerco are working on upgrades at the Marton GXP which will remove the protection limit which is limiting the transformer capacity at present. It is assumed that the capacity increase from this upgrade will not be adequate to supply this Load Site.

Capital Cost Estimate

Table 51. Mateurop Marton: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Subtransmission	Arahina second subtransmission circuit	1.00	$8.85
Distribution	33kV circuit breaker (ZSS)	1.00	$0.30
Distribution	Single underground 33kV cable	4.00	$3.60
		TOTAL	**$13.25**

MALTEUROP MARTON

Table 52. Mateurop Marton: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N-1)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Marton GXP Transformer upgrades	1.00	$10.00
Subtransmission	Arahina second subtransmission circuit	2.00	$17.70
Distribution	33kV circuit breaker (ZSS)	2.00	$0.60
Distribution	Double underground 33kV cable	4.00	$5.60
		TOTAL	**$33.90**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 24-36 months for an (N) security connection or 36-48 months for an (N-1) security connection 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.

8.9.3 Nestle Purina Petcare Marton

NESTLE PURINA PETCARE MARTON		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	2.40	Linton
Existing Electrical Supply to the Plant		

Nestle Purina Petcare Marton is presently supplied by Powerco's Arahina substation. It supplied via an overhead 11 kV feeder. Arahina is in turn supplied from Marton GXP by one 33 kV subtransmission circuit. This circuit tees off to Pukepapa zone substation (however the tee to Pukepapa is normally open). The subtransmission circuit current rating is approximately 372/477 A (21.2/27.2 MVA), summer/winter. The Rātā zone substation is fed from the Arahina zone substation 33 kV bus.

This site is located approximately 1.3 km from Arahina zone substation. In turn, Arahina zone substation is approximately 3.9 km from Marton GXP.

There is currently a maximum loading of 8 MVA on Arahina zone substation, with 2 MVA of spare (N) capacity and no spare (N-1) capacity (it is an (N) security site at present). Marton GXP presently has 34 MVA of spare (N) capacity and 8 MVA of spare (N-1) capacity.

There is presently a loading of 3 MVA on the Rātā zone substation. Combined with the 8 MVA peak loading on Arahina zone substation at present, the subtransmission line supplying Arahina has ~10 MVA of spare (N) capacity.

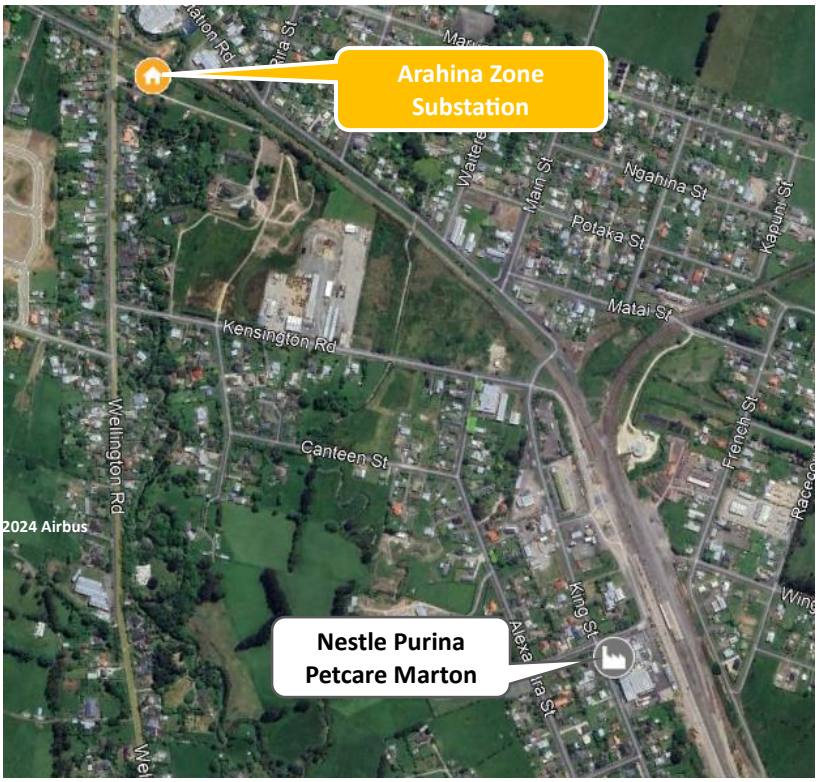


Figure 74. Nestle Purina Petcare Marton geographic location in relation to the surrounding zone substations

NESTLE PURINA PETCARE MARTON

Supply Option(s) for New Load

The zone substation does not have adequate (N) capacity to supply the increase of site load. The GXP has adequate spare (N) and (N-1) capacity for this load.

With demand at Arahina substation nearly exceeding the existing supply, Powerco has planned to install a second transformer at the substation, and to carry out an outdoor to indoor conversion (ODID) on the substation, both to increase the capacity of the substation. It is expected that these upgrades would be required to accommodate connection of the Load Site. The second transformer project is expected to cost $7.90M (timing 2023-2025), and the ODID $2.557M (timing 2026-2028).

To provide (N-1) security to the site, an additional 33 kV subtransmission line would need to be installed between Marton GXP and Arahina zone substation. Ergo understands that Powerco has a project underway to install a second 33 kV subtransmission circuit from Marton GXP to Arahina zone substation, with an expected cost of $8.85 M. The cost for this has been included in the costings below.

Due to the size of the load, it is expected that one new 11 kV feeder and associated circuit breaker would be required to supply this site. Due to the urban topography of the area, this would likely be an underground cable, at a length of 2.0 km.

The existing feeder to the site is presently loaded at a maximum of ~2.25 MVA. It is expected that the existing feeder will be able to accommodate the additional 2.4 MVA.

Capital Cost Estimate

Table 53. Nestle Purina Petcare Marton: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Arahina additional transformer	1.00	$7.90
Subtransmission	Arahina 33 kV ODID	1.00	$2.56
		TOTAL	**$10.46**

Table 54. Nestle Purina Petcare Marton: 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)**	
Subtransmission	Arahina additional transformer	1.00	$7.90
Subtransmission	Arahina 33 kV ODID	1.00	$2.56
Subtransmission	Arahina second subtransmission circuit	1.00	$8.85
		TOTAL	**$19.31**

NESTLE PURINA PETCARE MARTON
Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 24-36 months for either an (N) or an (N-1) security supply 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.

8.9.4 ANZCO Foods Rangitikei

ANZCO FOODS RANGITIKEI		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and/or high temperature heat pumps	1.61	Marton
Existing Electrical Supply to the Plant		

ANZCO Foods Rangitikei is presently supplied by Powerco's Bulls substation. It supplied via an 11 kV feeder (Racecourse). Bulls is in turn supplied from Marton GXP by one 33 kV subtransmission circuit. The subtransmission circuit current rating is approximately 372 A (21.2 MVA).

This site is located approximately 5.1 km from Bulls zone substation. In turn, Bulls zone substation is approximately 7.5 km from Marton GXP.

There is currently a maximum loading of 5.2 MVA on Bulls zone substation, with 14 MVA of spare (N) capacity and 4.4 MVA of (N-1) capacity. Marton GXP presently has 34 MVA of spare (N) capacity and 8 MVA of spare (N-1) capacity.

Figure 75. ANZCO Foods Rangitikei geographic location in relation to the surrounding zone substations

ANZCO FOODS RANGITIKEI

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity for this load. The GXP has adequate (N-1) for this load, but the zone substation does not.

Powerco has recently carried out projects to install a second transformer at Bulls, and to upgrade the Bunnythorpe GXP supply to Sanson substation, and install a 33 kV subtransmission line to Bulls from Sanson. To provide Bulls with (N-1) security, some upgrades of a section of overhead line between Feilding and Sanson are required.

It is expected that the existing 11 kV feeder has sufficient capacity to support the new site load.

Capital Cost Estimate

Table 55. ANZCO Foods Rangitikei: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.
(N/A)

Table 56. ANZCO Foods Rangitikei: 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)**
Subtransmission	Sanson-Feilding 33 kV line	1.00 $1.41
	TOTAL	**$1.41**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 3-6 months for an (N) security supply or 24-36 months for an (N-1) security supply 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.

8.9.5 ANZCO Foods Manawatū

		ANZCO FOODS MANAWATŪ
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	1.56	Marton

Existing Electrical Supply to the Plant

ANZCO Foods Manawatū is presently supplied by Powerco's Bulls substation. It supplied via an overhead 11 kV feeder. Bulls is in turn supplied from Marton GXP by one 33 kV subtransmission circuit. The subtransmission circuit current rating is approximately 430 A (24.6 MVA).

This site is located approximately 2.9 km from Bulls zone substation. In turn, Bulls zone substation is approximately 7.5 km from Marton GXP.

There is currently a maximum loading of 5.2 MVA on Bulls zone substation, with 14 MVA of spare (N) capacity and 4.4 MVA of (N-1) capacity. Marton GXP presently has 34 MVA of spare (N) capacity and 8 MVA of spare (N-1) capacity.

Figure 76. ANZCO Foods Manawatū geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) and (N-1) capacity for this load.

ANZCO FOODS MANAWATŪ

Powerco has recently carried out projects to install a second transformer at Bulls, and to upgrade the Bunnythorpe GXP supply to Sanson substation, and install a 33 kV subtransmission line to Bulls from Sanson. To provide Bulls with (N-1) security, some upgrades of a section of overhead line between Feilding and Sanson are required.

The existing 11 kV feeder supplying the site has approximately 1.3 MW of spare capacity. Due to the size of the load, it is expected that some of the feeder's overhead line (~0.7 km) may need to be replaced/reconductored.

Capital Cost Estimate

Table 57. ANZCO Foods Manawatū: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Reconductor 11 kV line (larger)	0.70	$0.14
		TOTAL	**$0.14**

Table 58. ANZCO Foods Manawatū: 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)**	
Subtransmission	Sanson-Feilding 33 kV line	1.00	$1.41
Distribution	Reconductor 11kV line (larger)	0.70	$0.14
		TOTAL	**$1.55**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 6-12 months for an (N) security connection, and 24-36 months for a (N-1) security connection, 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.

8.9.6 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 59. 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)
Farmland Foods Bulls	Pukepapa	N/A	7.5	Unknown	0.72	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.

8.9.7 Combined Load on Zone Substations

While individual Load Site assessments in the sections above focus on upgrades required if only one Load Site were to connect, this section details where multiple Load Sites are proposed to connect to the same zone substation and whether the proposed upgrades in the sections above are sufficient or if further upgrades are required.

It is noted that any costs in this section are additional to those stated in the preceding sections assessing individual loads.

8.9.7.1 Arahina

Two of the loads on Marton GXP are expected to connect to Arahina zone substation. The loads are Malteurop Marton and Nestle Purina Petcare Marton. The sum of peaks of these loads is 16.8 MW, which the zone substation does not have (N-1) capacity for. However, the upgrades specified for the individual Load Sites are expected to be adequate for all of the loads connecting. No further upgrades are considered at Arahina.

8.9.7.2 Bulls

Two of the loads on Marton GXP are expected to connect to Bulls zone substation. The loads are Malteurop Marton and Nestle Purina Petcare Marton. The sum of peaks of these loads is 3.17 MW, which the zone substation does have (N-1) capacity for. Therefore, no further upgrades are considered at Bulls.

8.9.8 Effect of all Load Sites Connecting to Marton GXP

The following Figure 77 illustrates the Marton GXP load profile together with the load profiles of all the Load Sites within the Marton GXP region. Also shown in Figure 77 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Marton GXP would increase to 31.1 MW, an increase of 15.1 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 36.7 MW there is a diversity factor of 0.85 between the loads.
- Based on Ergo's analysis, the Marton GXP's (N-1) limit is expected to be marginally exceeded. Ergo has discussed mitigation for this in Section 8.9.1.

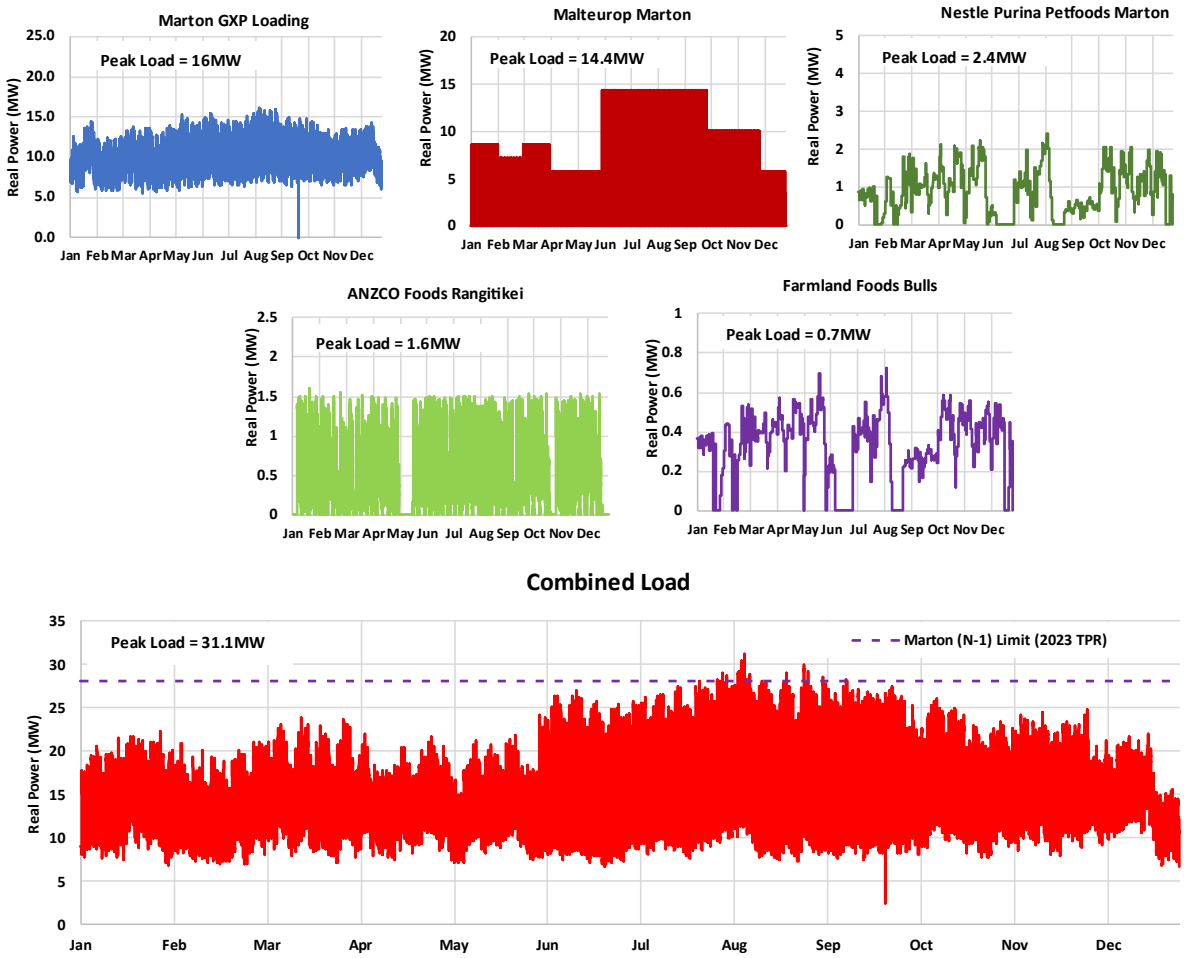


Figure 77. Loading Profiles: Marton GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.10 Mataroa GXP

None of the Load Sites are connecting to Mataroa GXP and therefore upgrades of this GXP are not considered.

8.11 National Park GXP

None of the Load Sites are connecting to National Park GXP and therefore upgrades of this GXP are not considered.

8.12 Ohakune GXP

None of the Load Sites are connecting to Ohakune GXP and therefore upgrades of this GXP are not considered.

8.13 Ongarue GXP

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

- King Country Pet Food Taumarunui (7.04 MW)

The "Small" Load Site connecting to the Ongarue GXP is (refer to Sections 8.13.3):

- Ministry of Health Taumarunui Hospital (0.90 MW)

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

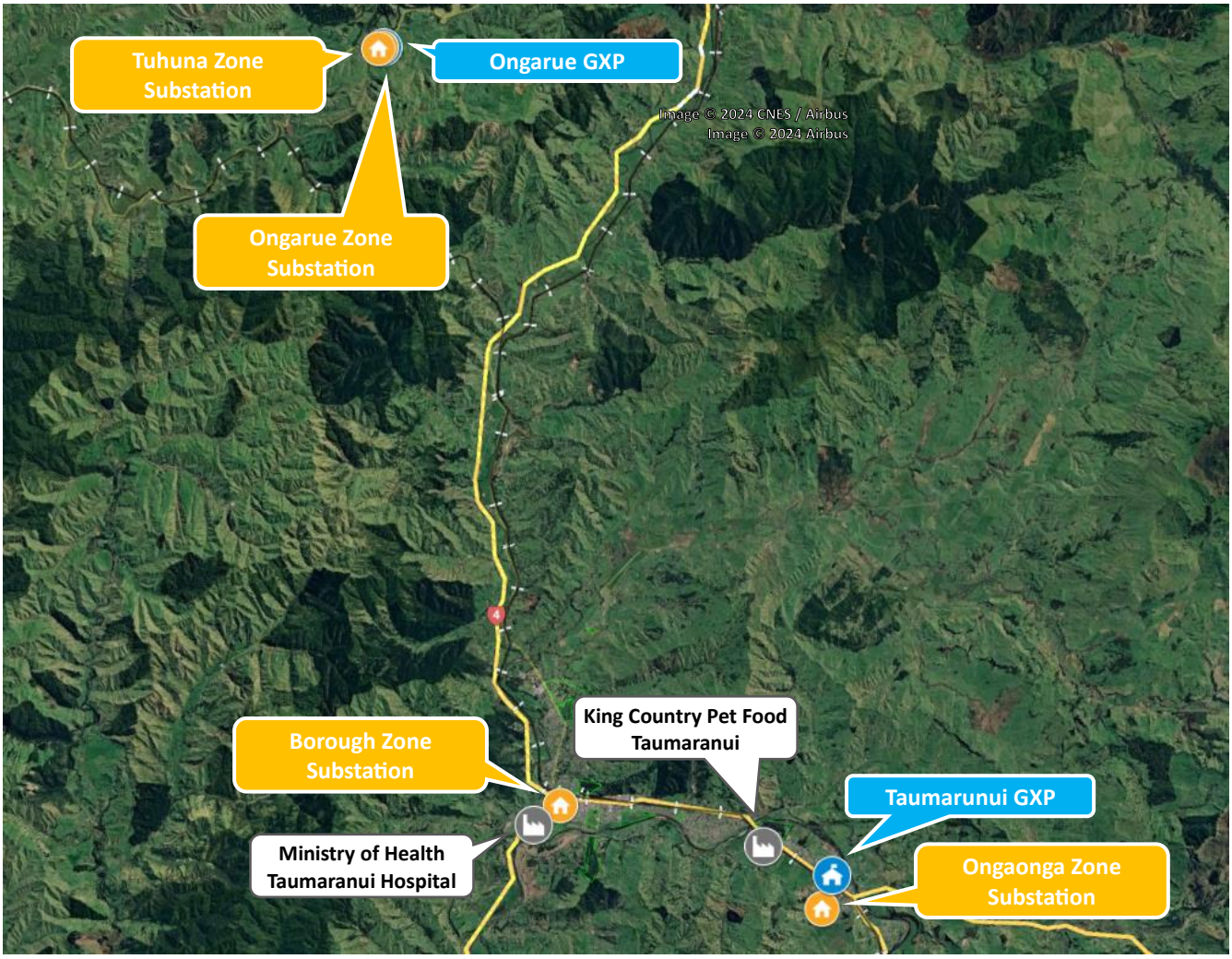


Figure 78. Ongarue GXP: EECA Load Sites vs local substations

8.13.1 Ongarue GXP Upgrade

The Ongarue GXP presently has no spare (N-1) capacity and 12 MVA of spare (N) capacity, based on the transformer ratings.

Ongarue GXP has only one transformer installed at the site. There is sufficient (N) capacity to supply all the proposed Load Sites, assuming the connected hydrogeneration generates similarly to in the past. No changes would be required to accommodate this security condition.

If the local hydrogenerators cannot be relied upon, for an (N) security condition, either the existing transformer at the site would need to be replaced with a larger unit (anticipated cost $4.6M); or a special protection scheme would be required, which would trip load when required while the hydrogenerators are offline (anticipated cost $0.5M).

To accommodate an (N-1) security condition, a new 110 kV/33 kV transformer may need to be installed. Given the topology of the site, it is expected there is sufficient room to install another transformer without major expansion to the site. The expected cost of the new transformer installations is $6M.

It is taken that the 110 kV lines from Hangatiki and Bunnythorpe have capacity to provide an (N-1) security supply to the GXP with the load increases.

8.13.2 King Country Pet Food Taumarunui

KING COUNTRY PET FOOD TAUMARUNUI		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	7.04	Ongarue

Existing Electrical Supply to the Plant

King Country Pet Food Taumarunui is presently supplied by The Line Company's Manunui substation. It supplied via an underground 11 kV feeder. Manunui is in turn supplied from Ongarue GXP by one 33 kV subtransmission circuit. This circuit tees the 33 kV circuit between Kuratau and Borough zone substations. The subtransmission circuit current rating is unknown.

This site is located approximately 2.7 km from Manunui zone substation. In turn, Manunui zone substation is approximately 23 km from Ongarue GXP.

There is currently a maximum loading of 3 MVA on Manunui zone substation, with 2 MVA of spare (N) capacity and no spare (N-1) capacity. Ongarue GXP presently has no spare (N-1) capacity (it operates on (N) transformer security at present) and 12 MVA of spare (N) capacity.

Figure 79. King Country Pet Food Taumarunui geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

The zone substation and GXP do not have adequate spare (N-1) capacity to supply the increased load to site. Additionally, the zone substation also lacks adequate (N) capacity for the site load.

For Manunui zone substation to achieve the required (N) capacity, it is expected that existing transformer may need to be upgraded or replaced. To achieve the required (N-1) capacity, it is

expected a new transformer would need to be installed at the site. Additionally, a second 33 kV line from the GXP and accompanying circuit breakers would be required. It is assumed that the second 33 kV line would be overhead, matching the existing supply, and would be ~26.5 km long.

For Ongarue GXP to reach the required spare (N-1) capacity, a second supply transformer would be required at the GXP.

Due to the size of the load, 1x new 11 kV feeder and associated circuit breaker are assumed to be required. Due to the rural topography of the area, this would likely be a mixture of overhead line, at a length of approximately 3 km.

Capital Cost Estimate

Table 60. King Country Pet Food Taumaranui: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**
Subtransmission	Medium supply transformer (ZSS)	1.00	$1.90
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single overhead 11 kV line	3.00	$0.75
	TOTAL	**$2.75**

Table 61. King Country Pet Food Taumaranui: 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	Ongarue GXP Second Transformer	1.00	$6.00
Subtransmission	33kV circuit breaker bay	2.00	$0.50
Subtransmission	Single overhead 33kV line	26.50	$9.28
Subtransmission	Medium supply transformer (ZSS)	2.00	$3.80
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single overhead 11kV line	3.00	$0.75
	TOTAL	**$20.43**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

KING COUNTRY PET FOOD TAUMARUNUI
It is estimated to take 24-36 months for an (N) security connection, or 36-48 months for an (N-1) security connection, 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.

8.13.3 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 62. 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)
Ministry of Health Taumarunui Hospital	Borough	2.2	12.2	Unknown	0.90	260

The 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.

8.13.4 Effect of all Load Sites Connecting to Ongarue GXP

The following Figure 80 illustrates the Ongarue GXP load profile together with the load profiles of all the Load Sites within the Ongarue GXP region. Also shown in Figure 80 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Ongarue GXP would increase to 14.2 MW, an increase of 6.22 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 15.9 MW there is a diversity factor of 0.89 between the loads.
- Based on Ergo's analysis, the Ongarue GXP's (N) limit is not expected to be exceeded. Ergo has discussed upgrades required for the GXP to meet (N-1) security in Section 8.3.1.
- Ergo notes that the loading on the GXP presently is negative for some periods of the year – this is where the connected hydro generation is higher than the local load at the GXP. The connected hydrogenerators, Mokauiti, Kuratau, and Wairere Falls, have a combined capacity of 12.2 MVA; given the generation levels of each throughout the year are unknown, it is conservatively taken that the total load at the GXP could be 12.2 MW higher than shown below, making the possible maximum load 26.4 MW, which exceeds the existing transformer's (N) capacity. Ergo has discussed mitigation for this in Section 8.3.1

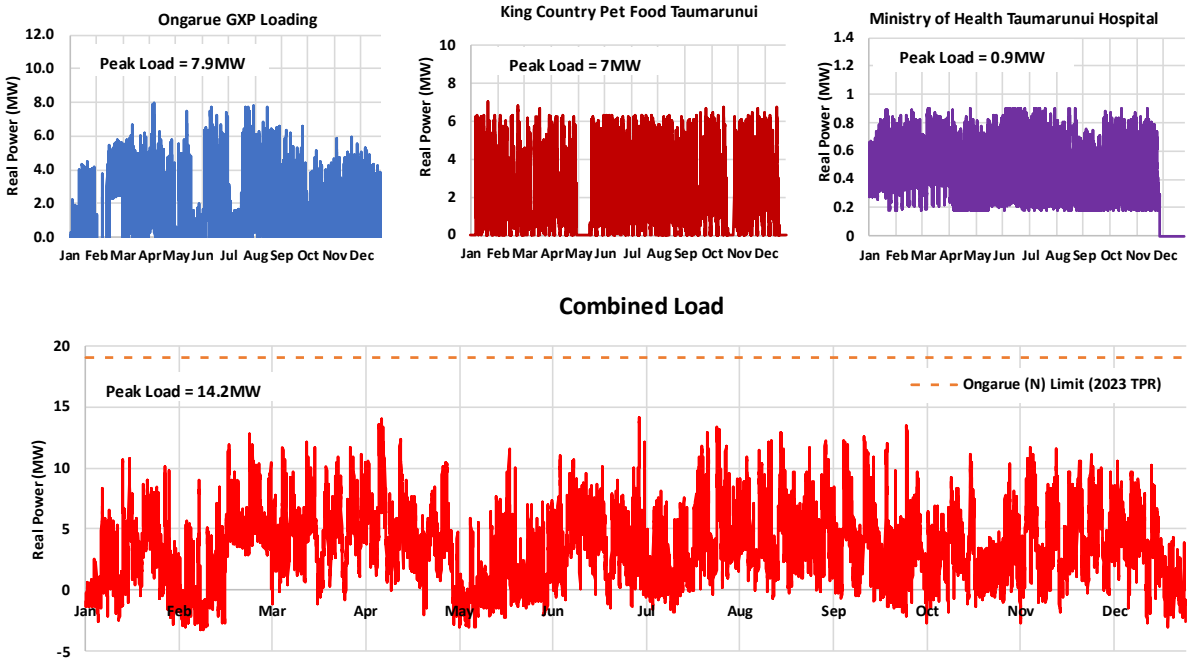


Figure 80. Loading Profiles: Ongarue GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.14 Tangiwai GXP

None of the Load Sites are connecting to Tangiwai GXP and therefore upgrades of this GXP are not considered.

8.15 Whanganui GXP

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

- Open Country Dairy Limited Whanganui (28.43 MW)
- AFFCO New Zealand Limited Imlay (7.09 MW)
- Department of Corrections Whanganui Prison (3.31 MW)
- Tasman Tanning Castlecliff (1.79 MW)

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

Figure 81. Whanganui GXP: EECA Load Sites vs local substations

Ergo notes that there is some uncertainty based on the Transmission Planning Report and Powerco's AMP around the supply of this area and whether the substations are likely to remain connected to Whanganui GXP or instead connect to Brunswick GXP. Ergo has assumed that the subtransmission network would not be reconfigured at this stage, meaning all of the loads presently supplied by this GXP would remain connected to the same GXP.

8.15.1 Whanganui GXP Upgrade

The Whanganui GXP presently has -11 MVA of spare (N-1) capacity and 15 MVA of spare (N) capacity, based on the transformer ratings.

The spare (N-1) capacity of the Whanganui GXP is already exceeded. Therefore, upgrades of the Whanganui GXP are expected to supply any of the load sites with (N-1) security.

To accommodate the (N) capacity condition, if all of the load sites connect, it is expected that the existing transformers at the Whanganui GXP would need to be upgraded/replaced, at an approximate cost of $10M. If only smaller load sites connect to the GXP, it is expected that a special protection scheme would be required for the transformers at Whanganui GXP, to avoid overloading the remaining transformer in the event of a single transformer outage. This is expected to cost approximately $0.5M.

To accommodate the (N-1) capacity condition, it is expected that the existing transformers at the Whanganui GXP may need to be upgraded/replaced. This is expected to cost approximately $10M.

8.15.2 Open Country Dairy Limited Whanganui

OPEN COUNTRY DAIRY LIMITED WHANGANUI		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	28.43	Whanganui
Existing Electrical Supply to the Plant		

Open Country Dairy Limited Whanganui is presently supplied by Powerco's Beach Road substation. The site is supplied by one feeder from each side of the Beach Road 11 kV bus (which is normally operated split), with two ties between the supplies to the site to provide the site with an (N-1) security supply down to distribution level. Beach Road is in turn supplied from Whanganui GXP by one overhead 33 kV subtransmission circuit via Taupō Quay substation. Beach Road can also be supplied from Brunswick GXP via Castlecliff and Peat St substations. The main 33 kV subtransmission circuit current rating is approximately 369 A (21 MVA).

This site is located approximately 0.4 km from Beach Road zone substation. In turn, Beach Road zone substation is approximately 9.2 km from Whanganui GXP.

There is currently a maximum loading of 10 MVA on Beach Road zone substation, with 7 MVA of spare (N) capacity and 6 MVA of spare (N-1) capacity. Whanganui GXP presently has 15 MVA of spare (N) capacity and -11 MVA of spare (N-1) capacity.

There is a loading on Taupō Quay substation of 4.5 MVA at present. Coupled with the 10 MVA loading on Beach Road, the subtransmission circuit supplying the two substations presently has approximately 6 MVA of spare (N) capacity and 1.5 MVA of switched (N-1) capacity.

Figure 82. Open Country Dairy Limited Whanganui geographic location in relation to the surrounding zone substations

OPEN COUNTRY DAIRY LIMITED WHANGANUI

Supply Option(s) for New Load

Due to the size of the load, analysis focuses on a staged approach to connect the load. Ergo has determined stages based on the network constraints (i.e. capacity levels at which additional upgrades would be triggered).

Stage 1 – 6 MW

The first stage of Open Country Dairy Limited Whanganui adds an additional 6 MVA onto the existing load.

Beach Road has sufficient spare (N) and (N-1) capacity to handle this increase. Whanganui GXP has adequate (N) capacity for this load, but insufficient (N-1) capacity.

Looking towards the final load to site, it is expected that a 33 kV rated feeder would be installed to supply the site. This will remove any requirement to upgrade the supply transformers at Beach Road substation in future stages. Due to the urban/industrial topography of the area, it is expected this feeder would be underground, and would approximately 0.3 km long. At this stage, the feeder would be operated at 11 kV, supplied by the Beach Road 11 kV switchboard.

The Brunswick GXP has an outdoor to indoor conversion (ODID) planned for 2025-2028. It is taken at this stage that the single circuit to Whanganui GXP and switchable circuit to Brunswick GXP would provide acceptable (N-1 switched) security for the subtransmission circuits, after the Brunswick ODID is carried out.

For Whanganui GXP to provide adequate (N-1) capacity, it is expected that the supply transformers at the GXP would need to be replaced/upgraded; these upgrades should account for the final Stage 3 load of this site development. If Whanganui is to provide (N) security to the load, a special protection scheme may be implemented to avoid overloading the remaining transformer in the event of a single transformer outage.

Stage 2 – 15 MVA

The second stage of Open Country Dairy Limited Whanganui adds an additional 9 MVA, bringing the proposed load to 15 MVA.

At this stage it is expected, for an (N-1) supply, that an additional subtransmission circuit from the GXP to the zone substation or Load Site would be required. It is expected that this subtransmission circuit would be underground due to space constraints (existing overhead lines) along the route, and the route would include a Whanganui river crossing. An additional 1 km of cabling has been allowed for to account for this, and it is taken that the cables may utilise one of the existing bridges across the river to cross. The subtransmission cables would be ~10 km long.

It is proposed that from this Stage, Open Country Dairy take supply at 33 kV. It is taken that, for an (N-1) security subtransmission supply Powerco may establish a 33 kV switchboard at the Open Country Dairy site, with the new subtransmission circuit mentioned above terminating at the new 33 kV switchboard. The feeder installed in Stage 1 would then be reterminated at both the Load Site side and the Beach

Road side at 33 kV, forming a 33 kV ring network with the Load Site and Beach Road off the GXP. For an (N) security supply, the 33 kV feeder installed in Stage 1 would be reterminated to supply the site at 33 kV.
For either security supply, the existing subtransmission circuit to Beach Road would need to be replaced/upgraded. It is expected that this would involve undergrounding the existing overhead lines, involving ~10 km of undergrounding and a bridge crossing.

Assuming the upgrades at Whanganui GXP mentioned Stage 1 were carried out, no further upgrades at the GXP are expected for this stage.

Stage 3 – 28 MVA

The third stage of Open Country Dairy Limited Whanganui adds an additional 13 MVA, bringing the proposed load to 28 MVA.

At this stage, for either an (N) or an (N-1) supply, an additional subtransmission circuit from the GXP to the site would be required, similar to the circuit installed in the previous stage.

Whanganui GXP does not have adequate (N) or (N-1) capacity to supply the load. For Whanganui GXP to provide (N) or (N-1) security to the site, it is expected that the existing supply transformers may need to be upgraded/replaced.

Assuming that the transformer replacements at the GXP were carried out for the (N-1) supply in Stage 1, no further upgrades at the GXP are expected. However, for an (N) security supply, it is expected that the GXP transformers would require replacements/upgrades.

Capital Cost Estimate

Table 63. Open Country Dairy Limited Whanganui (Stage 1): Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 33 kV cable	0.40	$0.36
		TOTAL	**$0.96**

Table 64. Open Country Dairy Limited Whanganui (Stage 1): 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	Whanganui GXP transformer replacements	1.00	$10.00
Subtransmission	Brunswick GXP ODID	1.00	$5.66
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 33kV cable	0.40	$0.36
		TOTAL	**$16.12**

Table 65. Open Country Dairy Limited Whanganui (Stage 2): Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => **(N)**	**Subtransmission =>** **(N)**	**Distribution =>** **(N)**	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Single underground 33 kV cable	11.00	$9.90
Subtransmission	33 kV circuit breaker (ZSS)	2.00	$0.60
		TOTAL	**$10.50**

Table 66. Open Country Dairy Limited Whanganui (Stage 2): 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)**	
Subtransmission	Double underground 33 kV cable	11.00	$15.40
Subtransmission	33 kV circuit breaker (ZSS)	5.00	$1.50
		TOTAL	**$16.90**

Table 67. Open Country Dairy Limited Whanganui (Stage 3): Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => **(N-1)**	**Subtransmission =>** **(N)**	**Distribution =>** **(N)**	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Whanganui GXP transformer replacements	1.00	$10.00
Subtransmission	33kV circuit breaker (ZSS)	2.00	$0.60
Subtransmission	Single underground 33kV cable	11.00	$9.90
		TOTAL	**$20.50**

Table 68. Open Country Dairy Limited Whanganui (Stage 3): 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)**	
Subtransmission	33 kV circuit breaker (ZSS)	2.00	$0.60

OPEN COUNTRY DAIRY LIMITED WHANGANUI			
Subtransmission	Single underground 33 kV cable	11.00	$9.90
		TOTAL	**$10.50**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

For stage 1, it is estimated to take 12-18 months for an (N) security connection or 36-48 months for an (N-1) security connection to plan, design, procure, construct, and commission the works.

For stage 2, it is estimated to take 24-36 months for either an (N) or an (N-1) security connection.

For stage 3, it is estimated to take 36-48 months for an (N) security connection, or 24-36 months for an (N-1) security connection.

Excluded are any work required to establish the Load Site.

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

8.15.3 AFFCO New Zealand Limited Imlay

AFFCO NEW ZEALAND LIMITED IMLAY		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	3.31	Whanganui

Existing Electrical Supply to the Plant

AFFCO New Zealand Limited Imlay is presently supplied by Powerco's Beach Road substation. The site is supplied by one feeder from each side of the Beach Road 11 kV bus (which is normally operated split), one of which is a contingency supply to provide (N-1) supply to the site at the distribution level. Beach Road is in turn supplied from Whanganui GXP by one overhead 33 kV subtransmission circuit via Taupō Quay substation. Beach Road can also be supplied from Brunswick GXP via Castlecliff and Peat St substations. The main 33 kV subtransmission circuit current rating is approximately 369 A (21 MVA).

This site is located approximately 0.5 km from Beach Road zone substation. In turn, Beach Road zone substation is approximately 9.2 km from Marton GXP.

There is currently a maximum loading of 10 MVA on Beach Road zone substation, with 5 MVA of spare (N) capacity and 5 MVA of spare switched (N-1) capacity. Whanganui GXP presently has 15 MVA of spare (N) capacity and -11 MVA of spare (N-1) capacity.

There is a loading on Taupō Quay substation of 4.5 MVA at present. Coupled with the 10 MVA loading on Beach Road, the subtransmission circuit supplying the two substations presently has approximately 6 MVA of spare (N) capacity and 1.5 MVA of switched (N-1) capacity.

Figure 83. AFFCO New Zealand Limited Imlay geographic location in relation to the surrounding zone substations

AFFCO NEW ZEALAND LIMITED IMLAY

Supply Option(s) for New Load

The GXP has adequate spare (N) but not (N-1) capacity for this load. The zone substation has adequate (N) and switched (N-1) capacity for this load.

The subtransmission circuit which normally supplies Beach Road has sufficient capacity for the proposed load. The Brunswick GXP has an outdoor to indoor conversion (ODID) planned for 2025-2028. It is taken at this stage that the single circuit to Whanganui GXP and switchable circuit to Brunswick GXP would provide acceptable (N-1 switched) security for the subtransmission circuits, after the Brunswick ODID is carried out.

For Whanganui GXP to operate under an (N) capacity condition, it is expected that a special protection scheme would be required for the transformers to avoid overloading the remaining transformer in the event of a single transformer outage.

For Whanganui GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced.

The existing 11 kV feeder has approximately 3 MVA spare capacity. Therefore, due to the size of the load, 1x new 11 kV feeder and associated circuit breaker are assumed to be required. Due to the urban/industrial topography of the area, this would likely be an underground cable, at a length of 0.4 km.

Capital Cost Estimate

Table 69. AFFCO New Zealand Limited Imlay: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Subtransmission	Single underground 33 kV cable	11.00	$9.90
Subtransmission	Special protection system (ZSS)	1.00	$0.25
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	0.40	$0.24
		TOTAL	**$10.49**

AFFCO NEW ZEALAND LIMITED IMLAY

Table 70. AFFCO New Zealand Limited Imlay: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**
Transmission	Whanganui GXP transformer replacements	1.00 $10.00
Subtransmission	Brunswick GXP ODID	1.00 $5.66
Subtransmission	Single underground 33kV cable	11.00 $9.90
Subtransmission	Medium supply transformer (ZSS)	2.00 $3.80
Distribution	11kV circuit breaker (ZSS)	1.00 $0.10
Distribution	Single underground 11kV cable	0.40 $0.24
	TOTAL	**$29.70**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to 24-36 months for an (N) security connection, or 36-48 months for an (N-1) security connection, 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.

8.15.4 Department of Corrections Whanganui Prison

DEPARTMENT OF CORRECTIONS WHANGANUI PRISON		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	7.09	Whanganui

Existing Electrical Supply to the Plant

Department of Corrections Whanganui Prison is presently supplied by Powerco's Blink Bonnie zone substation. It supplied via an overhead 11 kV feeder. Blink Bonnie is in turn supplied from Whanganui GXP by two overhead 33 kV subtransmission circuits (one of which is shared with Taupō Quay and Beach Road substations and is a normally open connection to Blink Bonnie). Both subtransmission circuits are rated to approximately 369 A (21 MVA).

This site is located approximately 11.5 km from Beach Road zone substation. In turn, Beach Road zone substation is approximately 0.1 km from Whanganui GXP.

There is currently a maximum loading of 2.6 MVA on Blink Bonnie zone substation, with 3.7 MVA of spare (N) capacity and no spare (N-1) capacity (this is a single transformer site at present with (N) security only). Whanganui GXP presently has 15 MVA of spare (N) capacity and -11 MVA of spare (N-1) capacity.

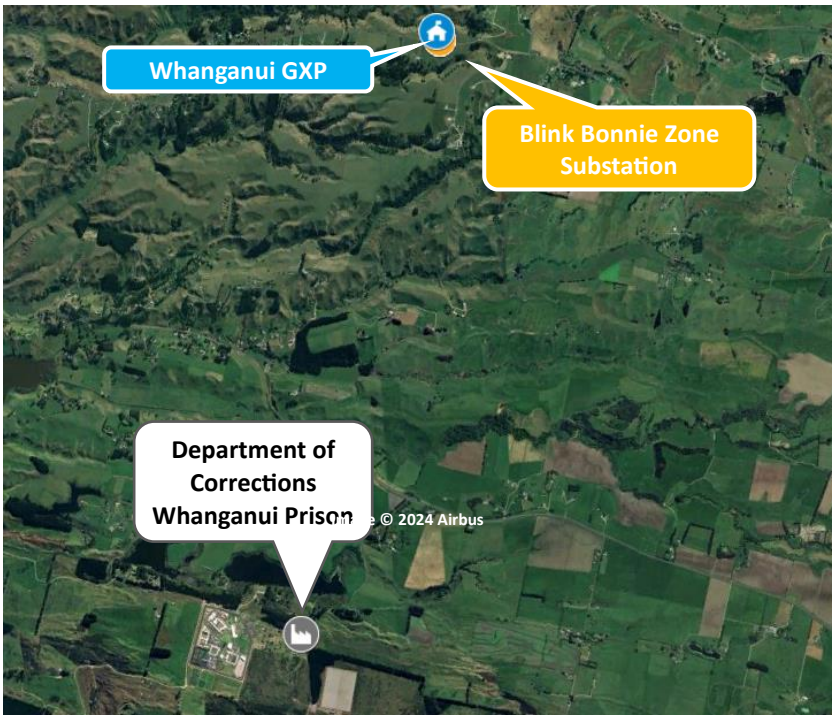


Figure 84. Department of Corrections Whanganui Prison geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

The zone substation and GXP both have adequate spare (N) but not (N-1) capacity for this load.

DEPARTMENT OF CORRECTIONS WHANGANUI PRISON

For Blink Bonnie zone substation to provide an (N) security supply, the existing single transformer at the site would need to be replaced. Additional to this, for an (N-1) supply, a second transformer would be required at the zone substation, including installation of the associated circuit breakers. A second 33 kV subtransmission circuit would also be required between the Blink Bonnie substation and the Whanganui GXP. Blink Bonnie is adjacent to the Whanganui GXP, so it is expected that the second subtransmission circuit would be underground, and would be approximately 0.2 km long.

For Whanganui GXP to accommodate an (N) capacity condition, it is expected that a special protection scheme would be required for the transformers to avoid overloading the remaining transformer in the event of a single transformer outage.

For Whanganui GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced.

The existing 11 kV feeder has approximately 2.3 MW of spare capacity. Therefore, due to the size of the load, 1x new 11 kV feeder and associated circuit breaker are assumed to be required. Due to the rural topography of the area, this would likely be an overhead line, at a length of 18 km. As the feeder to the site is long, it is expected that voltage support may be required at the Load Site, which would likely be in the form of an 11 kV capacitor bank.

Capital Cost Estimate

Table 71. Department of Corrections Whanganui Prison: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Medium supply transformer (ZSS)	1.00	$1.90
Distribution	11 kV Capacitor Bank	1.00	$0.30
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single overhead 11 kV line	18.00	$4.50
		TOTAL	**$6.80**

DEPARTMENT OF CORRECTIONS WHANGANUI PRISON

Table 72. Department of Corrections Whanganui Prison: 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	Whanganui GXP transformer replacements	1.00 $10.00
Subtransmission	Medium supply transformer (ZSS)	2.00 $3.80
Subtransmission	Single underground 33kV cable	0.20 $0.18
Distribution	33kV circuit breaker (ZSS)	3.00 $0.90
Distribution	11kV Capacitor Bank	1.00 $0.30
Distribution	11kV circuit breaker (ZSS)	2.00 $0.20
Distribution	Single overhead 11kV line	18.00 $4.50
	TOTAL	**$19.88**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N) security supply or 36-48 months for an (N-1) security supply 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.

8.15.5 Tasman Tanning Castlecliff

		TASMAN TANNING CASTLECLIFF
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and/or high temperature heat pumps	1.79	Whanganui

Existing Electrical Supply to the Plant

Tasman Tanning Castlecliff is presently supplied by Powerco's Beach Road substation. It supplied via two 11 kV feeders with three entry points, each consisting of a mixture of underground cable and overhead line. Beach Road is in turn supplied from Whanganui GXP by one overhead 33 kV subtransmission circuit via Taupō Quay substation. Beach Road can also be supplied from Brunswick GXP via Castlecliff and Peat St substations. The main 33 kV subtransmission circuit current rating is approximately 369 A (21 MVA).

This site is located approximately 0.4 km from Beach Road zone substation. In turn, Beach Road zone substation is approximately 9.2 km from Whanganui GXP.

There is currently a maximum loading of 10 MVA on Beach Road zone substation, with 7 MVA of spare (N) capacity and 6 MVA of spare (N-1) capacity. Whanganui GXP presently has 15 MVA of spare (N) capacity and -11 MVA of spare (N-1) capacity.

There is a loading on Taupō Quay substation of 4.5 MVA at present. Coupled with the 10 MVA loading on Beach Road, the subtransmission circuit supplying the two substations presently has approximately 6 MVA of spare (N) capacity and 1.5 MVA of switched (N-1) capacity.

Figure 85. Tasman Tanning Castlecliff geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

The GXP has adequate spare (N) but not (N-1) capacity for this load. The zone substation has adequate (N) and switched (N-1) capacity for this load.

The subtransmission circuit which normally supplies Beach Road has sufficient capacity for the proposed load. The Brunswick GXP has an outdoor to indoor conversion (ODID) planned for 2025-2028. It is taken at this stage that the single circuit to Whanganui GXP and switchable circuit to Brunswick GXP would provide acceptable (N-1 switched) security for the subtransmission circuits, after the Brunswick ODID is carried out.

To accommodate an (N) capacity condition, it is expected that a special protection scheme would be required for the transformers at Whanganui GXP, to avoid overloading the remaining transformer in the event of a single transformer outage.

For Whanganui GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced.

The existing two 11 kV feeders near the site have approximately 2.8 and 2.0 MW in spare capacity. Given the size of the load, it is expected the existing feeders are sufficient to supply the site.

Capital Cost Estimate

Table 73. Tasman Tanning Castlecliff: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission => (N)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
		TOTAL	**$0.50**

Table 74. Tasman Tanning Castlecliff: 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	Whanganui GXP transformer replacements	1.00	$10.00
Subtransmission	Brunswick GXP ODID	1.00	$5.66
		TOTAL	**$15.66**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.

Timeframe to Establish New Electrical Infrastructure

It is estimated to take 12-18 months for an (N) security supply, or 36-48 months for an (N-1) security supply to procure, construct, and commission the works.

TASMAN TANNING CASTLECLIFF
Excluded are any work required to establish the Load Site. Any land acquisition and consenting, if required, is excluded.

8.15.6 Combined Load on Zone Substations

While individual Load Site assessments in the sections above focus on upgrades required if only one Load Site were to connect, this section details where multiple Load Sites are proposed to connect to the same zone substation and whether the proposed upgrades in the sections above are sufficient or if further upgrades are required.

It is noted that any costs in this section are additional to those stated in the preceding sections assessing individual loads.

8.15.6.1 Beach Rd

Three of the loads on Whanganui GXP are expected to connect to Beach Rd zone substation. The loads are Open Country Dairy Limited Whanganui, AFFCO New Zealand Limited Imlay, and Department of Corrections Whanganui Prison. The sum of peaks of these loads is 37.3 MW, which the zone substation does not have (N-1) capacity for. Given the intention for Open Country Dairy Limited Whanganui to be fed from a 33 kV feeder, transformer upgrades at Beach Road are only expected if both AFFCO New Zealand Imlay and Tasman Tanning Castlecliff connect. Transformer replacements would be expected to cost approximately $4.6M. It is expected that this cost would be shared between the two Load Sites.

The subtransmission circuit upgrades specified for AFFCO Imlay and Tasman Tanning Castlecliff are considered adequate to supply both sites. Similarly, the subtransmission upgrades specified for Open Country Dairy are considered adequate for all of the connecting loads. This presents opportunities to share costs between Load Sites.

8.15.7 Effect of all Load Sites Connecting to Whanganui GXP

The following Figure 86 illustrates the Whanganui GXP load profile together with the load profiles of all the Load Sites within the Whanganui GXP region. Also shown in Figure 86 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Whanganui GXP would increase to 60.2 MW, an increase of 15.4 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 75.6 MW there is a diversity factor of 0.80 between the loads.
- Based on Ergo's analysis, the Whanganui GXP's (N-1) and (N) limit is expected to be exceeded, if all of the Load Sites connect. Ergo has discussed mitigation for this in Section 8.15.1.

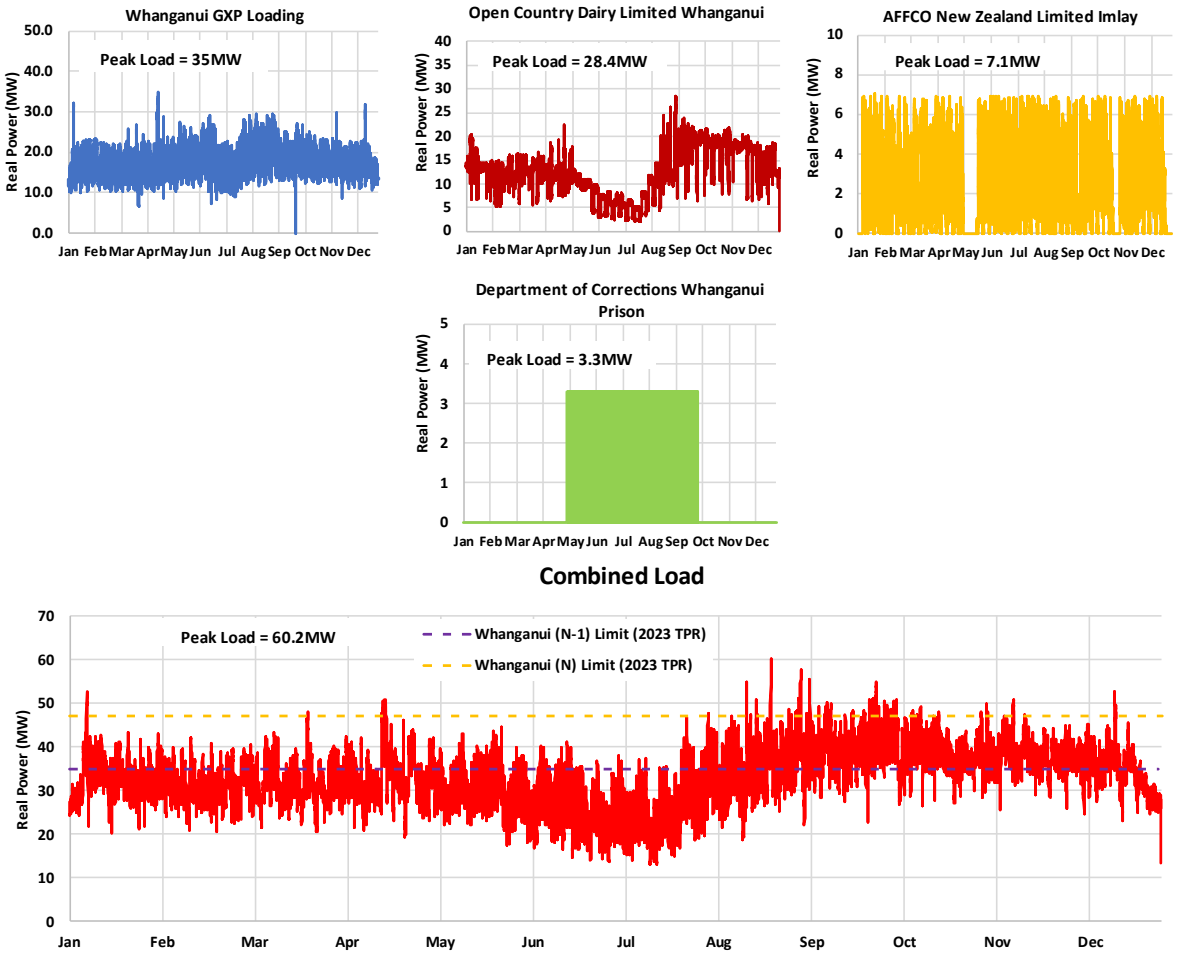


Figure 86. Loading Profiles: Whanganui GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.16 Woodville GXP

None of the Load Sites are connecting to Woodville GXP and therefore upgrades of this GXP are not considered.

9. Conclusions

9.1 Network Spare Capacity

The following Figure 87 illustrates the (N) and (N-1) spare capacity at the Transpower GXP substations in the Manawatū-Whanganui region.

Manawatū-Whanganui region: GXP Substations: Spare (N) and (N-1) Capacity

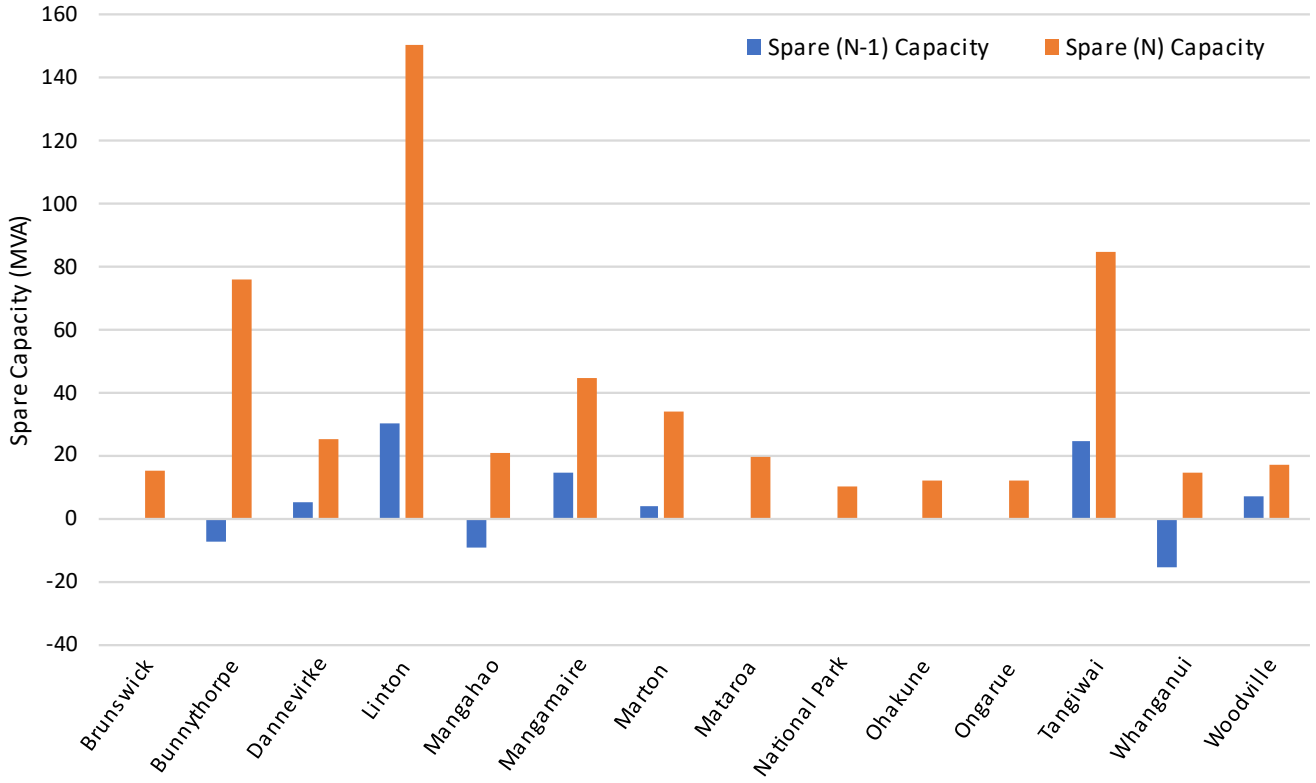


Figure 87 Summary: Approximate (N) and (N-1) spare capacity at GXP substations.

The following figures illustrate the (N) and (N-1) spare capacity at the EDB Zone Substations in the Manawatū-Whanganui region. These figures are based on the maximum loadings and the EDB 2023 disclosures. It is noted that one EDB in the region, Scanpower, presently has no zone substations and so is excluded from these graphs.

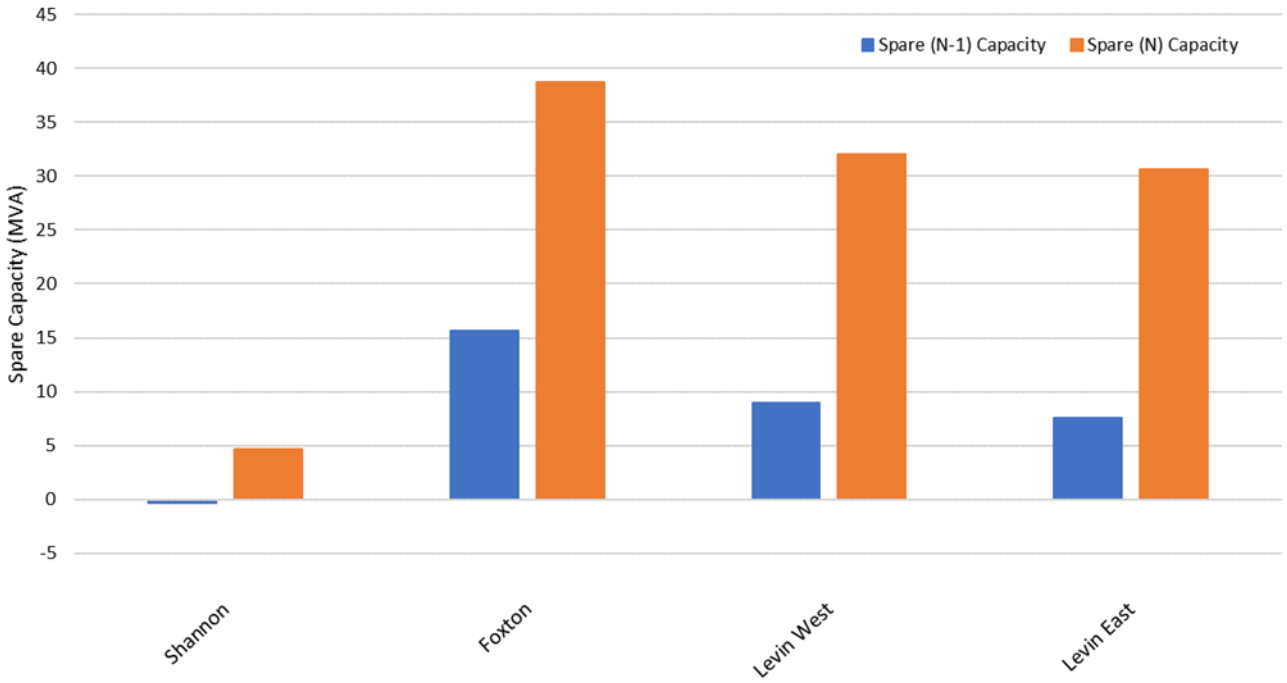


Figure 88. Summary: Approximate (N) and (N-1) spare capacity at Electra's zone substations.

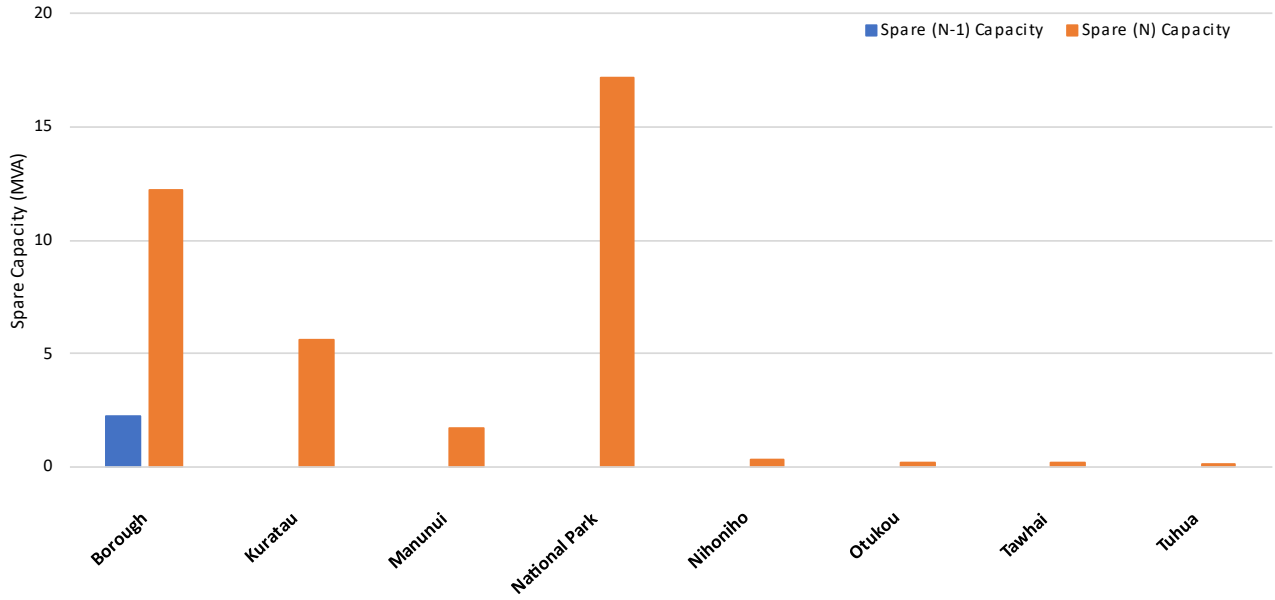


Figure 89 Summary: Approximate (N) and (N-1) spare capacity at The Lines Company's zone substations

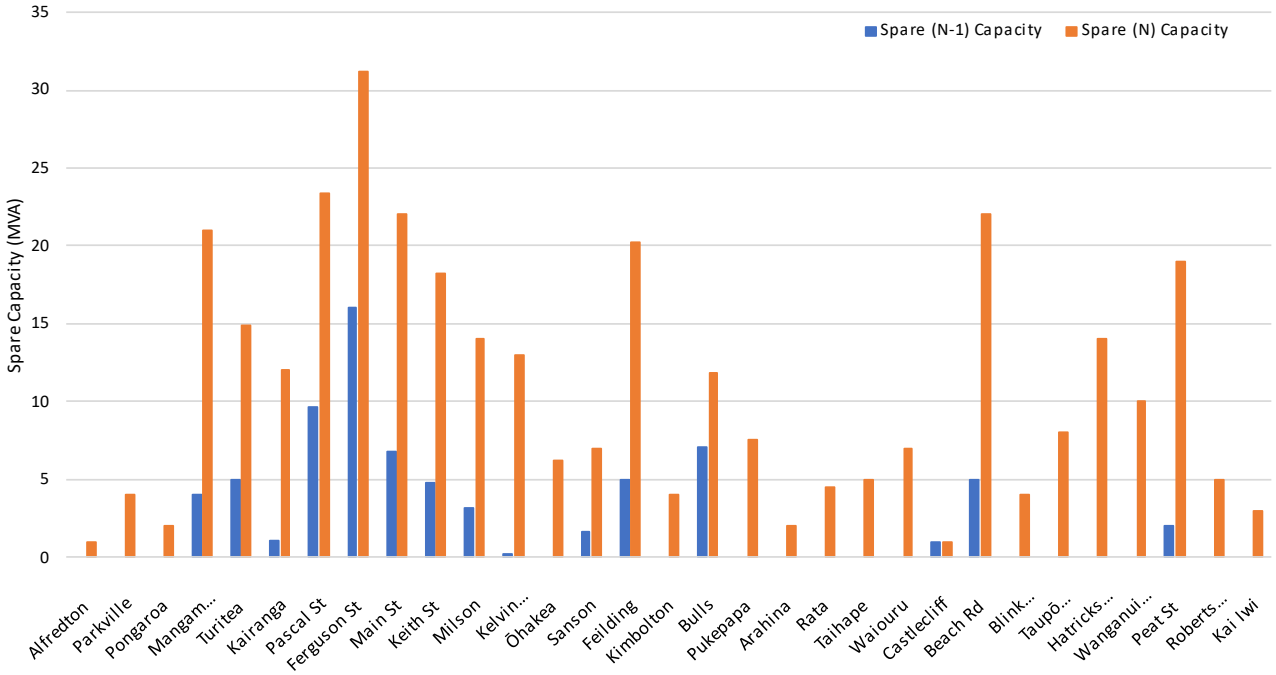


Figure 90. Summary: Approximate (N) and (N-1) spare capacity at Powerco's zone substations.

9.2 Load Characteristics

The substation load characteristics are documented in detail in the main body of the report (and the supplementary document 23163-RPT-008) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Brunswick GXP* – Along with Whanganui GXP, supplies Whanganui, with loads related to agriculture, forestry, and fishing in the nearby areas, along with a mix of other industrial, commercial, and residential loads. Load is winter peaking, with typical daily morning and evening peaks.
- *Bunnythorpe GXP* – Along with Linton GXP, supplies Palmerston North, with a mix of industrial, commercial, and residential loads. Load is reasonably flat throughout the year with a slight winter peak, and typical daily morning and evening peaks. A 34 MW wind farm (Mercury's Tararua Wind Stage 1) is connected within the distribution network connected to this GXP.
- *Dannevirke GXP* – Supplies Dannevirke town and the surrounding rural area, with a significant amount of agricultural (beef and sheep farming) loads, along with some industrial, commercial, and residential loads within Dannevirke. Load is reasonably flat throughout the year, with typical daily morning and evening peaks.
- *Linton GXP* – Along with Bunnythorpe GXP, supplies Palmerston North, with a mix of industrial, commercial, and residential loads. Load is winter peaking, with typical daily morning and evening peaks. Load is winter peaking, with typical daily morning and evening peaks. A 34 MW wind farm (Mercury's Tararua Wind Stage 2) is connected within the distribution network connected to this GXP.
- *Mangahao GXP* – Supplies Levin, Foxton, and Shannon, and provides connection of the embedded Mangahao generation. Mixture of agriculture/horticulture loads, along with some residential and commercial. Typical daily morning and evening peaks. The operation of the Mangahao generation is clear in the load profile of this GXP.
- *Mangamaire GXP* – Supplies some small towns including Pahiatua, Eketāhuna, Alfredton, and Pongaroa. Reasonably rural loading with some residential and industry (e.g. a dairy factory). Load peaks in winter-spring, with a reasonably flat daily load with slight morning and evening peaks.
- *Marton GXP* – Supplies the towns of Bulls and Marton, with significant portions of primary processing and downstream processing. Load is reasonably flat throughout the year, with typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *Mataroa GXP* – Supplies the towns of Taihape and Waiouru, resulting in a reasonably rural agricultural and residential load characteristic. Winter peaking. Typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *National Park GXP* – Supplies the town adjacent to the Tongariro National Park, with the load dominated by a winter ski-season tourist peak from the Whakapapa ski field. Throughout the day the load is reasonably flat.
- *Tangiwai GXP* – Supplies Winstone Pulp International. The load is reasonably flat throughout the year and throughout the day, which is typical of a large industrial load.
- *Ohakune GXP* – Supplies Ohakune town and the surrounding rural area, along with the Tūroa ski field. There is a mix of rural agricultural and residential loads with a prominent increase in load due to tourism/ski season through the winter. Load has a typical daily morning and evening peak, though load is flatter in the summer.

- *Ongarue GXP* – Supplies Taumaranui town, Ongarue village, and the surrounding rural areas. Load is peaky throughout the year. Typical daily morning and evening peaks with a slightly flatter profile through the summer. Operation of the 7.5 MW of connected embedded generation is clear in the load profile.
- *Whanganui GXP* – Along with Brunswick GXP, supplies Whanganui, with loads related to agriculture, forestry, and fishing in the nearby areas, along with a mix of other industrial, commercial, and residential loads. Load is winter peaking, with typical daily morning and evening peaks.
- *Woodville GXP* – Supplies Woodville town and the surrounding rural area, with a significant amount of agricultural (beef and sheep farming) loads, along with some industrial, commercial, and residential loads within Dannevirke. Load is winter peaking, with typical daily morning and evening peaks.

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[40], which is only suitable for concept screening. (Refer to the assumptions outlined in Section 8.2 for more details)

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

Table 75 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)			
MAWH8	AFFCO New Zealand Limited Castlecliff	2.59	Brunswick	$7.00	Castlecliff	$4.02	$11.02	$4.25	Major	1, 2
MAWH40	Alsco NZ Palmerston North	2.67	Bunnythorpe	$12.00	Keith St	$0.16	$12.16	$4.56	Major	1, 2
MAWH41	Kakariki Proteins	2.50	Bunnythorpe	$12.00	Sanson	$5.38	$17.38	$6.95	Major	1, 2
MAWH10	AFFCO New Zealand Limited Manawatu	1.26	Bunnythorpe	$12.00	Fielding	$8.28	$20.28	$16.04	Major	1, 2
MAWH27	NZ Defence Force Ohakea Air Base	1.14	Bunnythorpe	$12.25	Ohakea	$6.28	$18.53	$16.21	Major	1, 2
MAWH43	Moana New Zealand	0.51	Bunnythorpe	$0.00	Keith St	$0.00	$0.00	$0.00	Minor	1
MAWH17	Fonterra Brands Limited Palmerston North	0.21	Bunnythorpe	$0.00	Keith St	$0.00	$0.00	$0.00	Minor	1
MAWH32	Ovation New Zealand Limited Feilding	0.20	Bunnythorpe	$0.00	Fielding	$0.00	$0.00	$0.00	Minor	1
MAWH37	Godfrey Hirst NZ Limited Dannevirke	2.38	Dannevirke	$0.00	N/A	$3.08	$3.08	$1.29	Minor	1
MAWH36	Alliance Group Limited Dannevirke	0.35	Dannevirke	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
MAWH23	Higgins Palmerston North Asphalt Plant	10.70	Linton	$0.00	Kairanga	$6.70	$6.70	$0.63	Moderate	1, 2
MAWH25	Massey University Manawatu	5.70	Linton	$0.00	Turitea	$6.99	$6.99	$1.23	Moderate	1, 2
MAWH20	Fonterra Limited Research and Development Centre	3.96	Linton	$0.00	Turitea	$7.09	$7.09	$1.79	Moderate	1, 2
MAWH42	NZ Pharmaceuticals	3.75	Linton	$0.00	Turitea	$12.84	$12.84	$3.42	Moderate	1, 2
MAWH29	Ministry of Health Palmerston North Hospital	3.49	Linton	$0.00	Main St	$12.30	$12.30	$3.53	Moderate	1, 2
MAWH21	Goodman Fielder Longburn	3.25	Linton	$0.00	Kairanga	$4.58	$4.58	$1.41	Moderate	1, 2
MAWH18	Fonterra Limited Longburn	1.80	Linton	$0.00	Kairanga	$4.58	$4.58	$2.55	Moderate	1, 2
MAWH15	Goodman Fielder Ernest Adams	1.70	Linton	$0.00	Pascal St	$0.00	$0.00	$0.00	Minor	1
MAWH26	NZ Defence Force Linton	0.55	Linton	$0.00	Turitea	$0.00	$0.00	$0.00	Minor	1
MAWH11	AgResearch Grasslands Research Centre	0.44	Linton	$0.00	Turitea	$0.00	$0.00	$0.00	Minor	1
MAWH3	Horowhenua District Council Levin Aquatic Centre	3.87	Mangahao	$9.00	Levin West	$2.20	$11.20	$2.89	Major	1, 2
MAWH5	Oji Fibre Solutions Packaging NZ Central	3.75	Mangahao	$9.00	Levin East	$0.58	$9.58	$2.56	Major	1, 2
MAWH7	Turk's Poultry	2.31	Mangahao	$9.00	Foxton	$0.52	$9.52	$4.12	Major	1, 2
MAWH2	Health New Zealand Horowhenua Health Centre	1.50	Mangahao	$9.00	Levin East	$1.12	$10.12	$6.75	Major	1, 2
MAWH6	RJs Confectionery Levin	1.08	Mangahao	$9.00	Levin West	$2.20	$11.20	$10.40	Major	1, 2
MAWH4	Mitchpine Limited Levin	0.49	Mangahao	$0.00	Levin West	$0.00	$0.00	$0.00	Minor	1
MAWH19	Fonterra Limited Pahiatua - Stage 1	13.00	Mangamaire	$0.00	Mangamutu	$8.88	$8.88	$0.68	Moderate	1, 2
MAWH19	Fonterra Limited Pahiatua - Stage 2	25.00	Mangamaire	$50.40	Mangamutu	$14.75	$65.15	$2.61	Major	1, 2
MAWH24	Malteurop Marton	14.40	Marton	$10.00	Arahina	$23.90	$33.90	$2.35	Major	1, 2
MAWH30	Nestle Purina Petcare Marton	2.40	Marton	$0.00	Arahina	$10.46	$10.46	$4.37	Moderate	1, 2
MAWH13	ANZCO Foods Rangitikei	1.61	Marton	$0.00	Arahina	$1.41	$1.41	$0.88	Moderate	1, 2
MAWH12	ANZCO Foods Manawatū	1.56	Marton	$0.00	Bulls	$1.55	$1.55	$0.99	Moderate	1, 2
MAWH16	Farmland Foods Bulls	0.72	Marton	$0.00	Pukepapa	$0.00	$0.00	$0.00	Minor	1
MAWH38	King Country Pet Food Taumarunui	7.04	Ongarue	$6.00	Manunui	$14.43	$20.43	$2.90	Major	1, 2
MAWH39	Ministry of Health Taumarunui Hospital	0.90	Ongarue	$0.00	Borough	$0.00	$0.00	$0.00	Minor	1
MAWH31	Open Country Dairy Limited Whanganui - Stage 1	6.00	Whanganui	$10.00	Beach Rd	$0.46	$10.46	$1.74	Major	1, 2
MAWH31	Open Country Dairy Limited Whanganui - Stage 2	9.00	Whanganui	$0.00	Beach Rd	$16.90	$16.90	$1.88	Major	1, 2
MAWH31	Open Country Dairy Limited Whanganui - Stage 3	13.43	Whanganui	$0.00	Beach Rd	$10.50	$10.50	$0.78	Major	1, 2
MAWH9	AFFCO New Zealand Limited Imlay	7.09	Whanganui	$10.00	Beach Rd	$14.04	$24.04	$3.39	Major	1, 2
MAWH14	Department of Corrections Whanganui Prison	3.31	Whanganui	$10.00	Whanganui East	$9.88	$19.88	$6.01	Major	1, 2
MAWH34	Tasman Tanning Castlecliff	1.79	Whanganui	$5.66	Beach Rd	$0.00	$5.66	$3.15	Major	1, 2
	TOTAL =>	169.43	TOTAL =>	$202.31	TOTAL =>	$216.05	$418.36			

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 (N-1) scenario cost shown

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
ENA	Electricity Network Association
ESA	Electricity Supply Authority
GXP	Grid exit point substation
KAW	Kawerau GXP
KMO	Kaitemako GXP
kV	Kilovolts
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 76 Cost estimate classification matrix[41]

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.

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