Waikato

Spare Capacity and Load Characteristics Report

EECA

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Document History & Status

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A	05-04-2024	Caitlin Bergervoet	Kane Morison	Kane Morison	Stage 1 Draft
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Revision	Details
A	Stage 1 Draft for client review/comment
B	Stage 2 Draft for client review/comment
C	Updated for EECA, Transpower, WEL Networks, Powerco, and Counties Energy comments
D	Updated for Sapere comments

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1. Executive Summary

Transpower maintains/manages the transmission network in New Zealand and supplies the Waikato region (as described in this report) via eighteen GXPs (grid exit points), some of which provide supply at multiple voltage levels.

Seven Electrical Distribution Businesses (EDBs), Counties Energy, Powerco, Unison, The Lines Company, Vector, Waipā Networks, and WEL Networks, 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 programme that is called Regional Energy Transition Accelerator (RETA)[1]. The program is targeted at large energy-using businesses and public sector organisations seeking to identify the barriers involved and opportunities available to replace fossil fuels with renewable energy sources.

As part of the RETA program, EECA has developed a set of Load Sites for the Waikato 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 Waikato 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 information that can be used for early planning and investment decisions, with an end goal to 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 Waikato region. This figure shows spare capacities based on the historical maximum loadings as well as Transpower's *Transmission Planning Report 2023* data, and does not incorporate any future load growth. It is important to note that these spare capacities also do not include any voltage constraints or upstream transmission constraints (which would have to be confirmed by Transpower or the relevant EDB). As such, it is highly likely that any such constraints would prevent all the spare capacity shown below being utilised. Negative numbers for (N-1) capacity indicate zone substations where the load has exceeded the (N-1) capacity in the past.

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

Waikato: GXP Substations: Spare (N) and (N-1) Capacity

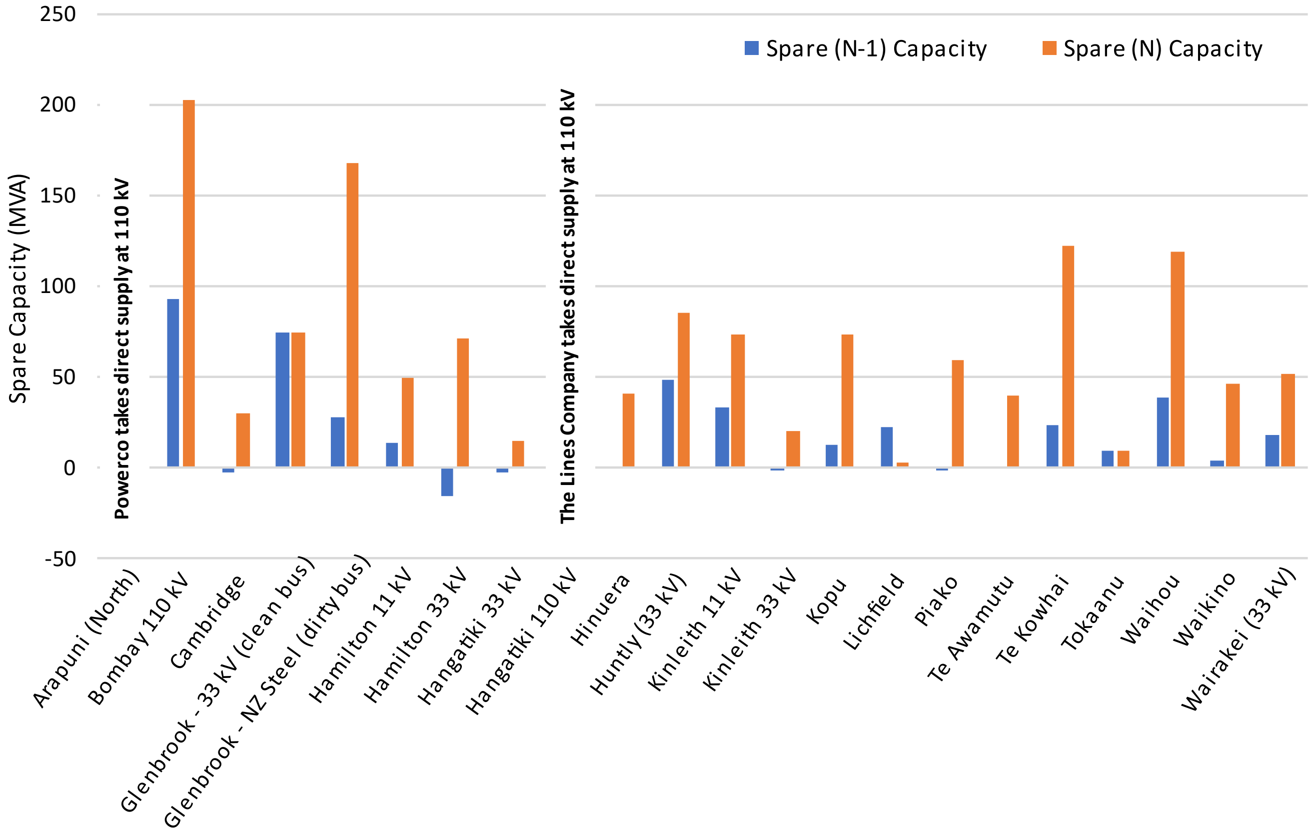

Figure 1 Summary: Approximate N and N-1 spare capacity at GXP substations.

The following Figure 2, Figure 3, Figure 4, Figure 5, Figure 6, and Figure 7 illustrate the (N) and (N-1) spare capacity at the five EDBs (Counties Energy, Powerco, Unison, The Lines Company, and WEL Networks respectively) zone substations (ZSSs) in the Waikato 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 sixth EDB in the region, Waipā Networks, presently has no zone substations and so is excluded from these graphs.

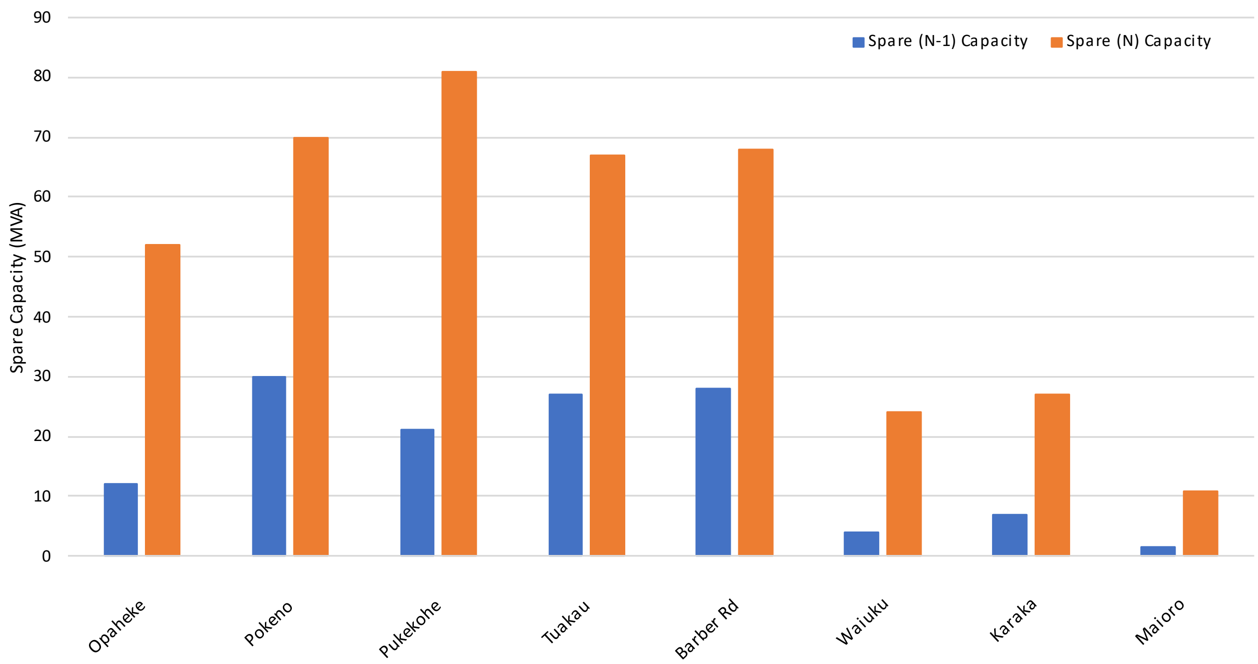

Figure 2. Summary: Approximate (N) and (N-1) spare capacity at Counties Energy's zone substations.

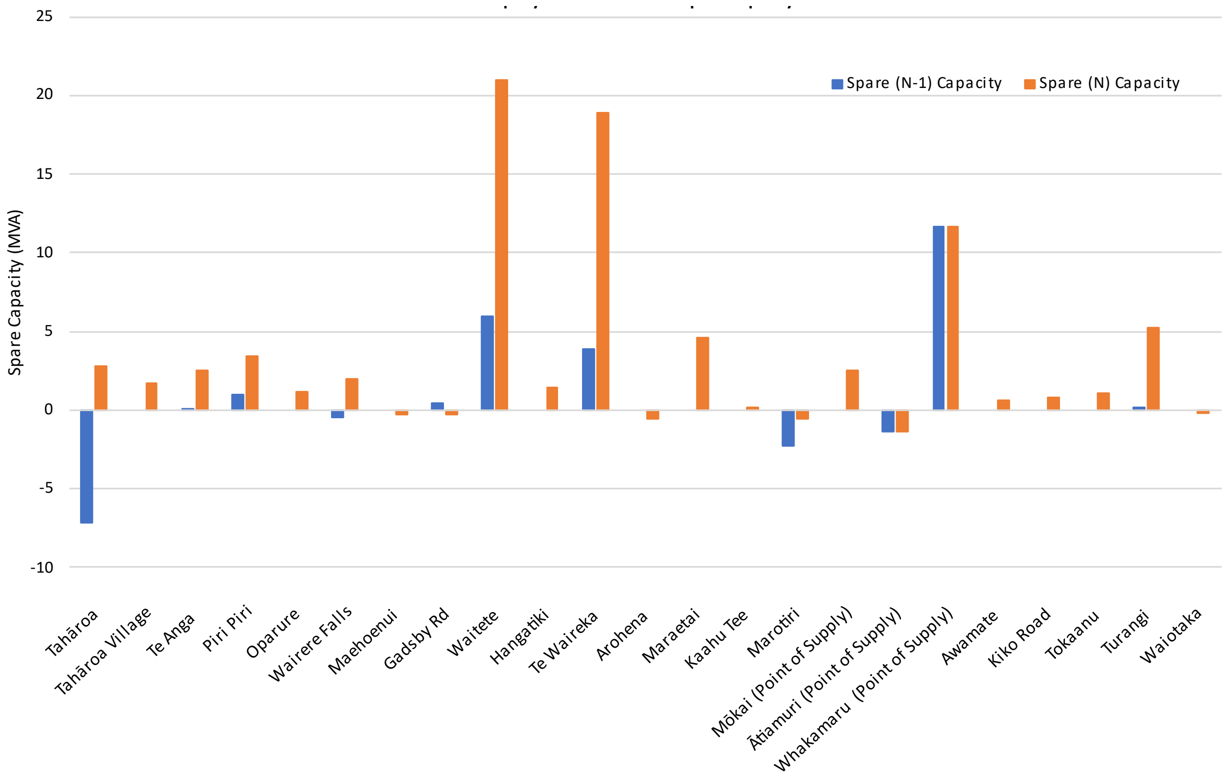

Figure 3 Summary: Approximate (N) and (N-1) spare capacity at The Lines Company's zone substations.

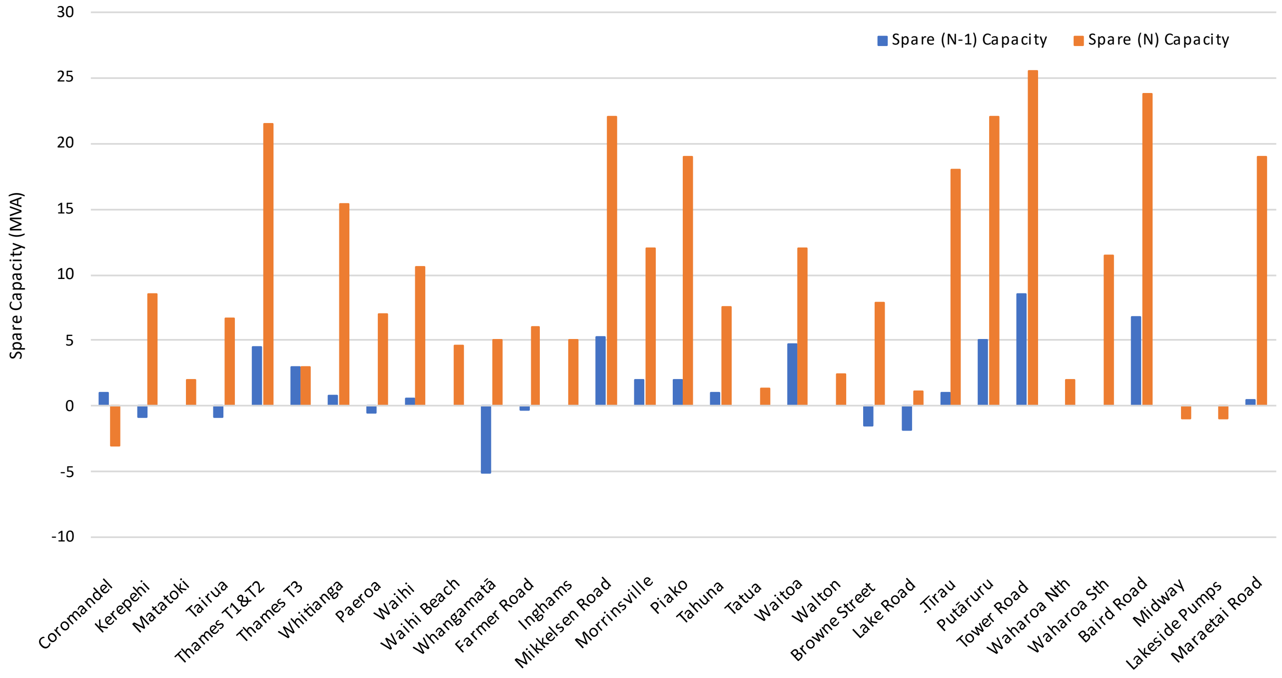

Figure 4. Summary: Approximate (N) and (N-1) spare capacity at Powerco's zone substations.

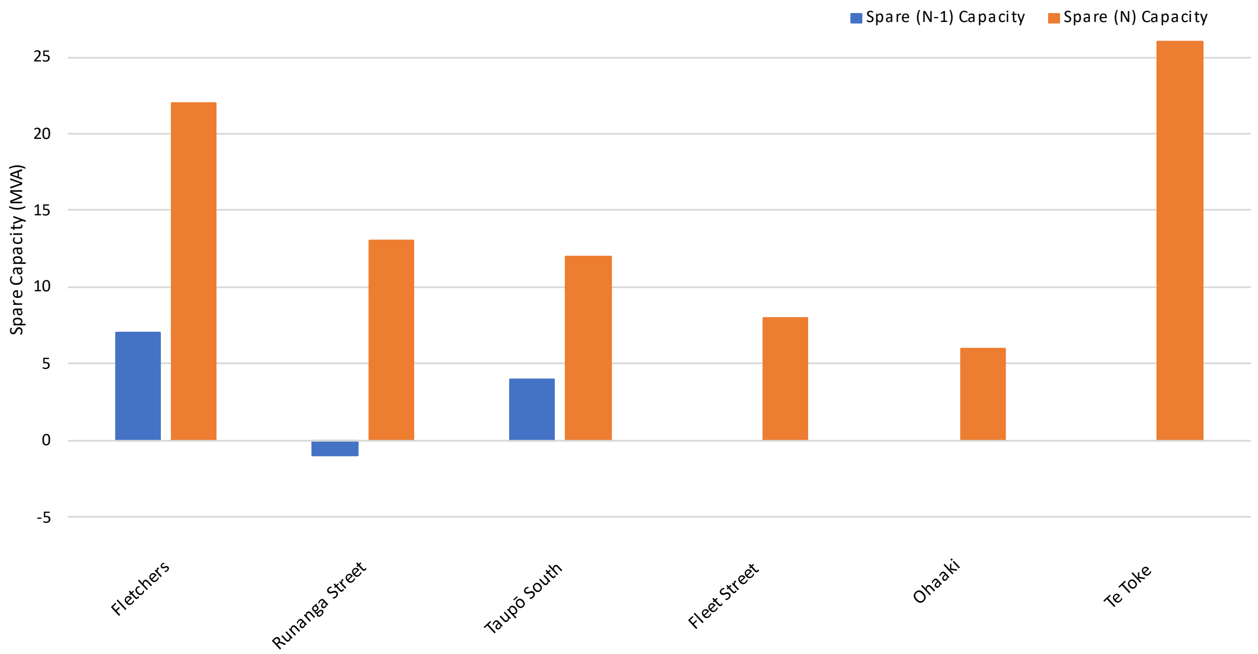

Figure 5. Summary: Approximate (N) and (N-1) spare capacity at Unison's zone substations.

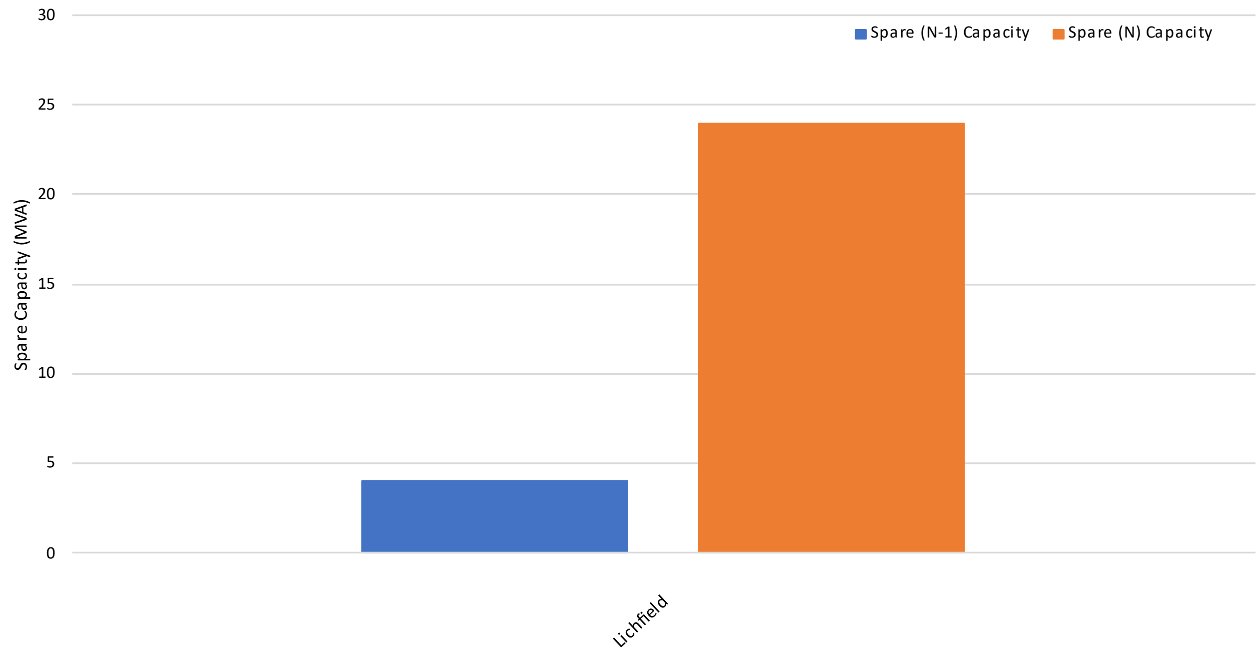

Figure 6. Summary: Approximate (N) and (N-1) spare capacity at Vector's zone substation.

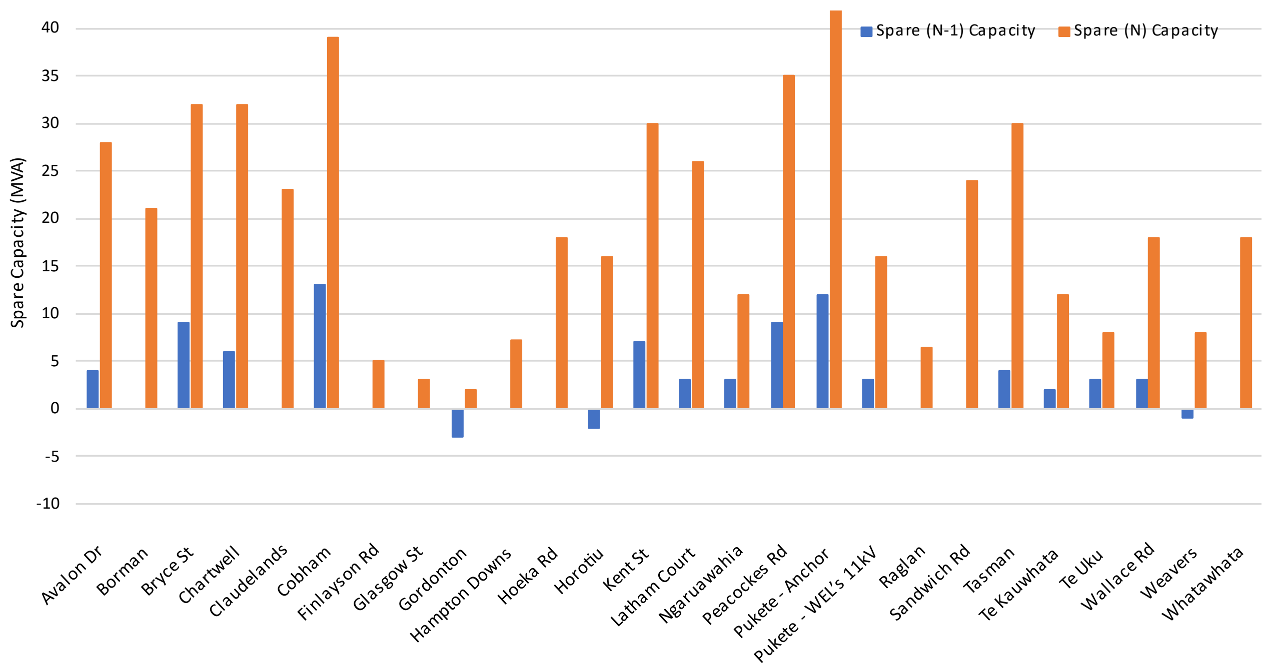

Figure 7. Summary: Approximate (N) and (N-1) spare capacity at WEL Networks' zone substations.

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-006) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Arapuni North GXP* – Supplies Tīrau town, with a large portion of the network being agricultural (dairying) along with a large industrial timber processing load, resulting in a mix of industrial, residential, and agricultural loads. Load is reasonably flat throughout the year, with typical daily morning and evening peaks.
- *Bombay GXP* – Supplies a mix of predominantly industrial, and residential loads, with some commercial customers. Provides supply to Pukekohe and the surrounding rural areas. The GXP is winter peaking with typical daily morning and evening peaks (though with a flatter daily profile over summer).
- *Cambridge GXP* – Supplies Cambridge town as well as a number of agricultural (dairying and irrigation) and industrial processing loads. Peak load in winter is driven by increased residential loads, though summer demands are still high due to the industrial and farming loads. Typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *Glenbrook GXP* – Supplies two large consumers, Glenbrook Steel Mill and Maioro Iron Sands Mine, otherwise supplying a mix of industrial, residential, and commercial customers throughout the Waiuku and Glenbrook areas. The GXP has similar load peaks throughout the year, with the load characteristic dominated by the industrial consumers.
- *Hamilton GXP* – Supplies a significant portion of Hamilton city, and the areas to the East of Hamilton, resulting in the dominant load being residential with some commercial, industrial, and agricultural loads. Winter peaking. Typical daily morning and evening peaks with a slightly flatter profile through the summer compared to the winter.
- *Hangatiki GXP* – Supplies industrial loads (iron sand extraction, timber, limestone and meat processing), with some rural dry stock and dairy loads; as well as a mix of residential and commercial loads at the Ōtorohanga and Te Kūiti towns. The 33 kV GXP has a typical residential load profile, with little variation between summer and winter, with typical daily morning and evening peaks. The 110 kV GXP is dominated by industrial loads.
- *Hinuera GXP* – Supplies Matamata town, with a large portion of the network being agricultural (dairying) along with a large industrial manufacturing and mining load, resulting in a mix of industrial, residential, and agricultural loads. Load is reasonably flat throughout the year, with typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *Huntly GXP* – Supplies Huntly town, and the areas at the North of WEL Network's region, resulting in the dominant load being residential with some commercial, industrial, and agricultural loads. Winter peaking. Typical daily morning and evening peaks with a slightly flatter profile through the summer compared to the winter.
- *Kinleith GXP* – Supplies Tokoroa town, and a large pulp and paper mill, along with a large portion of the network being agricultural (dairying and chicken farming), resulting in a mix of industrial, residential, and agricultural loads. The 11 kV GXP has a peaky load profile, with a flat daily load. The 11 kV GXP load peaks in spring, with typical daily morning and evening peaks.

- *Kopu GXP* – Supplies the Coromandel Peninsula area, including the towns of Thames, Coromandel, Whitianga, Tairua, and Ngātea. There are large industrial loads in agriculture, food processing, and forestry, along with a mix of residential, rural, and commercial loads. Load is peaky, with higher loads in summer and winter (summer peaks are likely due to tourism), with a typical daily morning and evening peak, though load is flatter in the summer.
- *Lichfield GXP* – Directly supplies the Fonterra Lichfield dairy plant. High load through summer, with a winter shutdown. Peaky profile throughout the day.
- *Piako GXP* – Supplies Morrinsville town, with a large portion of the network being agricultural (dairying) along with some large industrial dairy and meat processing loads, resulting in a mix of industrial, residential, and agricultural loads. Load is reasonably flat throughout the year, with the winter dairy shutdown resulting in a decrease in load during winter. Typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *Te Awamutu GXP* – Supplies Te Awamutu town as well as a number of agricultural (dairying and irrigation) and industrial processing loads. Peak load in winter is driven by increased residential loads, though summer demands are still high due to the industrial and farming loads. Typical daily morning and evening peaks.
- *Te Kowhai GXP* – Supplies a portion of Hamilton city, and the areas to the West of Hamilton, resulting in the dominant load being residential with some commercial, industrial, and agricultural loads. Load is sporadic and appears to be heavily influenced by the embedded generation (including the Te Uku wind farm and Te Rapa Cogeneration) in the area.
- *Tokaanu GXP* – Supplies Tūrangi town, a Department of Corrections complex, and some surrounding rural areas. Load is influenced by a large portion of holiday accommodation in the area. Winter peaking with typical daily morning and evening peaks, though load is flatter throughout the day in the summer.
- *Waihou GXP* – Supplies Te Aroha town, with a large portion of the network being agricultural (dairying) along with some large industrial dairy and meat processing loads, resulting in a mix of industrial, residential, and agricultural loads. Load is reasonably flat throughout the year, with the winter dairy shutdown resulting in a decrease in load during winter. Typical daily morning and evening peaks.
- *Waikino GXP* – Supplies popular holiday town Whangamatā, as well as Paeroa and Waihi. A large industrial load in the area is the Waihi mine, with other load in the region being residential (including holidaymakers) and agricultural. Winter peaking. Daily load has typical morning and evening peaks, though is somewhat flatter in summer.
- *Wairakei GXP* – Supplies Taupō, resulting in the dominant load being residential with some commercial, industrial (wood processing), and agricultural loads. Load profile is highly impacted by the embedded generation in the network, with fluctuation throughout the year and an unusual (somewhat flat) daily load profile.

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: GXP/Transmission Substation	Transmission Details: Upgrade Costs ($M)	Distribution: Zone Substation	Distribution: Upgrade Costs ($M)	TOTAL Upgrade Costs ($M)	Cost Efficiency ($M/MW)	Complexity of Connection	Refer to notes
WK13	Fonterra Tīrau - Stage 1	8.00	Arapuni (North)	$0.00	Tīrau	$2.84	$2.84	$0.36	Moderate	1, 2
	Fonterra Tīrau - Stage 2	10.04	Arapuni (North)	$0.00	Tīrau	$69.39	$69.39	$6.91	Major	1, 2
WK12	Yashili Pōkeno - Stage 1	12.00	Bombay 110 kV	$0.00	Pokeno	$1.68	$1.68	$0.14	Minor	1
	Yashili Pōkeno - Stage 2	16.95	Bombay 110 kV	$0.00	Pokeno	$5.03	$5.03	$0.30	Minor	1
WK14	Synlait Milk Pokeno	15.15	Bombay 110 kV	$0.00	Pokeno	$1.45	$1.45	$0.10	Minor	1
WK19	Turners & Growers New Zealand Limited Geraghty	3.29	Bombay 110 kV	$0.00	Tuakau	$0.35	$0.35	$0.11	Minor	1
WK57	Turners and Growers Harrisville	1.60	Bombay 110 kV	$0.00	Tuakau	$0.00	$0.00	$0.00	Minor	1
WK66	Grainhub Limited Tuakau	0.94	Bombay 110 kV	$0.00	Tuakau	$0.00	$0.00	$0.00	Minor	1
WK52	Passion Fresh Pukekohe	0.69	Bombay 110 kV	$0.00	Pukekohe	$0.00	$0.00	$0.00	Minor	1
WK76	House of Taste Pukekohe	0.63	Bombay 110 kV	$0.00	Pukekohe	$0.00	$0.00	$0.00	Minor	1
WK45	Green Valley Dairies Mangatāwhiri	0.50	Bombay 110 kV	$0.00	Mangatawhiri	$0.00	$0.00	$0.00	Minor	1
WK29	Mercer Mushrooms Tuakau	0.40	Bombay 110 kV	$0.00	Tuakau	$0.00	$0.00	$0.00	Minor	1
WK75	Blooming Hill Flowers Pukekohe	0.17	Bombay 110 kV	$0.00	Pukekohe	$0.00	$0.00	$0.00	Minor	1
WK37	Inghams Enterprises (NZ) Pty Limited Cambridge	2.73	Cambridge	$0.00	N/A	$4.30	$4.30	$1.57	Moderate	1
WK54	Riverton Nurseries Hautapu	1.03	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK65	Burwood Nurseries Limited Tamahere	0.46	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK68	Lilies by Blewden Cambridge	0.28	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK78	Ministry of Education Cambridge High School	0.15	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK48	Quack A Duck Cambridge	0.09	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK62	University of Waikato Hamilton	4.44	Hamilton 11 kV	$0.00	Hamilton 11 kV	$1.30	$1.30	$0.29	Minor	1
WK70	AgResearch Ruakura	0.15	Hamilton 11 kV	$0.00	Hamilton 11 kV	$0.00	$0.00	$0.00	Minor	1
WK18	Dairy Goat Co-operative Limited	10.29	Hamilton 33 kV	$9.00	Latham Court	$6.24	$15.24	$1.48	Major	1, 2
WK32	Higgins Contractors Limited Waikato	9.56	Hamilton 33 kV	$9.00	Latham Court	$6.24	$15.24	$1.59	Major	1, 2
WK9	Evonik Peroxide Limited Morrinsville	8.04	Hamilton 33 kV	$9.00	Hoeka Rd	$17.65	$26.65	$3.32	Major	1, 2
WK35	Waikato Hospital	5.68	Hamilton 33 kV	$9.00	Cobham	$1.66	$10.66	$1.88	Major	1, 2
WK72	Fonterra Canpac	0.45	Hamilton 33 kV	$0.00	Avalon Dr	$0.00	$0.00	$0.00	Minor	1
WK73	Sealed Air Hamilton	0.45	Hamilton 33 kV	$0.00	Avalon Dr	$0.00	$0.00	$0.00	Minor	1
WK55	Hamilton Boys High School	0.36	Hamilton 33 kV	$0.00	Claudelands	$0.00	$0.00	$0.00	Minor	1
WK80	Ministry of Education Fraser High School	0.32	Hamilton 33 kV	$0.00	Avalon Dr	$0.00	$0.00	$0.00	Minor	1
WK81	Ministry of Education Hamilton Girls High School	0.30	Hamilton 33 kV	$0.00	Bryce St	$0.00	$0.00	$0.00	Minor	1
WK38	Waterworld Pools and Spa	0.28	Hamilton 33 kV	$0.00	Avalon Dr	$0.00	$0.00	$0.00	Minor	1
WK61	Claudelands Event Centre	0.27	Hamilton 33 kV	$0.00	Claudelands	$0.00	$0.00	$0.00	Minor	1
WK69	Ministry of Education Fairfield College	0.20	Hamilton 33 kV	$0.00	Chartwell	$0.00	$0.00	$0.00	Minor	1
WK63	Waikato Rugby Stadium	0.18	Hamilton 33 kV	$0.00	Bryce St	$0.00	$0.00	$0.00	Minor	1
WK4	Graymont Otorohanga	14.70	Hangatiki 33 kV	$7.00	Te Waireka	$10.76	$17.76	$1.21	Major	1, 2
WK15	Graymont Te Kuiti Plant	8.00	Hangatiki 33 kV	$7.00	Waitete	$9.37	$16.37	$2.05	Major	1, 2
WK33	Graymont (NZ) Limited Oparure Quarry	0.98	Hangatiki 33 kV	$7.00	Oparure	$9.23	$16.23	$16.56	Major	1, 2
WK41	Universal Beef Packers Te Kuiti	0.85	Hangatiki 33 kV	$0.00	Waitete	$0.00	$0.00	$0.00	Minor	1
WK43	Ovation New Zealand Limited Te Kuiti	0.48	Hangatiki 33 kV	$0.00	Waitete	$0.00	$0.00	$0.00	Minor	1
WK89	Ministry of Education Te Kuiti High School	0.23	Hangatiki 33 kV	$0.00	Gadsby Rd	$0.00	$0.00	$0.00	Minor	1
WK84	Ministry of Education Otorohanga College	0.17	Hangatiki 33 kV	$0.00	Te Waireka	$0.00	$0.00	$0.00	Minor	1
WK30	Shinagawa Refractories Australasia Huntly	6.36	Huntly (33 kV)	$0.00	Glasgow St	$11.04	$11.04	$1.74	Moderate	1, 2
WK24	Springhill Corrections Facility	2.80	Huntly (33 kV)	$0.00	Hampton Downs	$12.75	$12.75	$4.56	Moderate	1, 2
WK31	Lumbercorp NZ Limited Ohinewai	4.73	Huntly (33 kV)	$0.00	Te Kauwhata	$6.47	$6.47	$1.37	Moderate	1, 2
WK83	Ministry of Education Huntly College	0.16	Huntly (33 kV)	$0.00	Weavers	$0.00	$0.00	$0.00	Minor	1
WK6	Roundwood NZ Tokoroa	3.84	Kinleith 33 kV	$4.50	Maraetai Road	$10.84	$15.34	$4.00	Major	1, 2
WK79	Ministry of Education Forest View High School	0.22	Kinleith 33 kV	$0.00	Baird Road	$0.00	$0.00	$0.00	Minor	1
WK58	Tokoroa Hospital	0.21	Kinleith 33 kV	$0.00	Maraetai Road	$0.00	$0.00	$0.00	Minor	1
WK90	Ministry of Educaiton Tokoroa High School	0.13	Kinleith 33 kV	$0.00	Maraetai Road	$0.00	$0.00	$0.00	Minor	1
WK86	Ministry of Education Tainui Primary	0.11	Kinleith 33 kV	$0.00	Maraetai Road	$0.00	$0.00	$0.00	Minor	1
WK64	A & G Price Ltd Thames	1.18	Kopu	$0.00	Thames T3	$0.00	$0.00	$0.00	Minor	1
WK44	Twentymans Funeral Services Thames	0.82	Kopu	$0.00	Thames T1&T2	$1.04	$1.04	$1.27	Minor	1
WK51	Mercury Bay Area School	0.07	Kopu	$0.00	Whitianga	$0.00	$0.00	$0.00	Minor	1
WK7	Fonterra Lichfield - Stage 1	12.00	Lichfield	$0.00	Lichfield	$6.98	$6.98	$0.58	Moderate	1, 2
	Fonterra Lichfield - Stage 2	19.90	Lichfield	$27.76	Lichfield	$6.98	$34.74	$1.75	Major	1, 2
WK16	The Tatua Dairy Co-operative Dairy Company Limited -	10.50	Piako	$25.20	Tatua	$11.50	$36.70	$3.50	Major	1, 2
	The Tatua Dairy Co-operative Dairy Company Limited -	10.63	Piako	$0.00	Tatua	$3.65	$3.65	$0.34	Minor	1
WK11	Fonterra Morrinsville	10.04	Piako	$25.20	Morrinsville	$9.20	$34.40	$3.43	Major	1, 2
WK67	Ixom Morrinsville	1.00	Piako	$0.00	Piako	$0.70	$0.70	$0.70	Minor	1
WK36	Greenlea Premier Meats Limited Morrinsville	0.23	Piako	$0.00	Morrinsville	$0.00	$0.00	$0.00	Minor	1
WK85	Ministry of Education Reporoa College	0.18	Rotorua	$0.00	Fernleaf	$0.00	$0.00	$0.00	Minor	1
WK5	Fonterra Te Awamutu - Stage 1	21.40	Te Awamutu	$28.60	N/A	$14.00	$42.60	$1.99	Major	1, 2
	Fonterra Te Awamutu - Stage 2	20.40	Te Awamutu	$28.60	N/A	$10.60	$39.20	$1.92	Major	1, 2

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)			
WK21	Turners & Growers New Zealand Limited Ōhaupō	1.43	Te Awamutu	$0.60	N/A	$0.00	$0.60	$0.42	Moderate	1, 2
WK20	Waikeria Prison	1.12	Te Awamutu	$0.60	N/A	$4.35	$4.95	$4.42	Moderate	1, 2
WK27	Quality Mushrooms	0.34	Te Awamutu	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK53	Te Awamutu College	0.30	Te Awamutu	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK56	Waipā District Council Te Awamutu Events and Aquati	0.28	Te Awamutu	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK3	Fonterra Te Rapa - Stage 1	12.00	Te Kowhai	$0.00	Pukete - Anchor	$3.36	$3.36	$0.28	Minor	1, 2
	Fonterra Te Rapa - Stage 2	31.00	New GXP	$45.00	N/A	$1.80	$46.80	$1.51	Major	1, 2
	Fonterra Te Rapa - Stage 3	56.54	New GXP	$10.50	N/A	$1.80	$12.30	$0.22	Major	1, 2
WK47	Fulton Hogan Limited Hamilton	12.78	Te Kowhai	$0.00	Kent St	$19.60	$19.60	$1.53	Moderate	1, 2
WK22	AFFCO Horotiu	7.16	Te Kowhai	$0.00	Horotiu	$5.82	$5.82	$0.81	Moderate	1, 2
WK40	Alsco New Zealand Hamilton	1.96	Te Kowhai	$0.00	Kent St	$0.58	$0.58	$0.30	Minor	1
WK49	Bowers Brothers Concrete Horotiu Masonry Plant	1.18	Te Kowhai	$0.00	Horotiu	$5.30	$5.30	$4.48	Moderate	1, 2
WK46	Humes Hamilton Pipe and Precast Plant	0.58	Te Kowhai	$0.00	Tasman	$0.00	$0.00	$0.00	Minor	1, 2
WK71	Milkio Foods Limited Hamilton	0.39	Te Kowhai	$0.00	Kent St	$0.00	$0.00	$0.00	Minor	1, 2
WK50	Pukete Wastewater Treatment Plant	0.13	Te Kowhai	$0.00	Tasman	$0.00	$0.00	$0.00	Minor	1, 2
WK25	Tongariro Prison	12.21	Tokaanu	$10.00	Waiotaka	$12.41	$22.41	$1.84	Major	1, 2
WK77	Fonterra Waitoa	6.64	Waihou	$0.00	Waitoa	$4.14	$4.14	$0.62	Moderate	1
WK91	PGG Wrightson Seeds Limited Walton	2.80	Waihou	$0.00	Walton	$19.88	$19.88	$7.11	Moderate	1, 2
WK26	Inghams Enterprises (NZ) Pty Limited Te Aroha	1.09	Waihou	$0.00	Inghams	$1.93	$1.93	$1.77	Moderate	1, 2
WK34	Greenlea Premier Meats Waitoa	0.28	Waihou	$0.00	Farmer Road	$0.00	$0.00	$0.00	Minor	1
WK39	Crusader Meats Benneydale	1.83	Waikato River Systen	$0.00	Maraetai	$15.56	$15.56	$8.50	Moderate	1, 2
WK17	Oceana Gold Limited Waihi	0.48	Waikino	$0.00	Waihi	$0.00	$0.00	$0.00	Minor	1
WK60	Higgins Rotokawa Asphalt Plant	9.06	Wairakei (33 kV)	$0.00	Fletchers	$14.14	$14.14	$1.56	Moderate	1, 2
WK74	Laminex Taupō	2.52	Wairakei (33 kV)	$0.00	Fletchers	$1.00	$1.00	$0.40	Minor	1
WK59	Taupō Funeral Services	0.45	Wairakei (33 kV)	$0.00	Runanga Street	$0.00	$0.00	$0.00	Minor	1
WK87	Ministry of Education Taupo Nui A Tia College	0.30	Wairakei (33 kV)	$0.00	Runanga Street	$0.00	$0.00	$0.00	Minor	1
	TOTAL =>	433.24	TOTAL =>	$ 263.56	TOTAL =>	$364.89	$628.45			

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 Waikato region are supplied with electricity via electrical networks that are owned by the following EDBs:

- Counties Energy - 9 zone substations
- The Lines Company (Northern and Waikato River areas, and a section of the Southern Area) – 20 zone substations
- Powerco (Valley area only) – 29 zone substations
- Unison Networks Ltd (Taupō area only) –6 zone substations
- Vector Limited – 1 zone substation
- Waipā Networks – 0 zone substations
- WEL Networks – 25 zone substations

The franchise areas of the EDBs are shown in Figure 8 for the six 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 seeking to identify the barriers involved and opportunities available to replace fossil fuels with renewable energy sources.

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 Waikato region. The region boundaries used for this project are the regional council boundaries, and it should be noted that some EDBs considered in this region also operate in neighbouring regions.

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 8 EDB franchise 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 Waikato region. This included reviewing both the GXPs and local distribution zone substations along with their associated lines/cables within the Waikato region.

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

- Transpower's Transmission Planning Report 2023.
- Counties Energy'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.
- Unison's 2023 regulatory information disclosures[8] and AMP.
- Vector's 2023 regulatory information disclosures[9] and AMP
- Waipā Networks' 2023 regulatory information disclosures[10] and AMP.
- WEL Networks' 2023 regulatory information disclosures[11] and AMP.
- SCADA substation loading data provided by Counties Energy, Powerco, Unison, The Lines Company, Waipā Networks, and WEL Networks.
- GXP metering data extracted from the Electricity Authority's website[12].
- Network diagrams provided by Counties Energy, Powerco, Unison, The Lines Company, Waipā Networks, and WEL Networks.
- Geographic Information System (GIS) asset and location data provided by Counties Energy, Powerco, Unison, The Lines Company, Waipā Networks, and WEL Networks.

5 https://countiesenergy.co.nz/about-us/regulatory-disclosures/
6 https://www.thelinescompany.co.nz/disclosures/
7 https://www.powerco.co.nz/who-we-are/disclosures-and-submissions/electricity-disclosures
8 https://www.unison.co.nz/tell-me-about/unison-group/publications-disclosures/
9 https://www.vector.co.nz/about-us/regulatory/disclosures-electricity/asset-management-plan
10 https://waipanetworks.co.nz/about/disclosures-pricing/
11 https://www.wel.co.nz/about-us/regulatory-disclosures/
12 https://www.emi.ea.govt.nz/Wholesale/Datasets

4. Waikato Network

The following sections describe (at a high level) the locations of the relevant substations and circuits. For the purposes of this document the franchise areas defined above and supplied by Counties Energy, Powerco, Unison, The Lines Company, Waipā Networks, and WEL Networks, are referred to as the Waikato region.

4.1 Transmission/GXP Substations

The following Figure 9 illustrates the relevant transmission substations (GXPs) within the Waikato region, which include the following (linked here to the EDB they supply and the name of the EDB network area if applicable):

- Counties Energy:
    - Bombay GXP (Eastern region).
    - Glenbrook GXP (Western region).
- The Lines Company:
    - Hangatiki GXP ("Northern" network).
    - The Waikato river network is not connected to a GXP, instead being supplied by three non-Transpower points of supply (POS) (geothermal and hydro generators): Whakamaru T8 (23 MVA total capacity), Ātiamuri T5 (10 MVA total capacity), and Mōkai (7.5 MVA total capacity).
    - Tokaanu GXP ("Southern" network).
- Powerco:
    - Kopu GXP ("Coromandel" network).
    - Waikino GXP ("Waikino" network).
    - Piako ("Waikato" network).
    - Waihou ("Waikato" network).
    - Hinuera GXP ("Waikato" network).
    - Arapuni GXP ("Waikato" network).
    - Kinleith GXP ("Kinleith" network).
- Unison:
    - Wairakei GXP ("Taupō" network).
- Waipā Networks:
    - Cambridge GXP.
    - Te Awamutu GXP.
- WEL Networks:
    - Hamilton GXP ("Hamilton" network).
    - Te Kowhai GXP ("Te Kowhai" network).
    - Huntly GXP ("Huntly" network).
- Direct industrial supplies:
    - Lichfield GXP (supplies a dairy factory, via a distribution network/substation operated by Vector).

Additionally, the Waikato region includes a significant portion of the North Island generation capacity, with generators connecting at dedicated GIPs (Grid Injection Points), or at the GXPs listed above. Many of these are hydroelectric power stations on the Waikato river, or geothermal stations in the Taupō geothermal region, and notably this region includes the Huntly coal/gas power plant. Some generators are grid-connected (connected directly to Transpower substations), whilst some are connected within EDB networks. The generation plants in the region include:

- Arapuni (hydroelectric generation) (198 MW) – connects at Arapuni GXP/GIP.
- Atiamuri (hydroelectric generation) (84 MW) – dedicated Atiamuri GIP.
- Swayne Road (diesel generation) (3 MW) – connects in Waipā's network off Cambridge GXP (is meant to be used to support peak load at the GXP).
- Mangapehi, Mokauiti, Speedies Road, and Wairere (hydrogeneration) (3, 2, 2, and 4 MW respectively) – connect within The Lines Company's network off Hangatiki GXP.
- Huntly (coal and gas generation) (presently 1204 MW, capacity to decrease to 454 MW in the near future, Transpower prudently estimates closure at the end of 2024) – connects at Huntly GXP/GIP.
- Karapiro (hydroelectric generation) (presently 96 MW, will increase to 112 MW when refurbished ~2024) – dedicated Karapiro GIP.
- Kinleith Pulp & Paper (cogeneration) (40 MW) – connects at Kinleith GXP.
- Maraetei (hydroelectric generation) (360 MW) – dedicated Maraetai GIP.
- Ohakuri (hydroelectric generation) (112 MW) – dedicated Ohakuri GIP.
- Anchor Products Te Awamutu (cogeneration) (4 MW) – connects within Waipā's network off Te Awamutu GXP.
- Te Uku (wind generation) (64 MW) and Horotiu Landfill (landfill gas generation) (1 MW) – connects within WEL's Network off Te Kowhai GXP.
- Tirohia Landfill (landfill gas generation) (1 MW) and Whangamata Diesel (diesel generation) (2 MW) – connects within Powerco's network off Waikino GXP.
- Waipapa (hydroelectric generation) (51 MW) – dedicated Waipapa GIP.
- Whakamaru (hydroelectric generation) (126 MW) – connects at the Whakamaru GIP.
- Mokai (geothermal generation) (136 MW) – connects at the Whakamaru GIP.
- Glenbrook (Steel Mill Site) (cogeneration) (112 MW) – connects at Glenbrook GXP/GIP.
- Te Mihi (geothermal generation) (175 MW) – dedicated Te Mihi GIP.
- Poihipi (geothermal generation) (51 MW) – dedicated Poihipi GIP.
- Grid connected generation off Wairakei GXP/GIP:
    - Aratiatia (hydroelectric generation) (78 MW)
    - Ngatamariki (geothermal generation) (82 MW)
    - Nga Awa Purua (geothermal generation) (140 MW)
    - Ohaaki (geothermal generation) (56 MW)
    - Wairakei (geothermal generation) (132 MW) (note this is planned to close no later than June 2031)
- Generation connected within Unison's network off Wairakei GXP/GIP:
    - Hinemaiaia (hydroelectric generation) (6 MW)
    - Rotokawa (geothermal generation) (30 MW)
    - Te Huka (geothermal generation) (30 MW)

Ergo notes that there may be additional generation in the region which is embedded within the distribution networks. The list above covers only those generators listed in Transpower's *Transmission Planning Report*, as an indication of the amount of large-scale generation in the region.

The transmission network in the Waikato region is also shown schematically in Figure 10. Generally, generation capacity in the Waikato region is higher than its maximum demand, with the excess exported to the National Grid.

The region is well interconnected with the National Grid, with connections to Auckland, Taranaki, the Central North Island, Hawke's Bay, and the Bay of Plenty:

- Eight 220 kV circuits run north to Auckland (Ōtāhuhu/Pakuranga) from Huntly (two circuits), Ohinewai (two circuits), and Whakamaru (four circuits).
- Two 220 kV circuits (Huntly-Stratford and Te Kowhai-Taumarunui) connect the region to Taranaki.
- Two 220 kV circuits (Whakamaru-Tokaanu) and one 110 kV circuit (Arapuni-Hangatiki-Ongarue) connect the region to the Central North Island.
- Two 220 kV circuits (Wairakei-Whirinaki, Wairakei-Redclyffe) connect the region to Hawke's Bay.
- Two 220/110 kV interconnecting transformers are located at Hamilton.

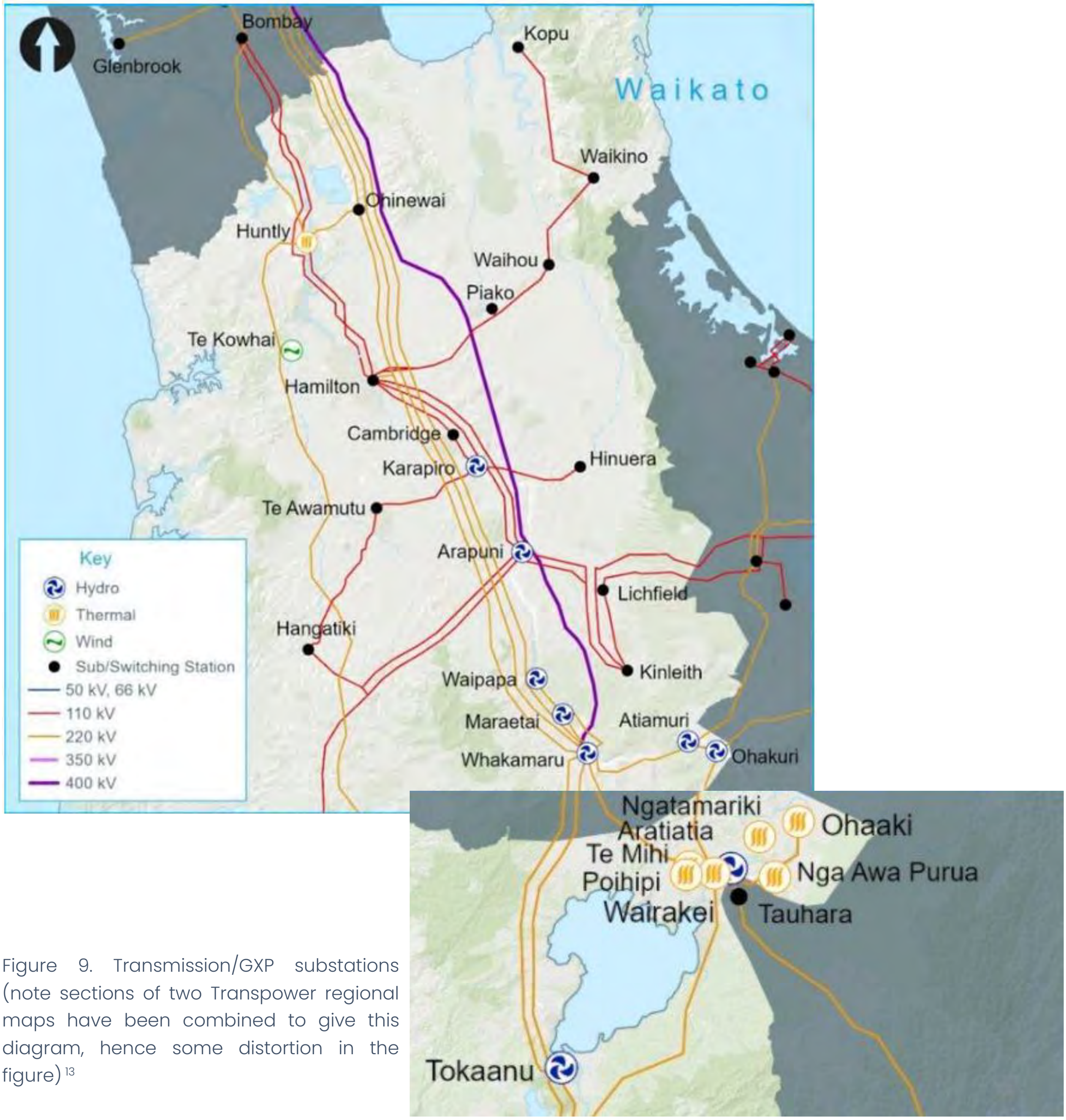

Figure 9. Transmission/GXP substations (note sections of two Transpower regional maps have been combined to give this diagram, hence some distortion in the figure) [13]

[13] *Transmission Planning Report 2023*.

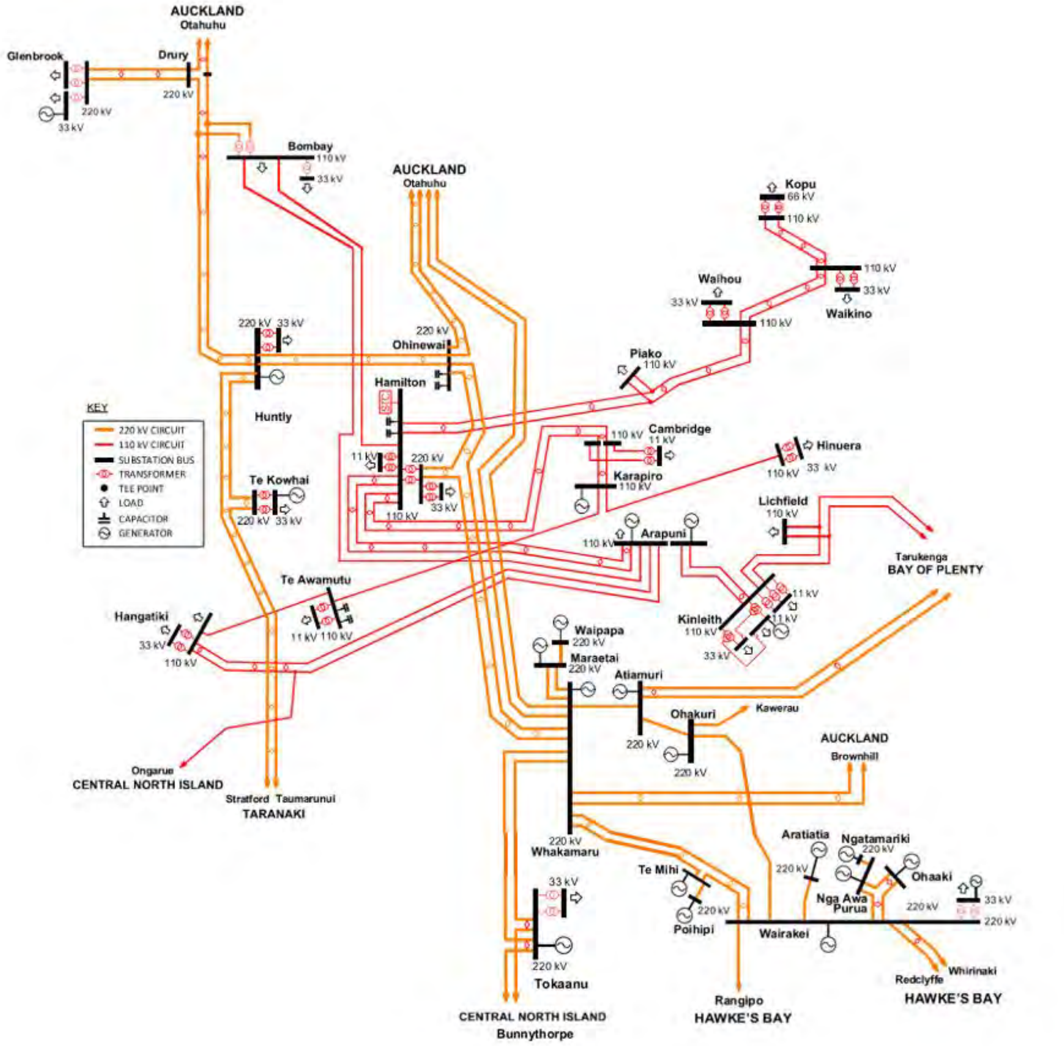

Figure 10 Existing transmission/GXP substations[14]

[14] *Transmission Planning Report 2023*.

4.2 Zone Substations

Zone substations are categorised by the EDB that owns and operates the network. As mentioned earlier, in the Waikato area, there are six relevant EDB's – Counties Energy, Powerco, Unison, The Lines Company, Waipā Networks, and WEL Networks. 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
Counties Energy	9	2
The Lines Company (Northern and Waikato River areas, and a portion of the Southern area)	20	2
Powerco (Valley area)	29	7
Unison (Taupō area)	6	1
Waipā Networks	0	2
WEL Networks	25	3

4.2.1 Counties Energy

The following Figure 11 shows the subtransmission network, zone substations, and GXPs for Counties Energy's region. The substations include:

- Bombay GXP (Eastern region):
  - Opaheke 110/22 kV zone substation
  - Barber Road 110/22 kV zone substation
  - Pukekohe 110/22 kV zone substation
  - Pōkeno 110/22 kV zone substation
  - Tuakau 110/22 kV zone substation
- Glenbrook GXP (Western region):
  - Karaka 33/11 kV zone substation
  - Waiuku 33/11 kV zone substation
  - Maioro 33/11 kV zone substation

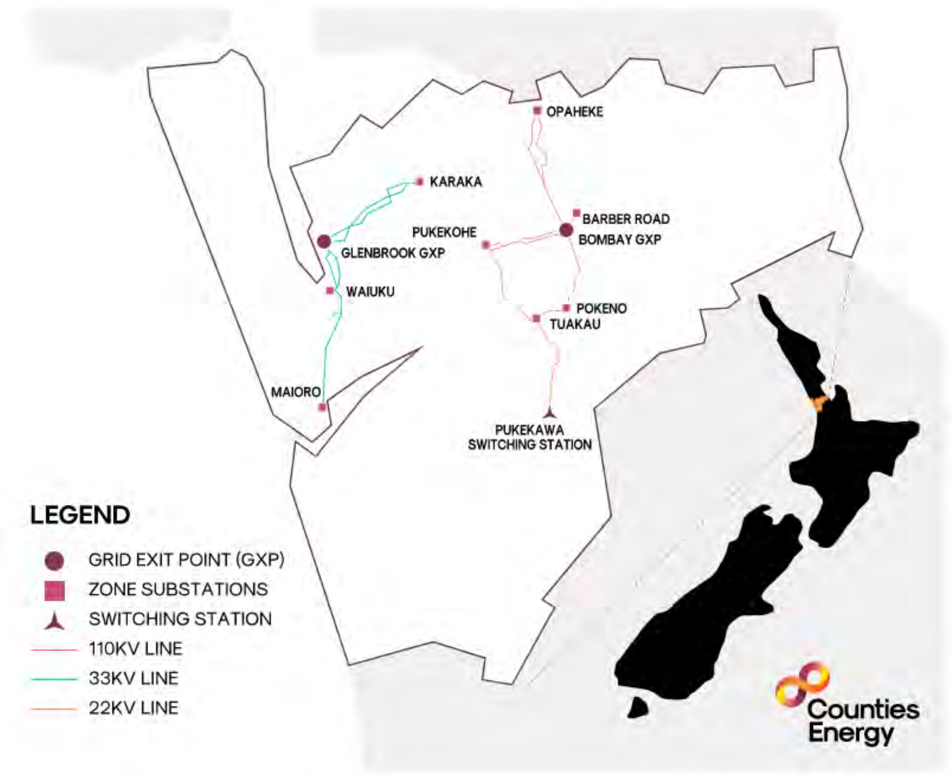

Figure 11. Counties Energy zone substations and interconnecting subtransmission circuits [15]

4.2.2 The Lines Company

The following Figure 12 shows the subtransmission network, zone substations, and GXPs for the relevant regions of The Lines Company's network, with the shaded area being the area considered as part of EECA's Waikato region. The Waikato substations include:

- Hangatiki GXP (Northern network area):
    - Tahāroa 33/11 kV zone substation
    - Tahāroa Village 33/11 kV zone substation
    - Te Anga 33/11 kV zone substation
    - Piri Piri 33/11 kV zone substation
    - Oparure 33/11 kV zone substation
    - Wairere Falls 33/11 kV zone substation
    - Maehoenui 33/11 kV zone substation
    - Gadsby Road 33/11 kV zone substation
    - Waitete 33/11 kV zone substation
    - Hangatiki 33/11 kV zone substation
    - Te Waireka 33/11 kV zone substation
- No GXP (Waikato River network area):
    - Arohena 33/11 kV zone substation
    - Maraetai 33/11 kV zone substation

[15] Counties Energy's 2024 Asset Management Plan found here: https://countiesenergy.co.nz/about-us/regulatory-disclosures/

- Kaahu Tee 33/11 kV zone substation
- Marotiri 33/11 kV zone substation

- Tokaanu GXP (Southern Network Area)
    - Awamate 33/11 kV zone substation
    - Tokaanu 33/11 kV zone substation
    - Turangi 33/11 kV zone substation
    - Waiotaka 33/11 kV zone substation
    - Kiko Rd 33/11 kV zone substation

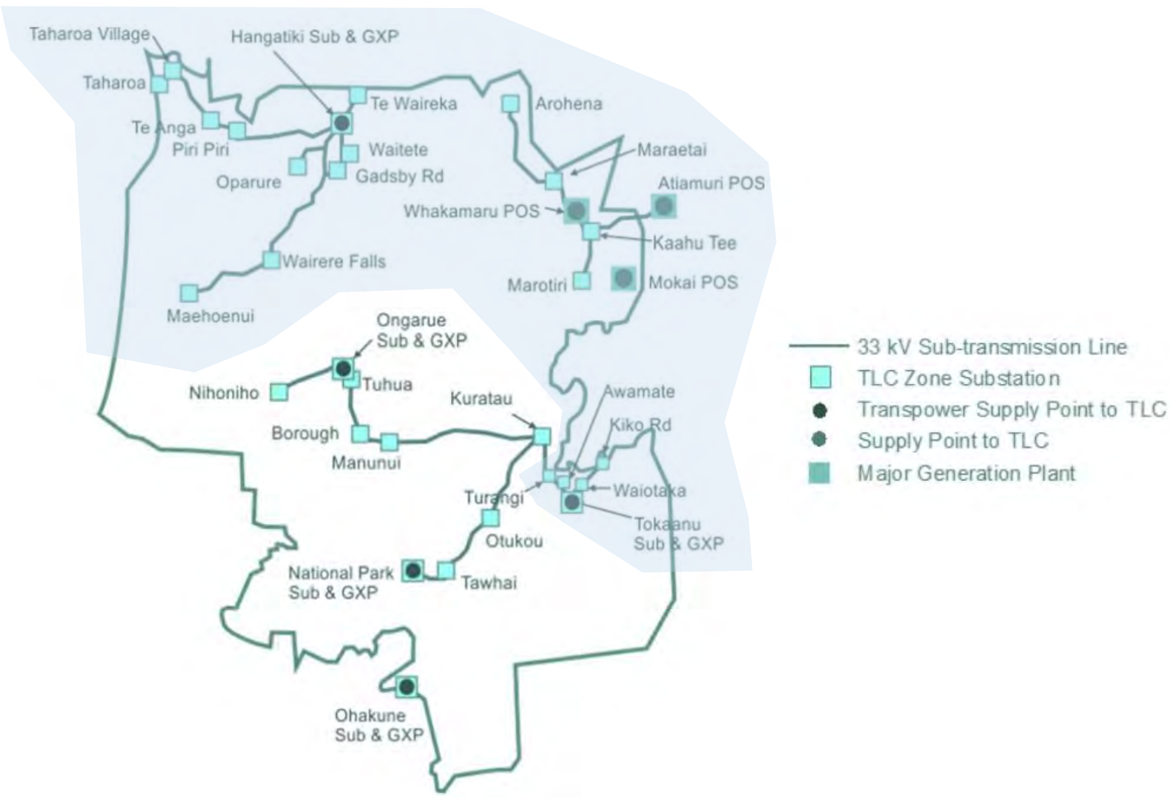

Figure 12. The Lines Company zone substations and interconnecting subtransmission circuits[16]

4.2.3 Powerco

The following Figure 13, Figure 14, Figure 15, and Figure 16 show the subtransmission network, zone substations, and GXPs for Powerco's Valley region (includes the Coromandel, Waikino, Waikato, and Kinleith subareas). The substations include:

- Kopu GXP (Coromandel network area):
    - Coromandel 66/11 kV zone substation
    - Kerepehi 66/11 kV zone substation
    - Matatoki 66/11 kV zone substation
    - Tairua 66/11 kV zone substation

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

- Thames 66/11 kV zone substation (operated with a split bus, so often referred to as Thames T1 & T2 or Thames T3)
- Whitianga 66/11 kV zone substation

- Waikino GXP (Waikino network area):
    - Paeroa 33/11 kV zone substation
    - Waihi 33/11 kV zone substation
    - Waihi Beach 33/11 kV zone substation
    - Whangamatā 33/11 kV zone substation
- Piako, Waihou, Hinuera, and Arapuni GXPs (Waikato network area):
    - Farmer Road 33/11 kV zone substation
    - Inghams 33/11 kV zone substation
    - Mikkelsen Road 33/11 kV zone substation
    - Morrinsville 33/11 kV zone substation
    - Piako 33/11 kV zone substation
    - Tahuna 33/11 kV zone substation
    - Tatua 33/11 kV zone substation
    - Waitoa 33/11 kV zone substation
    - Walton 33/11 kV zone substation
    - Browne Street 33/11 kV zone substation
    - Lake Road 33/11 kV zone substation
    - Tīrau 33/11 kV zone substation
    - Putāruru 33/11 kV zone substation
    - Tower Road 33/11 kV zone substation
    - Waharoa 33/11 kV zone substation (operated with a split 11 kV bus, so often referred to as Waharoa North and Waharoa South)
- Kinleith GXP (Kinleith network area):
    - Baird Road 33/11 kV zone substation
    - Midway 33/11 kV zone substation
    - Lakeside Pumps 33/11 kV zone substation
    - Maraetai Road 33/11 kV zone substation

Figure 13. Powerco's Coromandel region zone substations and interconnecting subtransmission circuits [17]

Figure 14. Powerco's Waikino region zone substations and interconnecting subtransmission circuits [17]

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

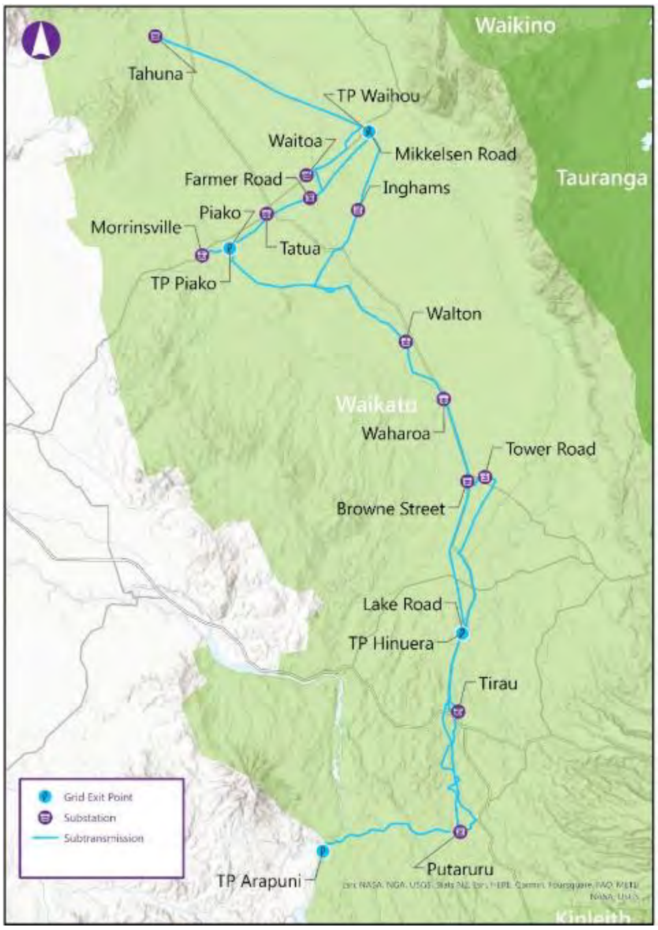

Figure 15. Powerco's Waikato region zone substations and interconnecting subtransmission circuits [17]

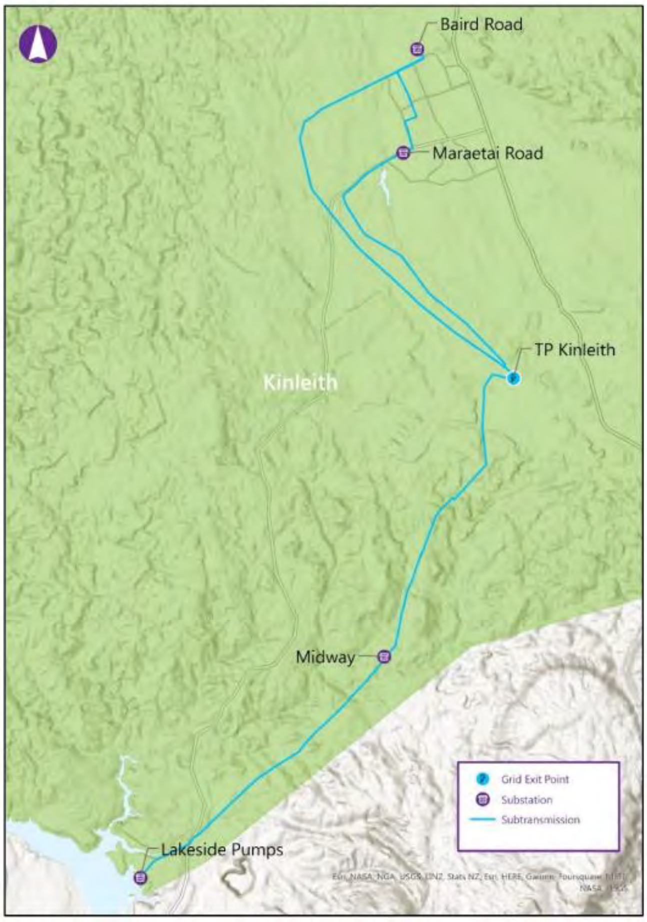

Figure 16. Powerco's Kinleith region zone substations and interconnecting subtransmission circuits [17]

4.2.4 Unison

The following Figure 17 shows the subtransmission network, zone substations, and GXPs for Unison's Waikato region. The substations include:

- Wairakei GXP:
    - Fletchers 33/11 kV zone substation
    - Runanga Street 33/11 kV zone substation
    - Taupō South 33/11 kV zone substation
    - Fleet Street 33/11 kV zone substation
    - Ohaaki 33/11 kV zone substation
    - Te Toke 33/11 kV zone substation

Figure 17. Unison's Taupō region zone substations and interconnecting subtransmission circuits [18]

[18] Unison's 2023 Asset Management Plan found here: https://www.unison.co.nz/tell-me-about/unison-group/publications-disclosures/asset-management-plan/

4.2.5 Vector

Vector operates a substation at Lichfield GXP, which is located at the site of the GXP, and directly supplies the local Fonterra plant.

4.2.6 Waipā Networks

Waipā Networks does not presently own subtransmission assets or zone substations, and it takes supply at 11 kV from the two GXPs in the area (Cambridge and Te Awamutu). Waipā operates 29 feeders at 11 kV, shown in Figure 18 below.

Figure 18. Waipā Network's region 11 kV network [19]

4.2.7 WEL Networks

The following Figure 19 shows the subtransmission network, zone substations, and GXPs for WEL Networks' region. The substations include:

- Hamilton GXP:
  - Avalon Dr 33/11 kV zone substation
  - Borman 33/11 kV zone substation
  - Bryce St 33/11 kV zone substation
  - Chartwell 33/11 kV zone substation
  - Claudelands 33/11 kV zone substation
  - Cobham 33/11 kV zone substation
  - Hoeka Rd 33/11 kV zone substation
  - Latham Court 33/11 kV zone substation
  - Peacockes Rd 33/11 kV zone substation
  - Wallace Rd 33/11 kV zone substation

[19] Waipā Networks' 2023 Asset Management Plan found here: https://waipanetworks.co.nz/about/disclosures-pricing/

- Huntly GXP:
    - Finlayson Rd 33/11 kV zone substation
    - Glasgow St 33/11 kV zone substation
    - Hampton Downs 33/11 kV zone substation
    - Ngaruawahia 33/11 kV zone substation
    - Te Kauwhata 33/11 kV zone substation
    - Weavers 33/11 kV zone substation
- Te Kowhai GXP:
    - Gordonton 33/11 kV zone substation
    - Horotiu 33/11 kV zone substation
    - Kent St 33/11 kV zone substation
    - Pukete 33/11 kV zone substation (operated with a split bus, may be referred to as Pukete Anchor and Pukete WEL 11 kV)
    - Raglan 33/11 kV zone substation
    - Sandwich Rd 33/11 kV zone substation
    - Tasman Road 33/11 kV zone substation
    - Te Uku 33/11 kV zone substation
    - Whatawhata 33/11 kV zone substation
    - Kohia Drive 33/11 kV zone substation[20]
- Additional zone substations not included:
    - Kimihia zone substation (appears to be decommissioned)
    - Meremere (disconnected Transpower Meremere GXP)
    - Silverdale (appears to be an 11 kV switching station or other small distribution station)

[20] This substation is presently under construction and is planned to be in service by February 2025

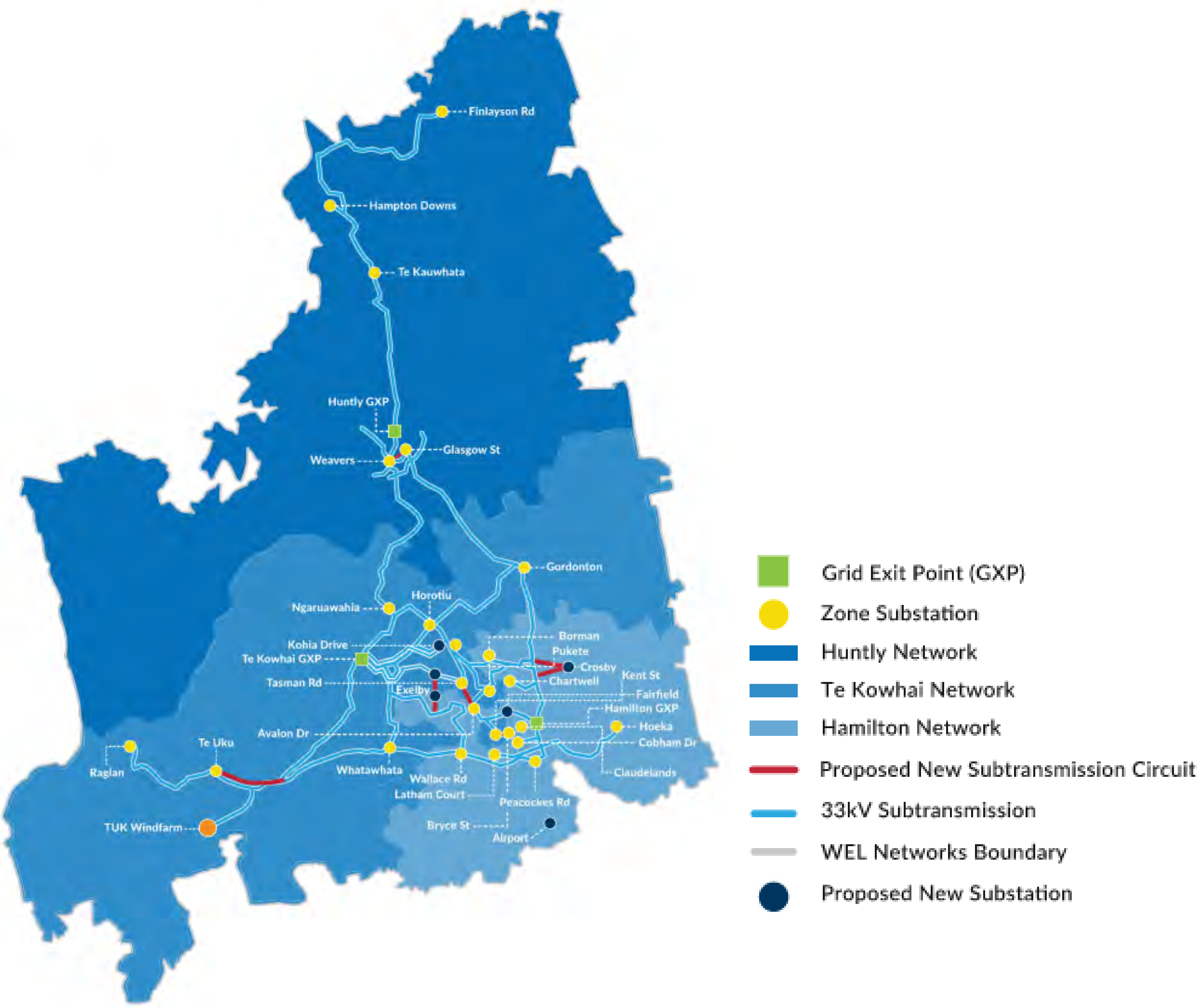

Figure 19. WEL Network's region zone substations and interconnecting subtransmission circuits [21]

[21] WEL Networks' 2023 Asset Management Plan found here: https://www.wel.co.nz/about-us/regulatory-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)[22]. 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.
- **Switched (N-1) security or strategic spares:** The network is designed and operates such that it can continue to supply load with an interruption in the event of a single asset failure. Interruptions in these cases could be as short as seconds to remotely switch, or hours to send an operator to manually switch the network, to drive a mobile substation to the site, or replace assets on site using spares which are kept relatively close. Again, can be compared with a single-engine aircraft, but in this case in the event of failure, a parachute is deployed.

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 circuits being designed and operated with (N-1) security of supply. 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.
- 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[23]) assets. For "non-core grid" assets, the decision to supply (N-1) is made by Transpower but must be economically justified.

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

[23] Assets which are considered "core grid" are listed in the EIPC Schedule 12.3

For connection assets that are dedicated to a single consumer the decision regarding security is made by the consumer/customer.

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., Counties Energy, The Lines Company, Powerco, Unison, Waipā Networks, and WEL Networks). For those substations that are supplied via dedicated incoming circuits, the circuits are also considered to be connection assets. The remaining circuits 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[24] has been initiated. There are examples of this at both transmission and distribution levels. This has allowed Transpower and EDBs 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.

[24] Demand side participation | Transpower

6. Spare Capacity – Transmission Substations (GXPs)

The following sections document the spare capacity that is available at the GXPs that supply the Waikato region.

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

- During periods of low Arapuni generation and high Waikato 110 kV load, the Arapuni-Hamilton circuits may overload for a loss of the Karapiro-Te Awamutu circuit or the Arapuni-Hamilton circuit. Ergo notes that an Arapuni-Hamilton circuit outage causing the other to overload happens at a much later date.
- An outage of the Karapiro-Te Awamutu circuit causes the Bunnythorpe-Mataroa circuit overload protection scheme to operate, resulting in the Te Awamutu, Hangatiki, Arapuni North, Ongarue, National Park and Ohakune loads being supplied from Hamilton via the two Arapuni-Hamilton circuits.
- The Arapuni 110 kV bus is normally operated split into two bus sections (Arapuni North and Arapuni South) – load is on the North bus section only, with generators typically connected to both buses (generating units G1-4 connect to the North bus, and units G5-8 can connect to either, with 3 units usually connected to the South bus). For some maintenance outages, the Arapuni 110 kV bus section must be closed. This causes overloading issues to cascade into the 110 kV networks of the adjacent Bay of Plenty and Central North Island regions. Constraining on generation in the Waikato 110 kV network and Huntly can be used to manage these problems, however this is becoming increasingly impractical due to generation availability.
- Kinleith and Lichfield GXPs are typically connected to the Arapuni 110 kV South bus, and are operated as a spur circuit off the Bay of Plenty region Tarukenga GXP. The loading on the circuits of the Tarukenga-Lichfield-Kinleith and Arapuni-Kinleith 110 kV circuits may exceed the (N-1) capacity of the circuits under certain operating conditions. Generation at Kinleith and Arapuni must be carefully managed to prevent the Lichfield-Tarukenga circuits exceeding their (N-1) capacity, which must be balanced with the requirement to manage Arapuni generation according to low or high hydro inflows. There is very limited capacity to accommodate additional load growth on the Arapuni-Kinleith-Lichfield-Tarukenga circuits.
- The Hamilton-Cambridge sections of the Karapiro spur (spur off Hamilton GXP which connects to Cambridge, Karapiro, Hinuera, and Te Awamutu GXPs) constrain transmission capacity into the spur. This is typically managed by constraining on generation at Karapiro, however from 2031, the maximum Karapiro generation will not be sufficient to avoid post-contingency overload on the Hamilton-Cambridge circuits.
- The Thames Valley spur (spur off Hamilton GXP which connects to Piako, Waihou, Waikino, and Kopu GXPs) peak load is forecast to exceed the (N-1) capacity of the Hamilton-Morrinsville Tee circuits from 2023, and of the Waihou-Waikino circuits from 2027. Additionally, a Hamilton-Piako-Waihou circuit outage during high load periods results in supply bus voltage steps exceeding 5% at Piako, Waihou, Waikino, and Kopu, with this outage resulting in the Kopu bus voltage dropping below 0.9 p.u. from 2027.

- Demand growth at Hangatiki and Te Awamutu is expected to eventually (~2025) result in the circuits supplying the two GXPs exceeding their (N-1) capacity. Part of this issue is due to the high load and low power factor existing at Hangatiki, however improving the power factor, while expected to improve the issue, is not expected to resolve it.
- Additionally, regardless of generation at Arapuni, a loss of the Karapiro-Te Awamutu circuit can cause the Arapuni-Hangatiki-Ongarue circuit to overload from 2025; and with low to moderate generation at Arapuni, and outage of the Karapiro-Te Awamutu circuit can result in low voltages (<0.95 p.u.) and voltage steps larger than 5% at Hangatiki and Te Awamutu, from 2027.
- During periods of high Waikato 110 kV load, the (N-1) capacity of the Waikato 220/110 kV interconnecting transformers (located in Hamilton) can be exceeded.

Figure 20 below illustrates Transpower's view of a possible 2038 configuration for the Waikato region's transmission network. It includes:

- Installation of an additional 33 kV transformer and bus at Glenbrook GXP.
- 220 kV conductor replacement of the section of lines between Bombay and Ōtāhuhu
- 220 kV conductor replacement on a section of the Whakamaru-Ōtāhuhu circuits, with minor upgrades.
- Duplexing of the 220 kV Whakamaru-Tokaanu circuits and implementation of variable line ratings.
- Replacement of one of the 220/33 kV transformers at Hamilton GXP.
- Establishment of a new Hamilton East 220/110 kV substation where the 220 kV Ohinewai-Whakamaru and the 110 kV Hamilton-Piako-Waihou circuits cross. Construct a new 110 kV line between Hamilton East and Waihou.
- Installation of capacitor banks at Waihou and Waikino GXPs.
- Establishment of a new Hautapu GXP, tee-ed off the 220 kV Whakamaru-Ōtāhuhu circuits.
- Supply transformers risk-based replacement at Hangatiki, Hinuera, Tokaanu, Wairakei and Waikino (possibly an upgrade in conjunction with replacement).
- Thermal upgrade of the 220 kV Wairakei-Whakamaru line, and replacement of the single-circuit Wairakei-Ohakuri-Atiamuri-Whakamaru line with a double-circuit line.
- 33 kV outdoor switchyard to indoor switchboard conversion at Tokaanu.
- Disconnection of 110 kV Bombay-Hamilton circuit
- Bus the Arapuni-Bombay circuit at Hamilton and remove the section north of Hamilton.

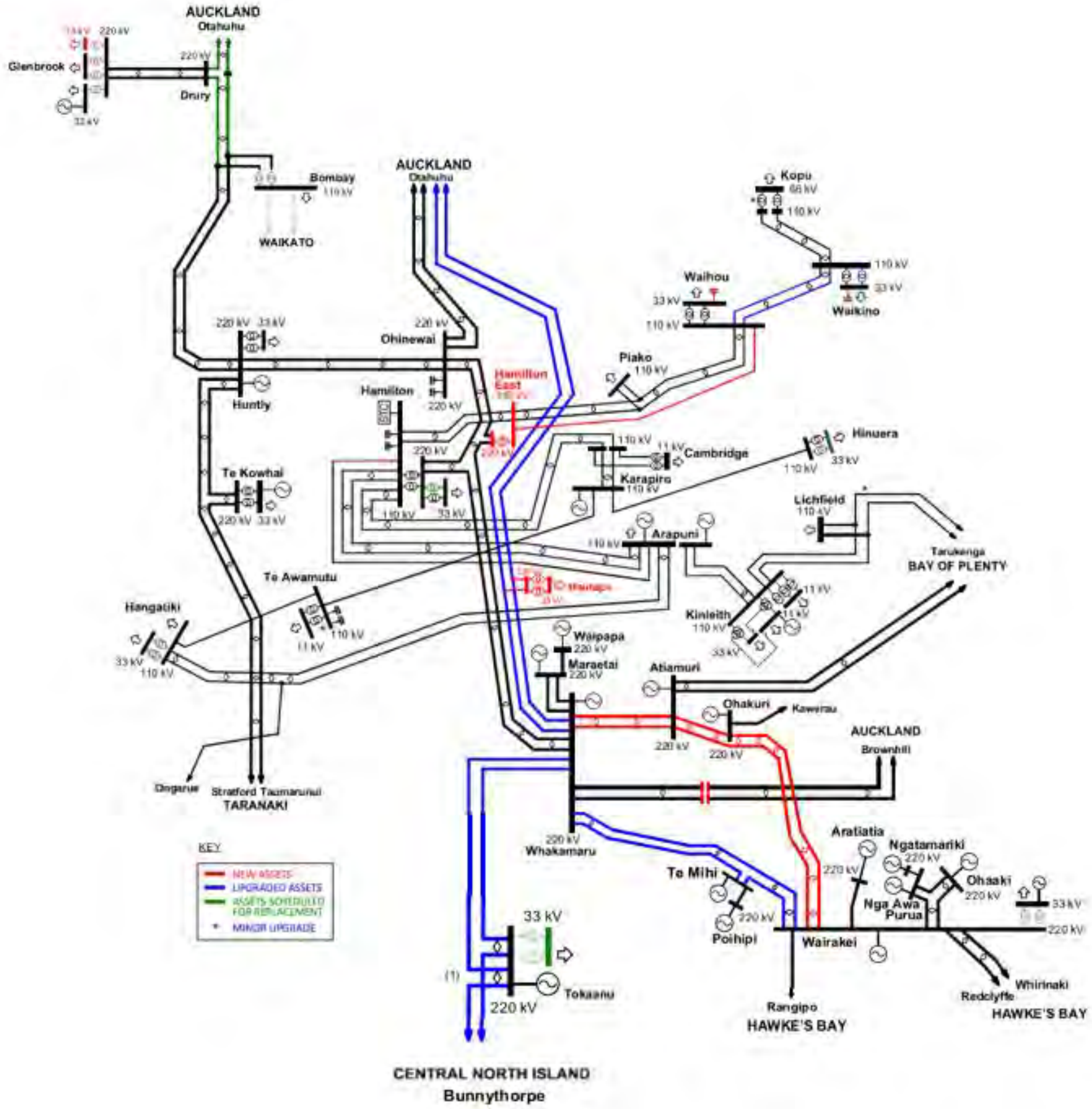


Figure 20 Existing transmission/GXP substations together with future possible upgraded/new assets[25]

[25] Transmission Planning Report 2023

6.1 Demand Forecast

The following Table 3 illustrates Transpower's forecast demand at the transmission substations in the Waikato region from its annual *Transmission Planning Report 2023*[26]. The forecast predicts the demand growing at an average of 3.2% 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 Waikato grid exit points to 2038.

GXP	Power factor	Peak demand (MW)											
		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2038
Arapuni (North)[1]	0.95	21	22	22	22	23	23	23	24	24	25	44	46
Bombay 110 kV[2]	1.00	106	116	122	128	132	136	140	143	146	149	151	156
Cambridge[3]	0.99	57	64	67	83	85	88	91	93	96	99	101	113
Glenbrook – 33 kV (clean bus)[4]	0.96	80	82	83	85	86	87	88	88	89	90	90	90
Glenbrook - NZ Steel (dirty bus)	0.96	112	112	112	112	112	112	112	112	112	112	112	112
Hamilton 11 kV	1.00	39	42	43	44	45	47	47	48	49	50	51	53
Hamilton 33 kV[5]	1.00	141	144	148	151	155	159	163	166	159	163	167	181
Hangatiki 33 kV[6]	0.96	30	40	41	42	50	51	52	53	53	54	55	58
Hangatiki 110 kV	0.84	16	16	29	29	29	29	29	29	29	29	29	29
Hinuera	1.00	26	29	31	31	32	33	33	33	34	34	35	36
Huntly[5]	1.00	33	34	35	36	37	38	39	41	51	52	53	55
Kinleith 11 kV	0.93	79	80	81	81	81	81	81	81	81	81	82	82
Kinleith 33 kV[1]	0.99	25	28	29	30	32	33	34	35	36	36	18	20
Kopu[7]	-0.98	51	53	55	57	58	59	60	61	62	63	64	66
Lichfield	0.92	16	16	16	16	16	16	16	16	16	16	16	16
Piako	0.99	46	49	48	51	54	56	58	60	61	61	62	66
Te Awamutu	0.99	45.00	46	51	52	54	61	63	64	66	67	69	76
Te Kowhai	1.00	101	106	111	114	117	120	123	126	131	132	134	138
Tokaanu	1.00	12	12	12	13	13	13	14	14	15	15	16	17
Waihou	0.99	38	39	44	45	46	47	47	48	48	48	49	51
Waikino	1.00	42	46	50	54	58	62	65	69	70	70	71	73
Wairakei[8]	0.98	56	58	72	75	77	80	81	82	83	83	84	86

Notes:

1. Load shift of 18 MW from Kinleith 33 kV to Arapuni north in 2033.
2. Previously, Bombay GXP supplied Counties Energy's load at both 33 kV and 110 kV. However, following the installation of Counties' Barber Road substation adjacent to the GXP, Counties Energy now takes supply at 110 kV only.
3. High growth at Cambridge from new industrial load and residential development. Transpower is currently constructing a new 220/33 kV grid exit point for Waipa Networks near Hautapu, some of the Cambridge load will be transferred to the new Hautapu grid exit point when it is commissioned end of 2024.
4. This is the Glenbrook 33 kV load on the clean bus with no contribution from the generation connected directly onto the 33 kV bus at Glenbrook.
5. Load shifting of 7 MW from Hamiton to Huntly in 2031.
6. New industrial loads added in 2024 (8 MW) and 2027 (7 MW).
7. Leading power factor.

[26] Transmission Planning Report 2023

8. Unison has advised of industrial load increases at Wairakei including 11.4 MW in 2025.

6.1.1 Arapuni (North) GXP

Powerco's Putāruru substation load was recently (in 2023) transferred to be supplied from Arapuni GXP's North bus, from its previous point of supply, Hinuera GXP. Putāruru and Tīrau substations are the only loads supplied by the Arapuni GXP. Transpower's demand forecast indicates that the Arapuni (North) GXP was expected to have a 2023 peak demand of 21 MW at 0.95 power factor (22.1 MVA). This differs from the historical SCADA data that indicates that, in 2023 the Arapuni GXP experienced a peak load of ~20 MVA (10% lower than forecast). The difference between forecast and actual load may be because Transpower's forecast is prudent.

Arapuni GXP does not have supply transformers, with Powerco taking supply directly at 110 kV.

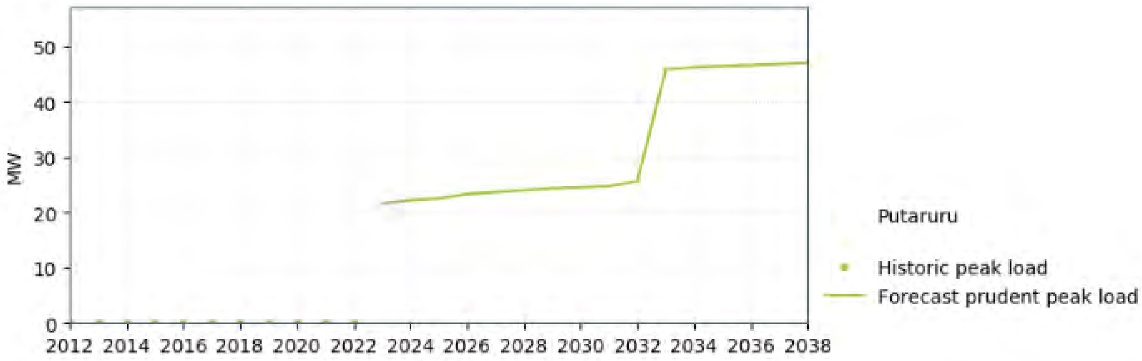
Arapuni's North bus is connected to the wider network via two circuits from Hamilton GXP, rated at 51/62 MVA (summer/winter) each; one circuit from Bombay, rated at 51/62 MVA (summer/winter); and two circuits connecting to Hangatiki (one of which tees off to Ongarue), rated at 57/70 MVA (summer/winter).

There are capacity constraints in the Waikato region as discussed earlier in this report. Namely, during low Arapuni generation and high Waikato load, loss of the Karapiro-Te Awamutu circuit (or an Arapuni-Hamilton circuit later on in the planning period) will result in overloading of the Arapuni-Hamilton circuits. Additionally, an outage of the Karapiro-Te Awamutu circuit activates the Bunnythorpe-Mataroa circuit overload protection scheme, which results in the load of Te Awamutu, Hangatiki, Arapuni North, Ongarue, National Park, and Ohakune GXPs to be supplied from Hamilton via the two Arapuni-Hamilton circuits. Transpower is investigating mitigations for this issue and the following steps are laid out in the TPR:

- Implement a permanent system split at Ongarue on the 110 kV Hangatiki-Rangitoto Hills-Ongarue circuit. This means the loads of Ongarue, National Park, and Ohakune will be supplied by Bunnythorpe instead of Arapuni, reducing loading on the Arapuni-Hamilton circuits. This upgrade is part of Transpower's Net Zero Grid Pathways (NZGP) submission to the Commerce Commission.
- Bussing the Arapuni-Bombay circuit at Hamilton (disconnecting the Hamilton-Bombay portion) to add additional capacity between Arapuni and Hamilton, which will eliminate the post-contingency overloads within the TPR forecast period. This upgrade has an expected cost of $2.5 M.

The following graph[27] shows Arapuni North GXP's historical loading (i.e. the load of Putāruru and Tīrau substations only) and Transpower's demand forecast.

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



The following Figure 21 illustrates Arapuni North's 2023 consumer loading (i.e. the load of Putāruru and Tīrau substations only, and excluding the output from the Arapuni power station). Additionally, Figure 22 illustrates Arapuni North's 2023 loading, including the effects of the connected generation (this gives an indication of how heavily loaded the circuits supplying the site are).

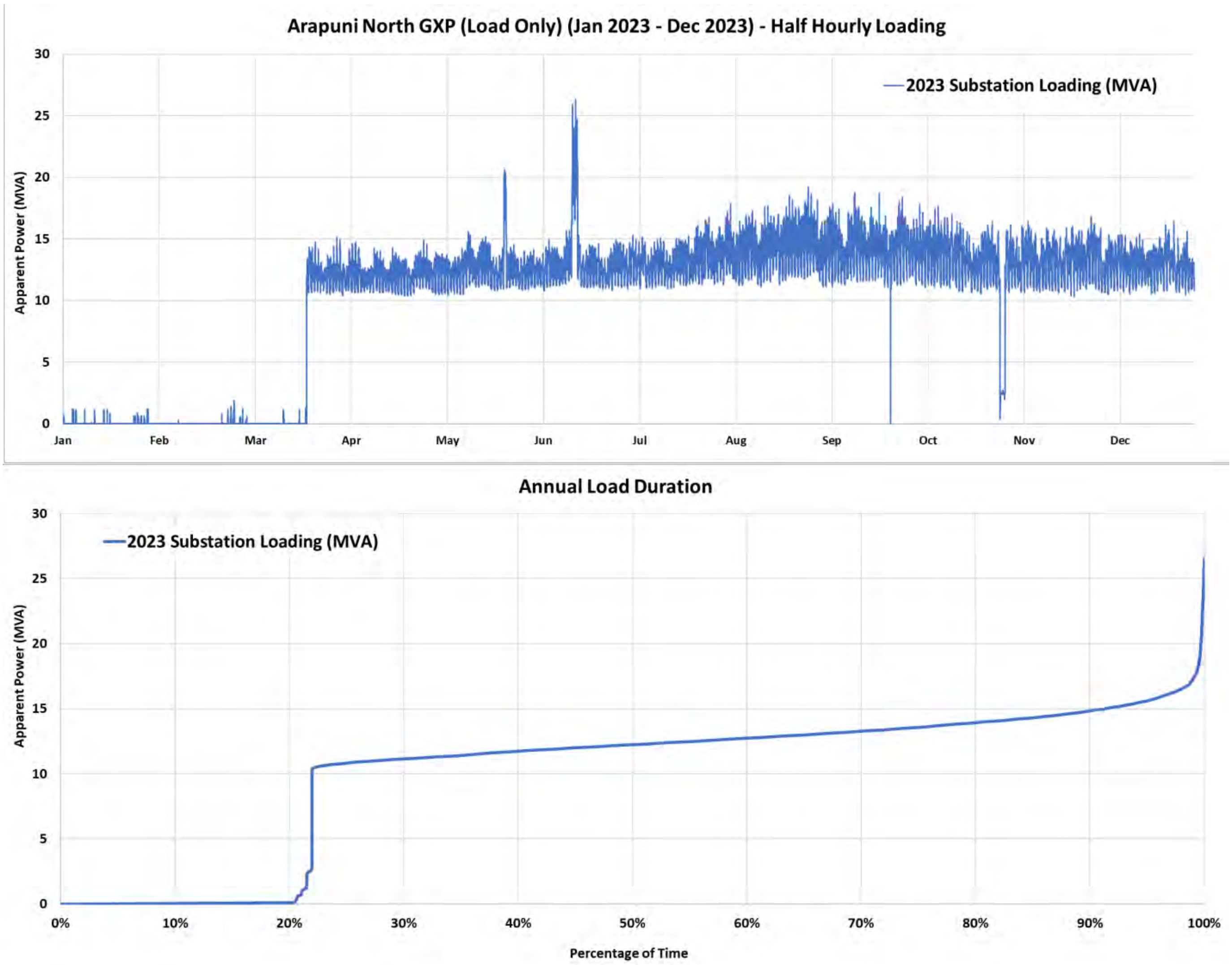
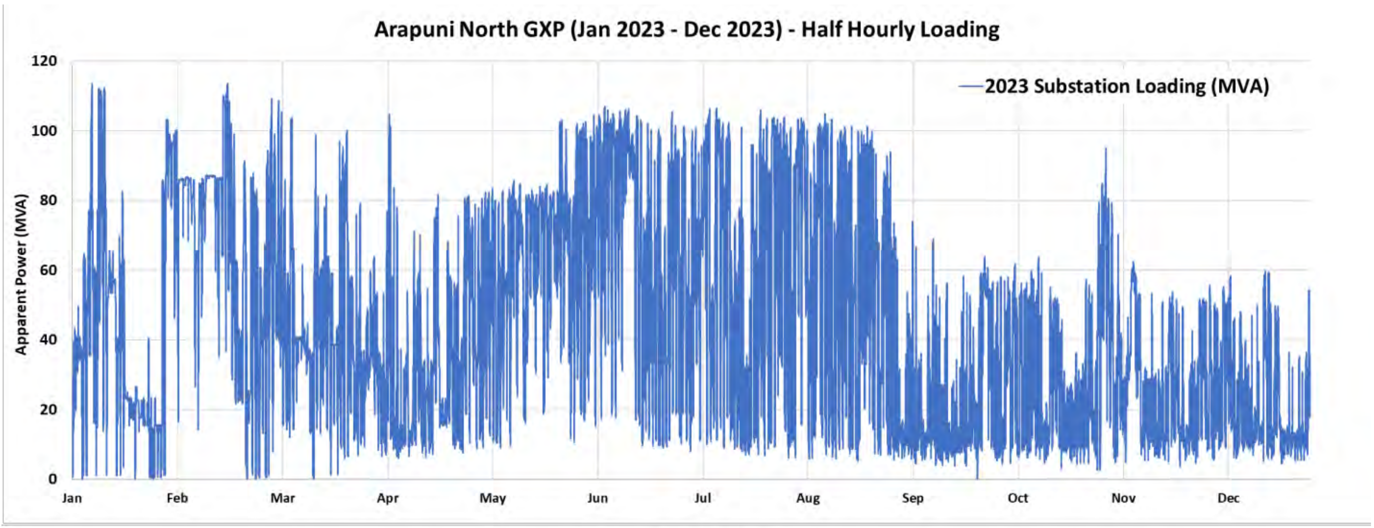


Figure 21. Arapuni North GXP (Load only): 2023 Loading.



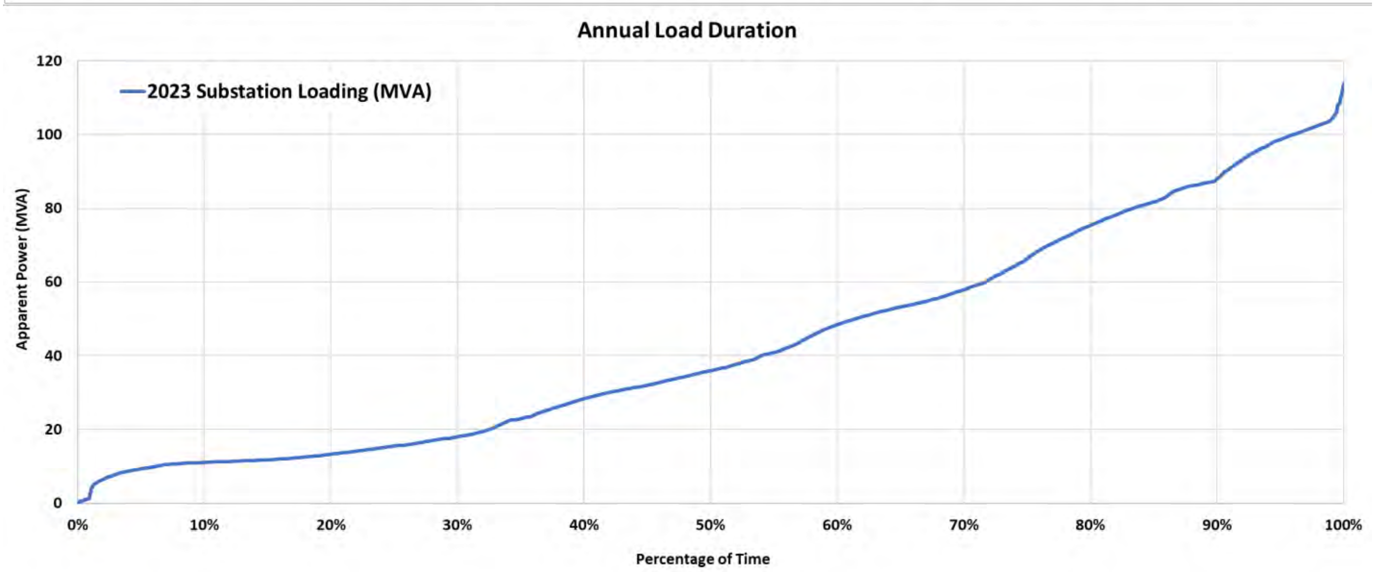


Figure 22. Arapuni North GXP (Load and generation combined): 2023 Loading: Substation capacity.

6.1.2 Bombay GXP

Previously, Bombay GXP supplied Counties Energy's load at both 33 kV and 110 kV. However, following the installation of Counties' Barber Road substation adjacent to the GXP, Counties Energy now takes supply at 110 kV only.

Transpower's demand forecast indicates that the Bombay GXP was expected to have a 2023 peak demand of 106 MW at 1.00 power factor (106 MVA). This value compares to the historical SCADA data that indicates the Bombay GXP recorded a peak load of 97 MVA during the 2023 year. The difference between forecast and actual load may be because Transpower's forecast is prudent.

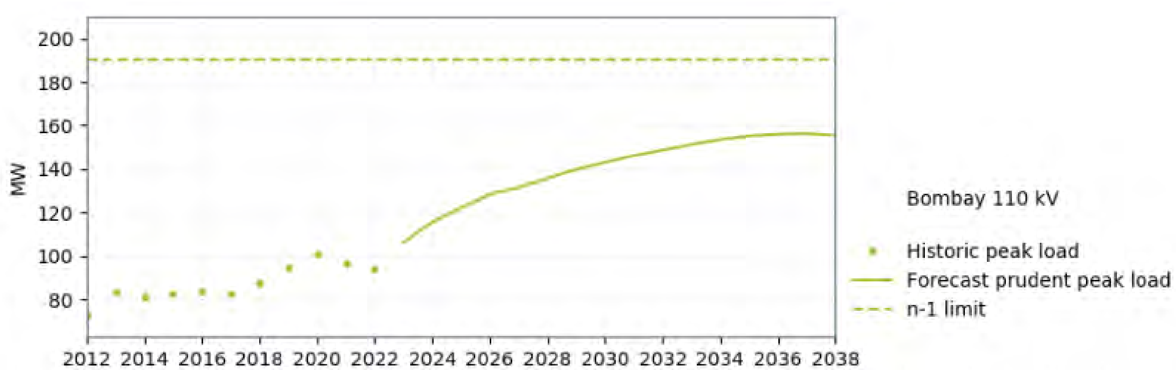
The Bombay GXP is equipped with two 220/110 kV interconnecting transformers providing:

- (N) capacity of 300 MVA and
- (N-1) capacity of 190 MVA.

Ergo notes that the (N-1) capacity at the GXP may be limited by the ICTs, which are rated to only 150 MVA continuously, and so may require upgrades if the full transformer (N-1) capacity of 190 MVA was to be utilised.

At present, two 110 kV circuits connect Bombay to Hamilton and Arapuni GXPs respectively, however Transpower is planning to disconnect these, resulting in the sole supply to Bombay being via the two 220/110 kV transformers.

The peak load is not forecast to exceed the (N-1) capacity of the transformers within the planning period. The following graph[28] compares Bombay GXP's supply capacity with the historical loading and Transpower's demand forecast.



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

The following Figure 23 illustrates Bombay's 2023 loading in comparison to its substation capacity. Ergo notes that the substation capacity shown below assumes the disconnection of the two 110 kV Arapuni-Bombay and Bombay-Hamilton circuits.

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

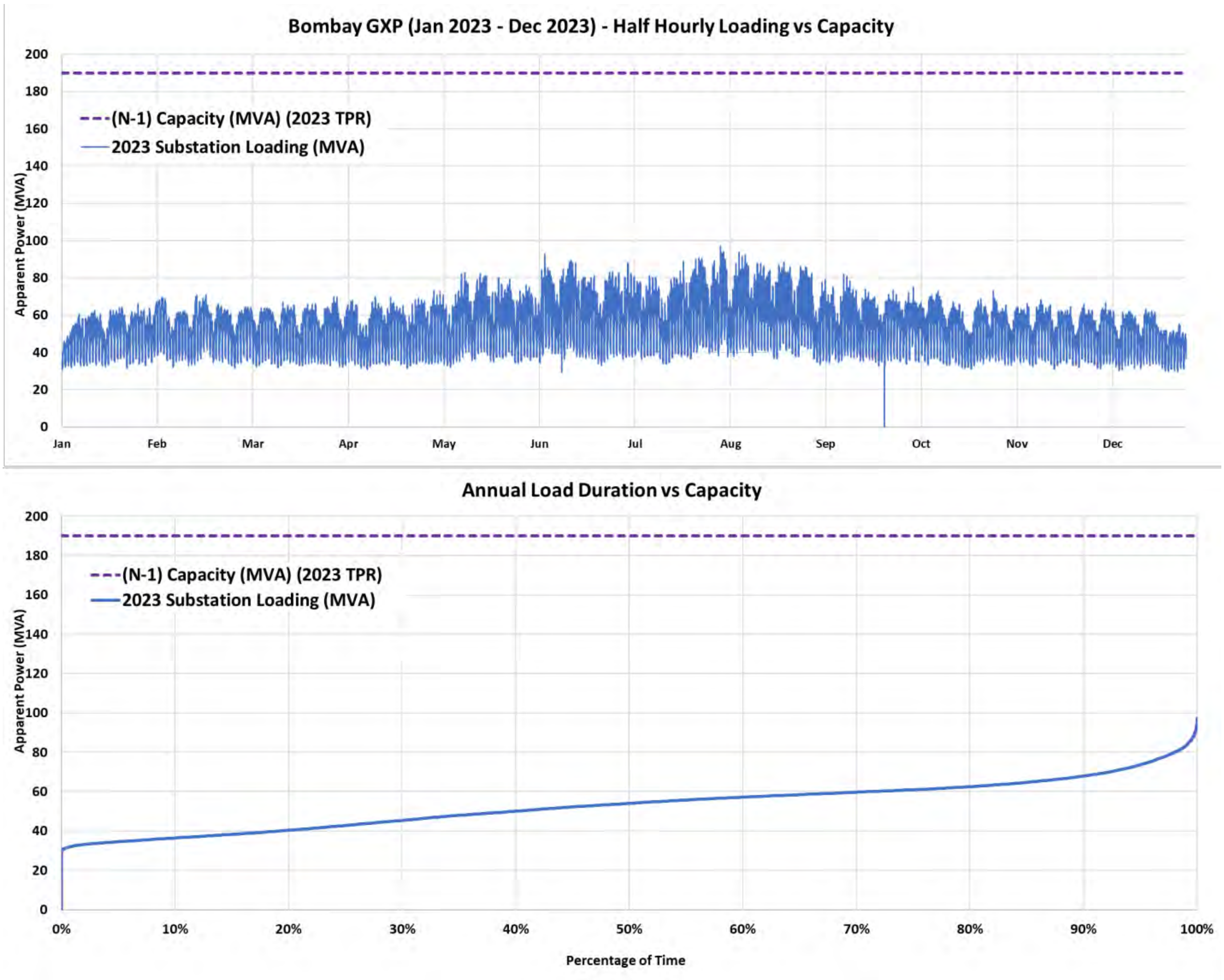


Figure 23. Bombay GXP: 2023 Loading: Substation capacity.

6.1.3 Cambridge GXP

Transpower's demand forecast indicates that the Cambridge GXP was expected to have a 2023 peak demand of 57 MW at 0.99 lagging power factor (~58 MVA). This contrasts with the historical SCADA data that indicates that during 2023 the Cambridge GXP experienced a peak load of 49.4 MVA.

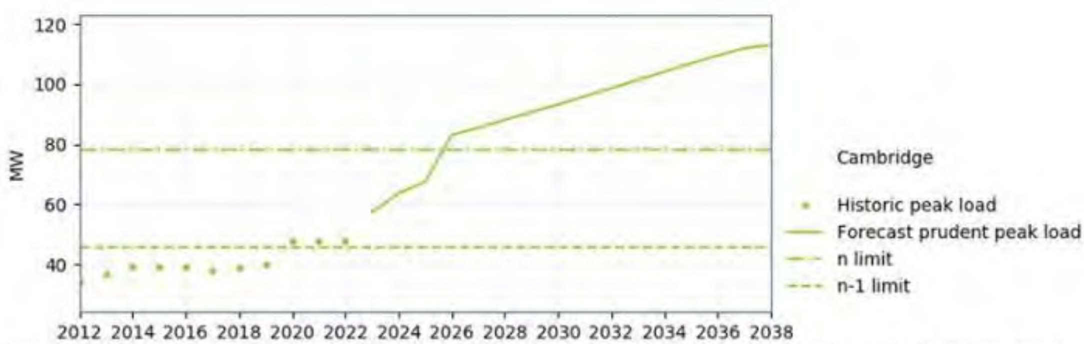
The Cambridge GXP is equipped with two 110/11 kV transformers providing:

- (N) capacity of 80 MVA and
- (N-1) capacity of 47 MVA.

Cambridge is supplied by the two Hamilton-Cambridge-Karapiro circuits which are rated at 57/70 MVA (summer/winter). These two circuits do not have circuit breakers at Cambridge and so a loss of either circuit also disconnects one of the Cambridge supply transformers.

Peak load at Cambridge already exceeds the (N-1) capacity of the transformers. A special protection scheme manages the (N-1) supply issue in the short to medium term, while the forecast predicts that the peak load will exceed the (N) rating of the transformers from 2026. Transpower conducted an investigation with Waipā Networks which determined that establishing a new GXP to offload Cambridge is the best long-term solution. Commissioning of the new GXP is targeted for 2025, and the cost is estimated at $37.9 M.

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

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

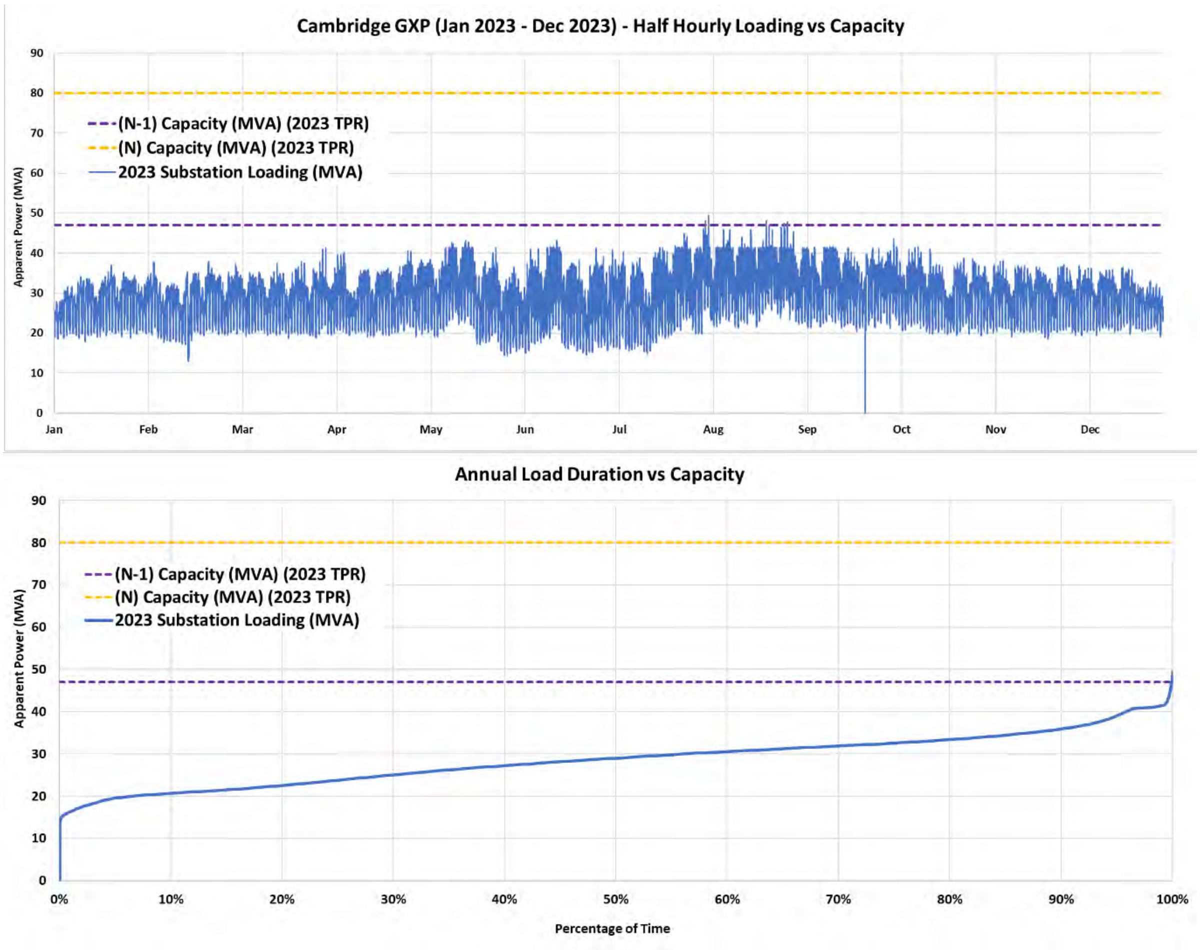


Figure 24. Cambridge GXP: 2023 Loading: Substation capacity.

6.1.4 Glenbrook GXP

Glenbrook GXP has two 33 kV buses, one "dirty bus" (which supplies the portion of the Glenbrook Steel Mill's load which creates significant and regular voltage disturbances) and one "clean bus" (which connects the remaining Steel Mill load and cogeneration and supplies the Counties Energy network). Generally, where Glenbrook GXP is referred to in this report, it refers to the clean bus.

Transpower's demand forecast predicts that the Glenbrook GXP dirty bus was expected to have a peak load of 112 MW at 0.96 power factor (~116.7 MVA) through to the end of the forecast period, which aligns with the historical SCADA data which indicates that, during 2023, the Glenbrook GXP dirty bus experienced a peak load of 112 MVA.

The dirty bus is supplied by two 220/33 kV transformers which provide the Steel Mill load with an (N) capacity of 280 MVA and (N-1) capacity of 140 MVA. The transformer capacity is limited by 33 kV switchgear and incomer cables.

Transpower's demand forecast indicates that the Glenbrook GXP clean bus was expected to have a 2023 peak demand of 80 MW at 0.96 power factor (~83.3 MVA). This differs from the historical SCADA data that indicates that, during 2023, the Glenbrook GXP clean bus experienced a peak load of 64.8 MVA (22% lower than forecast). The difference between forecast and actual load may be because Transpower's forecast is prudent.

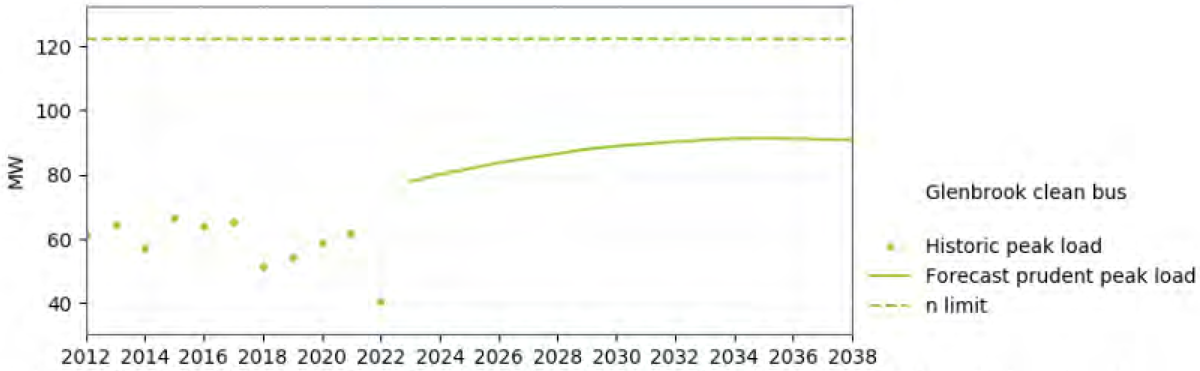
The Glenbrook GXP clean bus is equipped with one 220/33 kV transformer which is rated at 140 MVA. Additionally, one of the dirty bus transformers can be switched to supply the clean bus when required, resulting in:

- (N) capacity of 140 MVA and
- (N-1-switched) capacity of 140 MVA.

circuitsGlenbrook is supplied from Drury via a double circuit 220kV spur line. Each of the circuits are rated to approximately 694/762 MVA (summer/winter), which well exceeds the installed transformer capacity at the Glenbrook GXP. circuits

Peak load at Glenbrook GXP clean bus is well within the continuous rating of the single supply transformer, even without the generation contribution at the Steel Mill. The following graph[30] compares Glenbrook GXP's supply capacity with the historical loading and Transpower's demand forecast.

[30] 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 25 illustrates Glenbrook clean bus' 2023 loading in comparison to its substation capacity.

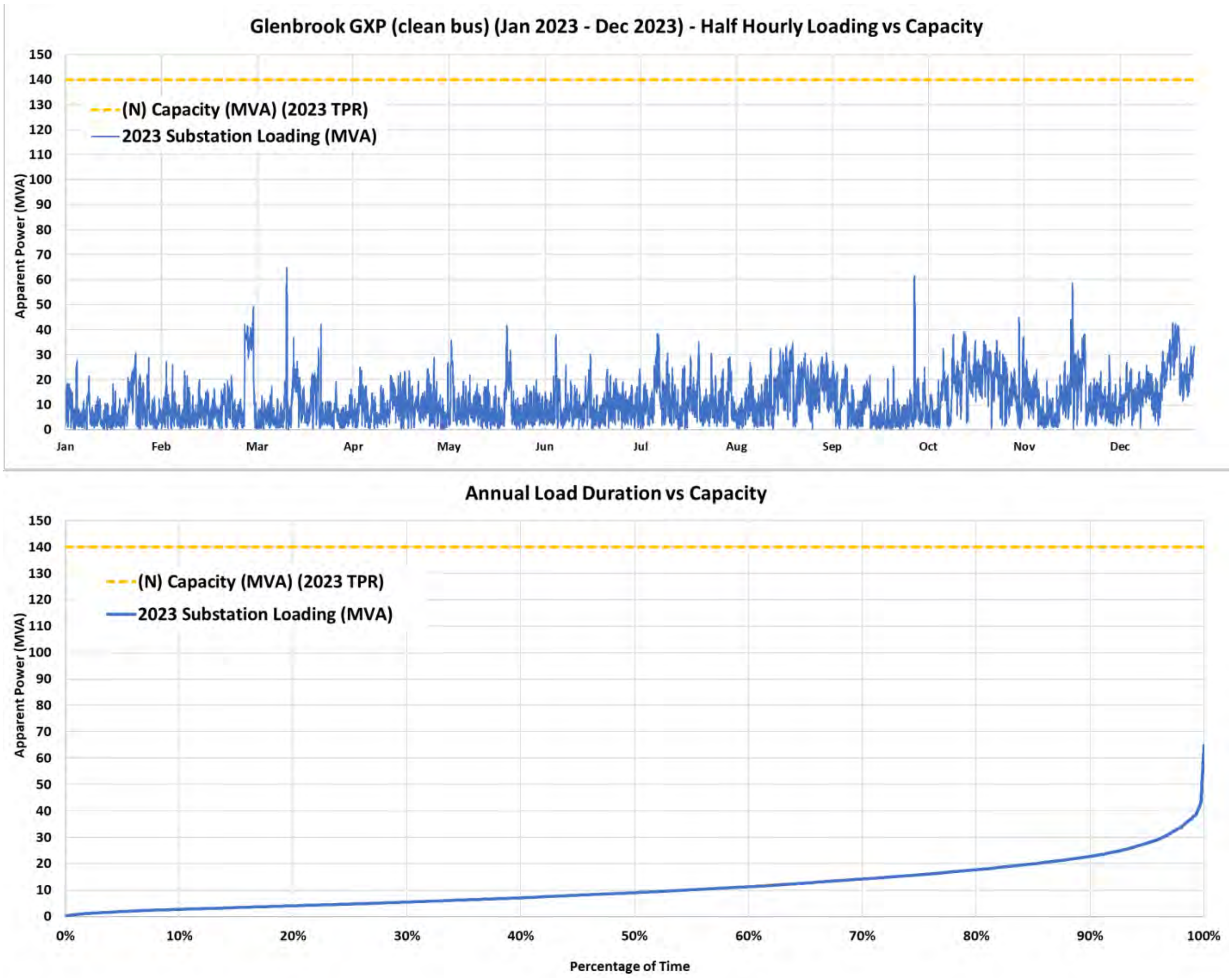


Figure 25. Glenbrook GXP: 2023 Loading: Substation capacity.

6.1.5 Hamilton 11 kV GXP

Transpower's demand forecast indicates that the Hamilton 11 kV GXP was expected to have a 2023 peak demand of 39 MW at 1.00 power factor (39 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Hamilton 11 kV GXP experienced a peak load of 30.0 MVA (23% lower than forecasted). The difference between forecast and actual load may be because Transpower's forecast is prudent.

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

- (N) secure capacity of 80 MVA and
- (N-1) capacity of 44 MVA.

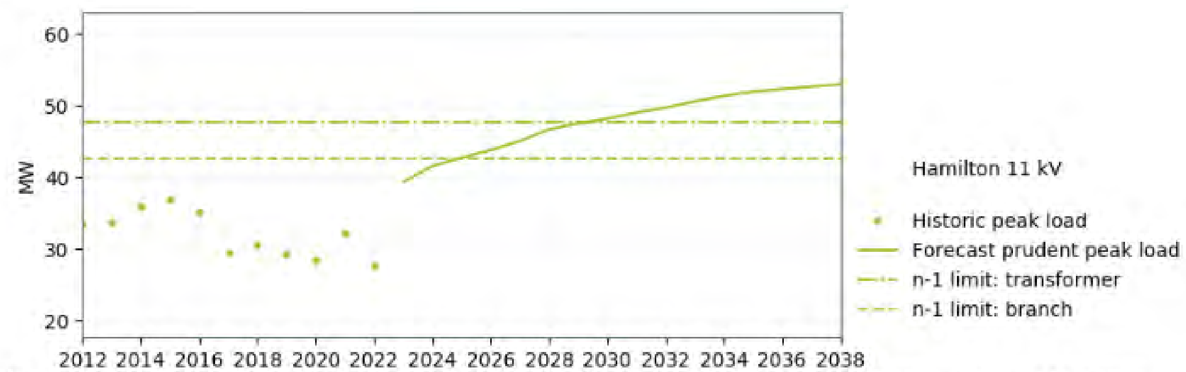
The 110/11 kV transformer capacity is presently limited by the 11 kV protection and switchgear.

Hamilton's 110 kV bus is supplied by the generation at the Arapuni North GXP (via two circuits rated at 51/62 MVA (summer/winter)), as well as via the 220/110 kV interconnecting transformers at Hamilton GXP, which have an (N) capacity of 420 MVA and (N-1) capacity of 248/259 MVA (summer/winter). As discussed above, during periods of high Waikato 110 kV load, the (N-1) capacity of the Waikato 220/110 kV interconnecting transformers (located in Hamilton) can be exceeded. Transpower are investigating options to mitigate this issue, including:

- Migration of the Hamilton 110/11 kV loads to the 220 kV system.
- Developing one or more new GXPs within the region to supply loads presently supplied by the 110 kV system.
- Installing a third interconnecting transformer in the Hamilton East area.

Estimates are not given for the first two options, with the installation of a Hamilton East interconnector estimated at $30 M.

The following graph[31] compares Hamilton 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.

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

The following Figure 26 illustrates Hamilton 11 kV's 2023 loading in comparison to its substation capacity.

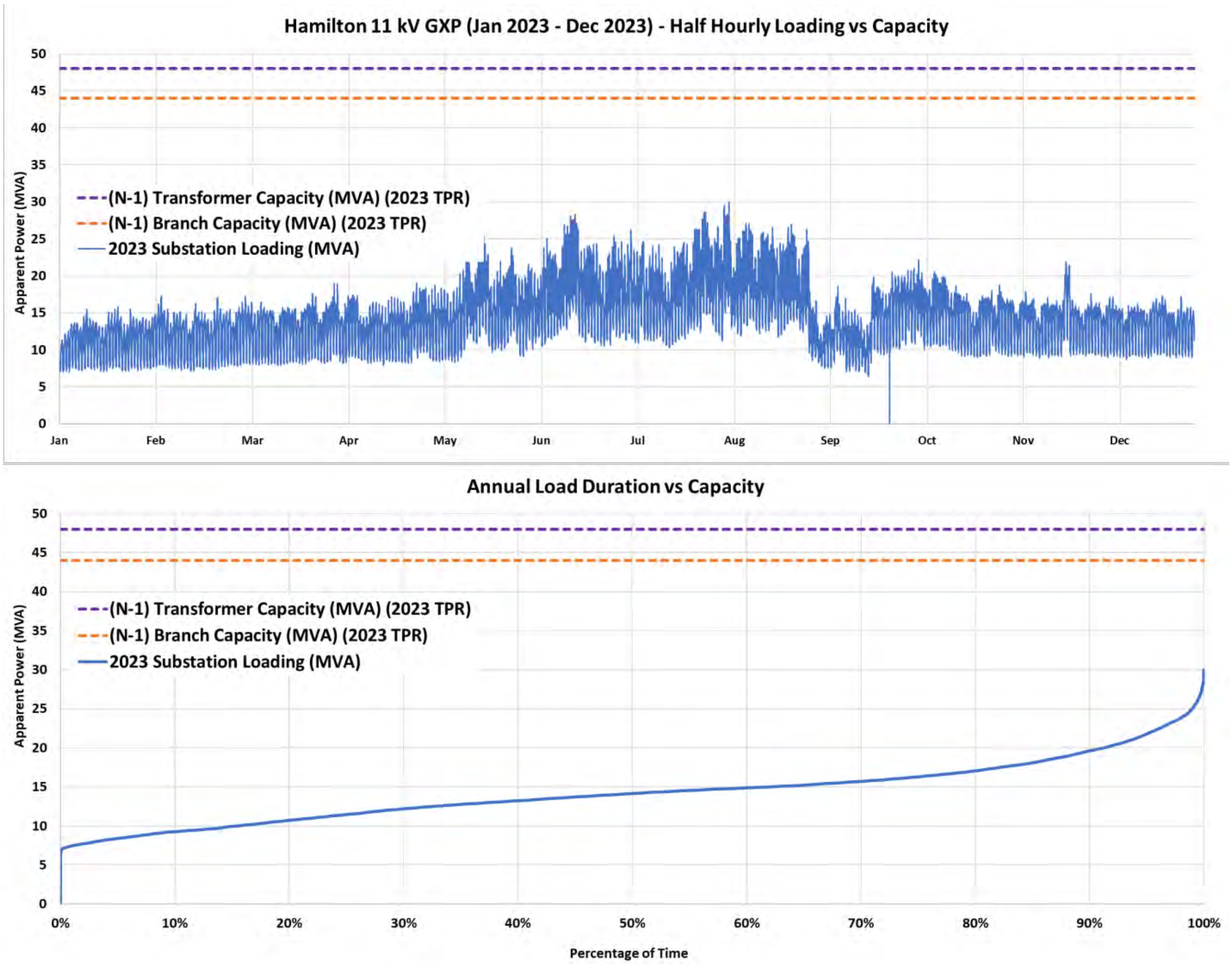


Figure 26. Hamilton 11 kV GXP: 2023 Loading: Substation capacity.

6.1.6 Hamilton 33 kV GXP

Transpower's demand forecast indicates that the Hamilton 33 kV GXP was expected to have a 2023 peak demand of 141 MW at 1.00 power factor (141 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Hamilton 33 kV GXP experienced a peak load of 148 MVA.

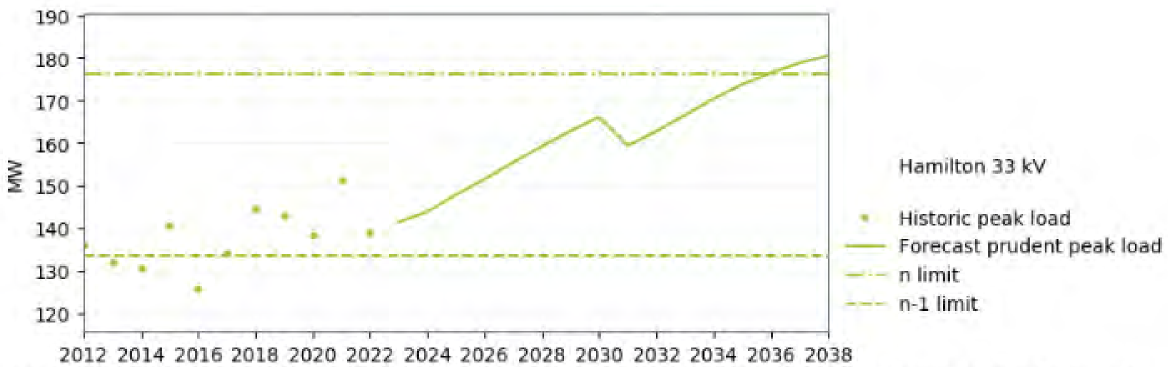
The Hamilton 33 kV GXP is equipped with two 220/33 kV transformers providing:

- (N) secure capacity of 220 MVA and
- (N-1) capacity of 132 MVA.

Hamilton GXP's 220 kV bus is supplied by two 220 kV circuits from Whakamaru (one of which connects via Ohinewai), each rated at 615/671 MVA (summer/winter).

Peak load at Hamilton 33 kV already exceeds the (N-1) capacity of the transformers and is expected to exceed the (N) capacity by the end of the forecast period. At present, this supply issue is operationally managed by WEL Networks, by shifting load between the Hamilton GXP and the Te Kowhai GXP. Transpower intends to investigate more options to address the issue when WEL Networks can no longer manage the issue operationally.

The following graph[32] compares Hamilton 33 kV GXP's supply capacity with the historical loading and Transpower's demand forecast.



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

The following Figure 27 illustrates Hamilton 33 kV's 2023 loading in comparison to its substation capacity.

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

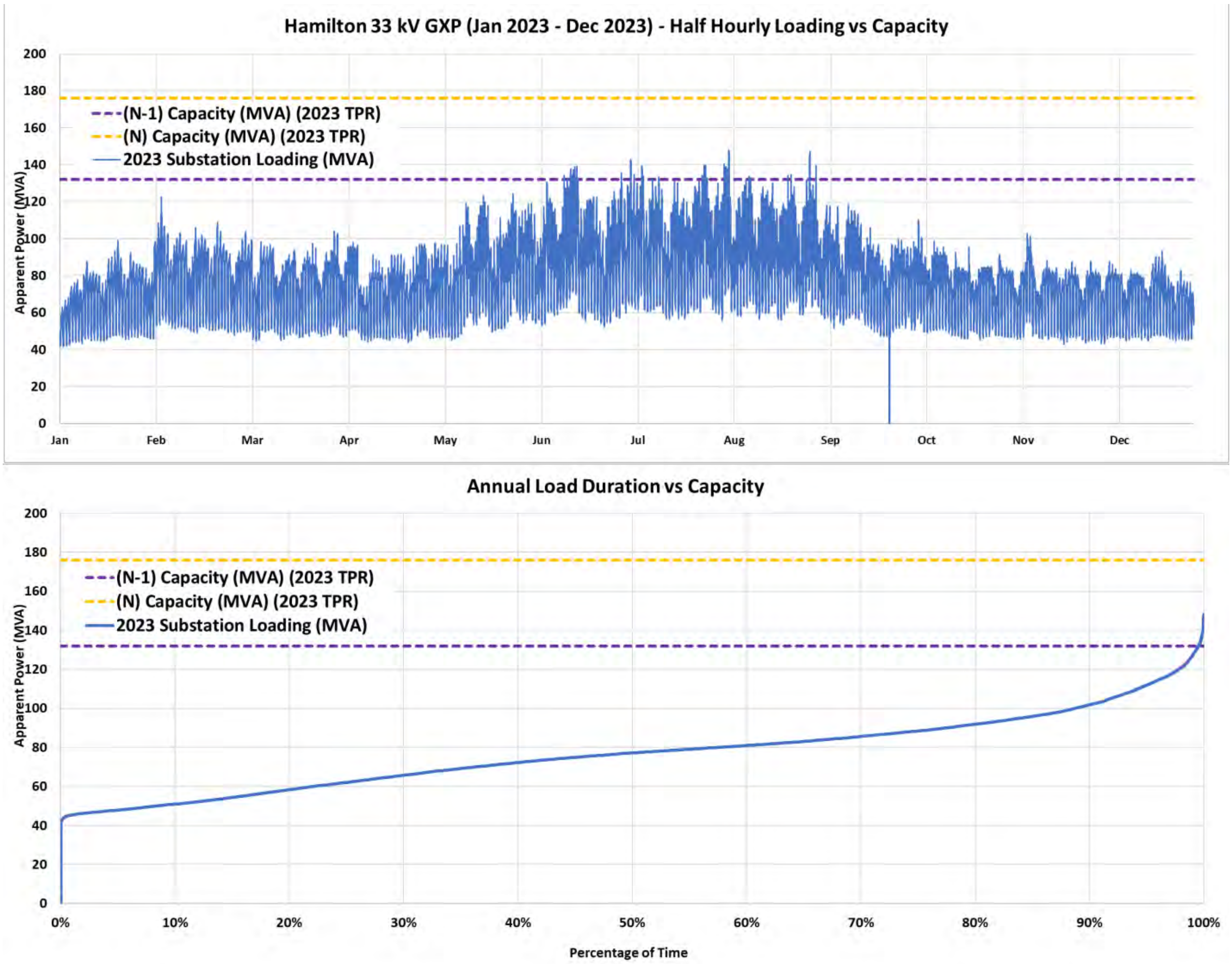


Figure 27. Hamilton 33 kV GXP: 2023 Loading: Substation capacity.

6.1.7 Hangatiki 33 kV GXP

Transpower's demand forecast indicates that the Hangatiki 33 kV GXP was expected to have a 2023 peak demand of 30 MW at 0.96 power factor (~31.3 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Hangatiki 33 kV GXP experienced a peak load of 25 MVA (20% lower than forecasted). The difference between forecast and actual load may be because Transpower's forecast is prudent.

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

- (N) secure capacity of 40 MVA and
- (N-1) capacity of 22 MVA.

Hangatiki GXP is supplied at 110 kV via two circuits from Arapuni North (each rated at 57/70 MVA (summer/winter)), and by one circuit from Karapiro via Te Awamutu (rated at 63/77 MVA (summer/winter). The Karapiro GIP is connected to Hamilton GXP via two circuits each rated at 57/70 MVA (summer/winter).

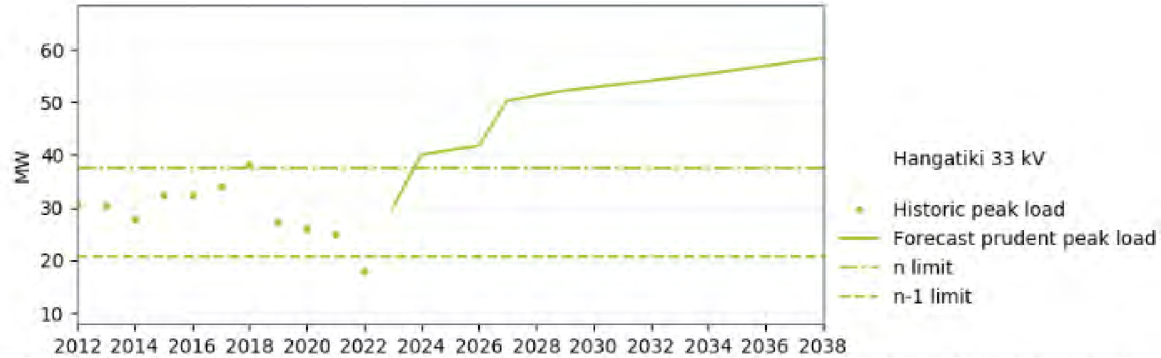
Peak load at Hangatiki 33 kV already exceeds the (N-1) capacity of the supply transformers, and is expected to exceed the (N) capacity from summer of 2024. The supply transformers have an overload scheme preventing the loss of one transformer causing significant overloading of the other. When operating close to the (N) capacity, loss of one transformer results in the tripping of the other.

The Hangatiki 33 kV bus voltage may fall below 0.95 p.u. following a supply transformer or 110 kV circuit outage during high load periods. This issue is related to the poor power factor of the Hangatiki loads, coupled with heavy loadings on the 110 kV transmission circuits into Hangatiki and lack of on-load tap-changers (OLTC) on the two Hangatiki 110/33 kV transformers.

Transpower has plans to work with The Lines Company to increase the supply capacity/security to Hangatiki. Longer term solutions being considered are upgrades of the 110/33 kV transformers or establishing a new 220/33 kV GXP. No cost estimates are provided for these potential improvements at present.

The following graph[33] compares Hangatiki 33 kV GXP's supply capacity with the historical loading and Transpower's demand forecast.

[33] 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 28 illustrates Hangatiki 33 kV's 2023 loading in comparison to its substation capacity.

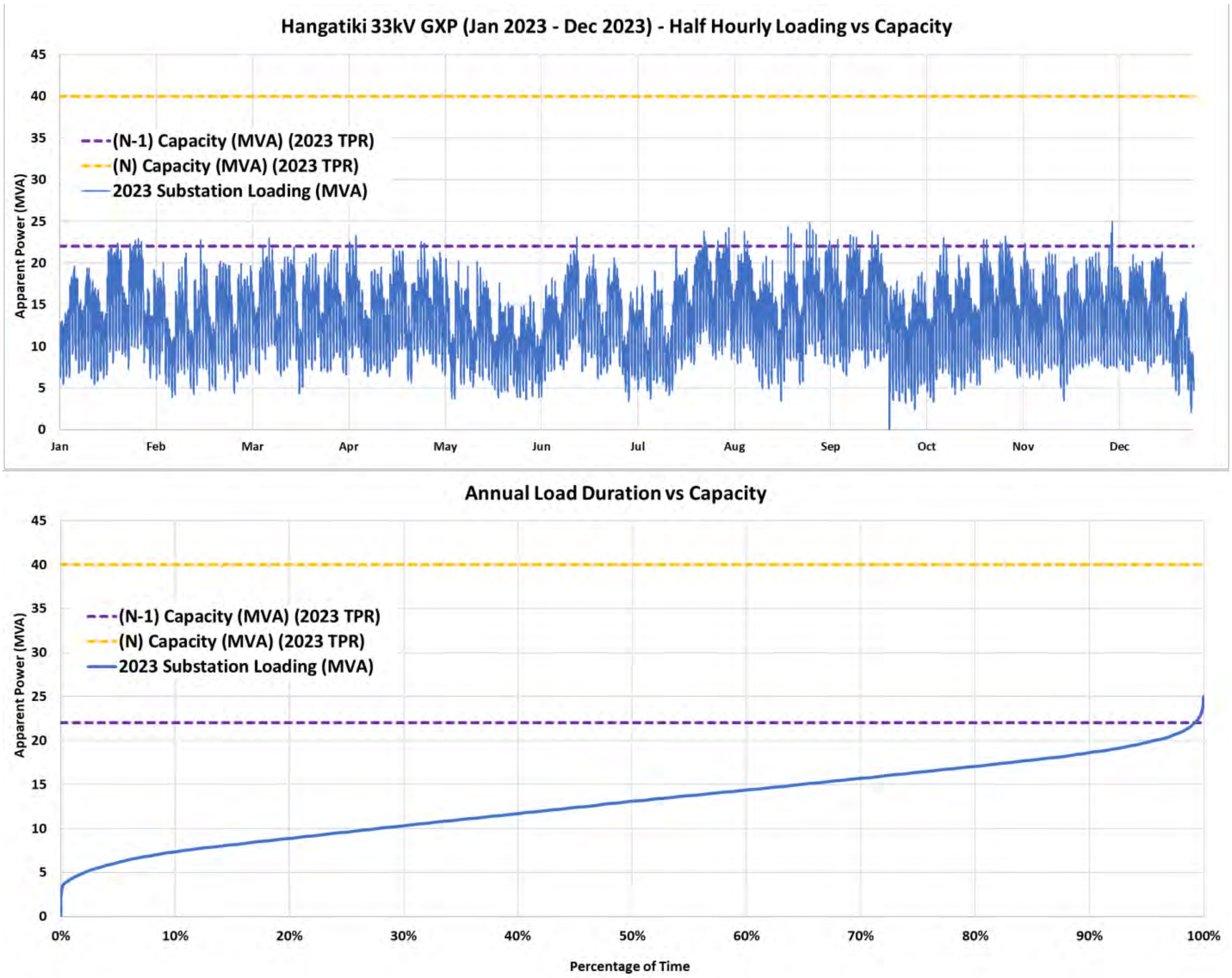


Figure 28. Hangatiki 33 kV GXP: 2023 Loading: Substation capacity.

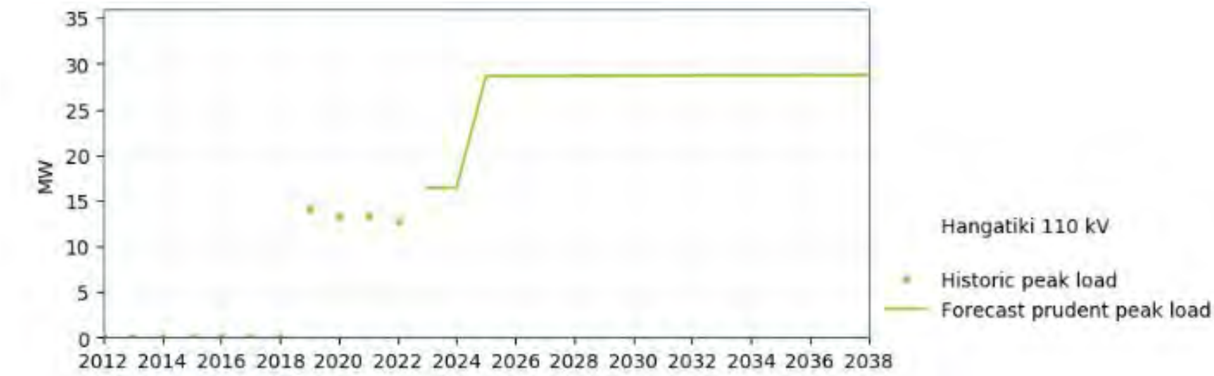
6.1.8 Hangatiki 110 kV GXP

Transpower's demand forecast indicates that the Hangatiki 110 kV GXP was expected to have a 2023 peak demand of 16 MW at 0.84 power factor (~19 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Hangatiki 110 kV GXP experienced a peak load of 18.9 MVA.

The Lines Company takes direct supply from the 110 kV bus. A single 110/33 kV transformer (30 MVA) and 33 kV bus both owned by The Lines Company supply the Taharoa Iron Sands operation.

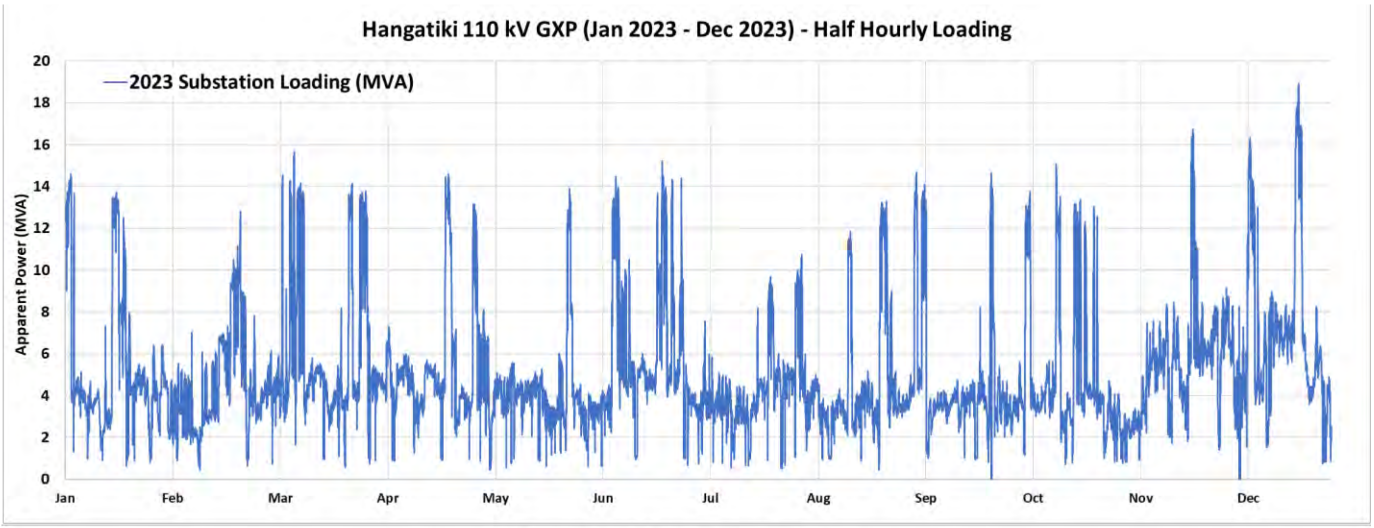
Hangatiki GXP is supplied at 110 kV via two circuits from Arapuni North (each rated at 57/70 MVA (summer/winter)), and by one circuit from Karapiro via Te Awamutu (rated at 63/77 MVA (summer/winter). The Karapiro GIP is connected to Hamilton GXP via two circuits each rated at 57/70 MVA (summer/winter).

The following graph[34] shows Hangatiki 110 kV GXP's historical loading and Transpower's demand forecast.



The following Figure 29 illustrates Hangatiki 110 kV's 2023 loading.

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



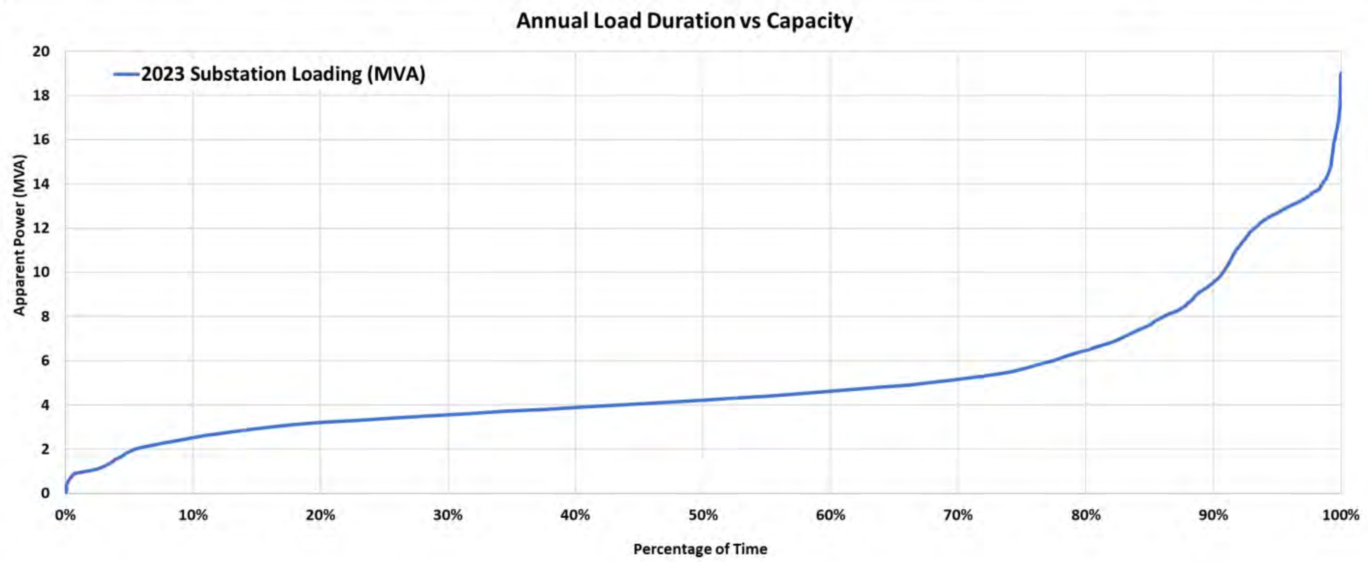


Figure 29. Hangatiki 110 kV GXP: 2023 Loading.

6.1.9 Hinuera GXP

Transpower's demand forecast indicates that the Hinuera GXP was expected to have a 2023 peak demand of 26 MW at 1.00 power factor (26 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Hinuera GXP experienced a peak load of 38.6 MVA (49% higher than the forecast). The difference between the forecast and the actual load is because the TPR assumed that Powerco's Putāruru load was transferred to Arapuni, which was not the case in reality for the investigated year.

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

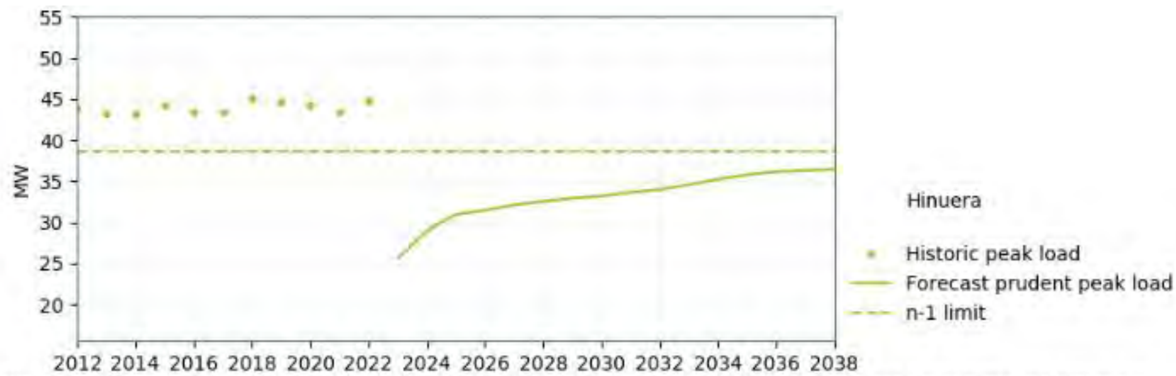
- (N) secure capacity of 80 MVA and
- (N-1) capacity of 39 MVA.

Hinuera GXP is supplied by one circuit from Karapiro, rated at 63/77 MVA (summer/winter). The Karapiro GIP is connected to Hamilton GXP via two circuits each rated at 57/70 MVA (summer/winter).

While the single circuit from Karapiro provides the GXP with (N) security overall, Powerco is able to backfeed its Hinuera load operationally within their network from the Arapuni North and Piako GXPs.

While recent loading has been above the (N-1) capacity of the transformers at Hinuera, Transpower expects that peak load at Hinuera will remain below the transformer (N-1) capacity for the forecast period. Ergo expects that the drop in load forecasted by Transpower relates to the shifting of the Powerco Putāruru and Tīrau substations to the new Arapuni North GXP supply.

The following graph[35] compares Hinuera 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 30 illustrates Hinuera's 2023 loading in comparison to its substation capacity, and which clearly illustrates the off-loading of Hinuera onto Arapuni North during the first quarter of 2023.

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

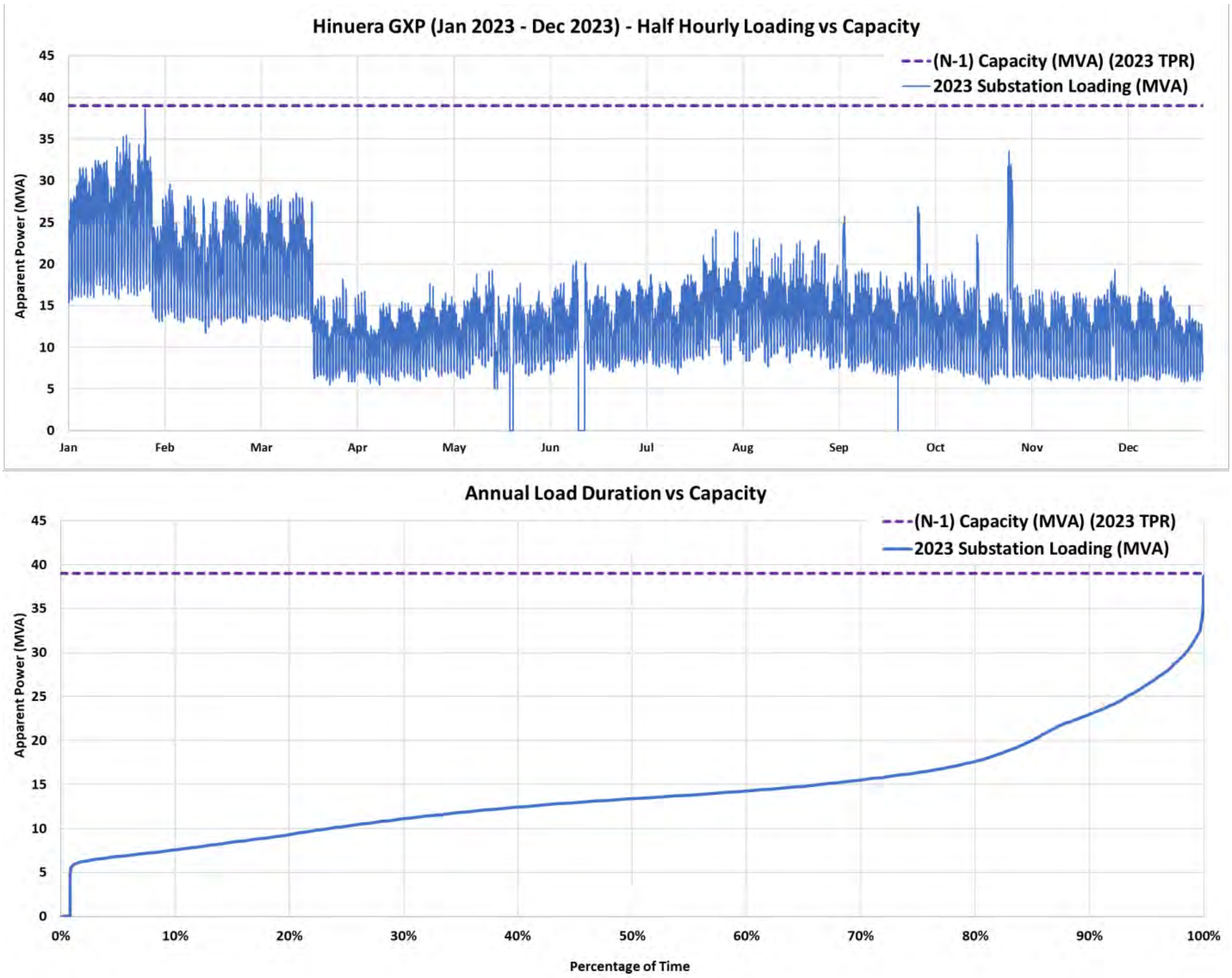


Figure 30. Hinuera GXP: 2023 Loading: Substation capacity.

6.1.10 Huntly GXP

Transpower's demand forecast indicates that the Huntly GXP was expected to have a 2023 peak demand of 33 MW at 1.00 power factor (33 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Huntly GXP experienced a peak load of 33.9 MVA. This peak appears to have occurred during a period of temporary backfeed, however it is not substantially larger than the peak at the GXP under normal loading conditions.

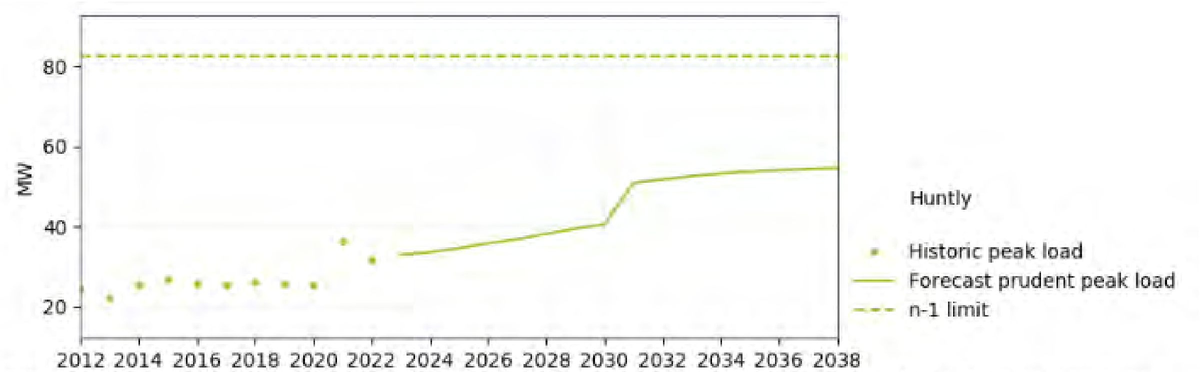
The Huntly GXP is equipped with two 220/33 kV transformers providing:

- (N) secure capacity of 120 MVA and
- (N-1) capacity of 82 MVA.

The transformer capacity at Huntly is presently limited by the 33 kV incomer cables.

Huntly GXP is supplied by two 220 kV Huntly-Ohinewai transmission circuits which are rated at 694/764 MVA (summer/winter), which in turn connect to the Hamilton (single circuit with summer/winter rating 615/675 MVA) and Whakamaru (single circuit with summer/winter rating 615/675 MVA) 220 kV buses. Huntly connects to Te Kowhai, Stratford and Taumaranui via two circuits rated at 354 MVA and 469/492 MVA (summer/winter) (Stratford and Taumaranui are within the Taranaki region). Huntly connects to Ōtāhuhu directly via two circuits rated at 694/762 MVA (summer/winter), as well as via two circuits from Ohinewai to Ōtāhuhu rated at 615/671 MVA (summer/winter).

The following graph[36] compares Huntly 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 31 illustrates Huntly's 2023 loading in comparison to its substation capacity.

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

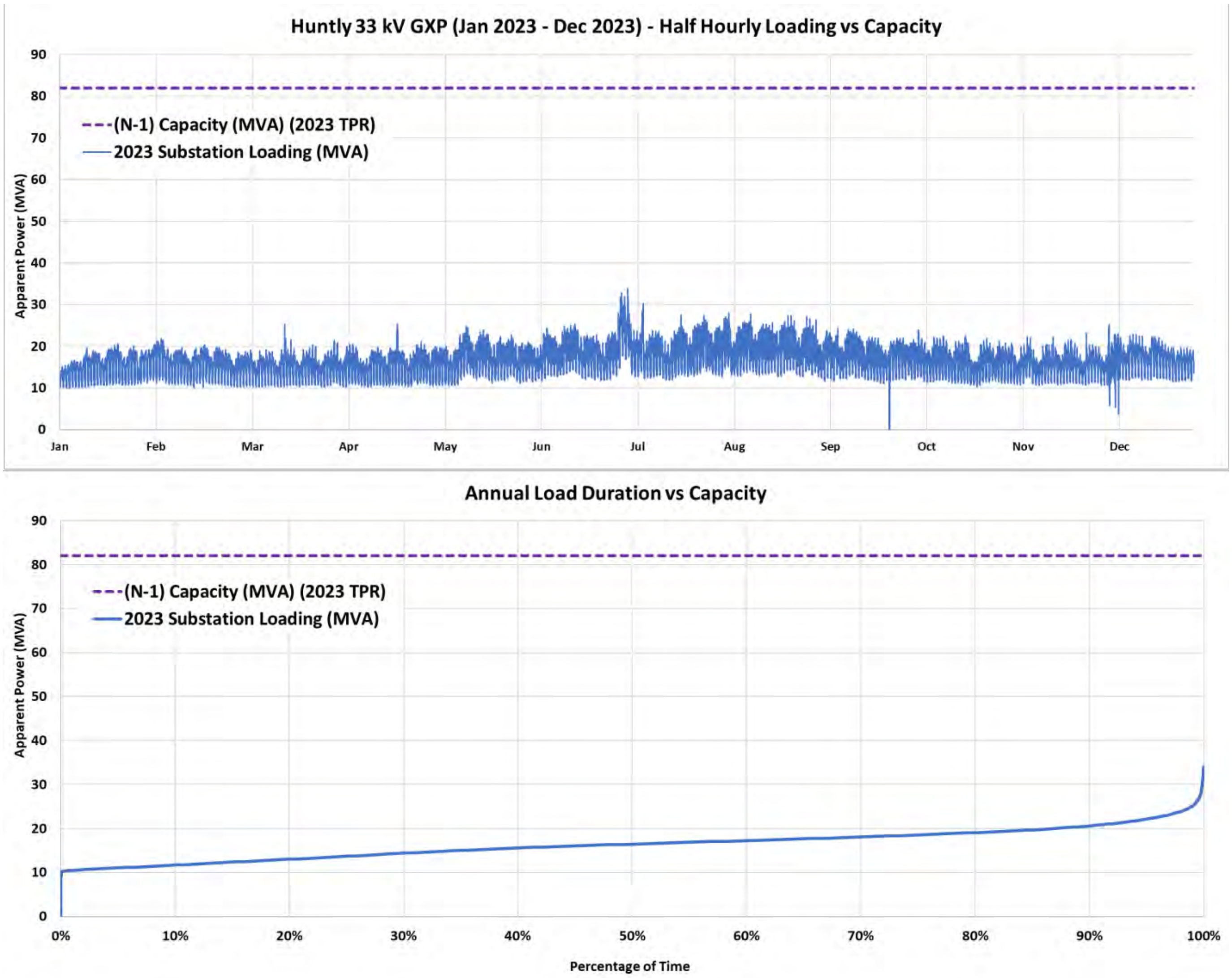


Figure 31 Huntly GXP: 2023 Loading: Substation capacity.

6.1.11 Kinleith 11 kV GXP

Transpower's demand forecast indicates that the Kinleith 11 kV GXP was expected to have a 2023 peak demand of 79 MW at 0.93 power factor (~85 MVA). This compares to the historical SCADA data that indicates that, during 2023, the Kinleith 11 kV GXP experienced a peak load of 76.6 MVA. The only load on the 11 kV GXP is that of the Oji Fibre Solutions plant.

The Oji Fibre Solutions plant is supplied by three 40 MVA 110/11 kV transformers, and two 110/33/11 kV transformers (only one of the three-winding transformers can be connected to the 11 kV bus at a time). There is a 47 MVA embedded generator which connects to plant's 11kV bus via a 50/20/30MVA, 110/33/11 kV transformer.

The three 110/11 kV transformers and one 110/33/11 kV transformer provide the 11 kV GXP with:

- (N) secure capacity of 150 MVA and
- (N-1) capacity of 110 MVA.

Kinleith 110 kV bus connects to the generation at Arapuni's South bus via two transmission circuits, rated at 57/70 MVA and 63/77 MVA (summer/winter), respectively. Kinleith is also supplied from the Bay of Plenty GXP Tarukenga via two circuits rated at 51/62 MVA and 63/77 MVA (summer/winter) respectively.

The following Figure 32 illustrates Kinleith 11 kV's 2023 loading in comparison to its substation capacity.

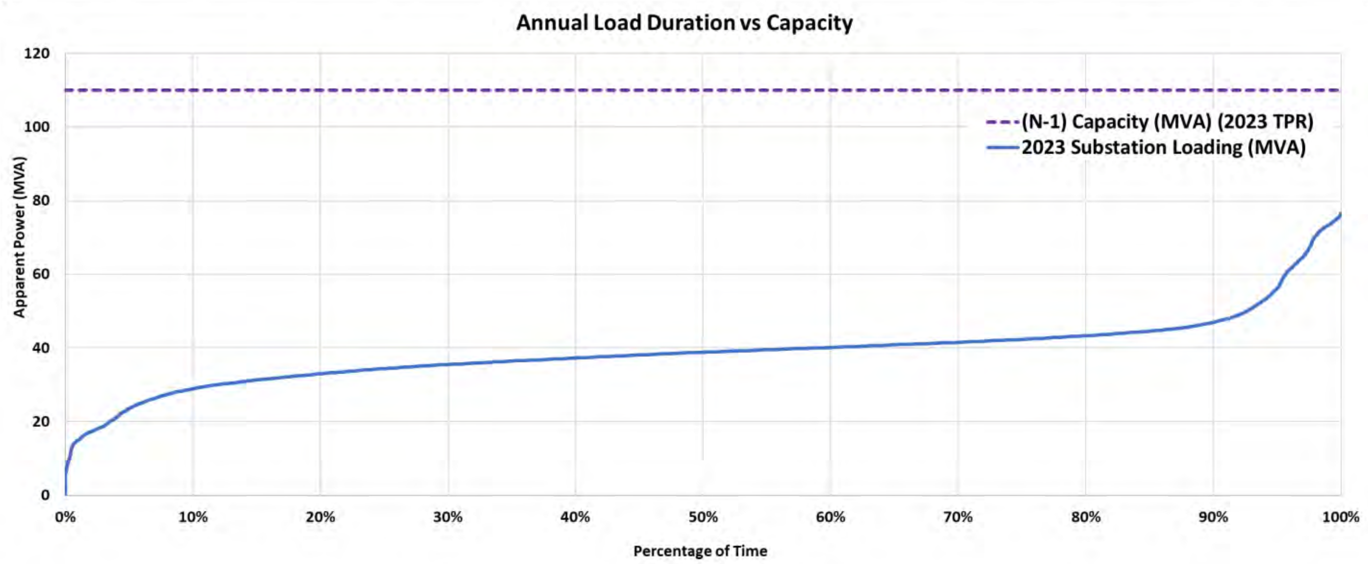


Figure 32 Kinleith 11 kV GXP: 2023 Loading: Substation capacity.

6.1.12 Kinleith 33 kV GXP

Transpower's demand forecast indicates that the Kinleith 33 kV GXP was expected to have a 2023 peak demand of 25 MW at 0.99 power factor (~25.3 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Kinleith 33 kV GXP experienced a peak load of 20.1 MVA (20% lower than the forecast). The difference between forecast and actual load may be because Transpower's forecast is prudent.

The Kinleith 33 kV GXP is equipped with a single 50/40/50MVA, 110/33/11 kV transformer, but has a switched backup via the 50/20/30MVA, 110/33/11 kV transformer discussed above in Section 6.1.11. This means the Kinleith 33kV GXP is afforded with the following capacity:

- (N) secure capacity of 40 MVA and
- Switched (N-1) capacity of 20 MVA.

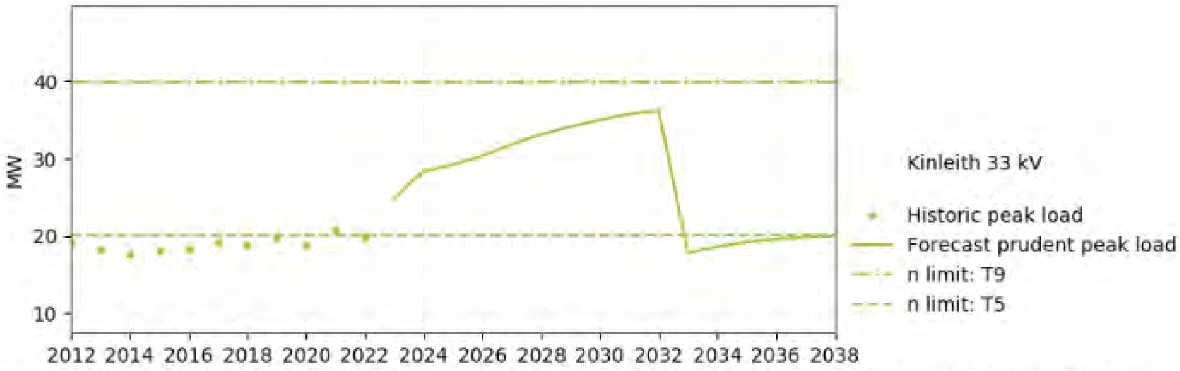
As discussed above the 33 kV windings of the transformers T9 and T5 are rated at 40 MVA and 20 MVA respectively but due to a vector group mismatch only one 110/33/11 kV transformer can supply the Kinleith 33 kV GXP at any one time. If both transformers are available ((N) security), the higher rating of 40 MVA is available; however, in (N-1) conditions, the worst case is if the 40 MVA transformer is offline, resulting in a switched (N-1) rating of 20 MVA.

Kinleith 110 kV bus connects to the generation at Arapuni's South bus via two transmission circuits, rated at 57/70 MVA and 63/77 MVA (summer/winter), respectively. Kinleith is also supplied from the Bay of Plenty GXP Tarukenga via two circuits rated at 51/62 MVA and 63/77 MVA (summer/winter) respectively.

The winter peak load at Kinleith 33 kV already exceeds the 20 MVA continuous rating of the T5 transformer. However, as there are planned load shifts off the 33 kV GXP (onto the Arapuni North GXP) in the early 2030's, which is forecast to reduce the load below the 20 MVA limit there are presently no plans to upgrade the supply capacity. Transpower and Powerco are investigating options to improve the security of supply at Kinleith, with options including shifting load from Kinleith to Arapuni North, which is expected to manage the loading issue; or further developing the 33 kV network from Kinleith.

The following graph[37] compares Kinleith 33 kV GXP's supply capacity with the historical loading and Transpower's demand forecast.

[37] 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 33 illustrates Kinleith 33 kV's 2023 loading in comparison to its substation capacity.

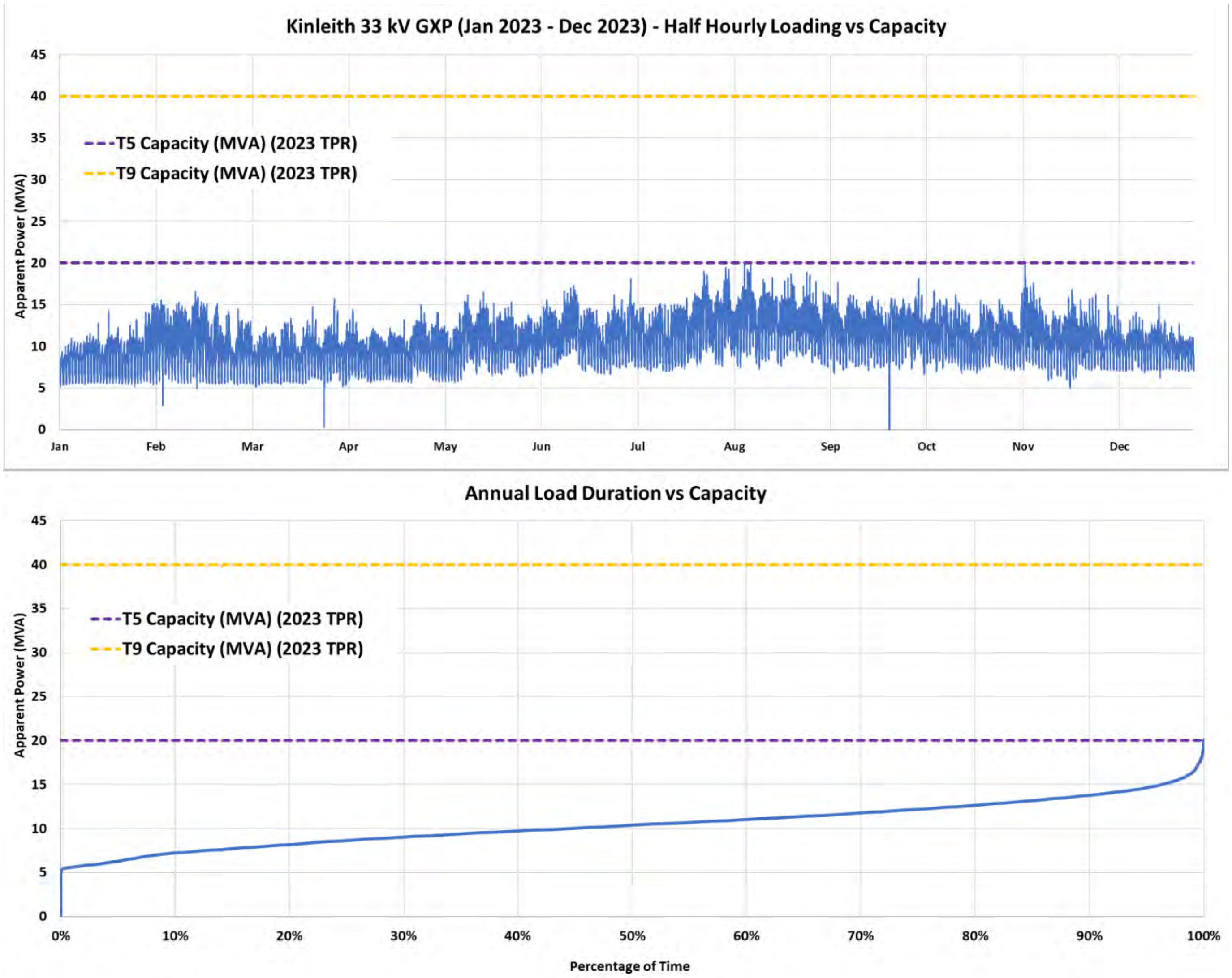


Figure 33 Kinleith 33 kV GXP: 2023 Loading: Substation capacity.

6.1.13 Kopu GXP

Transpower's demand forecast indicates that the Kopu GXP was expected to have a 2023 peak demand of 51 MW at 0.98 (leading) power factor (~52 MVA). This compares with the historical SCADA data that indicates that, during 2023, the Kopu GXP experienced a peak load of 46.8 MVA. The difference between forecast and actual load may be because Transpower's forecast is prudent.

The Kopu GXP is equipped with two 110/66 kV transformers providing:

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

The transformer capacity is limited by protection equipment.

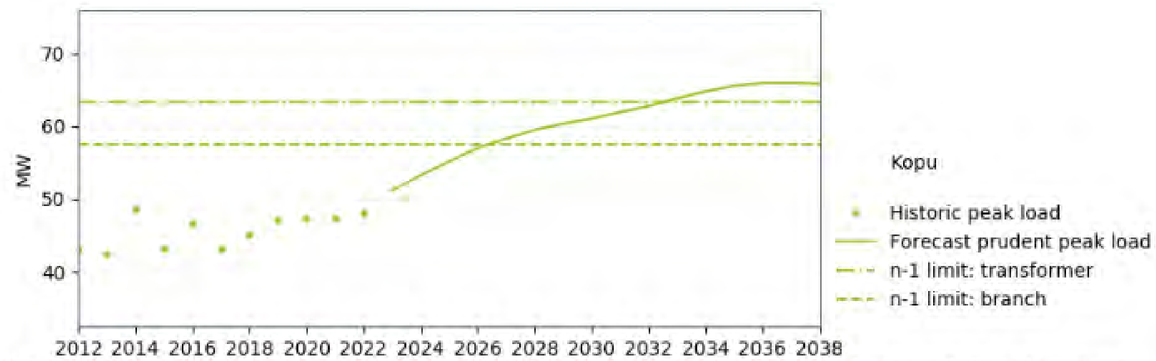
Kopu is supplied via the Thames Valley Spur, by two 110 kV Waikino-Kopu circuits each rated at 114 MVA (summer and winter, limited by protection settings and disconnectors). Waikino is in turn supplied by Waihou by two 110 kV circuit rated at 101/123 MVA (summer/winter). Waihou is supplied at 110 kV by two Hamilton-Piako-Waihou circuits rated at 154/168 MVA (summer/winter).

As mentioned at the start of Section 6, a Hamilton-Piako-Waihou circuit outage results in a voltage step greater than 5% at Kopu, with Kopu voltage forecast to drop below 0.9 p.u. from 2027. Additionally, peak load on the Valley spur was expected to exceed the (N-1) capacity of the Hamilton-Piako-Waihou circuits from winter of 2023. Transpower is investigating options with Powerco to mitigate these issues, including:

- Short-term: Installing a special protection scheme to manage post-contingency load. An indicative cost for this is $0.5 M.
- Short-term: Applying variable line ratings to achieve better ratings during peak demand periods. This option will resolve the (N-1) capacity issue but not the low-voltage/voltage-step issues.
- Short-term: Installing capacitors at Waihou and Waikino. This option will resolve the voltage issues, but not the (N-1) capacity issue. An indicative cost for this is $2.5 M.
- Longer-term: Thermally uprating the circuits on the Waihou-Waikino A line.
- Longer-term: Reconductoring the circuits on the Hamilton-Waihou line.
- Longer-term: Building a new transmission circuit to connect substations along the Valley Spur.

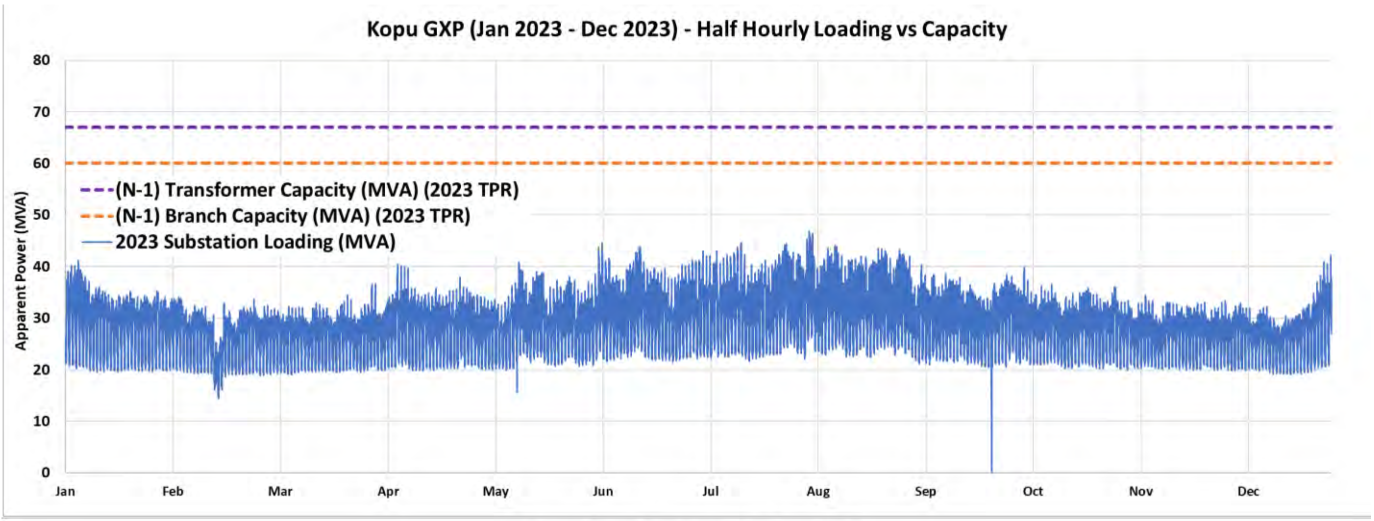
The following graph[38] compares Kopu GXP's supply capacity with the historical loading and Transpower's demand forecast.

[38] 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 34 illustrates Kopu's 2023 loading in comparison to its substation capacity.



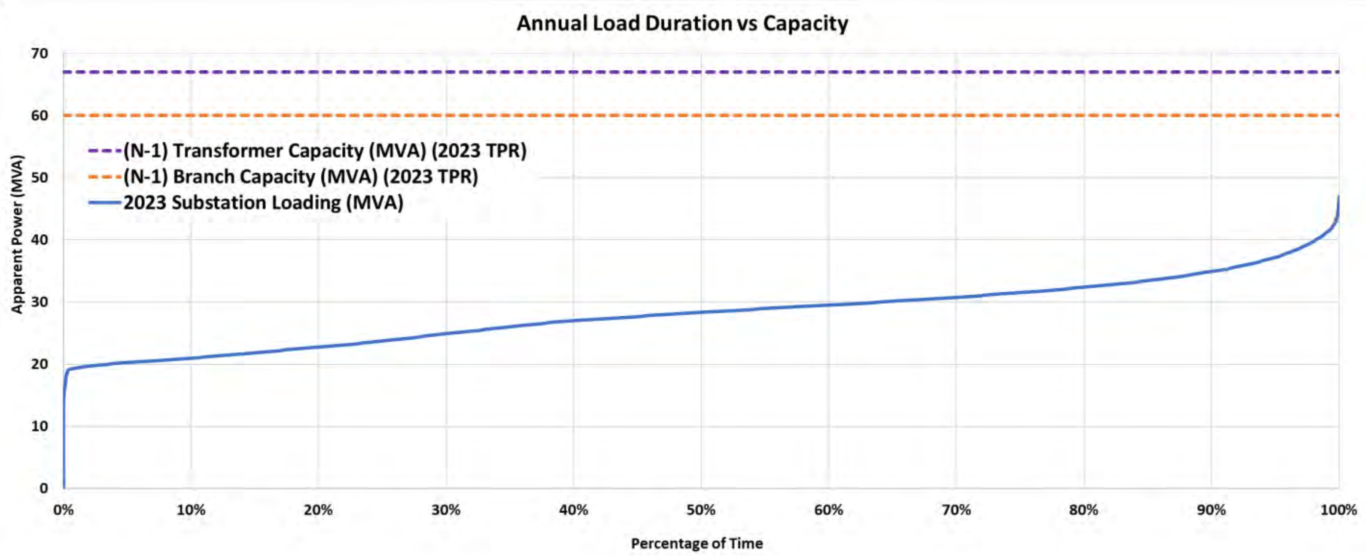


Figure 34 Kopu GXP: 2023 Loading: Substation capacity.

6.1.14 Lichfield GXP

Transpower's demand forecast indicates that the Lichfield GXP was expected to have a 2023 peak demand of 16 MW at 0.92 power factor (~17.4 MVA). This aligns well with the historical SCADA data that indicates that, during 2023, the Lichfield GXP experienced a peak load of 17.4 MVA.

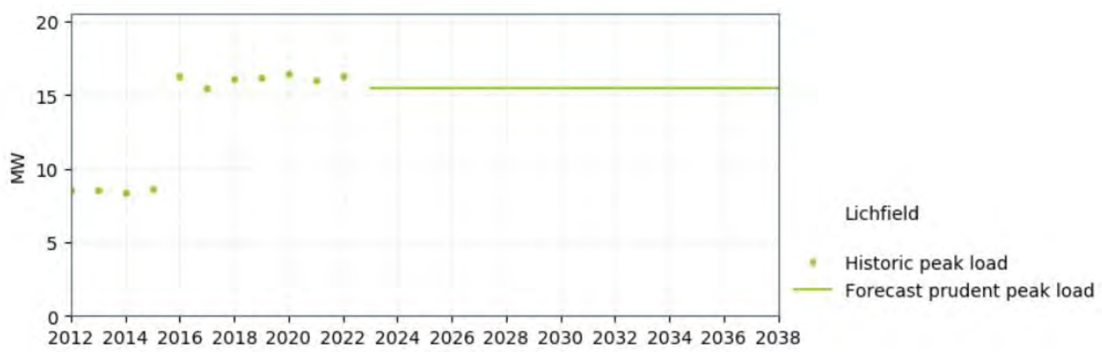
It is noted that the Lichfield GXP supply transformers are owned by Vector and so are not disclosed in Transpower's TPR. The substation only supplies Fonterra's Lichfield dairy factory.

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

- (N) secure capacity of 40 MVA and
- (N-1) capacity of 20 MVA.

Lichfield is supplied via a tee off from the two Tarukenga-Kinleith circuits which are each rated at 51/62 MVA and 63/77 MVA (summer/winter) respectively.

The following graph[39] compares Lichfield GXP's supply capacity with the historical loading and Transpower's demand forecast.



The following Figure 34 illustrates Lichfield's 2023 loading.

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

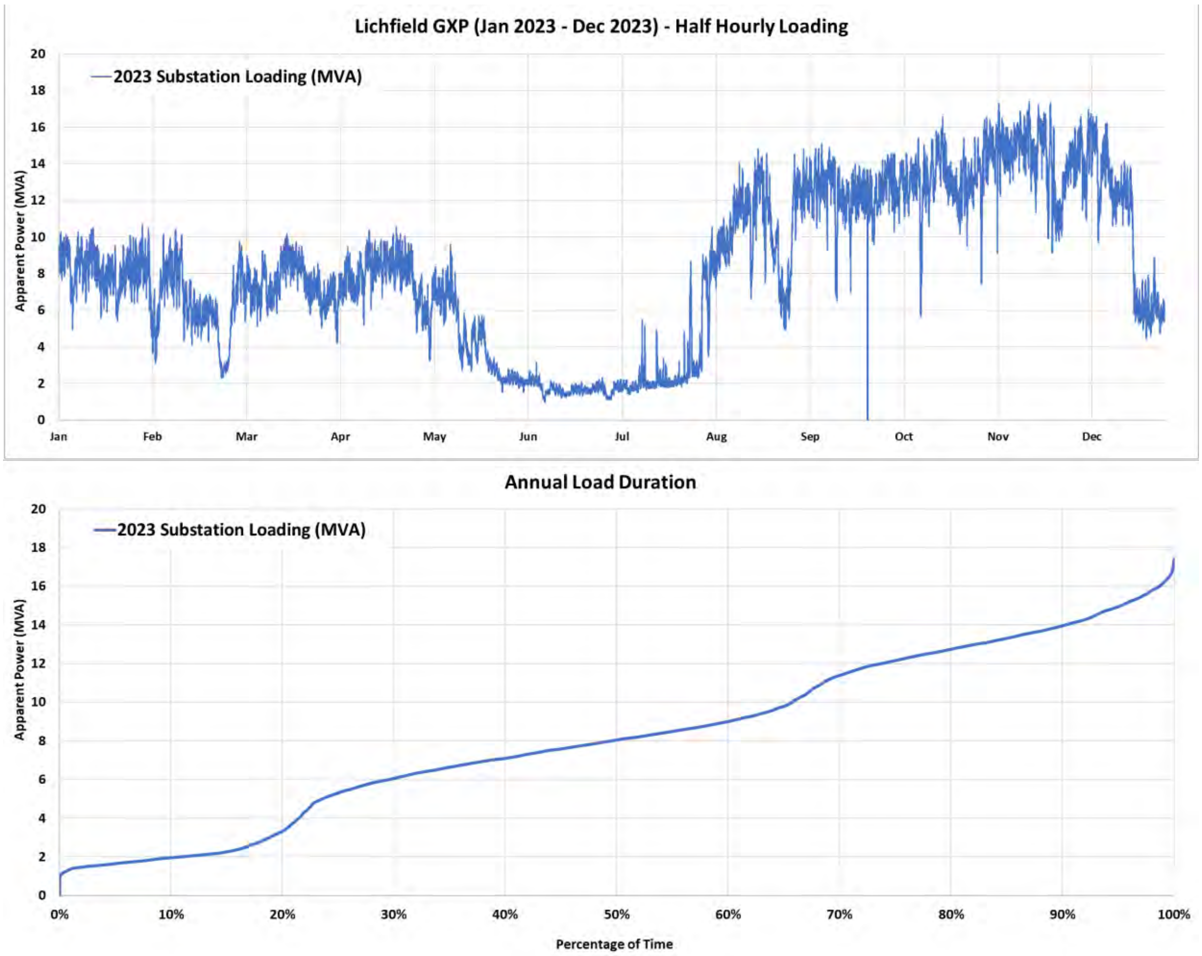


Figure 35 Lichfield GXP: 2023 Loading.

6.1.15 Piako GXP

Transpower's demand forecast indicates that the Piako GXP was expected to have a 2023 peak demand of 46 MW at 0.99 power factor (~46.5 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Piako GXP experienced a peak load of 40.1 MVA (14% lower than forecast). The difference between forecast and actual load may be because Transpower's forecast is prudent.

Powerco owns the two 110/33 kV supply transformers at Piako, each rated at 60 MVA. These two transformers provide the Piako GXP with:

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

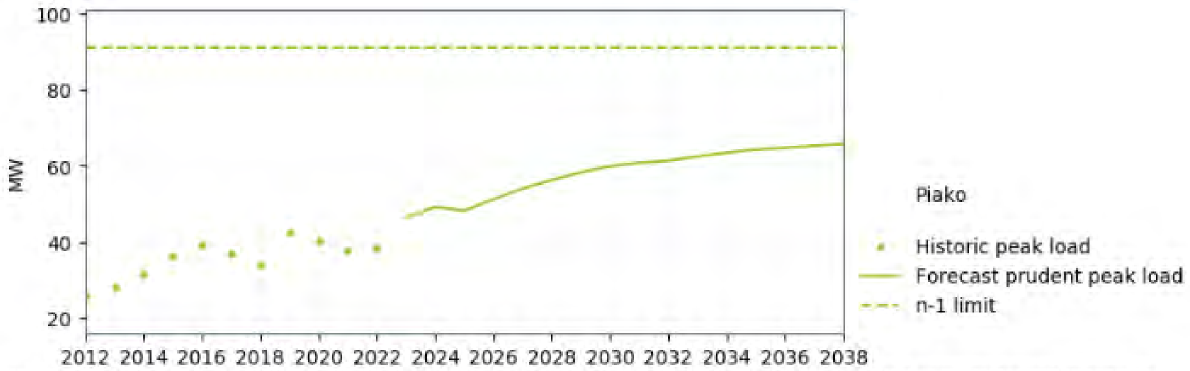
Piako is supplied via the Thames Valley Spur, by the two circuits of the Hamilton-Piako-Waihou (Hamilton to Morrinsville Tee) line, each rated at 154/168 MVA (summer/winter). From the Morrinsville Tee to Piako are two circuits rated at 110/114 MVA (summer/winter).

As mentioned at the start of Section 6, a Hamilton-Piako-Waihou circuit outage results in a voltage step greater than 5% at Piako. Additionally, peak load on the Valley spur was expected to exceed the (N-1) capacity of the Hamilton-Piako-Waihou circuits from winter of 2023 (specifically, on the Hamilton-Morrinsville Tee section of these circuits). Transpower is investigating options with Powerco to mitigate these issues, including:

- Short-term: Installing a special protection scheme to manage post-contingency load. And indicative cost for this is $0.5 M.
- Short-term: Applying variable line ratings to achieve better ratings during peak demand periods. This option will resolve the (N-1) capacity issue but not the low voltage/voltage step issues.
- Short-term: Installing capacitors at Waihou and Waikino. This option will resolve the voltage issues, but not the (N-1) capacity issue. An indicative cost for this is $2.5 M.
- Longer-term: Thermally uprating the Waihou-Waikino A line.
- Longer-term: Reconductoring the Hamilton-Waihou line.
- Longer-term: Building a new transmission circuit to connect substations along the Valley Spur.

The following graph[40] compares Piako GXP's supply capacity with the historical loading and Transpower's demand forecast. The graph(s) below use the ratings of the circuits between the Morrinsville Tee and Piako as a basis for the (N-1) ratings, rather than the Powerco-owned transformers.

[40] 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 36 illustrates Piako's 2023 loading in comparison to its substation capacity.

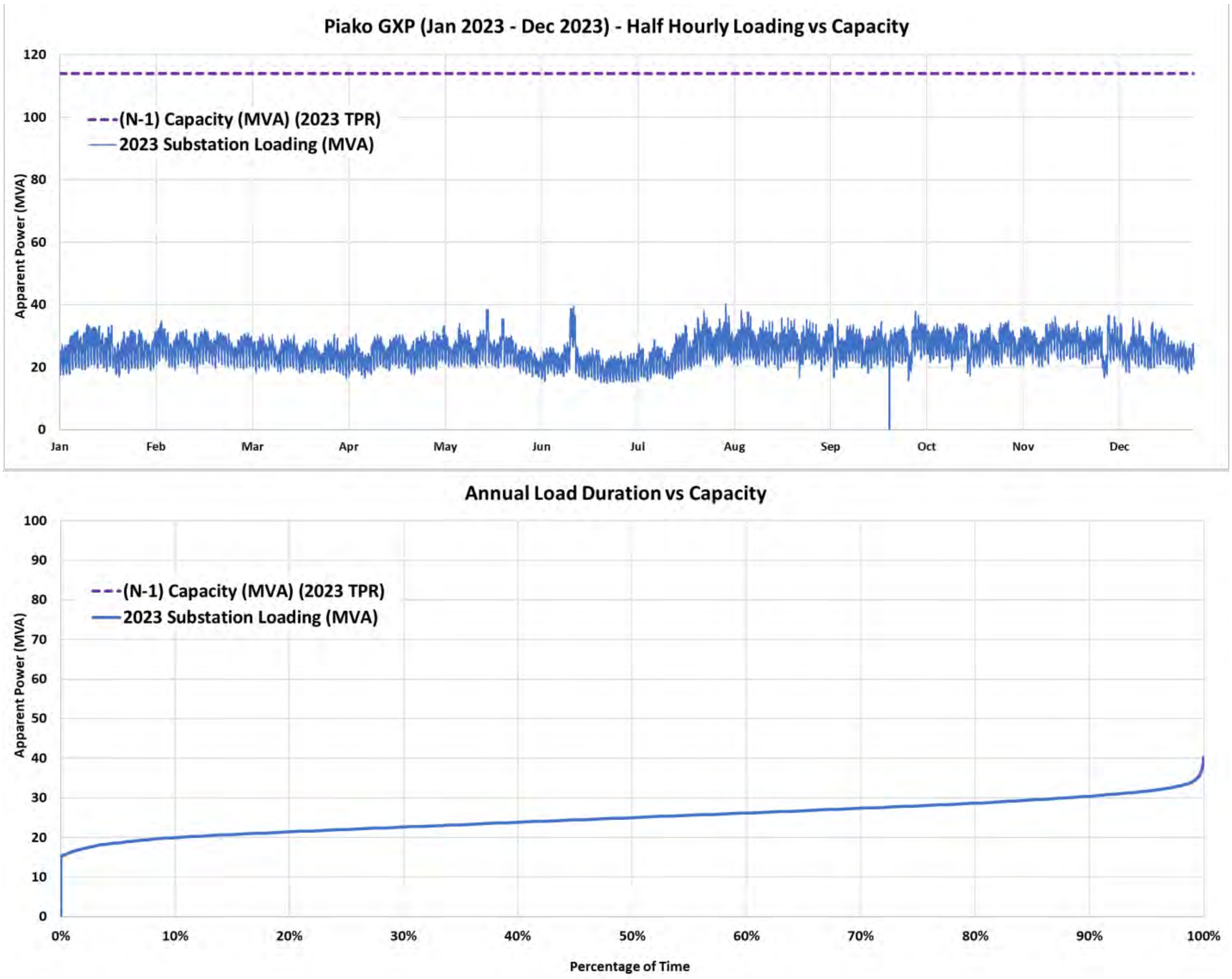


Figure 36 Piako GXP: 2023 Loading: Substation capacity.

6.1.16 Te Awamutu GXP

Transpower's demand forecast indicates that the Te Awamutu GXP was expected to have a 2023 peak demand of 45 MW at 0.99 power factor (~45.5 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Te Awamutu GXP experienced a peak load of 39.9 MVA (12% lower than forecast). The difference between forecast and actual load may be because Transpower's forecast is prudent.

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

- (N) secure capacity of 80 MVA and
- (N-1) capacity of 40 MVA.

The transformer capacity at Te Awamutu is presently limited by the protection equipment.

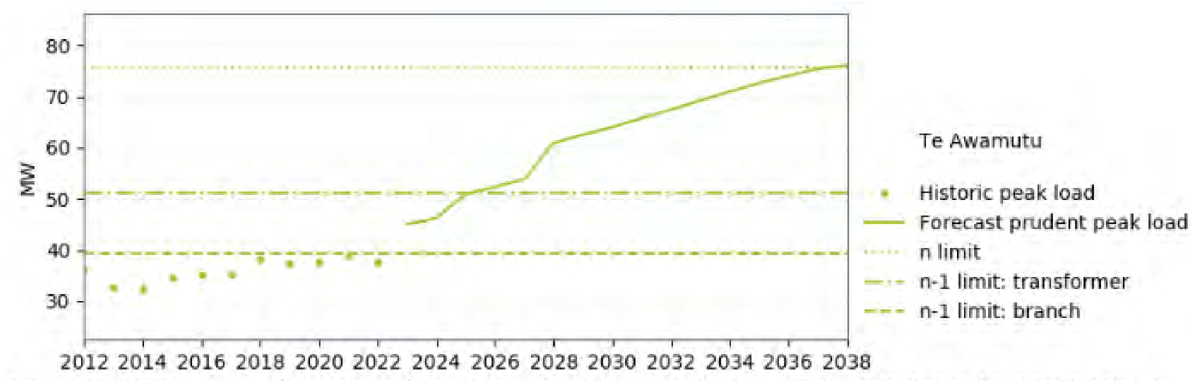
Te Awamutu GXP is supplied by one circuit from Karapiro, rated at 63/77 MVA (summer/winter). The Karapiro GIP is connected to Hamilton GXP via two circuits each rated at 57/70 MVA (summer/winter). Te Awamutu is also supplied by one circuit from Hangatiki, rated at 105/116 MVA (summer/winter).

Peak load at Te Awamutu was expected to exceed the (N-1) capacity of the transformers from 2023. By the end of the forecast period, peak load is expected to exceed the (N) capacity of the transformers. Transpower are replacing the transformer protection, which will resolve the protection limit on the transformers, deferring the (N-1) capacity issue until ~2025. Transpower is working with Waipā Networks to resolve the capacity issues in the longer-term. Options being investigated include:

- Upgrading the cooling on the existing supply transformers and branch limits to further increase transformer capacity. The indicative cost for this is $0.6M.
- Installing a transformer overload protection scheme.
- Replacing the existing supply transformers with 110/33 kV banks and installing a new 33 kV switchboard, in conjunction with Waipā Networks upgrading some of its feeders to 33 kV.
- Installing a new 220/33 kV GXP to offload Te Awamutu.

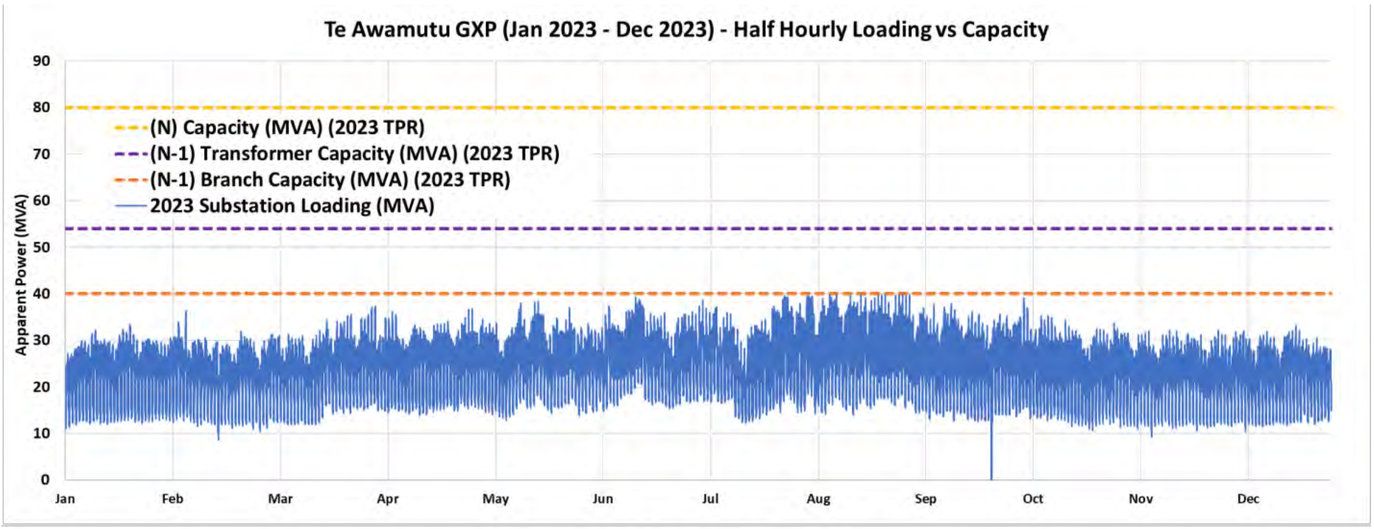
The following graph[41] compares Te Awamutu GXP's supply capacity with the historical loading and Transpower's demand forecast.

[41] 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 37 illustrates Te Awamutu's 2023 loading in comparison to its substation capacity.



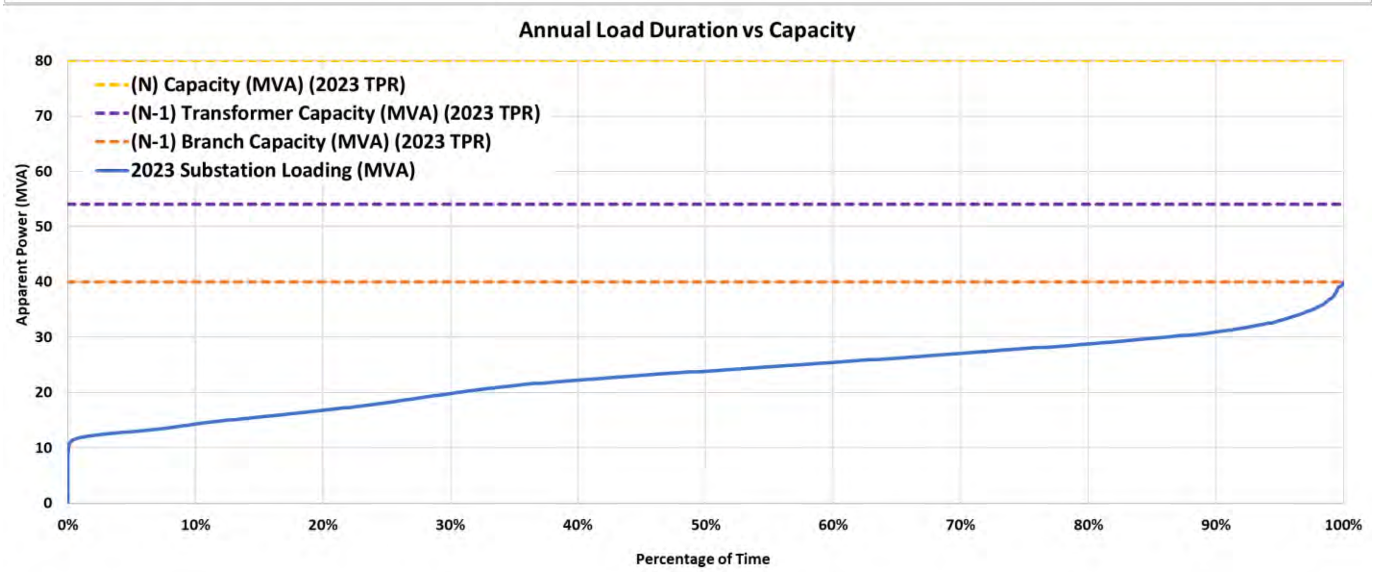


Figure 37 Te Awamutu GXP: 2023 Loading: Substation capacity.

6.1.17 Te Kowhai GXP

Transpower's demand forecast indicates that the Te Kowhai GXP was expected to have a 2023 peak demand of 101 MW at 1.00 power factor (~101 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Te Kowhai GXP experienced a peak load of 108 MVA.

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

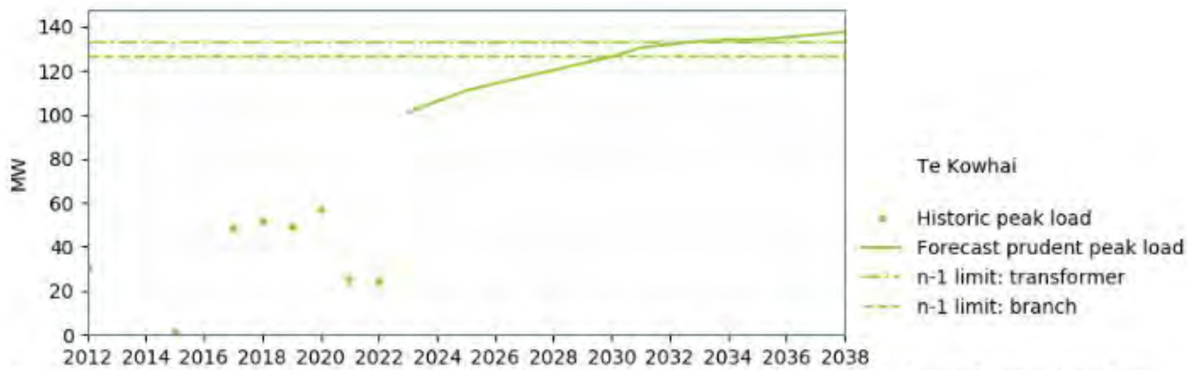
- (N) secure capacity of 230 MVA and
- (N-1) capacity of 132/136 MVA (summer/winter).

The transformer capacity at Te Kowhai is presently limited by the 33 kV cables, current transformers (CTs), disconnectors, and circuit breakers.

Te Kowhai is connected by one 220 kV circuit to Huntly, and one 220 kV circuit to Taumaranui, both rated at 469/492 MVA (summer/winter).

Peak load at Te Kowhai is forecast to exceed the (N-1) capacity of the transformers from 2031. This does not take into account the generation connected at Te Uku (a wind farm, which is not reliably dispatchable) and Te Rapa (has now closed). Transpower intends to discuss long term capacity requirements at Te Kowhai with WEL Networks. At present, no upgrades are planned.

The following graph[42] compares Te Kowhai 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 38 illustrates Te Kowhai's 2023 loading in comparison to its substation capacity.

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

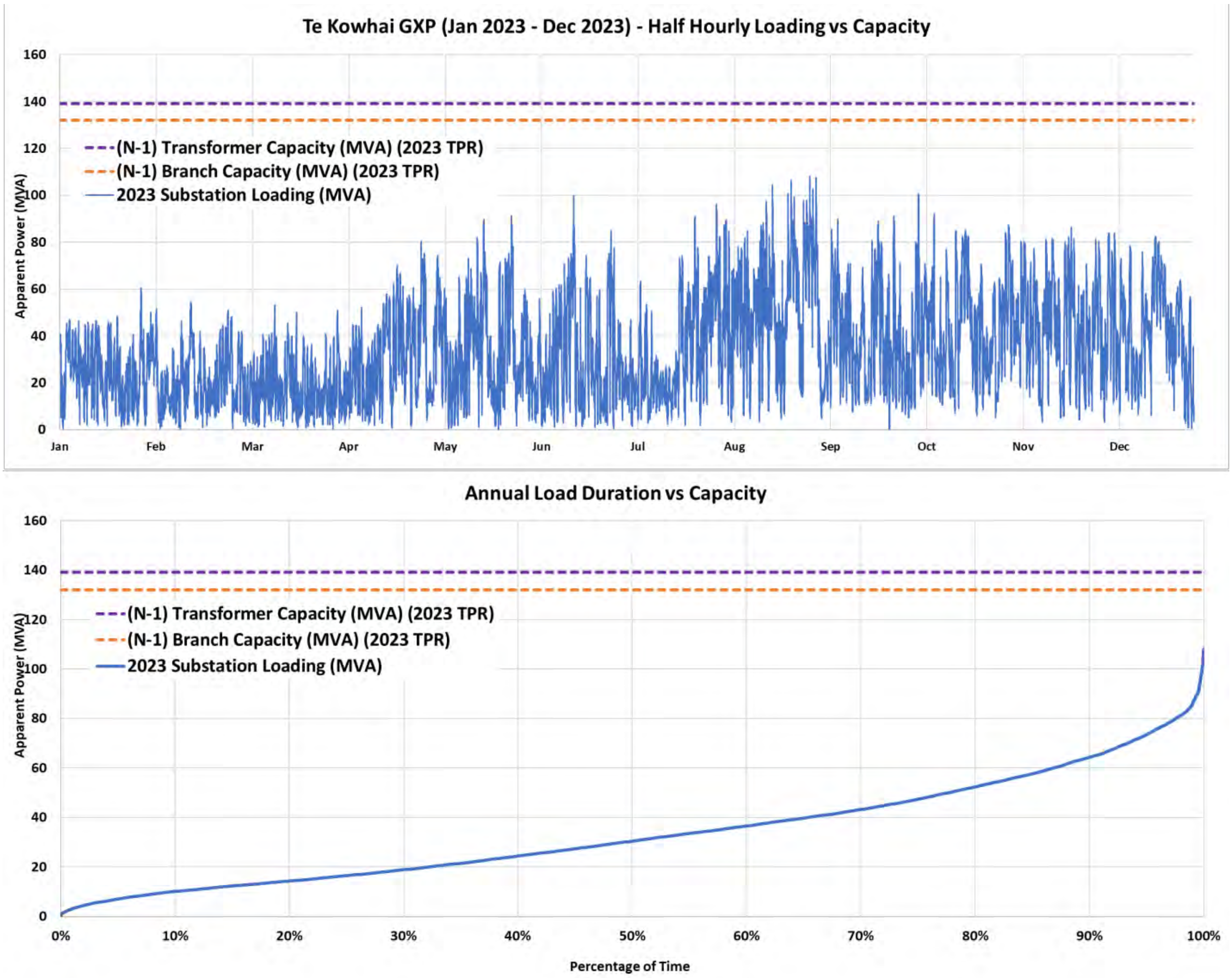


Figure 38 Te Kowhai GXP: 2023 Loading: Substation capacity.

6.1.18 Tokaanu GXP

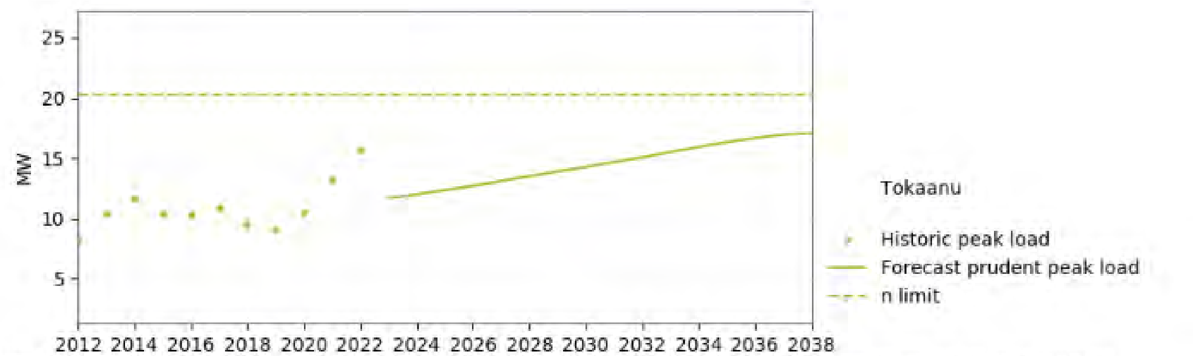
Transpower's demand forecast indicates that the Tokaanu GXP was expected to have a 2023 peak demand of 12 MW at 1.00 power factor (12 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Tokaanu GXP experienced a peak load of 10.6 MVA.

Tokaanu GXP is supplied by a single 220/33 kV transformer rated to 20 MVA. A second transformer is on site which can be switched into service when required. However, switching of the second transformer is manual, which results in a loss of supply in the event of a transformer failure, until manual switching can be completed. This provides the GXP switched (N-1) security, which would include some interruption while the second transformer is manually switched in.

Tokaanu is connected to Bunnythorpe via two 220 kV circuits, each rated at 308/335 MVA (summer/winter). Tokaanu is also connected to Whakamaru in the Waikato region, via two 220 kV circuits which are also each rated at 308/335 MVA (summer/winter).

The forecasted load is below the transformer capacity, and The Lines Company has not requested a higher level of security at Tokaanu, so upgrades are not planned.

The following graph[43] compares Tokaanu 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 33 illustrates Tokaanu's 2023 loading in comparison to its substation capacity.

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

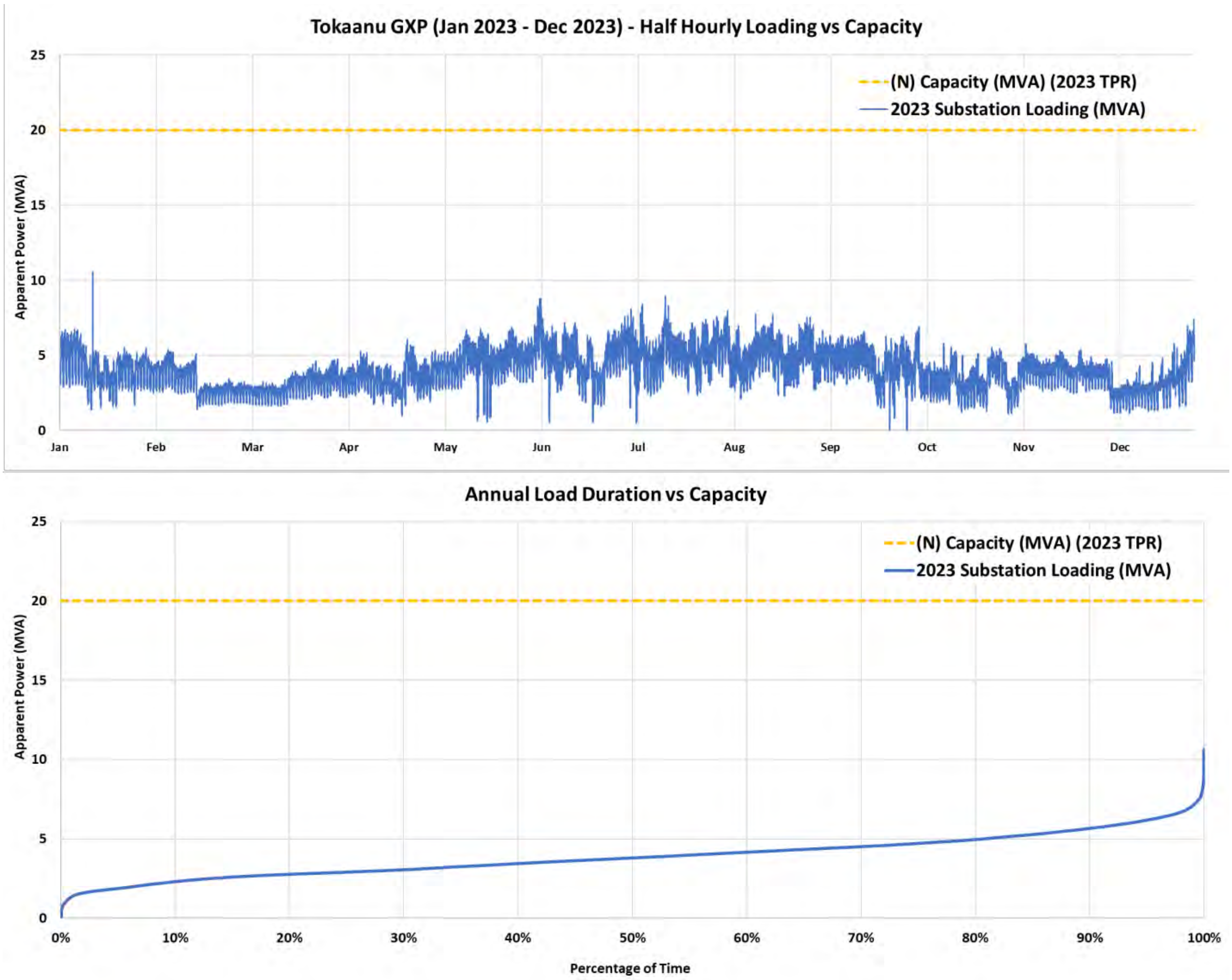


Figure 39 Tokaanu GXP: 2023 Loading: Substation capacity

6.1.19 Waihou GXP

Transpower's demand forecast indicates that the Waihou GXP was expected to have a 2023 peak demand of 38 MW at 0.99 power factor (~38.4 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Waihou GXP experienced a peak load of 35.7 MVA.

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

- (N) secure capacity of 155 MVA and
- (N-1) capacity of 75 MVA.

The transformer capacity at Waihou is presently limited by the 110 kV bus section ratings for T3.

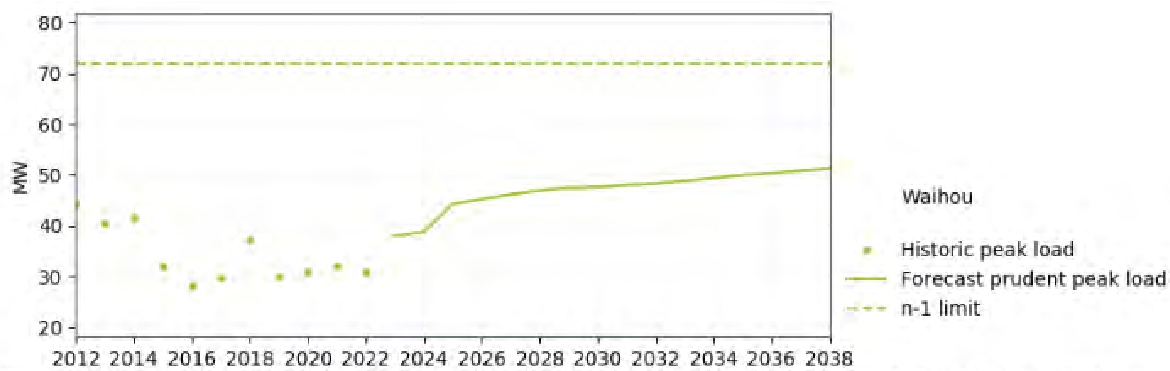
Waihou is supplied by the 110kV Thames Valley Spur line. The Hamilton-Piako-Waihou section of this line has two circuits that are rated at 154/168 MVA (summer/winter).

As mentioned at the start of Section 6, a Hamilton-Piako-Waihou circuit outage results in a voltage step greater than 5% at Waihou. Additionally, peak load on the Valley spur was expected to exceed the (N-1) capacity of the Hamilton-Piako-Waihou circuits from winter of 2023. Transpower is investigating options with Powerco to mitigate these issues, including:

- Short-term: Installing a special protection scheme to manage post-contingency load. An indicative cost for this is $0.5 M.
- Short-term: Applying variable line ratings to achieve better ratings during peak demand periods. This option will resolve the (N-1) capacity issue but not the low voltage/voltage step issues.
- Short-term: Installing capacitors at Waihou and Waikino. This option will resolve the voltage issues, but not the (N-1) capacity issue. An indicative cost for this is $2.5 M.
- Longer-term: Thermally uprating the Waihou-Waikino A line.
- Longer-term: Reconductoring the Hamilton-Waihou line.
- Longer-term: Building a new transmission circuit to connect substations along the Valley Spur.

The following graph[44] compares Waihou GXP's supply capacity with the historical loading and Transpower's demand forecast.

[44] 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 40 illustrates Waihou's 2023 loading in comparison to its substation capacity.

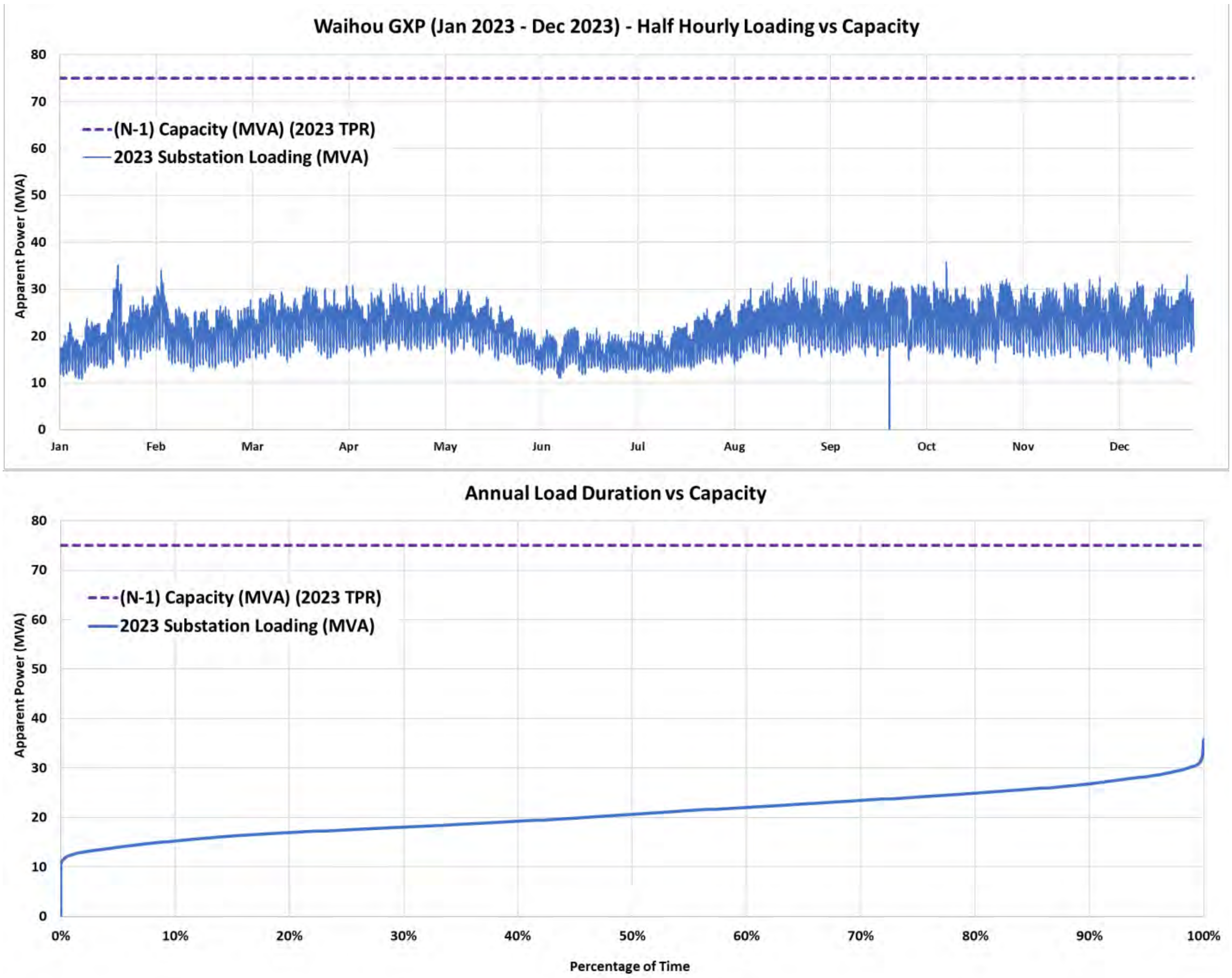


Figure 40 Waihou GXP: 2023 Loading: Substation capacity.

6.1.20 Waikino GXP

Transpower's demand forecast indicates that the Waikino GXP was expected to have a 2023 peak demand of 42 MW at 1.00 power factor (42 MVA). This aligns with the historical SCADA data that indicates that, during 2023, the Waikino GXP experienced a peak load of 37.9 MVA.

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

- (N) secure capacity of 84 MVA and
- (N-1) capacity of 42 MVA.

The transformer capacity at Waikino is presently limited by the 33 kV bushings on T1 and a metering accuracy limit on T2.

Waikino is supplied by the 110kV Thames Valley Spur line. The section of the circuit between Waihou and Waikino has two circuits that are rated at 101/123 MVA (summer/winter). Waihou is, in turn, supplied by the Hamilton-Piako-Waihou section of the Thames Valley Spur line which is equipped with two circuits rated at 154/168 MVA (summer/winter).

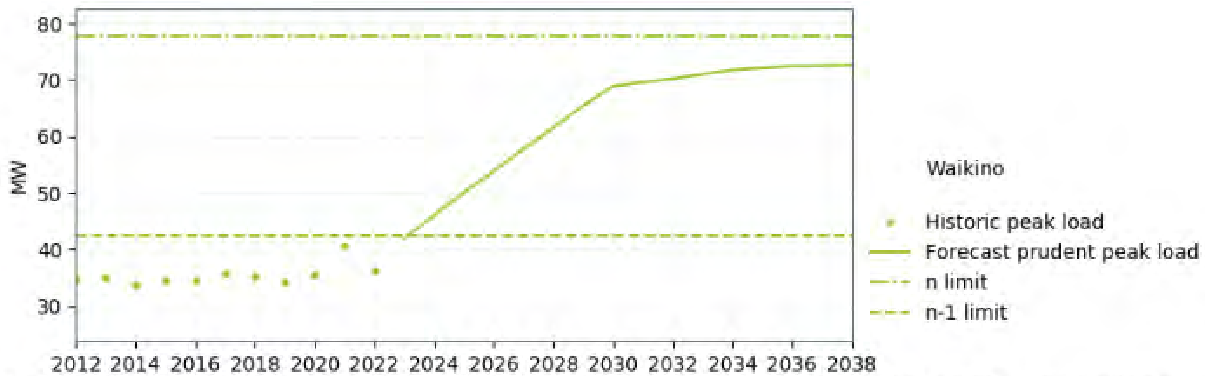
As mentioned at the start of Section 6, a Hamilton-Piako-Waihou circuit outage results in a voltage step greater than 5% at Waikino. Additionally, peak load on the Valley spur was expected to exceed the (N-1) capacity of the Hamilton-Piako-Waihou circuits from winter of 2023. Transpower is investigating options with Powerco to mitigate these issues, including:

- Short-term: Installing a special protection scheme to manage post-contingency load. An indicative cost for this is $0.5 M.
- Short-term: Applying variable line ratings to achieve better ratings during peak demand periods. This option will resolve the (N-1) capacity issue but not the low voltage/voltage step issues.
- Short-term: Installing capacitors at Waihou and Waikino. This option will resolve the voltage issues, but not the (N-1) capacity issue. An indicative cost for this is $2.5 M.
- Longer-term: Thermally uprating the Waihou-Waikino A line.
- Longer-term: Reconductoring the Hamilton-Waihou line.
- Longer-term: Building a new transmission circuit to connect substations along the Valley Spur.

Peak winter load was expected to exceed the (N-1) capacity of the T1 transformer at Waikino from 2023. This will be managed through operational measures in the short-term. The T1 transformer is due for replacement before the end of the forecast period. Transpower plans to discuss the timing and capacity requirements for the transformer replacement with Powerco.

The following graph[45] compares Waikino GXP's supply capacity with the historical loading and Transpower's demand forecast.

[45] 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 41 illustrates Waikino's 2023 loading in comparison to its substation capacity.

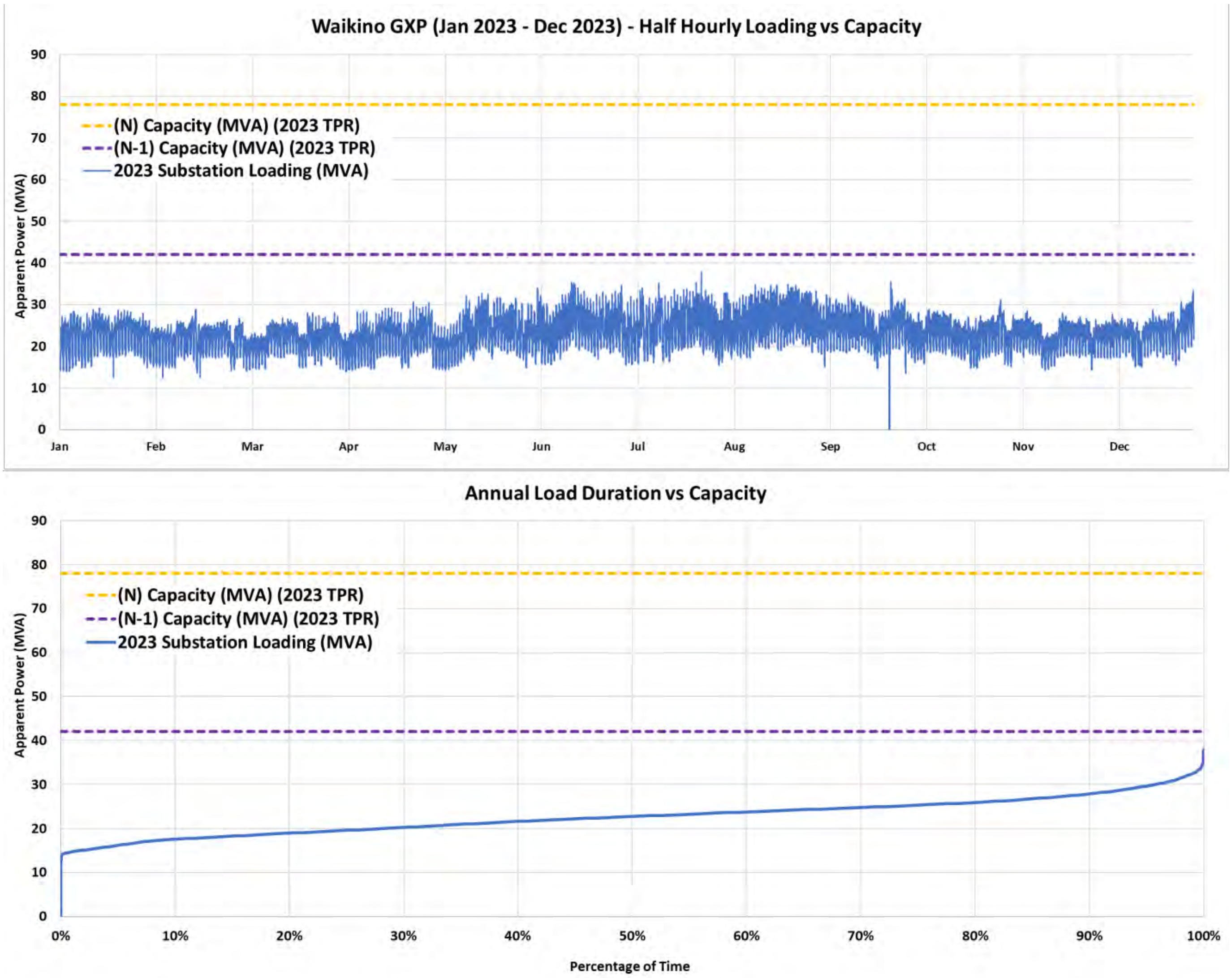


Figure 41 Waikino GXP: 2023 Loading: Substation capacity.

6.1.21 Wairakei GXP

Transpower's demand forecast indicates that the Wairakei GXP was expected to have a 2023 peak demand of 56 MW at 0.98 power factor (~57.1 MVA). This contrasts with the historical SCADA data that indicates that, during 2023, the Wairakei GXP experienced a peak load of 47.7 MVA (16% lower than forecast). The difference between forecast and actual load may be because Transpower's forecast is prudent.

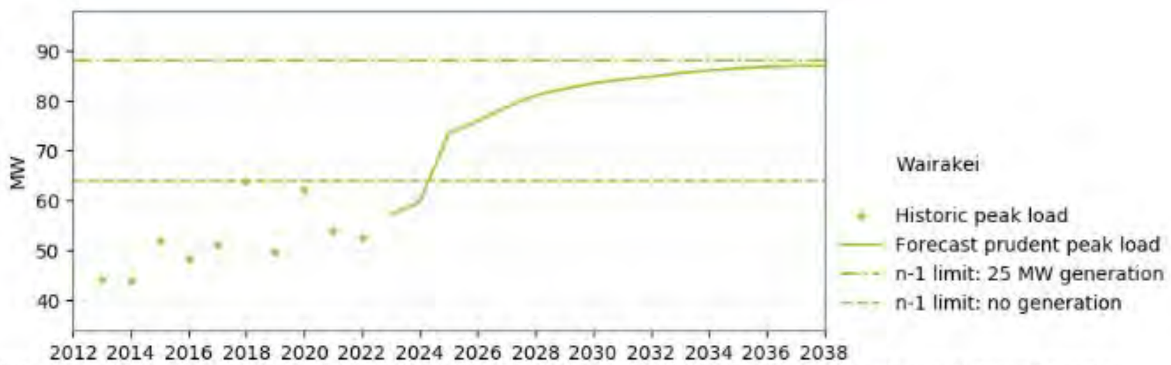
The Wairakei GXP is equipped with two 220/33 kV transformers providing:

- (N) secure capacity of 100 MVA and
- (N-1) capacity of 66 MVA.

The Wairakei GXP connects to Whakamaru via two 220 kV circuits rated at 903/952 MVA (summer/winter), one of which tees into Te Mihi (for generation connection of Te Mihi and Poihipi); and to Ohakuri through a 220 kV circuit rated at 333/358 MVA (summer/winter). Wairakei additionally connects to the Hawke's Bay network via single circuits to Redclyffe and Whirinaki, rated at 478/583 MVA (summer/winter), and via a single circuit to Rangipo, rated at 364/397 MVA (summer/winter).

Peak load at Wairakei is forecast to exceed the (N-1) capacity of the supply transformers from winter 2025. This forecast conservatively assumes that the generation connected within the 33 kV network downstream from the GXP (two geothermal generators and one hydro generator), are offline. However, the local geothermal generation is operational 24/7 (unless being maintained) and thus the (N-1) capacity is significantly higher. Additionally, Transpower has plans to replace the transformers with 60 MVA units, which would increase the capacity of the GXP slightly.

The following graph[46] compares Wairakei 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 42 illustrates Wairakei's 2023 loading in comparison to its substation capacity.

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

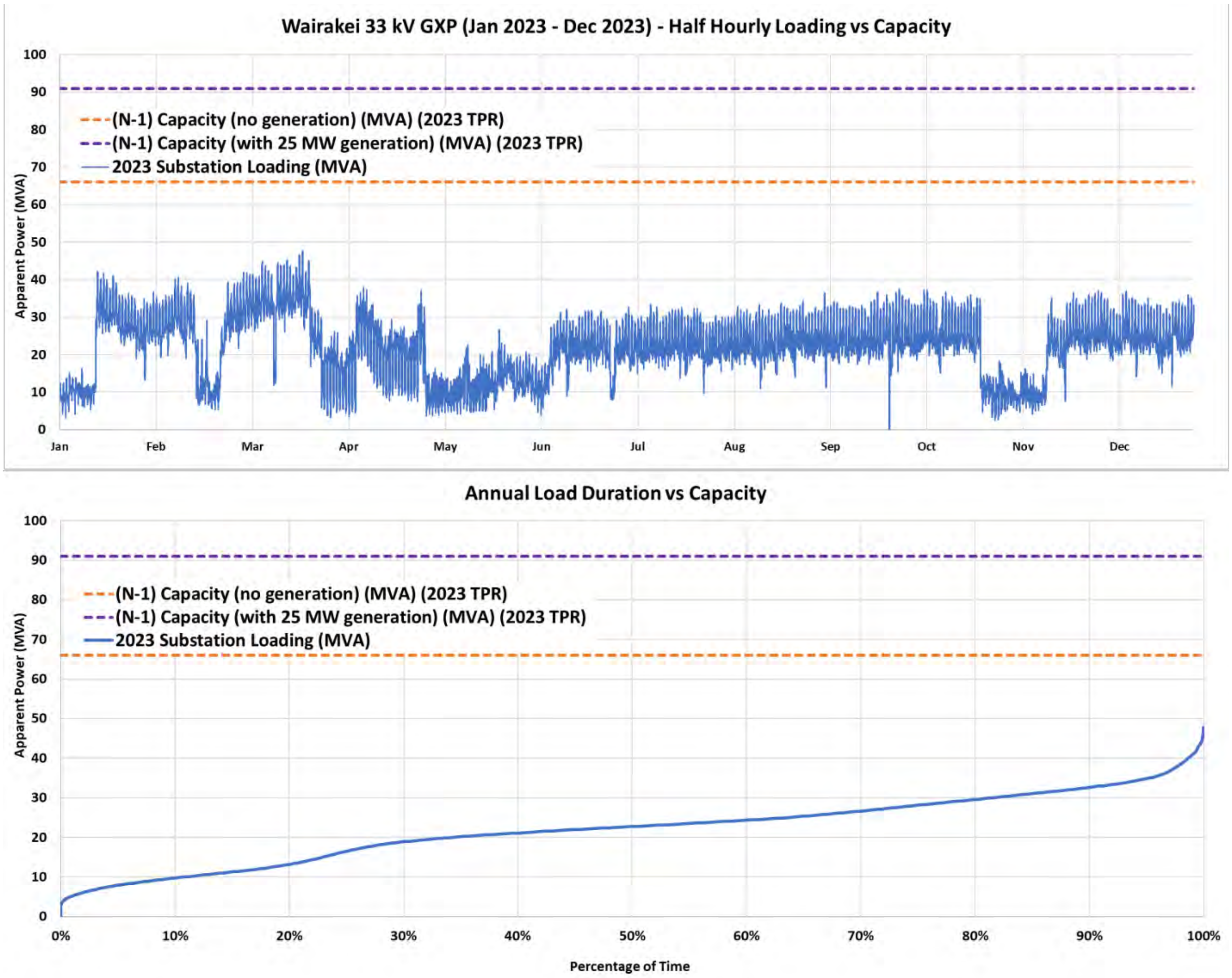


Figure 42 Wairakei GXP: 2023 Loading: Substation capacity.

6.2 Spare Capacity based on Historical Loadings

The following Figure 43 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.*
- Half hourly load data from the Electricity Market Information (EMI) website.
- The 2023 Counties Energy, The Lines Company, Powerco, Unison, Waipā Networks, and WEL Networks *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.

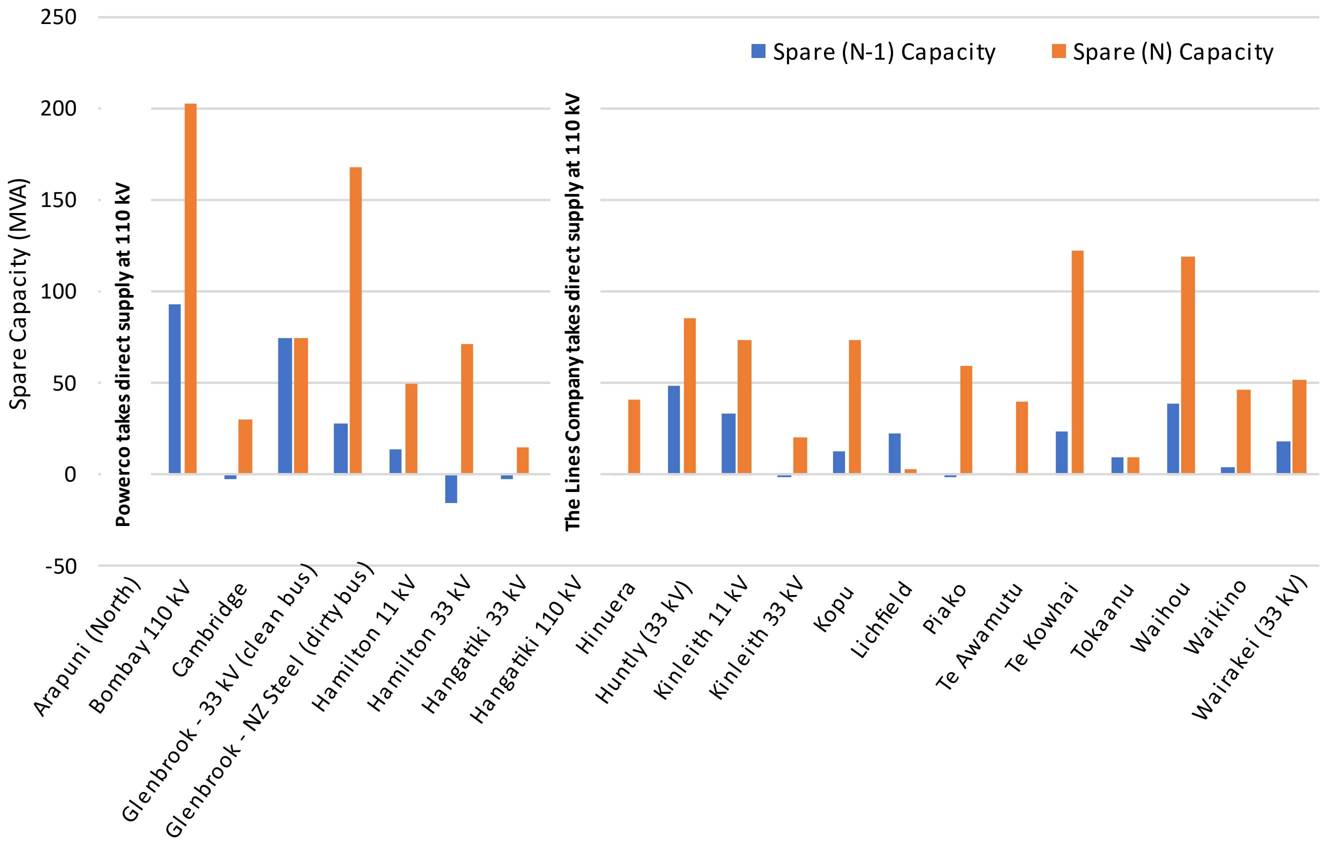


Figure 43 Summary: GXP Spare Capacity based on the GXP 2023 EMI loading data.

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.**

7. Spare Capacity – Zone Substations

In determining the (N) and (N-1) spare capacities for the zone substation, Ergo reviewed the EDBs' 2023 disclosure data and the historical substation loading data for 2023. Actual historical loading data was provided by Counties Energy, The Lines Company, Powerco, Waipā Networks, and WEL Networks, and the information is summarised in Table 4, Table 5, Table 6, Table 7, and Table 9.

7.1 Counties Energy

Table 4 Counties Energy: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Opaheke	52.0	39.8	12.0	-0.2
2	Pōkeno	70.0	67.0	30.0	27.0
3	Pukekohe	81.0	75.3	21.0	15.3
4	Tuakau	67.0	66.8	27.0	26.8
5	Barber Rd	68.0	68.3	28.0	28.3
6	Waiuku	24.0	22.0	4.0	2.0
7	Karaka	27.0	23.8	7.0	3.8
8	Maioro	10.8	6.5	1.4	-2.9

Note: The negative (N-1) values represent a zone substation where the (N-1) rating is already exceeded for periods during the year.

7.2 The Lines Company

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

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Tahāroa	2.80	5.2	-7.2	-4.8
2	Tahāroa Village	1.70	0.9	0.0	-0.8
3	Te Anga	2.50	2.6	0.1	0.2
4	Piri Piri	3.40	Unknown	1.0	Unknown
5	Oparure	1.20	0.6	N/A	N/A
6	Wairere Falls	2.00	2.4	-0.5	-0.1
7	Maehoenui	-0.30	1.0	N/A	N/A
8	Gadsby Rd	-0.30	0.4	0.4	1.1
9	Waitete	21.00	Unknown	6.0	Unknown
10	Hangatiki	1.40	1.4	N/A	N/A
11	Te Waireka	18.90	18.6	3.9	3.6
12	Arohena	-0.60	Unknown	N/A	N/A
13	Maraetai	4.60	Unknown	N/A	N/A
14	Kaahu Tee	0.20	Unknown	N/A	N/A
15	Marotiri	-0.60	Unknown	-2.3	Unknown
16	Mōkai (Point of Supply)	2.50	Unknown	N/A	N/A
17	Ātiamuri (Point of Supply)	-1.40	Unknown	-1.4	Unknown
18	Whakamaru (Point of Supply)	11.70	Unknown	11.7	Unknown
19	Awamate	0.60	0.2	30%	N/A
20	Kiko Road	0.80	0.9	32%	N/A
21	Tokaanu	1.05	Unknown	84%	N/A
22	Turangi	5.20	6.1	52%	1.1
23	Waiotaka	-0.20	0.2	-10%	N/A

Note: The negative (N-1) values represent a zone substation where the (N-1) rating is already exceeded for periods during the year.

7.3 Powerco

Table 6 Powerco: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Coromandel	-3.00	-2.3	1.0	-3.3
2	Kerepehi	8.50	1.5	-0.9	-6.0
3	Matatoki	2.00	2.8	N/A	N/A
4	Tairua	6.70	6.1	-0.8	-1.4
5	Thames T1&T2	21.50	3.3	4.5	-4.2
6	Thames T3	3.00	1.3	3.0	1.3
7	Whitianga	15.40	2.5	0.8	-13.5

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
8	Paeroa	7.00	14.2	-0.5	3.2
9	Waihi	10.60	-12.0	0.6	-15.0
10	Waihi Beach	4.60	Unknown	N/A	N/A
11	Whangamatā	5.00	3.4	-5.1	-6.6
12	Farmer Road	6.00	3.3	-0.3	-1.7
13	Inghams	5.00	3.2	N/A	N/A
14	Mikkelsen Road	22.00	25.8	5.3	6.8
15	Morrinsville	12.00	14.1	2.0	3.1
16	Piako	19.00	21.8	2.0	3.8
17	Tahuna	7.50	8.6	1.0	1.6
18	Tatua	1.30	1.2	N/A	N/A
19	Waitoa	12.00	Unknown	4.7	Unknown
20	Walton	2.40	2.4	N/A	N/A
21	Browne Street	7.90	8.7	-1.5	-0.7
22	Lake Road	1.10	2.9	-1.8	-2.1
23	Tīrau	18.00	17.7	1.0	0.7
24	Putāruru	22.00	22.4	5.0	5.4
25	Tower Road	25.50	26.2	8.5	9.2
26	Waharoa Nth	2.00	3.0	N/A	N/A
27	Waharoa Sth	11.50	11.1	N/A	N/A
28	Baird Road	23.80	27.8	6.8	8.8
29	Midway	-1.00	-1.2	N/A	N/A
30	Lakeside Pumps	-1.00	Unknown	N/A	N/A
31	Maraetai Road	19.00	29.5	0.5	10.5

Note: The negative (N-1) values represent a zone substation where the (N-1) rating is already exceeded for periods during the year.

7.4 Unison

Table 7 Unison: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Fletchers	22.00	Not Supplied	7.0	Not Supplied
2	Runanga Street	13.00	Not Supplied	-1.0	Not Supplied
3	Taupō South	12.00	Not Supplied	4.0	Not Supplied
4	Fleet Street	8.00	Not Supplied	-7.0	Not Supplied
5	Ohaaki	6.00	Not Supplied	N/A	Not Supplied
6	Te Toke	26.00	Not Supplied	N/A	Not Supplied

Note: The negative (N-1) ratings represent a zone substation where the (N-1) rating is already exceeded for periods during the year.

7.5 Vector

Table 8 Vector: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Lichfield	24.0	Not Supplied	4.0	Not Supplied

7.6 Waipā Networks

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

7.7 WEL Networks

Table 9 WEL Networks: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Avalon Dr	28.00	31.8	4.0	7.8
2	Borman	21.00	22.5	0.0	1.5
3	Bryce St	32.00	24.3	9.0	1.3
4	Chartwell	32.00	34.8	6.0	8.8
5	Claudelands	23.00	26.6	0.0	3.6
6	Cobham	39.00	39.4	13.0	13.4
7	Finlayson Rd	5.00	3.4	N/A	N/A
8	Glasgow St	3.00	2.1	N/A	N/A
9	Gordonton	2.00	2.0	-3.0	-3.0
10	Hampton Downs	7.10	7.4	N/A	N/A
11	Hoeka Rd	17.90	21.4	N/A	N/A
12	Horotiu	16.00	23.3	-2.0	5.3
13	Kent St	30.00	23.9	7.0	0.9
14	Latham Court	26.00	27.9	3.0	4.9
15	Ngaruawahia	12.00	12.3	3.0	3.3
16	Peacockes Rd	35.00	36.6	9.0	10.6
17	Pukete - Anchor	42.00	Unknown	12.0	Unknown
18	Pukete - WEL's 11kV	16.00	16.4	3.0	3.4
19	Raglan	6.40	6.2	N/A	N/A
20	Sandwich Rd	24.00	26.4	0.0	2.4
21	Tasman Road	30.00	31.1	4.0	5.1
22	Te Kauwhata	12.00	12.8	2.0	2.8
23	Te Uku	8.00	5.8	3.0	0.8
24	Wallace Rd	18.00	19.9	3.0	4.9
25	Weavers	8.00	5.4	-1.0	-3.6

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
26	Whatawhata	17.90	17.9	N/A	N/A

Note: The negative (N-1) values represent a zone substation where the (N-1) rating is already exceeded for periods during the year.

7.8 Summary

7.8.1 Counties Energy

(N-1) Capacity Summary

The following Figure 44 illustrates the approximate (N-1) spare capacities at Counties' zone substations, for the disclosed peak demand estimates. It should be noted that these have been calculated based on the transformer ratings disclosed by Counties.

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

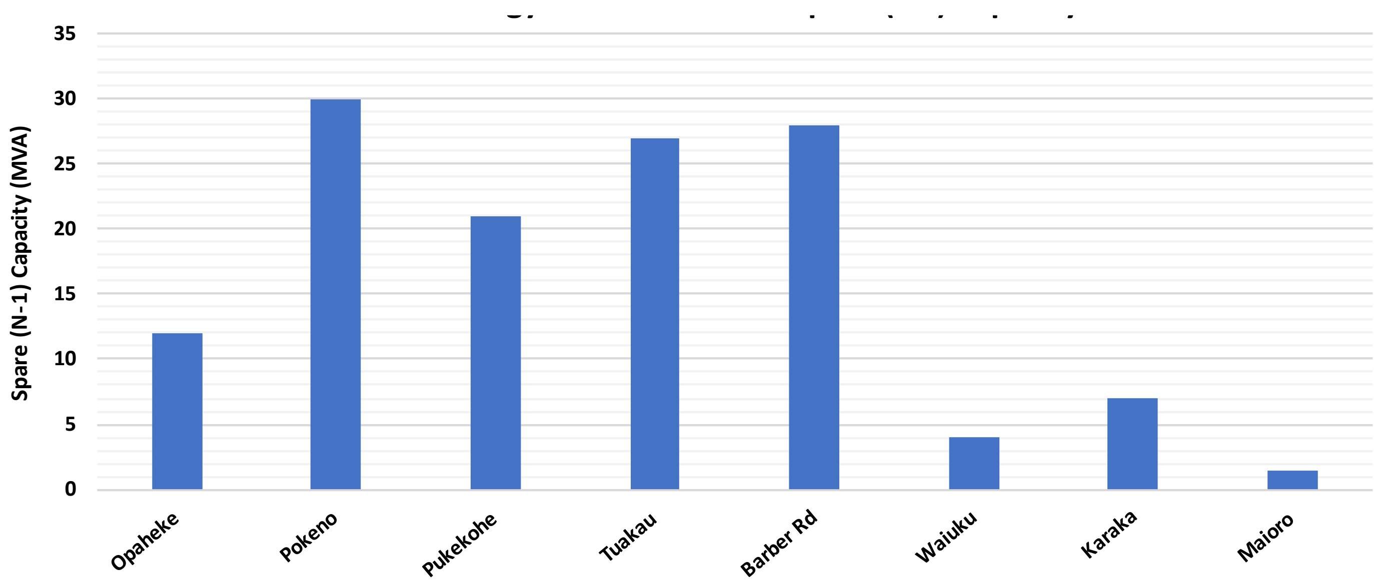


Figure 44. Summary: Approximate (N-1) spare capacity at Counties' zone substations

The zone substations with spare (N-1) capacity available vary from 15% (for Maioro) to 75% (for Pōkeno).

(N) Capacity Summary

The following Figure 45 illustrates the approximate (N) spare capacities at Counties' zone substations, for the disclosed peak demand estimates[47]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Counties.

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 45 indicates that there is a moderate volume of spare (N) capacity at Counties' substations, with spare capacity ranging from 15% to 88%, although we note that these may be in locations where (N-1) security of supply would be a standard requirement.

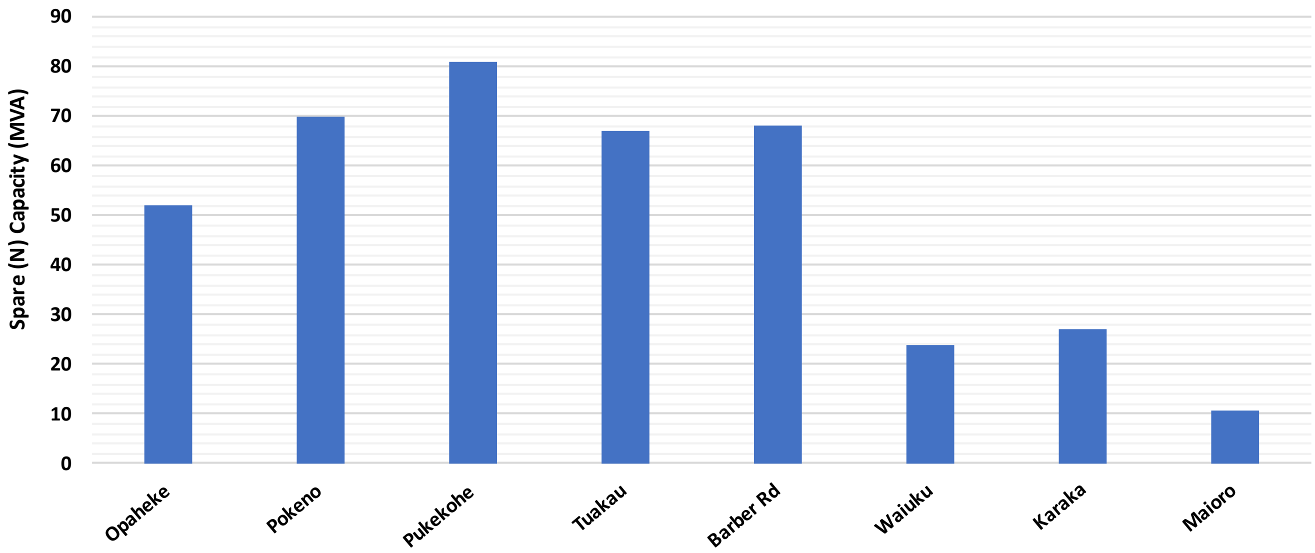


Figure 45. Summary: Approximate (N) spare capacity at Counties' zone substations

[47] Counties' 2023 AMP available here: https://countiesenergy.co.nz/about-us/regulatory-disclosures/

7.8.2 The Lines Company

Five of The Lines Company's zone substations in the region (Tahāroa Village, Gadsby Road, Marotiri, Ātiamuri, and Whakamaru) 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 46 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.

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 eleven of the twenty zone substations (Oparure, Maehoenui, Hangatiki, Arohena, Maraetai, Kaahu Tee, Mōkai, Awamate, Kiko Road, Tokaanu, and Waiotaka) do not have (N-1) security with respect to the supply transformers. At five of the zone substations, the (N-1) supply capacity is close to being exceeded or was exceeded in 2023.

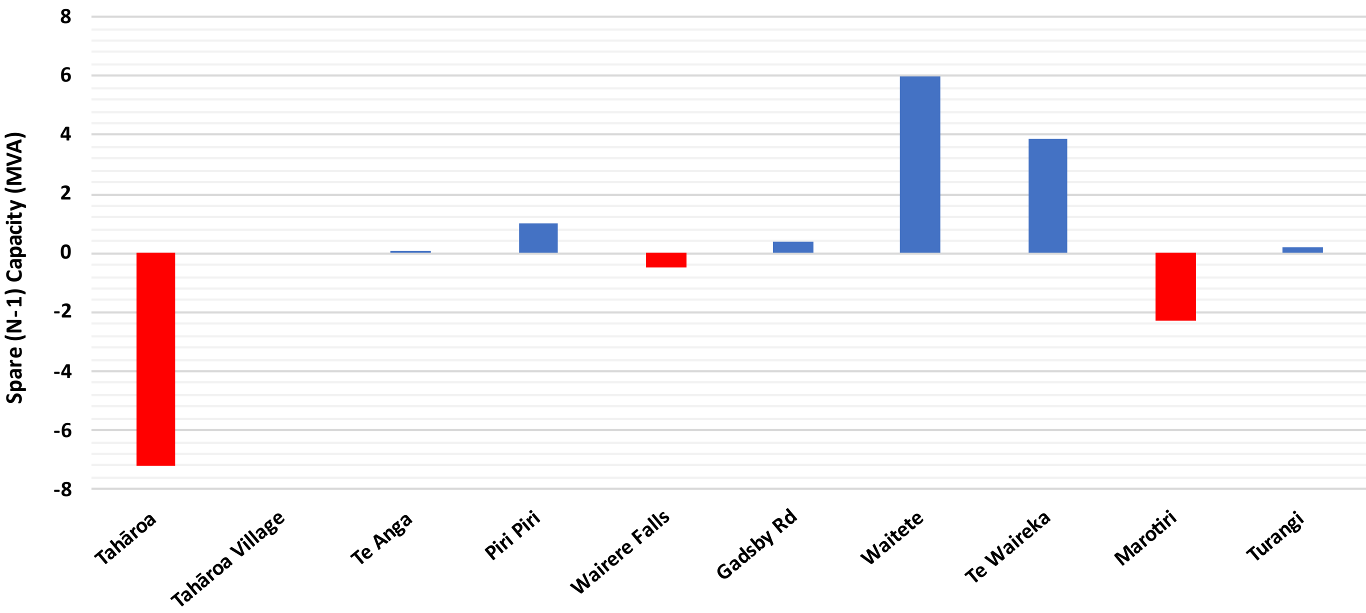


Figure 46. Summary: Approximate (N-1) spare capacity at The Lines Company's zone substations

The zone substations with spare (N-1) capacity available vary from 4% (for Te Anga) to 52% (for Turangi).

(N) Capacity Summary

The following Figure 47 illustrates the approximate (N) spare capacities at The Lines Company's zone substations, for the disclosed peak demand estimates[48]. 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 47 indicates that there is a wide range of spare (N) capacity, from -20% to 85%, although we note that where there is (N) capacity, it may be in locations where (N-1) security of supply would be a standard requirement.

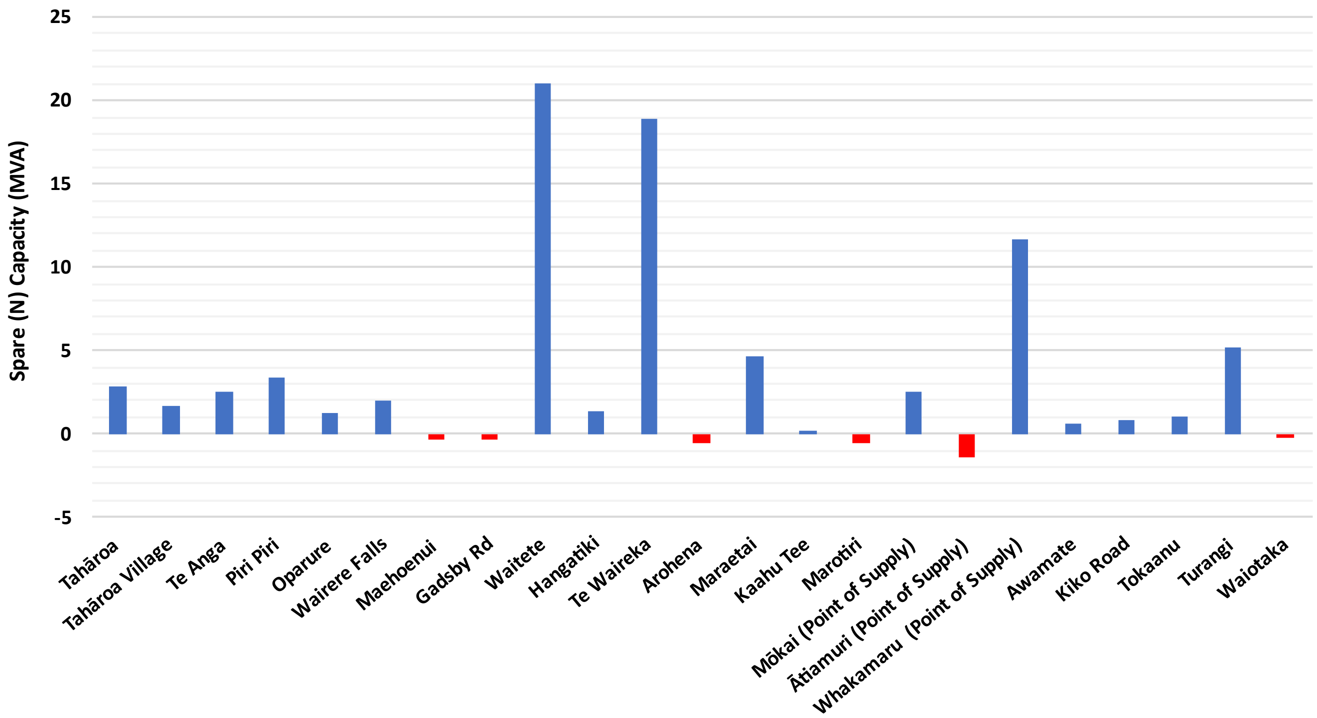


Figure 47. Summary: Approximate (N) spare capacity at The Lines Company's zone substations

7.8.3 Powerco

Four of Powerco's zone substations in the region (Thames T3, Whitianga, Lake Road, and Tīrau) have (N-1 switched) security rather than full (N-1) security. These substations each have one transformer only, however, back feed 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 back feed capability (also called "transfer capacity") for that substation's load.

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

(N-1) Capacity Summary

The following Figure 48 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 lines, cables 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 during periods of 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 nine of the thirty-one zone substations (Matatoki, Waihi Beach, Inghams, Tatua, Walton, Waharoa North, Waharoa South, Midway, Lakeside Pumps) do not have (N-1) security with respect to the supply transformers. At eleven of the zone substations, the (N-1) supply capacity has been exceeded in 2023.

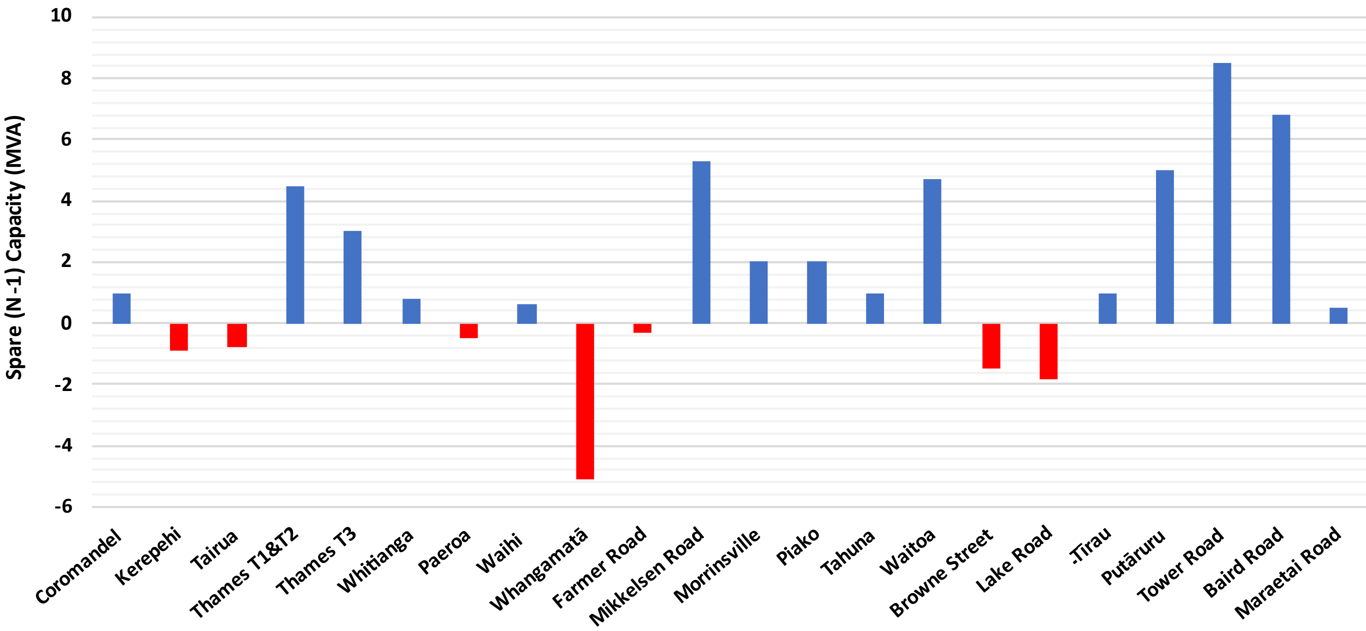


Figure 48. Summary: Approximate (N-1) spare capacity at Powerco's zone substations

The zone substations with spare (N-1) capacity available vary from 3% (for Maraetai Rd) to 60% (for Thames T1&T2).

(N) Capacity Summary

The following Figure 49 illustrates the approximate (N) spare capacities at Powerco's zone substations, for the disclosed peak demand estimates[49]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Powerco.

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

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 49 indicates that there is a limited volume of spare (N) capacity, with spare (N) capacity ranging from -150% to 92%. We note that where substations have spare (N) capacity may be in locations where (N-1) security of supply would be a standard requirement.

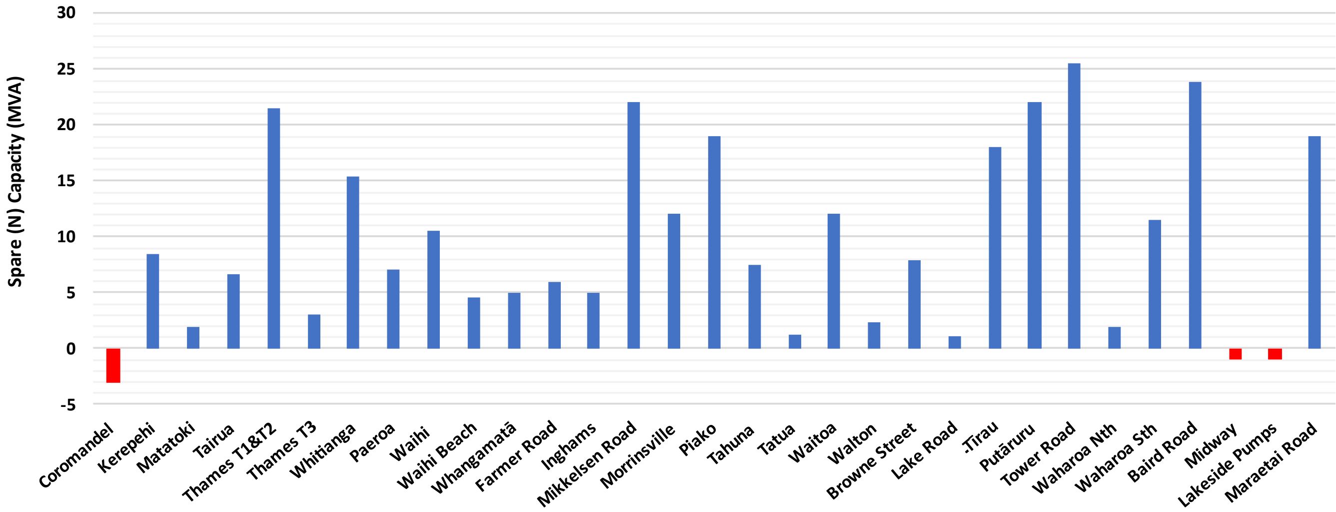


Figure 49. Summary: Approximate (N) spare capacity at Powerco's zone substations

7.8.4 Unison

(N-1) Capacity Summary

The following Figure 50 illustrates the approximate (N-1) spare capacities at Unison's zone substations, for the disclosed peak demand estimates. It should be noted that these have been calculated based on the transformer ratings disclosed by Unison.

The spare capacities shown do not include any upstream or downstream lines, cables 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 during periods of 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 two of the six zone substations (Ohaaki and Te Toke) do not have (N-1) security with respect to the supply transformers. At two of the zone substations, the (N-1) supply capacity has been exceeded in 2023.

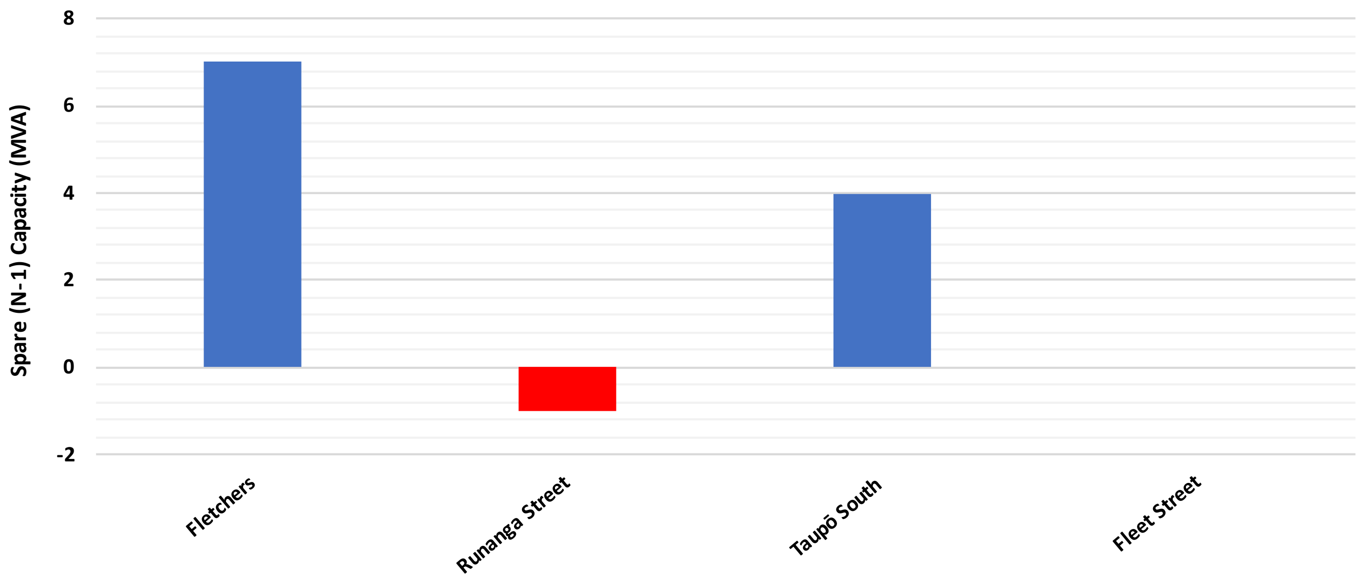


Figure 50. Summary: Approximate (N-1) spare capacity at Unison's zone substations

The zone substations with spare (N-1) capacity available vary from 33% (for Taupō South) to 47% (for Fletchers).

(N) Capacity Summary

The following Figure 51 illustrates the approximate (N) spare capacities at Unison's zone substations, for the disclosed peak demand estimates[50]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Unison.

The spare capacities shown do not include any upstream or downstream lines, cables or other equipment thermal constraints, which may be discussed for selected zone substations in Section 8. Figure 51 indicates that there is a moderate volume of spare (N) capacity, with most substations having at least 36%, although we note that these may be in locations where (N-1) security of supply would be a standard requirement.

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

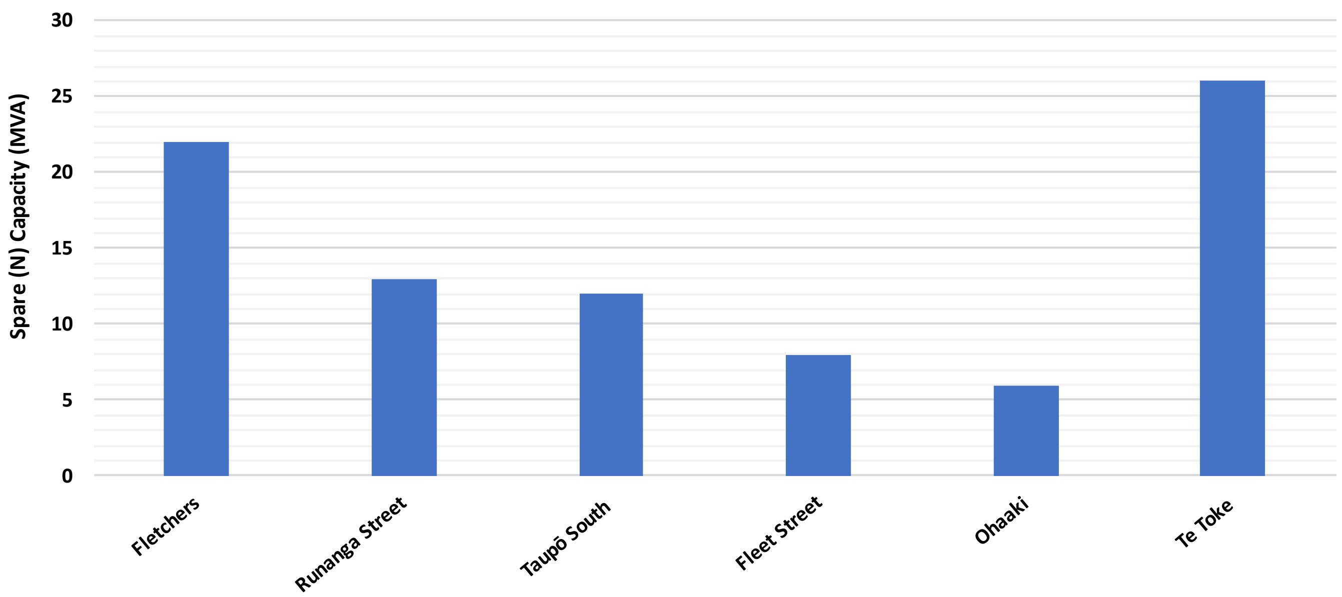


Figure 51. Summary: Approximate (N) spare capacity at Unison's zone substations

7.8.5 Vector

(N-1) Capacity Summary

The following Figure 52 illustrates the approximate (N-1) spare capacity at Vector's zone substation, for the disclosed peak demand estimates[51]. It should be noted that this has been calculated based on the transformer ratings disclosed by Vector Limited.

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

[51] Vector's 2023 AMP available here: https://www.vector.co.nz/about-us/regulatory/disclosures-electricity/asset-management-plan

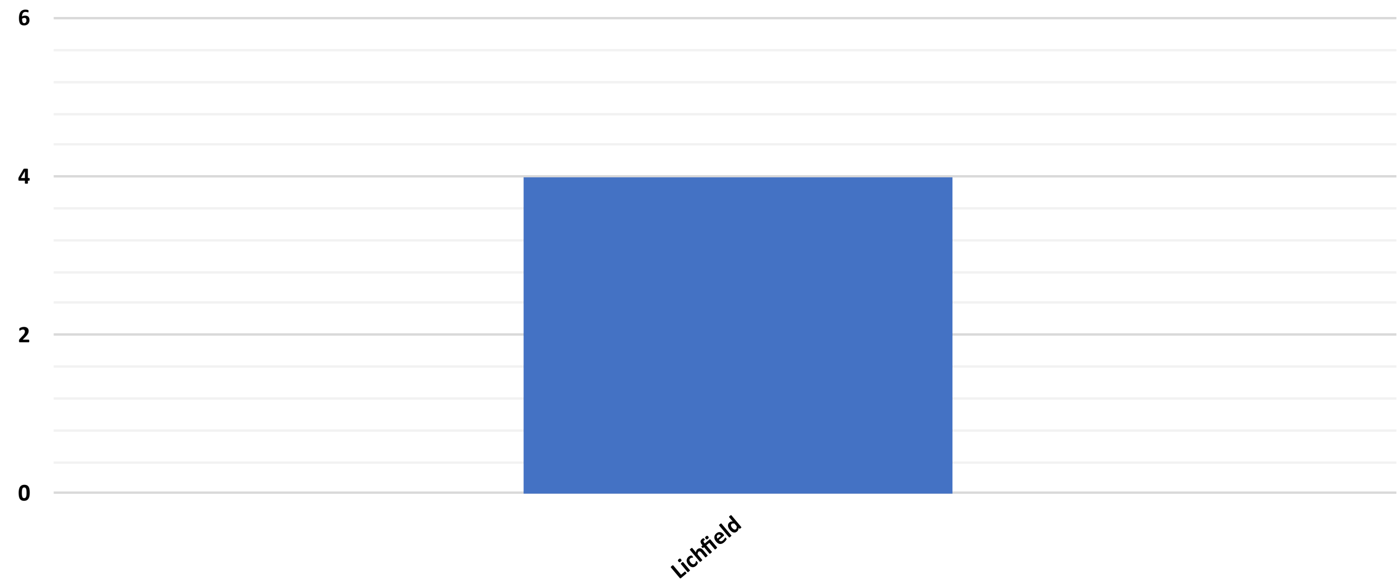
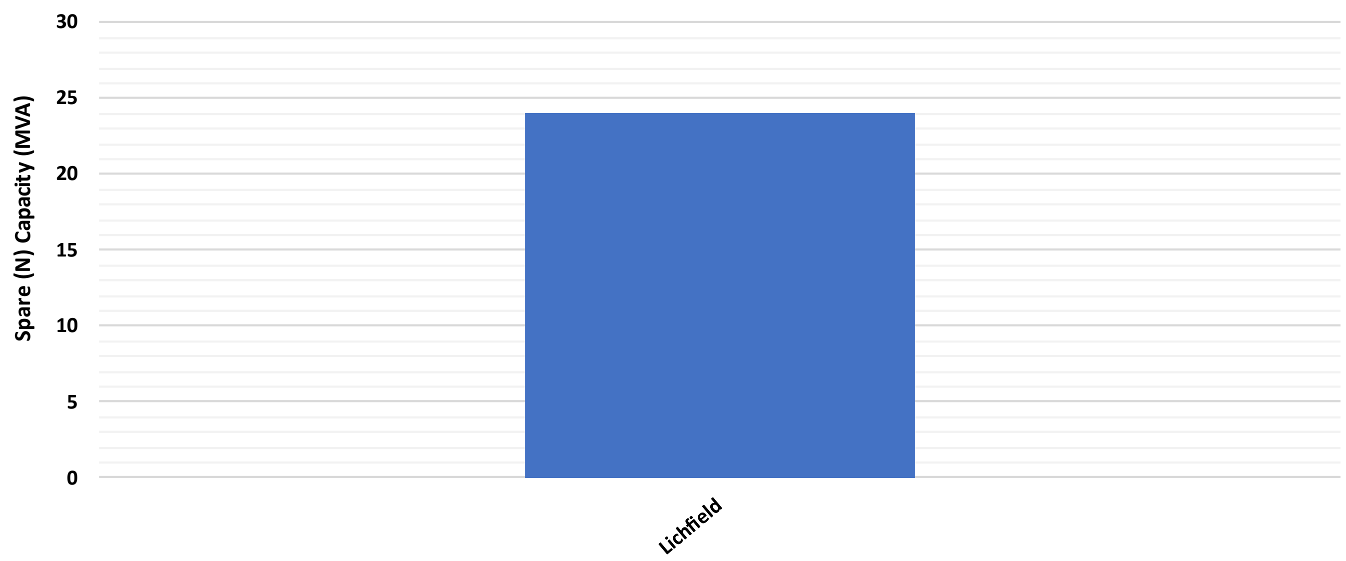


Figure 52. Summary: Approximate (N-1) spare capacity at Vector's zone substation

(N) Capacity Summary

The following Figure 53 illustrates the approximate (N) spare capacities at Vector's zone substation, for the disclosed peak demand estimates[52]. Again, it should be noted that this has been calculated based on the transformer ratings disclosed by Vector Limited.

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 53 indicates that there is a reasonable amount of spare (N) capacity at the substation.



[52] Vector's 2023 AMP available here: https://www.vector.co.nz/about-us/regulatory/disclosures-electricity/asset-management-plan

Figure 53. Summary: Approximate (N) spare capacity at Vector's zone substation

7.8.6 Waipā Networks

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

7.8.7 WEL Networks

(N-1) Capacity Summary

The following Figure 54 illustrates the approximate (N-1) spare capacities at WEL Networks' zone substations, for the disclosed peak demand estimates. It should be noted that these have been calculated based on the transformer ratings disclosed by WEL Networks.

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.

The negative (N-1) ratings represent a zone substation where the (N-1) rating is already exceeded for periods during 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 six of the twenty-six zone substations (Finlayson Rd, Glasgow St, Hampton Downs, Hoeka Rd, Raglan, and Whatawhata) 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 exceeded in 2023.

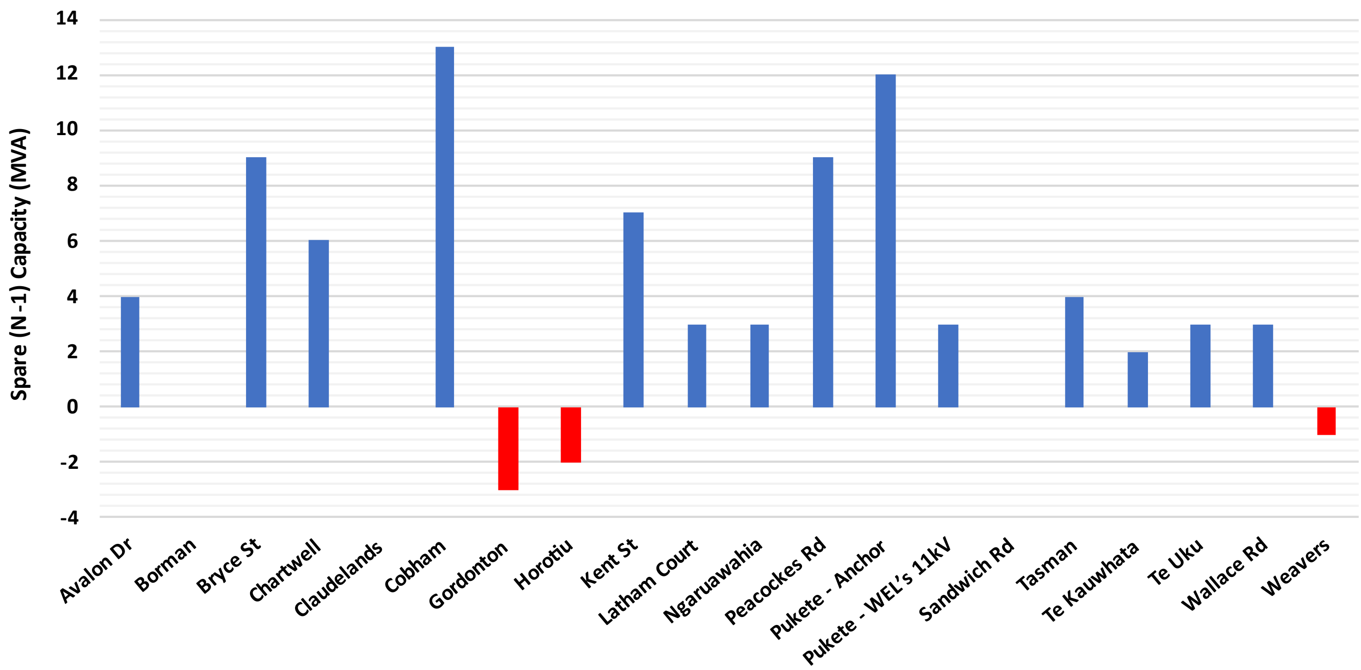


Figure 54. Summary: Approximate (N-1) spare capacity at WEL Networks' zone substations

The zone substations with spare (N-1) capacity available vary from 13% (for Latham Court) to 60% (for Te Uku).

(N) Capacity Summary

The following Figure 55 illustrates the approximate (N) spare capacities at WEL Networks' zone substations, for the disclosed peak demand estimates[53]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by WEL Networks.

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 55 indicates that there is a moderate volume of spare (N) capacity, with most substations having at least 20%, although we note that these may be in locations where (N-1) security of supply would be a standard requirement.

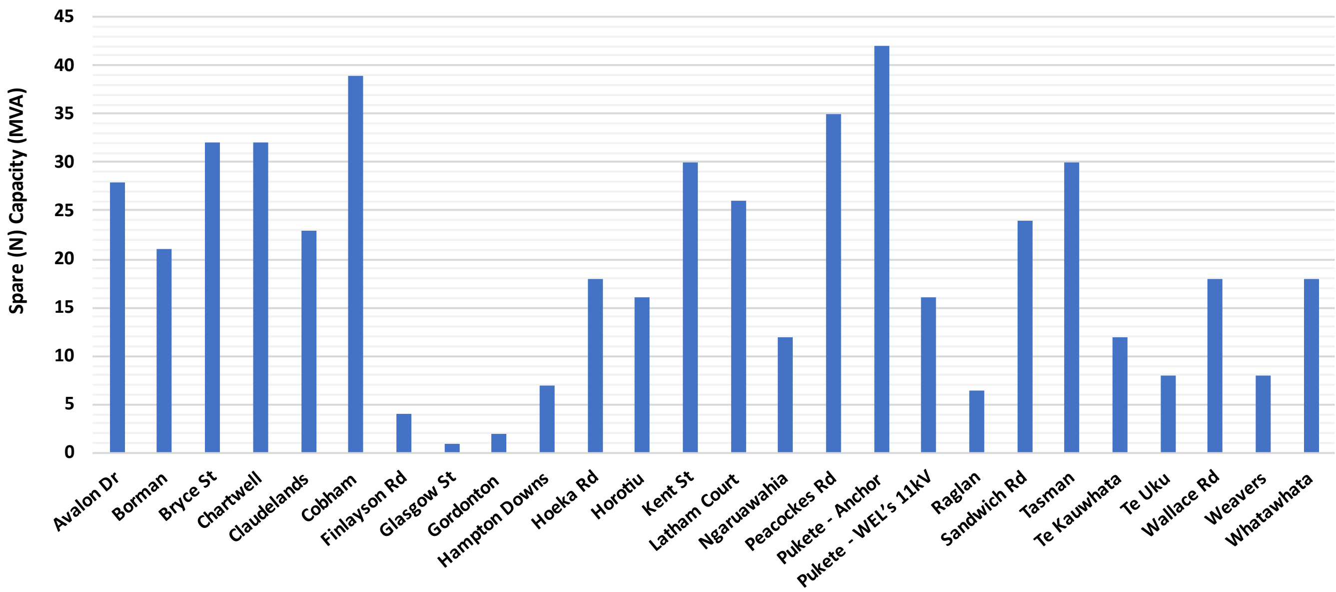


Figure 55. Summary: Approximate (N) spare capacity at WEL Networks' zone substations

[53] WEL Networks' 2023 AMP available here: https://www.wel.co.nz/about-us/regulatory-disclosures/

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 Sites 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 Site uses a top-down approach where the Load Site's peak load is assessed in conjunction with the spare capacity that is available:

- On the incoming transmission circuits.
- At the GXP substation.
- On the sub-transmission circuits feeding the nearby zone substation.
- At the nearby zone substation.
- On the adjacent 11kV or 22kV feeder.

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

Once the spare capacity across the supply network has been established, Ergo has been able to determine the implications of connecting the Load Site and the associated infrastructure upgrades. Ergo has used a building block approach to the costing of the necessary upgrades whereby 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 is expected to be able to accommodate the Load Site with minor distribution level changes and without the need for substantial infrastructure upgrade costs.

- **Moderate** – The "as designed" electrical system requires some infrastructure upgrades including, for example, 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, Powerco, Counties Energy, Waipa, WEL, and Unison). Ergo's view is that these are typically more conservative than the actual loading and are therefore appropriate when undertaking a high-level assessment.
- We have assumed the existing site's security of supply should be maintained (unless otherwise stated). For example, if the site presently has (N-1) security, we have recommended infrastructure upgrades to maintain this.
- The upgrades and costs of individual Load Sites are considered in isolation of the adjacent Load Sites. The scope and costs associated with connecting multiple Load Sites are briefly considered in the "GXP upgrade" sections at the start of each GXP's discussion, and in the "Combined Load on Zone Substations" and "Effect of all Load Sites Connecting to the GXP" sections at the end of each GXP's discussions.
- The Load Site loads will have unity power factor which is reasonable considering the preliminary nature of the assessment.
- Unless otherwise stated, we have assumed the existing incoming sub-transmission line/cable capacities exceed the capacity of the existing zone substation(s) they supply.
- Unless capacity information is available, we assumed existing 33 kV and 11 kV feeders are capable of supplying up to 12 MVA and 4.5 MVA respectively which is generally accepted as a conservative capacity limit in the absence of detailed information.
- Cost estimates have a Class 5[54] accuracy - suitable for concept screening. Appendix 4: 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

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

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).
- 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 projects are assessed in stages, the analysis undertaken assumes that upgrades continue down either the (N) or (N-1) security path, and the two options are not mixed between stages. Costs are cumulative as the Load Site growth progresses.
- Some Load Sites have staged analysis. For these Sites, EECA provided Ergo with preferred staging MW levels, however, at EECA's request, some of these sites staging MW levels have been adjusted by Ergo to better align with electrical system constraints.

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 Arapuni (North) GXP

One "Large" EECA Load Site is proposed to connect to the Arapuni (North) GXP (refer to Section 8.3.2):

- Fonterra Tīrau (18.04 MW)

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

Figure 56. Arapuni (North) GXP: EECA Load Site vs local substations

8.3.1 Arapuni (North) GXP Upgrade

As only one Load Site is connecting to the GXP, any required GXP upgrades are discussed in Section 8.3.2.

8.3.2 Fonterra Tīrau

FONTERRA TĪRAU		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	18.041	Arapuni (North)
Existing Electrical Supply to the Plant		

Fonterra Tīrau is presently supplied by Powerco's Tīrau zone substation's T2 Transformer (12.5/17 MVA) via an underground 11 kV feeder. Tīrau's T1 Transformer (7.5/10 MVA) supplies the local area and provides some backup to Fonterra when T2 is out of service. Tīrau is in turn supplied from Arapuni (North) GXP (via Putāruru zone substation) by two 33 kV subtransmission circuits. One of these circuits is underground and rated to ~32.5 MVA, while the other is overhead and rated to ~16 MVA. Putāruru's 33 kV bus is supplied from the Arapuni GXP via a single 110 kV overhead circuit rated at 61 MVA, which connects to a single 110/33 kV, 40 MVA transformer at Putāruru.

The Tīrau and Putāruru zone substations can be backfed from Hinuera GXP by two 33 kV circuits from Lake Road substation if either the 110 kV line supplying Putāruru or the 110/33 kV transformer at Putāruru are out of service.

This site is located approximately 0.3 km from Tīrau zone substation. In turn, Tīrau zone substation is approximately 15.2 km from Arapuni (North) GXP.

There is currently a maximum loading of 9 MVA on Tīrau zone substation, with 18 MVA of spare (N) capacity and 1 MVA of spare (switched N-1) capacity. The Putāruru substation presently has a maximum loading of 12 MVA, meaning the 110 kV lines and 110/33 kV transformer are presently loaded to a maximum of approximately 21 MVA.

FONTERRA TĪRAU

Figure 57. Fonterra Tīrau geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Due to the size of this load, analysis focuses on a staged approach to connecting the load.

For this Site, the staging provided was determined by Ergo to match the electrical system constraints.

Stage 1 - 8 MVA

The first stage of Fonterra Tīrau adds an additional 8 MW onto the existing load. As Tīrau zone substation primarily supplies Fonterra Tīrau, the existing feeder loading can be assumed to be the maximum substation loading, which is 9 MVA.

Tīrau zone substation has adequate spare (N), but insufficient spare (N-1) capacity to handle this increase.

For Tīrau zone substation to achieve the required (switched N-1) capacity, replacement of the smaller of the two supply transformers would be required at the substation.

Due to the size of the load, it is expected that 2x new 11 kV feeders from Tīrau substation would be required for this project. Due to the urban/industrial topography of the area, it is expected that this feeder would be underground, and would be approximately 0.3 km long.

As Putāruru zone substation takes a direct 110 kV supply from Arapuni, upgrades to the GXP are not considered for this load.

Stage 2 - 18 MVA

The second stage of Fonterra Tīrau adds an additional 10 MVA, bringing the total proposed load to 18 MVA.

Tīrau zone substation does not have adequate spare (N) or (N-1) capacity to handle this increase.

To fulfil an (N) condition Tīrau zone substation's existing 33 kV overhead incomer from Putāruru zone substation may need to be upgraded/replaced (re-conductored). Additionally, replacement of the smaller of the two supply transformers would be required at the substation.

For Tīrau zone substation to achieve the required (N-1) capacity, the above (N) capacity upgrade for reconductoring the existing overhead circuit between Putāruru and Tīrau must be carried out. Additionally, a third transformer would be required at Tīrau substation.

Additionally, to provide an (N-1) supply for this load, a second 110 kV circuit and 110/33 kV transformer from Arapuni GXP to Putāruru would be required. The second 110 kV circuit is assumed to be underground due to space constraints along the route due to existing lines.

Due to the size of the load, it is expected that 2x new 11 kV feeders from Tīrau substation would be required for this project. Due to the urban/industrial topography of the area, it is expected that this feeder would be underground, and would be approximately 0.3 km long.

As Putāruru zone substation takes a direct 110 kV supply from Arapuni, upgrades to the GXP are not considered for this load.

Capital Cost Estimate

Table 10. Fonterra Tīrau (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)**	
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	0.30	$0.24
		TOTAL	**$0.44**

Table 11. Fonterra Tīrau (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)**	
Distribution	11kV circuit breaker (ZSS)	3.00	$0.30
Distribution	Double underground 11kV cable	0.30	$0.24
Subtransmission	Large supply transformer (ZSS)	1.00	$2.30
		TOTAL	**$2.84**

Table 12. Fonterra Tīrau (Stage 2): 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	0.30	$0.24
Subtransmission	Large supply transformer (ZSS)	1.00	$2.30
Subtransmission	Reconductor single overhead 33kV line	11.60	$3.05
		TOTAL	**$5.79**

FONTERRA TĪRAU

Table 13. Fonterra Tīrau (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)**	
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	0.30	$0.24
Subtransmission	Large supply transformer (ZSS)	1.00	$2.30
Subtransmission	11kV circuit breaker (ZSS)	1.00	$0.10
Subtransmission	33kV circuit breaker (ZSS)	1.00	$0.30
Subtransmission	Reconductor single overhead 33kV line	11.60	$3.05
Subtransmission	Single underground 110 kV cable	13.00	$58.50
Subtransmission	Medium supply transformer (GXP)	1.00	$3.50
Subtransmission	110kV circuit breaker bay	2.00	$1.20
		TOTAL	**$69.39**

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 the (N) security case, it is estimated to take the following periods to plan, design, procure, construct, and commission the works for each stage:

- Stage 1 – 12-18 months
- Stage 2 – 24-36 months

For the (N-1) security case, it is estimated to take the following periods to plan, design, procure, construct, and commission the works for each stage:

- Stage 1 – 24-36 months
- Stage 2 – 36-48 months

Excluded are any works 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 Arapuni (North) GXP

The following Figure 58 illustrates the Arapuni (North) GXP load profile together with the load profiles of all the Load Sites within the Arapuni (North) GXP region. Also shown in Figure 58 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Arapuni (North) GXP would increase to 33.22 MW, an increase of 7.12 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 44.14 MW there is a diversity factor of 0.75 between the loads.

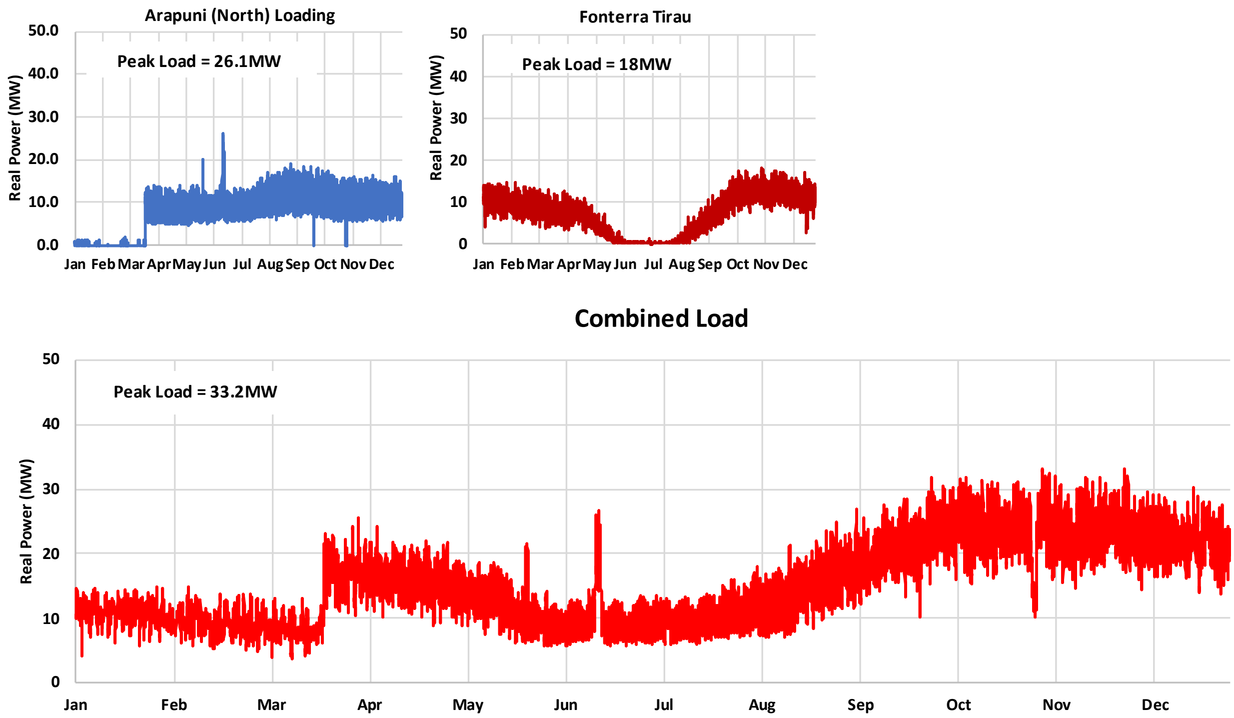


Figure 58. Loading Profiles: Arapuni (North) GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.4 Bombay 110 kV GXP

The "Large" EECA Load Sites connecting to the Bombay 110 kV GXP include:

- Yashili Pōkeno (28.95 MW)
- Synlait Milk Pōkeno (15.15 MW)
- Turners & Growers NZ Geraghty (3.29 MW)
- Turners and Growers Harrisville (1.60 MW)

The "Small" Load Sites connecting to the Bombay 110 kV GXP include (refer to sections 8.4.6 and 8.4.8):

- Grainhub Limited Tuakau (0.94 MW)
- Passion Fresh Pukekohe (0.69 MW)
- House of Taste Pukekohe (0.63 MW)
- Green Valley Dairies Mangatāwhiri (0.50 MW)
- Mercer Mushrooms Tuakau (0.40 MW)
- Blooming Hill Flowers Pukekohe (0.17 MW)

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

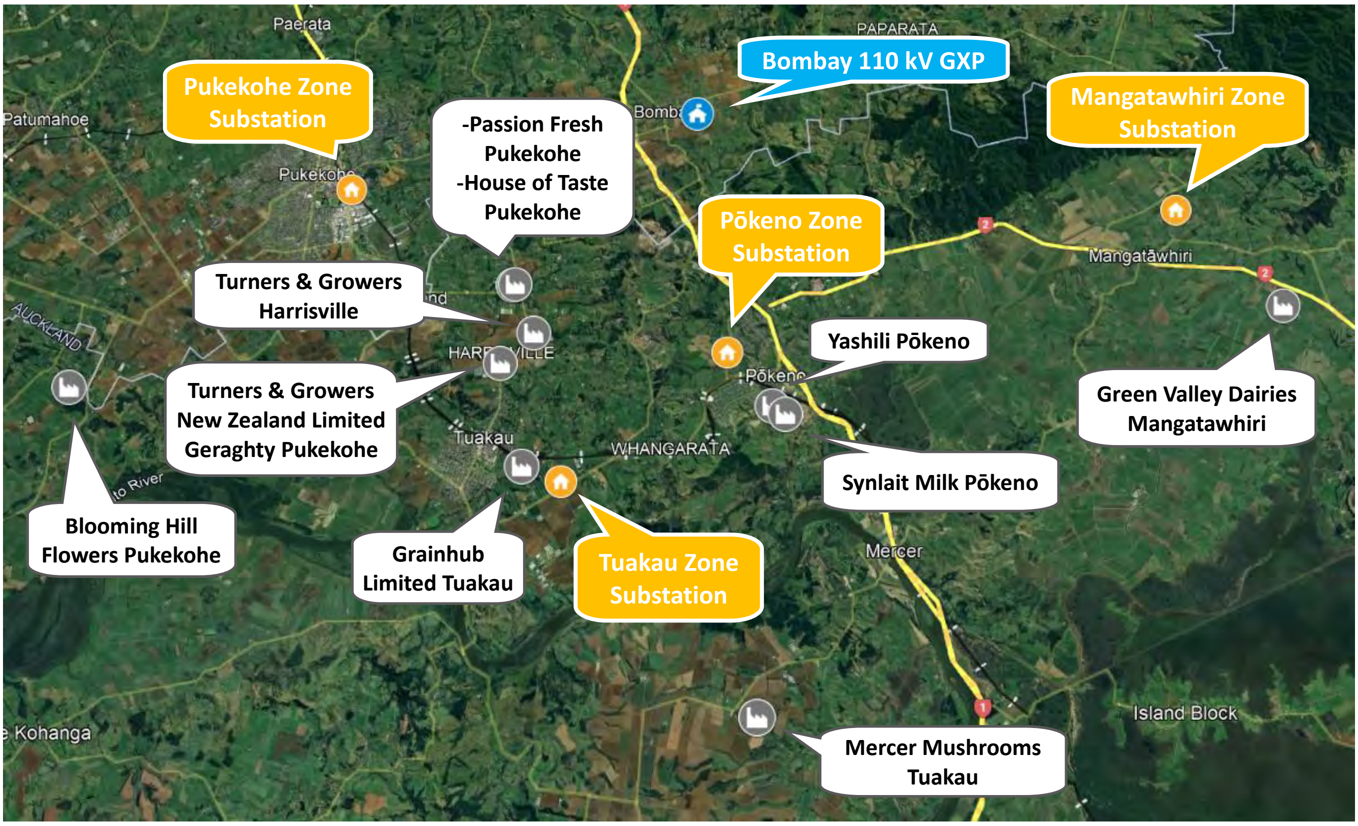


Figure 59. Bombay 110 kV GXP: EECA Load Sites vs local substations

8.4.1 Bombay 110 kV GXP Upgrade

The Bombay 110 kV GXP presently has ~93 MVA of spare (N-1) capacity and 202 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.4.9 indicates that the spare (N-1) capacity of the Bombay 110 kV GXP is not expected to be exceeded if all the Load Sites connect. Therefore, upgrades of the Bombay 110 kV GXP are not expected.

8.4.2 Yashili Pōkeno

YASHILI PŌKENO		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and high temperature heat pumps	28.95	Bombay 110 kV
Existing Electrical Supply to the Plant		

Yashili Pōkeno is presently supplied by Counties' Pōkeno zone substation via two underground 22 kV feeders. Pōkeno zone substation is in turn supplied from Bombay 110 kV GXP by two 110 kV subtransmission circuits. The subtransmission circuits are rated to approximately 80 MVA each. Pōkeno substation is equipped with 2x 40 MVA transformers at present.

This site is located approximately 1.7 km from Pōkeno zone substation. In turn, Pōkeno zone substation is approximately 6.0 km from Bombay 110 kV GXP.

There is currently a maximum loading of 10 MVA on Pōkeno zone substation, with 70 MVA of spare (N) capacity and 30 MVA spare (N-1) capacity. Bombay 110 kV GXP presently has 93 MVA of spare (N-1) capacity and 202 MVA of spare (N) capacity.

Figure 60. Yashili Pōkeno geographic location in relation to the surrounding zone substations

YASHILI PŌKENO

Supply Option(s) for New Load

Due to the size of this load, analysis focuses on a staged approach to connecting the load.

For this Site, the staging provided by EECA has been adjusted by Ergo to better match the electrical system constraints.

<u>Stage 1 - 12 MVA</u>

The first stage of Yashili Pōkeno adds an additional 12 MVA onto the existing load.

Pōkeno zone substation has adequate spare (N) and (N-1) capacity for this load. Therefore, upgrades to Pōkeno zone substation are not considered.

Yashili is presently supplied by the 22 kV "Gateway" feeder. The feeder is presently loaded at a maximum of 104 A (3.96 MVA).

Due to the size of the load, it is expected that 1x new 22 kV feeder from Pōkeno substation would be required for this project. Due to the urban/industrial topography of the area, it is expected that this feeder would be underground, and would be 3.5 km long.

Counties have advised that the full 12 MVA load would require a new feeder, however they note that, with some flexibility, the existing feeder could accommodate a portion of the new load, without upgrading the network.

<u>Stage 2 - 28.95 MVA</u>

The second stage of Yashili Pōkeno adds an additional ~17 MVA, bringing the total proposed load to 28.95 MVA.

Pōkeno zone substation has adequate spare (N) and (N-1) capacity for this load.

Due to the size of this load, it is expected that 3x new 22 kV feeders from Pōkeno substation would be required for this project. Due to the urban/industrial topography of the area, it is expected that these feeders would be underground, and would be 3.5 km long.

As the zone substation and GXP have adequate (N-1) capacity for this load, consideration has not been given to an (N) security supply.

YASHILI PŌKENO

Capital Cost Estimate

Table 14. Yashili Pōkeno (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)**	
Distribution	22kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 22kV cable	3.50	$1.58
		TOTAL	**$1.68**

Table 15. Yashili Pōkeno (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)**	
Distribution	22kV circuit breaker (ZSS)	3.00	$0.30
Distribution	Single underground 22kV cable	10.50	$4.73
		TOTAL	**$5.03**

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 each stage, 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 Synlait Milk Pōkeno

SYNLAIT MILK PŌKENO		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	15.149	Bombay 110 kV

Existing Electrical Supply to the Plant

Synlait Milk Pōkeno is presently supplied by Counties' Pōkeno substation via two underground 22 kV feeders. Pōkeno zone substation is in turn supplied via two 110kV circuits that connect to the Bombay 110 kV GXP. The two incoming 110kV circuits, to Pokeno, form part of a 110kV ring that supplies the Pokeno, Tuakau and Pukekohe zone substations (from the Bombay GXP). Each of the 110kV circuits are rated to approximately 80 MVA. Pōkeno substation is equipped with 2x 40 MVA transformers at present.

This Load Site is located approximately 2.1 km from Pōkeno zone substation. In turn, Pōkeno zone substation is approximately 6.0 km from Bombay 110 kV GXP.

There is currently a maximum loading of 10 MVA on the Pōkeno zone substation, with 70 MVA of spare (N) capacity and 30 MVA of spare (N-1) capacity. Bombay 110 kV GXP presently has 93 MVA of spare (N-1) capacity and 202 MVA of spare (N) capacity.

Figure 61. Synlait Milk Pōkeno 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-1) capacity for this load.

Yashili is presently supplied by the 22 kV "Gateway" feeder. The feeder is presently loaded at a maximum of 104 A (3.96 MVA).

Due to the size of the load, it is expected that 1x new 22 kV feeder from Pōkeno substation would be required for this project. Due to the urban/industrial topography of the area, it is expected that this feeder would be underground, and would be 3.0 km long (following existing cable route).

Counties have advised that the full 15.15 MVA load would require a new feeder, however they note that, with some flexibility, the existing feeder could accommodate a portion of the new load, without upgrading the network.

As the zone substation and GXP have adequate (N-1) capacity for this load, consideration has not been given to an (N) security supply.

Capital Cost Estimate

Table 16. Synlait Milk Pōkeno: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	22kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 22kV cable	3.00	$1.35
		TOTAL	**$1.45**

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 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 Turners & Growers NZ Geraghty

TURNERS & GROWERS NZ GERAGHTY		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New high temperature heat pumps	3.292	Bombay 110 kV

Existing Electrical Supply to the Plant

Turners & Growers NZ Geraghty is presently supplied by Counties' Pukekohe zone substation via a 22 kV feeder which consists of a mixture of underground cable and overhead line. Pukekohe zone substation is in turn supplied via one 110 kV circuit that is connected to the Bombay 110 kV GXP. The incoming 110 kV circuits, form part of a 110 kV ring that supplies the Pokeno, Tuakau and Pukekohe zone substations (from the Bombay GXP). The subtransmission circuits in the ring are rated to approximately 80 MVA each. Pukekohe substation is equipped with 2x 60 MVA transformers at present.

This site is located approximately 5.6 km from the Pukekohe zone substation. In turn, Pukekohe zone substation is approximately 8.2 km from Bombay 110 kV GXP.

There is currently a maximum loading of 39 MVA on the Pukekohe zone substation, with 81 MVA of spare (N) capacity and 21 MVA of spare (N-1) capacity. Bombay 110 kV GXP presently has 93 MVA of spare (N-1) capacity and 202 MVA of spare (N) capacity.

Figure 62. Turners & Growers NZ Geraghty geographic location in relation to the surrounding zone substations

TURNERS & GROWERS NZ GERAGHTY

Supply Option(s) for New Load

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

Turners & Growers is presently supplied by the 22 kV "Railway" feeder. The feeder is presently loaded at a maximum of 70 A (2.67 MVA).

Ergo expects that the existing feeder could accommodate both this and the other Turners & Growers load. It is possible, given the size of the load, that voltage support (i.e. capacitor bank) may be required at the Load Site.

As the zone substation and GXP have adequate (N-1) capacity for this load, consideration has not been given to an (N) security supply.

Capital Cost Estimate

Table 17. Turners & Growers NZ Geraghty: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	**Subtransmission => (N-1)**	**Distribution => (N)**	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	22kV Capacitor Bank	1.00	$0.35
		TOTAL	**$0.35**

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 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 Turners and Growers Harrisville

TURNERS AND GROWERS HARRISVILLE		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New high temperature heat pumps	1.599	Bombay 110 kV
Existing Electrical Supply to the Plant		

Turners & Growers NZ Harrisville is presently supplied by Counties' Pukekohe zone substation via a 22 kV feeder which consists of a mixture of underground cable and overhead line. Pukekohe zone substation is in turn supplied via one 110 kV circuit that is connected to the Bombay 110 kV GXP. The incoming 110 kV circuits, form part of a 110 kV ring that supplies the Pokeno, Tuakau and Pukekohe zone substations (from the Bombay GXP). The subtransmission circuits in the ring are rated to approximately 80 MVA each. Pukekohe substation is equipped with 2x 60 MVA transformers at present.

This site is located approximately 5.6 km from Pukekohe zone substation. In turn, Pukekohe zone substation is approximately 8.2 km from Bombay 110 kV GXP.

There is currently a maximum loading of 39 MVA on Pukekohe zone substation, with 81 MVA of spare (N) capacity and 21 MVA of spare (N-1) capacity. Bombay 110 kV GXP presently has 93 MVA of spare (N-1) capacity and 202 MVA of spare (N) capacity.

Figure 63. Turners and Growers Harrisville geographic location in relation to the surrounding zone substations

TURNERS AND GROWERS HARRISVILLE
Supply Option(s) for New Load
Both the zone substation and the GXP have adequate spare (N-1) capacity for this load. Turners & Growers is presently supplied by the 22 kV "Railway" feeder. The feeder is presently loaded at a maximum of 70 A (2.67 MVA). Ergo expects that the existing feeder could accommodate both this and the other Turners & Growers load. Therefore the only expected upgrades to connect this Load Site would be those associated with installation of a new RMU and distribution transformer. As the zone substation and GXP have adequate (N-1) capacity for this load, consideration has not been given to an (N) security supply.
Capital Cost Estimate
Table 18. Turners and Growers Harrisville: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security. (N/A) Indicatively, the expected cost of a distribution transformer to supply this load is $350k. 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.

8.4.6 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 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)
Grainhub Limited Tuakau	Tuakau	27	67	0.876	0.937	260
Passion Fresh Pukekohe	Pukekohe	21	81	2.02	0.688	200
House of Taste Pukekohe	Pukekohe	21	81	2.02	0.631	200
Green Valley Dairies Mangatāwhiri	Mangatawhiri	N/A	1.4	7.81	0.498	130
Mercer Mushrooms Tuakau	Tuakau	27	67	2.26	0.401	130
Blooming Hill Flowers Pukekohe	Pukekohe	21	81	3.65	0.172	80

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 Pōkeno

Two of the loads on Bombay 110 kV GXP are expected to connect to Pōkeno zone substation. The loads are Yashili Pōkeno, and Synlait Milk Pōkeno. The sum of peaks of these loads is 44.09 MW, which the zone substation doesn't have (N-1) capacity for. Therefore, upgrades at Pōkeno are expected.

Ergo expects that the substation would be able to support these loads if the transformers at the site were replaced with larger, 60 MVA units rather than the 40 MVA units presently installed. Indicatively, this would cost around $9M.

8.4.7.2 Tuakau

Two of the loads on Bombay 110 kV GXP are expected to connect to Tuakau zone substation. The loads are Grainhub Limited Tuakau and Mercer Mushrooms Tuakau. The sum of peaks of these loads is 1.34 MW, which the zone substation has (N-1) capacity for. Therefore, further upgrades at Tuakau are not considered.

8.4.7.3 Pukekohe

Five of the loads on Bombay 110 kV GXP are expected to connect to Pukekohe zone substation. The loads are Turners & Growers New Zealand Limited Geraghty, Turners & Growers Harrisville, Passion Fresh Pukekohe, House of Taste Pukekohe, and Blooming Hill Flowers Pukekohe. The sum of peaks of these loads is 6.38 MW, which the zone substation has (N-1) capacity for. Therefore, further upgrades at Pukekohe are not considered.

8.4.8 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Bombay 110 kV GXP gives a combined load of 3.33 MW. When the load shapes are combined, they result in the following load shape (Figure 64), with a maximum load of 2.25 MW, with a diversity factor of 0.68.

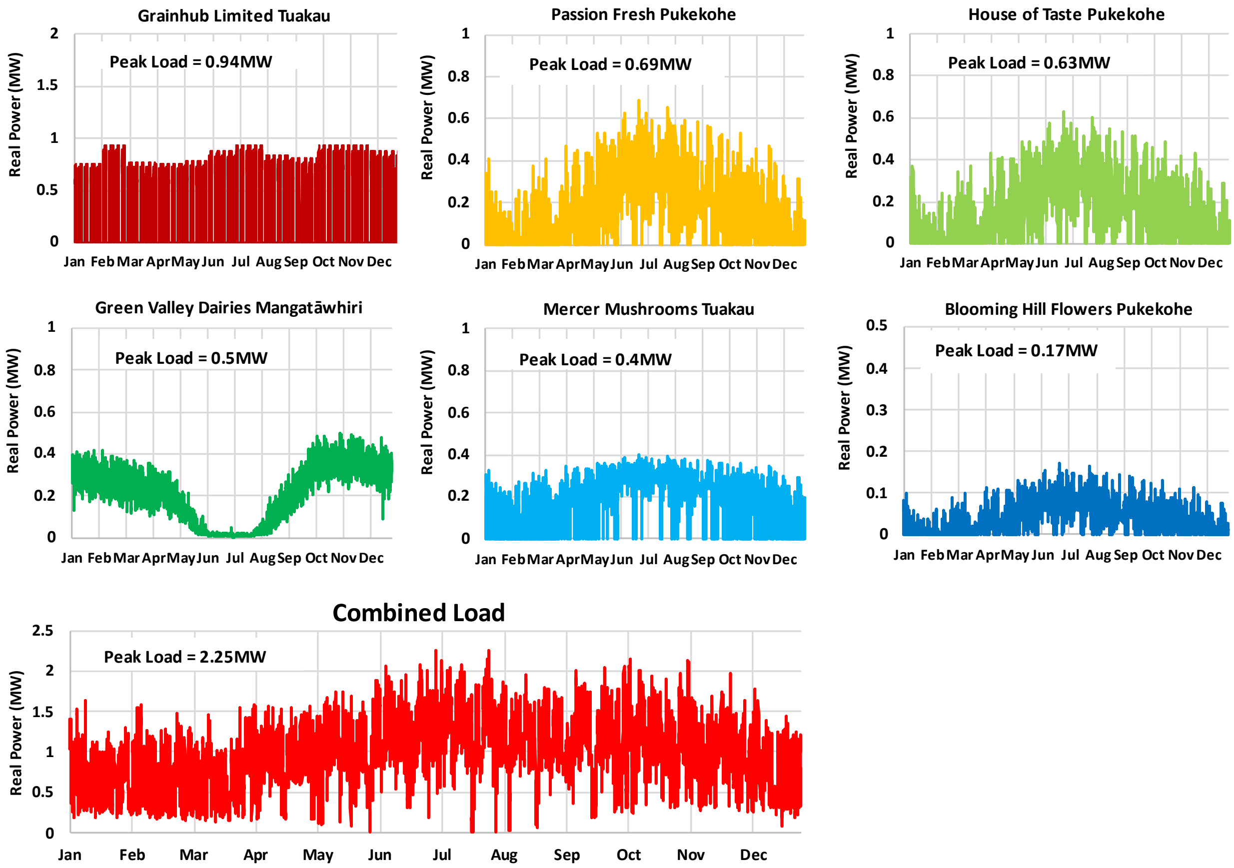


Figure 64. Loading Profiles: Bombay 110 kV GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.4.9 Effect of all Load Sites Connecting to Bombay 110 kV GXP

The following Figure 65 illustrates the Bombay 110 kV GXP load profile together with the load profiles of all the Load Sites within the Bombay 110 kV GXP region. Also shown in Figure 65 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Bombay 110 kV GXP would increase to 112.86 MW, an increase of 20.55 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 143.55 MW there is a diversity factor of 0.79 between the loads.
- Based on Ergo's analysis, the Bombay 110 kV GXP's (N-1) limit is not expected to be exceeded.

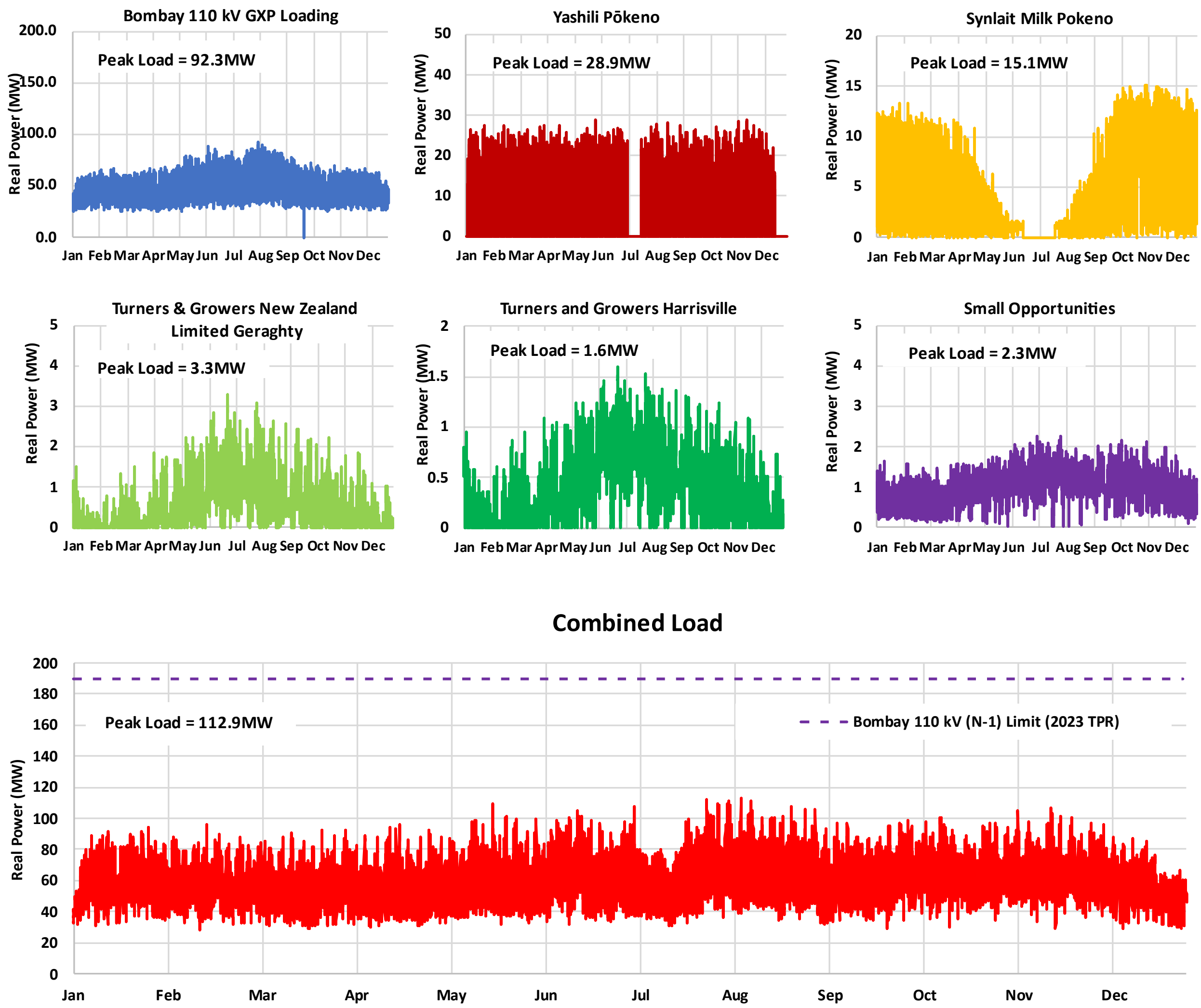


Figure 65. Loading Profiles: Bombay 110 kV GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.5 Cambridge GXP

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

- Inghams Enterprises (NZ) Pty Limited Cambridge (2.73 MW)
- Riverton Nurseries Hautapu (1.03 MW)

The "Small" Load Sites connecting to the Cambridge GXP include (refer to sections 8.5.4 and 8.5.5):

- Burwood Nurseries Limited Tamahere (0.46 MW)
- Lilies by Blewden Cambridge (0.28 MW)
- Ministry of Education Cambridge High School (0.15 MW)
- Quack A Duck Cambridge (0.09 MW)

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

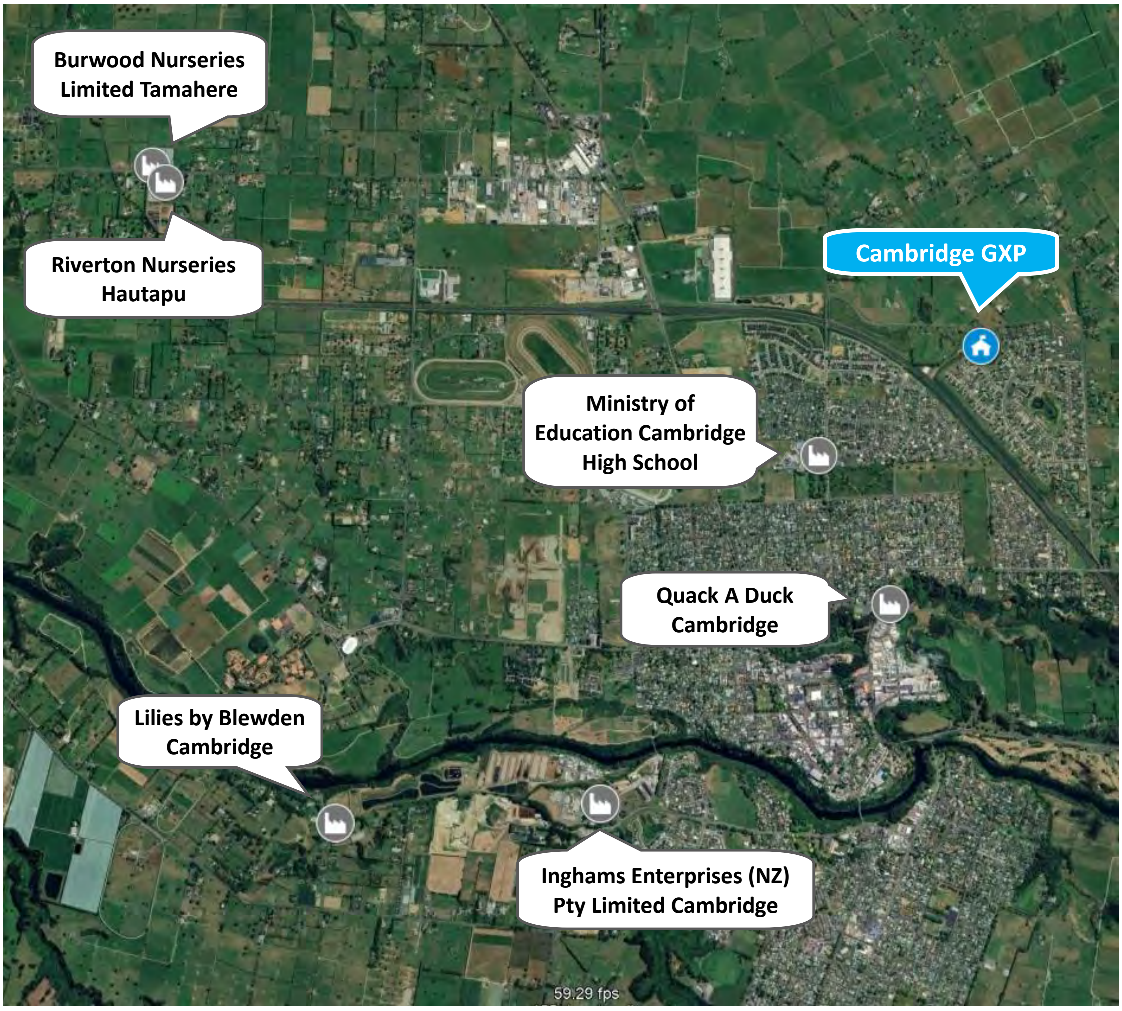


Figure 66. Cambridge GXP: EECA Load Sites vs local substations

8.5.1 Cambridge GXP Upgrade

The Cambridge GXP presently has -2 MVA of spare (N-1) capacity and 31 MVA of spare (N) capacity, based on the transformer ratings.

The spare (N) and (N-1) capacity of the Cambridge GXP is already exceeded during peak loading.

Currently, to minimise overloading of its supply transformers, Transpower has implemented a special transformer protection scheme to manage short to medium term peaks. Transpower is also constructing a new 220/33 kV GXP for Waipa Networks near Hautapu with the expectation this will reduce the load on the existing Cambridge GXP. This new GXP will supply Waipā Network's first 33/11kV zone substation that is under construction.

It is expected that the transformer replacements at the GXP required for the two larger loads connecting to Cambridge GXP would be adequate to supply all of the proposed Load Sites.

Ergo expects that, to manage loading at the Cambridge GXP, load will be shifted onto the new Hautapu GXP and Waipā Networks' accompanying Forrest Road zone substation. Therefore, no upgrades at Cambridge GXP are expected.

8.5.2 Inghams Enterprises (NZ) Pty Limited Cambridge

INGHAMS ENTERPRISES (NZ) PTY LIMITED CAMBRIDGE		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and high temperature heat pumps	2.734	Cambridge

Existing Electrical Supply to the Plant

Inghams Enterprises (NZ) Pty Limited Cambridge is presently supplied from Cambridge GXP via the 11 kV bus.

This site is located approximately 4.2 km from Cambridge GXP.

There is currently a maximum loading of 49.3 MVA on Cambridge GXP, with 31 MVA of spare (N) capacity and -2 MVA of spare (N-1) capacity.

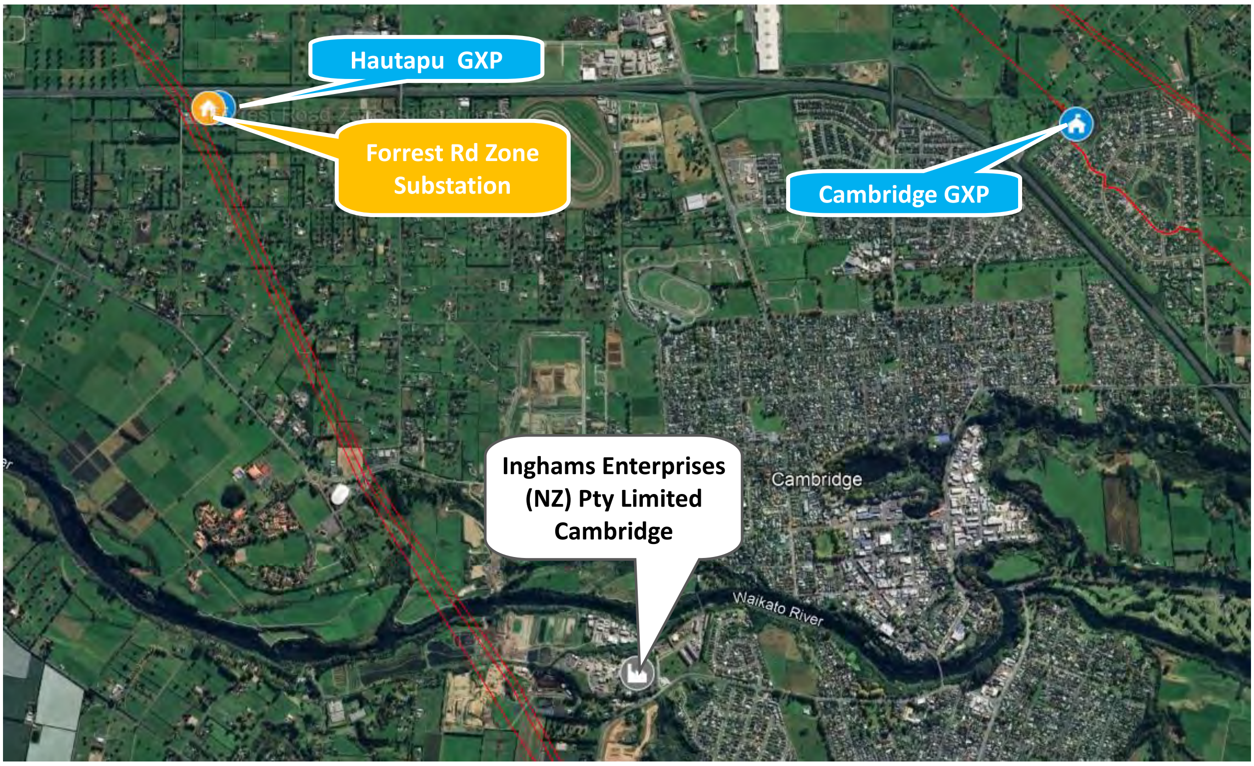


Figure 67. Inghams Enterprises (NZ) Pty Limited Cambridge geographic location in relation to the surrounding GXPs

Supply Option(s) for New Load

The GXP does not have adequate spare (N-1) capacity for this load. However, it does have adequate (N) capacity. A special protection scheme is already installed at the GXP. The new Hautapu GXP and Forrest Rd zone substation are expected to have (N-1) capacity for the additional load.

Due to the size of the load and the existing feeder loading, it is expected that 1x new 11 kV feeder from Hautapu GXP/Waipā Networks' new Forrest Road substation (both presently in construction) would be required for this project. Due to the urban/industrial topography along the feeder path, and development in the area, it is expected that this feeder would be underground cable, and would be ~6 km long.

Ergo notes that due to the location of the new GXP and zone substation, establishing a feeder to the site would require crossing the Waikato river. There is an existing pipeline bridge which Ergo has assumed could be utilised for this crossing. To account for the complexity of achieving this crossing, an additional 1 km of cabling has been allowed for.

As the zone substation and GXP have adequate (N-1) capacity for this load, consideration has not been given to an (N) security supply.

Capital Cost Estimate

Table 20. Inghams Enterprises (NZ) Pty Limited Cambridge: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	7.00	$4.20
		TOTAL	**$4.30**

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 12-18 months to plan, design, procure, construct, and commission the works.

Excluded are any work required to establish the Load Site.

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

8.5.3 Riverton Nurseries Hautapu

RIVERTON NURSERIES HAUTAPU		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New high temperature heat pumps	1.031	Cambridge

Existing Electrical Supply to the Plant

Riverton Nurseries Hautapu is presently supplied from Cambridge GXP via the 11 kV bus.

This site is located approximately 6.0 km from Cambridge GXP.

There is currently a maximum loading of 49.3 MVA on Cambridge GXP, with 31 MVA of spare (N) capacity and -2 MVA of spare (N-1) capacity.

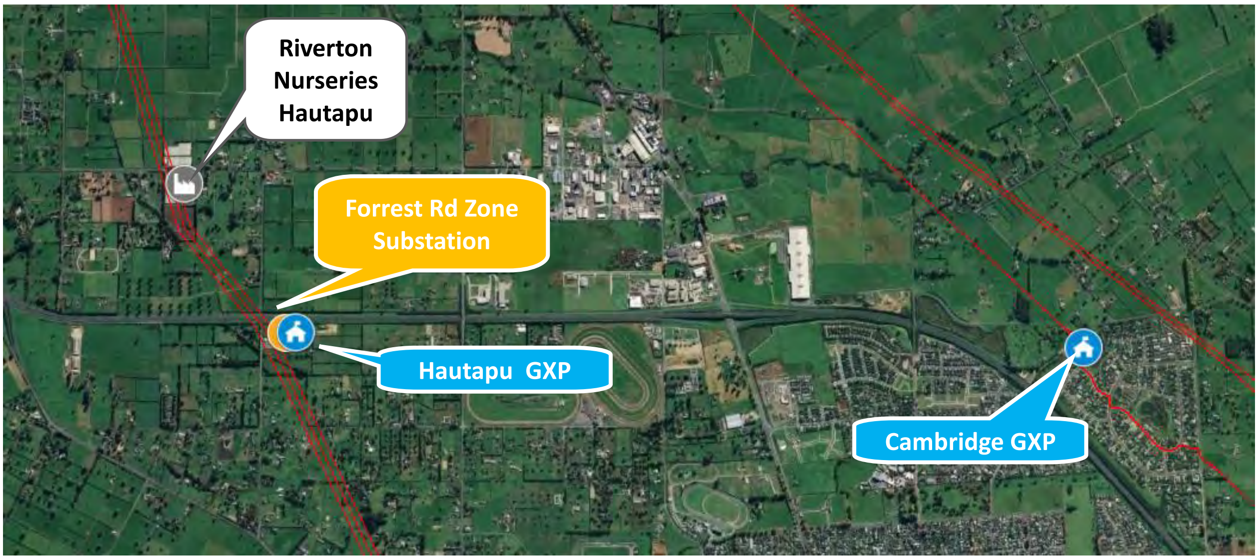


Figure 68. Riverton Nurseries Hautapu geographic location in relation to the surrounding GXPs

Supply Option(s) for New Load

The GXP does not have adequate spare (N-1) capacity for this load. However, it does have adequate (N) capacity. A special protection scheme is already installed at the GXP. The new Hautapu GXP and Forrest Rd zone substation are expected to have (N-1) capacity for the additional load.

The existing feeder is expected to have adequate capacity for the increased load of the site, and it is not expected that any conductors will require upgrading. To establish an (N-1) security supply, it is expected that the feeder presently feeding Riverton Nurseries Hautapu could be transferred onto the new Forrest Road zone substation, due to the proximity of the substation to the Load Site.As the zone substation and GXP have adequate (N-1) capacity for this load, consideration has not been given to an (N) security supply.

RIVERTON NURSERIES HAUTAPU
Capital Cost Estimate
Table 21. Riverton Nurseries Hautapu: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security. (N/A) Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site. Indicatively, a new distribution transformer to supply this load is expected to cost approximately $350k.
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.

8.5.4 Small Opportunities

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

Table 22. 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)
Burwood Nurseries Limited Tamahere	N/A	N/A	N/A	4.88	0.458	130
Lilies by Blewden Cambridge	N/A	N/A	N/A	6.13	0.275	130
Ministry of Education Cambridge High School	N/A	N/A	N/A	4.47	0.154	80
Quack A Duck Cambridge Pool	N/A	N/A	N/A	5.52	0.093	50

Ergo notes that due to high feeder loadings for some of these feeders, Ergo has carried out checks of the actual increase in feeder loading for these feeders, similar to analysis carried out at the GXP level in Section 8.5.6, to confirm that feeder loading would stay within acceptable limits.

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.

8.5.5 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Cambridge GXP gives a combined load of 0.98 MW. When the load shapes are combined, they result in the following load shape (Figure 69), with a maximum load of 0.84 MW, with a diversity factor of 0.86.

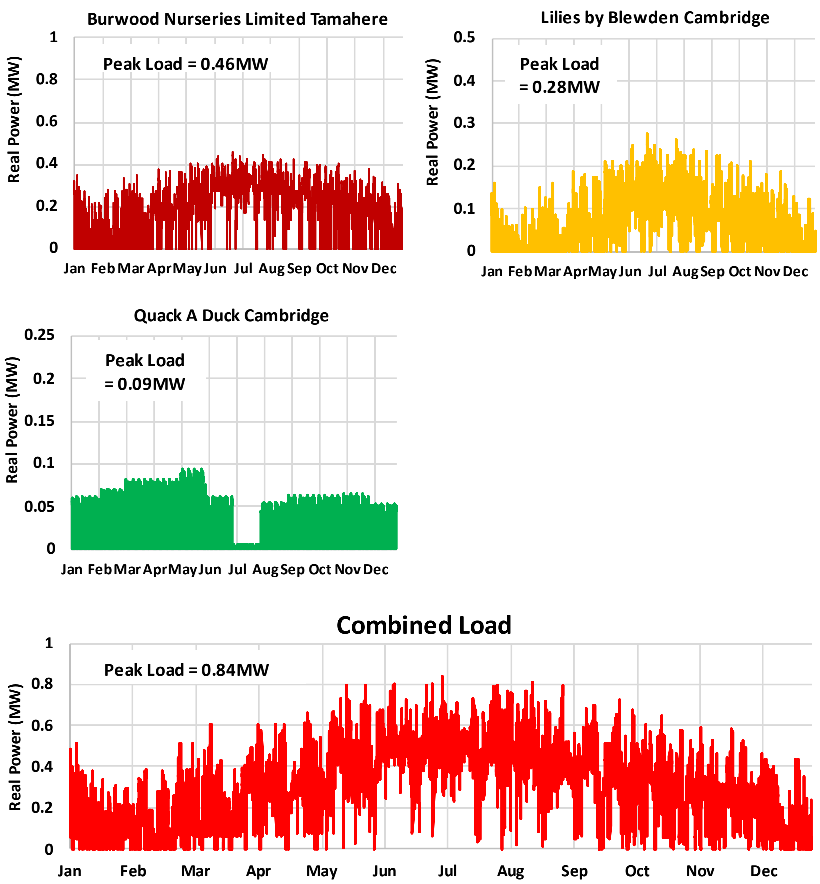


Figure 69. Loading Profiles: Cambridge GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.5.6 Effect of all Load Sites Connecting to Cambridge GXP

The following Figure 70 illustrates the Cambridge GXP load profile together with the load profiles of all the Load Sites within the Cambridge GXP region. Also shown in Figure 70 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Cambridge GXP would increase to 51.23 MW, an increase of 1.97 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 53.87 MW there is a diversity factor of 0.95 between the loads.
- Based on Ergo's analysis, the Cambridge GXP's (N-1) limit is expected to be exceeded. Ergo has discussed this in Section 8.5.1.

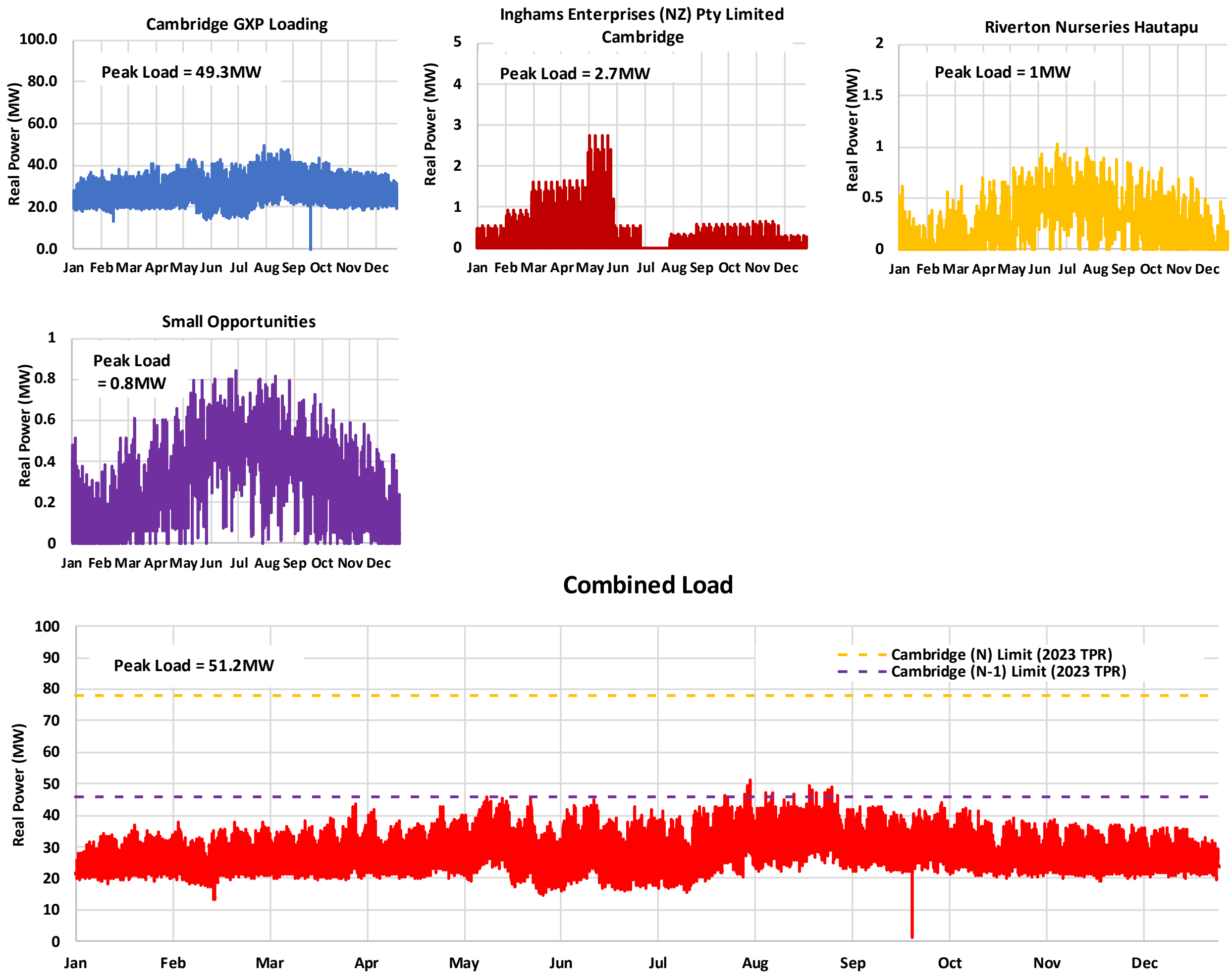


Figure 70. Loading Profiles: Cambridge GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.6 Glenbrook GXP

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

8.7 Hamilton 11 kV GXP

The "Large" EECA Load Sites connecting to the Hamilton 11 kV GXP include:

- University of Waikato Hamilton (4.44 MW)

One "Small" Load Site is connecting to the Hamilton 11 kV GXP (refer to section 8.7.3):

- AgResearch Ruakura (0.15 MW)

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

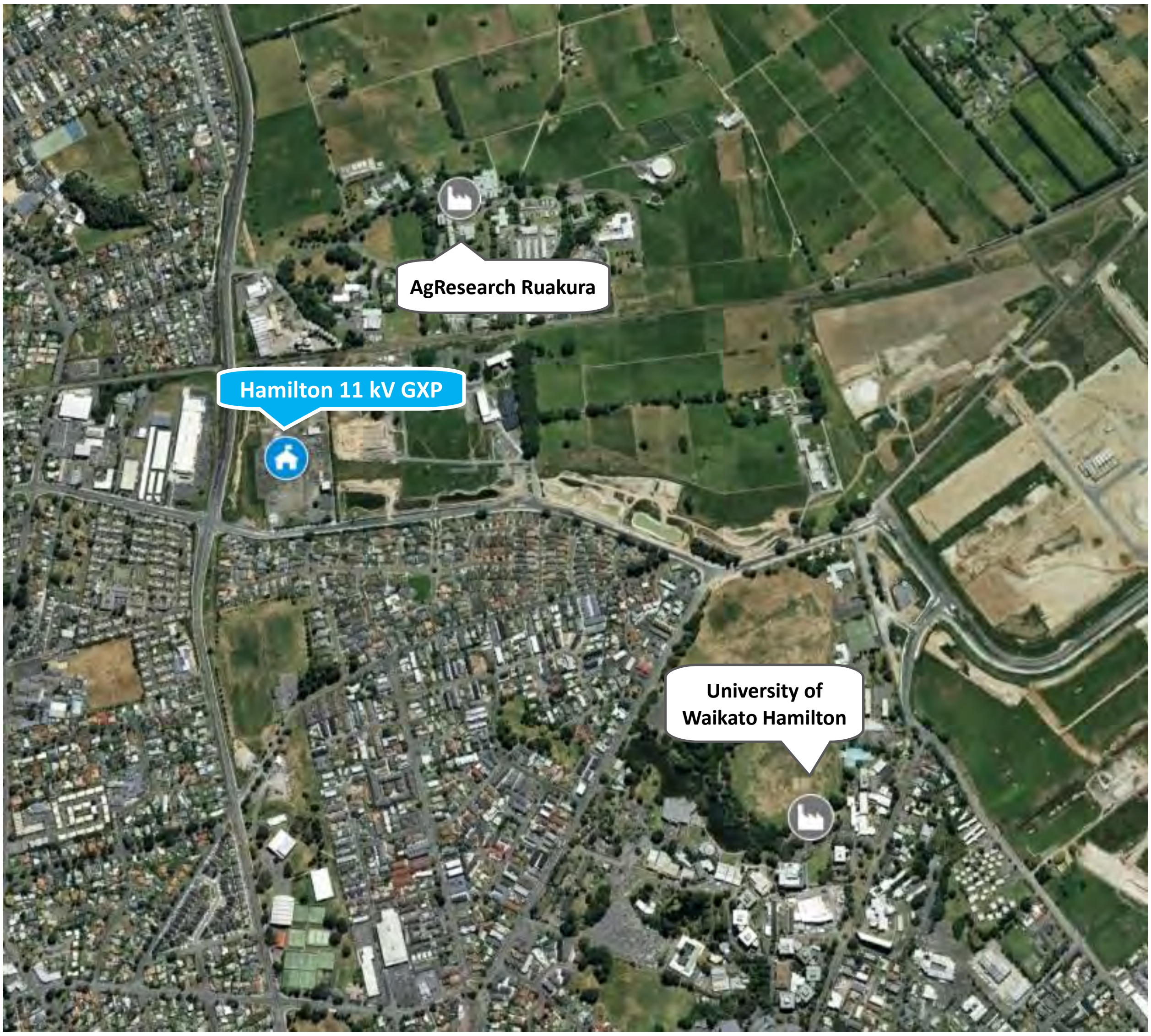


Figure 71. Hamilton 11 kV GXP: EECA Load Sites vs local substations

8.7.1 Hamilton 11 kV GXP Upgrade

The Hamilton 11 kV GXP presently has 14 MVA of spare (N-1) capacity and 50 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.7.4 indicates that the spare (N-1) capacity of the Hamilton 11 kV GXP is not expected to be exceeded if all the Load Sites connect. Therefore, upgrades of the Hamilton 11 kV GXP are not expected.

8.7.2 University of Waikato Hamilton

		UNIVERSITY OF WAIKATO HAMILTON
Load Site Description	Electrical Demand (MW)	Transpower GXP
New high temperature heat pumps	4.445	Hamilton 11 kV

Existing Electrical Supply to the Plant

University of Waikato Hamilton is presently supplied from Hamilton 11 kV GXP via an 11 kV feeder which consists of an underground cable, rated to approximately 520 A (9.9 MVA).

This site is located approximately 1.5 km from Hamilton 11 kV GXP.

There is currently a maximum loading of 30.0 MVA on Hamilton 11 kV GXP, with 50 MVA of spare (N) capacity and 14 MVA of spare (N-1) capacity.

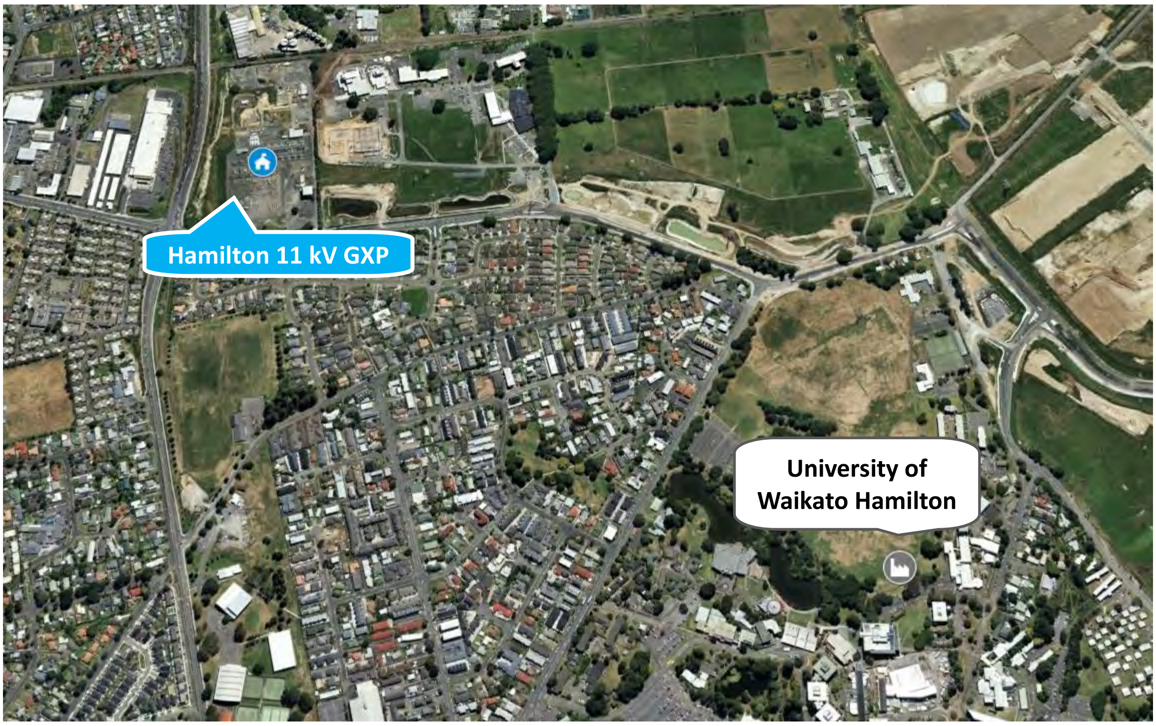


Figure 72. University of Waikato Hamilton geographic location in relation to the surrounding GXPs

Supply Option(s) for New Load

Hamilton 11 kV GXP has adequate spare (N) and (N-1) capacity. Therefore, no upgrades to Hamilton 11 kV GXP are expected.

The existing feeder loading is not known, to Ergo. Due to the size of the load, 1x new 11 kV feeder and associated circuit breaker may be required. Due to the urban/residential topography of the area, this would likely be an underground cable, at a length of 2.0 km (following the existing cable route).

As the GXP has adequate (N-1) capacity for this load, consideration has not been given to an (N)

UNIVERSITY OF WAIKATO HAMILTON

security supply.

Capital Cost Estimate

Table 23. University of Waikato Hamilton: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

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

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 12-18 months to plan, design, procure, construct, and commission the works.

Excluded are any work required to establish the Load Site.

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

8.7.3 Small Opportunities

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

Table 24. Summary of the "small" Load Sites that are unlikely to have a material effect on the MV/HV network

Opportunity name	GXP	Zone sub (N-1) spare capacity (MVA)	Zone sub (N) spare capacity (MVA)	Current Feeder loading (MW)	Opportunity Load (MW)	Estimate cost ($k)
AgResearch Ruakura	Hamilton 11 kV	50	10	Unknown	0.727	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.

8.7.4 Effect of all Load Sites Connecting to Hamilton 11 kV GXP

The following Figure 73 illustrates the Hamilton 11 kV GXP load profile together with the load profiles of all the Load Sites within the Hamilton 11 kV GXP region. Also shown in Figure 73 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Hamilton 11 kV GXP would increase to 33.78 MW, an increase of 3.82 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 34.55 MW there is a diversity factor of 0.98 between the loads.
- Based on Ergo's analysis, the Hamilton 11 kV GXP's (N-1) limit is not expected to be exceeded.

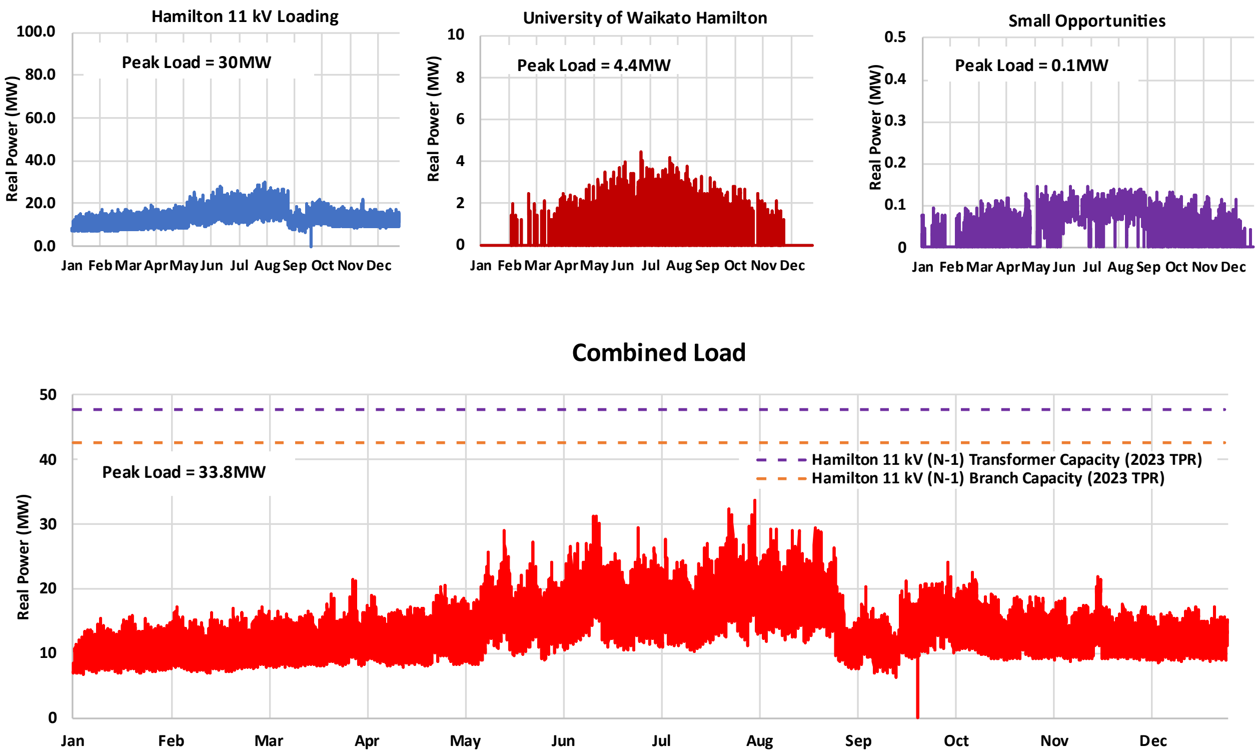


Figure 73. Loading Profiles: Hamilton 11 kV GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.8 Hamilton 33 kV GXP

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

- Dairy Goat Co-operative Limited (10.29 MW)
- Higgins Contractors Limited Waikato (9.56 MW)
- Evonik Peroxide Limited Morrinsville (8.04 MW)
- Waikato Hospital (5.68 MW)

The "Small" Load Sites connecting to the Hamilton 33 kV GXP include (refer to sections 8.8.6 and 8.8.8):

- Fonterra Canpac (0.45 MW)
- Sealed Air Hamilton (0.45 MW)
- Hamilton Boys High School (0.36 MW)
- Ministry of Education Fraser High School (0.32 MW)
- Ministry of Education Hamilton Girls High School (0.30 MW)
- Waterworld Pools and Spa (0.28 MW)
- Claudelands Event Centre (0.27 MW)
- Ministry of Education Fairfield College (0.20 MW)
- Waikato Rugby Stadium (0.18 MW)

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

Figure 74. Hamilton 33 kV GXP: EECA Load Sites vs local substations

8.8.1 Hamilton 33 kV GXP Upgrade

The Hamilton 33 kV GXP presently has -16 MVA of spare (N-1) capacity and 72 MVA of spare (N) capacity, based on the transformer ratings.

The spare (N-1) capacity of the Hamilton 33 kV GXP is already exceeded. Therefore, upgrades of the Hamilton 33 kV GXP are expected, to supply any of the Load Sites with (N-1) security.

Currently, to minimise the overloading of its supply transformers, load shifting occurs between Hamilton 33 kV GXP and Te Kowhai GXP. However, due to the additional load proposed on Te Kowhai GXP, this may no longer be feasible.

To accommodate an (N) capacity condition, it is expected that a special protection scheme would be required for the transformers at Hamilton 33 kV GXP, to avoid overloading the remaining transformer in the event of a single transformer outage. This upgrade is expected to cost approximately $0.5M.

Due to Hamilton GXP's present (N-1) capacity being so heavily exceeded, it is expected that transformer replacements would be required, as stated in the individual load analysis for the large Load Sites below. This upgrade is expected to cost approximately $13.6M, and may be shared between the connecting loads. Alternatively, a third transformer may be installed at Hamilton GXP, which Ergo expects would cost a similar amount.

8.8.2 Dairy Goat Co-operative Limited

DAIRY GOAT CO-OPERATIVE LIMITED		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	10.286	Hamilton 33 kV
Existing Electrical Supply to the Plant		

Dairy Goat Co-operative Limited is presently supplied by WEL Networks' Latham Court substation via an underground 11 kV feeder. Latham Court is in turn supplied from Hamilton 33 kV GXP by a single 33 kV subtransmission circuit. This subtransmission circuit is rated to approximately 520 A (29.7 MVA). Latham Court zone substation is presently equipped with 2x 23 MVA transformers.

This site is located approximately 0.7 km from Latham Court zone substation. In turn, Latham Court zone substation is approximately 5.0 km from Hamilton 33 kV GXP.

There is currently a maximum loading of 20 MVA on Latham Court zone substation, with 26 MVA of spare (N) capacity and 3 MVA of (N-1) capacity. Hamilton 33 kV GXP presently has 72 MVA of spare (N) capacity and -16 MVA of spare (N-1) capacity.

Figure 75. Dairy Goat Co-operative Limited geographic location in relation to the surrounding zone substations

DAIRY GOAT CO-OPERATIVE LIMITED

Supply Option(s) for New Load

Both Latham Court zone substation and Hamilton 33 kV GXP have adequate spare (N) capacity. However, they're both lacking in spare (N-1) capacity.

To accommodate an (N) capacity condition at the GXP, it is expected that a special protection scheme would be required for the transformers at Hamilton 33 kV GXP, to avoid overloading the remaining transformer in the event of a single transformer outage.

For Hamilton 33 kV GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced to accommodate the additional load, along with replacements of the corresponding 110 kV circuit breakers and 33 kV bus. Similarly, for Latham Court zone substation to achieve the required (N-1) capacity, upgrades/replacement of the existing transformers would be required.

Due to the size of the load, 2x new 11 kV feeders and associated circuit breakers would be required to supply the proposed load. Due to the urban/industrial topography of the area, these would likely be underground cables, at a length of 1.4 km (each).

Capital Cost Estimate

Table 25. Dairy Goat Co-operative Limited: 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	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	1.40	$1.12
		TOTAL	**$1.82**

Table 26. Dairy Goat Co-operative Limited: 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
Subtransmission	Large supply transformer (ZSS)	2.00	$4.60
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	1.80	$1.44
		TOTAL	**$15.24**

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

DAIRY GOAT CO-OPERATIVE LIMITED
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.

8.8.3 Higgins Contractors Limited Waikato

HIGGINS CONTRACTORS LIMITED WAIKATO		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers	9.561	Hamilton 33 kV
Existing Electrical Supply to the Plant		

Higgins Contractors Limited Waikato is presently supplied by WEL Networks' Latham Court substation via an 11 kV feeder which consists of an underground cable. Latham Court is in turn supplied from Hamilton 33 kV GXP by two 33 kV subtransmission circuits. The subtransmission circuits are rated to approximately 520 A (29.7 MVA) and 590 A (33.7 MVA). Latham Court substation is presently equipped with 2x 23 MVA transformers.

This site is located approximately 1.0 km from Latham Court zone substation. In turn, Latham Court zone substation is approximately 5.0 km from Hamilton 33 kV GXP.

There is currently a maximum loading of 20 MVA on Latham Court zone substation, with 26 MVA of spare (N) capacity and 3 MVA of (N-1) capacity Hamilton 33 kV GXP presently has 72 MVA of spare (N) capacity and -16 MVA of spare (N-1) capacity.

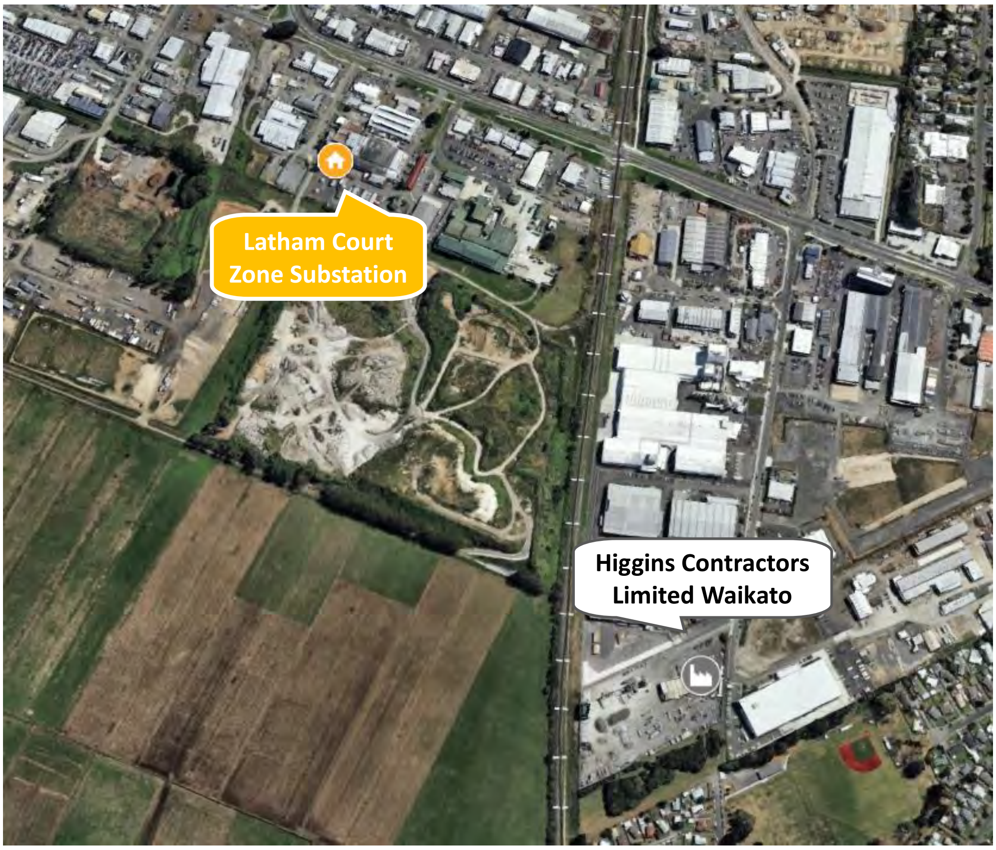


Figure 76. Higgins Contractors Limited Waikato geographic location in relation to the surrounding zone substations

HIGGINS CONTRACTORS LIMITED WAIKATO

Supply Option(s) for New Load

Both Latham Court zone substation and Hamilton 33 kV GXP have adequate spare (N) capacity. However, they're both lacking in spare (N-1) capacity.

To accommodate an (N) capacity condition at the GXP, it is expected that a special protection scheme would be required for the transformers at Hamilton 33 kV GXP, to avoid overloading the remaining transformer in the event of a single transformer outage.

For Hamilton 33 kV GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced to accommodate the additional load. Similarly, for Latham Court zone substation to achieve the required (N-1) capacity, upgrades/replacement of the existing transformers would be required.

Due to the size of the load, 2x new 11 kV feeders and associated circuit breakers may be required. Due to the urban/industrial topography of the area, these would likely be underground cables, at a length of 1.8 km (each), as per the existing cable route.

Capital Cost Estimate

Table 27. Higgins Contractors Limited Waikato: 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	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	1.80	$1.44
		TOTAL	**$2.14**

Table 28. Higgins Contractors Limited Waikato: 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
Subtransmission	Large supply transformer (ZSS)	2.00	$4.60
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	1.80	$1.44
		TOTAL	**$15.24**

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

HIGGINS CONTRACTORS LIMITED WAIKATO
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.

8.8.4 Evonik Peroxide Limited Morrinsville

EVONIK PEROXIDE LIMITED MORRINSVILLE		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers	8.038	Hamilton 33 kV
Existing Electrical Supply to the Plant		

Evonik Peroxide Limited Morrinsville is presently supplied by WEL Networks' Hoeka Rd substation via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Hoeka Rd is in turn supplied from Hamilton 33 kV GXP by a single 33 kV subtransmission circuit. The subtransmission circuit is rated to approximately 680 A (38.9 MVA). Hoeka Rd substation is presently equipped with 1x 26 MVA transformer.

This site is located approximately 2.7 km from Hoeka Rd zone substation. In turn, Hoeka Rd zone substation is approximately 7.4 km from Hamilton 33 kV GXP.

There is currently a maximum loading of 8 MVA on Hoeka Rd zone substation, with 18 MVA of spare (N) capacity. Hamilton 33 kV GXP presently has 72 MVA of spare (N) capacity and -16 MVA of spare (N-1) capacity.

Figure 77. Evonik Peroxide Limited Morrinsville geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Hoeka Rd zone substation and Hamilton 33 kV GXP have adequate spare (N) capacity. However, they're lacking in spare (N-1) capacity.

To accommodate an (N) capacity condition at the GXP, it is expected that a special protection scheme would be required for the transformers at Hamilton 33 kV GXP, to avoid overloading the remaining transformer in the event of a single transformer outage.

For Hamilton 33 kV GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced to accommodate the additional load. For Hoeka zone substation to achieve the required spare (N-1) capacity, 1x new supply transformer would be required, along with 2x new circuit breakers (one 11 kV and one 33 kV) and a new 33 kV feeder to the GXP. Although the feeder route is through a rural area, due to space constraints it is expected that an overhead line supply could not be accommodated, the new 33 kV feeder will likely be underground, at a length of 13.4 km (following existing routes).

Due to the size of the load, 2x new 11 kV feeders and associated circuit breaker may be required. Although the feeder route is through a rural area, due to space constraints it is expected that an overhead line supply could not be accommodated, so the new feeder is assumed to be underground cable, at a length of 3.3 km.

Capital Cost Estimate

Table 29. Evonik Peroxide Limited Morrinsville: 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	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	3.30	$2.64
		TOTAL	**$3.34**

Table 30. Evonik Peroxide Limited Morrinsville: 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	11kV circuit breaker (ZSS)	3.00	$0.30
Distribution	Double underground 11kV cable	3.30	$2.64
Distribution	Medium supply transformer (ZSS)	1.00	$1.90
Subtransmission	Single underground 33kV cable	13.40	$12.06
Subtransmission	33kV circuit breaker bay	3.00	$0.75
		TOTAL	**$26.65**

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

EVONIK PEROXIDE LIMITED MORRINSVILLE
It is estimated to take 12-18 months for an (N) security supply and 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.

8.8.5 Waikato Hospital

WAIKATO HOSPITAL		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	5.682	Hamilton 33 kV
Existing Electrical Supply to the Plant		

Waikato Hospital is presently supplied by WEL Networks' Cobham substation via two underground 11 kV feeders. Cobham is in turn supplied from Hamilton 33 kV GXP by two 33 kV subtransmission circuits. The subtransmission circuits are rated to approximately 680 A (38.9 MVA) each. Cobham zone substation is presently equipped with 2x 26 MVA transformers.

This site is located approximately 1.4 km from Cobham zone substation. In turn, Cobham zone substation is approximately 2.5 km from Hamilton 33 kV GXP.

There is currently a maximum loading of 13 MVA on Cobham zone substation, with 39 MVA of spare (N) capacity and 13 MVA of (N-1) capacity. Hamilton 33 kV GXP presently has 72 MVA of spare (N) capacity and -16 MVA of spare (N-1) capacity.

Figure 78. Waikato Hospital geographic location in relation to the surrounding zone substations

WAIKATO HOSPITAL

Supply Option(s) for New Load

Cobham zone substation has adequate spare (N) and (N-1) capacity. Therefore, further upgrades to Cobham zone substation are not considered for this load.

However, Hamilton 33 kV GXP is lacking in spare (N-1) capacity.

To accommodate an (N) capacity condition at the GXP, it is expected that a special protection scheme would be required for the transformers at Hamilton 33 kV GXP, to avoid overloading the remaining transformer in the event of a single transformer outage.

For Hamilton 33 kV GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced to accommodate the additional load.

Existing feeder loading is not known. However, due to the size of the load, 1x new feeder and an associated circuit breaker may be required. Due to the urban topography of the area, this would likely be underground, at a length of 2.6 km.

Capital Cost Estimate

Table 31. Waikato Hospital: Capital cost estimate to supply the Load Site with (N) transmission 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
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	2.60	$1.56
		TOTAL	**$2.16**

Table 32. Waikato Hospital: Capital cost estimate to supply the Load Site with (N) transmission 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	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	2.60	$1.56
		TOTAL	**$10.66**

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

WAIKATO HOSPITAL
It is estimated to take 12-18 months to plan, design, procure, construct, and commission the works. Excluded are any work required to establish the Load Site. Any land acquisition and consenting, if required, is excluded.

8.8.6 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 33. 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)
Fonterra Canpac	Avalon Dr	4	28	0.63	0.455	130
Sealed Air Hamilton	Avalon Dr	4	28	1.16	0.455	130
Hamilton Boys High School	Claudelands	0	23	0.38	0.360	130
MoE Fraser High School Pool	Avalon Dr	4	28	2.70	0.315	130
MoE Hamilton Girls High School	Bryce St	9	32	1.48	0.302	130
Waterworld Pools and Spa	Avalon Dr	4	28	3.62	0.275	130
Claudelands Event Centre	Claudelands	0	23	1.25	0.269	130
Ministry of Education Fairfield College	Chartwell	6	32	2.65	0.202	130
Waikato Rugby Stadium	Bryce St	9	32	1.73	0.176	80

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.

8.8.7 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.

8.8.7.1 Latham Court

Two of the loads on Hamilton 33 kV GXP are expected to connect to Latham Court zone substation. The loads are Dairy Goat Co-operative Limited, and Higgins Contractors Limited Waikato. The sum of peaks of these loads is 19.85 MW, which the zone substation doesn't have (N-1) capacity for. Therefore, further upgrades at Latham Court are expected.

For each of the loads proposed to connect to Latham court, transformer upgrades are required for an (N-1) supply, as in the individual Load Site analysis. It is expected that should the two loads connect, they would be able to share the cost of this upgrade if required.

8.8.7.2 Avalon Dr

Four of the loads on Hamilton 33 kV GXP are expected to connect to Avalon Dr zone substation. The loads are Fonterra Canpac, Sealed Air Hamilton, Ministry of Education Fraser High School, and Waterworld Pools and Spa. The sum of peaks of these loads is 1.50 MW, which the zone substation does have (N-1) capacity for. Therefore, no further upgrades at Avalon Dr are considered.

8.8.7.3 Claudelands

Two of the loads on Hamilton 33 kV GXP are expected to connect to Claudelands zone substation. The loads are Hamilton Boys High School, and Claudelands Event Centre. The sum of peaks of these loads is 0.63 MW, which the zone substation doesn't have (N-1) capacity for. Therefore, further upgrades at Claudelands are expected, for an (N-1) supply to the Load Sites.

For Claudelands zone substation to achieve the required spare (N-1) capacity, upgrades/replacement of the existing transformers may be required. This is expected to cost approximately $4.6M.

8.8.7.4 Bryce St

Two of the loads on Hamilton 33 kV GXP are expected to connect to Bryce St zone substation. The loads are Ministry of Education Hamilton Girls High School, and Waikato Rugby Stadium. The sum of peaks of these loads is 0.48 MW, which the zone substation does have (N-1) capacity for. Therefore, no further upgrades at Bryce St are considered.

8.8.8 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Hamilton 33 kV GXP gives a combined load of 2.16 MW. When the load shapes are combined, they result in the following load shape (Figure 79), with a maximum load of 1.78 MW, with a diversity factor of 0.82.

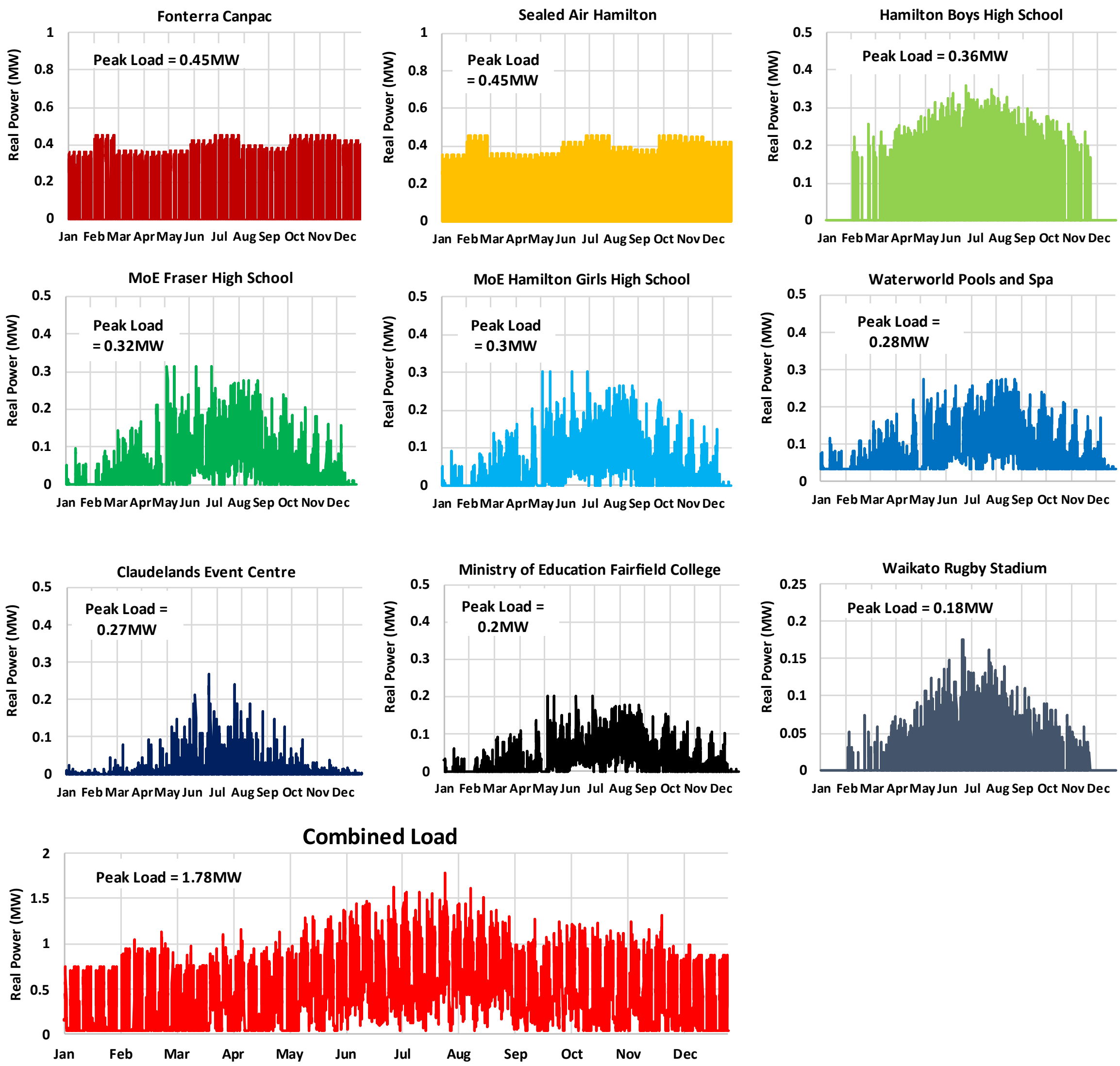


Figure 79. Loading Profiles: Hamilton 33 kV GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.8.9 Effect of all Load Sites Connecting to Hamilton 33 kV GXP

The following Figure 80 illustrates the Hamilton 33 kV GXP load profile together with the load profiles of all the Load Sites within the Hamilton 33 kV 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 Hamilton 33 kV GXP would increase to 161.74 MW, an increase of 21.66 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 183.40 MW there is a diversity factor of 0.88 between the loads.
- Based on Ergo's analysis, the Hamilton 33 kV GXP's (N-1) limit is expected to be exceeded. Ergo has discussed mitigation for this in Section 8.8.1.

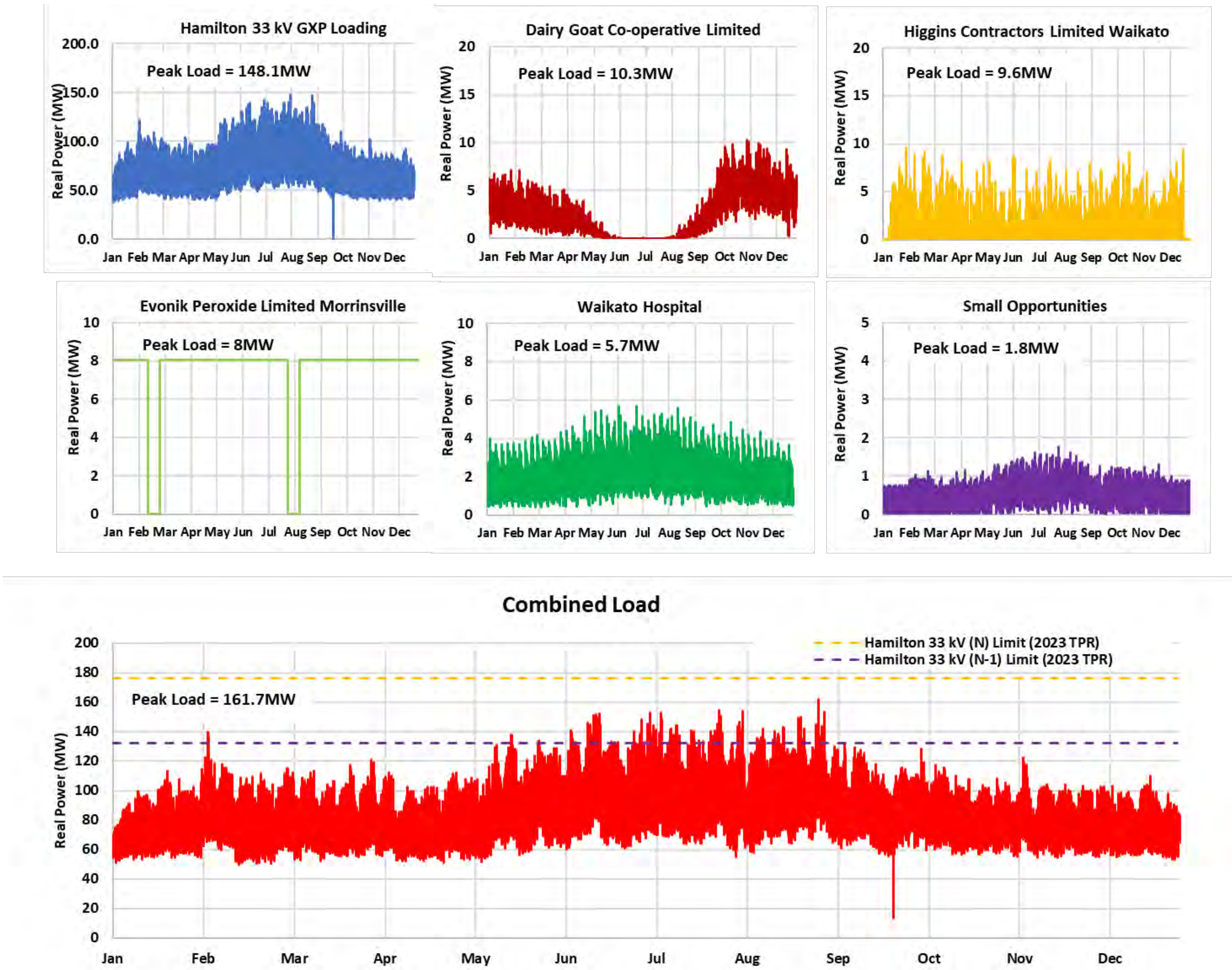


Figure 80. Loading Profiles: Hamilton 33 kV GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.9 Hangatiki 33 kV GXP

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

- Graymont Otorohanga (14.70MW)
- Graymont Te Kuiti Plant (5.15 MW)

The "Small" Load Sites connecting to the Hangatiki 33 kV GXP include (refer to sections 8.9.5 and 8.9.7):

- Graymont (NZ) Limited Oparure Quarry (0.98 MW)
- Universal Beef Packers Te Kuiti (0.85 MW)
- Ovation New Zealand Limited Te Kuiti (0.48 MW)
- Ministry of Education Te Kuiti High School (0.23 MW)
- Ministry of Education Otorohanga College (0.17 MW)

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

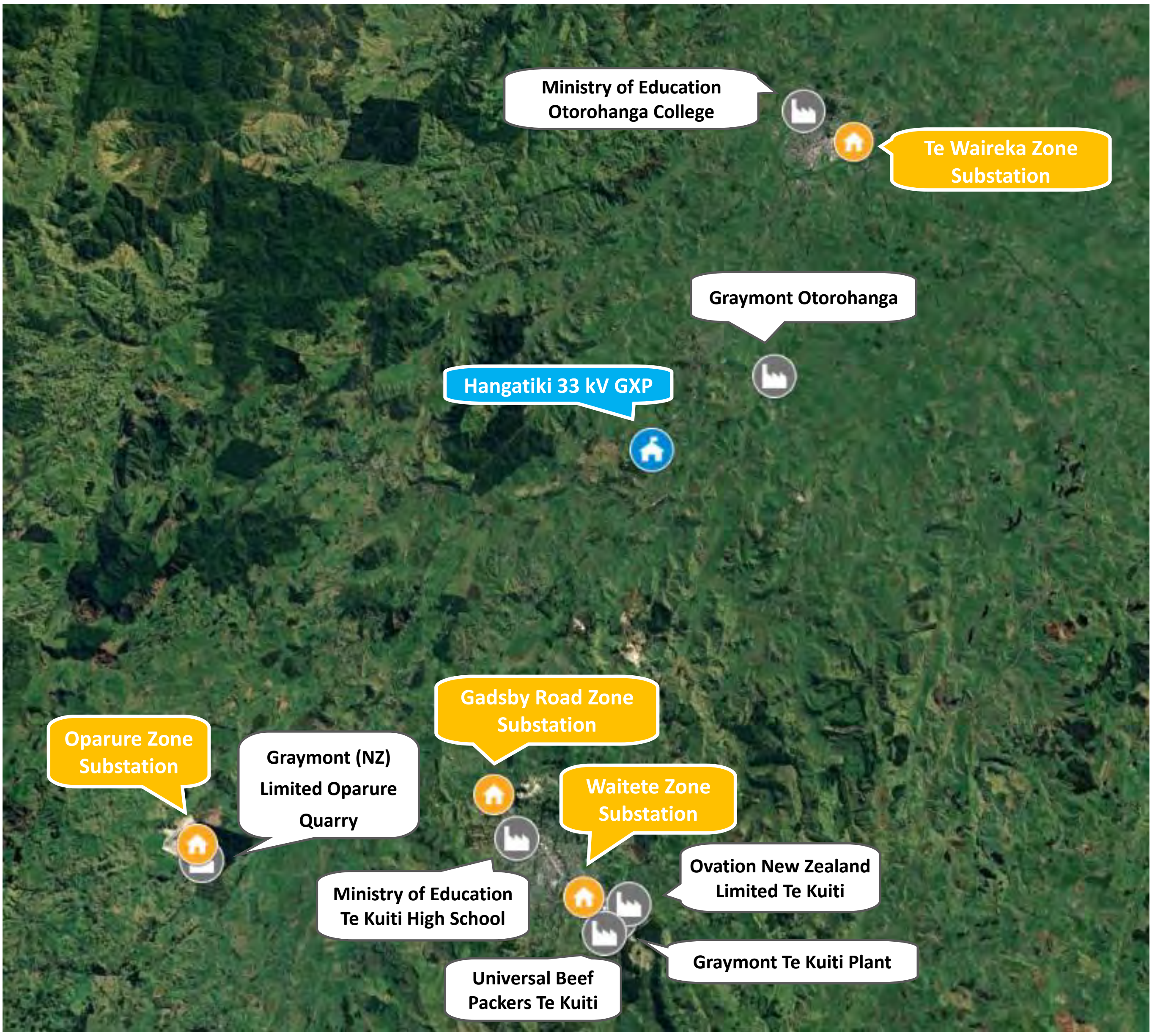


Figure 81. Hangatiki 33 kV GXP: EECA Load Sites vs local substations

8.9.1 Hangatiki 33 kV GXP Upgrade

The Hangatiki 33 kV GXP presently has –3 MVA of spare (N-1) capacity and 15 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.9.8 indicates that the spare (N-1) capacity of the Hangatiki 33 kV GXP is expected to be exceeded if all the Load Sites connect. Therefore, upgrades of the Hangatiki 33 kV GXP are expected.

Currently, to minimise overloading of its supply transformers, Transpower has implemented a special transformer protection scheme to manage short to medium term peaks.

For Hangatiki 33 kV GXP to reach the required spare (N) and (N-1) capacities, the existing supply transformers would need to be upgraded/replaced to accommodate the additional loads, as described in the individual load assessments below. This would cost approximately $7M.

8.9.2 Graymont Otorohanga

		GRAYMONT OTOROHANGA
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers	14.697	Hangatiki 33 kV
Existing Electrical Supply to the Plant		

Graymont Otorohanga is presently supplied by The Lines Company's Te Waireka substation via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Te Waireka is in turn supplied from Hangatiki 33 kV GXP by two 33 kV subtransmission circuits. Te Waireka zone substation is presently equipped with 2x 15 MVA transformers.

This Load Site is located approximately 6.0 km from Te Waireka zone substation. In turn, Te Waireka zone substation is approximately 8.6 km from Hangatiki 33 kV GXP.

There is currently a maximum loading of 11.1 MVA on Te Waireka zone substation, with 18.9 MVA of spare (N) capacity and 3.9 MVA of spare (N-1) capacity. Hangatiki 33 kV GXP presently has 15 MVA of spare (N) capacity and -3 MVA of spare (N-1) capacity.

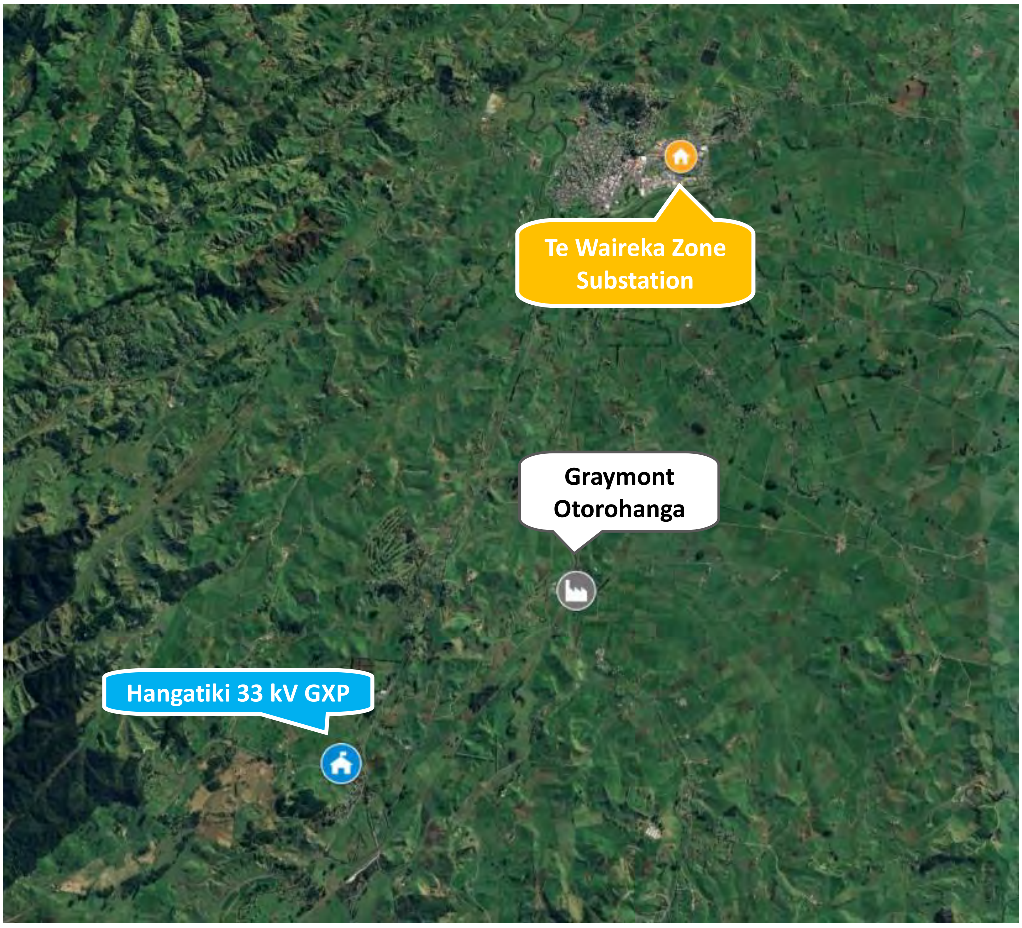


Figure 82. Graymont Otorohanga geographic location in relation to the surrounding zone substations

GRAYMONT OTOROHANGA

Supply Option(s) for New Load

Both Te Waireka zone substation and Hangatiki 33 kV GXP have adequate spare (N) capacity. However, they're both lacking in spare (N-1) capacity.

For Hangatiki 33 kV GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced to accommodate the additional load.

The existing feeder loading is not known, to Ergo. However, due to the size of the load as well as the distance away from its existing supply, it is proposed that the load be directly connected to Hangatiki 33 kV GXP, establishing a new 33/11 kV zone substation at the site. This is due to the GXP being in closer proximity than its existing supply and thereby reducing the expected voltage drop, and the fact that it has a 33 kV supply from which the load can be supplied.

Therefore, for an (N) security condition, 1x new 33 kV feeder and an associated circuit breaker may be required, and for an (N-1) security condition, 2x new 33 kV feeders and associated circuit breakers may be required.

Due to the rural topography of the area, the new 33 kV feeders from the GXP will most likely run overhead at a length of approximately 6km.

Capital Cost Estimate

Table 34. Graymont Otorohanga: 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	Small zone substation	1.00	$5.00
Subtransmission	Single overhead 33kV line	4.40	$1.54
Transmission	33kV circuit breaker bay	2.00	$0.50
		TOTAL	**$7.04**

Table 35. Graymont Otorohanga: 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	Medium supply transformer (GXP)	2.00	$7.00
Subtransmission	Medium zone substation	1.00	$8.00
Subtransmission	Double overhead 33kV line	4.40	$1.76
Transmission	33kV circuit breaker bay	4.00	$1.00
		TOTAL	**$17.76**

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

GRAYMONT OTOROHANGA
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.

8.9.3 Graymont Te Kuiti Plant

		GRAYMONT TE KUITI PLANT
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	8.000	Hangatiki 33 kV
Existing Electrical Supply to the Plant		

Graymont Te Kuiti Plant is presently supplied by The Lines Company's Waitete substation via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Waitete is in turn supplied from Hangatiki 33 kV GXP by two 33 kV subtransmission circuits. Waitete zone substation is presently equipped with 2x 15 MVA transformers.

This site is located approximately 1.0 km from Waitete zone substation. In turn, Waitete zone substation is approximately 10.0 km from Hangatiki 33 kV GXP.

There is currently a maximum loading of 9.0 MVA on Waitete zone substation, with 21 MVA of spare (N) capacity and 6 MVA of spare (N-1) capacity. Hangatiki 33 kV GXP presently has 15.0 MVA of spare (N) capacity and -5.0 MVA of spare (N-1) capacity.

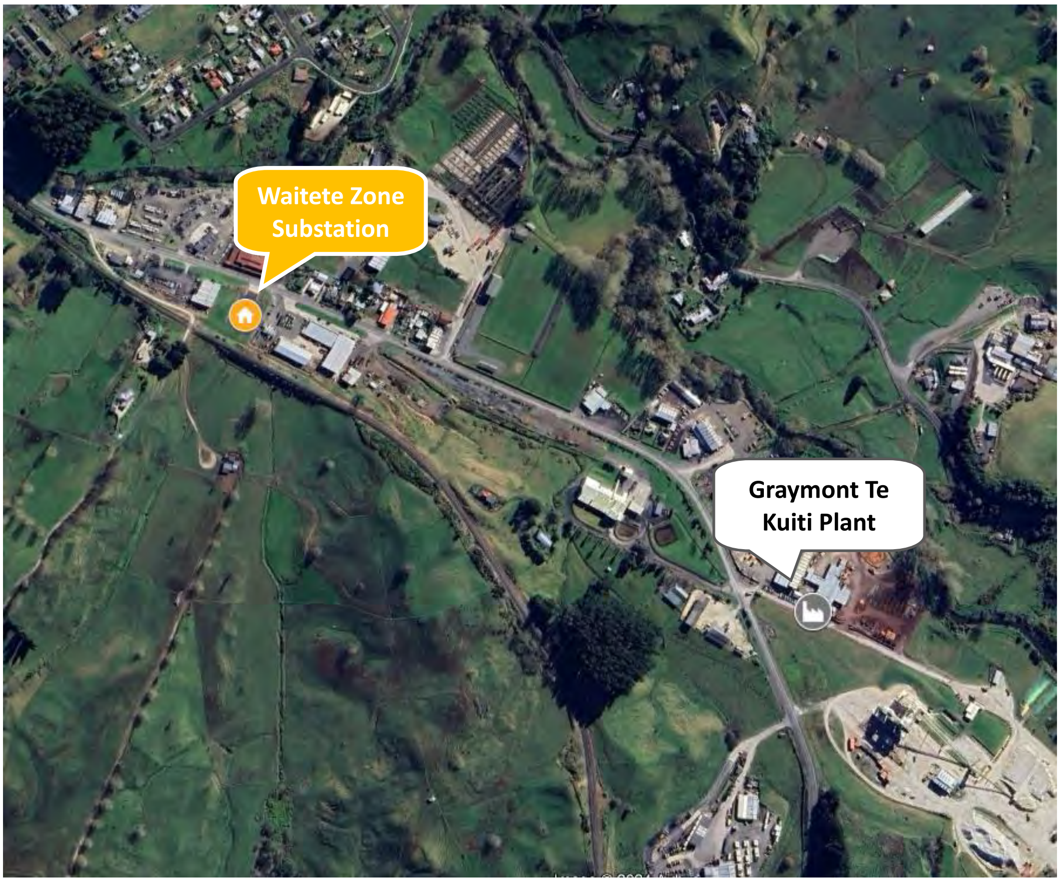


Figure 83. Graymont Te Kuiti Plant geographic location in relation to the surrounding zone substations

GRAYMONT TE KUITI PLANT

Supply Option(s) for New Load

Both Waitete zone substation and Hangatiki 33 kV GXP have adequate spare (N) capacity. However, they're both lacking in spare (N-1) capacity.

For Hangatiki 33 kV GXP to reach the required spare (N-1) capacity, the existing supply transformers may need to be upgraded/replaced to accommodate the additional load. To reach the required (N-1) capacity at Waitete zone substation, transformer upgrades would be required. This would likely also involve the upgrading/replacement of the existing 33 kV feeders from the GXP.

Existing feeder loading is not known. However, due to the size of the load, 2x new 11 kV feeders and associated circuit breakers would be required. Due to the urban/industrial topography of the area, these would likely be underground cables, at a length of 1.0 km (each), following the main road between the two sites.

Capital Cost Estimate

Table 36. Graymont Te Kuiti Plant: 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	Double underground 11kV cable	1.00	$0.80
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
		TOTAL	**$1.00**

Table 37. Graymont Te Kuiti Plant: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Medium supply transformer (GXP)	2.00	$7.00
Distribution	Double underground 11kV cable	1.00	$0.80
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Subtransmission	Medium supply transformer (ZSS)	2.00	$3.80
Subtransmission	Reconductor single overhead 33kV line	17.40	$4.57
		TOTAL	**$16.37**

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 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.

8.9.4 Graymont (NZ) Limited Oparure Quarry

		GRAYMONT (NZ) LIMIED OPARURE QUARRY
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	0.980	Hangatiki 33 kV
Existing Electrical Supply to the Plant		

Graymont (NZ) Limited Oparure Quarry is presently supplied by The Lines Company's Oparure substation via an 11 kV feeder which consists of an overhead line. Oparure is in turn supplied from Hangatiki 33 kV GXP by one 33 kV subtransmission circuits. Oparure zone substation is presently equipped with 1x 3 MVA transformer.

This site is located approximately 1.0 km from Oparure zone substation. In turn, Oparure zone substation is approximately 13.2 km from Hangatiki 33 kV GXP.

There is currently a maximum loading of 1.8 MVA on Oparure zone substation, with 1.1 MVA of spare (N) capacity and no (N-1) capacity. Hangatiki 33 kV GXP presently has 15.0 MVA of spare (N) capacity and -5.0 MVA of spare (N-1) capacity.

Figure 84. Graymont Te Kuiti Plant geographic location in relation to the surrounding zone substations

GRAYMONT (NZ) LIMIED OPARURE QUARRY

Supply Option(s) for New Load

Although this site is <1 MW and therefore would typically be considered a "small" Load Site, due to capacity constraints a more detailed analysis has been carried out for this load.

Both Oparure zone substation and Hangatiki 33 kV GXP have adequate spare (N) capacity. However, they're both lacking in spare (N-1) capacity.

Oparure zone substation currently does not have any (N-1) security. To reach an (N-1) capacity, a new 33 kV subtransmission circuit would need to be installed, alongside a new supply transformer at the site. Additionally, it is expected the existing transformer at the site may also require upgrades/replacements.

For Hangatiki 33 kV GXP to reach the required spare (N-1) capacity, the existing supply transformers would need to be upgraded/replaced to accommodate the additional load.

The existing feeder loading is not known, to Ergo. However, due to the size of the load it is expected the existing feeder may need to be upgraded to accommodate the increase in supply.

Capital Cost Estimate

Table 38. Graymont (NZ) Limited Oparure Quarry: 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	Reconductor 11kV line (larger)	0.50	$0.10
		TOTAL	**$0.10**

Table 39. Graymont (NZ) Limited Oparure Quarry: 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	Medium supply transformer (GXP)	2.00	$7.00
Subtransmission	Medium supply transformer (ZSS)	2.00	$3.80
Subtransmission	33kV circuit breaker bay	2.00	$0.50
Subtransmission	Single overhead 33kV line	13.50	$4.73
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Reconductor 11kV line (larger)	0.50	$0.10
		TOTAL	**$16.23**

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

GRAYMONT (NZ) LIMIED OPARURE QUARRY
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.

8.9.5 Small Opportunities

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

Table 40. 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)
Universal Beef Packers Te Kuiti	Waitete	6	21	Unknown	0.854	260
Ovation New Zealand Limited Te Kuiti	Waitete	6	21	Unknown	0.477	130
Ministry of Education Te Kuiti High School	Gadsby Rd	-0.3	0.4	Unknown	0.231	130
Ministry of Education Otorohanga College	Te Waireka	3.9	18.9	Unknown	0.168	80

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.

8.9.6 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.

8.9.6.1 Te Waireka

Two of the loads on Hangatiki 33 kV GXP are expected to connect to Te Waireka zone substation. The loads are Graymont Otorohanga, and Ministry of Education Otorohanga College. The sum of peaks of these loads is 14.86 MW, which the zone substation doesn't have (N-1) capacity for.

However, since we are proposing that Graymont Otorohanga's supply be moved to a new substation, supplied directly from Hangatiki GXP, only one of the opportunity loads remain, at a peak load of only 0.17 MVA. As a result, upgrades to Te Waireka zone substation are not considered.

8.9.6.2 Waitete

Three of the loads on Hangatiki 33 kV GXP are expected to connect to Waitete zone substation. The loads are Graymont Te Kuiti Plant, Universal Beef Packers Te Kuiti, and Ovation New Zealand Limited Te Kuiti. The sum of peaks of these loads is 9.33 MW, which the zone substation doesn't have (N-1) capacity for. Therefore, upgrades at Waitete are expected.

However, the upgrades described for the connection of the Graymont Te Kuiti plant are considered adequate for all of the loads to connect to the substation, and therefore further upgrades are not considered.

8.9.7 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Hangatiki 33 kV GXP gives a combined load of 2.31 MW. When the load shapes are combined, they result in the following load shape (Figure 85) with a maximum load of 2.21 MW, with a diversity factor of 0.96.

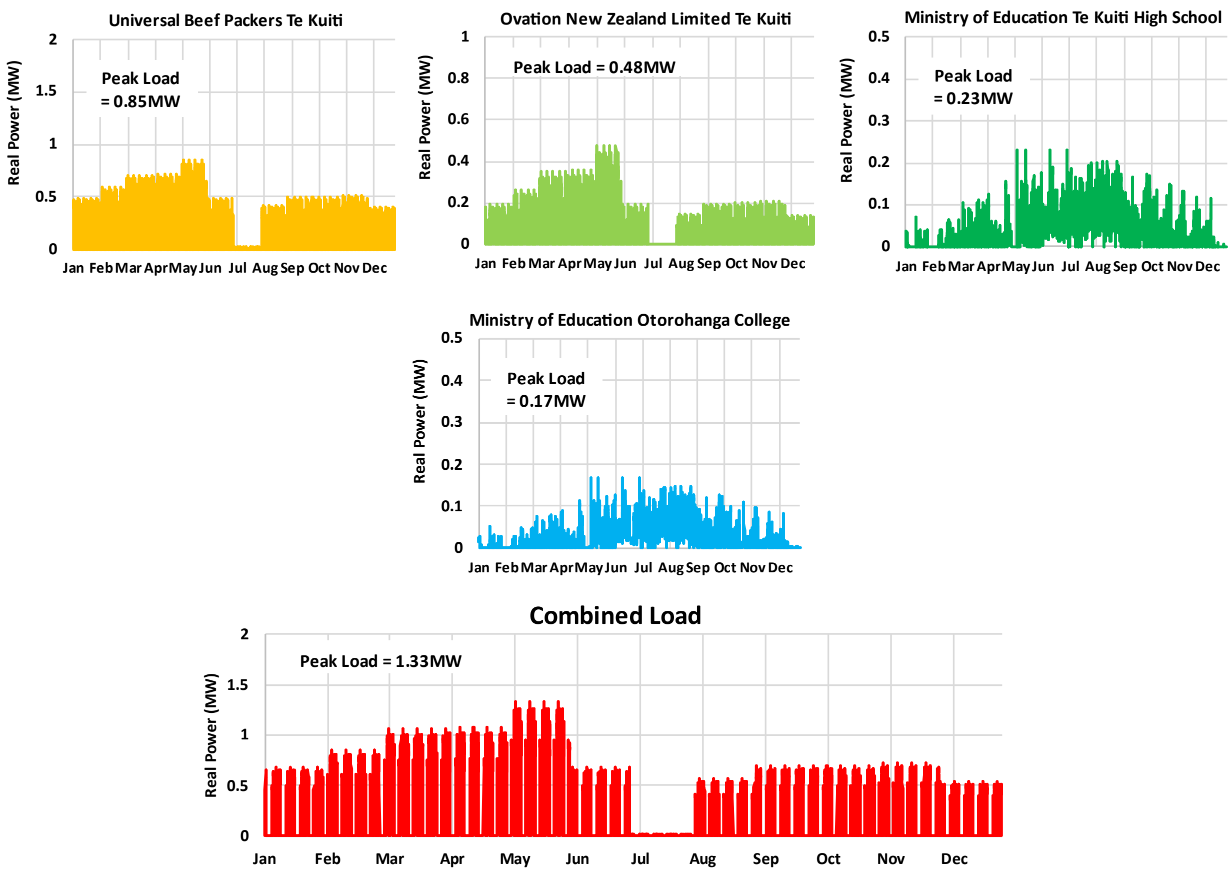


Figure 85. Loading Profiles: Hangatiki 33 kV GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.9.8 Effect of all Load Sites Connecting to Hangatiki 33 kV GXP

The following Figure 86 illustrates the Hangatiki 33 kV GXP load profile together with the load profiles of all the Load Sites within the Hangatiki 33 kV 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 Hangatiki 33 kV GXP would increase to 44.94 MW, an increase of 21.02 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 48.82 MW there is a diversity factor of 0.92 between the loads.
- Based on Ergo's analysis, the Hangatiki 33 kV GXP's (N) and (N-1) limits are expected to be exceeded. Ergo has discussed mitigation for this in Section 8.9.1.

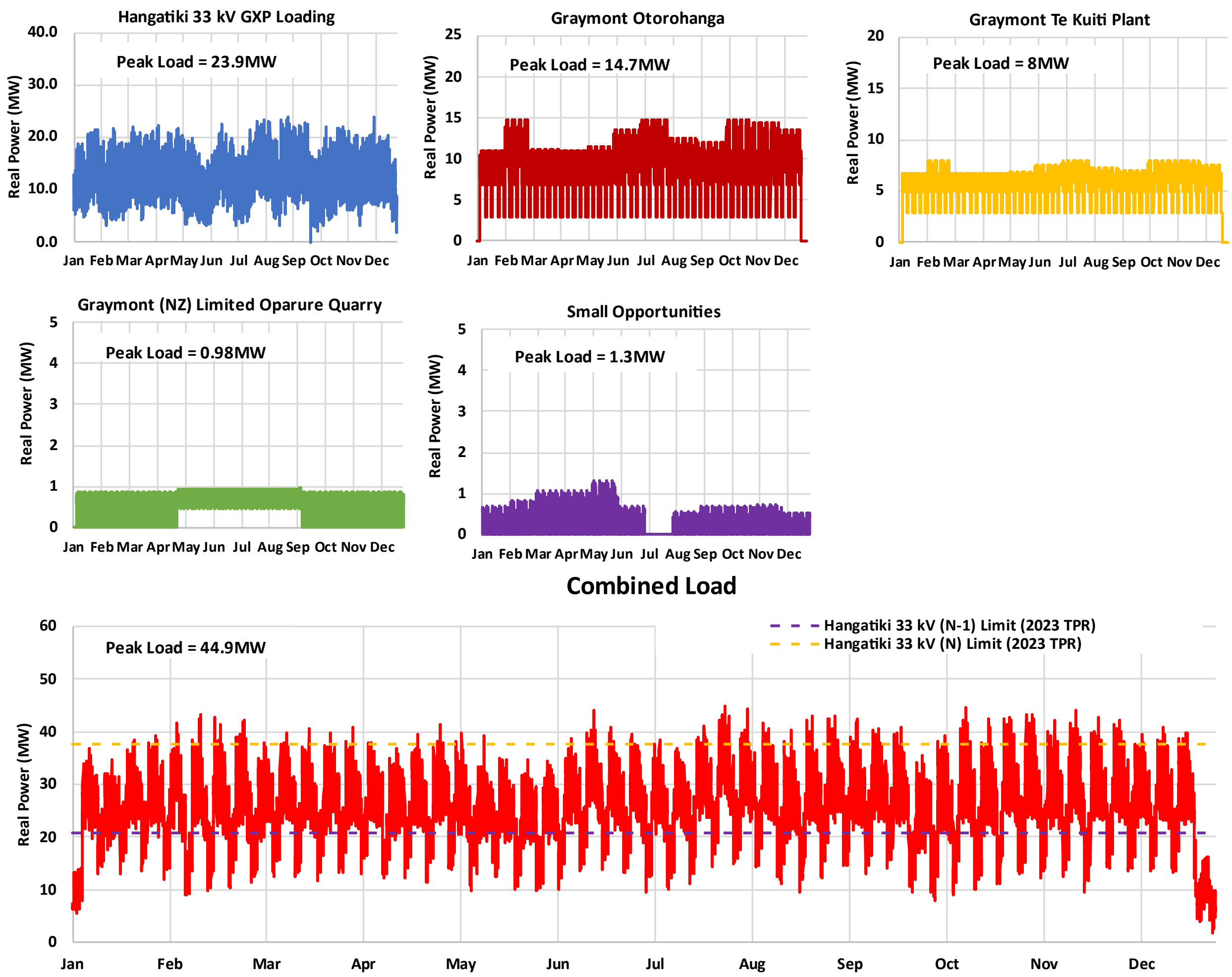


Figure 86. Loading Profiles: Hangatiki 33 kV GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.10 Hangatiki 110 kV GXP

None of the Load Sites are connecting to Hangatiki 110 kV GXP and therefore upgrades of this GXP are not considered.

8.11 Hinuera GXP

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

8.12 Huntly 33 kV GXP

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

- Shinagawa Refractories (6.36 MW)
- Springhill Corrections Facility (2.80 MW)
- Lumbercorp NZ Limited Ohinewai (4.73 MW)

The "Small" Load Site connecting to the Huntly (33 kV) GXP is (refer to Section 8.12.5):

- Ministry of Education Huntly College (0.16 MW)

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

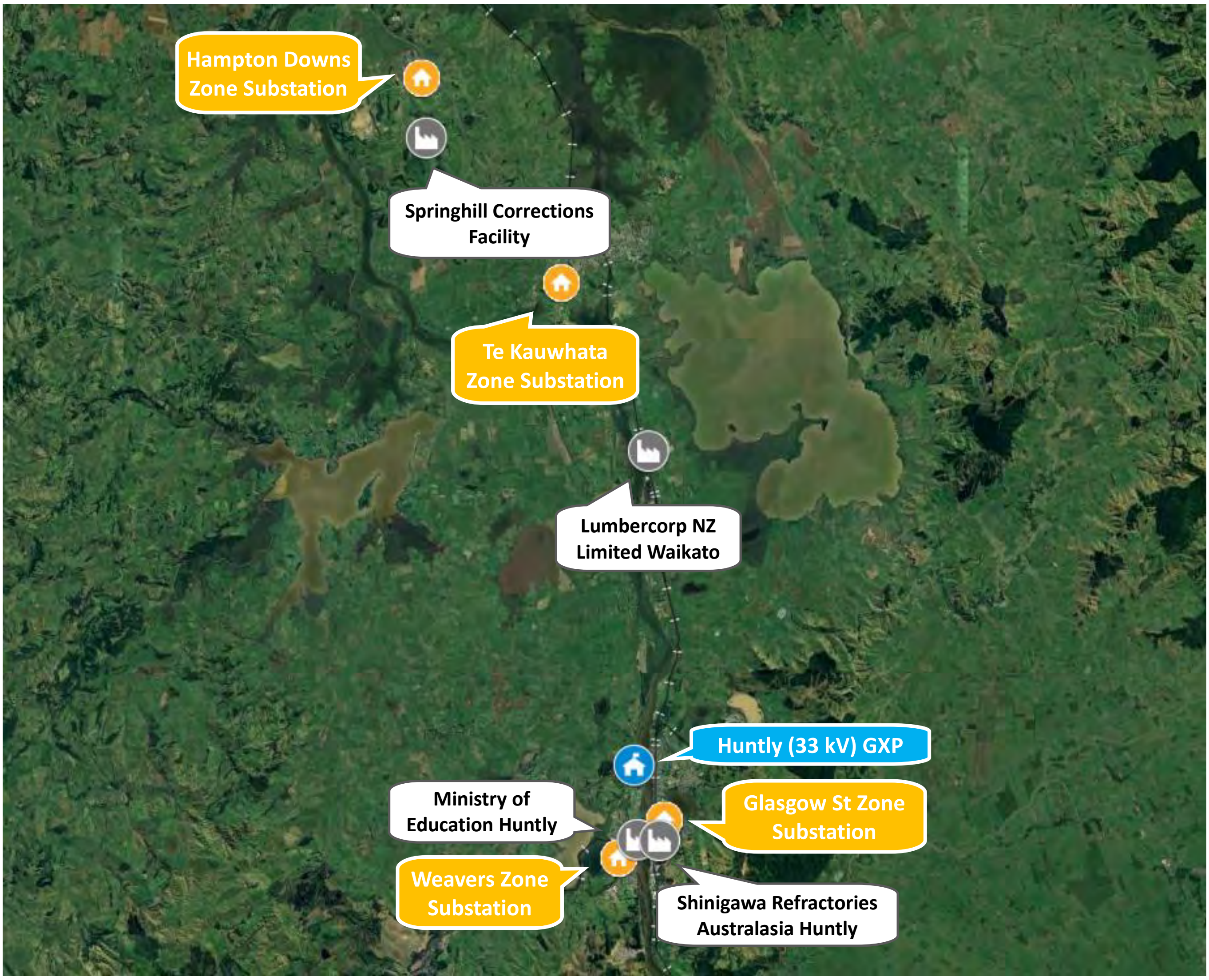


Figure 87. Huntly 33 kV GXP: EECA Load Sites vs local substations

8.12.1 Huntly 33 kV GXP Upgrade

The Huntly 33 kV GXP presently has 48 MVA of spare (N-1) capacity and 86 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.12.6 indicates that the spare (N) and (N-1) capacity of Huntly 33 kV GXP's spare (N) and (N-1) capacities are adequate for the proposed loads Therefore, upgrades to Huntly 33 kV GXP are not considered.

8.12.2 Shinagawa Refractories

SHINAGAWA REFRACTORIES		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers	6.363	Huntly 33 kV

Existing Electrical Supply to the Plant

Shinagawa Refractories is presently supplied by WEL Networks' Glasgow St substation via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Glasgow St is in turn supplied from Huntly 33 kV GXP by a single 33 kV subtransmission circuit. This subtransmission circuit is rated to approximately 360 A (20.6 MVA). Glasgow St zone substation is presently equipped with 1x 10 MVA transformer.

This site is located approximately 0.7 km from Glasgow St zone substation. In turn, Glasgow St zone substation is approximately 2.0 km from Huntly (33 kV) GXP.

There is currently a maximum loading of 9 MVA on Glasgow St zone substation, with 1 MVA of spare (N) capacity. Glasgow St zone substation presently has (N) security only. Huntly 33 kV GXP presently has 86 MVA of spare (N) capacity and 48 MVA of spare (N-1) capacity.

Figure 88. Shinagawa Refractories geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

While the GXP has adequate (N) and (N-1) spare capacity for this load, Glasgow St zone substation is lacking in both spare (N) and (N-1) capacity.

For Glasgow St zone substation to achieve the required spare (N) capacity, upgrades/replacement of the existing supply transformer would be required. As well as this, the existing 33 kV subtransmission circuit would likely need to be upgraded/replaced to allow for additional capacity in the future.

SHINAGAWA REFRACTORIES

For Glasgow St zone substation to achieve the required spare (N-1) capacity, additional to the upgrades to the existing transformer and substransmission circuit above, a second transformer and accompanying subtransmission feeder to the zone substation would be required. Due to the urban/industrial topography of the area, the new 33 kV feeder from the GXP will most likely run overhead, following the existing route.

As per the supplied PowerFactory model, the existing maximum 11 kV feeder loading on Glasgow St zone substation is approximately 0.83 MVA. Due to the size of the Load Site, 1x new feeder and an associated circuit breaker may be required. Due to the urban/residential topography of the area, this would likely be underground, at a length of 0.9 km (following the existing overhead route).

Capital Cost Estimate

Table 41. Shinagawa Refractories: 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	Single underground 11kV cable	0.90	$0.54
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Subtransmission	Reconductor single overhead 33kV line	9.80	$2.57
Subtransmission	Medium supply transformer (ZSS)	1.00	$1.90
		TOTAL	**$5.11**

Table 42. Shinagawa Refractories: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single underground 11kV cable	0.90	$0.54
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Subtransmission	Reconductor single overhead 33kV line	9.80	$2.57
Subtransmission	Single overhead 33kV line	9.80	$3.43
Subtransmission	Medium supply transformer (ZSS)	2.00	$3.80
Transmission	33kV circuit breaker bay	2.00	$0.50
		TOTAL	**$11.04**

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

SHINAGAWA REFRACTORIES
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 24-36 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.

8.12.3 Springhill Corrections Facility

		SPRINGHILL CORRECTIONS FACILITY
Load Site Description	Electrical Demand (MW)	Transpower GXP
New high temperature heat pumps	2.797	Huntly 33 kV
Existing Electrical Supply to the Plant		

Springhill Corrections Facility is presently supplied by WEL Networks' Hampton Downs substation via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Hampton Downs is in turn supplied from Huntly 33 kV GXP by a single 33 kV subtransmission circuit. The subtransmission circuit is rated to approximately 300 A (17.2 MVA). Hampton Downs zone substation is presently equipped with 1x 9 MVA transformer.

This site is located approximately 1.9 km from Hampton Downs zone substation. In turn, Hampton Downs zone substation is approximately 21.7 km from Huntly 33 kV GXP.

There is currently a maximum loading of 1.87 MVA on Hampton Downs zone substation, with 7 MVA of spare (N) capacity. Hampton Downs presently operates on (N) security only. Huntly 33 kV GXP presently has 86 MVA of spare (N) capacity and 48 MVA of spare (N-1) capacity.

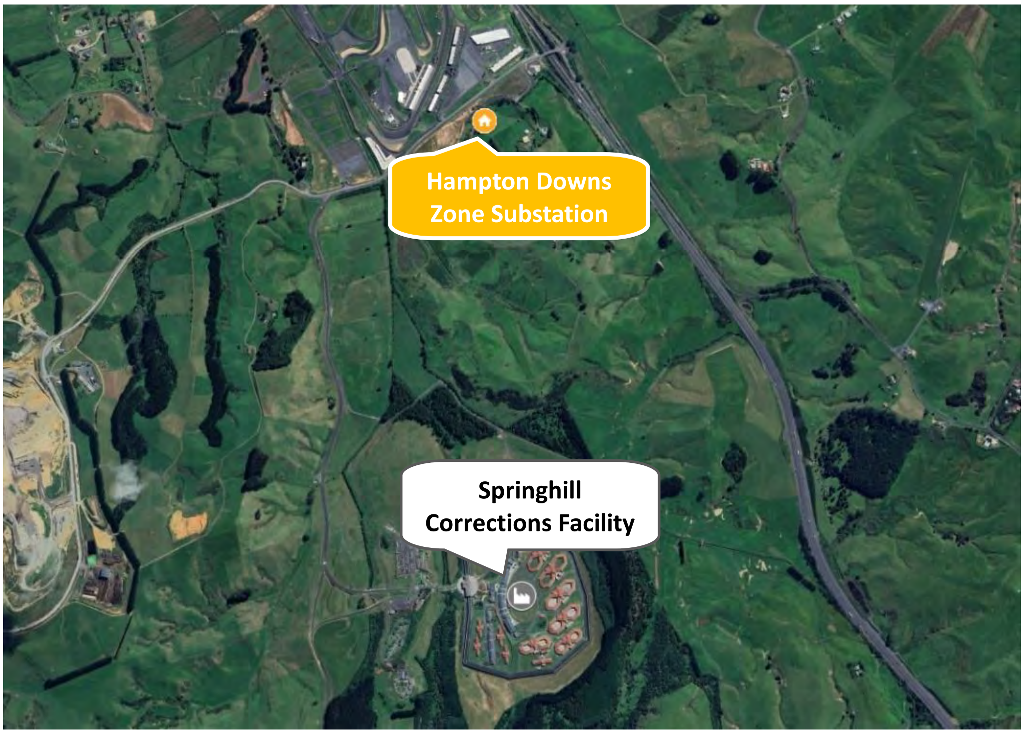


Figure 89. Springhill Corrections Facility geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

While the GXP has adequate (N) and (N-1) spare capacity for this load, Hampton Downs zone substation has adequate spare (N) capacity, but no spare (N-1) capacity.

For Hampton Downs zone substation to achieve the required spare (N-1) capacity, a new supply transformer would be needed. An additional 2x new circuit breakers and a 33 kV feeder from the GXP would also be required.

As per the supplied PowerFactory model, the existing maximum 11 kV feeder loading on Hampton Downs zone substation is approximately 0.19 MVA. Due to the size of the Load Site, 1x new 11kV feeder and an associated circuit breaker may be required. Due to the rural topology of the area, this would likely be an overhead line, at a length of 2.8 km (following the existing cable route).

Capital Cost Estimate

Table 43. Springhill Corrections Facility: 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	Single overhead 11kV line	2.80	$0.70
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
		TOTAL	**$0.80**

Table 44. Springhill Corrections Facility: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single overhead 11kV line	2.80	$0.70
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Subtransmission	Single overhead 33kV line	27.00	$9.45
Subtransmission	Medium supply transformer (ZSS)	1.00	$1.90
Transmission	33kV circuit breaker bay	2.00	$0.50
		TOTAL	**$12.75**

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 and 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.

8.12.4 Lumbercorp NZ Limited Ohinewai

LUMBERCORP NZ LIMITED OHINEWAI		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electric boilers	4.727	Huntly 33 kV
Existing Electrical Supply to the Plant		

Lumbercorp NZ Limited Ohinewai is presently supplied by WEL Networks' Te Kauwhata substation via an 11 kV feeder (TEK CB5) which consists of a mixture of underground cable and overhead line. Te Kauwhata is in turn supplied from Huntly 33 kV GXP by two 33 kV subtransmission circuits. The subtransmission circuits are rated to approximately 530 A (30.3 MVA) each. Te Kauwhata zone substation is presently equipped with 2x 10 MVA transformers.

This site is located approximately 5.7 km from Te Kauwhata zone substation. In turn, Te Kauwhata zone substation is approximately 14.7 km from Huntly 33 kV GXP.

There is currently a maximum loading of 8 MVA on Te Kauwhata zone substation, with 12 MVA of spare (N) capacity and 2 MVA of spare (N-1) capacity. Huntly 33 kV GXP presently has 86 MVA of spare (N) capacity and 48 MVA of spare (N-1) capacity.

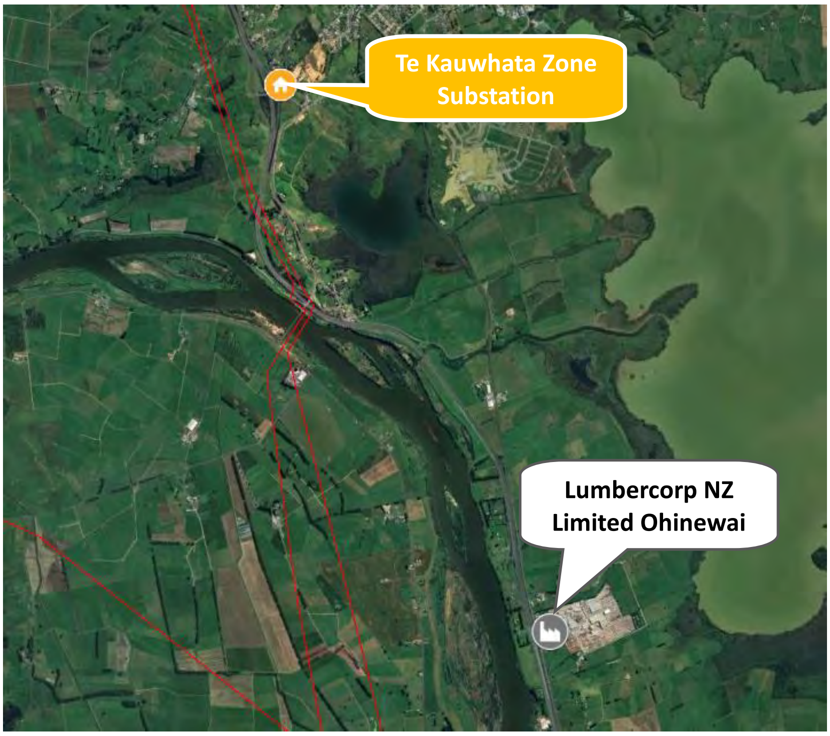


Figure 90. Lumbercorp NZ Limited Ohinewai geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

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

For Hampton Downs zone substation to achieve the required spare (N-1) capacity, replacements of the supply transformers at the substation would be required.

As per the supplied PowerFactory model, the existing maximum 11 kV feeder loading on TEK CB5 is approximately 2.1 MVA. Due to the size of the Load Site, 1x new 11 kV feeder and an associated circuit breaker are likely required. Due to the rural topology of the area, this would likely be an overhead line, at a length of 6.5 km, following the same route as the existing supply, with ~2.7 km of underground cabling and ~3.8 km of overhead line.

Capital Cost Estimate

Table 45. Lumbercorp NZ Limited Ohinewai: 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)	1.00	$0.10
Distribution	Single overhead 11kV line	3.80	$0.95
Distribution	Single underground 11kV cable	2.70	$1.62
		TOTAL	**$2.67**

Table 46. Lumbercorp NZ Limited Ohinewai: 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	Medium supply transformer (ZSS)	2.00	$3.80
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single overhead 11kV line	3.80	$0.95
Distribution	Single underground 11kV cable	2.70	$1.62
		TOTAL	**$6.47**

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 and 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.

8.12.5 Small Opportunities

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

Table 47. 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 Education Huntly College	Weavers	-1	8	1.68	0.157	80

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.

8.12.6 Effect of all Load Sites Connecting to Huntly 33 kV GXP

The following Figure 91 illustrates the Huntly 33 kV GXP load profile together with the load profiles of all the Load Sites within the Huntly 33 kV GXP region. Also shown in Figure 91 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Huntly 33 kV GXP would increase to 44.6 MW, an increase of 10.8 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 47.9 MW there is a diversity factor of 0.93 between the loads.
- Based on Ergo's analysis, Huntly 33 kV GXP's spare (N) and (N-1) capacities are adequate for the proposed loads. Therefore, upgrades to Huntly 33 kV GXP are not considered.

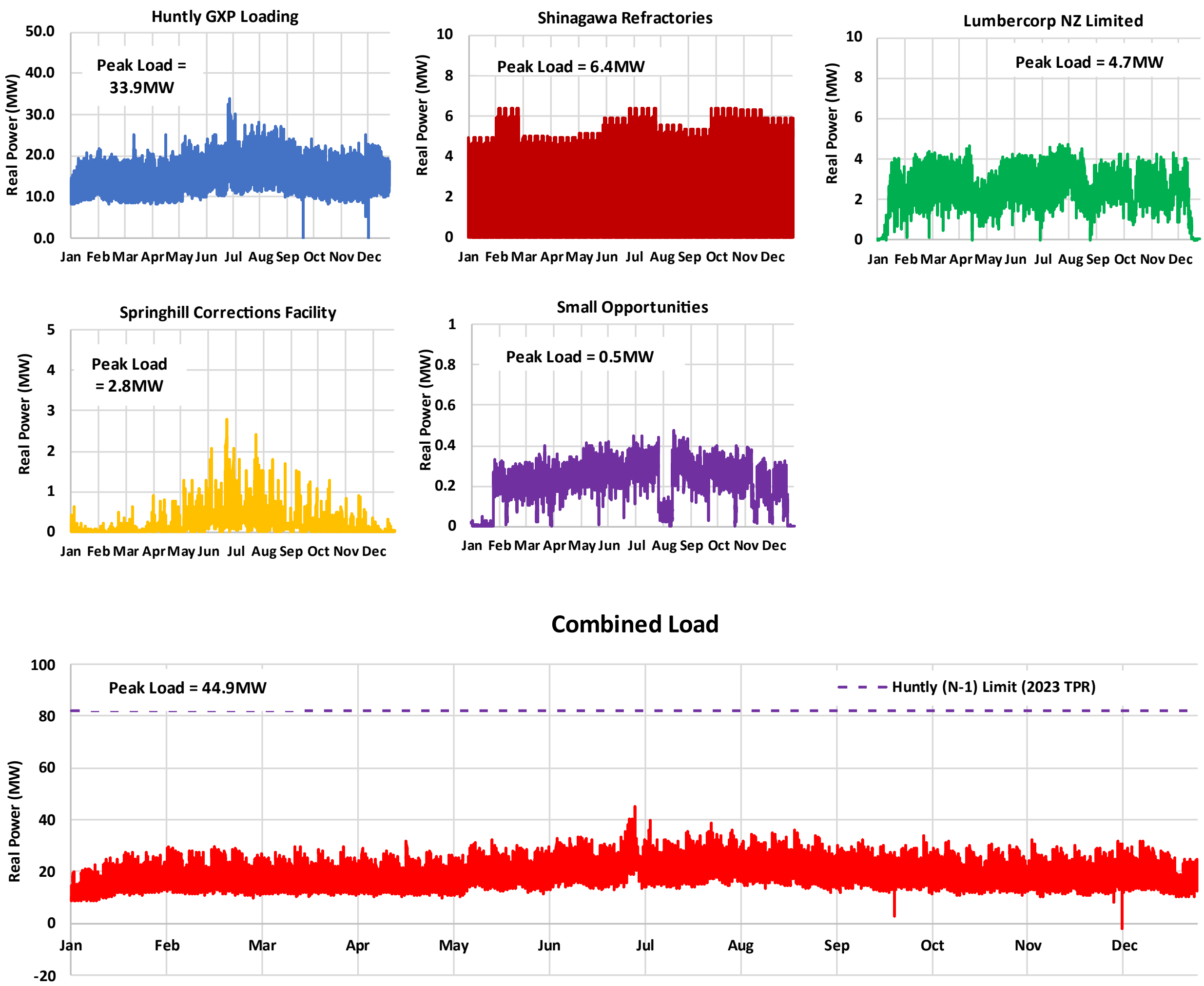


Figure 91. Loading Profiles: Huntly 33 kV GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.13 Kinleith 11 kV GXP

None of the Load Sites are connecting to Kinleith 11 kV GXP and therefore upgrades of this GXP are not considered.

8.14 Kinleith 33 kV GXP

The "Large" EECA Load Site connecting to the Kinleith 33 kV GXP is:

- Roundwood NZ Tokoroa (3.8 MW)

The "Small" Load Sites connecting to the Kinleith 33 kV GXP include (refer to sections 8.14.3 and 8.14.5):

- Ministry of Education Forest View High School (0.22 MW)
- Tokoroa Hospital (0.21 MW)
- Ministry of Education Tokoroa High School (0.13 MW)
- Ministry of Education Tainui Primary (0.11 MW)

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

Figure 92. Kinleith 33 kV GXP: EECA Load Sites vs local substations

8.14.1 Kinleith 33 kV GXP Upgrade

The Kinleith 33 kV GXP presently has 19.9 MVA of spare (N) capacity and -0.1 MVA of spare switched (N-1) capacity, based on the transformer ratings.

Analysis in Section 8.14.6 indicates that the spare (N-1) capacity of the Kinleith 33 kV GXP is expected to be exceeded if all the Load Sites connect. However, most of the connecting Load Sites are “small” and the capacity of the GXP is only marginally exceeded if all sites connect. Should only the small loads connect, then further upgrades at the GXP are not expected.

Should the Roundwood site connect as well as any others, upgrades at the GXP may be required. The upgrades specified in the Roundwood analysis below are considered sufficient for all connecting Load Sites.

8.14.2 Roundwood NZ Tokoroa

ROUNDWOOD NZ TOKOROA		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	3.838	Kinleith 33 kV
Existing Electrical Supply to the Plant		

Roundwood NZ Tokoroa is presently supplied by Powerco's Maraetai Road substation via a single 11 kV feeder which is a mixture of underground cables and overhead lines. Maraetai Road is in turn supplied from Kinleith 33 kV GXP by two 33 kV subtransmission circuits (one via Baird Rd substation). The subtransmission circuits are rated to approximately 380 A (~21.7 MVA). The Maraetai Road substation is equipped with 2x 12.5/17 MVA transformers.

This Load Site is located approximately 3.1 km from Maraetai Road zone substation. In turn, Maraetai Road zone substation is approximately 5.2 km from Kinleith 33 kV GXP.

There is currently a maximum loading of 9 MVA on Maraetai Road zone substation, with 19 MVA of spare (N) capacity and 0.5 MVA of spare (N-1) capacity. The Baird Road zone substation, which shares subtransmission circuits with Maraetai Road, is presently loaded to a maximum of 10 MVA. The Kinleith 33 kV GXP presently has 19.9 MVA of spare (N) capacity and -0.1 MVA of spare switched (N-1) capacity, based on the transformer ratings.

Figure 93. Roundwood NZ Tokoroa geographic location in relation to the surrounding zone substations

ROUNDWOOD NZ TOKOROA

Supply Option(s) for New Load

Both Kinleith 33 kV GXP and the Maraetai Road zone substation have adequate spare (N) capacity but not (N-1) capacity for this load.

For an (N) security supply, a special protection scheme would likely be required at the GXP, to prevent overloading of the smaller transformer if it is switched into service. Similarly, a special protection scheme would be required at Maraetai Rd zone substation.

While load shifts are planned to free up capacity on the Kinleith GXP, Ergo has conservatively assumed that the load shifts would not be adequate to provide sufficient (N-1) GXP capacity for this Load Site. Therefore, for an (N-1) supply, it is assumed that replacement of the smaller of the two GXP transformers would be required.

Additionally, for an (N-1) supply, an additional subtransmission circuit from Kinleith 33 kV GXP to Maraetai Rd substation, and upgrades of the transformers at Maraetai Road substation would be required. It is expected that the new subtransmission circuit would be underground due to space constraints due to existing overhead lines, and would be approximately 7 km long.

The existing feeder is loaded to a maximum of approximately 104 A (1.98 MVA). For the existing feeder to accommodate this load, it is expected that ~0.4 km of lines and ~0.1 km of underground cable would need to be reconductored or replaced, respectively.

Capital Cost Estimate

Table 48. Roundwood NZ Tokoroa: 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	Reconductor 11kV line (larger)	0.40	$0.08
Distribution	Single underground 11kV cable	0.10	$0.06
		TOTAL	**$0.64**

ROUNDWOOD NZ TOKOROA

Table 49. Roundwood NZ Tokoroa: 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)	1.00	$4.50
Subtransmission	Medium supply transformer (ZSS)	2.00	$3.80
Subtransmission	33kV circuit breaker (ZSS)	2.00	$0.60
Subtransmission	Single underground 33kV cable	7.00	$6.30
Distribution	Reconductor 11kV line (larger)	0.40	$0.08
Distribution	Single underground 11kV cable	0.10	$0.06
		TOTAL	**$15.34**

Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site.
Indicatively, a distribution transformer to supply the site is expected to cost approximately $350k.

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.

8.14.3 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 50. 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 Education Forest View High School	Baird Rd	6.8	23.8	Unknown	0.224	130
Tokoroa Hospital	Maraetai Road	0.5	19	Unknown	0.213	130
Ministry of Education Tokoroa High School	Maraetai Road	0.5	19	Unknown	0.134	80
Ministry of Education Tainui Primary Pool	Maraetai Road	0.5	19	Unknown	0.112	80

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.

8.14.4 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.

8.14.4.1 Maraetai Road

Four of the loads on Kinleith 33 kV GXP are expected to connect to Maraetai Road zone substation. The loads are Roundwood NZ Tokoroa, Ministry of Education Forest View High School, Tokoroa Hospital, and Ministry of Education Tokoroa High School. The sum of peaks of these loads is 4.3 MW, which the zone substation does not have (N-1) capacity for, and therefore if all of the Load Sites connect, upgrades will be expected at Maraetai substation.

The upgrades specified for connection of Roundwood NZ Tokoroa are considered sufficient for all of the connecting loads. If only the three smaller loads connect, upgrades are not expected.

8.14.5 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Kinleith 33 kV GXP gives a combined load of 0.44 MW. When the load shapes are combined, they result in the following load shape (Figure 94), with a maximum load of 0.37 MW, with a diversity factor of 0.84.

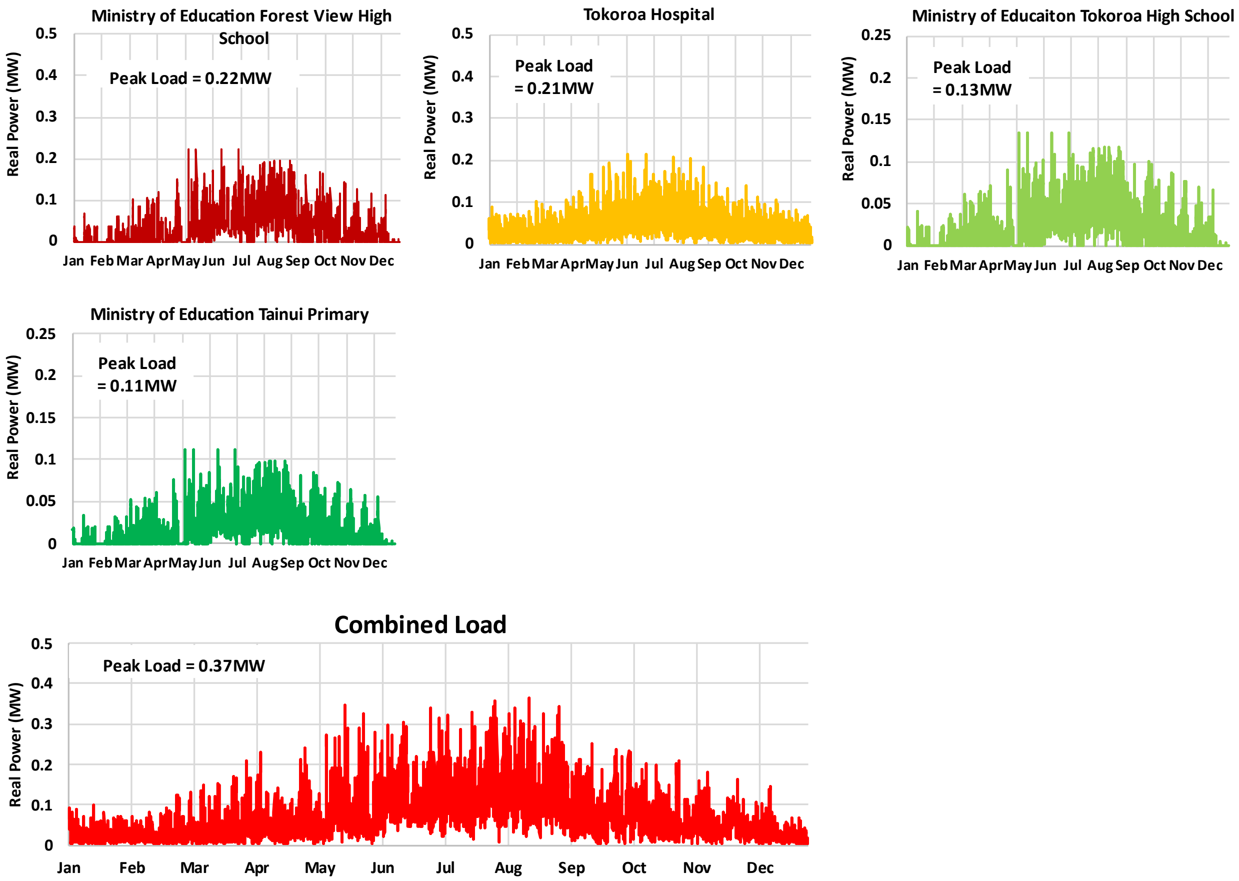


Figure 94. Loading Profiles: Kinleith 33 kV GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.14.6 Effect of all Load Sites Connecting to Kinleith 33 kV GXP

The following Figure 95 illustrates the Kinleith 33 kV GXP load profile together with the load profiles of all the Load Sites within the Kinleith 33 kV GXP region. Also shown in Figure 95 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Kinleith 33 kV GXP would increase to 22.0 MW, an increase of 1.9 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 20.42 MW there is a diversity factor of 0.91 between the loads.
- Based on Ergo's analysis, the Kinleith 33 kV GXP's (N-1) limit is expected to be exceeded. Ergo has discussed mitigation for this in Section 8.14.1.

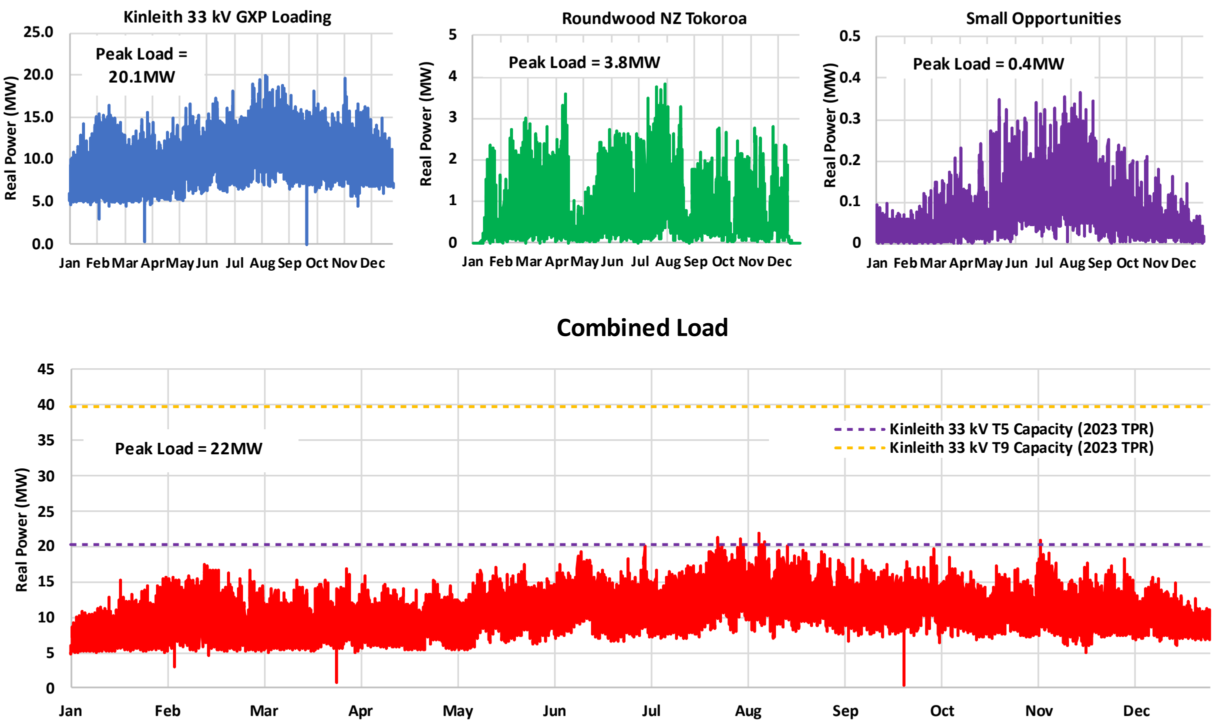


Figure 95. Loading Profiles: Kinleith 33 kV GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.15 Kopu GXP

One "Large" EECA Load Site is connecting to the Kopu GXP:

- A & G Price Ltd Thames (1.18 MW)
- Twentymans Funeral Services Thames (0.82 MW)

The "Small" Load Sites connecting to the Kopu GXP include (refer to Section 8.15.4):

- Mercury Bay Area School (0.07 MW)

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

Figure 96. Kopu GXP: EECA Load Sites vs local substations

8.15.1 Kopu GXP Upgrade

The Kopu GXP presently has 13.2 MVA of spare (N-1) capacity and 73.2 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.15.6 indicates that the spare (N-1) capacity of the Kopu GXP is not expected to be exceeded if all the Load Sites connect. Therefore, upgrades of the Kopu GXP are not expected.

8.15.2 A & G Price Ltd Thames

A & G PRICE LTD THAMES		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	1.182	Kopu
Existing Electrical Supply to the Plant		

A & G Price Ltd Thames is presently supplied by Powerco's Thames T3 substation via a single 11 kV underground feeder. Thames T3 is in turn supplied from Kopu GXP by two 66 kV subtransmission circuits. The subtransmission circuits are rated to approximately 157 A (18 MVA) and 270 A (31 MVA). The Thames T3 transformer is rated to 5 MVA, and the T1 and T2 transformers are each rated to 12.5/17 MVA.

This Load Site is located approximately 0.2 km from Thames T3 zone substation. In turn, Thames T3 zone substation is approximately 9.2 km from Kopu GXP.

There is currently a maximum loading of 2 MVA on Thames T3 zone substation (part of the overall Thames substation site), with 3 MVA of spare (N) capacity (as a sole transformer supply, the T3 substation operates on (N-1 switched) security presently). As the sole customer supplied by Thames T3 presently, A&G Price already have an agreement with Powerco regarding their security of supply. There is currently a maximum loading of 12 MVA on the adjacent Thames T1&T2 zone substation, with 21.5 MVA of spare (N) capacity and 4.5 MVA of spare (N-1) capacity. Kopu GXP presently has 73.2 MVA of spare (N) capacity and 13.2 MVA of spare (N-1) capacity.

Figure 97. A & G Price Ltd Thames geographic location in relation to the surrounding zone substations

A & G PRICE LTD THAMES
Supply Option(s) for New Load
Kopu GXP has adequate spare (N) and (N-1) capacity for this load. Therefore, upgrades to Kopu GXP are not expected for this load. It is considered that the proposed additional load would be best placed on the Thames T1&T2 supply, rather than on the existing T3 supply, as Ergo understands that the T3 supply is considered a "dirty" supply (i.e. has a low power factor or high harmonic levels), and the new load would most likely not be "dirty" - so could be connected to the main substation supply. Thames T1&T2 zone substation has adequate spare (N) and (N-1) capacity for this load. Existing 11 kV feeder loading is not known, to Ergo. However, due to the size of the load, it is expected that the new load could be accommodated on an existing 11 kV feeder from Thames T1&T2.
Capital Cost Estimate
Table 51. A & G Price Ltd Thames: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security. (N/A) Does not include the costs of any electrical equipment (i.e. distribution transformers/switchgear and cables) on the plant site. Indicatively, a distribution transformer to supply the site is expected to cost approximately $350k.
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.

8.15.3 Twentymans Funeral Services Thames

TWENTYMANS FUNERAL SERVICES THAMES		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	0.818	Kopu
Existing Electrical Supply to the Plant		

Twentymans Funeral Services Thames is presently supplied by Powerco's Thames T1&T2 substation via a single 11 kV underground feeder. Thames T1&T2 is in turn supplied from Kopu GXP by two 66 kV subtransmission circuits. The subtransmission circuits are rated to approximately 157 A (18 MVA) and 270 A (31 MVA). The Thames T1 and T2 transformers are each rated to 12.5/17 MVA.

This site is located approximately 1.3 km from Thames T1&T2 zone substation. In turn, Thames T1&T2 zone substation is approximately 9.2 km from Kopu GXP.

There is currently a maximum loading of 12 MVA on Thames T1&T2 zone substation, with 21.5 MVA of spare (N) capacity and 4.5 MVA of spare (N-1) capacity. Kopu GXP presently has 73.2 MVA of spare (N) capacity and 13.2 MVA of spare (N-1) capacity.

Figure 98. Twentymans Funeral Services Thames geographic location in relation to the surrounding zone substations.

TWENTYMANS FUNERAL SERVICES THAMES

Supply Option(s) for New Load

Although this site is <1 MW and as such would typically be considered a "small" Load Site, due to network constraints, a more detailed analysis was required for this site.

Kopu GXP has adequate spare (N) and (N-1) capacity for this load. Therefore, upgrades to Kopu GXP are not expected for this load.

Thames T1&T2 zone substation has adequate spare (N) and (N-1) capacity for this load.

The existing feeder loading is not known, to Ergo. However, it is expected that the feeder may need to be upgraded due to the size of the load. Due to the urban/industrial topography of the area, these would likely be underground cables, at a length of approximately 1.3 km.

Capital Cost Estimate

Table 52. A & G Price Ltd Thames: Capital cost estimate to supply the Load Site with (N-1 switched) subtransmission supply security.

Transmission => (N-1)	**Subtransmission => (N)**	**Distribution => (N)**	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single underground 11kV cable	1.30	$1.04
		TOTAL	**$1.04**

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 and 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.

8.15.4 Small Opportunities

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

Table 53. 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)
Mercury Bay Area School	Whitianga	0.8	15.4	Unknown	0.073	50

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.

8.15.5 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.

8.15.5.1 Thames T1&T2

Two of the loads on Kopu GXP are expected to connect to Thames T1&T2 zone substation. The loads are A & G Price Ltd Thames and Twentymans Funeral Services Thames. The sum of peaks of these loads is 2 MW, which the zone substation does have (N-1) capacity for. Therefore, further upgrades at Thames T1&T2 are not expected.

8.15.6 Effect of all Load Sites Connecting to Kopu GXP

The following Figure 99 illustrates the Kopu GXP load profile together with the load profiles of all the Load Sites within the Kopu GXP region. Also shown in Figure 99 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Kopu GXP would increase to 46.43 MW, an increase of 0.05 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 48.43 MW there is a diversity factor of 0.96 between the loads.
- Based on Ergo's analysis, the Kopu GXP's (N-1) limit is not expected to be exceeded.

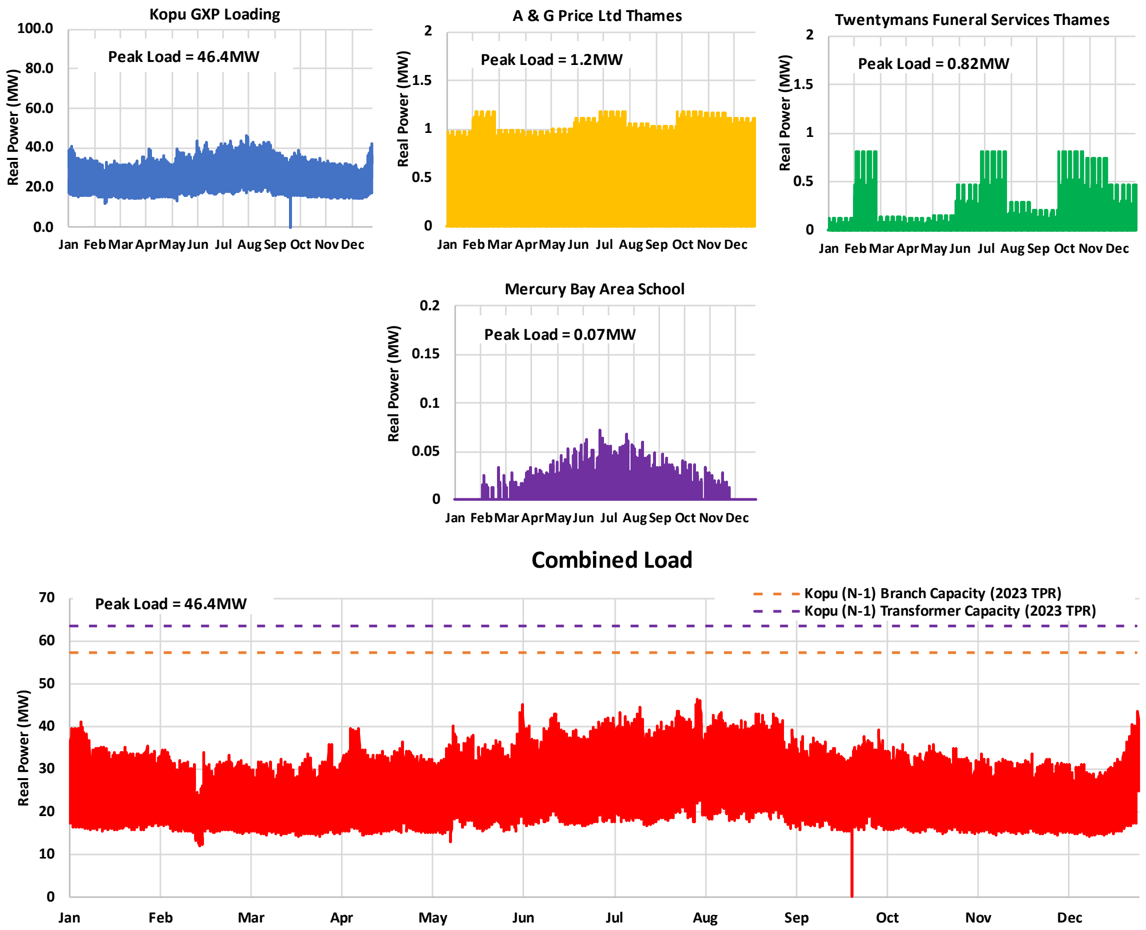


Figure 99. Loading Profiles: Kopu GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.16 Lichfield GXP

One “Large” EECA Load Site is connecting to the Lichfield GXP:

- Fonterra Lichfield (31.94 MW)

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

Figure 100. Lichfield GXP: EECA Load Site vs local substations

8.16.1 Lichfield GXP Upgrade

As only one Load Site is connecting to the GXP, any required GXP upgrades are discussed in Section 8.16.2.

8.16.2 Fonterra Lichfield

FONTERRA LICHFIELD		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and high temperature heat pumps	31.936	Lichfield
Existing Electrical Supply to the Plant		

Fonterra Lichfield is presently supplied, by two 11 kV feeders, via Vector's 110/11 kV Lichfield substation which in turn takes supply at 110 kV from the Transpower grid. The path and cable/line configuration is unknown, to Ergo. Vector's Lichfield substation is presently equipped with 2x 20 MVA transformers.

This site is located approximately 0.7 km from Vector's Lichfield substation.

There is currently a maximum loading of 18 MVA on Lichfield GXP. Lichfield GXP presently has 22.6 MVA of spare (N) capacity and 2.6 MVA of spare (N-1) capacity.

Figure 101. Fonterra Lichfield geographic location in relation to the surrounding GXPs

FONTERRA LICHFIELD

Supply Option(s) for New Load

Due to the size of this load, analysis focuses on a staged approach to connecting the load. Ergo has used the staging MW values supplied by EECA for this site.

For this site, additional transformers are added onto the Lichfield substation, rather than replacing or upgrading the existing ones, as Ergo expects that replacements or upgrades of the existing transformers would involve a plant shutdown, which Fonterra would likely prefer to avoid.

Stage 1 - 12 MVA

The first stage of Fonterra Lichfield adds an additional 12 MVA onto the existing load.

Lichfield GXP has adequate spare (N) capacity, but not spare (N-1) capacity for this load.

To achieve the required spare (N-1) capacity, it is expected that a third 110/11 kV transformer would be required at the Lichfield substation, which would require extension of the existing 110 kV bus, and installation of a new 11 kV bus (mentioned below).

Due to the size of the load, it is expected that 3x new 11 kV feeders from Lichfield GXP would be required for this project. To accommodate these new circuit breakers, it is expected that a new 11 kV bus and associated building would be required. Due to the urban/industrial topography of the area, it is expected that these feeders would be underground, and would be approximately 1.1 km long.

Stage 2 – 31.9 MVA

The second stage of Fonterra Lichfield adds an additional 19.9 MVA, bringing the total proposed load to 31.9 MVA.

Lichfield GXP has inadequate spare (N) and (N-1) capacity for this load.

For either an (N) or (N-1) condition, it is expected that 1x new 110/11 kV transformer and accompanying 11 kV switchboard would be required to supply the load, additional to the two existing (upgraded for the (N-1) case for Stage 1). This would also require extension of the existing 110 kV bus, and installation of a new 11 kV bus (mentioned below).

Due to the size of the load, it is expected that 3x new 11 kV feeders from Lichfield GXP would be required for this project. It is expected that a new 11 kV bus and associated building (note this may be an extension to the switchroom building added in Stage 1) would be required to house these. Due to the urban/industrial topography of the area, it is expected that these feeders would be underground, and would be approximately 1.1 km long.

Assuming that the previous stage's upgrades had been carried out, the existing Lichfield-Kinleith circuits may need to be upgraded/replaced. Each of these circuits are overhead, at lengths of 16.9 km and 17.8 km respectively.

Capital Cost Estimate

Table 54. Fonterra Lichfield (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)**	
Distribution	Small switchroom (ZSS)	1.00	$1.50
Distribution	Single underground 11kV cable	3.30	$1.98
		TOTAL	**$3.48**

Table 55. Fonterra Lichfield (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)**	
Distribution	Small switchroom (ZSS)	1.00	$1.50
Distribution	Single underground 11kV cable	3.30	$1.98
Distribution	110kV circuit breaker bay	2.00	$1.20
Distribution	Large supply transformer (ZSS)	1.00	$2.30
		TOTAL	**$6.98**

Table 56. Fonterra Lichfield (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)**	
Distribution	Small switchroom (ZSS)	1.00	$1.50
Distribution	Single underground 11kV cable	3.30	$1.98
Distribution	110kV circuit breaker bay	2.00	$1.20
Distribution	Large supply transformer (ZSS)	1.00	$2.30
		TOTAL	**$6.98**

Table 57. Fonterra Lichfield (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)**	
Distribution	Small switchroom (ZSS)	1.00	$1.50
Distribution	Single underground 11kV cable	3.30	$1.98
Distribution	110kV circuit breaker bay	2.00	$1.20
Distribution	Large supply transformer (ZSS)	1.00	$2.30
Transmission	110kV single overhead line	34.70	$27.76

		FONTERRA LICHFIELD
	TOTAL	$34.74

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 the (N) security case, it is estimated to take the following periods to plan, design, procure, construct, and commission the works for each stage:

- Stage 1 – 12-18 months
- Stage 2 – 36-48 months

For the (N-1) security case, it is estimated to take the following periods to plan, design, procure, construct, and commission the works for each stage:

- Stage 1 – 36-48 months
- Stage 2 – 36-48 months

Excluded are any work required to establish the Load Site.

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

8.16.3 Effect of all Load Sites Connecting to Lichfield GXP

The following Figure 102 illustrates the Lichfield GXP load profile together with the load profiles of all the Load Sites within the Lichfield GXP region. Also shown in Figure 102 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Lichfield GXP would increase to 47.30 MW, an increase of 0.67 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 47.97 MW there is a diversity factor of 0.99 between the loads.

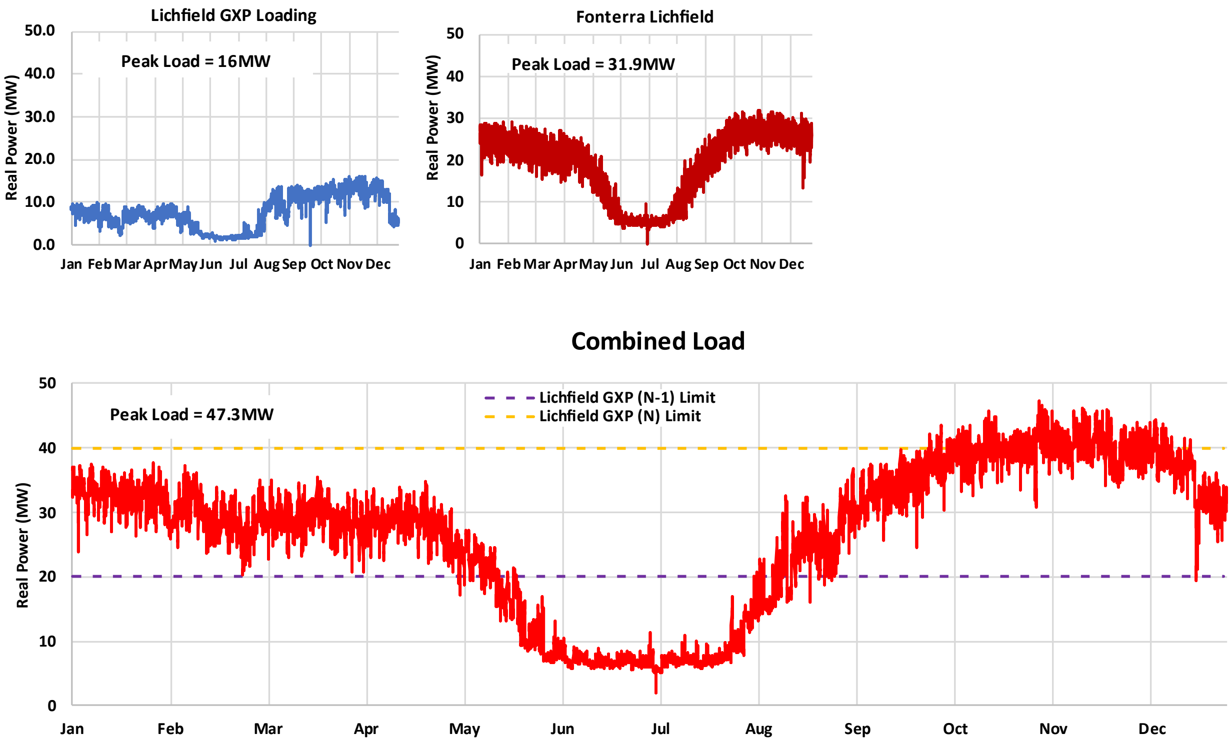


Figure 102. Loading Profiles: Lichfield GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.17 Piako GXP

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

- The Tatua Dairy Co-operative Dairy Company Limited (21.13 MW)
- Fonterra Morrinsville (10.04 MW)
- Ixom Morrinsville (1.00 MW)

One "Small" Load Site is connecting to the Piako GXP (refer to section 8.17.5):

- Greenlea Premier Meats Limited Morrinsville (0.23 MW)

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

Figure 103. Piako GXP: EECA Load Sites vs local substations

8.17.1 Piako GXP Upgrade

The Piako GXP presently has 20 MVA of spare (N-1) capacity and 80 MVA of spare (N) capacity, based on the transformer ratings.

Analysis for the individual Load Sites (particularly the Tatua site), indicates that upgrades of the 110 kV circuits supplying Piako GXP would be required if that Load Site connects.

Ergo notes that the limit relates to the line section between Morrinsville Tee and Piako. This section of line was expected to exceed its (N-1) capacity from winter of 2023 according to Transpower's forecast and, though existing loading does not reflect this, additional loads connecting may exacerbate the issue. Transpower and Powerco are investigating solutions to this issue, in the interim a special protection scheme may be employed on the line, to prevent post-contingency overloading, at a cost of ~$0.5M.

The ratings of the Powerco-owned Piako transformers may also be exceeded, in which case, it may be expected that the loads connecting would share the cost of transformer upgrades at the GXP (the costs for which have been included in analysis for relevant loads).

8.17.2 The Tatua Dairy Co-operative Dairy Company Limited

THE TATUA DAIRY CO-OPERATIVE DAIRY COMPANY LIMITED		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	21.129	Piako
Existing Electrical Supply to the Plant		

The Tatua Dairy Co-operative Dairy Company Limited is presently supplied by Powerco's Tatua substation via four dedicated underground circuits. Tatua is in turn supplied by a single 33 kV subtransmission circuit. However, this 33 kV circuit tees off from two points of supply, Piako GXP and Waihou GXP (via the Farmer Rd substation, where the open point is), with supply normally taken from Piako GXP. The upstream subtransmission circuits are rated to approximately 378 A (21.6 MVA) each. Tatua substation is presently equipped with a single 7.5 MVA transformer, affording it (N) security only. The Tatua substation transformer will be replaced with a 12.5/17 MVA unit in 2025.

This site is located adjacent to Tatua zone substation. In turn, Tatua zone substation is approximately 4.1 km from Piako GXP.

There is currently a maximum loading of 6.5 MVA on Tatua zone substation, with 1.3 MVA of spare (N) capacity. Piako GXP presently has 80 MVA of spare (N) capacity and 20 MVA of spare (N-1) capacity.

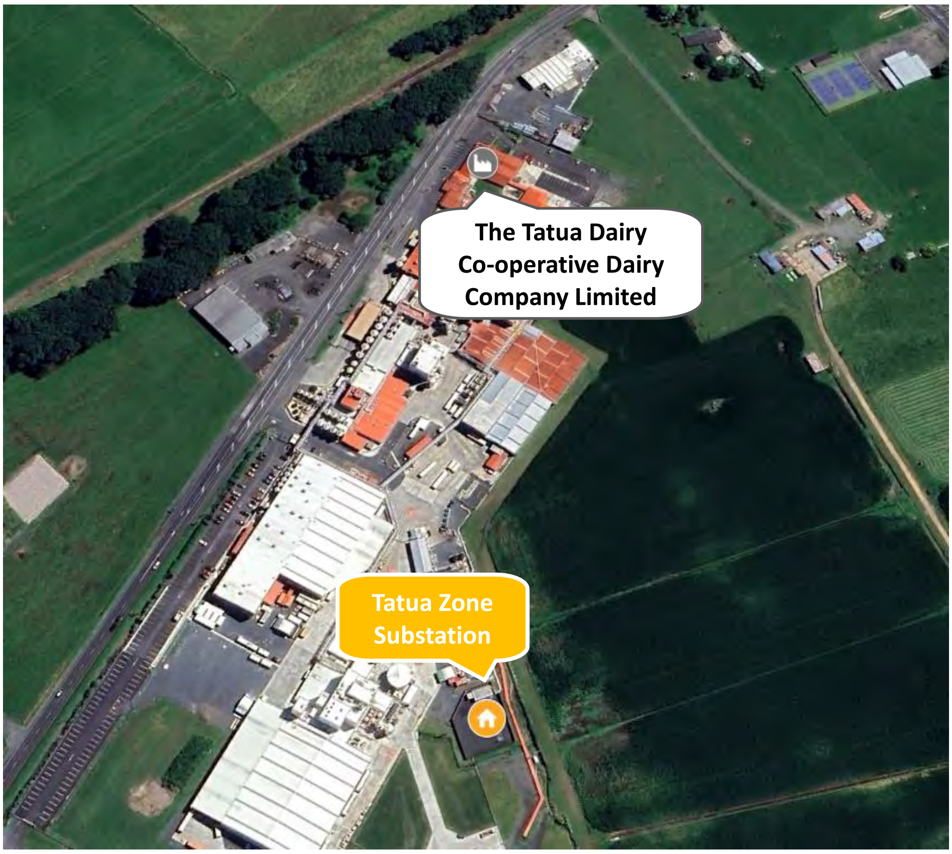


Figure 104. The Tatua Dairy Co-operative Dairy Company Limited geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Due to the size of this load, analysis focuses on a staged approach to connecting the load. Ergo has used the staging MW values supplied by EECA for this site.

Given the constraints on both the existing substation and the local GXP, significant upgrades will be required to provide adequate (N) or (N-1) capacity to the site.

Ergo has assumed that at the point the Load Site connects, the planned replacement of the Tatua transformer would have been carried out.

<u>Stage 1 – 10.5 MVA</u>

For an (N) security supply for Stage 1, a special protection scheme would likely be required for the 110 kV lines supplying the Piako GXP.

For an (N-1) security supply for Stage 1, an additional 110 kV circuit between Hamilton GXP and Piako GXP would be required (~30 km of overhead line). It is also expected that an additional subtransmission circuit between Piako GXP and Tatua substation would be required. This would likely be an underground cable circuit at ~5 km long. Additionally, a second transformer would be required at the Tatua zone substation, with associated 11 kV switchboard/switchroom and additional 33 kV circuit breaker. When sizing this transformer, the Stage 2 load should be considered.

It is also expected that for either security supply, 2x new 11 kV feeders to the site would be required. Due to the industrial nature of the site, it is expected that these feeders would be underground, and ~0.5 km each.

<u>Stage 2 – 21.13 MVA</u>

Stage 2 would add an additional load of 10.63 MVA onto the Stage 1 load, giving a total of 21.13 MVA.

For an (N) security supply, at this stage, some of the existing underground subtransmission cables supplying the Tatua zone substation would require replacements/upgrades (~0.5 km). Additionally, a second transformer would be required at Tatua zone substation.

For an (N-1) security supply, the first transformer at Tatua would need to be replaced with a larger unit. The underground cable upgrades required for an (N) supply would also be required.

To accommodate the additional Stage 2 load, it is expected that a further 2x new 11 kV feeders to the site would be required. Due to the industrial nature of the site, it is expected that these feeders would be underground, and ~0.5 km each.

Capital Cost Estimate

Table 58. The Tatua Dairy Co-operative Dairy Company Limited (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)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	0.50	$0.40
		TOTAL	**$1.10**

Table 59. The Tatua Dairy Co-operative Dairy Company Limited (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	110kV circuit breaker bay	2.00	$1.20
Transmission	110kV single overhead line	30.00	$24.00
Subtransmission	Large supply transformer (ZSS)	1.00	$2.30
Subtransmission	Single underground 33kV cable	5.00	$4.50
Subtransmission	33kV circuit breaker (ZSS)	3.00	$0.90
Distribution	Medium switchroom (ZSS)	1.00	$3.00
Distribution	11kV circuit breaker (ZSS)	4.00	$0.40
Distribution	Double underground 11kV cable	0.50	$0.40
		TOTAL	**$36.70**

Table 60. The Tatua Dairy Co-operative Dairy Company Limited (Stage 2): Capital cost estimate to supply the Load Site with (N-1) or (N) subtransmission supply security.

Transmission => Stage 1	Subtransmission => Stage 1		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Large supply transformer (ZSS)	1.00	$2.30
Subtransmission	33kV circuit breaker (ZSS)	1.00	$0.30
Subtransmission	Single underground 33kV cable	0.50	$0.45
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	0.50	$0.40
		TOTAL	**$3.65**

THE TATUA DAIRY CO-OPERATIVE DAIRY COMPANY LIMITED
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 36-48 months for Stage 1 and 24-36 months for Stage 2 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.

8.17.3 Fonterra Morrinsville

		FONTERRA MORRINSVILLE
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	10.043	Morrinsville
Existing Electrical Supply to the Plant		

Fonterra Morrinsville is presently supplied by Powerco's Morrinsville substation via a single 11 kV underground feeder. Morrinsville is in turn supplied from Piako GXP by two 33 kV subtransmission circuits. These subtransmission circuits are rated to approximately 290 A (16.6 MVA) each. Morrinsville substation is presently equipped with 2x 7.5/10 MVA transformers.

This site is located approximately 0.4 km from Morrinsville zone substation. In turn, Morrinsville zone substation is approximately 2.3 km from Piako GXP.

There is currently a maximum loading of 8 MVA on Morrinsville zone substation, with 12 MVA of spare (N) capacity and 2 MVA of spare (N-1) capacity. Piako GXP presently has 80 MVA of spare (N) capacity and 20 MVA of spare (N-1) capacity.

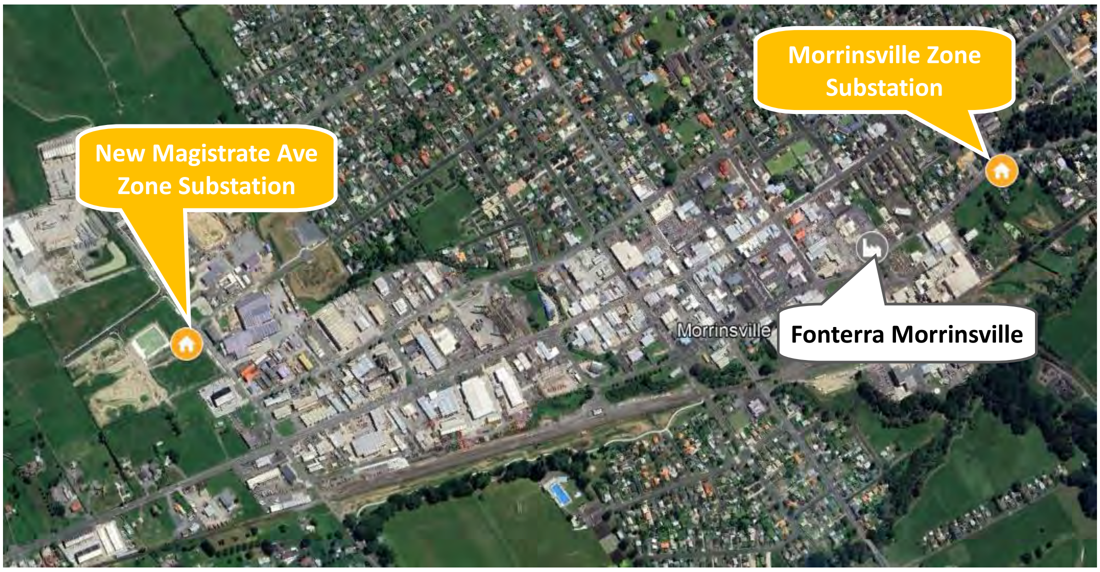


Figure 105. Fonterra Morrinsville geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Both the zone substation and the GXP have adequate spare (N) capacity for this load. Piako GXP's transformers have adequate spare (N-1) capacity, while Morrinsville substation does not have adequate spare (N-1) capacity.

Ergo understands that once the planned upgrades at Morrinsville and the new Magistrate Avenue substation are complete, there will be room at Morrinsville substation for further upgrades (transformer replacements). Ergo notes that the planned installation of the Magistrate Ave substation is $19.512M (including upgrades at Morrisville to accommodate a 33 kV supply to Magistrate Ave). As this is an upgrade already planned by Powerco, Ergo has assumed that the Load Site will not share in this cost.

For an (N) security supply, a special protection scheme would likely be required for the 110 kV lines supplying the Piako GXP. Similarly, a special protection scheme would be required for the subtransmission lines and the zone substation transformers.

For an (N-1) security supply, an additional 110 kV circuit between Hamilton GXP and Piako GXP would be required (~30 km of overhead line). Additionally, transformer replacements would be required at Morrinsville, and installation of a third 33 kV circuit from the GXP to the substation. This new 33 kV circuit would be underground, and would be approximately 4 km long.

The existing feeder loading is not known, to Ergo. However, due to the size of the load, 3x new 11 kV feeders and associated circuit breakers may be required. Due to the urban/industrial topography of the area, these would likely be underground cables, at a length of approximately 0.5 km.

Capital Cost Estimate

Table 61. Fonterra Morrinsville: 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)	2.00	$0.50
Distribution	11kV circuit breaker (ZSS)	3.00	$0.30
Distribution	Single underground 11kV cable	1.50	$0.90
		TOTAL	**$2.20**

Table 62. Fonterra Morrinsville: 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	110kV circuit breaker bay	2.00	$1.20
Transmission	110kV single overhead line	30.00	$24.00
Subtransmission	33kV circuit breaker (ZSS)	2.00	$0.60
Subtransmission	Single underground 33kV cable	4.00	$3.60
Subtransmission	Medium supply transformer (ZSS)	2.00	$3.80
Distribution	11kV circuit breaker (ZSS)	3.00	$0.30
Distribution	Single underground 11kV cable	1.50	$0.90
		TOTAL	**$34.40**

FONTERRA MORRINSVILLE
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) supply (following construction of Magistrate Ave substation), or 36-48 months for an (N-1) 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.

8.17.4 Ixom Morrinsville

IXOM MORRINSVILLE		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers	1.000	Piako
Existing Electrical Supply to the Plant		

Ixom Morrinsville is presently supplied by Powerco's Piako substation via an 11 kV underground feeder. Piako is in turn directly supplied from Piako GXP. This subtransmission circuit is rated to approximately 530 A (30.3 MVA).

This site is located approximately 3.4 km from Piako zone substation. In turn, Piako zone substation is adjacent to Piako GXP.

There is currently a maximum loading of 14 MVA on Piako zone substation, with 19 MVA of spare (N) capacity and 2 MVA of spare (N-1) capacity. Piako GXP presently has 80 MVA of spare (N) capacity and 20 MVA of spare (N-1) capacity.

Figure 106. Ixom Morrinsville geographic location in relation to the surrounding zone substations

IXOM MORRINSVILLE

Supply Option(s) for New Load

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

The existing 11kV feeder loading is not known, to Ergo. However, due to the size of the load, it's existing feeder may be adequate to supply the additional load. If not, sections of the existing 11 kV feeder may need to be re-conductored to allow for a higher current-carrying capacity.

As the zone substation and GXP have adequate (N-1) capacity for this load, consideration has not been given to an (N) security supply.

Capital Cost Estimate

Table 63. Ixom Morrinsville: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Reconductor 11kV line (larger)	3.50	$0.70
		TOTAL	**$0.70**

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 take 12-24 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.

8.17.5 Small Opportunities

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

Table 64. 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)
Greenlea Premier Meats Limited Morrinsville	Morrinsville	2	12	Unknown	0.234	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.

8.17.6 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.

8.17.6.1 Morrinsville

Two of the loads on Piako GXP are expected to connect to Morrinsville zone substation. The loads are Fonterra Morrinsville, and Greenlea Premier Meats Limited Morrinsville. The sum of peaks of these loads is 10.28 MW, which the zone substation doesn’t have (N-1) capacity for. Therefore, upgrades at Morrinsville are expected. However, the upgrades discussed for connection of the Fonterra Morrinsville load are considered adequate should both loads connect.

8.17.7 Effect of all Load Sites Connecting to Piako GXP

The following Figure 107 illustrates the Piako GXP load profile together with the load profiles of all the Load Sites within the Piako GXP region. Also shown in Figure 107 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Piako GXP would increase to 64.83 MW, an increase of 24.77 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 72.46 MW there is a diversity factor of 0.89 between the loads.
- Based on Ergo's analysis, the Piako GXP's (N-1) (line) limit is not expected to be exceeded. Ergo notes that the limit relates to the line section between Morrinsville Tee and Piako. This section of line was expected to exceed its (N-1) capacity from winter of 2023 according to Transpower's forecast and, though existing loading does not reflect this, additional loads connecting may exacerbate the issue.

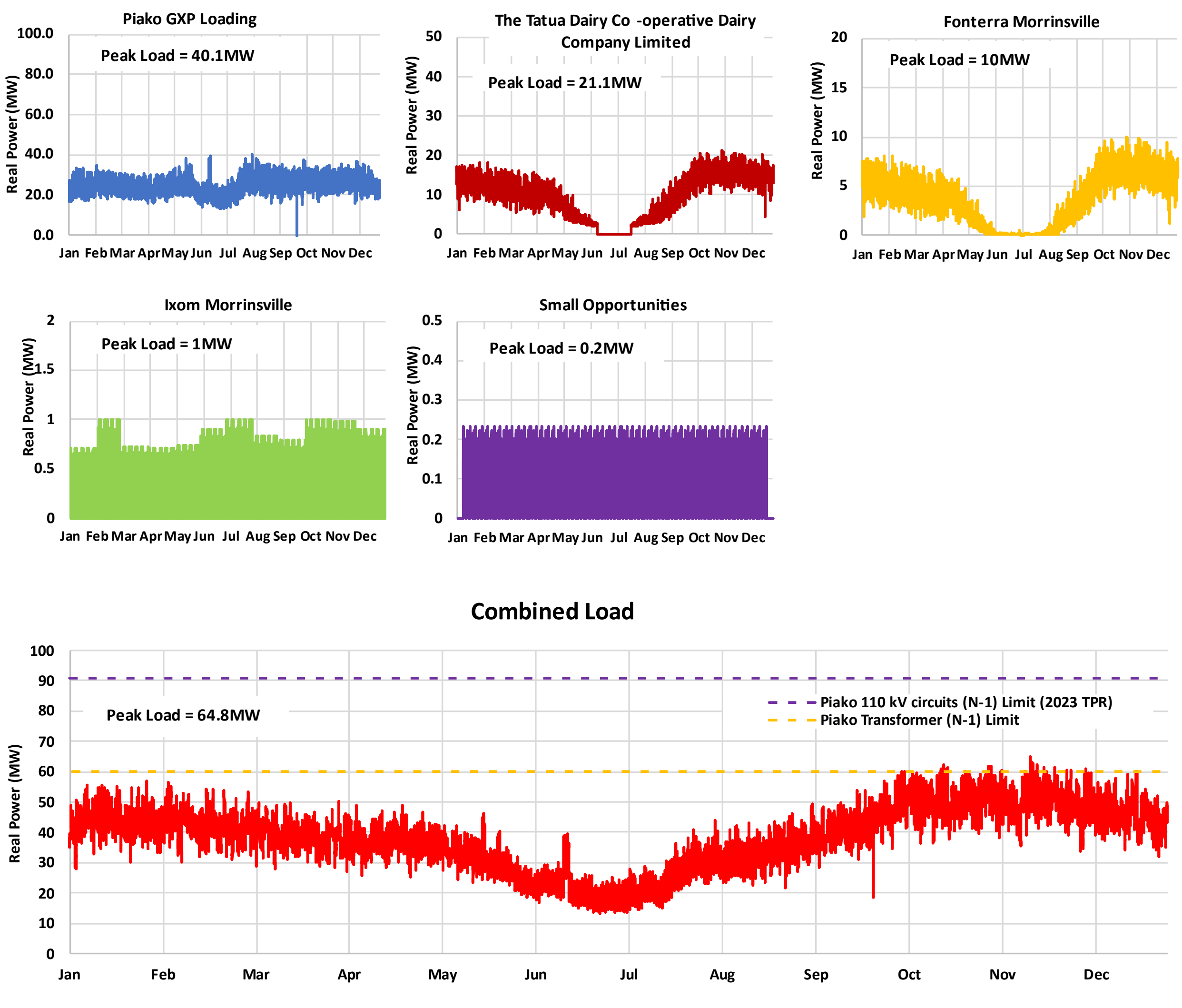


Figure 107. Loading Profiles: Piako GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.18 Rotorua GXP

One "Small" Load Site is connecting to the Rotorua GXP (refer to Section 8.18.1):

- Ministry of Education Reporoa College (0.18 MW)

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

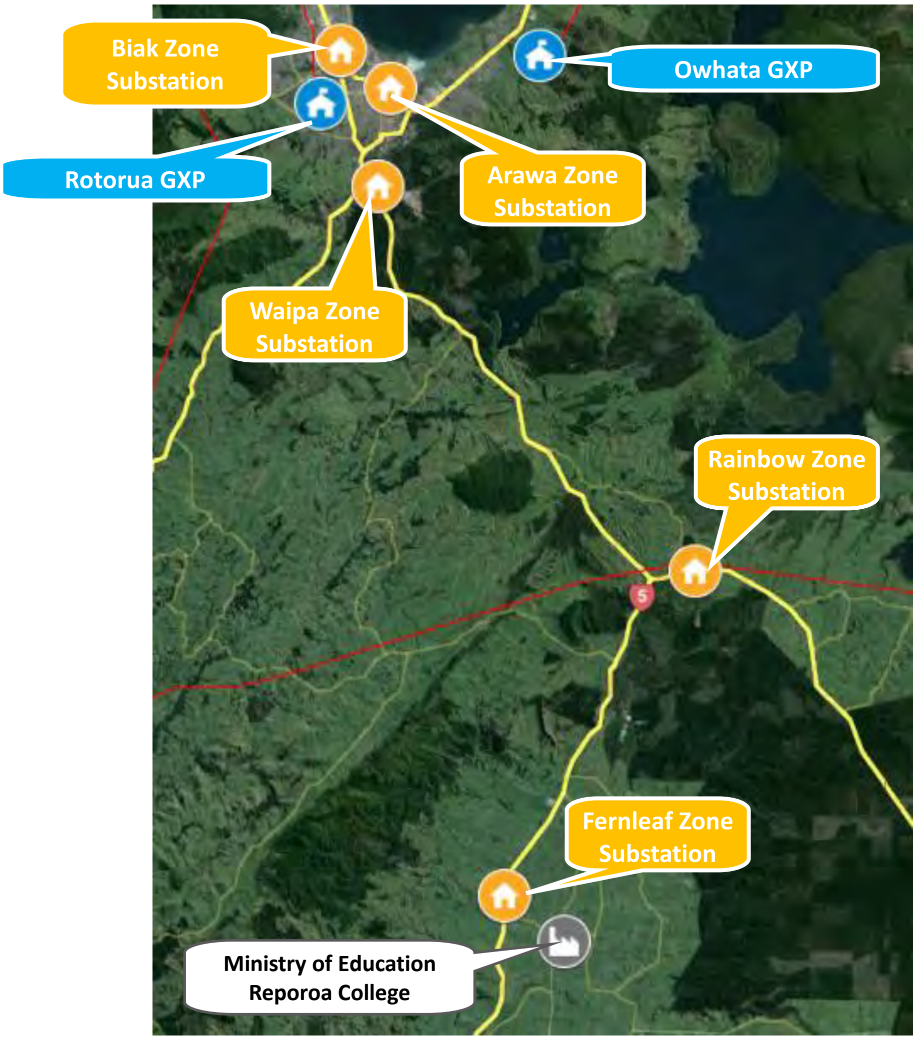


Figure 108. Rotorua GXP: EECA Load Sites vs local substations

Ergo notes that the Rotorua GXP sits within the Bay of Plenty region, however, this Load Site was added as a part of the Waikato region analysis. Due to its size, it is not expected to have a material impact on the GXP or the distribution network.

8.18.1 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 65. 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 Education Reporoa College	Fernleaf	N/A	11	Unknown	0.182	80

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.

8.19 Te Awamutu GXP

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

- Fonterra Te Awamutu (41.81 MW)
- Turners & Growers New Zealand Limited Ōhaupō (1.43 MW)
- Waikeria Prison (1.12 MW)

The "Small" Load Sites connecting to the Te Awamutu GXP include (refer to sections 8.19.5 and 8.19.6):

- Quality Mushrooms (0.34 MW)
- Te Awamutu College (0.30 MW)
- Waipā District Council Te Awamutu Events and Aquatic Centre (0.28 MW)

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

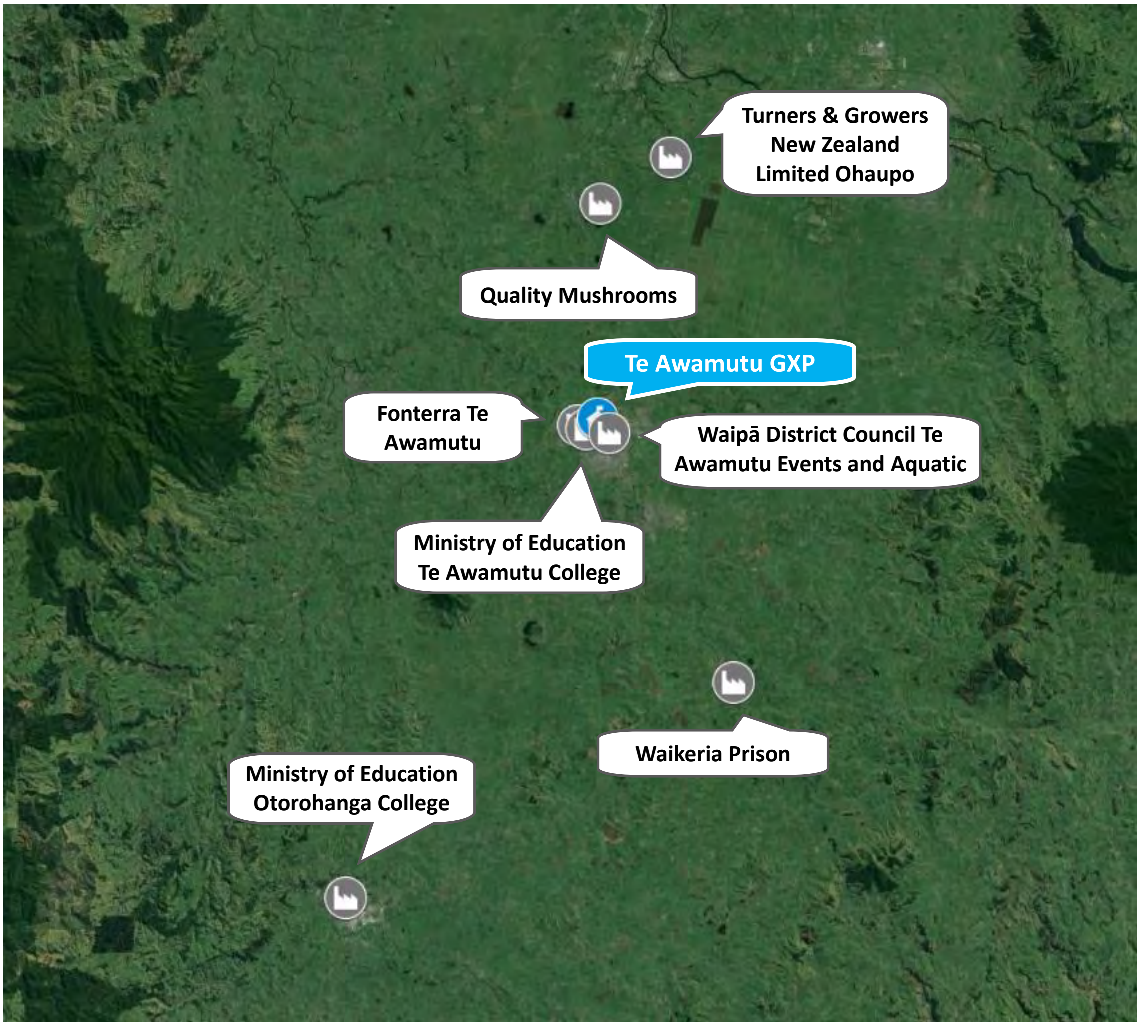


Figure 109. Te Awamutu GXP: EECA Load Sites

8.19.1 Te Awamutu GXP Upgrade

The Te Awamutu GXP presently has no spare (N-1) capacity and 40 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.19.7 indicates that the spare (N-1) capacity of the Te Awamutu GXP is expected to be exceeded if all the Load Sites connect. Therefore, upgrades of the Te Awamutu GXP are expected.

Additional to the transformer and circuit upgrades specified in the individual load analysis sections below, it is expected that installation of a second 110 kV Hangtiki-Te Awamutu circuit may be required if all Load Sites were connecting. It is also expected that additional voltage support may be required at the GXP, e.g. in the form of an 110 kV capacitor bank. These upgrades are expected to cost approx. $50.4M.

8.19.2 Fonterra Te Awamutu

FONTERRA TE AWAMUTU		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers and high temperature heat pumps	41.808	Te Awamutu
Existing Electrical Supply to the Plant		

Fonterra Te Awamutu is presently supplied by Transpower's Te Awamutu GXP via 2x Waipā Networks underground 11 kV feeders.

This site is located approximately 1.0 km from Te Awamutu GXP.

There is currently a maximum loading of 39.4 MVA on Te Awamutu GXP, with 40 MVA of spare (N) capacity and no spare (N-1) capacity.

Figure 110. Fonterra Te Awamutu geographic location in relation to the surrounding GXPs

Supply Option(s) for New Load

Due to the size of this load, analysis focusses on a staged approach to connecting the load. Ergo has used the staging MW values supplied by EECA for this site.

<u>Stage 1 - 21.4 MVA</u>

The first stage of Fonterra Te Awamutu adds an additional 21.4 MVA onto the existing load.

Te Awamutu has sufficient spare (N) capacity, but no spare (N-1) capacity for this load.

FONTERRA TE AWAMUTU

To achieve the required (N-1) capacity, the existing supply transformers would need to be updated/replaced. It is assumed that at the same time the transformers are upgraded, the associated switchboards would also be upgraded, as the switchboards are presently part of the capacity constraint issue. To achieve (N) security, it is assumed that a special protection scheme at the GXP would be required to protect remaining GXP Transformer in the event the other is offline.

Due to the size of the load, along with expected constraints of the transformers and 11 kV switchboard(s) at Te Awamutu GXP, it is suggested that a new zone substation would be established at the Fonterra site.

For an (N) security supply, this would involve installing 1x 110/33 kV transformer at the Te Awamutu GXP, and running 1x 33 kV circuit from the GXP to the Load Site. A single, ~24 MVA (33/11 kV), transformer zone substation would then be required at the site, with accompanying switchgear. Given the urban/industrial topography of the area, it is expected that any 33 kV feeders to the site would be underground and would be approximately 1.0 km long each.

For an (N-1) supply, in addition to the above, a second 110/33 kV transformer at the GXP, and second 33/11 kV transformer at the new zone substation, would both be required. A second 110 kV line from Te Awamutu GXP to Karapiro GXP would also be required.

Due to the size of the load, it is expected that 6x new 11 kV feeders from the new zone substation would be required for the project. To account for these in the costing, 0.5 km of cabling per feeder has been allowed for.

<u>Stage 2 - 42 MVA</u>

The second stage of Fonterra Te Awamutu adds an additional 20.4 MVA, bringing the total proposed load to 41.81 MVA.

For either an (N) or (N-1) security supply, it is expected that an additional transformer (and related 33 kV feeder from Te Awamutu) would be required at the new zone substation. Additionally, an additional 110 kV Te Awamutu-Karapiro line would also be required.

Due to the size of the load, it is expected that an additional 6x new 11 kV feeders from the new zone substation would be required for this stage. It is assumed that the switchroom installation in Stage 1 allowed space for these feeders, but that the additional circuit breakers would be installed at this stage.

Capital Cost Estimate

Table 66. Fonterra Te Awamutu Stage 1: Capital cost estimate to supply the Load Site with (N) subtransmission supply security.

Transmission =>	(N)	Subtransmission =>	(N)	Distribution =>	(N)

FONTERRA TE AWAMUTU

Network Asset	Equipment	Number and Capital Cost ($M)	
Transmission	Medium supply transformer (GXP)	1.00	$3.50
Transmission	110kV circuit breaker bay	1.00	$0.60
Subtransmission	Medium switchroom (ZSS)	1.00	$3.00
Subtransmission	Single underground 33kV cable	1.00	$0.90
Subtransmission	Medium supply transformer (ZSS)	1.00	$1.90
Distribution	Large switchroom (ZSS)	1.00	$4.00
Distribution	Single underground 11kV cable	3.00	$1.80
		TOTAL	**$15.70**

Table 67. Fonterra Te Awamutu 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	110kV circuit breaker bay	2.00	$1.20
Transmission	110kV single overhead line	24.00	$19.20
Transmission	Medium supply transformer (GXP)	2.00	$7.00
Transmission	110kV circuit breaker bay	2.00	$1.20
Subtransmission	Medium switchroom (ZSS)	1.00	$3.00
Subtransmission	Double underground 33kV cable	1.00	$1.40
Subtransmission	Medium supply transformer (ZSS)	2.00	$3.80
Distribution	Large switchroom (ZSS)	1.00	$4.00
Distribution	Single underground 11kV cable	3.00	$1.80
		TOTAL	**$42.60**

Table 68. Fonterra Te Awamutu Stage 2: Capital cost estimate to supply the Load Site.

Transmission => Stage 1	**Subtransmission => Stage 1**		**Distribution => (N)**
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	110kV circuit breaker bay	2.00	$1.20
Transmission	110kV single overhead line	24.00	$19.20
Transmission	Medium supply transformer (GXP)	2.00	$7.00
Transmission	110kV circuit breaker bay	2.00	$1.20
Subtransmission	Medium switchroom (ZSS)	1.00	$3.00
Subtransmission	Double underground 33kV cable	1.00	$1.40
Subtransmission	Medium supply transformer (ZSS)	2.00	$3.80
Distribution	11kV circuit breaker (ZSS)	6.00	$0.60
Distribution	Single underground 11kV cable	3.00	$1.80
		TOTAL	**$39.20**

FONTERRA TE AWAMUTU
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 the (N) security case, it is estimated to take the following periods to plan, design, procure, construct, and commission the works for each stage: • Stage 1 – 36-48 months • Stage 2 – 36-48 months For the (N-1) security case, it is estimated to take the following periods to plan, design, procure, construct, and commission the works for each stage: • Stage 1 – 36-48 months • Stage 2 – 36-48 months Excluded are any work required to establish the Load Site. Any land acquisition and consenting, if required, is excluded. Note that the establishment of a "firm" route for an overhead 110kV line that includes land purchase and consents can take as much as 5 years, which would be in addition to the times noted above.

8.19.3 Turners & Growers New Zealand Limited Ōhaupō

TURNERS & GROWERS NEW ZEALAND LIMITED ŌHAUPŌ		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New high temperature heat pumps	1.429	Te Awamutu
Existing Electrical Supply to the Plant		

Turners & Growers New Zealand Limited Ōhaupō is presently supplied by Waipawa Networks' Te Awamutu GXP via the 11 kV bus. The feeder presently supply Turners & Growers, Te Awamutu CB2752 (Mystery Creek), is presently loaded at a maximum of ~1.89 MVA.

This site is located approximately 11.5 km from Te Awamutu GXP.

There is currently a maximum loading of 39.4 MVA on Te Awamutu GXP, with 40 MVA of spare (N) capacity and no spare (N-1) capacity.

Figure 111. Turners & Growers New Zealand Limited Ōhaupō geographic location in relation to the surrounding GXPs

Supply Option(s) for New Load

The GXP does not have adequate spare (N-1) capacity for this load. However, it does have adequate (N) capacity.

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

For Te Awamutu GXP to reach the required spare (N-1) capacity, the branch limit which is presently limiting the transformer's supply capacity at the GXP would need to be removed/resolved.

The existing 11 kV feeder is expected to have adequate capacity for the increased load of the site and it is not expected that any conductors will require upgrading.

Capital Cost Estimate

Table 69. Turners & Growers New Zealand Limited Ōhaupō: 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
		TOTAL	**$0.50**

Table 70. Turners & Growers New Zealand Limited Ōhaupō: 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	Te Awamutu TX Branch Limit Upgrades	1.00	$0.60
		TOTAL	**$0.60**

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.

8.19.4 Waikeria Prison

WAIKERIA PRISON		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	1.120	Te Awamutu

Existing Electrical Supply to the Plant

Waikeria Prison is presently supplied by Waipawa Networks' Te Awamutu GXP via the 11 kV bus. The existing feeder supplying Waikeria Prison, Te Awamutu CB2852 (Waikeria) is presently loaded at a maximum of ~4.99 MVA.

This site is located approximately 12.2 km from Te Awamutu GXP.

There is currently a maximum loading of 39.4 MVA on Te Awamutu GXP, with 40 MVA of spare (N) capacity and no spare (N-1) capacity.

Figure 112. Waikeria Prison geographic location in relation to the surrounding GXPs

Supply Option(s) for New Load

The GXP does not have adequate spare (N-1) capacity for this load. However, it does have adequate (N) capacity.

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

For Te Awamutu GXP to reach the required spare (N-1) capacity, the branch limit which is presently limiting the transformer's supply capacity at the GXP would need to be removed/resolved.

WAIKERIA PRISON

Due to the size of the site and the existing load on the feeder, 1x new 11 kV feeder and associated circuit breaker may be required. Due to the urban/industrial topography of part of the route, this would likely be a combination of overhead line and underground cable, at a length of 13.5 km.

Capital Cost Estimate

Table 71. Waikeria 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)**	
Distribution	Special protection system (GXP)	1.00	$0.50
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	2.50	$1.50
Distribution	Single overhead 11kV line	11.00	$2.75
		TOTAL	**$4.85**

Table 72. Waikeria 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	Te Awamutu TX Branch Limit Upgrades	1.00	$0.60
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	2.50	$1.50
Distribution	Single overhead 11kV line	11.00	$2.75
		TOTAL	**$4.95**

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 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.

8.19.5 Small Opportunities

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

Table 73. 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)
Quality Mushrooms	N/A	N/A	N/A	1.89	0.342	130
Te Awamutu College	N/A	N/A	N/A	4.12	0.302	130
Waipā District Council Te Awamutu Events and Aquatic Centre	N/A	N/A	N/A	5.48	0.275	130

Ergo notes that due to high feeder loadings for some of these feeders, Ergo has carried out checks of the actual increase in feeder loading for these feeders, similar to analysis carried out at the GXP level in Section 8.19.7, to confirm that feeder loading would stay within acceptable limits.

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.

8.19.6 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Te Awamutu GXP gives a combined load of 1.09 MW. When the load shapes are combined, they result in the following load shape (Figure 113), with a maximum load of 0.80 MW, with a diversity factor of 0.87.

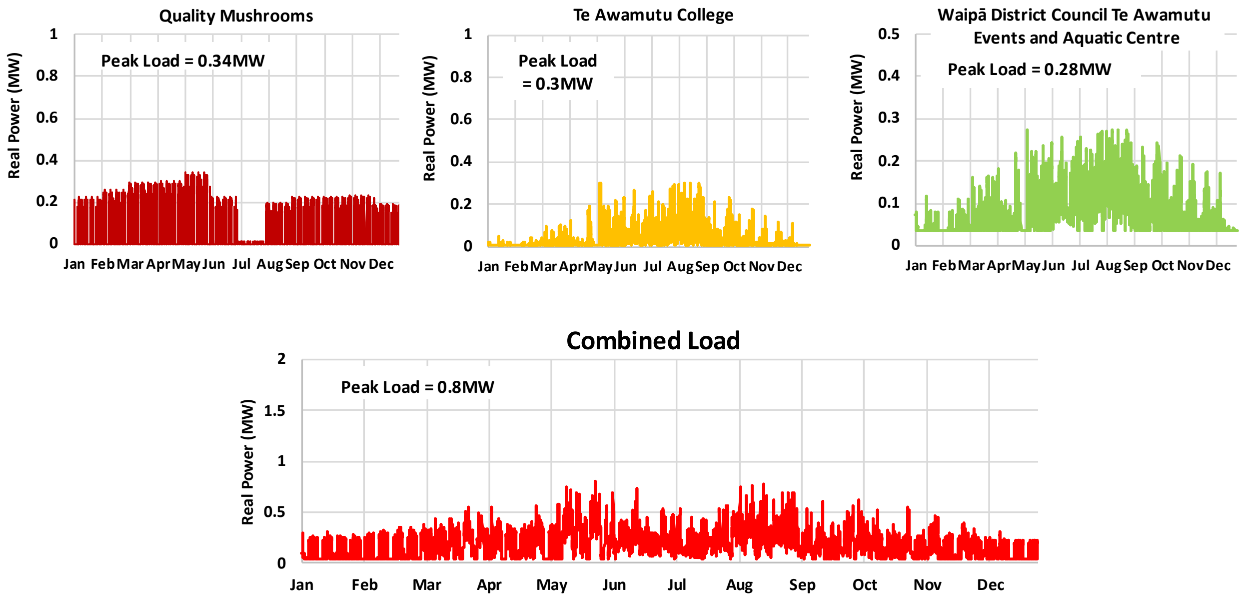


Figure 113. Loading Profiles: Te Awamutu GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.19.7 Effect of all Load Sites Connecting to Te Awamutu GXP

The following Figure 114 illustrates the Te Awamutu GXP load profile together with the load profiles of all the Load Sites within the Te Awamutu GXP region. Also shown in Figure 114 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Te Awamutu GXP would increase to 71.82 MW, an increase of 32.42 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 84.55 MW there is a diversity factor of 0.85 between the loads.
- Based on Ergo's analysis, the Te Awamutu GXP's (N-1) limit is expected to be exceeded. Ergo has discussed mitigation for this in Section 8.19.1.

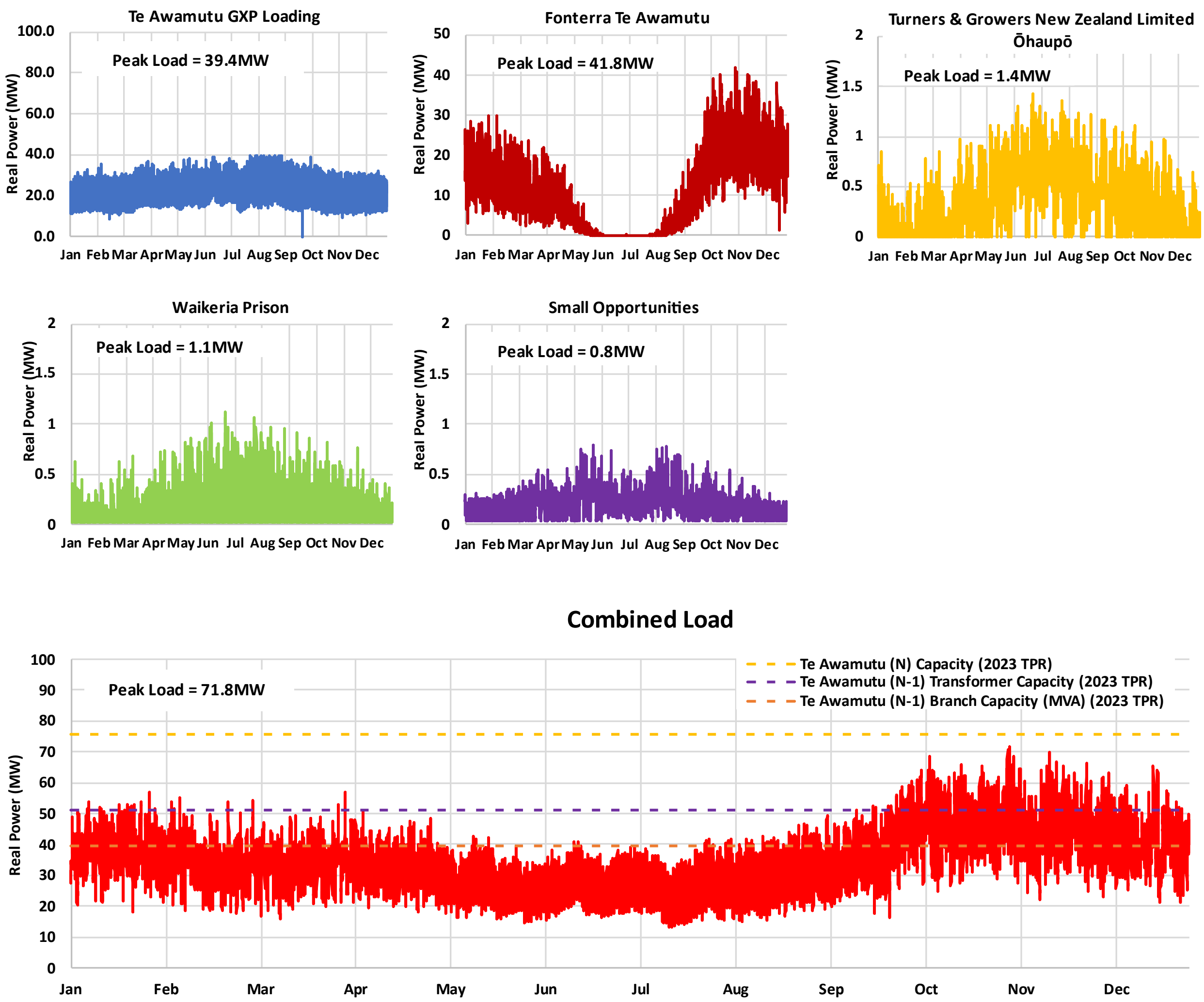


Figure 114. Loading Profiles: Te Awamutu GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.20Te Kowhai GXP

The “Large” EECA Load Sites connecting to the Te Kowhai GXP include:

- Fonterra Te Rapa (99.54 MW)
- Fulton Hogan Limited Hamilton (12.78 MW)
- AFFCO Horotiu (7.16 MW)
- Alsco New Zealand Hamilton (1.96 MW)
- Bowers Brothers Concrete Horotiu Masonry Plant (1.18 MW)

The “Small” Load Sites connecting to the Te Kowhai GXP include (refer to sections 8.20.7 and 8.20.9):

- Humes Hamilton Pipe and Precast Plant (0.58 MW)
- Milkio Foods Limited Hamilton (0.39 MW)
- Pukete Wastewater Treatment Plant (0.13 MW)

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

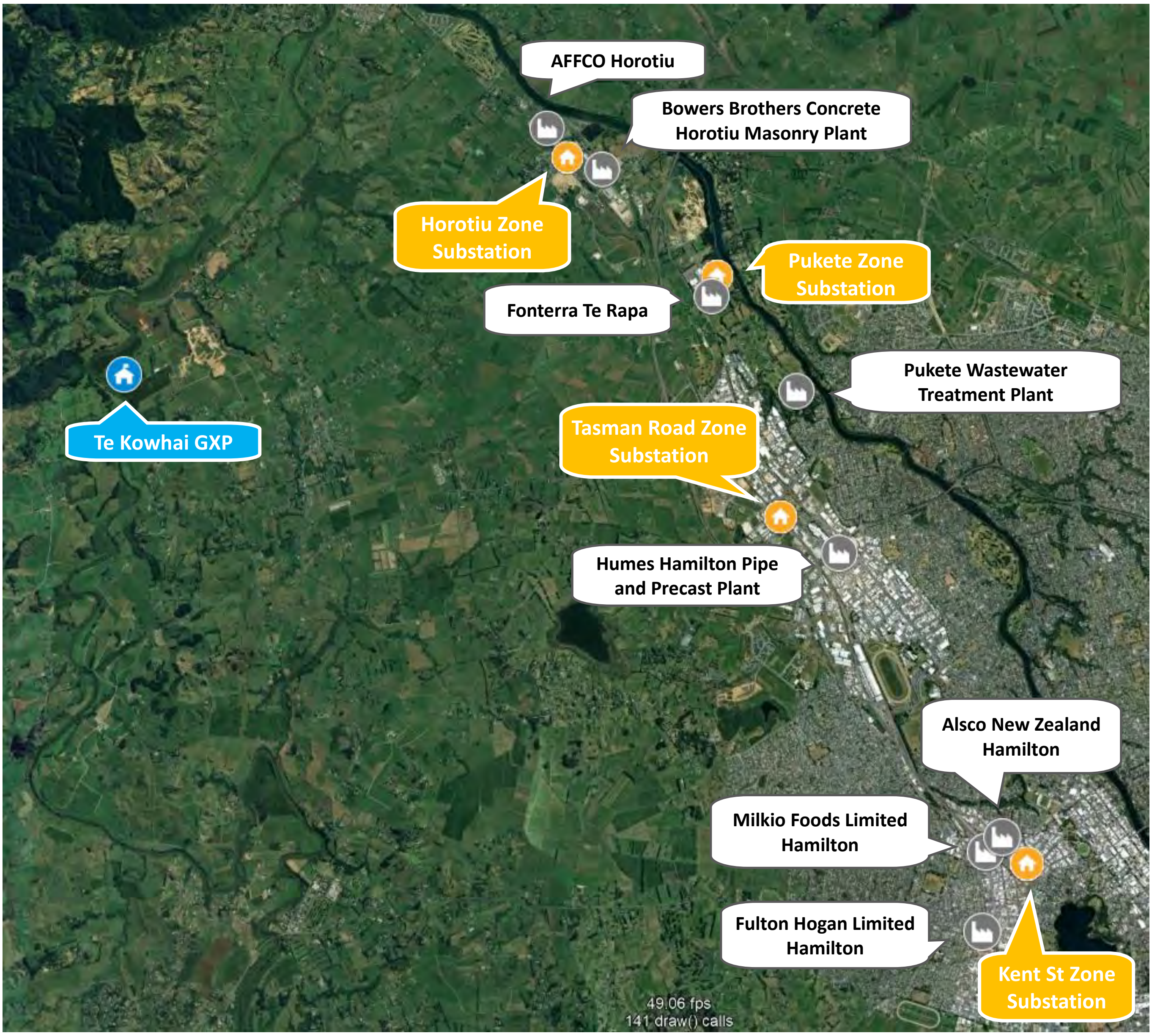


Figure 115. Te Kowhai GXP: EECA Load Sites vs local substations

8.20.1 Te Kowhai GXP Upgrade

The Te Kowhai GXP presently has 24 MVA of spare (N-1) capacity and 122 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.20.10 indicates that the spare (N-1) capacity of the Te Kowhai GXP is expected to be exceeded if all the Load Sites connect.

It is expected that the upgrades at Te Kowhai included as part of the individual Load Site analysis below would be sufficient to supply all of the connecting loads. If Fonterra Te Rapa connects, with a proposed new GXP, it is possible that some load may also be offloaded to the new GXP. The costs of these upgrades may be shared between the loads in the case that multiple connect.

8.20.2 Fonterra Te Rapa

FONTERRA TE RAPA		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	99.542	Te Kowhai
Existing Electrical Supply to the Plant		

Fonterra Te Rapa is presently supplied by WEL Networks' Pukete - Anchor substation via a number of 11 kV feeders. Pukete - Anchor is in turn supplied from Te Kowhai GXP by two 33 kV subtransmission circuits. The subtransmission circuits are rated to approximately 680 A (38.9 MVA) and 760 A (43.4 MVA). The Pukete substation is presently equipped with 2x 3-winding transformers which each provide the Anchor supply with 30 MVA capacity.

This site is located approximately 0.4 km from Pukete - Anchor zone substation. In turn, Pukete - Anchor zone substation is approximately 8.6 km from Te Kowhai GXP.

There is currently a maximum loading of 18 MVA on Pukete - Anchor zone substation, with 42 MVA of spare (N) capacity and 12 MVA of spare (N-1) capacity. Te Kowhai GXP presently has 122 MVA of spare (N) capacity and 24 MVA of spare (N-1) capacity.

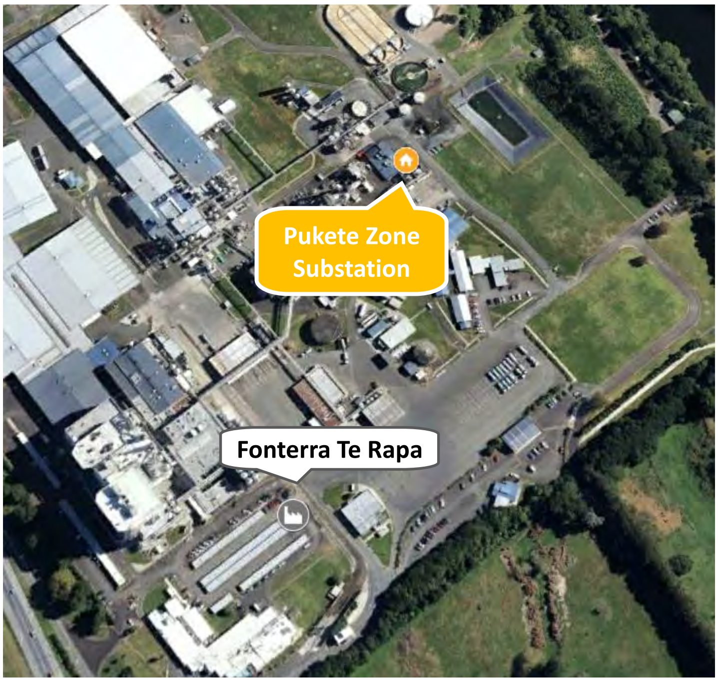


Figure 116. Fonterra Te Rapa geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Due to the size of the load, analysis focusses on a staged approach to connect the load. For this Site, the staging provided by EECA has been adjusted by Ergo to better match the electrical system constraints.

FONTERRA TE RAPA

Stage 1 - 12 MVA

The second stage of Fonterra Te Rapa adds an additional 5 MVA, bringing the total proposed load to 12 MVA.

Pukete-Anchor zone substation and Te Kowhai GXP both have adequate (N) and (N-1) capacity for this load.

Due to the size of the load, it is expected that 3x new 11 kV feeders from Anchor-Pukete zone substation will be required for this stage. Given the industrial topography of the area, it is expected that these feeders would be underground, and would be approximately 1.7 km long.

Stage 2 - 43 MVA

The third stage of Fonterra Te Rapa adds an additional 31 MVA, bringing the total load proposed to 43 MVA.

Pukete-Anchor does not have spare (N) or (N-1) capacity for this load. Te Kowhai has (N) capacity, but not (N-1) capacity. Additionally, this load will exceed the circuit capacity of one of the sub-transmission circuits (38.9 MVA).

Due to the scale of zone substation or subtransmission upgrades that would be required at this stage (i.e. upgrades to the subtransmission circuits between Pukete and Te Kowhai, and upgrades of the transformers at Te Kowhai, as well as zone substation transformer and switchboard upgrades), it is instead suggested that at this stage a new GXP would be established adjacent to the Load Site, with the Load Site now taking supply at either 33 kV or 11 kV.

For an (N) supply, this would include installation of one new 220 kV circuit from Te Kowhai to the site, establishing a new GXP with one 220/11 or 220/33 kV transformer and associated switchboards. For an (N-1) supply, a second 220 kV circuit from Te Kowhai to the new GXP would be required, and a second transformer would also be required at the GXP. It is assumed that the new 220 kV circuits are sized to accommodate the future Stage 4 load as well.

Also included in the pricing is 2 km of underground 33 kV cabling from the new GXP to the Load Site, which may vary depending on the actual location of the new GXP.

Ergo notes that as Stage 2 establishes a new GXP, previous stages are not required to be completed before Stage 3 is carried out – there may be cost savings possible if the Load Site were to jump straight to Stage 2.

Stage 3 – 99.542 MVA

The fourth stage of Fonterra Te Rapa adds an additional 56.542 MVA, increasing the total proposed load to 99.542 MVA.

At this stage, for an (N) supply, a second medium-sized transformer and associated switchboard would be required at the GXP established in Stage 3.

For an (N-1) supply, it is expected that at this stage the two transformers installed at the new GXP in Stage 3 would be paralleled to form one large "Transformer bank", and one additional large transformer installed at the new GXP, with associated switchboard.

Again, also included in the pricing is 2 km of underground 33 kV cabling from the new GXP to the Load Site, which may vary depending on the actual location of the new GXP.

Capital Cost Estimate

Table 74. Fonterra Te Rapa 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)**	
Distribution	11kV circuit breaker (ZSS)	3.00	$0.30
Distribution	Single underground 11kV cable	5.10	$3.06
		TOTAL	**$3.36**

Table 75. Fonterra Te Rapa 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	220kV circuit breaker bay	8.00	$8.00
Transmission	220kV double cct line	12.00	$24.00
Transmission	Medium supply transformer (GXP)	2.00	$7.00
Transmission	Medium switchroom (ZSS)	2.00	$6.00
Distribution	Single underground 33kV cable	2.00	$1.80
		TOTAL	**$46.80**

FONTERRA TE RAPA

Table 76. Fonterra Te Rapa 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	220kV circuit breaker bay	4.00	$4.00
Transmission	220kV single cct line	12.00	$14.40
Transmission	Medium supply transformer (GXP)	1.00	$3.50
Transmission	Medium switchroom (ZSS)	1.00	$3.00
Distribution	Single underground 33kV cable	2.00	$1.80
		TOTAL	**$26.70**

Table 77. Fonterra Te Rapa Stage 3: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Medium supply transformer (GXP)	1.00	$3.50
Transmission	220kV circuit breaker bay	2.00	$2.00
Transmission	Medium switchroom (ZSS)	1.00	$3.00
Distribution	Single underground 33kV cable	2.00	$1.80
		TOTAL	**$10.30**

Table 78. Fonterra Te Rapa Stage 3: 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	Large supply transformer (GXP)	1.00	$4.50
Transmission	220kV circuit breaker bay	3.00	$3.00
Transmission	Medium switchroom (ZSS)	1.00	$3.00
Distribution	Single underground 33kV cable	2.00	$1.80
		TOTAL	**$12.30**

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

FONTERRA TE RAPA
Timeframe to Establish New Electrical Infrastructure
For the (N) security case, it is estimated to take the following periods to plan, design, procure, construct, and commission the works for each stage: • Stage 1 – 12-18 months • Stage 2 – 36-48 months • Stage 3 – 36-48 months For the (N-1) security case, it is estimated to take the following periods to plan, design, procure, construct, and commission the works for each stage: • Stage 1 – 12-18 months • Stage 2 – 36-48 months • Stage 3 – 36-48 months Excluded are any work required to establish the Load Site. Any land acquisition and consenting, if required, is excluded.

8.20.3 Fulton Hogan Limited Hamilton

FULTON HOGAN LIMITED HAMILTON		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	12.779	Te Kowhai
Existing Electrical Supply to the Plant		

Fulton Hogan Limited Hamilton is presently supplied by WEL Networks' Kent St substation via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Kent St is in turn supplied from Te Kowhai GXP (via Avalon Dr) by two 33 kV subtransmission circuits. The subtransmission circuits are rated to approximately 680 A (38.9 MVA) each. Kent St zone substation is presently equipped with 2x 23 MVA transformers.

This site is located approximately 1.2 km from Kent St zone substation. In turn, Kent St zone substation is approximately 14.3 km from Te Kowhai GXP.

There is currently a maximum loading of 16 MVA on Kent St zone substation, with 30 MVA of spare (N) capacity and 7 MVA of spare (N-1) capacity. Te Kowhai GXP presently has 122 MVA of spare (N) capacity and 24 MVA of spare (N-1) capacity.

Figure 117. Fulton Hogan Limited Hamilton geographic location in relation to the surrounding zone substations

FULTON HOGAN LIMITED HAMILTON

Supply Option(s) for New Load

Kent St zone substation has adequate spare (N) capacity but lacks in spare (N-1) capacity. The GXP has adequate (N) and (N-1) capacity for this load.

For an (N-1) condition, 1x new 33 kV feeder from Te Kowhai to Kent St and associated circuit breakers would be required. This feeder is expected to be a combination of overhead line and underground cable. Additionally, transformer replacements would be required at Kent St zone substation.

As per the supplied PowerFactory model, the existing maximum 11 kV feeder loading on Kent St zone substation is approximately 1.30 MVA. Due to the size of the load, 2x new 11 kV feeders and associated circuit breakers would likely be required to supply the additional load. Due to the urban/industrial topography of the area, these would likely be underground cables, at a length of 2.5 km (following the existing cable routes).

Capital Cost Estimate

Table 79. Fulton Hogan Limited Hamilton: 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	2.50	$2.00
		TOTAL	**$2.20**

Table 80. Fulton Hogan Limited Hamilton: 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)	2.00	$4.60
Subtransmission	33kV circuit breaker (ZSS)	1.00	$0.30
Subtransmission	Single overhead 33kV line	10.00	$3.50
Subtransmission	Single underground 33kV cable	10.00	$9.00
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	2.50	$2.00
		TOTAL	**$19.60**

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

FULTON HOGAN LIMITED HAMILTON
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 12-24 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.

8.20.4 AFFCO Horotiu

AFFCO HOROTIU		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	7.161	Te Kowhai
Existing Electrical Supply to the Plant		

AFFCO Horotiu is presently supplied by WEL Networks' Horotiu substation via two 11 kV feeders which consist of a mixture of underground cable and overhead line. Horotiu is in turn supplied from Te Kowhai GXP by a number of 33 kV subtransmission circuits in a meshed configuration with the other nearby substations (e.g. Gordonton, Ngaruawahia). Horotiu zone substation is presently equipped with 2x 18 MVA transformers.

This site is located approximately 0.6 km from Horotiu zone substation. In turn, Horotiu zone substation is approximately 7.1 km from Te Kowhai GXP.

There is currently a maximum loading of 20 MVA on Horotiu zone substation, with 16 MVA of spare (N) capacity and -2 MVA of spare (N-1) capacity. Te Kowhai GXP presently has 122 MVA of spare (N) capacity and 24 MVA of spare (N-1) capacity.

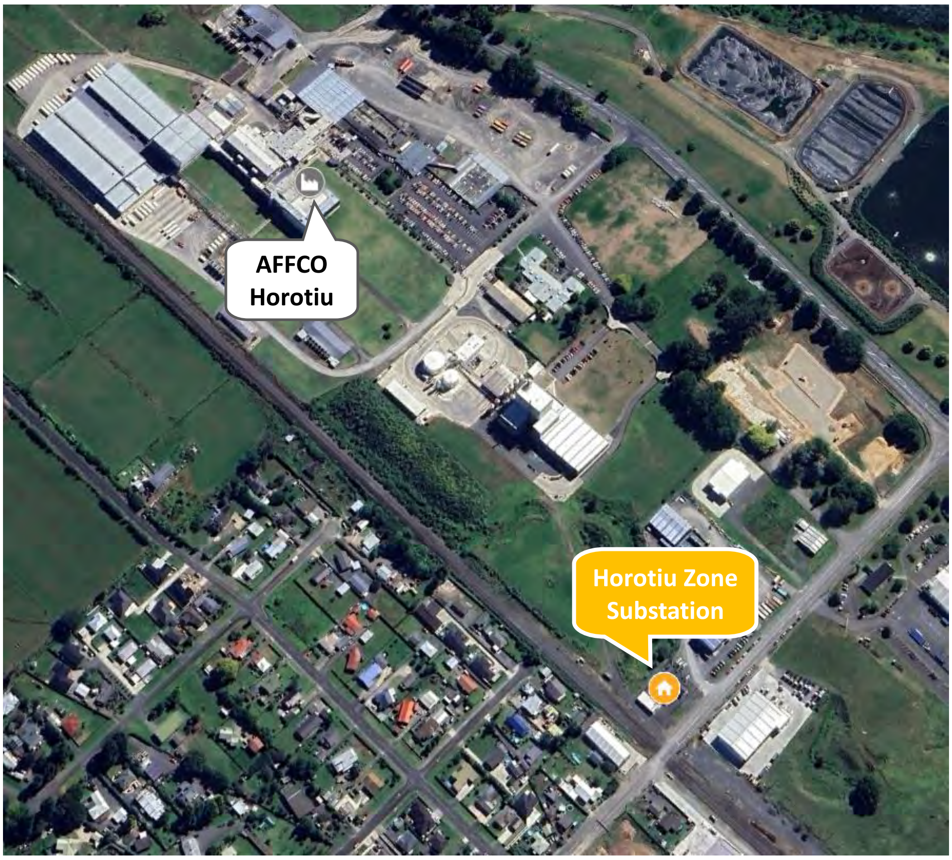


Figure 118. AFFCO Horotiu geographic location in relation to the surrounding zone substations

AFFCO HOROTIU

Supply Option(s) for New Load

Horotiu zone substation has adequate spare (N) capacity but lacks in spare (N-1) capacity. To mitigate this, transformer replacements would be required at Horotiu substation for an (N-1) security supply.

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

Due to the size of the load, 2x new feeders and associated circuit breakers will likely be required to supply the load. Due to the urban/industrial topography of the area, these would likely be underground cables, at a length of 0.9 km (following existing cable routes).

Capital Cost Estimate

Table 81. AFFCO Horotiu: 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	0.90	$0.72
		TOTAL	**$0.92**

Table 82. AFFCO Horotiu: 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)	2.00	$4.60
Subtransmission	33kV circuit breaker (ZSS)	1.00	$0.30
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	0.90	$0.72
		TOTAL	**$5.82**

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 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.

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

8.20.5 Alsco New Zealand Hamilton

ALSCO NEW ZEALAND HAMILTON		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	1.961	Te Kowhai
Existing Electrical Supply to the Plant		

Alsco New Zealand Hamilton is presently supplied by WEL Networks' Kent St substation via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Kent St is in turn supplied from Te Kowhai GXP (via Avalon Dr) by two 33 kV subtransmission circuits. The subtransmission circuits are rated to approximately 680 A (38.9 MVA) each. Kent St zone substation is presently equipped with 2x 23 MVA transformers.

This site is located approximately 0.6 km from Kent St zone substation. In turn, Kent St zone substation is approximately 14.3 km from Te Kowhai GXP.

There is currently a maximum loading of 16 MVA on Kent St zone substation, with 30 MVA of spare (N) capacity and 7 MVA of spare (N-1) capacity. Te Kowhai GXP presently has 122 MVA of spare (N) capacity and 24 MVA of spare (N-1) capacity.

Figure 119. Alsco New Zealand Hamilton geographic location in relation to the surrounding zone substations

ALSCO NEW ZEALAND HAMILTON

Supply Option(s) for New Load

Both Kent St zone substation and Te Kowhai GXP's current spare (N) and (N-1) capacities are adequate for this scenario. Therefore, no upgrades are expected at these sites for the additional load.

The existing feeder loading is not known to Ergo. As such, it has been assumed that, due to the size of the load, 1x new feeder and associated circuit breaker would be required. Due to the urban/industrial topography of the area, this would likely be an underground cable, at a length of 0.8 km (following the existing cable route).

Capital Cost Estimate

Table 83. Alsco New Zealand Hamilton: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

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

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 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.

8.20.6 Bowers Brothers Concrete Horotiu Masonry Plant

		BOWERS BROTHERS CONCRETE HOROTIU MASONRY PLANT
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers	1.182	Te Kowhai
Existing Electrical Supply to the Plant		

Bowers Brothers Concrete Horotiu Masonry Plant is presently supplied by WEL Networks' Horotiu substation via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Horotiu is in turn supplied from Te Kowhai GXP by a number of 33 kV subtransmission circuits in a meshed configuration with the other nearby substations (e.g. Gordonton, Ngaruawahia). Horotiu zone substation is presently equipped with 2x 18 MVA transformers.

This site is located approximately 0.6 km from Horotiu zone substation. In turn, Horotiu zone substation is approximately 7.1 km from Te Kowhai GXP.

There is currently a maximum loading of 20 MVA on Horotiu zone substation, with 16 MVA of spare (N) capacity and -2 MVA of spare (N-1) capacity. Te Kowhai GXP presently has 122 MVA of spare (N) capacity and 24 MVA of spare (N-1) capacity.

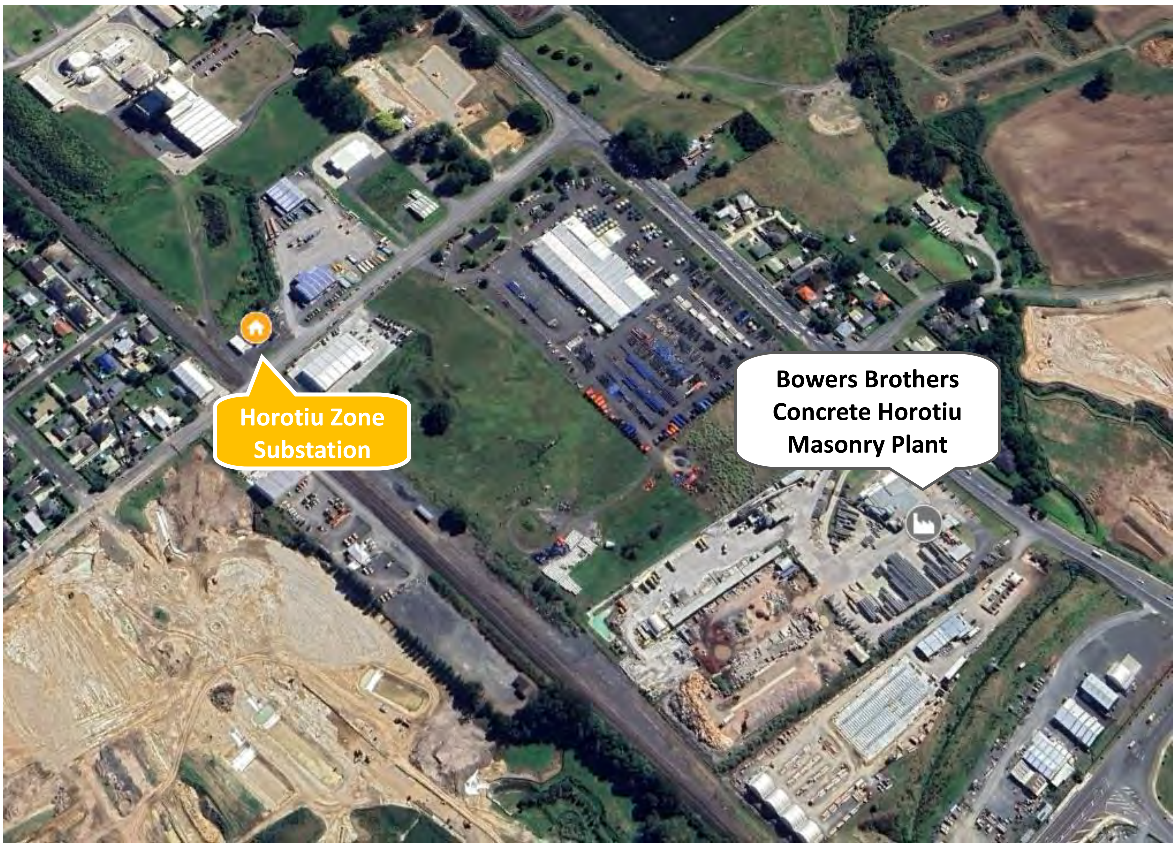


Figure 120. Bowers Brothers Concrete Horotiu Masonry Plant geographic location in relation to the surrounding zone substations

BOWERS BROTHERS CONCRETE HOROTIU MASONRY PLANT

Supply Option(s) for New Load

Horotiu zone substation has adequate spare (N) capacity but lacks in spare (N-1) capacity. The GXP's current spare (N) and (N-1) capacity is adequate for the supply scenario. Therefore, no GXP upgrades are expected for this load.

For an (N-1) condition, transformer replacements would be required at Horotiu zone substation.

Due to the size of the load, 1x new feeder and associated circuit breaker may be required. This would likely be an underground cable, at a length of 1.0 km (following the existing cable route).

Capital Cost Estimate

Table 84. Bowers Brothers Concrete Horotiu Masonry Plant: 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)**	
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	1.00	$0.60
		TOTAL	**$0.70**

Table 85. Bowers Brothers Concrete Horotiu Masonry 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	Large supply transformer (ZSS)	2.00	$4.60
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	1.00	$0.60
		TOTAL	**$5.30**

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 6-12 months for an (N) security scenario and 24-36 months for an (N-1) security scenario 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.

8.20.7 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 86. 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)
Humes Hamilton Pipe and Precast Plant	Tasman Road	4	30	Unknown	0.576	200
Milkio Foods Limited Hamilton	Kent St	7	30	0.85	0.387	130
Pukete Wastewater Treatment Plant	Tasman Road	4	30	0.79	0.125	80

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.

8.20.8 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.

8.20.8.1 Kent St

Three of the loads on Te Kowhai GXP are expected to connect to Kent St zone substation. The loads are Fulton Hogan Limited Hamilton, Alsco New Zealand Hamilton, and Milkio Foods Limited Hamilton. The sum of peaks of these loads is 15.13 MW, which the zone substation doesn't have (N-1) capacity for. Therefore, upgrades at Kent St are expected.

The zone substation upgrades specified in the individual Load Site analysis above for Fulton Hogan Limited Hamilton and Alsco New Zealand Hamilton are considered adequate for all of the connecting loads. Should multiple Load Sites connect, the costs of the zone substation upgrades may be shared.

8.20.8.2 Horotiu

Two of the loads on Te Kowhai GXP are expected to connect to Horotiu zone substation. The loads are AFFCO Horotiu, and Bowers Brothers Concrete Horotiu Masonry Plant. The sum of peaks of these loads is 8.34 MW, which the zone substation doesn't have (N-1) capacity for. Therefore, upgrades at Horotiu are expected.

The zone substation upgrades specified in the individual Load Site analysis above for AFFCO Horotiu and Bowers Brothers Concrete Horotiu are considered adequate for all of the connecting loads. Should multiple Load Sites connect, the costs of the zone substation upgrades may be shared.

8.20.8.3 Tasman Road

Two of the loads on Te Kowhai GXP are expected to connect to Tasman Road zone substation. The loads are Humes Hamilton Pipe and Precast Plant, and Pukete Wastewater Treatment Plant. The sum of peaks of these loads is 0.7 MW, which the zone substation does have (N-1) capacity for. Therefore, upgrades at Tasman Road are not considered.

8.20.9 Combined Load of Small Opportunities

Summing the maximum values of the "small" loads on Te Kowhai GXP gives a combined load of 1.09 MW. When the load shapes are combined, they result in the following load shape (Figure 121), with a maximum load of 1.09 MW, with a diversity factor of 1.

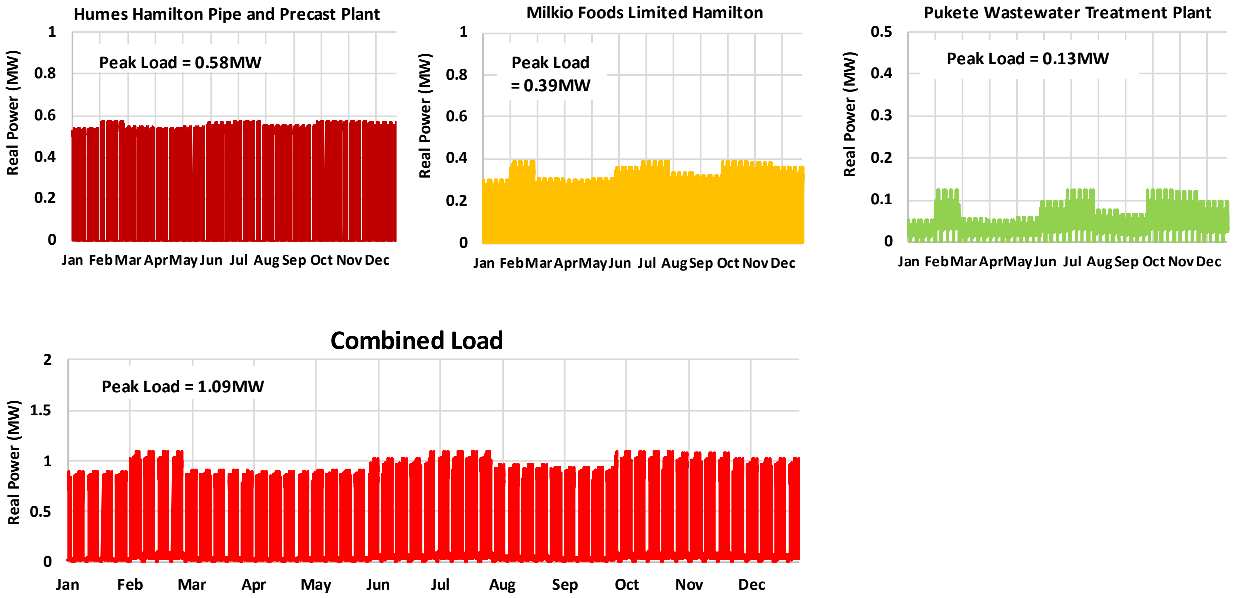


Figure 121. Loading Profiles: Te Kowhai GXP "small" Load Site Profiles: Combined Load (sum of all profiles)

8.20.10 Effect of all Load Sites Connecting to Te Kowhai GXP

The following Figure 122 illustrates the Te Kowhai GXP load profile together with the load profiles of all the Load Sites within the Te Kowhai GXP region. Also shown in Figure 122 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Te Kowhai GXP would increase to 200.90 MW, an increase of 7.41 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 231.51 MW there is a diversity factor of 0.87 between the loads.
- Ergo notes that the Te Uku wind farm is connected to the Te Kowhai GXP. As this is wind generation, and is therefore unreliable for base load, any contribution from the generation has been excluded from the below graph.
- Based on Ergo's analysis, the Te Kowhai GXP's (N-1) limit is expected to be exceeded. Ergo has discussed mitigation for this in Section 8.20.1.

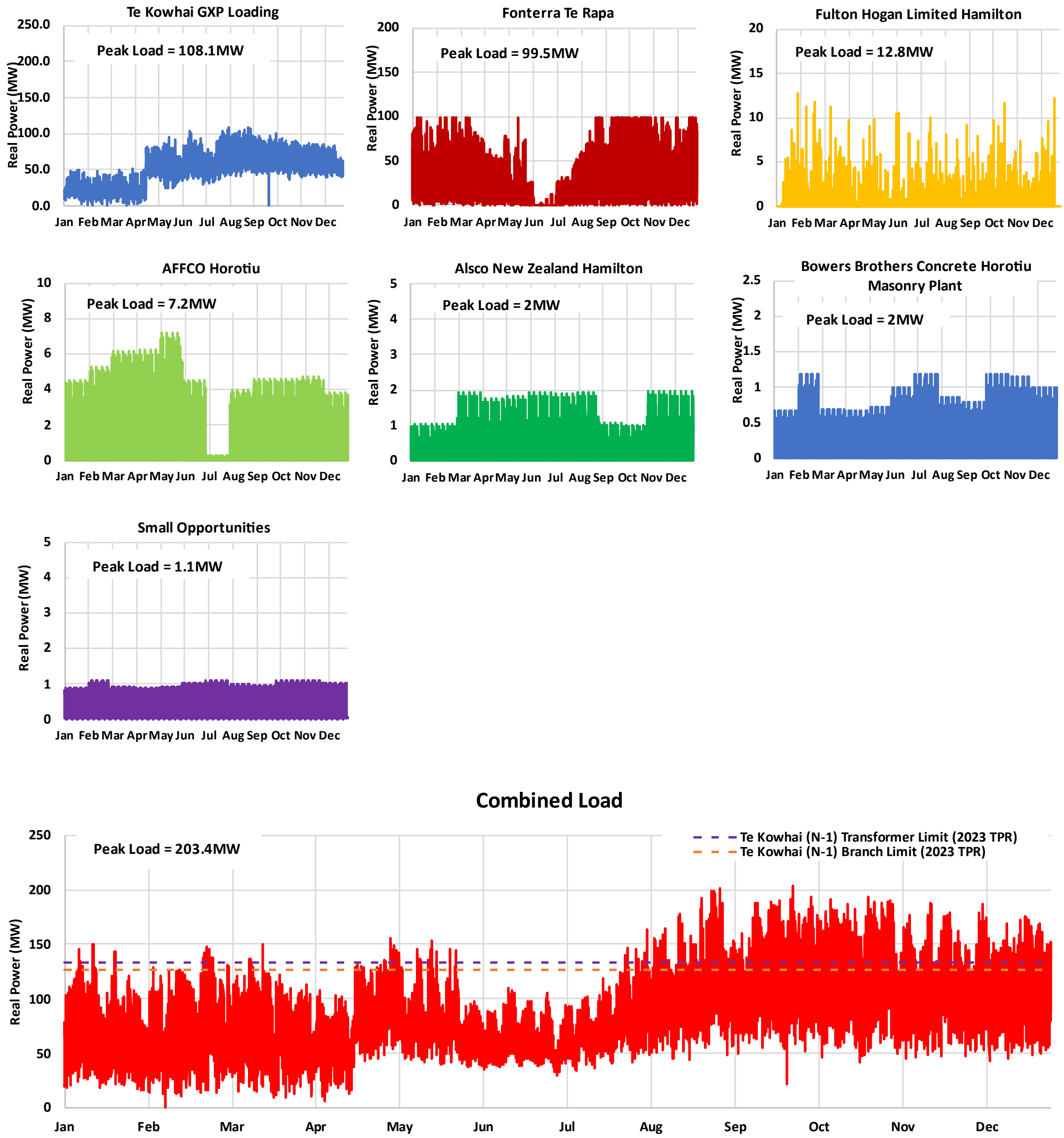


Figure 122. Loading Profiles: Te Kowhai GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.21 Tokaanu GXP

One "Large" EECA Load Site is connecting to the Tokaanu GXP:

- Tongariro Prison (12.21 MW)

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

Figure 123. Tokaanu GXP: EECA Load Sites vs local substations

8.21.1 Tokaanu GXP Upgrade

The Tokaanu GXP presently has 9.44 MVA of spare capacity (N or N-1, as this is a switched supply that can only be supplied by one of the GXP transformers at a time), based on the transformer ratings.

Analysis in Section 8.21.3 indicates that the spare (N-1) capacity of the Tokaanu GXP is expected to be exceeded if all the Load Sites connect. Therefore, upgrades to Tokaanu GXP are expected.

With only one Load Site connecting, any required GXP upgrades are discussed in the Load Site analysis below.

8.21.2 Tongariro Prison

TONGARIRO PRISON		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	12.208	Tokaanu
Existing Electrical Supply to the Plant		

Tongariro Prison is presently supplied by The Lines Company's Waiotaka substation via an 11 kV feeder which consists of a mixture of underground cable and overhead line. Waiotaka is in turn supplied from Tokaanu GXP by a single 33 kV subtransmission circuit. Waiotaka substation is presently equipped with a single 2 MVA transformer, which affords the site (N) security only.

This site is located approximately 2.2 km from Waiotaka zone substation. In turn, Waiotaka zone substation is approximately 5.7 km from Tokaanu GXP.

There is currently a maximum loading of 2.2 MVA on Waiotaka zone substation, with -0.2 MVA of spare (N) capacity. Tokaanu GXP presently has 9.44 MVA of spare capacity.

Figure 124. Tongariro Prison geographic location in relation to the surrounding zone substations

TONGARIRO PRISON
Supply Option(s) for New Load
Waiotaka zone substation does not have adequate (N) or (N-1) spare capacity. Tokaanu GXP has adequate (N) but not (N-1) spare capacity for this load. It is expected that for an (N) or (N-1) security supply, the zone substation would require a rebuild. For an (N) security scenario, this is represented by a "small" zone substation in the costings, or a "medium" zone substation for (N-1). For either security of supply, the existing Waiotaka-Tokaanu 33 kV line would require upgrades/replacments. For Waiotaka zone substation to accommodate an (N-1) condition, a new 33 kV feeder from Tokaanu GXP would be required. This is assumed to be overhead, and ~6.1 km long, matching the existing line. To accommodate an (N) capacity condition at the GXP, it is expected that one of the GXP transformers (the one usually in service) would require replacement with a larger unit. For Tokaanu GXP to reach the required spare (N-1) capacity, both existing GXP transformers would require replacements. Replacing the two transformers may allow the GXP to provide (N-1) security instead of (switched N-1) security, however this should be confirmed with Transpower. Existing feeder loading is not known. However, due to the size of the load, 2x new feeders and associated circuit breakers may be required. Due to the rural topography of the area, these would likely be overhead lines, at a length of 1.8 km (following the existing overhead route).

Capital Cost Estimate

Table 87. Tongariro 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)**	
Transmission	Medium supply transformer (GXP)	1.00	$3.50
Subtransmission	Small zone substation	1.00	$5.00
Subtransmission	Reconductor single overhead 33kV line	6.10	$1.60
Distribution	Double overhead 11kV line	1.80	$0.68
		TOTAL	**$10.78**

Table 88. Tongariro 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	Medium supply transformer (GXP)	2.00	$7.00
Transmission	Medium switchroom (ZSS)	1.00	$3.00
Subtransmission	Medium zone substation	1.00	$8.00
Subtransmission	Reconductor single overhead 33kV line	6.10	$1.60
Subtransmission	Single overhead 33kV line	6.10	$2.14
Distribution	Double overhead 11kV line	1.80	$0.68
		TOTAL	**$22.41**

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 36-48 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.

8.21.3 Effect of all Load Sites Connecting to Tokaanu GXP

The following Figure 125 illustrates the Tokaanu GXP load profile together with the load profiles of all the Load Sites within the Tokaanu GXP region. Also shown in Figure 125 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Tokaanu GXP would increase to 19.53 MW, an increase of 9.05 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 22.68 MW there is a diversity factor of 0.86 between the loads.
- Based on Ergo's analysis, the Tokaanu GXP's (N-1) limit remains acceptable, yet borderline. Coupled with other load growth, the GXP's limit is likely to be exceeded. Ergo has discussed mitigation for this in Section 8.21.1.

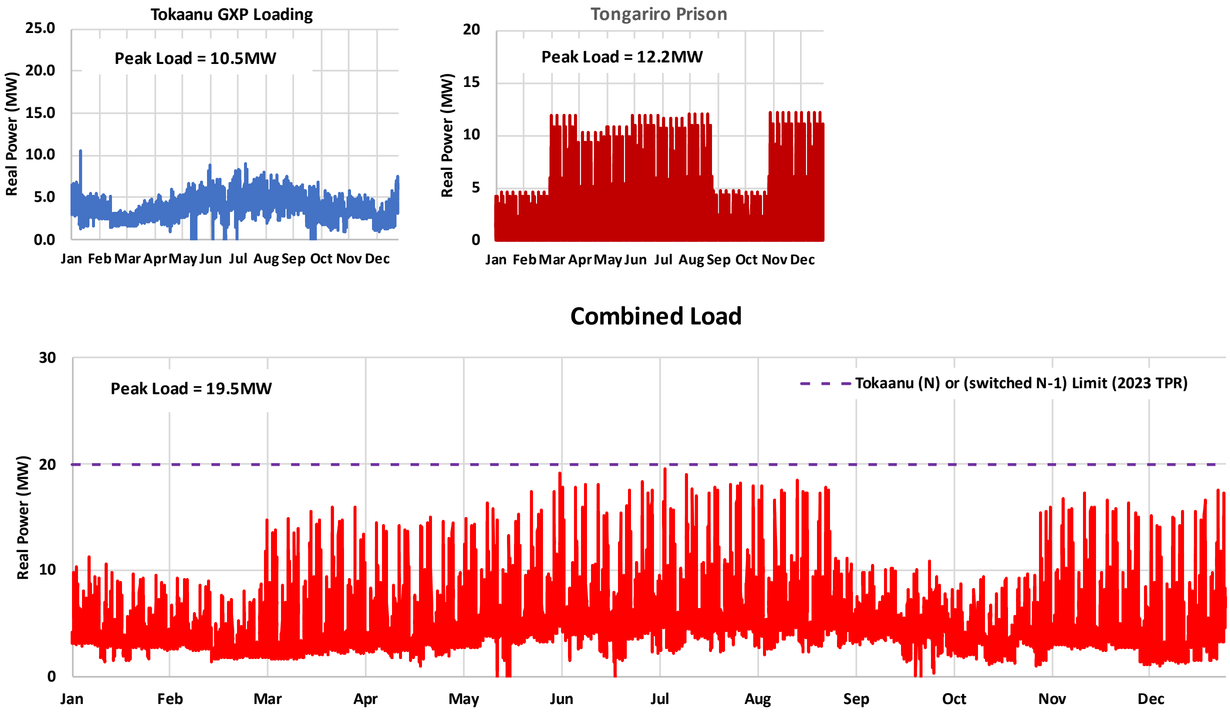


Figure 125. Loading Profiles: Tokaanu GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.22 Waihou GXP

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

- Fonterra Waitoa (6.64 MW)
- Inghams Enterprises (NZ) Pty Limited Te Aroha (1.09 MW)
- PGG Wrightson Seeds Limited Walton (2.80 MW)

The "Small" Load Sites connecting to the Waihou GXP include (refer to section 8.22.5):

- Greenlea Premier Meats Waitoa (0.28 MW)

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

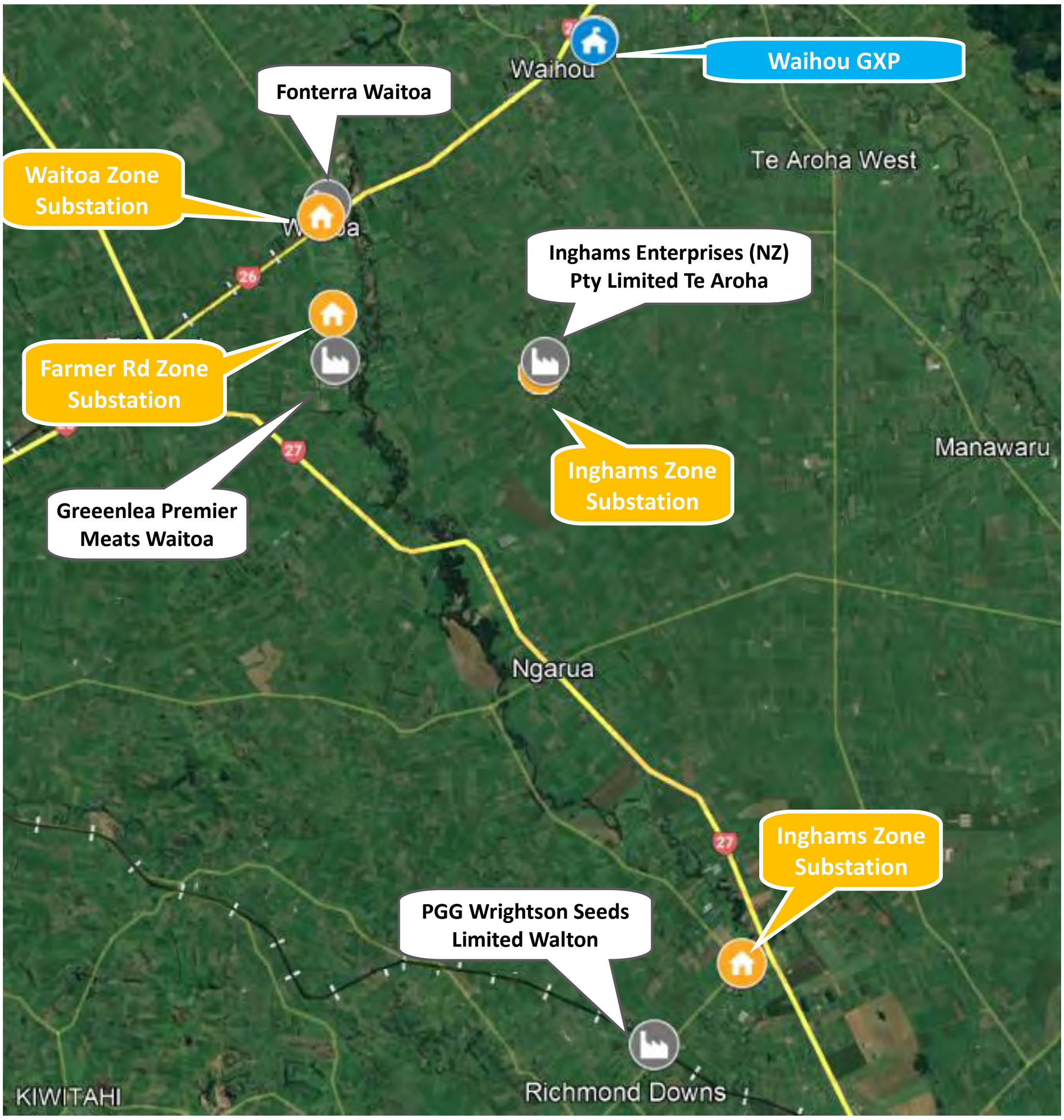


Figure 126. Waihou GXP: EECA Load Sites vs local substations

8.22.1 Waihou GXP Upgrade

The Waihou GXP presently has 39.3 MVA of spare (N-1) capacity and 119.3 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.22.6 indicates that the spare (N-1) capacity of the Waihou GXP is not expected to be exceeded if all the Load Sites connect. Therefore, upgrades of the Waihou GXP are not investigated.

8.22.2 Fonterra Waitoa

FONTERRA WAITOA		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	6.636	Waihou
Existing Electrical Supply to the Plant		

Fonterra Waitoa is presently supplied by Powerco's Waitoa substation, which is a dedicated supply to the Waitoa dairy plant. Waitoa is in turn supplied from Waihou GXP by two 33 kV subtransmission circuits. The subtransmission circuits are rated to approximately 378 A (21.6 MVA) and 437 A (25.0 MVA). Waitoa zone substation is presently equipped with 3x 7.5/9.4 MVA transformers.

This site is located approximately 0.3 km from Waitoa zone substation. In turn, Waitoa zone substation is approximately 6.0 km from Waihou GXP.

There is currently a maximum loading of 12 MVA on Waitoa zone substation, with 12 MVA of spare (N) capacity and 4.7 MVA of spare (N-1) capacity (across the transformers and the subtransmission lines supplying the site). The full capacity of the zone substation transformers cannot presently be utilised as the transformers have different impedances which results in uneven load sharing between the three units. Waihou GXP presently has 119.3 MVA of spare (N) capacity and 39.3 MVA of spare (N-1) capacity.

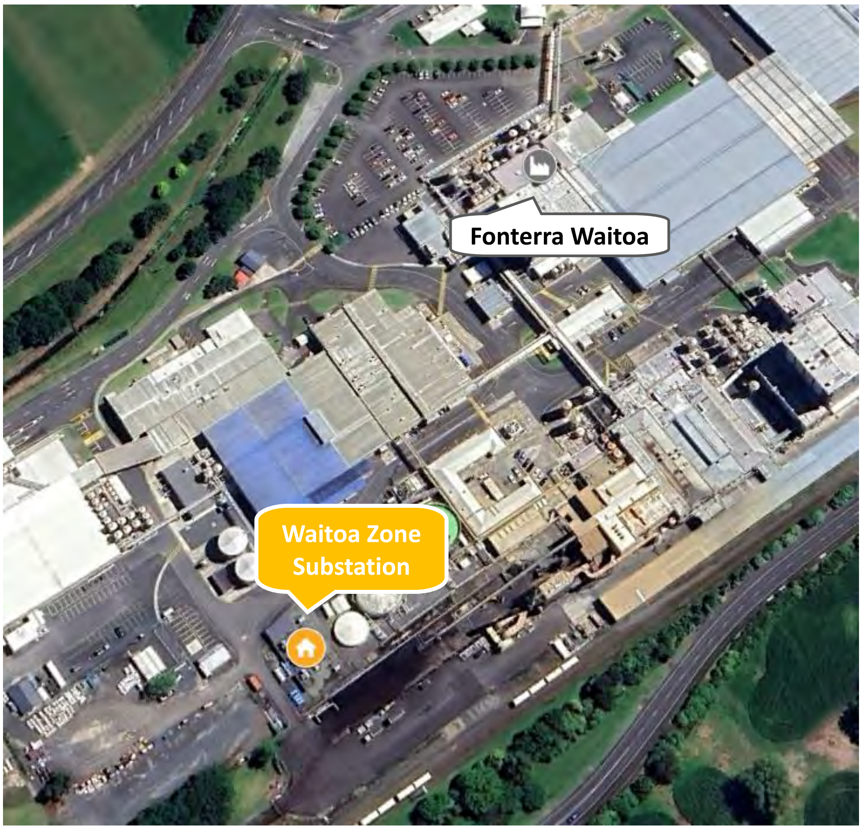


Figure 127. Fonterra Waitoa geographic location in relation to the surrounding zone substations

FONTERRA WAITOA

Supply Option(s) for New Load

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

To provide the load with an (N-1) security supply, two of the existing substation transformers would require replacements, to allow for impedance matching with the other transformer.

Due to the size of the load, 1x new 11 kV feeder and associated circuit breaker would likely be required. Due to the urban/industrial topography of the area, these would likely be underground cables, at a length of approximately 0.4 km.

Capital Cost Estimate

Table 89. Fonterra Waitoa: 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)	1.00	$0.10
Distribution	Single underground 11kV cable	0.40	$0.24
		TOTAL	**$0.34**

Table 90. Fonterra Waitoa: 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	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	**$4.14**

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 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.

8.22.3 PGG Wrighton Seeds Walton

PGG WRIGHTSON SEEDS LIMITED WALTON		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New high temperature heat pumps	2.796	Waihou
Existing Electrical Supply to the Plant		

PGG Wrightson Seeds Walton is presently supplied by Powerco's Walton substation via an 11 kV overhead feeder. Walton substation is in turn supplied by a single 33 kV subtransmission circuit from Waihou GXP. The upstream subtransmission circuit is rated to approximately 309 A (17.7 MVA). Walton zone substation is presently equipped with one 7.5 MVA transformer which affords the substation (N) security only.

This site is located approximately 2.2 km from Walton zone substation. In turn, Walton zone substation is approximately 16.6 km from Waihou GXP.

There is currently a maximum loading of 5 MVA on Walton zone substation, with 2.4 MVA of spare (N) capacity and no (N-1) capacity. Waihou GXP presently has 119.3 MVA of spare (N) capacity and 39.3 MVA of spare (N-1) capacity.

Figure 128. PGG Wrightson Seeds Walton geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Waihou GXP has adequate spare (N) and (N-1) capacity. Therefore, upgrades to the GXP are not considered for this additional load.

PGG WRIGHTSON SEEDS LIMITED WALTON

Walton zone substation does not have adequate (N) or (N-1) capacity to supply the increase in load to the site.

For Walton zone substation to reach the required (N) capacity requirements, a supply transformer replacement would be required. To provide sufficient (N-1) capacity requirements, an additional supply transformer would be required, as well as an additional 33 kV feeder from Waihou GXP. It is assumed that the new 33 kV feeder would be underground cabling due to space constraints along the route.

Ergo understands that the Walton substation was recently upgraded to install the required switchgear for provision of a second future transformer, and as such, switchboard upgrades are not expected for installation of a second transformer.

The existing 11kV feeder loadings are not known, to Ergo. However, due to the size of the load, it's existing feeder would be adequate to supply the additional load. If not, sections of the existing 11 kV feeder may need to be re-conductored to allow for a higher current-carrying capacity. To allow for this in costing, 2.2 km of line reconductoring has been included in the cost estimate.

Capital Cost Estimate

Table 91. PGG Wrightson Seeds Walton: 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	Medium supply transformer (ZSS)	1.00	$1.90
Distribution	Reconductor 11kV line (larger)	2.20	$0.44
			$2.34

Table 92. PGG Wrightson Seeds Walton: 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 (ZSS)	2.00	$0.60
Subtransmission	Single underground 33kV cable	16.60	$14.94
Subtransmission	Medium supply transformer (ZSS)	2.00	$3.80
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Reconductor 11kV line (larger)	2.20	$0.44
			$19.88

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

PGG WRIGHTSON SEEDS LIMITED WALTON
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.

8.22.4 Inghams Enterprises (NZ) Pty Limited Te Aroha

INGHAMS ENTERPRISES (NZ) PTY LIMITED TE AROHA		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New high temperature heat pumps	1.090	Waihou

Existing Electrical Supply to the Plant

Inghams Enterprises (NZ) Pty Limited Te Aroha is presently supplied by Powerco's Inghams substation via an 11 kV overhead feeder. Inghams is in turn supplied by a single 33 kV subtransmission circuit. However, this 33 kV circuit tees off from two points of supply, Piako GXP and Waihou GXP. The upstream subtransmission circuits are rated to approximately 320 A (18.3 MVA) and 378 A (21.6 MVA). Inghams zone substation is equipped with a single 7.5/9.4 MVA transformer, affording the site (N) security.

This site is located approximately 0.3 km from Inghams zone substation. In turn, Inghams zone substation is approximately 8.0 km from Waihou GXP.

There is currently a maximum loading of 4.2 MVA on Inghams zone substation, with 5 MVA of spare (N) capacity. Inghams is an (N) security substation at present, with only one transformer at the site. Waihou GXP presently has 119.3 MVA of spare (N) capacity and 39.3 MVA of spare (N-1) capacity.

Figure 129. Inghams Enterprises (NZ) Pty Limited Te Aroha geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Waihou GXP has adequate spare (N) and (N-1) capacity. Therefore, upgrades to the GXP are not considered for this additional load. Inghams zone substation has adequate spare (N) capacity, but does not have (N-1) capacity.

To afford the Load Site an (N-1) security supply, a new supply transformer would be required at

INGHAMS ENTERPRISES (NZ) PTY LIMITED TE AROHA

Inghams zone substation, as well as the associated switchgear.

The existing 11 kV feeder loading is not known, to Ergo. However, given the size of the load, it's existing feeder may be adequate to supply the additional load. If not, sections of the existing 11 kV feeder may need to be reconductored to allow for a higher current-carrying capacity. To allow for this, 0.4 km of line reconductoring has been included in the cost estimate.

Capital Cost Estimate

Table 93. Inghams Enterprises (NZ) Pty Limited Te Aroha: 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 11kV line (larger)	0.40	$0.08
		TOTAL	**$0.08**

Table 94. Inghams Enterprises (NZ) Pty Limited Te Aroha: 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	1.00	$0.25
Subtransmission	Small supply transformer (ZSS)	1.00	$1.50
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Reconductor 11kV line (larger)	0.40	$0.08
			$1.93

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 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.

8.22.5 Small Opportunities

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

Table 95. 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)
Greenlea Premier Meats Waitoa	Farmer Road	-0.3	6	Unknown	0.282	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.

8.22.6 Effect of all Load Sites Connecting to Waihou GXP

The following Figure 130 illustrates the Waihou GXP load profile together with the load profiles of all the Load Sites within the Waihou GXP region. Also shown in Figure 130 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Waihou GXP would increase to 41.69 MW, an increase of 6.40 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 43.30 MW there is a diversity factor of 0.96 between the loads.
- Based on Ergo's analysis, the Waihou GXP's (N-1) limit is not expected to be exceeded.

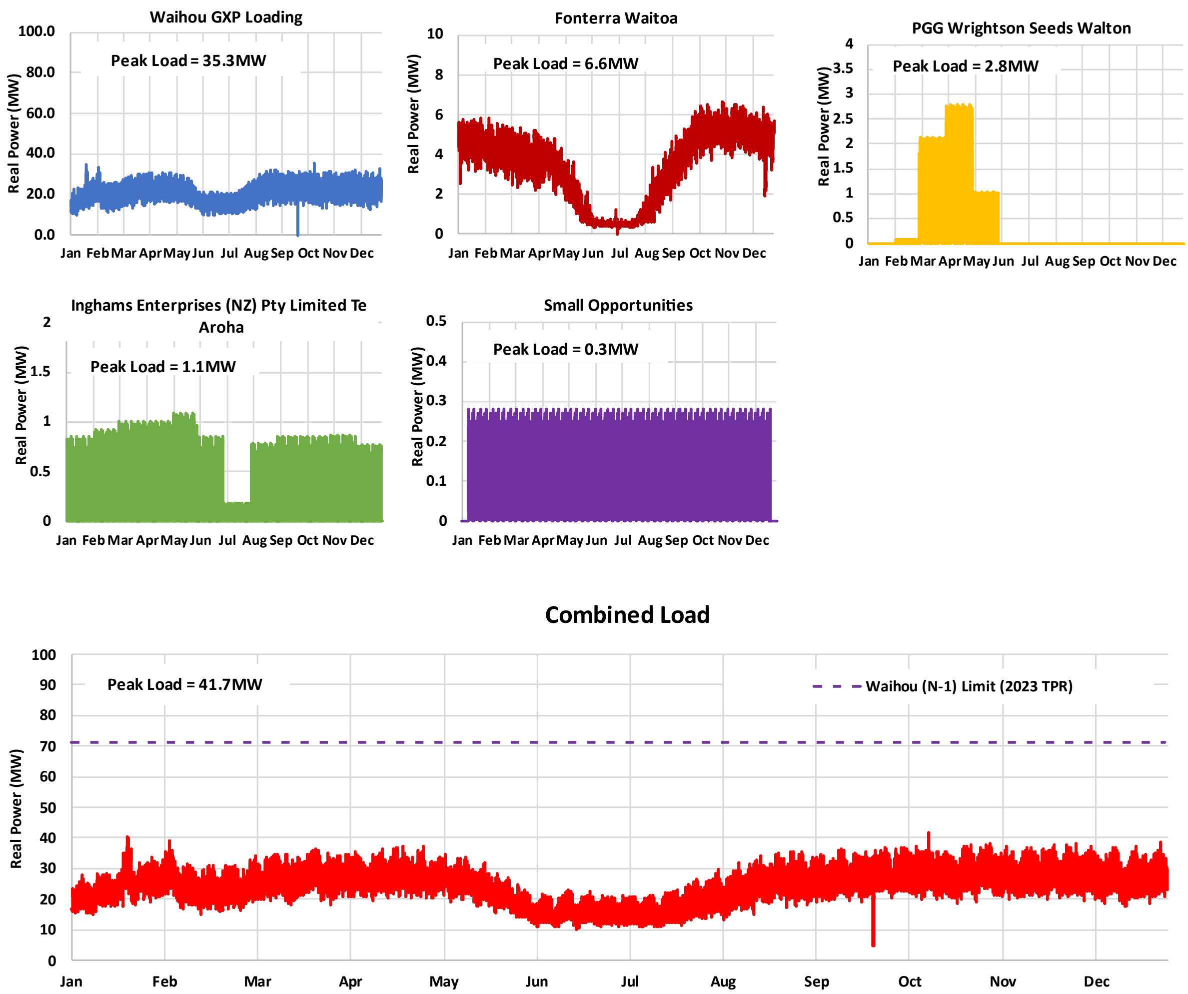


Figure 130. Loading Profiles: Waihou GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.23Waikato River System (Whakamaru POS)

One "Large" EECA Load Site is connecting to the Waikato River System (Whakamaru POS):

- Crusader Meats Benneydale (1.83 MW)

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

There is no Transpower/Transmission network connection point for this area, and the site presently takes supply directly from the Whakamaru hydrogeneration station – labelled Whakamaru POS (Point of Supply) below.

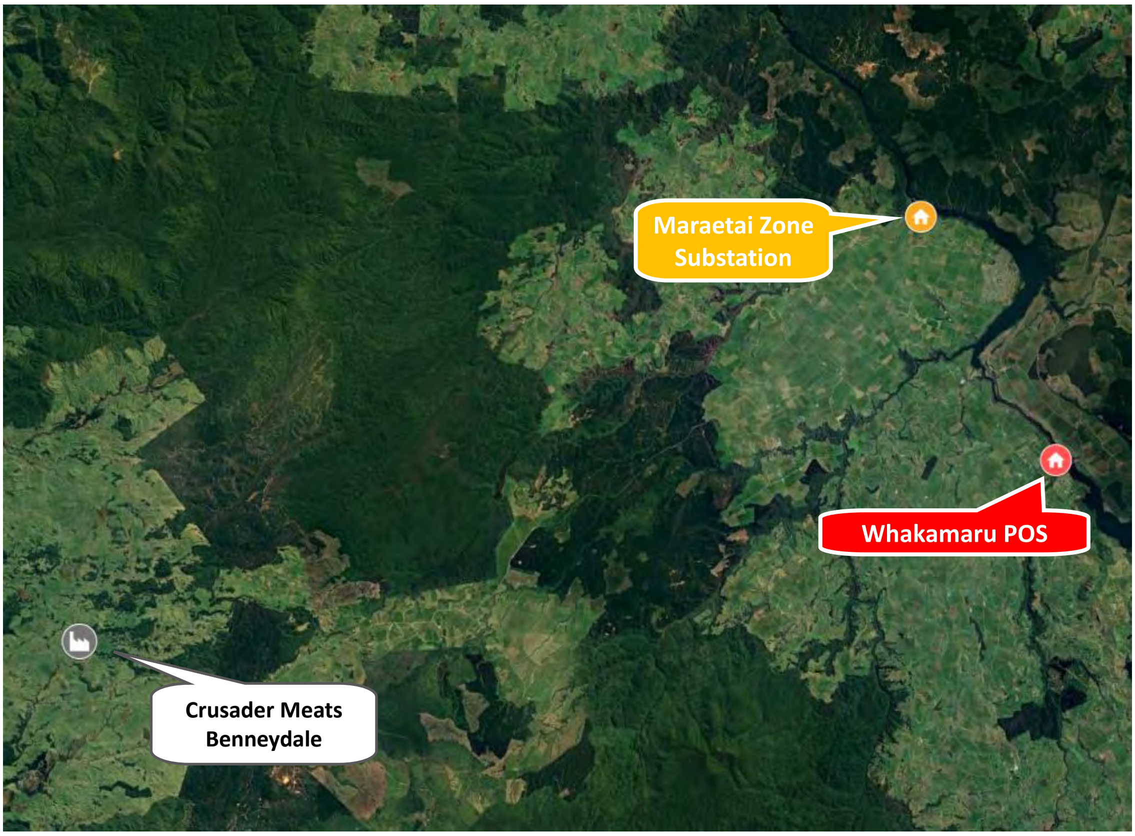


Figure 131. Waikato River System (Whakamaru POS): EECA Load Sites vs local substations

8.23.1 Waikato River System (Whakamaru POS) Upgrade

The Waikato River System (Whakamaru POS) is a non-Transpower point of supply, that supplies The Lines Company via a 23 MVA transformer which in turn feeds the downstream connections.

Whakamaru POS has approximately 12 MVA of spare (N) or (N-1) capacity (it operates with (N-1 switched) security and can instead be supplied via the other nearby generation points of supply which connect to The Lines Company's network, Mōkai and Ātiamuri).

As only one Load Site is connecting, any upgrades required are discussed in the Load Site analysis section below.

8.23.2 Crusader Meats Benneydale

CRUSADER MEATS BENNEYDALE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and high temperature heat pumps	1.830	N/A
Existing Electrical Supply to the Plant		

Crusader Meats Benneydale is presently supplied by The Lines Company's Maraetai substation via an overhead 11 kV feeder. Maraetai is in turn supplied from Waikato River System (Whakamaru POS) by a single 33 kV subtransmission circuit. Maraetai zone substation is presently equipped with a single 7.5 MVA transformer, affording the site (N) security.

This Load Site is located approximately 30.5 km from Maraetai zone substation. In turn, Maraetai zone substation is approximately 9.6 km from Waikato River System (Whakamaru POS).

There is currently a maximum loading of 5.4 MVA on Maraetai zone substation, with 4.6 MVA of spare (N) capacity. Maraetai substation presently operates on (N) security, with only one transformer. Whakamaru POS has approximately 12 MVA of spare (N) or (N-1) capacity (it operates with (N-1 switched) security and can instead be supplied via the other nearby generation points of supply which connect to The Lines Company's network, Mōkai and Ātiamuri).

Figure 132. Crusader Meats Benneydale geographic location in relation to the surrounding zone substations

CRUSADER MEATS BENNEYDALE

Supply Option(s) for New Load

Whakamaru POS has adequate capacity for the proposed load. Maraetai zone substation has adequate spare (N) capacity, but not (N-1) capacity.

To establish an (N-1) security supply, a second 33 kV circuit from Whakamaru POS to Maraetai substation would be required, along with a second transformer at the zone substation, and associated switchgear. The second 33 kV circuit is assumed to be 10.3 km of overhead line, matching the existing line.

The existing 11kV feeder loading is not known, to Ergo. However, due to the size of the load as well as the distance away from its point of supply, 1x new 11 kV feeder and associated circuit breakers would likely be required. Due to the rural topography of the area, the new feeder would likely be overhead, at a length of 43.4 km (following the existing overhead route).

Due to the length of this proposed feeder, and the size of the load, it is expected that an 11 kV capacitor bank would be required at the Load Site, to support the voltage.

Capital Cost Estimate

Table 96. Crusader Meats Benneydale: 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)	1.00	$0.10
Distribution	Single overhead 11kV line	43.40	$10.85
Distribution	11kV Capacitor Bank	1.00	$0.30
		TOTAL	**$11.25**

Table 97. Crusader Meats Benneydale: 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 (ZSS)	2.00	$0.60
Subtransmission	Single overhead 33kV line	10.30	$3.61
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Single overhead 11kV line	43.40	$10.85
Distribution	11kV Capacitor Bank	1.00	$0.30
		TOTAL	**$15.56**

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

CRUSADER MEATS BENNEYDALE
Timeframe to Establish New Electrical Infrastructure
It is estimated to take 12-18 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.

8.24 Waikino GXP

One "Small" Load Site is connecting to the Waikino GXP (refer to section 8.24.2):

- Oceana Gold Limited Waihi (0.48 MW)

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

Figure 133. Waikino GXP: EECA Load Sites vs local substations

8.24.1 Waikino GXP Upgrade

The Waikino GXP presently has 4.1 MVA of spare (N-1) capacity and 46.1 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.24.3 indicates that the spare (N-1) capacity of the Waikino GXP is not expected to be exceeded if all the Load Sites connect. Therefore, upgrades of the Waikino GXP are not expected.

8.24.2 Small Opportunities

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

Table 98. 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)
Oceana Gold Limited Waihi	Waihi	0.6	10.6	10.6*	0.480	130

*Note: Oceana Gold Limited is supplied via 2x 11 kV feeders at present.

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.

8.24.3 Effect of all Load Sites Connecting to Waikino GXP

The following Figure 134 illustrates the Waikino GXP load profile together with the load profiles of all the Load Sites within the Waikino GXP region. Also shown in Figure 134 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Waikino GXP would increase to 38.24 MW, an increase of 0.40 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 38.32 MW there is a diversity factor of 0.98 between the loads.
- Based on Ergo's analysis, the Waikino GXP's (N-1) limit is not expected to be exceeded.

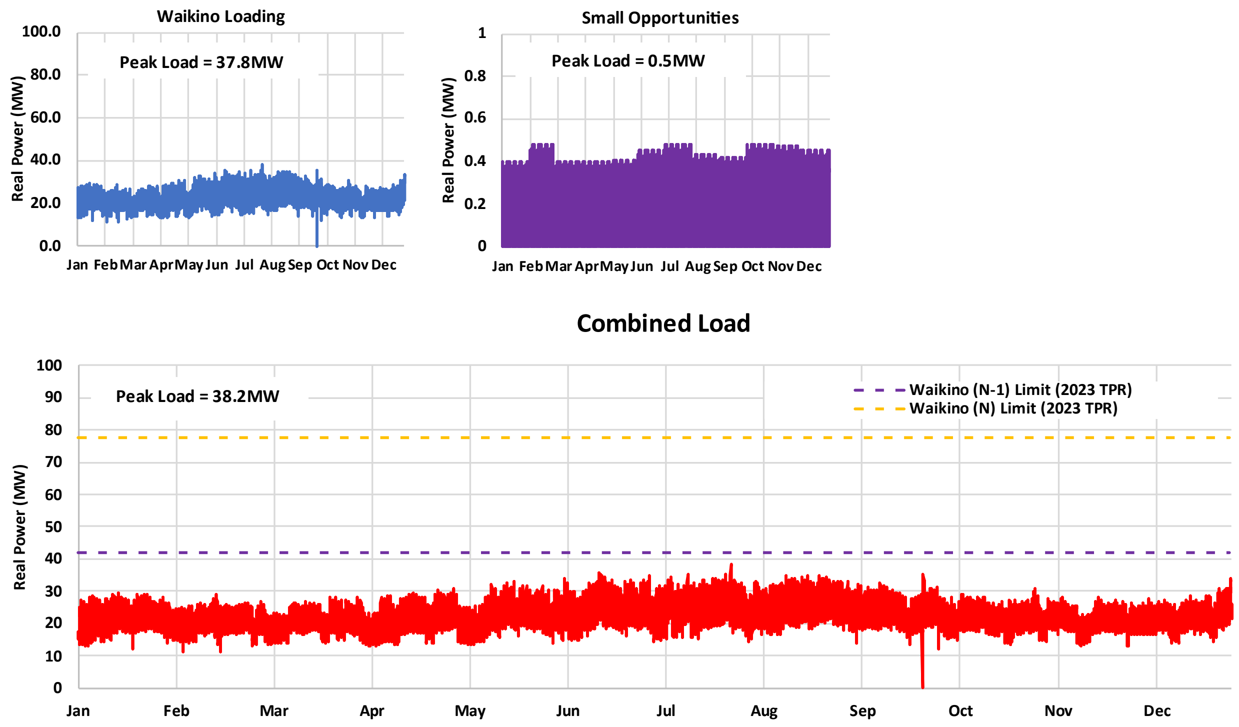


Figure 134. Loading Profiles: Waikino GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.25Wairakei 33 kV GXP

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

- Higgins Rotokawa Asphalt Plant (9.06 MW)
- Laminex Taupō (2.52 MW)

The “Small” Load Sites connecting to the Wairakei 33 kV GXP include (refer to sections 8.25.4 and 8.25.6):

- Taupō Funeral Services (0.45 MW)
- Ministry of Education Taupo Nui A Tia College (0.30 MW)

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

Figure 135. Wairakei 33 kV GXP: EECA Load Sites vs local substations

8.25.1 Wairakei 33 kV GXP Upgrade

The Wairakei 33 kV GXP presently has 18.3 MVA of spare (N-1) capacity and 52.3 MVA of spare (N) capacity, based on the transformer ratings.

Analysis in Section 8.25.7 indicates that the spare (N-1) capacity of the Wairakei 33 kV GXP is not expected to be exceeded if all the Load Sites connect, in the short term, however, due to load growth in the area, the GXP may exceed its capacity in the near future and therefore require upgrades, particularly if the larger Load Site connects. However, the upgrades mentioned in the Load assessments below are considered acceptable if all loads connect.

8.25.2 Higgins Rotokawa Asphalt Plant

HIGGINS ROTOKAWA ASPHALT PLANT		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers	9.058	Wairakei (33 kV)

Existing Electrical Supply to the Plant

Higgins Rotokawa Asphalt Plant is presently supplied by Unison Networks' Fletchers substation. The feeder supply details are unknown, to Ergo. Fletchers is in turn supplied from Wairakei (33 kV) GXP by two 33 kV subtransmission circuits. The subtransmission circuit ratings are unknown, to Ergo, but are expected to be rated for the associated transformer.

This site is located approximately 1.1 km from Fletchers zone substation. In turn, Fletchers zone substation is approximately 4.3 km from Wairakei (33 kV) GXP.

There is currently a maximum loading of 8 MVA on Fletchers zone substation, with 22 MVA of spare (N) capacity and 7 MVA of spare (N-1) capacity. Wairakei (33 kV) GXP presently has 52.3 MVA of spare (N) capacity and 18.3 MVA of spare (N-1) capacity.

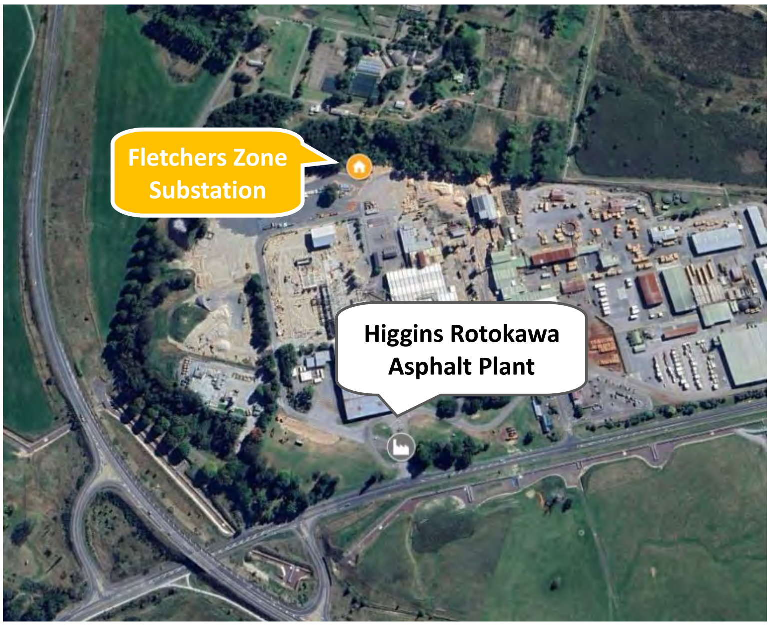


Figure 136. Higgins Rotokawa Asphalt Plant geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

The Fletchers zone substation has adequate spare (N) but not (N-1) capacity. Wairakei (33 kV) GXP has adequate spare (N) and (N-1) capacity to supply the site.

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

HIGGINS ROTOKAWA ASPHALT PLANT

To supply (N-1) security to the site, it is expected that the supply transformers at Fletcher zone substation would require replacements. Given the subtransmission circuit capacities are unknown, to Ergo, it is also expected that the 33 kV circuits between Fletchers zone substation and Wairakei (33 kV) GXP may also need to be upgraded/replaced.

Due to the size of the load, it is expected that 2x new 11 kV feeders would be installed to supply the site. Given the industrial topography of the area, it is expected that these feeders would be underground, and would be approximately 1.1 km long.

Capital Cost Estimate

Table 99. Higgins Rotokawa Asphalt Plant: 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	Special protection system (ZSS)	1.00	$0.25
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	1.10	$0.66
		TOTAL	**$1.01**

Table 100. Higgins Rotokawa 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	Single underground 33kV cable	9.80	$8.82
Distribution	Medium supply transformer (ZSS)	2.00	$3.80
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Single underground 11kV cable	2.20	$1.32
		TOTAL	**$14.14**

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.

HIGGINS ROTOKAWA ASPHALT PLANT
Any land acquisition and consenting, if required, is excluded.

8.25.3 Laminex Taupō

LAMINEX TAUPŌ		
Load Site Description	Electrical Demand (MW)	Transpower GXP
New electrical boilers	2.515	Wairakei (33 kV)

Existing Electrical Supply to the Plant

Laminex Taupō is presently supplied by Unison Networks' Fletchers substation. The feeder supply details are unknown to Ergo. Fletchers is in turn supplied from Wairakei (33 kV) GXP by two 33 kV subtransmission circuits. The subtransmission circuit ratings are unknown, to Ergo, but are expected to be rated for the associated transformer.

This site is located approximately 1.5 km from Fletchers zone substation. In turn, Fletchers zone substation is approximately 4.3 km from Wairakei (33 kV) GXP.

There is currently a maximum loading of 7 MVA on Fletchers zone substation, with 22 MVA of spare (N) capacity and 7 MVA of spare (N-1) capacity. Wairakei (33 kV) GXP presently has 52.3 MVA of spare (N) capacity and 18.3 MVA of spare (N-1) capacity.

Figure 137. Laminex Taupō 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. Due to the size of the load, it is expected that 1x new 11 kV feeder from Fletchers substation would be required for this project. Due to the urban topography, it is expected that this feeder would be underground, and would be ~1.5 km long.

As the zone substation and GXP have adequate (N-1) capacity for this load, consideration has not been given to an (N) security supply.

Capital Cost Estimate

Table 101. Laminex Taupō: Capital cost estimate to supply the Load Site with (N-1) subtransmission supply security.

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11 kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11 kV cable	1.50	$0.90
		TOTAL	**$1.00**

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 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.

8.25.4 Small Opportunities

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

Table 102. 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)
Taupō Funeral Services	Runanga Street	-1	13	Unknown	0.455	130
Ministry of Education Taupo Nui A Tia College	Runanga Street	-1	13	Unknown	0.302	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.

8.25.5 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.

8.25.5.1 Fletchers

Two of the loads on Wairakei (33 kV) GXP are expected to connect to Fletchers zone substation. The loads are Higgins Rotokawa Asphalt Plant, and Laminex Taupō. The sum of peaks of these loads is 11.6 MW, which the zone substation doesn't have (N-1) capacity for. Therefore, upgrades at Fletchers are expected.

The zone substation upgrades specified in the analysis for the Higgins Rotokawa Asphalt plant are considered adequate for connection of both loads connecting, if (N-1) security is required. The cost of the upgrades may be shared between the Load Sites.

8.25.5.2 Runanga Street

Two of the loads on Wairakei (33 kV) GXP are expected to connect to Runanga Street zone substation. The loads are Taupō Funeral Services, and Ministry of Education Taupo Nui A Tia College. The sum of peaks of these loads is 0.76 MW, which the zone substation doesn't have (N-1) capacity for. Therefore, upgrades at Runanga Street are expected.

If (N-1) security is required, the approximate cost of the substation upgrade would be $7M, as the existing transformers would need to be upgraded/replaced.

8.25.6 Combined Load of Small Opportunities

Summing the maximum values of the “small” loads on Wairakei (33 kV) GXP gives a combined load of 0.76 MW. When the load shapes are combined, they result in the following load shape (Figure 138), with a maximum load of 0.63 MW, with a diversity factor of 0.83.

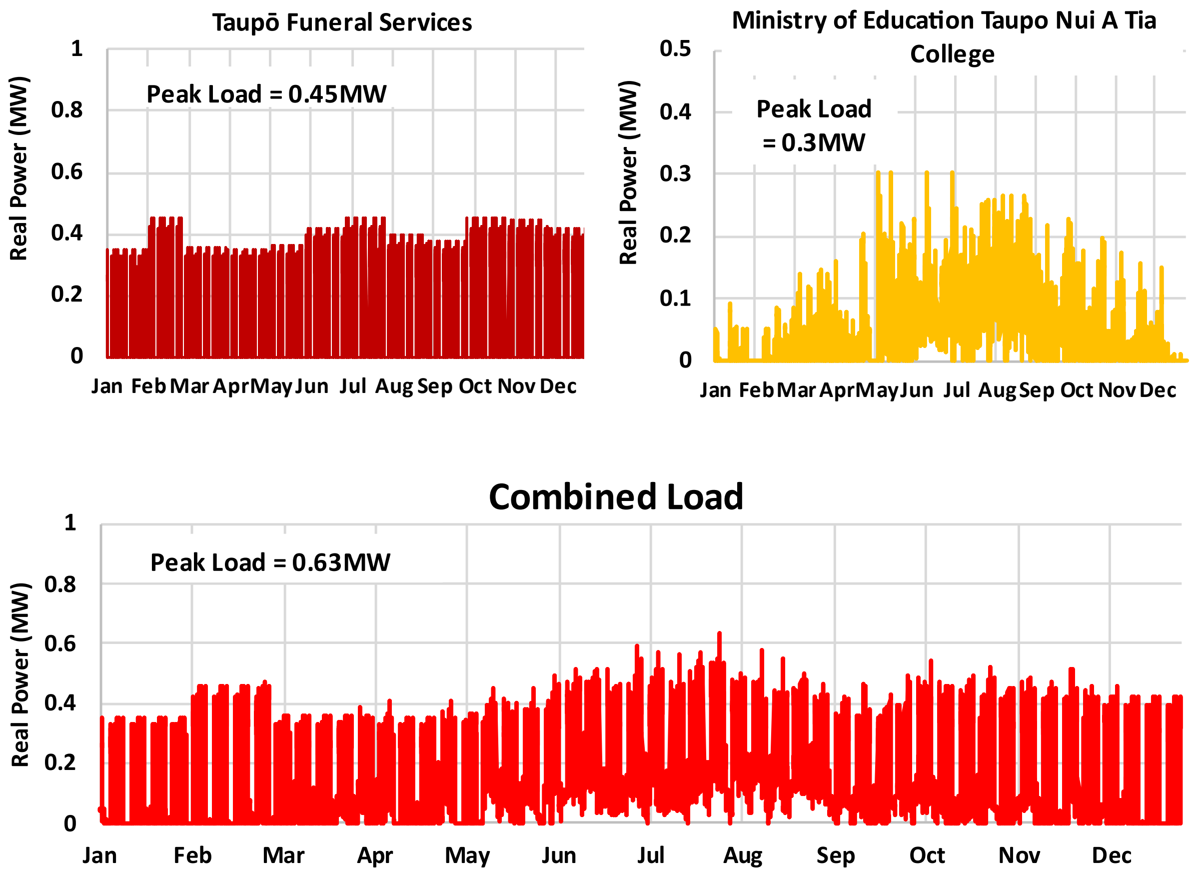


Figure 138. Loading Profiles: Wairakei (33 kV) GXP “small” Load Site Profiles: Combined Load (sum of all profiles)

8.25.7 Effect of all Load Sites Connecting to Wairakei 33 kV GXP

The following Figure 139 illustrates the Wairakei 33 kV GXP load profile together with the load profiles of all the Load Sites within the Wairakei 33 kV GXP region. Also shown in Figure 139 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Wairakei (33 kV) GXP would increase to 40.66 MW, an increase of 3.42 MW on the 2023 maximum demand. Given that the independent sum of the individual load peaks is 49.44 MW there is a diversity factor of 0.82 between the loads.
- Ergo notes that there is some hydro and geothermal generation connected to Wairakei's 33 kV bus, embedded within Unison's distribution network. Contributions from these generators have been excluded from the below graphs in order to better align with the Transpower TPR methodology.
- Based on Ergo's analysis, the Wairakei 33 kV GXP's (N-1) limit is not expected to be exceeded in the short term, however the expected growth at the GXP indicates that the limits may be exceeded in the near future.

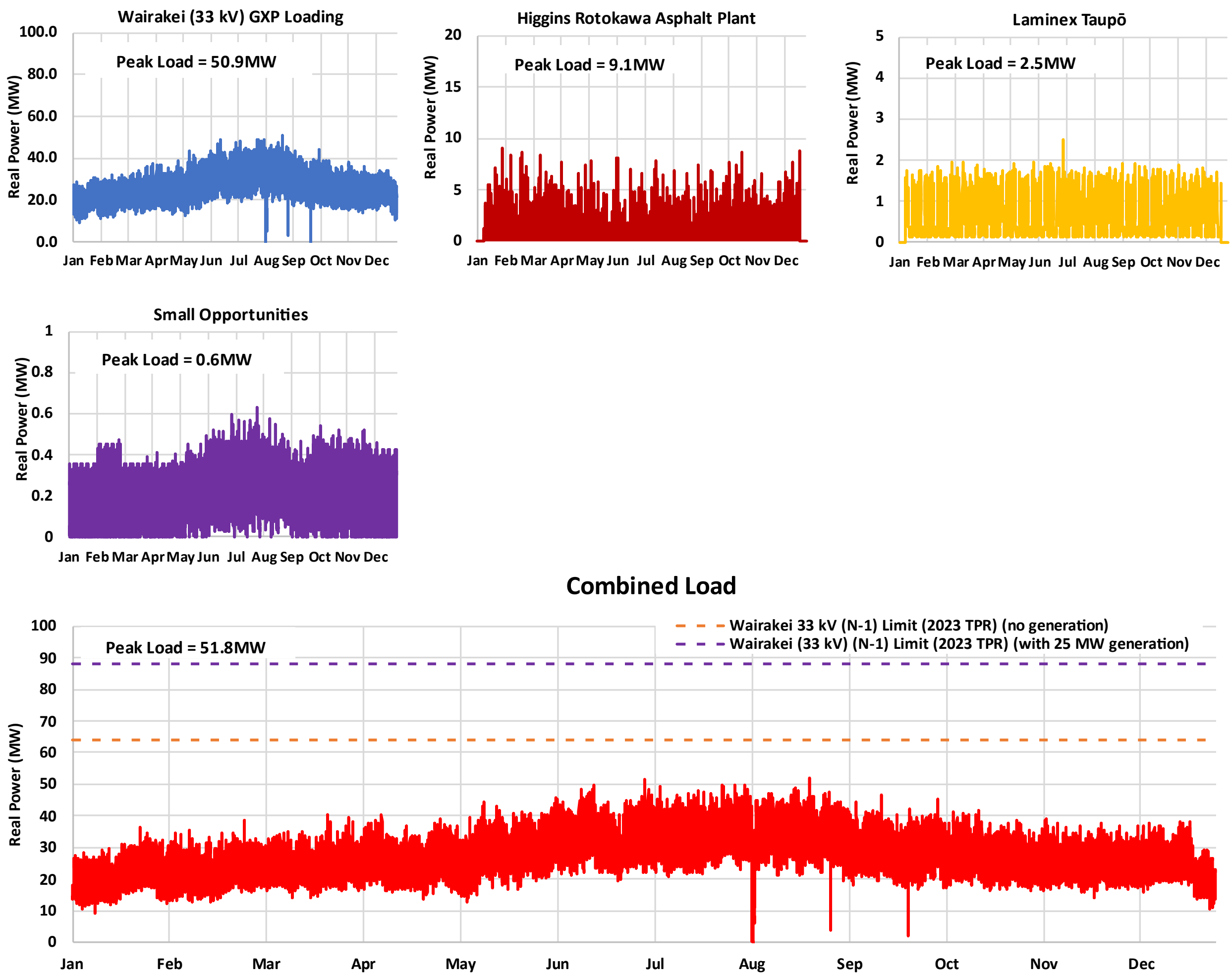


Figure 139. Loading Profiles: Wairakei 33 kV GXP 2023 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

9. Conclusions

9.1 Network Spare Capacity

The following Figure 140 illustrates the (N) and (N-1) spare capacity at the Transpower GXP substations in the Waikato region.

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

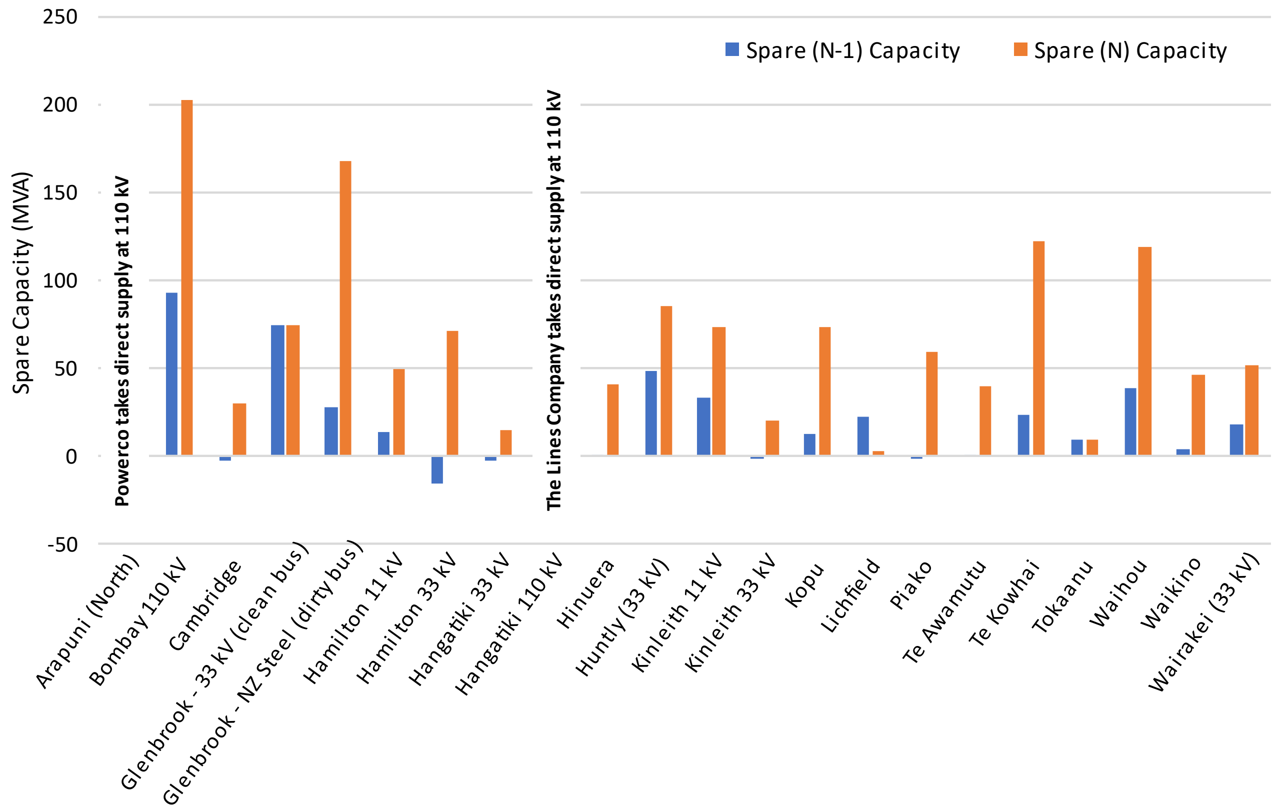


Figure 140 Summary: Approximate (N) and (N-1) spare capacity at GXP substations.

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

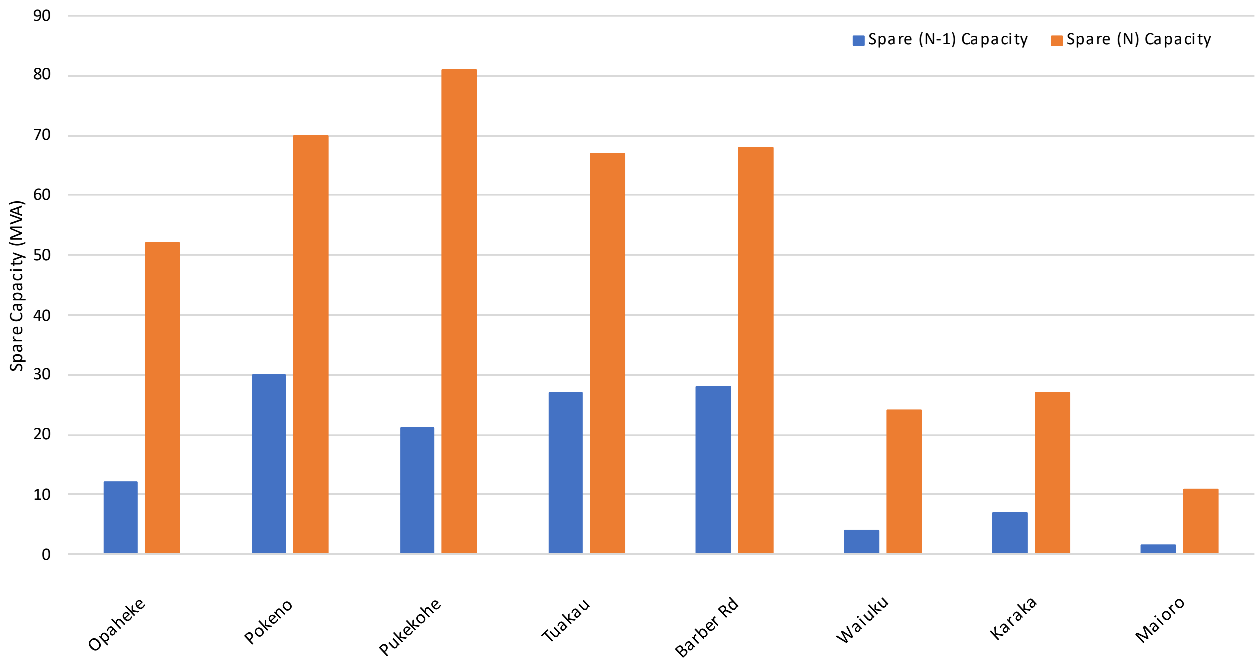


Figure 141. Summary: Approximate (N) and (N-1) spare capacity at Counties Energy's zone substations.

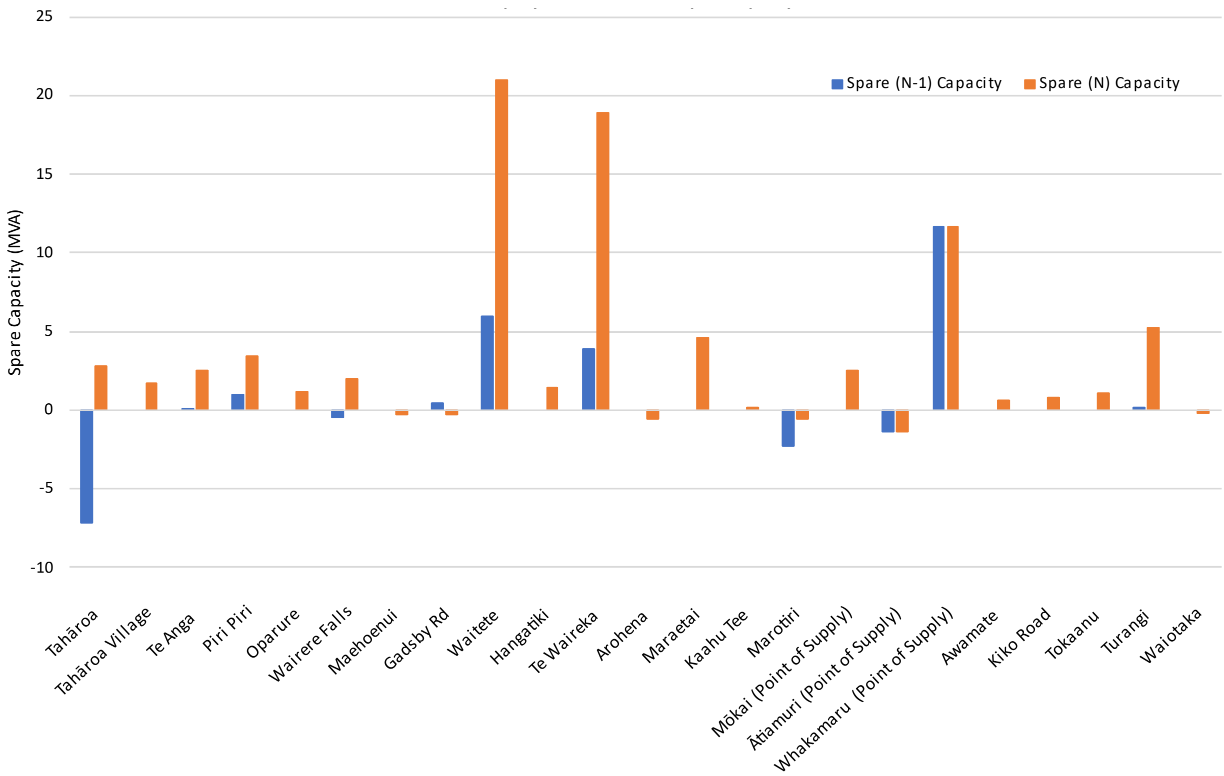


Figure 142 Summary: Approximate (N) and (N-1) spare capacity at The Lines Company's zone substations

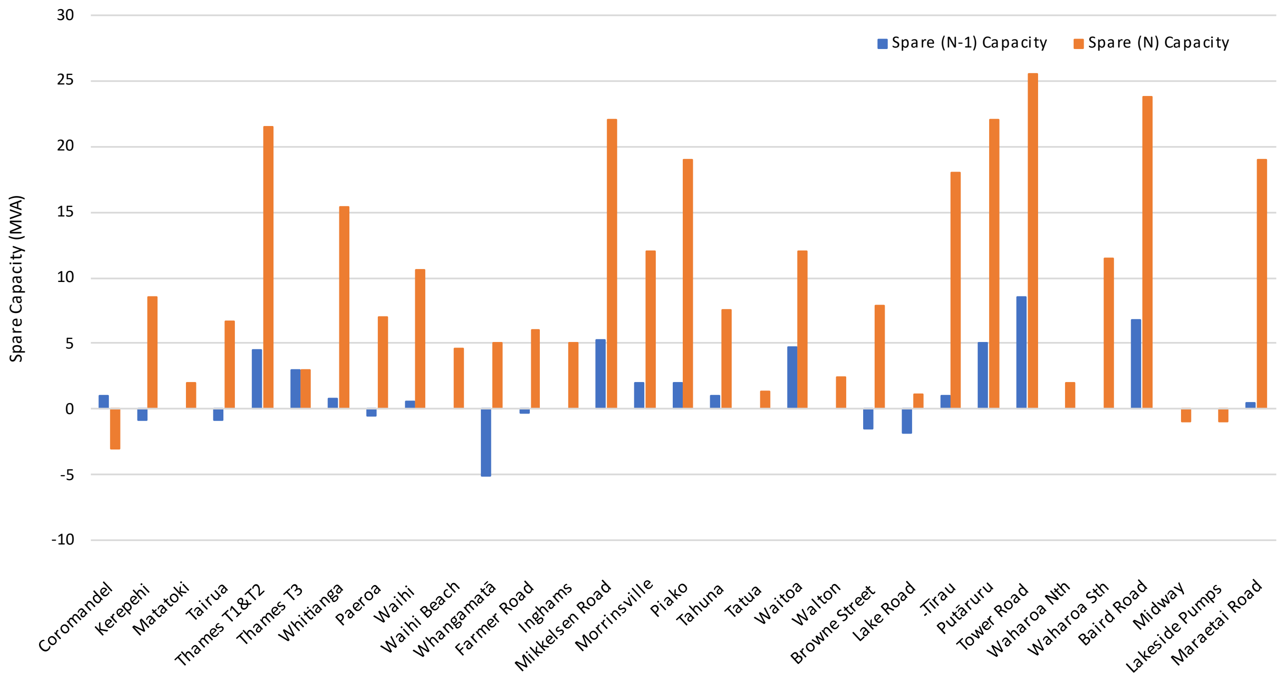


Figure 143. Summary: Approximate (N) and (N-1) spare capacity at Powerco's zone substations.

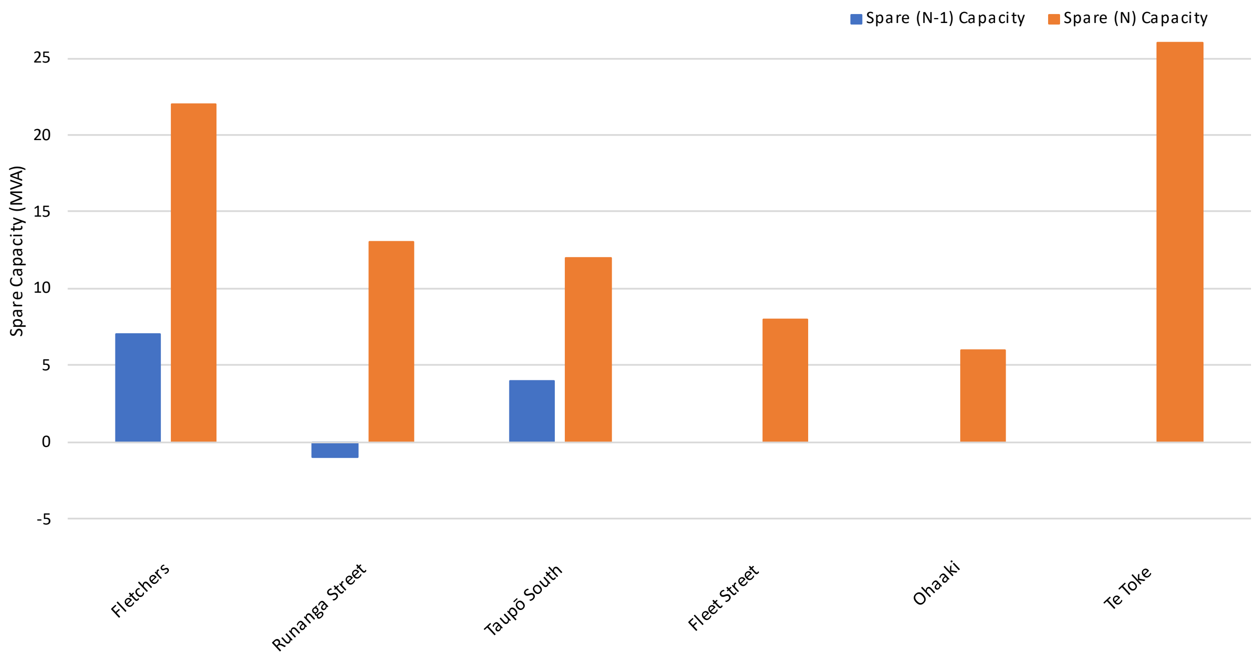


Figure 144. Summary: Approximate (N) and (N-1) spare capacity at Unison's zone substations.

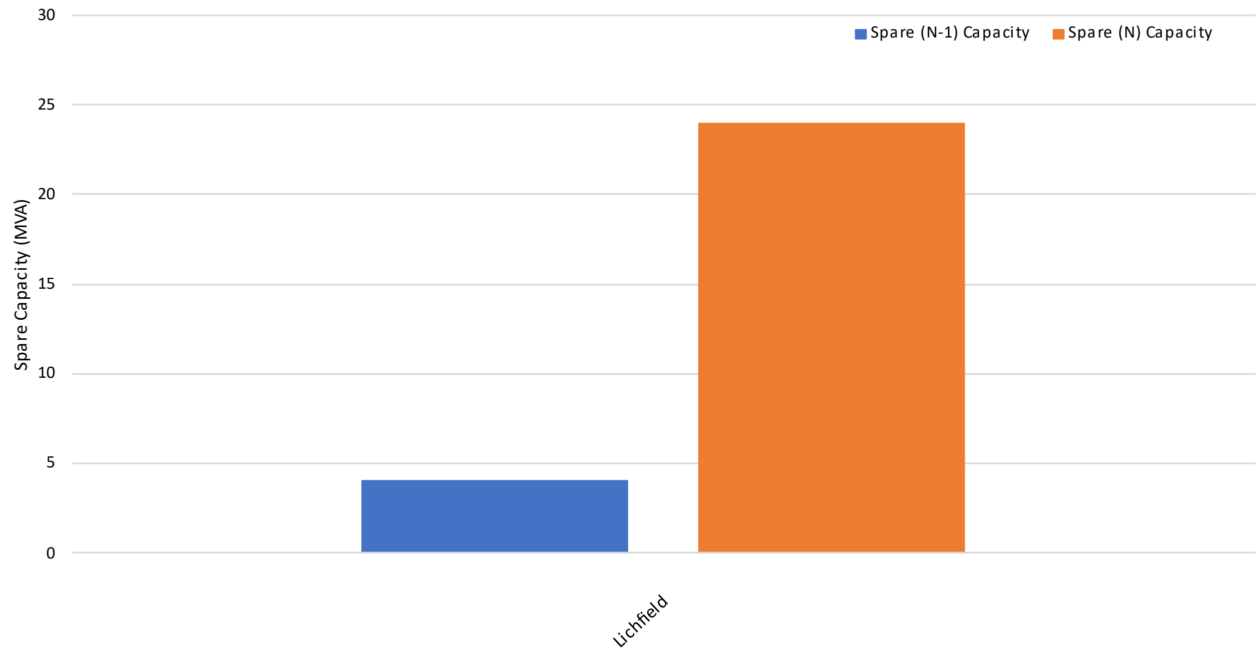


Figure 145. Summary: Approximate (N) and (N-1) spare capacity at Vector's zone substation.

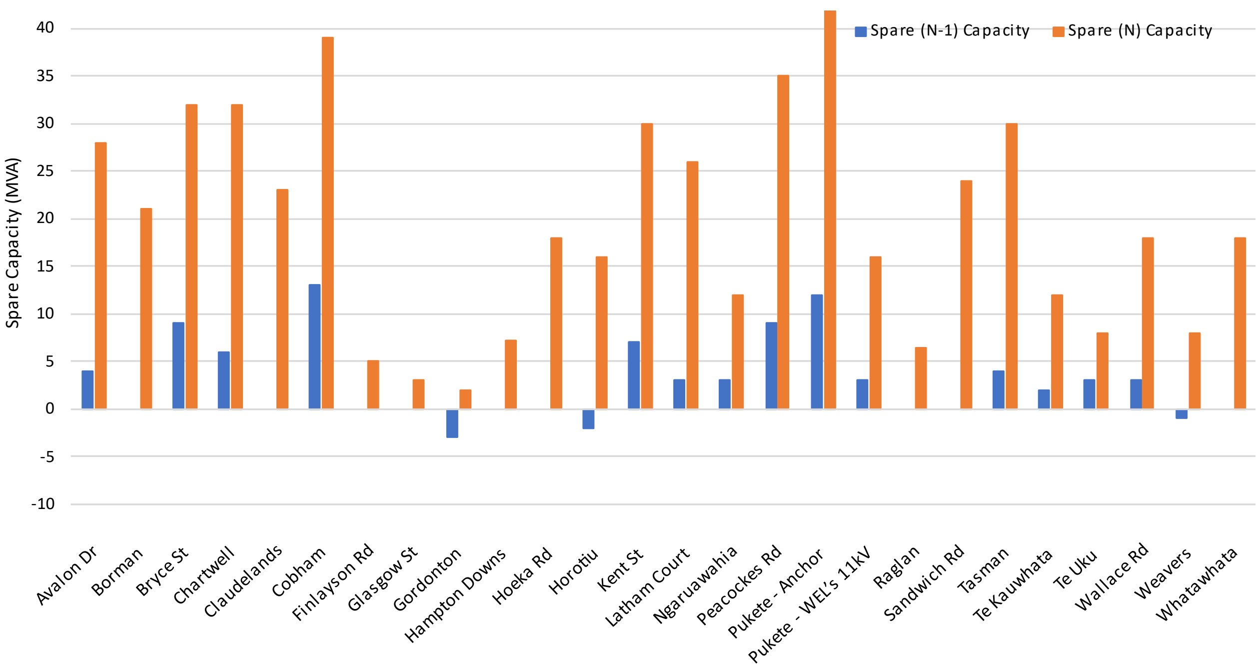


Figure 146. Summary: Approximate (N) and (N-1) spare capacity at WEL Networks' zone substations.

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-006) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Arapuni North GXP* – Supplies Tīrau town, with a large portion of the network being agricultural (dairying) along with a large industrial timber processing load, resulting in a mix of industrial, residential, and agricultural loads. Load is reasonably flat throughout the year, with typical daily morning and evening peaks.
- *Bombay GXP* – Supplies a mix of predominantly industrial, and residential loads, with some commercial customers. Provides supply to Pukekohe and the surrounding rural areas. The GXP is winter peaking with typical daily morning and evening peaks (though with a flatter daily profile over summer).
- *Cambridge GXP* – Supplies Cambridge town as well as a number of agricultural (dairying and irrigation) and industrial processing loads. Peak load in winter is driven by increased residential loads, though summer demands are still high due to the industrial and farming loads. Typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *Glenbrook GXP* – Supplies two large consumers, Glenbrook Steel Mill and Maioro Iron Sands Mine, otherwise supplying a mix of industrial, residential, and commercial customers throughout the Waiuku and Glenbrook areas. The GXP has similar load peaks throughout the year, with the load characteristic dominated by the industrial consumers.
- *Hamilton GXP* – Supplies a significant portion of Hamilton city, and the areas to the East of Hamilton, resulting in the dominant load being residential with some commercial, industrial, and agricultural loads. Winter peaking. Typical daily morning and evening peaks with a slightly flatter profile through the summer compared to the winter.
- *Hangatiki GXP* – Supplies industrial loads (iron sand extraction, timber, limestone and meat processing), with some rural dry stock and dairy loads; as well as a mix of residential and commercial loads at the Ōtorohanga and Te Kūiti towns. The 33 kV GXP has a typical residential load profile, with little variation between summer and winter, with typical daily morning and evening peaks. The 110 kV GXP is dominated by industrial loads.
- *Hinuera GXP* – Supplies Matamata town, with a large portion of the network being agricultural (dairying) along with a large industrial manufacturing and mining load, resulting in a mix of industrial, residential, and agricultural loads. Load is reasonably flat throughout the year, with typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *Huntly GXP* – Supplies Huntly town, and the areas at the North of WEL Network's region, resulting in the dominant load being residential with some commercial, industrial, and agricultural loads. Winter peaking. Typical daily morning and evening peaks with a slightly flatter profile through the summer compared to the winter.
- *Kinleith GXP* – Supplies Tokoroa town, and a large pulp and paper mill, along with a large portion of the network being agricultural (dairying and chicken farming), resulting in a mix of industrial, residential, and agricultural loads. The 11 kV GXP has a peaky load profile, with a flat daily load. The 11 kV GXP load peaks in spring, with typical daily morning and evening peaks.

- *Kopu GXP* – Supplies the Coromandel Peninsula area, including the towns of Thames, Coromandel, Whitianga, Tairua, and Ngātea. There are large industrial loads in agriculture, food processing, and forestry, along with a mix of residential, rural, and commercial loads. Load is peaky, with higher loads in summer and winter (summer peaks are likely due to tourism), with a typical daily morning and evening peak, though load is flatter in the summer.
- *Lichfield GXP* – Directly supplies the Fonterra Lichfield dairy plant. High load through summer, with a winter shutdown. Peaky profile throughout the day.
- *Piako GXP* – Supplies Morrinsville town, with a large portion of the network being agricultural (dairying) along with some large industrial dairy and meat processing loads, resulting in a mix of industrial, residential, and agricultural loads. Load is reasonably flat throughout the year, with the winter dairy shutdown resulting in a decrease in load during winter. Typical daily morning and evening peaks with a slightly flatter profile through the summer.
- *Te Awamutu GXP* – Supplies Te Awamutu town as well as a number of agricultural (dairying and irrigation) and industrial processing loads. Peak load in winter is driven by increased residential loads, though summer demands are still high due to the industrial and farming loads. Typical daily morning and evening peaks.
- *Te Kowhai GXP* – Supplies a portion of Hamilton city, and the areas to the West of Hamilton, resulting in the dominant load being residential with some commercial, industrial, and agricultural loads. Load is sporadic and appears to be heavily influenced by the embedded generation (including the Te Uku wind farm and Te Rapa Cogeneration) in the area.
- *Tokaanu GXP* – Supplies Tūrangi town, a Department of Corrections complex, and some surrounding rural areas. Load is influenced by a large portion of holiday accommodation in the area. Winter peaking with typical daily morning and evening peaks, though load is flatter throughout the day in the summer.
- *Waihou GXP* – Supplies Te Aroha town, with a large portion of the network being agricultural (dairying) along with some large industrial dairy and meat processing loads, resulting in a mix of industrial, residential, and agricultural loads. Load is reasonably flat throughout the year, with the winter dairy shutdown resulting in a decrease in load during winter. Typical daily morning and evening peaks.
- *Waikino GXP* – Supplies popular holiday town Whangamatā, as well as Paeroa and Waihi. A large industrial load in the area is the Waihi mine, with other load in the region being residential (including holidaymakers) and agricultural. Winter peaking. Daily load has typical morning and evening peaks, though is somewhat flatter in summer.
- *Wairakei GXP* – Supplies Taupō, resulting in the dominant load being residential with some commercial, industrial (wood processing), and agricultural loads. Load profile is highly impacted by the embedded generation in the network, with fluctuation throughout the year and an unusual (somewhat flat) daily load profile.

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 (circuits 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[55], which is only suitable for concept screening. (Refer to the assumptions outlined in Section 8.2 for more details)

Summary: Load Sites vs transmission/distribution capital cost estimates

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

Table 103 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)			
WK13	Fonterra Tirau - Stage 1	8.00	Arapuni (North)	$0.00	Tirau	$2.84	$2.84	$0.36	Moderate	1, 2
	Fonterra Tirau - Stage 2	10.04	Arapuni (North)	$0.00	Tirau	$69.39	$69.39	$6.91	Major	1, 2
WK12	Yashili Pōkeno - Stage 1	12.00	Bombay 110 kV	$0.00	Pokeno	$1.68	$1.68	$0.14	Minor	1
	Yashili Pōkeno - Stage 2	16.95	Bombay 110 kV	$0.00	Pokeno	$5.03	$5.03	$0.30	Minor	1
WK14	Synlait Milk Pokeno	15.15	Bombay 110 kV	$0.00	Pokeno	$1.45	$1.45	$0.10	Minor	1
WK19	Turners & Growers New Zealand Limited Geraghty	3.29	Bombay 110 kV	$0.00	Tuakau	$0.35	$0.35	$0.11	Minor	1
WK57	Turners and Growers Harrisville	1.60	Bombay 110 kV	$0.00	Tuakau	$0.00	$0.00	$0.00	Minor	1
WK66	Grainhub Limited Tuakau	0.94	Bombay 110 kV	$0.00	Tuakau	$0.00	$0.00	$0.00	Minor	1
WK52	Passion Fresh Pukekohe	0.69	Bombay 110 kV	$0.00	Pukekohe	$0.00	$0.00	$0.00	Minor	1
WK76	House of Taste Pukekohe	0.63	Bombay 110 kV	$0.00	Pukekohe	$0.00	$0.00	$0.00	Minor	1
WK45	Green Valley Dairies Mangatāwhiri	0.50	Bombay 110 kV	$0.00	Mangatawhiri	$0.00	$0.00	$0.00	Minor	1
WK29	Mercer Mushrooms Tuakau	0.40	Bombay 110 kV	$0.00	Tuakau	$0.00	$0.00	$0.00	Minor	1
WK75	Blooming Hill Flowers Pukekohe	0.17	Bombay 110 kV	$0.00	Pukekohe	$0.00	$0.00	$0.00	Minor	1
WK37	Inghams Enterprises (NZ) Pty Limited Cambridge	2.73	Cambridge	$0.00	N/A	$4.30	$4.30	$1.57	Moderate	1
WK54	Riverton Nurseries Hautapu	1.03	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK65	Burwood Nurseries Limited Tamahere	0.46	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK68	Lilies by Blewden Cambridge	0.28	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK78	Ministry of Education Cambridge High School	0.15	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK48	Quack A Duck Cambridge	0.09	Cambridge	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK62	University of Waikato Hamilton	4.44	Hamilton 11 kV	$0.00	Hamilton 11 kV	$1.30	$1.30	$0.29	Minor	1
WK70	AgResearch Ruakura	0.15	Hamilton 11 kV	$0.00	Hamilton 11 kV	$0.00	$0.00	$0.00	Minor	1
WK18	Dairy Goat Co-operative Limited	10.29	Hamilton 33 kV	$9.00	Latham Court	$6.24	$15.24	$1.48	Major	1, 2
WK32	Higgins Contractors Limited Waikato	9.56	Hamilton 33 kV	$9.00	Latham Court	$6.24	$15.24	$1.59	Major	1, 2
WK9	Evonik Peroxide Limited Morrinsville	8.04	Hamilton 33 kV	$9.00	Hoeka Rd	$17.65	$26.65	$3.32	Major	1, 2
WK35	Waikato Hospital	5.68	Hamilton 33 kV	$9.00	Cobham	$1.66	$10.66	$1.88	Major	1, 2
WK72	Fonterra Canpac	0.45	Hamilton 33 kV	$0.00	Avalon Dr	$0.00	$0.00	$0.00	Minor	1
WK73	Sealed Air Hamilton	0.45	Hamilton 33 kV	$0.00	Avalon Dr	$0.00	$0.00	$0.00	Minor	1
WK55	Hamilton Boys High School	0.36	Hamilton 33 kV	$0.00	Claudelands	$0.00	$0.00	$0.00	Minor	1
WK80	Ministry of Education Fraser High School	0.32	Hamilton 33 kV	$0.00	Avalon Dr	$0.00	$0.00	$0.00	Minor	1
WK81	Ministry of Education Hamilton Girls High School	0.30	Hamilton 33 kV	$0.00	Bryce St	$0.00	$0.00	$0.00	Minor	1
WK38	Waterworld Pools and Spa	0.28	Hamilton 33 kV	$0.00	Avalon Dr	$0.00	$0.00	$0.00	Minor	1
WK61	Claudelands Event Centre	0.27	Hamilton 33 kV	$0.00	Claudelands	$0.00	$0.00	$0.00	Minor	1
WK69	Ministry of Education Fairfield College	0.20	Hamilton 33 kV	$0.00	Chartwell	$0.00	$0.00	$0.00	Minor	1
WK63	Waikato Rugby Stadium	0.18	Hamilton 33 kV	$0.00	Bryce St	$0.00	$0.00	$0.00	Minor	1
WK4	Graymont Otorohanga	14.70	Hangatiki 33 kV	$7.00	Te Waireka	$10.76	$17.76	$1.21	Major	1, 2
WK15	Graymont Te Kuiti Plant	8.00	Hangatiki 33 kV	$7.00	Waitete	$9.37	$16.37	$2.05	Major	1, 2
WK33	Graymont (NZ) Limited Oparure Quarry	0.98	Hangatiki 33 kV	$7.00	Oparure	$9.23	$16.23	$16.56	Major	1, 2
WK41	Universal Beef Packers Te Kuiti	0.85	Hangatiki 33 kV	$0.00	Waitete	$0.00	$0.00	$0.00	Minor	1
WK43	Ovation New Zealand Limited Te Kuiti	0.48	Hangatiki 33 kV	$0.00	Waitete	$0.00	$0.00	$0.00	Minor	1
WK89	Ministry of Education Te Kuiti High School	0.23	Hangatiki 33 kV	$0.00	Gadsby Rd	$0.00	$0.00	$0.00	Minor	1
WK84	Ministry of Education Otorohanga College	0.17	Hangatiki 33 kV	$0.00	Te Waireka	$0.00	$0.00	$0.00	Minor	1
WK30	Shinagawa Refractories Australasia Huntly	6.36	Huntly (33 kV)	$0.00	Glasgow St	$11.04	$11.04	$1.74	Moderate	1, 2
WK24	Springhill Corrections Facility	2.80	Huntly (33 kV)	$0.00	Hampton Downs	$12.75	$12.75	$4.56	Moderate	1, 2
WK31	Lumbercorp NZ Limited Ohinewai	4.73	Huntly (33 kV)	$0.00	Te Kauwhata	$6.47	$6.47	$1.37	Moderate	1, 2
WK83	Ministry of Education Huntly College	0.16	Huntly (33 kV)	$0.00	Weavers	$0.00	$0.00	$0.00	Minor	1
WK6	Roundwood NZ Tokoroa	3.84	Kinleith 33 kV	$4.50	Maraetai Road	$10.84	$15.34	$4.00	Major	1, 2
WK79	Ministry of Education Forest View High School	0.22	Kinleith 33 kV	$0.00	Baird Road	$0.00	$0.00	$0.00	Minor	1
WK58	Tokoroa Hospital	0.21	Kinleith 33 kV	$0.00	Maraetai Road	$0.00	$0.00	$0.00	Minor	1
WK90	Ministry of Educaiton Tokoroa High School	0.13	Kinleith 33 kV	$0.00	Maraetai Road	$0.00	$0.00	$0.00	Minor	1
WK86	Ministry of Education Tainui Primary	0.11	Kinleith 33 kV	$0.00	Maraetai Road	$0.00	$0.00	$0.00	Minor	1
WK64	A & G Price Ltd Thames	1.18	Kopu	$0.00	Thames T3	$0.00	$0.00	$0.00	Minor	1
WK44	Twentymans Funeral Services Thames	0.82	Kopu	$0.00	Thames T1&T2	$1.04	$1.04	$1.27	Minor	1
WK51	Mercury Bay Area School	0.07	Kopu	$0.00	Whitianga	$0.00	$0.00	$0.00	Minor	1
WK7	Fonterra Lichfield - Stage 1	12.00	Lichfield	$0.00	Lichfield	$6.98	$6.98	$0.58	Moderate	1, 2
	Fonterra Lichfield - Stage 2	19.90	Lichfield	$27.76	Lichfield	$6.98	$34.74	$1.75	Major	1, 2
WK16	The Tatua Dairy Co-operative Dairy Company Limited -	10.50	Piako	$25.20	Tatua	$11.50	$36.70	$3.50	Major	1, 2
	The Tatua Dairy Co-operative Dairy Company Limited -	10.63	Piako	$0.00	Tatua	$3.65	$3.65	$0.34	Minor	1
WK11	Fonterra Morrinsville	10.04	Piako	$25.20	Morrinsville	$9.20	$34.40	$3.43	Major	1, 2
WK67	Ixom Morrinsville	1.00	Piako	$0.00	Piako	$0.70	$0.70	$0.70	Minor	1
WK36	Greenlea Premier Meats Limited Morrinsville	0.23	Piako	$0.00	Morrinsville	$0.00	$0.00	$0.00	Minor	1
WK85	Ministry of Education Reporoa College	0.18	Rotorua	$0.00	Fernleaf	$0.00	$0.00	$0.00	Minor	1
WK5	Fonterra Te Awamutu - Stage 1	21.40	Te Awamutu	$28.60	N/A	$14.00	$42.60	$1.99	Major	1, 2
	Fonterra Te Awamutu - Stage 2	20.40	Te Awamutu	$28.60	N/A	$10.60	$39.20	$1.92	Major	1, 2

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)			
WK21	Turners & Growers New Zealand Limited Ōhaupō	1.43	Te Awamutu	$0.60	N/A	$0.00	$0.60	$0.42	Moderate	1, 2
WK20	Waikeria Prison	1.12	Te Awamutu	$0.60	N/A	$4.35	$4.95	$4.42	Moderate	1, 2
WK27	Quality Mushrooms	0.34	Te Awamutu	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK53	Te Awamutu College	0.30	Te Awamutu	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK56	Waipā District Council Te Awamutu Events and Aquati	0.28	Te Awamutu	$0.00	N/A	$0.00	$0.00	$0.00	Minor	1
WK3	Fonterra Te Rapa - Stage 1	12.00	Te Kowhai	$0.00	Pukete - Anchor	$3.36	$3.36	$0.28	Minor	1, 2
	Fonterra Te Rapa - Stage 2	31.00	New GXP	$45.00	N/A	$1.80	$46.80	$1.51	Major	1, 2
	Fonterra Te Rapa - Stage 3	56.54	New GXP	$10.50	N/A	$1.80	$12.30	$0.22	Major	1, 2
WK47	Fulton Hogan Limited Hamilton	12.78	Te Kowhai	$0.00	Kent St	$19.60	$19.60	$1.53	Moderate	1, 2
WK22	AFFCO Horotiu	7.16	Te Kowhai	$0.00	Horotiu	$5.82	$5.82	$0.81	Moderate	1, 2
WK40	Alsco New Zealand Hamilton	1.96	Te Kowhai	$0.00	Kent St	$0.58	$0.58	$0.30	Minor	1
WK49	Bowers Brothers Concrete Horotiu Masonry Plant	1.18	Te Kowhai	$0.00	Horotiu	$5.30	$5.30	$4.48	Moderate	1, 2
WK46	Humes Hamilton Pipe and Precast Plant	0.58	Te Kowhai	$0.00	Tasman	$0.00	$0.00	$0.00	Minor	1, 2
WK71	Milkio Foods Limited Hamilton	0.39	Te Kowhai	$0.00	Kent St	$0.00	$0.00	$0.00	Minor	1, 2
WK50	Pukete Wastewater Treatment Plant	0.13	Te Kowhai	$0.00	Tasman	$0.00	$0.00	$0.00	Minor	1, 2
WK25	Tongariro Prison	12.21	Tokaanu	$10.00	Waiotaka	$12.41	$22.41	$1.84	Major	1, 2
WK77	Fonterra Waitoa	6.64	Waihou	$0.00	Waitoa	$4.14	$4.14	$0.62	Moderate	1
WK91	PGG Wrightson Seeds Limited Walton	2.80	Waihou	$0.00	Walton	$19.88	$19.88	$7.11	Moderate	1, 2
WK26	Inghams Enterprises (NZ) Pty Limited Te Aroha	1.09	Waihou	$0.00	Inghams	$1.93	$1.93	$1.77	Moderate	1, 2
WK34	Greenlea Premier Meats Waitoa	0.28	Waihou	$0.00	Farmer Road	$0.00	$0.00	$0.00	Minor	1
WK39	Crusader Meats Benneydale	1.83	Waikato River Systen	$0.00	Maraetai	$15.56	$15.56	$8.50	Moderate	1, 2
WK17	Oceana Gold Limited Waihi	0.48	Waikino	$0.00	Waihi	$0.00	$0.00	$0.00	Minor	1
WK60	Higgins Rotokawa Asphalt Plant	9.06	Wairakei (33 kV)	$0.00	Fletchers	$14.14	$14.14	$1.56	Moderate	1, 2
WK74	Laminex Taupō	2.52	Wairakei (33 kV)	$0.00	Fletchers	$1.00	$1.00	$0.40	Minor	1
WK59	Taupō Funeral Services	0.45	Wairakei (33 kV)	$0.00	Runanga Street	$0.00	$0.00	$0.00	Minor	1
WK87	Ministry of Education Taupo Nui A Tia College	0.30	Wairakei (33 kV)	$0.00	Runanga Street	$0.00	$0.00	$0.00	Minor	1
	TOTAL =>	433.24	TOTAL =>	$ 263.56	TOTAL =>	$364.89	$628.45			

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: List of Tables

Appendix 2: List of Figures

Appendix 3: Glossary

CT	Current transformer
DG	Distributed generator
EDB	Electrical Distribution Business
EIPC	Electricity Industry Participation Code
ENA	Electricity Network Association
ESA	Electricity Supply Authority
GXP	Grid exit point substation
kV	Kilovolts
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)
SCADA	Supervisory control and data acquisition

Appendix 4: 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 104 Cost estimate classification matrix[56]

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 individual Load Sites and do not consider the connection of multiple Load Sites.

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