South Canterbury

Spare Capacity and Load Conversion Opportunity Report

EECA

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ERGO CONSULTING

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1. Executive Summary

Transpower maintains/manages the transmission network in New Zealand and supplies the South Canterbury region (as described in this report) via 11 GXP's.

Three Electrical Distribution Businesses (EDB's), EA Networks, Alpine Energy and Network Waitaki then take supply from Transpower and distribute the electricity to end customers in the region.

The Energy Efficiency & Conservation Authority (EECA) is running a flagship program that is called Energy Transition Accelerator (ETA)[1]. The program is targeted at large energy-using businesses and public sector organisations that are committed to reducing carbon emissions.

As part of the ETA program, EECA has developed a set of Load Sites for the South Canterbury 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 South Canterbury region):

- The existing spare supply capacity at the major electrical substations.
- The load characteristics at the major electrical substations.
- A capital cost estimate to supply electricity to each of the Load Sites.

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

1.1 Network Spare Capacity

The following Figure 1 illustrates the (N) and (N-1) spare capacity at the Transpower GXP substations in the South Canterbury Region.

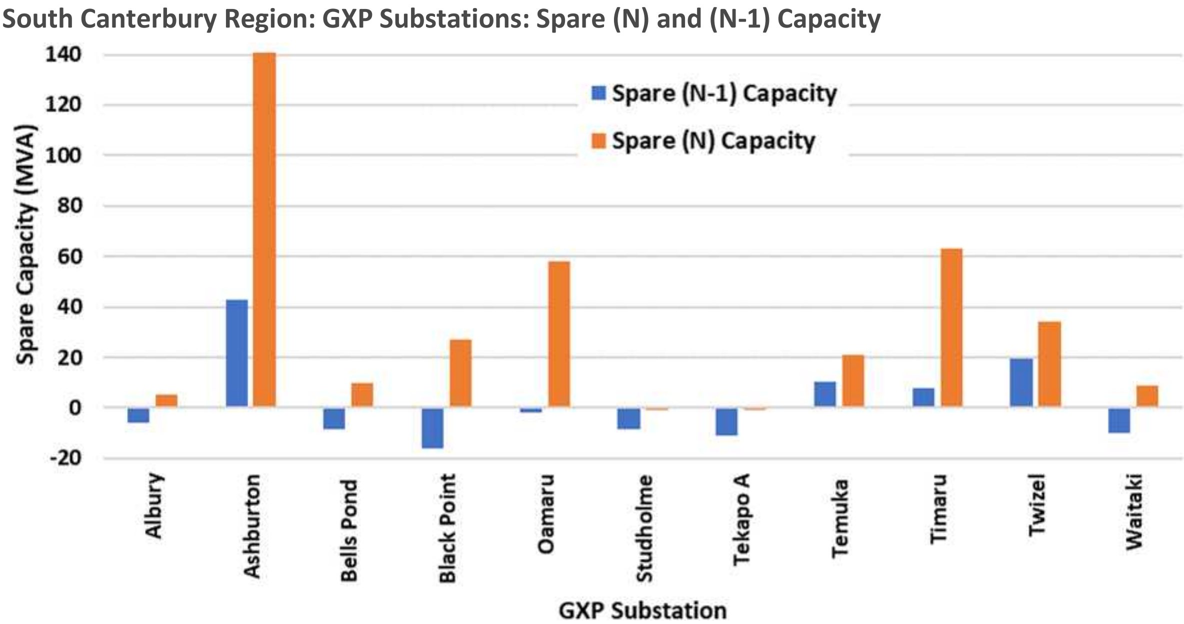

Figure 1 Summary: Approximate (N) and (N-1) spare capacity at GXP substations

[1] https://www.eeca.govt.nz/co-funding/energy-transition-accelerator/

The following figures illustrate the (N) and (N-1) spare capacity at the EDB Zone Substations in the South Canterbury Region. These figures are based off the maximum loadings and the EDB 2021 disclosures.

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

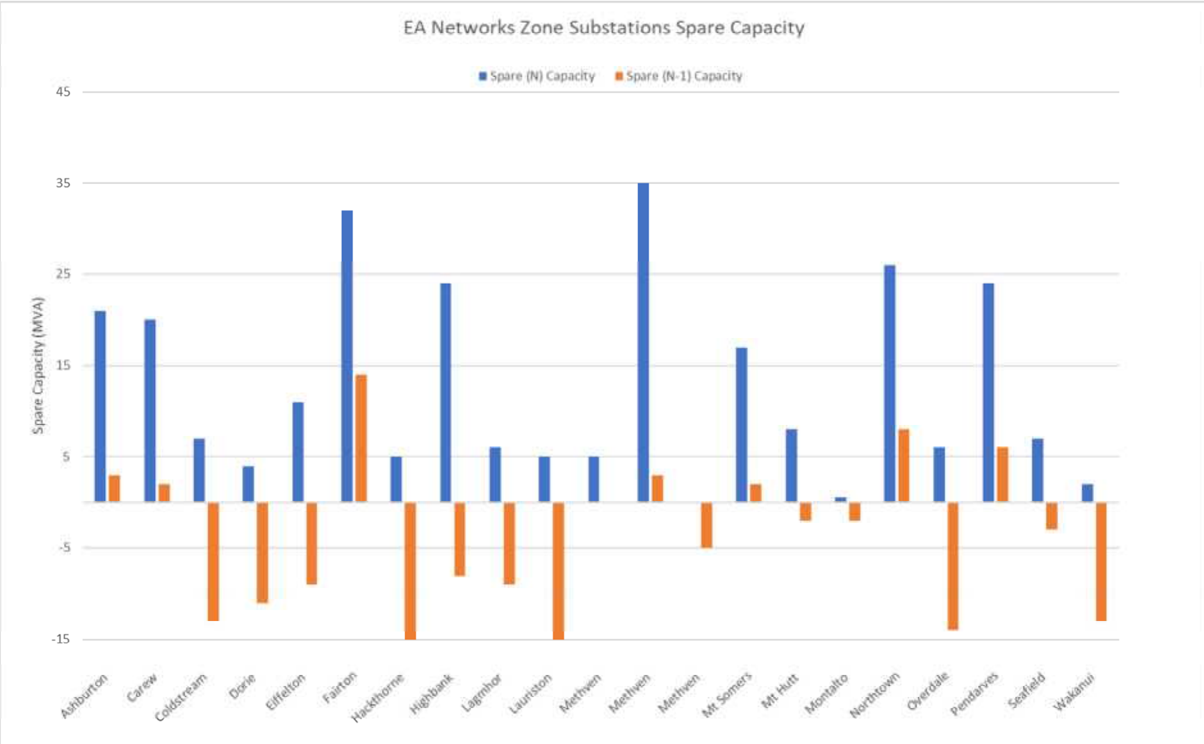

Figure 2 Summary: Approximate (N) and (N-1) spare capacity at EA Networks' zone substations

Alpine Energy Zone Substations: Spare (N) and (N-1) Capacity

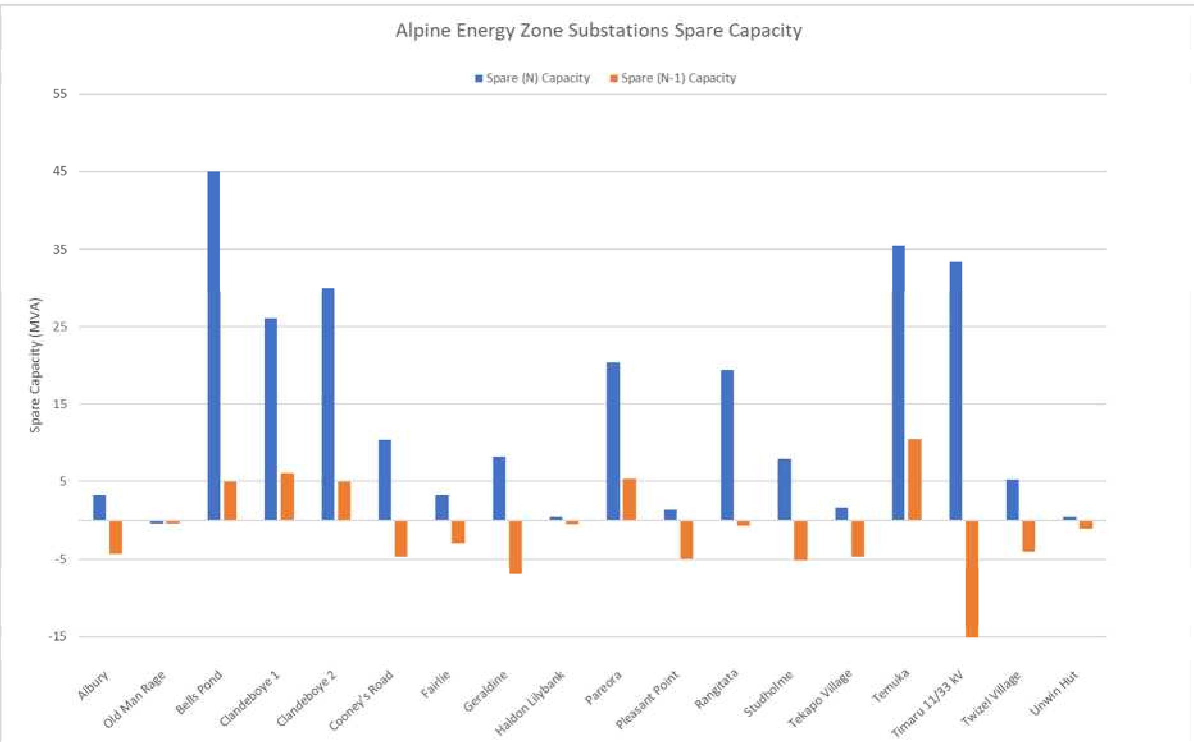

Figure 3 Summary: Approximate (N) and (N-1) spare capacity at Alpine Energy's zone substations

Network Waitaki Zone Substations: Spare (N) and (N-1) Capacity

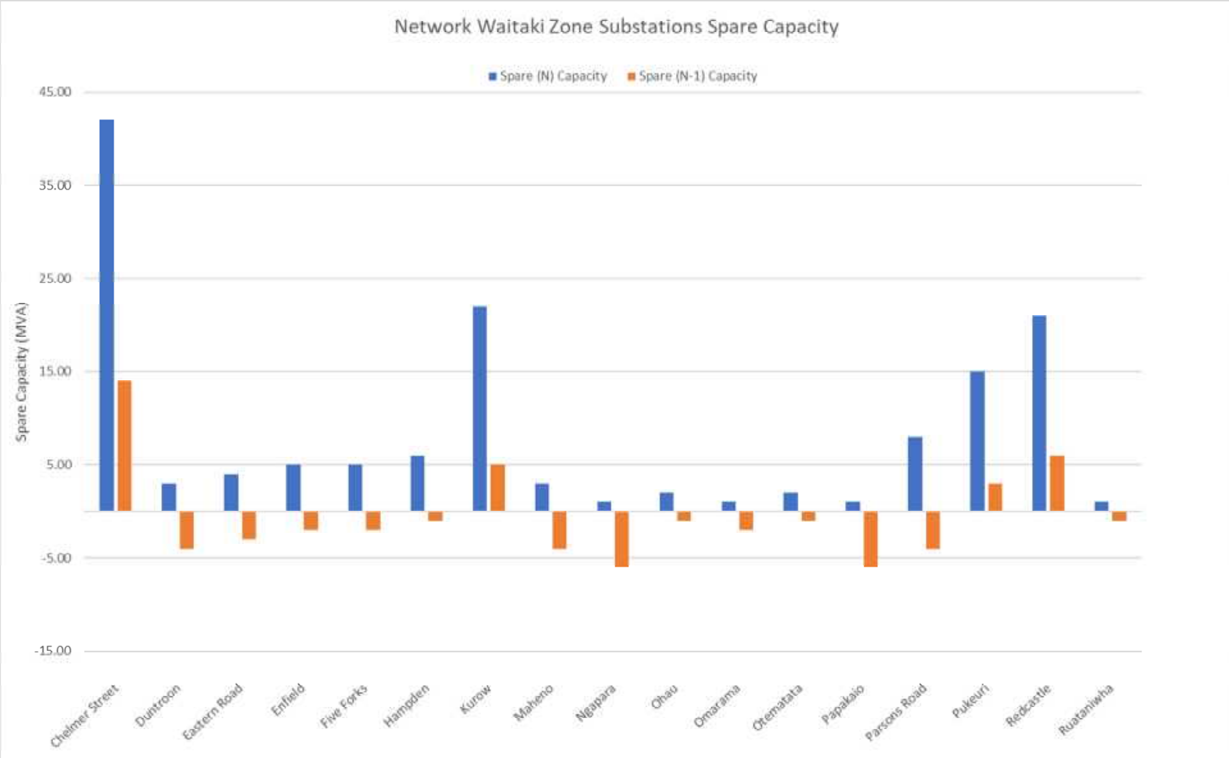

Figure 4 Summary: Approximate (N) and (N-1) spare capacity at Network Waitaki's zone substations

The above figures do not consider the spare capacity of the network of lines/cables that supply the associated GXP or zone substations. This is due to the fact that in most cases multiple substations are supplied via the same lines/cables and the spare capacity is a function of both load current and network voltage. This means that detailed load-flow studies are required to establish the spare capacity of the lines/cables that supply the substations. Having said this, the line/cable networks that supply the three EDB networks have a number of key features, as follows:

- The majority of zone substations in EA Networks are supplied at 66kV and distribute power to consumers at 22kV. EA Networks' 66kV and 22kV networks are generally lightly loaded, not subject to voltage constraints and well placed to supply additional load.
- EA Networks is supplied via the single Ashburton 220/66kV GXP that, in turn, is supplied by a high capacity 220kV network. The GXP supplies a significant load, is afforded with a significant amount of (N) spare capacity and is at risk from a high impact low probability (HILP) event. This is due to the lack of a second GXP that provides backup supply into EA Networks. Transpower's demand forecast infers that the Ashburton GXP has a relatively low level of spare (N-1) capacity, but EA Networks has indicated there could be as much as 40MVA available. The connection of significant additional load on Ashburton will bring forward the planned installation of a second GXP to supply EA Networks.
- The majority of Alpine's zone substations are supplied at 33kV and distribute power to consumers at 11kV. In some locations Alpine takes supply at 11kV from Transpower (i.e. GXP afforded with 110/11kV transformers), steps voltages up to 33kV (i.e. 33/11kV transformers) in order to supply its 33kV network.
- The majority of Network Waitaki's zone substations are supplied at 33kV and distribute power to consumers at 11kV. Many of the 33kV supply lines supply multiple 33/11kV zone substations.

- Both Alpine and Network Waitaki take supply from GXP's that are supplied via a shared 110kV network that is capacity constrained and afforded with a special protection system (SPS) to manage network outages. Network Waitaki is proposing the installation of a new 220/110kV GXP west of the existing Black Point GXP, coupled with the construction of a new 110kV line from the new GXP to the existing Oamaru GXP. If installed the new GXP and 110kV line could be used to off-load the existing 110kV network which, in turn, would deliver additional capacity to both Network Waitaki and Alpine Energy. The connection of a modest amount of additional load to the Alpine and Network Waitaki networks will bring forward the need to install the GXP (or implement an alternative solution).

1.2 Load Characteristics

The substation load characteristics are documented in detail in the main body of the report (and the supplementary document 22108-RPT-0002) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Albury GXP* – Predominantly rural loading with summer peaks, likely due to irrigation in the area. GXP loading is impacted by the presence of a 7MW embedded generator.
- *Ashburton GXP* – Significant summer peaks due to large irrigation load in the area. GXP loading is somewhat impacted by the intermittent nature of the two embedded hydro generators.
- *Bells Pond GXP* – Mix of dairy and irrigation load results in summer peaks. Winter loading is relatively flat throughout the day.
- *Black Point GXP* – GXP supplies a large irrigation scheme which results in intermittent loading, predominantly from September to May.
- *Oamaru GXP* - A typical mix of residential and commercial/industrial loads. The load tends to peak in the mornings and evenings and is lower during weekends.
- Studholme GXP – GXP supplies a dairy factory which results in a relatively flat load profile with a summer peak.
- *Tekapo A GXP* – Largely residential load with typical winter peak. Winter peak increases over weekends, likely due to the large number of holiday houses in the area.
- *Temuka GXP* – Loading is a mix of residential, irrigation and dairy loading. This results in a summer with a relatively flat load profile throughout the day and week.
- *Timaru GXP* - A typical mix of residential and commercial/industrial loads. The load tends to peak in the mornings and evenings and is lower during weekends.
- *Twizel GXP* - Largely residential load with typical winter peak. Winter peak increases over weekends, likely due to the large number of holiday houses in the area.
- *Waitaki GXP* - Significant summer peaks due to large irrigation load in the area. The load profile throughout the day and week is relatively flat.

Zone Substations:

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

1.3 EECA Load Sites

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

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

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

Summary: Load Sites vs transmission/distribution capital cost estimates

Table 1 Summary of Load Sites and estimated capital costs

No.	Load Site Name	Load (MW)	Transmission Details		Distribution		TOTAL	Cost Efficiency ($M/MW)	Complexity of Connection	Refer to notes
			GXP Substation	Upgrade Costs ($M)	Zone Substation	Upgrade Costs ($M)	Upgrade Costs ($M)			
1	Talleys - Ashburton (with N-1 Supply)	14.00	Ashburton	$0.00	Fairton	$1.61	**$1.61**	**$0.12**	Minor	1,2,3
2	Ashburton Meat Processors	0.98	Ashburton		Northtown	$0.29	**$0.29**	**$0.30**	Minor	3
3	Canterbury Dried Foods	2.25	Ashburton		Elgin	$0.05	**$0.05**	**$0.02**	Minor	3
4	ANZCO Canterbury	10.12	Ashburton		Seafield	$1.91	**$1.91**	**$0.19**	Minor	3
5	Mt Hutt Lime	1.72	Ashburton		Methven	$1.52	**$1.52**	**$0.88**	Minor	3
6	Oceania Dairy Ltd (Option 4 - 110kV Supply)	26.10	Bells Pond	$1.20	Cooneys Road	$3.90	**$5.10**	**$0.20**	Moderate	5
7	Canterbury Spinners	3.22	Oamaru	$0.00	Chelmer St/Redcastle	$1.30	**$1.30**	**$0.40**	Minor	3
8	Oamaru Meats	1.08	Oamaru		Redcastle	$0.00	**$0.00**	**$0.00**	Minor	3
9	Alliance Pukerui	8.75	Oamaru		Pukerui	$3.55	**$3.55**	**$0.41**	Moderate	4
10	Moeraki Charging Station (Option 1 - 1.5MW)	1.50	Oamaru		Hampden	$0.62	**$0.62**	**$0.41**	Minor	3
11	Fonterra Studholme	16.00	Studholme	$1.00	Studholme	$2.10	**$3.10**	**$0.19**	Moderate	5
12	Barkers Fruit Processing	1.29	Temuka	$0.00	Geraldine	$1.13	**$1.13**	**$0.87**	Minor	3
13	Ravensdown Lime	1.29	Temuka		Geraldine	$1.17	**$1.17**	**$0.91**	Minor	3
14	Synlait Talbot Forest Cheese	1.30	Temuka		Temuka	$0.75	**$0.75**	**$0.58**	Minor	3
15	Fonterra Clandeboye (Option 3 - heat pump and 4 boilers)	91.00	New	$51.90	New	$0.00	**$51.90**	**$0.57**	Major	6
16	South Canterbury By Products (Option 1 - 8.5MW)	8.50	Timaru	$0.00	Timaru	$3.00	**$3.00**	**$0.35**	Minor	3
17	McCain Foods (Option 1 - 8MW)	8.00	Timaru		Timaru	$1.80	**$1.80**	**$0.23**	Minor	3
18	Woolworks Washdyke	9.00	Timaru		Timaru	**Load Site committed**			Minor	3,7
19	Silver Fern Farms Pareora (N Supply)	7.91	Timaru		Paerora	$0.24	**$0.24**	**$0.03**	Minor	3
20	Alliance Smithfield	5.85	Timaru		Timaru	$0.95	**$0.40**	**$0.07**	Minor	3
21	Timaru Charging Station (Option 1 - 1.1MW)	1.10	Timaru		Timaru	$0.40	**$0.40**	**$0.36**	Minor	3
22	Omarama Charging Station (Option 1 - 1.5MW)	1.50	Twizel	$0.00	Omarama	$0.31	**$0.31**	**$0.21**	Minor	3
	TOTAL =>	**222.5**	**TOTAL =>**	**$54.1**	**TOTAL =>**	**$26.59**	**$80.14**			

1 Load Site requirement was indicated by EECA to be 11 - 14MW. Option 2 (N-1) costs are assumed
2 Assuming a 14MW load, Ergo has used the (N-1) supply option costing
3 Transmission upgrade is unlikely required for supply of individual Load Sites, but connection of multiple sites could require transmission upgrade
4 Ergo understands Network Waitaki are planning a new GXP by 2027 which will be required to connect this Load Site
5 Assumes Network Waitaki's new GXP removes the upcoming constraint on the 110kV line so connection would be limited to after 2027
6 Assumes "Option 3" providing a 110kV connection between Orari-Clandeboye-Temuka
7 Load site is committed/proceeding and costs have been estimated in detail by others

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.

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

2. Introduction

The consumers in the South Canterbury Region are supplied with electricity via electrical networks that are owned by the following Electrical Distribution Businesses (EDB):

- EA Networks – 21 zone substations
- Alpine Energy - 21 zone substations
- Network Waitaki - 17 zone substations

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

The Energy Efficiency & Conservation Authority (EECA) is running a flagship program that is called Energy Transition Accelerator (ETA)[3]. The program is targeted at large energy-using businesses and public sector organisations that are committed to reducing carbon emissions.

As part of the ETA program, EECA contracted Ergo to determine the existing spare supply capacity and the load characteristics at the major electrical substations within the South Canterbury Region. The scope of Ergo's work is discussed in more detail in Section 3.

Ergo previously developed a similar report for the Southland Region.[4]

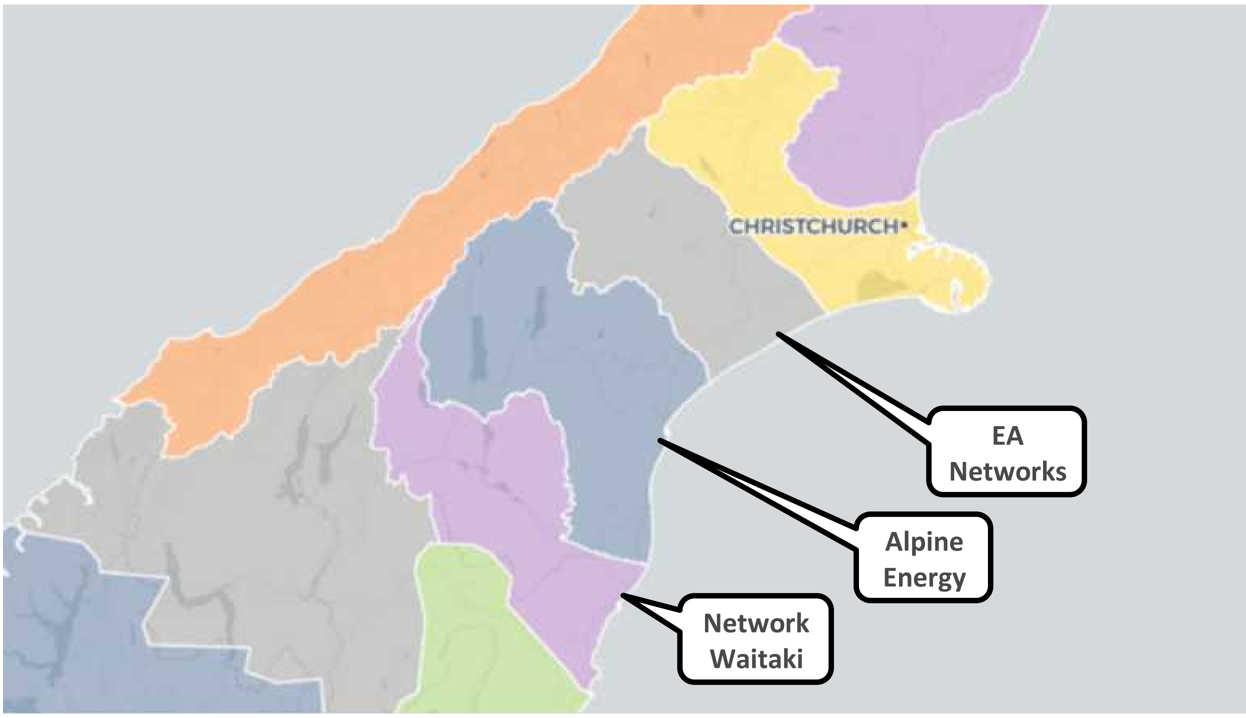


Figure 5 Electrical Distribution Business (EDB) franchise areas[5]

[3] https://www.eeca.govt.nz/co-funding/energy-transition-accelerator/

[4] 21177-RPT-0001 [G] Southland Electrical Network - Spare Capacity and Load Characteristics.

[5] 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-1) and (N) security) and supply characteristics (peak and average supply and seasonality information) for the major electrical infrastructure in the South Canterbury Region. This included reviewing both the GXP's and local distribution zone substations along with their associated lines/cables within the South Canterbury Region.

In addition to the above, EECA provided a number of Load Sites in which Ergo were asked to assess:

1) Whether the existing electrical infrastructure was likely able to supply the additional load, and
2) If upgrades were required, outline option(s) and estimate capital costs for the necessary electrical infrastructure upgrades from both a transmission and distribution perspective.

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

- Transpower's 2022 Planning Report.
- EA Networks' 2021 Disclosures and Asset Management Plan.
- Alpine Energy's 2021 Disclosures and Asset Management Plan.
- Network Waitaki's 2021 Disclosures and Asset Management Plan.
- SCADA substation loading data provided by EA Networks, Alpine Energy, Network Waitaki, and Transpower for a 12-month period.
- Network diagrams provided by EA Networks, Alpine Energy and Network Waitaki.
- Geographic Information System (GIS) asset and location data provided by Alpine Energy, Network Waitaki and EA Networks. This was mostly supplied in the form of *.kmz files.

4. South Canterbury Network

The following sections describes (at a high level), the locations of the relevant substations and lines. For the purposes of this document the franchise areas supplied by EA Networks, Alpine Energy and Network Waitaki are referred to as the South Canterbury Region.

4.1 Transmission/GXP Substations

The following Figure 6 illustrates the relevant transmission substations (GXPs) within the South Canterbury Region, which include the following:

- Albury GXP (and hydro power station).
- Ashburton GXP.
- Bells Pond GXP.
- Black Point GXP.
- Oamaru GXP.
- Studholme GXP.
- Tekapo A GXP (and hydro power station).
- Temuka GXP.
- Timaru GXP.
- Twizel GXP (and hydro power station).
- Waitaki GXP (and hydro power station).

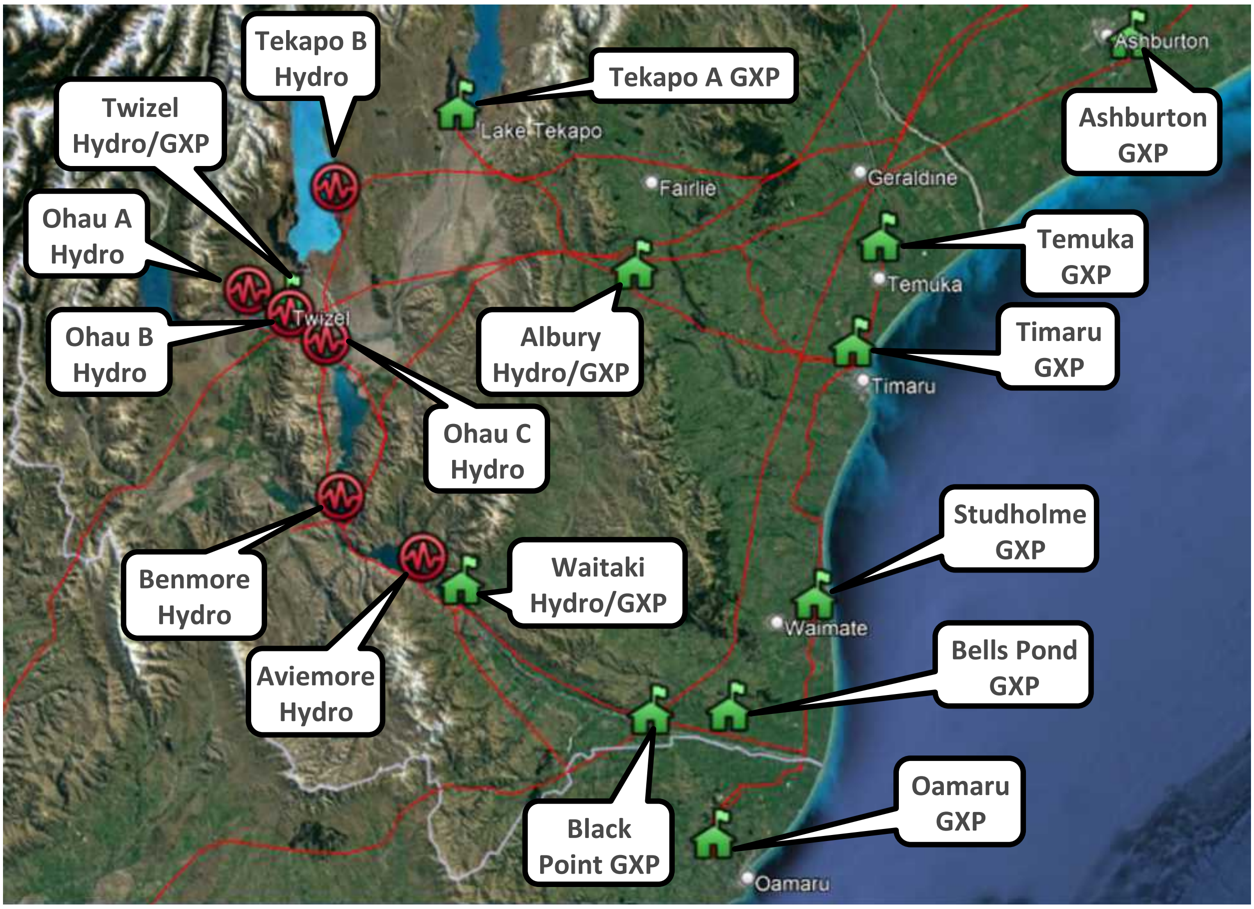


Figure 6 Transmission/GXP/Hydro substations (red lines are Transpower's transmission lines, yellow lines are roads)

The transmission network in the South Canterbury Region is also shown diagramatically in Figure 7 and Figure 8. The network is comprised of 220 kV and 110 kV transmission circuits, with 220/110kV interconnecting transformers at Timaru and Waitaki. A key feature is that almost all loads (i.e. GXPs) in the South Canterbury region are supplied via the 110 kV transmission network, which runs up the east coast from Oamaru to Temuka. The 110 kV transmission network is split at Studholme from May to September, which results in two radial 110kV networks that incorporate:

- Timaru 220/110 kV interconnecting transformers supplying the Timaru, Albury, Tekapo A and Temuka GXPs.
- Waitaki 220/110 kV interconnecting transformers supplying the Bells Pond, Black Point, Oamaru and Studholme GXPs.

Much of the 110 kV transmission network is at capacity. This is mainly due to growth associated with the dairy industry, including dairy processing expansion and irrigation. Supplying existing and committed new load via the 110 kV network is achievable but will become increasingly difficult to manage if significant increases in demand occur.

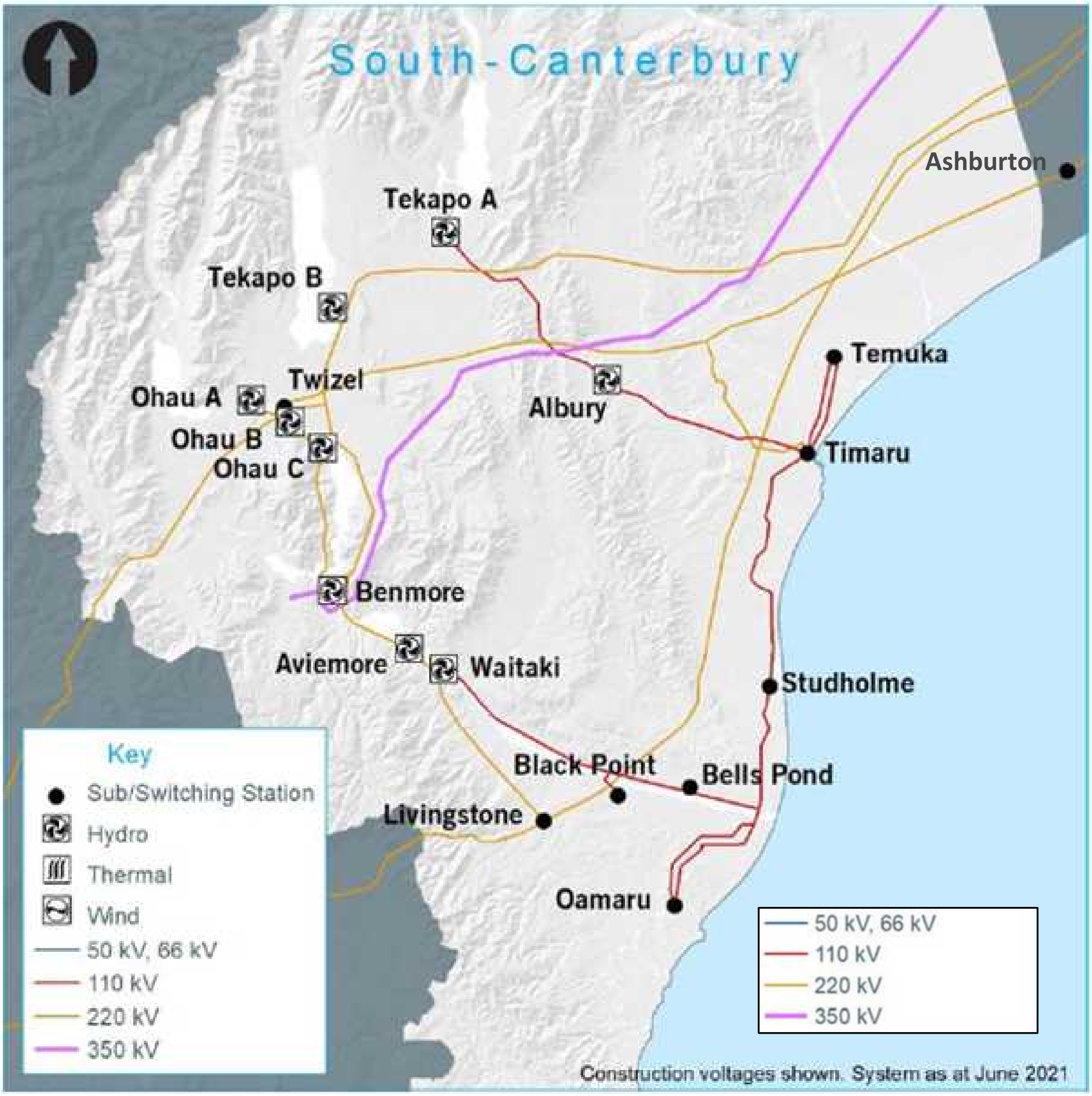


Figure 7 Transmission/GXP substations[6]

[6] https://tpow-corp-content.catalystdemo.net.nz/sites/default/files/publications/resources/2022 Transmission Planning Report.pdf.

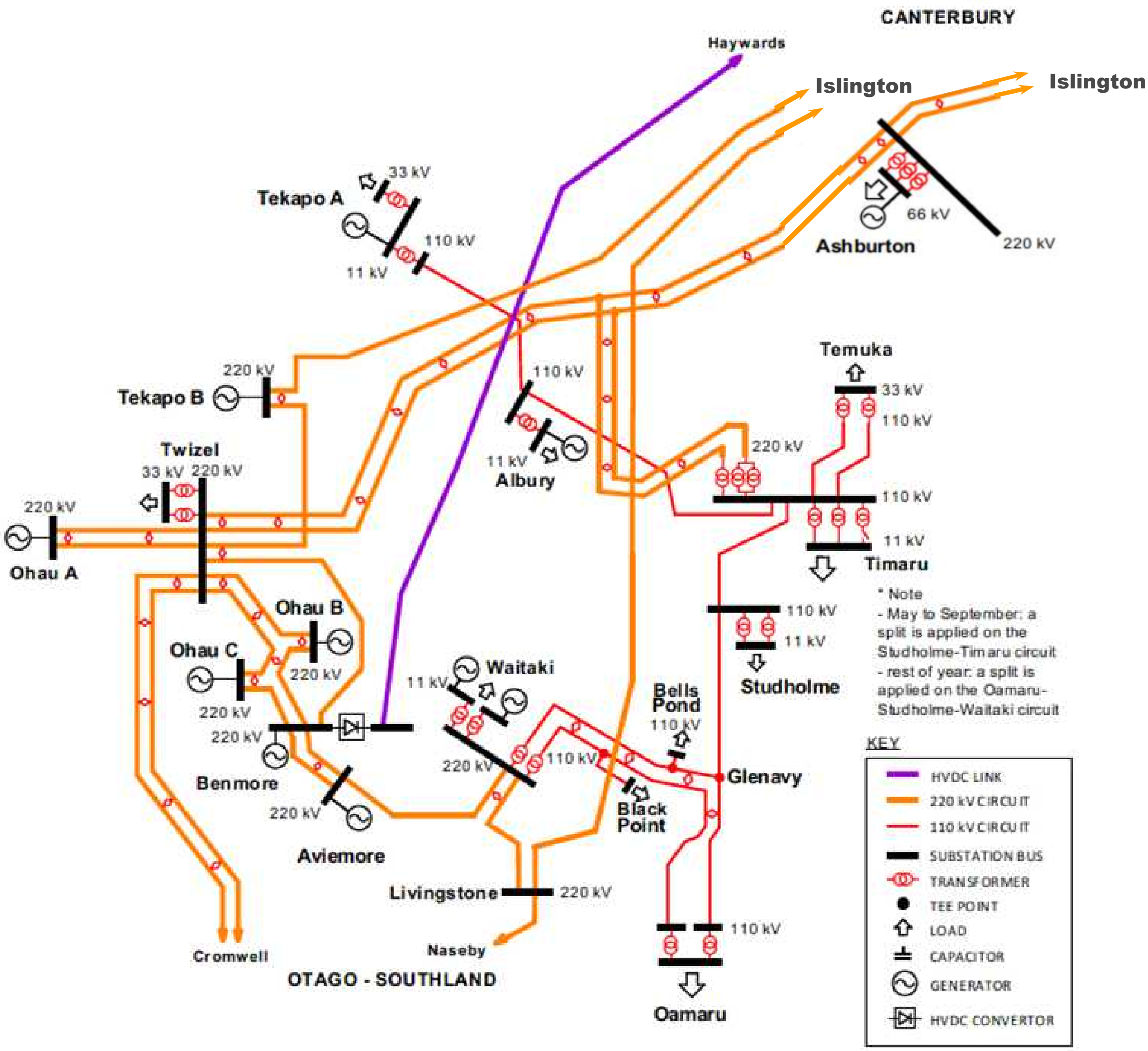


Figure 8 Existing transmission/GXP substations[6]

4.2 Zone Substations

Zone substations are categorised by the Electrical Distribution Business (EDB) that owns and operates the network. As mentioned earlier, in the area investigated, there are three relevant EDB's – EA Networks, Alpine Energy and Network Waitaki. Table 2 below gives an overview of the number of Zone Substations managed by each investigated EDB, and the number of Transpower GXPs they take power from.

Table 2 Overview of substation numbers for each EDB investigated

EDB Name	Three-letter acronym	Number of Zone Substations	Number of GXPs
EA Networks	EAN	20	1
Alpine Energy	ALP	21	7
Network Waitaki	NTW	17	4

4.2.1 EA Networks

The following Figure 9 and Figure 10 shows the zone substations on EA Networks' network diagrammatically. The substations include:

- Ashburton (ASH) 66/11kV zone substation
- Carew (CRW) 66/22kV zone substation
- Coldstream (CSM) 66/22kV zone substation
- Dorie (DOR) 66/22kV zone substation
- Eiffelton (EFN) 66/22kV zone substation
- Fairton (FTN) 66/22/11kV zone substation
- Hackthorne (HTH) 66/22kV zone substation
- Lagmhor (LGM) 66/22kV zone substation
- Lauriston (LSN) 66/22kV zone substation
- Methven (MVT) 66/22kV zone substation
- Mt Hutt (MHT) 33/11kV zone substation
- Methven (MTV) 66/11kV zone substation
- Montalto (MON33) 33/11kV zone substation
- Mt Somers 66/22kV zone substation
- Northtown (NTN) 66/11kV zone substation
- Overdale (OVD) 66/22kV zone substation
- Pendarves (PDS) 66/22kV zone substation
- Seafield (SFD22) 22/11kV zone substation (only provides backup to
- Seafield (SFD66) 66/11kV zone substation
- Tinwald (TIN) 66/22/11kV zone substation
- Wakanui (WNU) 66/22kV zone substation

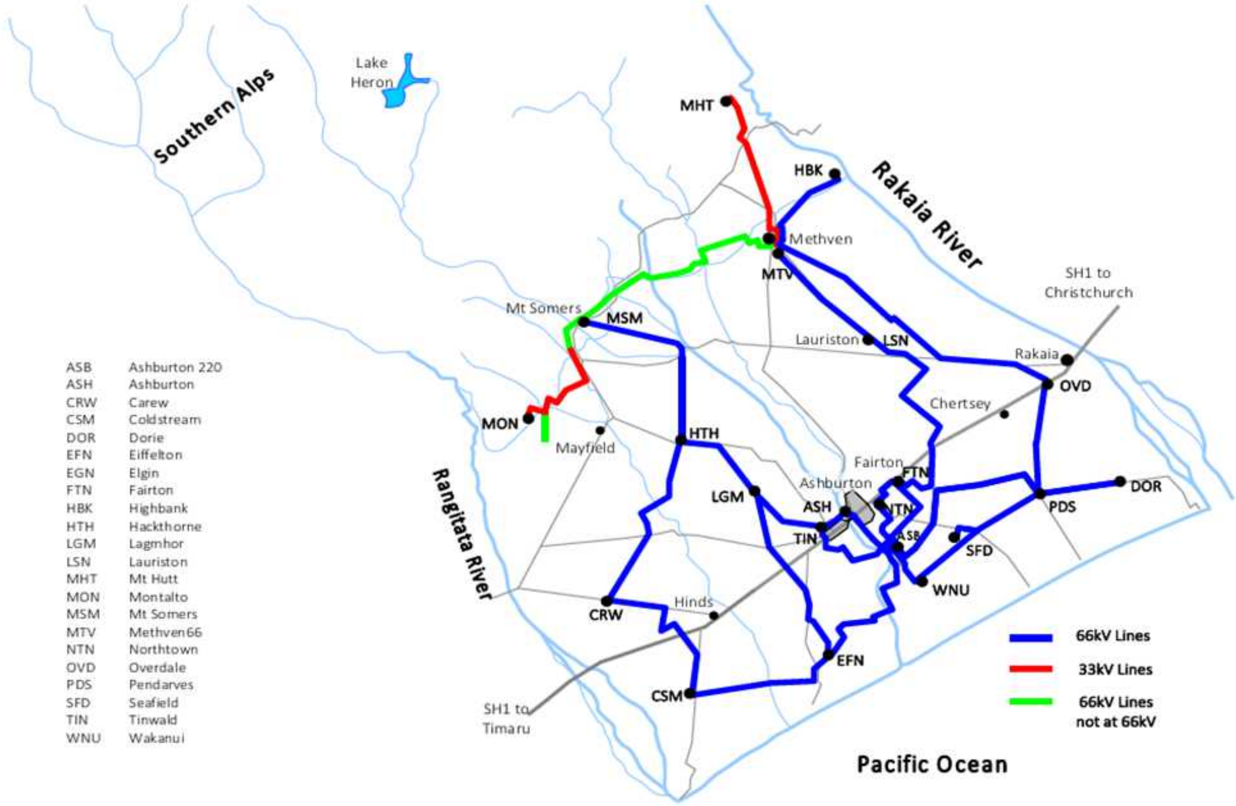


Figure 9 EA Networks' Zone Substation Geospatial Sub-transmission Diagram[7]

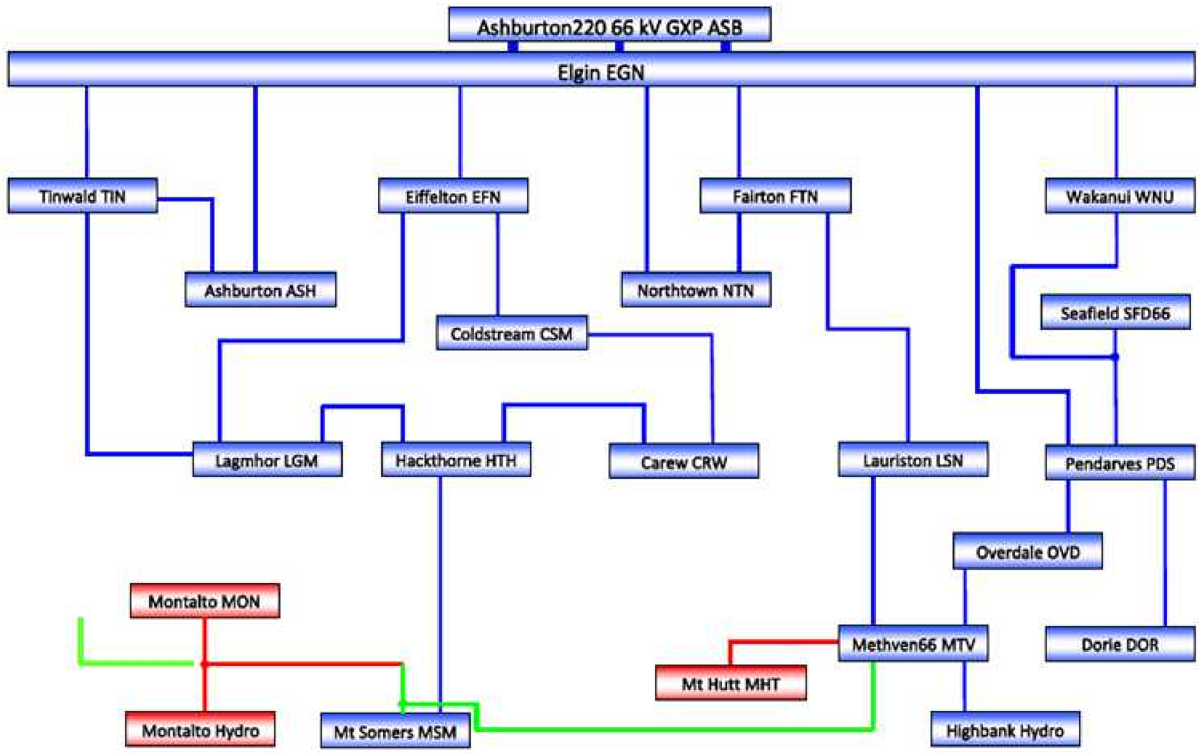


Figure 10 EA Networks' Zone Substation One-line Sub-transmission Diagram[7]

[7] https://www.eanetworks.co.nz/assets/PDFs/Disclosures/Asset-Management-Plan/AMP_2021-31_Final.pdf

4.2.2 Alpine Energy

The following Figure 11 shows zone substations on Alpine Energy's network diagrammatically. The substations include:

- Albury (ABY) 110/11kV zone substation (Alpine owns the transformers)
- Bells Pond (BPD) 110/33/11kV zone substation (Alpine Energy owns the transformers)
- Old Man Rage (OMR) 11/22kV zone substation (Auto-transformer)
- Clandeboye 1 (CD1) 33/11kV zone substation
- Clandeboye 2 (CD2) 33/11kV zone substation
- Cooney's Road (CNR) 33/11kV zone substation
- Fairlie (FLE) 33/11kV zone substation
- Geraldine (GLD) 33/11kV zone substation
- Haldon Lilybank (HLB) 11/22kV zone substation (Auto-transformer)
- Pareora (PAR) 33/11kV zone substation
- Pleasant Point (PLP) 33/11kV zone substation
- Rangitata (RGA) 33/11kV zone substation
- Studholme (STU) 110/11kV zone substation (Transpower owns the transformers)
- Tekapo Village (TEK) 33/11kV zone substation
- Temuka (TMK) 33/11kV zone substation
- Timaru (TIM) 110/11kV zone substation (Transpower owns the transformers)
- Twizel Village (TVS) 33/11kV zone substation
- Unwin Hut (UHT) 33/11kV zone substation

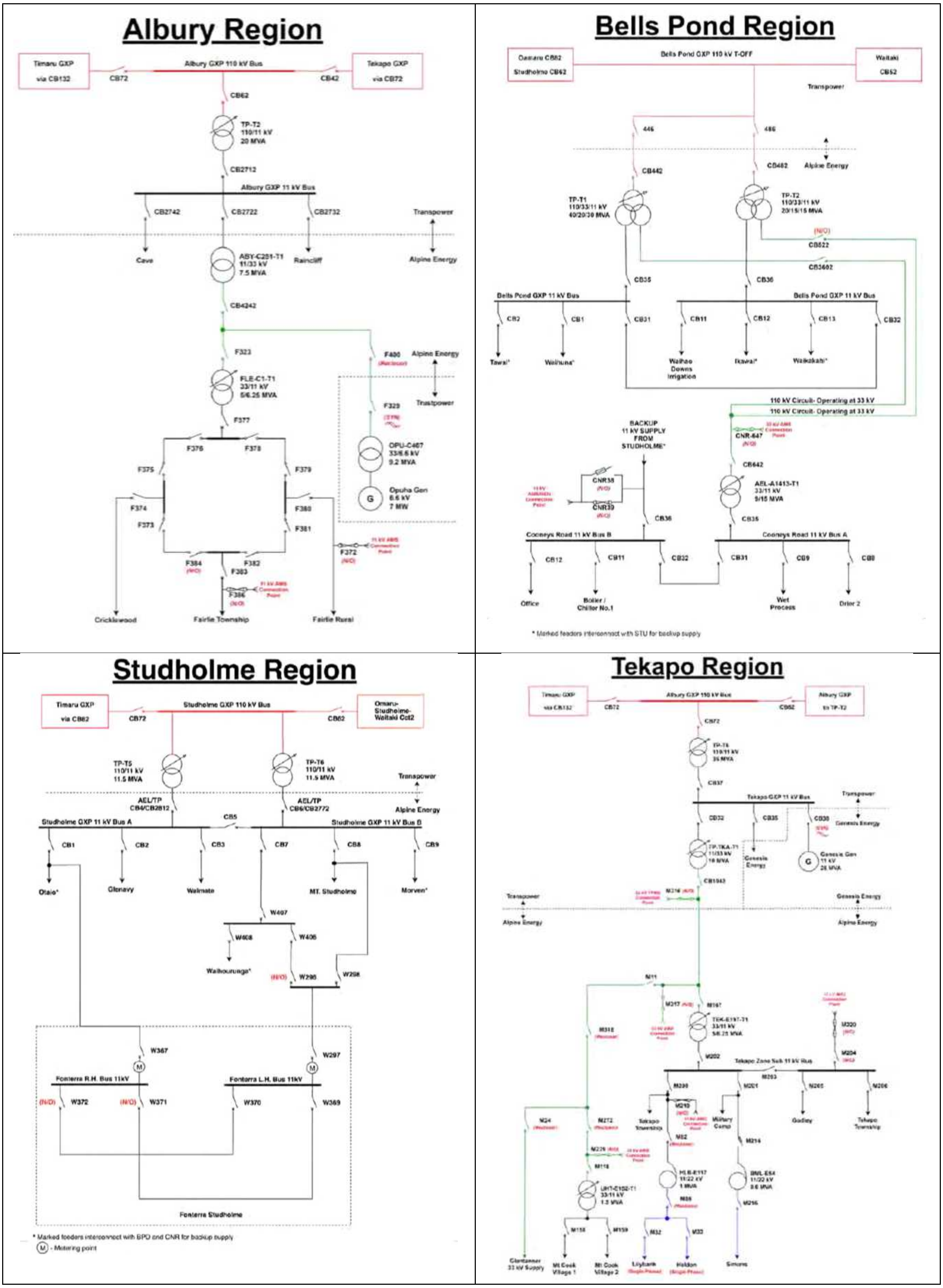


Figure 11 Alpine Energy's Zone Substation Sub-transmission Diagram[8]

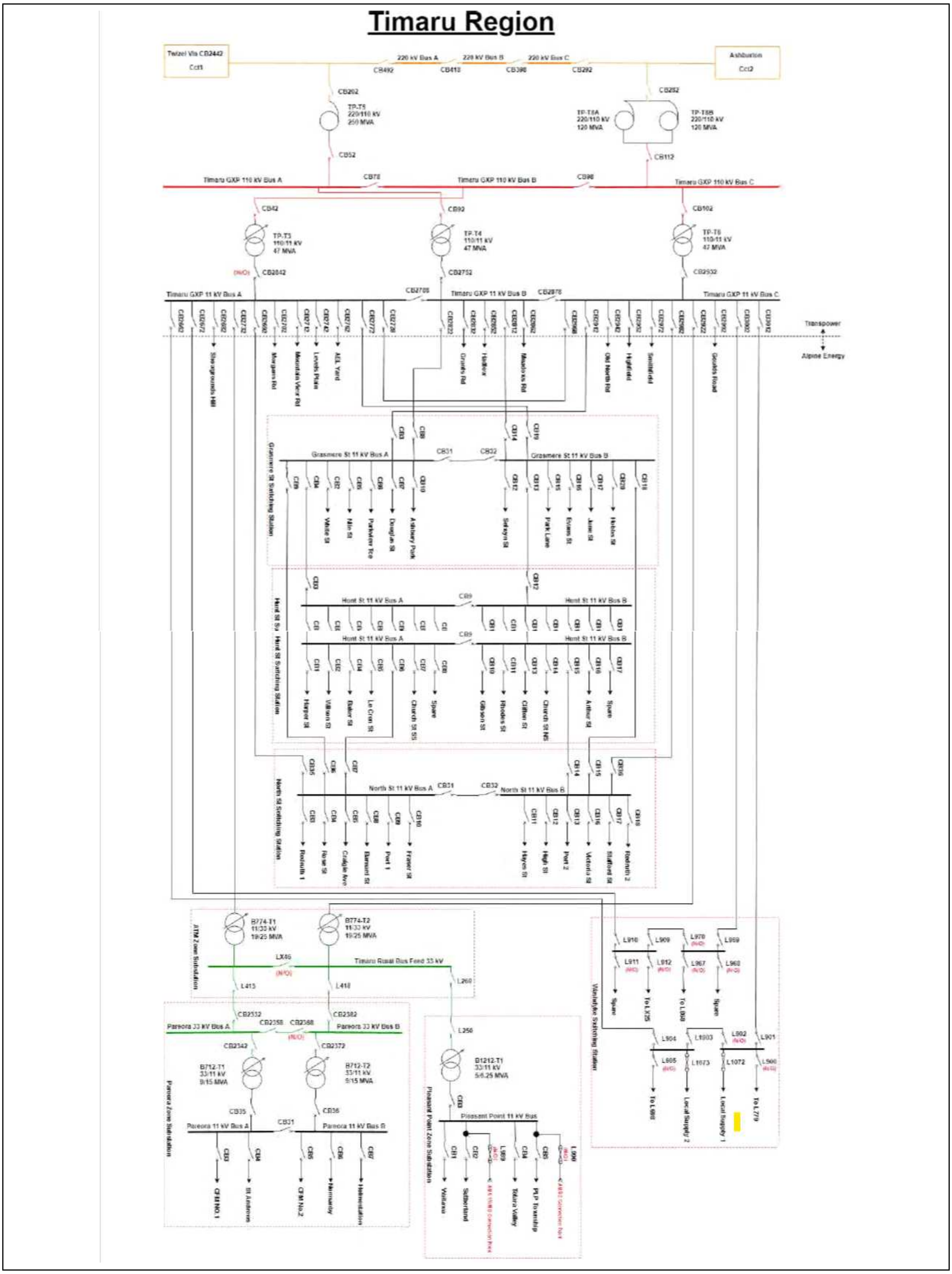


Figure 12 Alpine Energy's Zone Substation Sub-transmission Diagram[8]

[8] https://www.networkwaitaki.co.nz/assets/Uploads/Asset-Management-Plans/Network-Waitaki-Ltd-Asset-Management-Plan-31-March-2022-signed.pdf

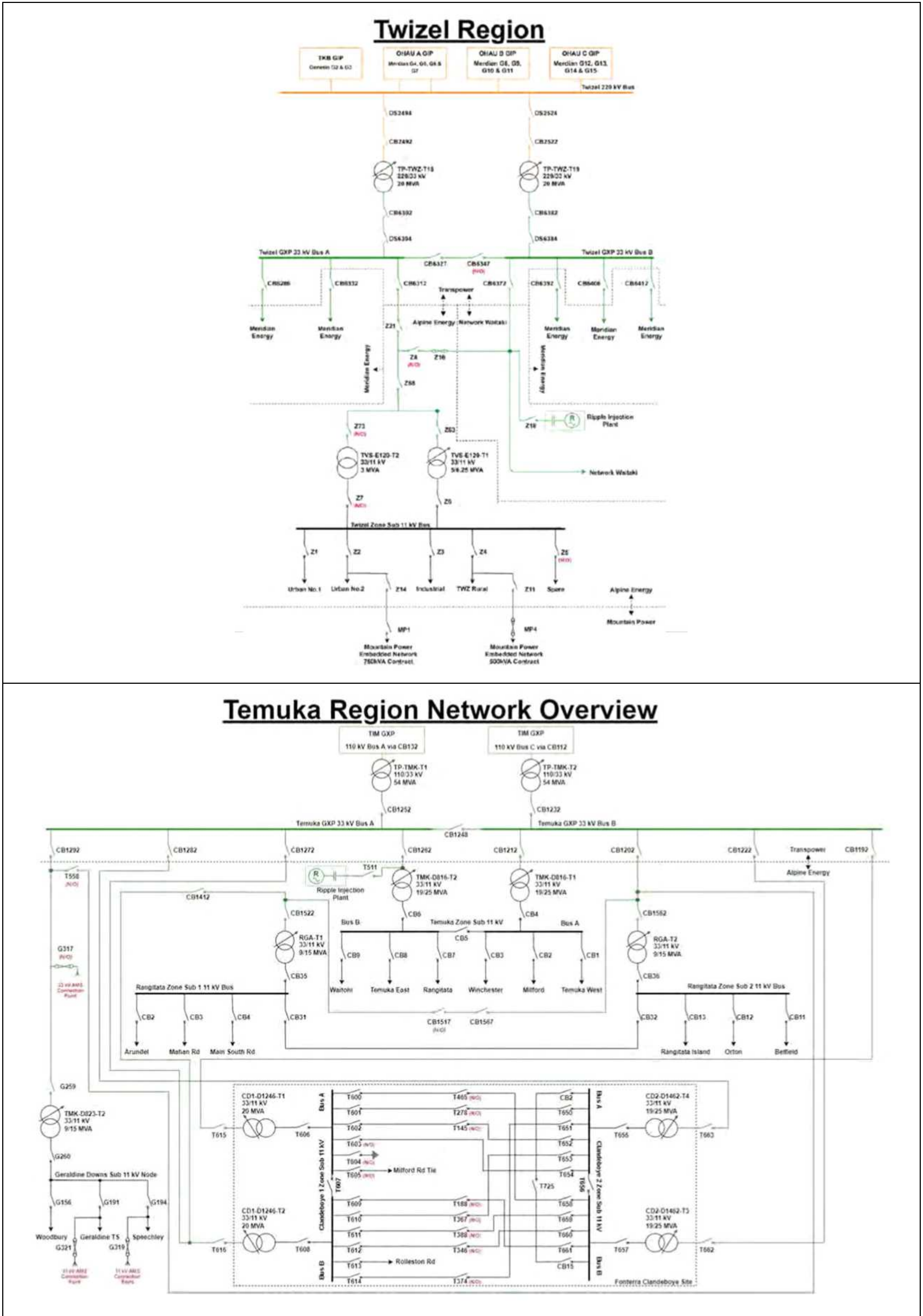


Figure 13 Alpine Energy's Zone Substation Sub-transmission Diagram[8]

4.2.3 Network Waitaki

The following Figure 14 shows zone substations on Network Waitaki's network diagrammatically. The substations include:

- Chelmer Street 33/11kV zone substation
- Duntroon 33/11kV zone substation
- Eastern Road 33/11kV zone substation
- Enfield 33/11kV zone substation
- Five Forks 33/11kV zone substation
- Hampden 33/11kV zone substation
- Kurow 33/11kV zone substation
- Maheno 33/11kV zone substation
- Ngapara 33/11kV zone substation
- Ohau 33/11kV zone substation
- Omarama 33/11kV zone substation
- Otematata 33/11kV zone substation
- Papakaio 33/11kV zone substation
- Parsons Road 33/11kV zone substation
- Pukeuri 33/11kV zone substation
- Redcastle 33/11kV zone substation
- Ruataniwha 33/11kV zone substation

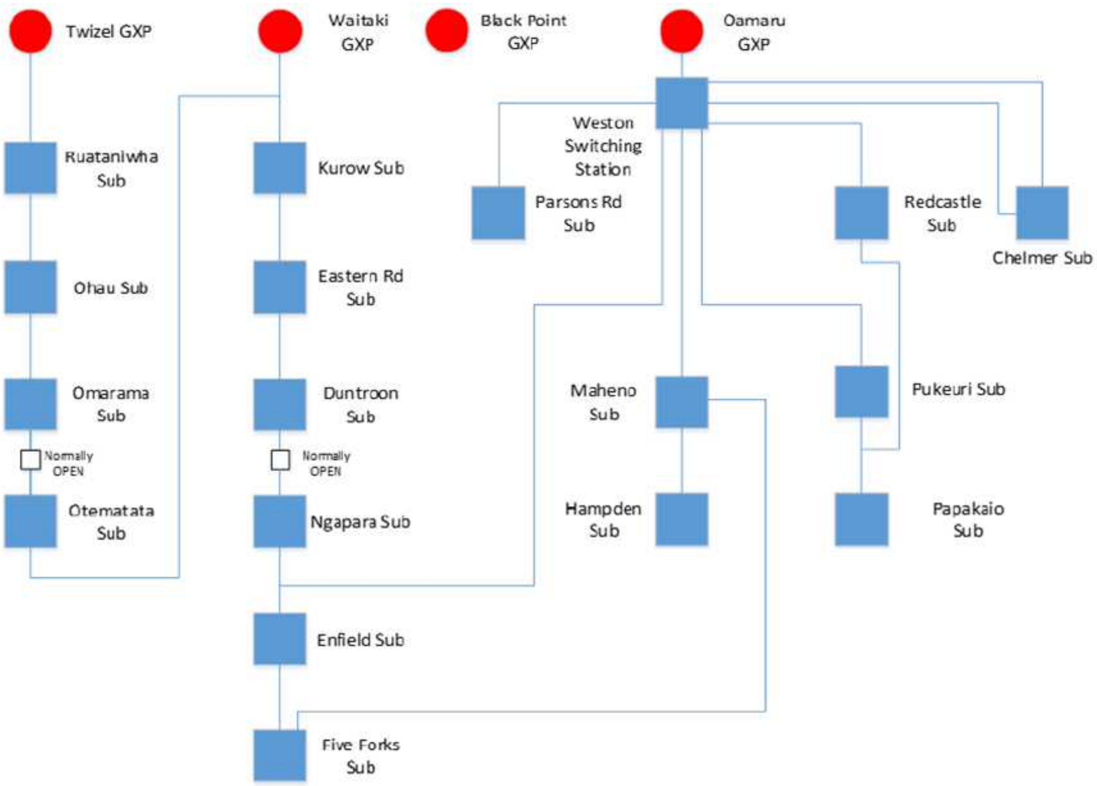


Figure 14 Network Waitaki's Zone Substation Sub-transmission Diagram[9]

[9] https://www.networkwaitaki.co.nz/assets/Uploads/Asset-Management-Plans/Network-Waitaki-Ltd-Asset-Management-Plan-31-March-2022-signed.pdf

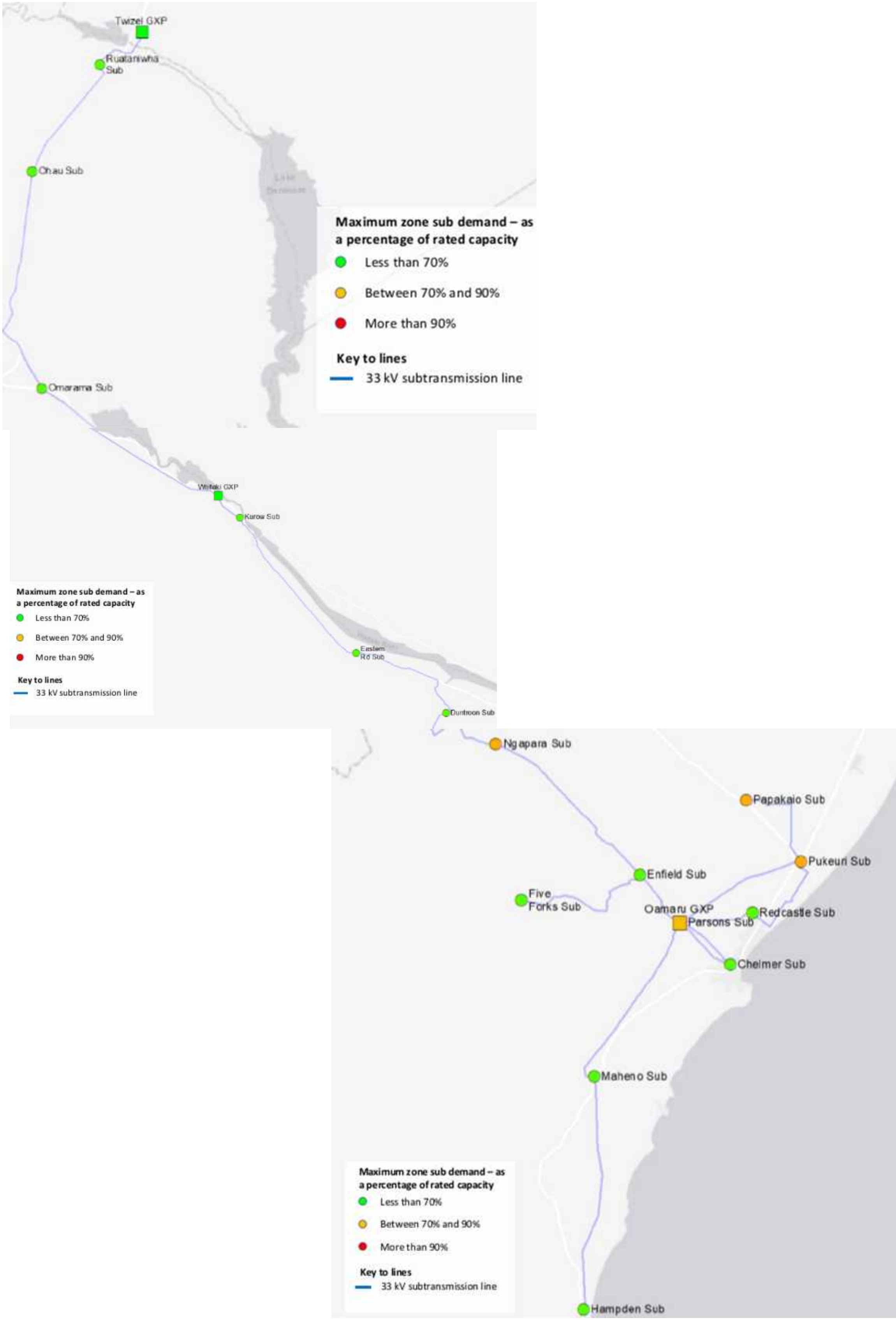


Figure 15 Network Waitaki's Zone Substation Sub-transmission Diagram[9]

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)[10]. In contrast, EDBs are required to publish a network security criteria, 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 assets). 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. Again, can be compared with an aircraft, but in this case with two engines, which in the event of single engine failure will not crash.

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

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

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

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

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

The 11 South Canterbury Transpower GXPs discussed in this report are considered connection assets and therefore decisions around their security classifications lie with their end customers (i.e. EA Networks, Alpine Energy or Network Waitaki). For those substations that are supplied via dedicated incoming lines, the lines are also considered to be connection assets. The remaining lines that are not dedicated to a single substation are interconnection assets.

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

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

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 and also the development of a market for interruptible load[11]. There are examples of this at both transmission and distribution levels. This has allowed Transpower and EDB's to operate some sections of their networks well beyond their (N-1) limits, whilst still maintaining sufficient security of supply to the majority of their consumers.

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

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

6. Spare Capacity – Transmission Substations

The following sections document the spare capacity that is individually available on the 11 GXP's that take supply from within the South Canterbury Region.

Transpower has identified the following "*core grid issues*" that result from increasing electrical demand in the South Canterbury Region including:

- The Oamaru, Black Point, Bells Pond, and Studholme GXPs are collectively referred to as the lower Waitaki Valley area. These substations are supplied via two 110 kV circuits from Waitaki:
    - Oamaru–Black Point–Waitaki 1 circuit (supplies Black Point via a Tee connection)
    - Oamaru–Studholme–Bells Pond–Waitaki 2 circuit (supplies the Bells Pond and Studholme loads from Tee connections).

  There is also a 110 kV circuit into Studholme from Timaru, but this circuit is normally opened in the dairy off-season (May to September) when demand is lower. This open configuration significantly reduces transmission losses and outweighs the benefits of providing (N-1) capacity to Studholme during winter. In the event of an unplanned outage of the Oamaru–Studholme–Bells Pond–Waitaki 2 circuit, the Studholme auto-changeover scheme switches to the Studholme–Timaru circuit so that the Studholme load is supplied from Timaru. When demand from the dairy factory connected to Studholme is high (over the summer months) the 110 kV Studholme–Timaru circuit is closed to provide (N-1) security to Studholme. The increased load at Studholme and the higher value of the load (the dairy factory) means the benefit of providing higher security to Studholme is higher than the cost of increased transmission losses. With the 110 kV Studholme–Timaru circuit closed, power normally flows from Waitaki, via Studholme, to Timaru. With the circuit closed, Timaru provides some voltage support to the lower Waitaki Valley area.
- Two 220/110 kV interconnecting transformers supply the Timaru, Temuka, Albury, Tekapo A, and Studholme GXPs (collectively referred to as the Timaru area), and provide:
    - A total nominal installed capacity of 490 MVA.
    - (N-1) thermal capacity of 244/256 MVA (summer/winter).
    - Low voltage limits on 110 kV buses of approximately 150-165 MW (without Tekapo A generation).
    - Static voltage stability limits of approximately 165-185 MW (without Tekapo A generation).
    - Dynamic voltage stability limits similar to the static voltage stability limits.

[11] https://www.transpower.co.nz/system-operator/electricity-market/instantaneous-reserve.

- A thermal limit set by the 220 kV Opihi–Timaru circuits of approximately 170-180 MW (without Tekapo A generation[12]).

The Timaru area load is forecast to exceed:

- The Timaru area voltage stability limits from 2021 (without Tekapo A generation[12]).
- The 220 kV Opihi–Timaru summer (N-1) capacity from 2027 (without Tekapo A generation[12]).

- Two 220/110 kV interconnecting transformers at Waitaki supply the lower Waitaki Valley loads, and provide:
  - A total nominal installed capacity of 130 MVA.
  - (N-1) capacity of 80/85 MVA (summer/winter).

  The combined load (un-diversified) on the Oamaru and Bells Pond GXPs exceeds the post-contingency capacity of the network. A special protection scheme is installed that will manage load within the capacity of the transformers post-contingency. Also, the tap changers on the interconnecting transformers cannot be operated due to their condition. The lack of operable tap changers marginally worsens voltage issues on the lower Waitaki Valley 110 kV transmission system.

Figure 16 below illustrates Transpower's plans for new/upgraded transmission/substation assets in the South Canterbury Region. They include:

- A new 220/110kV substation to supply the loads supplied from the existing Oamaru, Waitaki and Black Point substations.
- The following enhancements at the Timaru GXP:
  - Installation of a 220kV bus.
  - Upgrade of the existing 110kV bus.
  - Upgrade of the 220/110kV interconnecting banks.
  - Installation of a new 220/33kV supply to Alpine Energy.
- Upgrade of the Timaru-Temuka 110kV lines and installation of a third 110/33kV transformer and 33kV bus extension at the Temuka GXP.
- The installation of the Rangitata and Orari 220kV switching stations.
- A new 220/66kV GXP to supply EA Networks.

6.1 Demand Forecast

The following Table 3 illustrates Transpower's forecast demand at the transmission substations in the South Canterbury Region. Note that the Twizel GXP has a leading power factor. Also, that EA Networks is reporting lower GXP loadings than that reported by Transpower. Also, both EA Networks and Network Waitaki have indicated that the year 2021 loads, that are presented and discussed in this report, were lower than as it was a particularly wet year and irrigation loads were lower.

[12] Generators, like Tekapo, are dispatched in accordance with bids into the Electricity Market. Depending on water flow, market conditions and power station maintenance, varying number of the station's generators would be operational. Under extreme conditions the station's output could be zero and may need to be "constrained on" by the NZ System Operator.

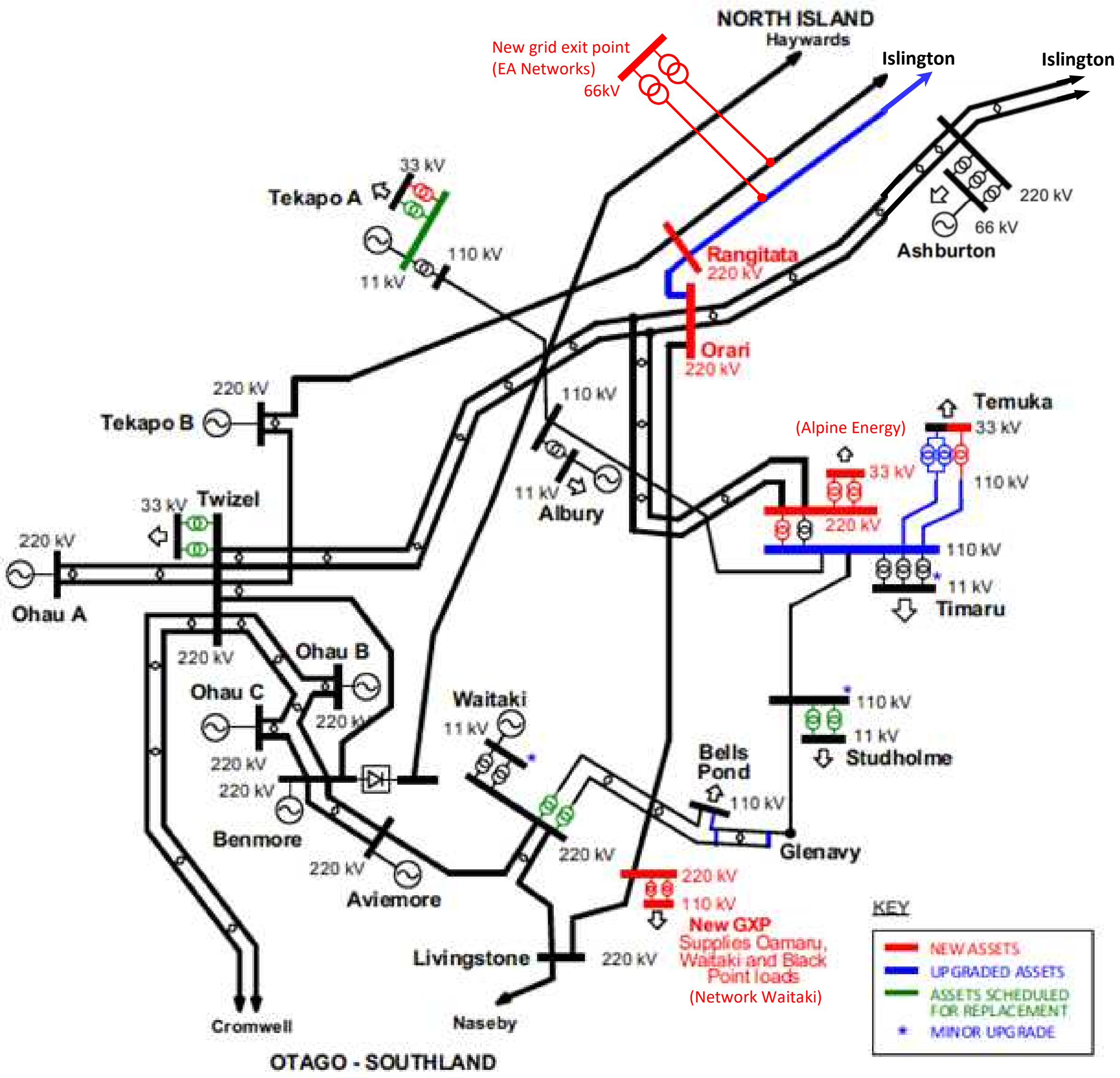


Figure 16 Existing transmission/GXP substations together with future proposed upgraded/new assets[6]

Table 3 Transpower demand forecast (Active Power)

No.	Substation / GXP	Power Factor	Demand (MW)											
			2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2037
1	Albury	0.98	6	6	7	7	7	7	7	7	8	8	8	9
2	Ashburton	0.96	199	206	210	212	228	231	234	236	238	240	243	260
3	Bells Pond[1]	0.96	24	26	27	29	30	32	33	34	36	37	38	44
4	Black Point[1]	0.91	16	16	20	20	20	20	20	20	20	20	20	21
5	Oamaru	0.98	46	51	53	55	62	64	66	67	69	69	70	72
6	Studholme	0.96	19	19	20	20	20	21	21	22	22	22	23	24
7	Tekapo A[2]	1.00	11	13	14	14	14	15	15	15	15	16	16	17
8	Temuka[1]	0.96	78	80	86	90	94	98	102	105	108	110	113	128
9	Timaru	0.99	80	80	81	84	85	86	86	87	87	88	88	90
10	Twizel	1.00	6	6	6	6	6	7	7	7	7	7	8	9
11	Waitaki[3]	0.91	15	15	15	15	16	16	16	16	16	16	16	17
		TOTAL	500	518	539	552	582	597	607	616	626	633	643	691

1. Includes committed step changes in customer loads (irrigation and dairy developments).
2. Includes committed commercial developments.
3. Load increases from additional irrigation demand.

6.1.1 Albury GXP (Opuha)

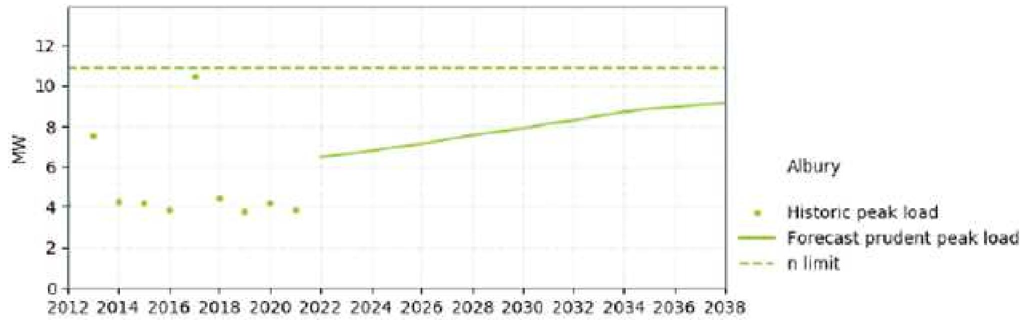
Transpower's demand forecast (refer Table 3) indicates that the Albury GXP is expected to have a 2022 peak demand of 6MW at 0.98pf. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Albury GXP experienced a peak load of 5.5MW.

Alpine Energy owns and operates the distribution network in the Albury area which supplies small townships and rural consumers. The predominant rural activity involves sheep, beef and dairy farming.

The Albury GXP load is supplied by a single 20MVA, 110/11kV transformer (i.e. N security). Albury has embedded generation at Opuha (7MW), which results in active power being injected (from Albury) onto the South Island Grid during periods of low demand and/or high generation.

The Albury GXP connects to the South Island grid via an ≈80km, single-circuit, 110kV, spur line that emanates from the Timaru GXP (summer/winter rating of 51/62MVA). Albury connects at ≈20km along the spur line and shares the spur with Tekapo A GXP that connects at ≈80km (i.e. the end).

The following graph compares Albury GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR).



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.

For the following reasons, Transpower indicates that the N security issue can be managed operationally for the forecast period:

- The existing embedded Opuha generation can supply some of the local load during planned outages at Albury.
- Alpine Energy can transfer some Albury load to adjacent GXPs.
- Transpower's mobile substation could be used at Albury to cover planned transformer outages.

Accordingly, Transpower has no planned investments to increase the security of supply to Albury.

There are no EECA Load Sites close to the substation.

The following Figure 17 illustrates Albury's July 2021 through June 2022 loading in comparison to the spare capacity that Transpower indicates is available at the substation. The significant, hour by hour, changes in the load on the substation result from the changes in the output in the above mentioned Opuha hydro.

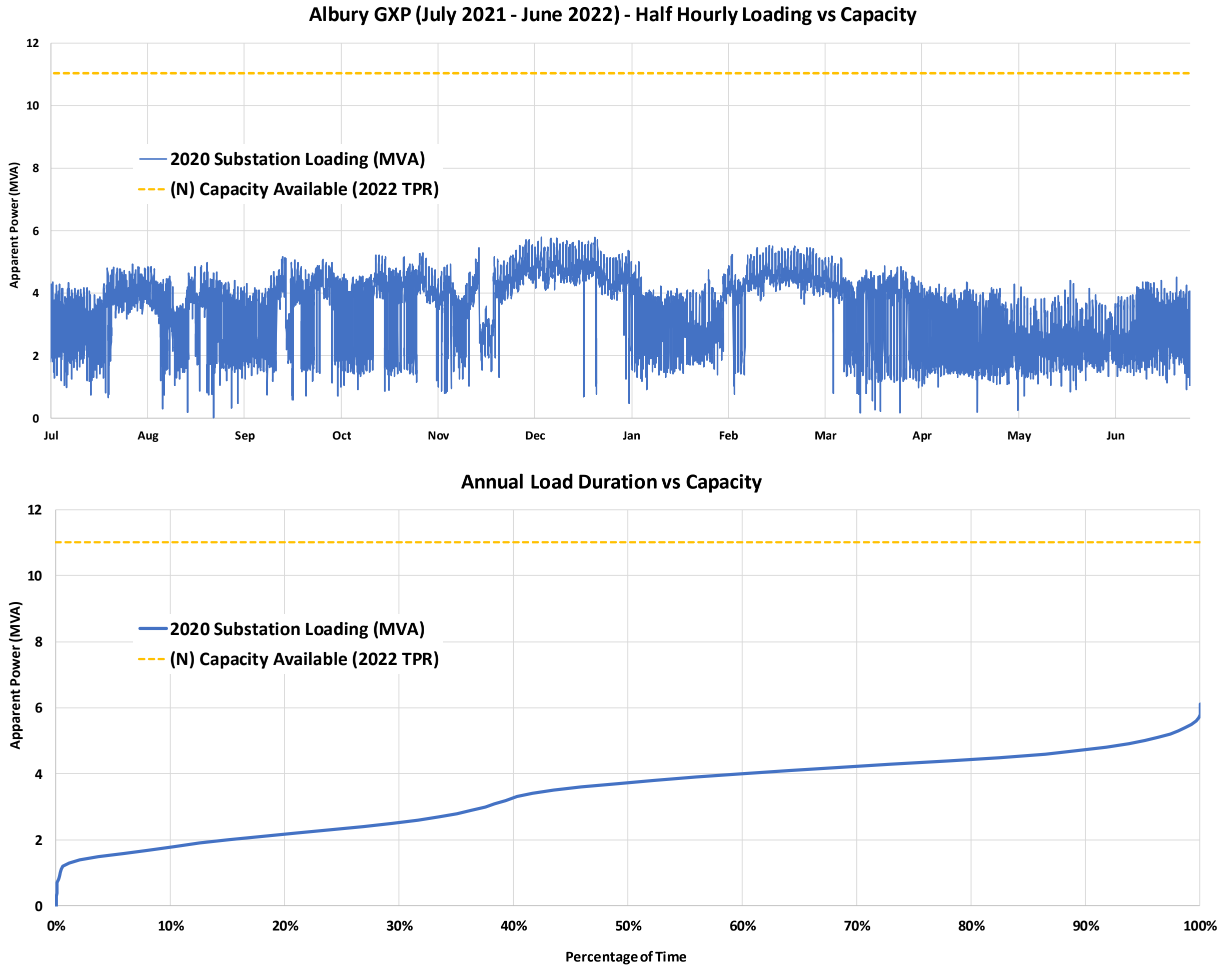


Figure 17 Albury GXP: 2020 Loading: Capacity Available

6.1.2 Ashburton GXP

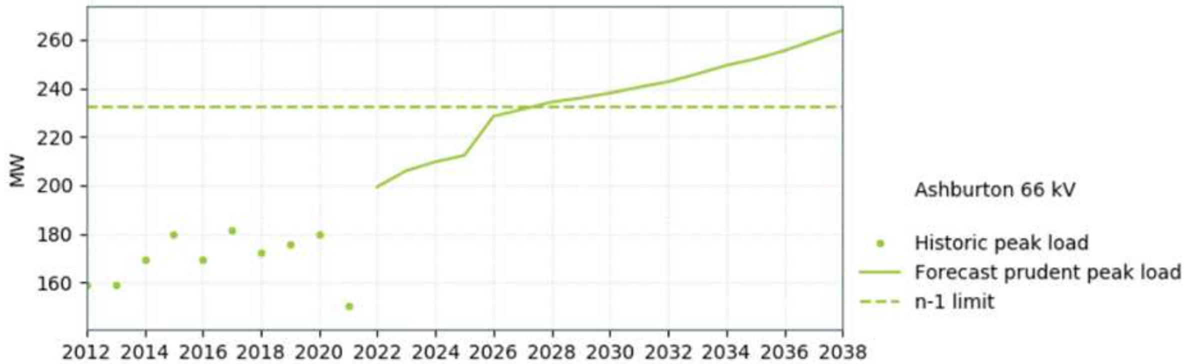
Transpower's demand forecast (refer Table 3) indicates that the Ashburton GXP is expected to have a 2022 peak demand of 199MW at 0.96pf. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Ashburton GXP experienced a peak load of 158MW.

EA Networks owns and operates the distribution network in the Ashburton area. The Highbank (25MW) and Montalto (2MW) hydro power stations connect to EA Networks. Ergo is not clear regarding the difference between Transpower's demand forecast and the historical loading. We discussed the Ashburton GXP's loading with EA Networks who indicated that the all-time maximum demand is 181MW and that the substation loading is impacted by "*seasonal differences in rainfall and temperature, due to the dominance of irrigation load*". Also, that the output from the Highbank hydro does not influence the peak loading as it does not generate when the load exceeds ~100MW.

The Ashburton GXP substation has the following capacity:

- Total nominal installed capacity of 340MVA (three transformers, 120MVA/120MVA/100MVA)
- (N-1) capacity of 229/238MVA (summer/winter)

Transpower's Transmission Planning Report[13] forecasts that the (N-1) capacity of the supply transformers will be exceeded in 2027. Also, the long term solution involves the installation of a new Rakaia GXP, which would be determined by EA Networks. The following graph compares Ashburton GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR).

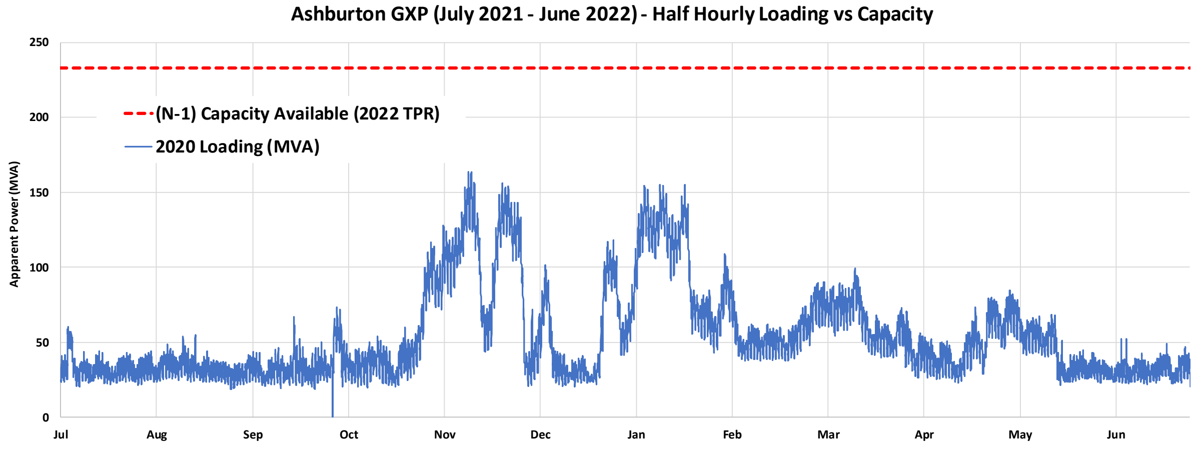


Note: Any difference in the supply capacity on the graph (in MW) and the asset rating (in MVA) is due to load power factor and impedance.

The following Figure 18 illustrates Ashburton's July 2021 through June 2022 loading in comparison to the available spare capacity disclosed by Transpower. The electrical load on the Ashburton GXP peaks during the summer period is due to it providing supply to a significant number of irrigation schemes.

EA Networks has indicated that, as of December 2022, it is processing 77MW of solar farm connection applications to its network. If these farms are installed they would have a significant impact on the loading on the Ashburton GXP, but may not impact the peak network, which occurred during late afternoon in the summer of 2021.

[13] https://tpow-corp-content.catalystdemo.net.nz/sites/default/files/publications/resources/2022 Transmission Planning Report.pdf.



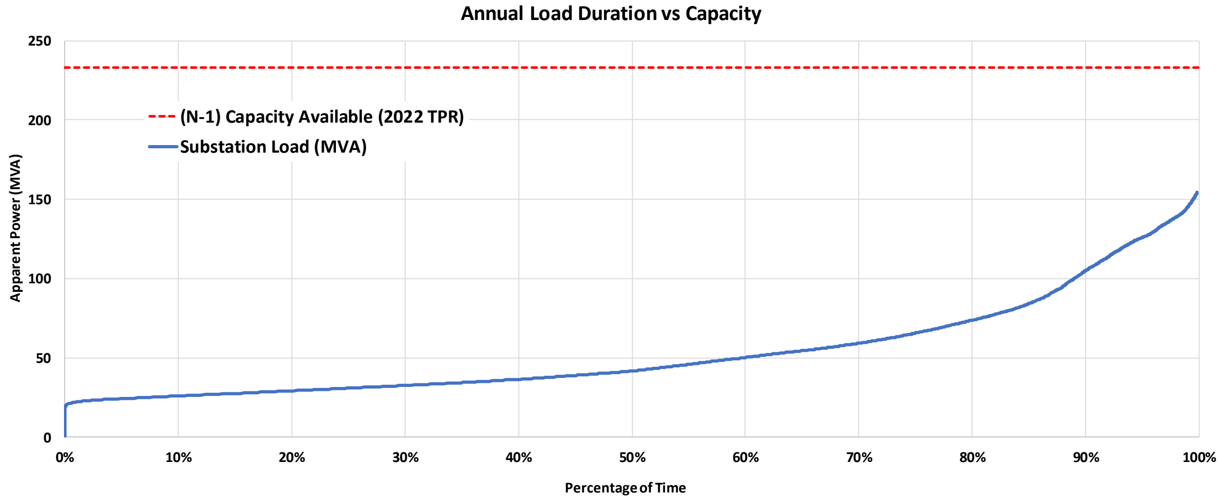


Figure 18 Ashburton GXP: 2020 Loading: Capacity Available

6.1.3 Bells Pond GXP

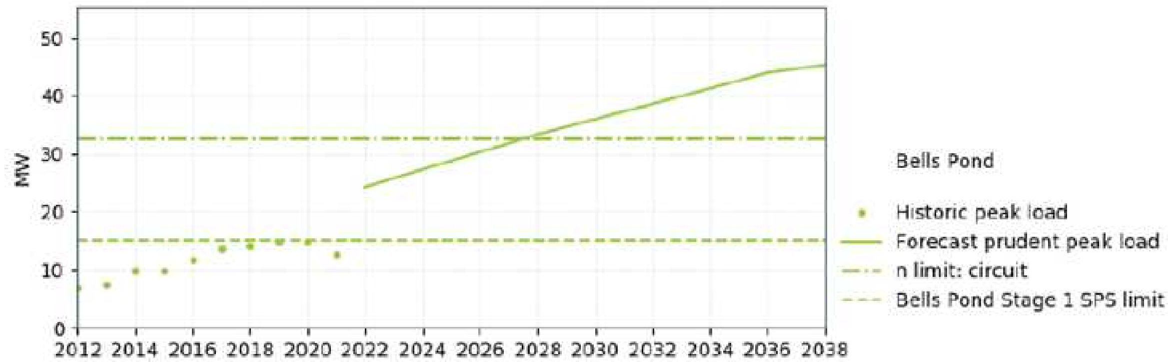
Alpine Energy owns and operates the distribution network supplied from the Bells Pond GXP. The predominant loads supplied are the Oceania Dairy Limited (ODL) factory (near Glenavy) and the Waihao Downs irrigation scheme. The load on the substation peaks during summer.

Transpower's demand forecast (refer Table 3) indicates that the Bells Pond GXP is expected to have a 2022 peak demand of 24MW at 0.96pf. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Bells Pond GXP experienced a peak load of 12.7MW.

The GXP supplies 2 x 40/20/20MVA, 110/33/11kV transformers that are owned by Alpine Energy. The 33kV winding supplies Alpine's Cooneys Road 33/11kV zone substation, which in turn supplies the ODL dairy factory. The 11kV winding supplies the local distribution network including the Waihao Downs irrigation scheme.

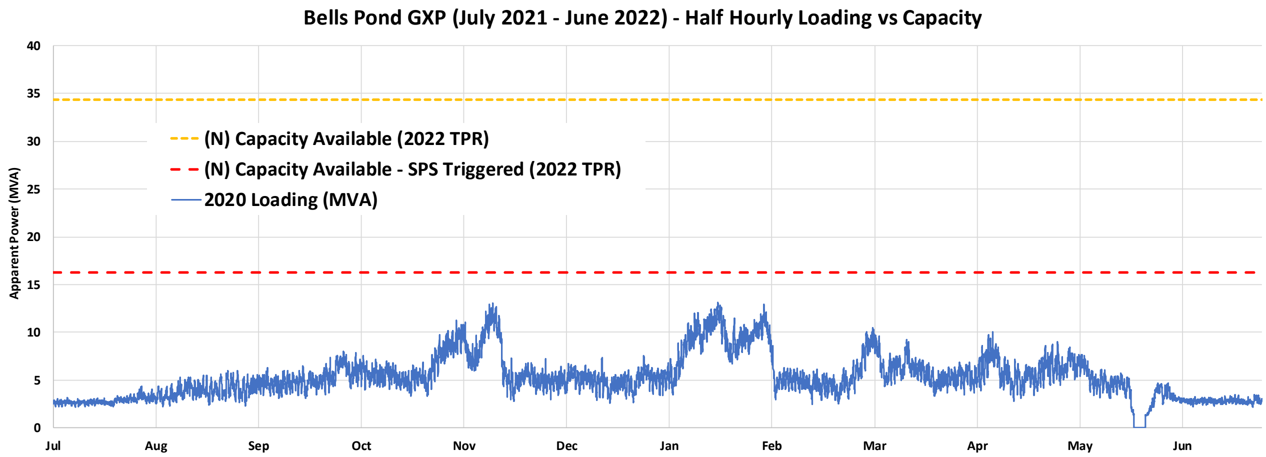
Transmission into Bells Pond is via a short single-circuit tee onto the 110 kV Oamaru–Studholme–Bells Pond–Waitaki circuit that provides 34/34 MVA (summer/winter) capacity. An outage of the 110kV circuit or its associated Waitaki 220/110kV inter-connecting transformer results in a loss of supply to Bells Pond. The load on the Bells Pond GXP is predicted to reach the 110kV supply circuit's limit by 2028. Transpower's documents indicate that the circuit's capacity is limited by a current transformer (CT), which if replaced (at a cost of $0.1M) would result in a circuit rating of 66/80MVA. However, other constraints in the lower Waitaki 110 kV transmission system will need to be resolved before this new constraint is a limiting factor.

The following graph compares Bells Pond GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR). The Stage 1 SPS limit indicates the Bells Pond load that can be supplied in the event that the SPS is "triggered" due to the loss of the adjacent 110kV transmission line (i.e. supplying Black Point GXP).



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

The following Figure 19 illustrates Bells Pond's July 2021 through June 2022 loading in comparison to its substation capacity. Also included is (N) capacity available, as disclosed by Transpower.



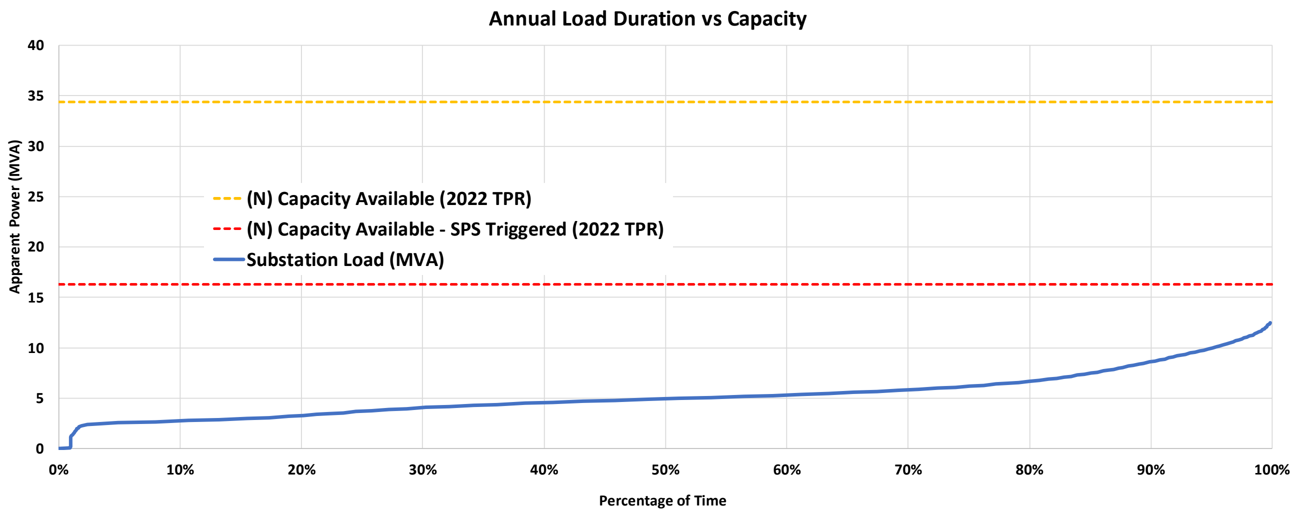


Figure 19 Bells Pond GXP: 2020 Loading: Capacity Available

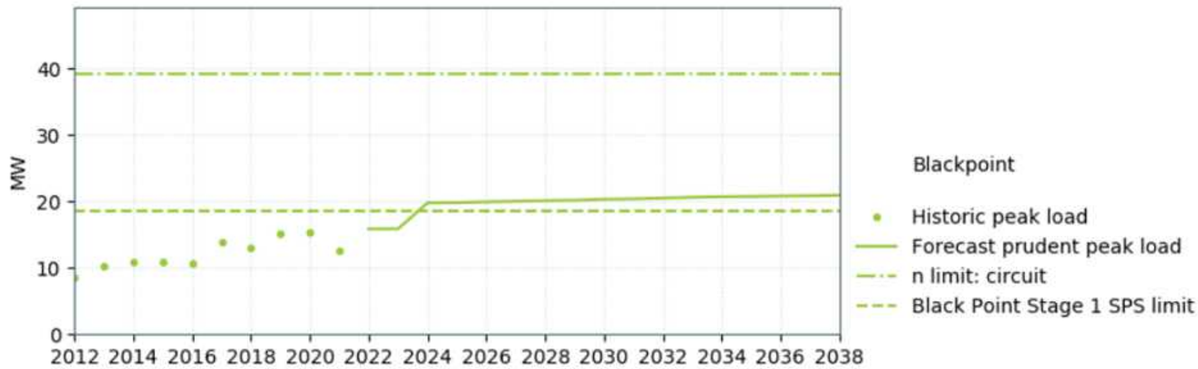
6.1.4 Black Point GXP

Network Waitaki owns and operates the distribution network supplied from the Black Point GXP. The load on the substation peaks during summer.

Transpower's demand forecast (refer Table 3) indicates that the Black Point GXP is expected to have a 2022 peak demand of 16MW at 0.91pf. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Black Point GXP experienced a peak load of 12.6MW.

The GXP supplies a single 25MVA, 110/11kV transformer that is owned by Alpine Energy. The 11kV supply is dedicated to the North Otago Irrigation Company's (NOIC) irrigation scheme. Constraints on Transpower's 110 kV network required the installation of a Special Protection Scheme (SPS) (demand control) between the Waitaki/Oamaru/Black Point/Bells Pond/Studholme GXPs to allow NOIC to increase their demand beyond 10.7 MVA. In the event of a contingent event (fault on the Waitaki-Bells Pond-Oamaru 110 kV line) during a constraint period, the SPS may operate to reduce the NOIC pumping demand below the constraint.

The following graph compares Black Point GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR). The Stage 1 SPS limit indicates the Black Point load that can be supplied in the event that the SPS is "triggered" due to the loss of a transmission line (i.e. it effectively reflects the N-1 capacity).



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.

There are no EECA Load Sites close to the substation.

Black Point is connected via a single 110 kV Tee connection (summer/winter rating of 44/80MVA) to the Oamaru–Black Point–Waitaki 110kV circuit. An outage of the circuit or its associated Waitaki 220/110 kV interconnecting transformer results in a loss of supply to Black Point. Network Waitaki cannot supply the Black Point load from an alternative grid exit point. Therefore, there are constraints on maintenance outages during the irrigation season, which extends from September to May. The outage constraints are difficult to manage as some maintenance cannot be done during winter, leaving a narrow window for outages. The load on the Black Point GXP cannot be supplied during an outage of the 110 kV Oamaru-Black Point-Waitaki circuit or its associated Waitaki 220/110 kV interconnecting transformer. This creates challenges in planning outages for the circuit and its associated interconnecting transformer. Transpower is considering one of the following developments options:

- The installation of a 110 kV bus breaker at the Oamaru GXP that will allow the Oamaru 110 kV bus split to be closed during outages of the Waitaki interconnecting transformer. Some of the Black Point GXP's load can then be supplied via Oamaru GXP (Black Point will still be disconnected for an Oamaru–Black Point–Waitaki 1 circuit outage).
- Transferring the Black Point GXP load to a new 220/110kV substation (refer to Figure 16) that would resolve the issues.

The following Figure 20 illustrates Black Point's July 2021 through June 2022 loading in comparison to the available capacity disclosed by Transpower. The sporadic nature of the pumping load is clearly evident in Figure 20.

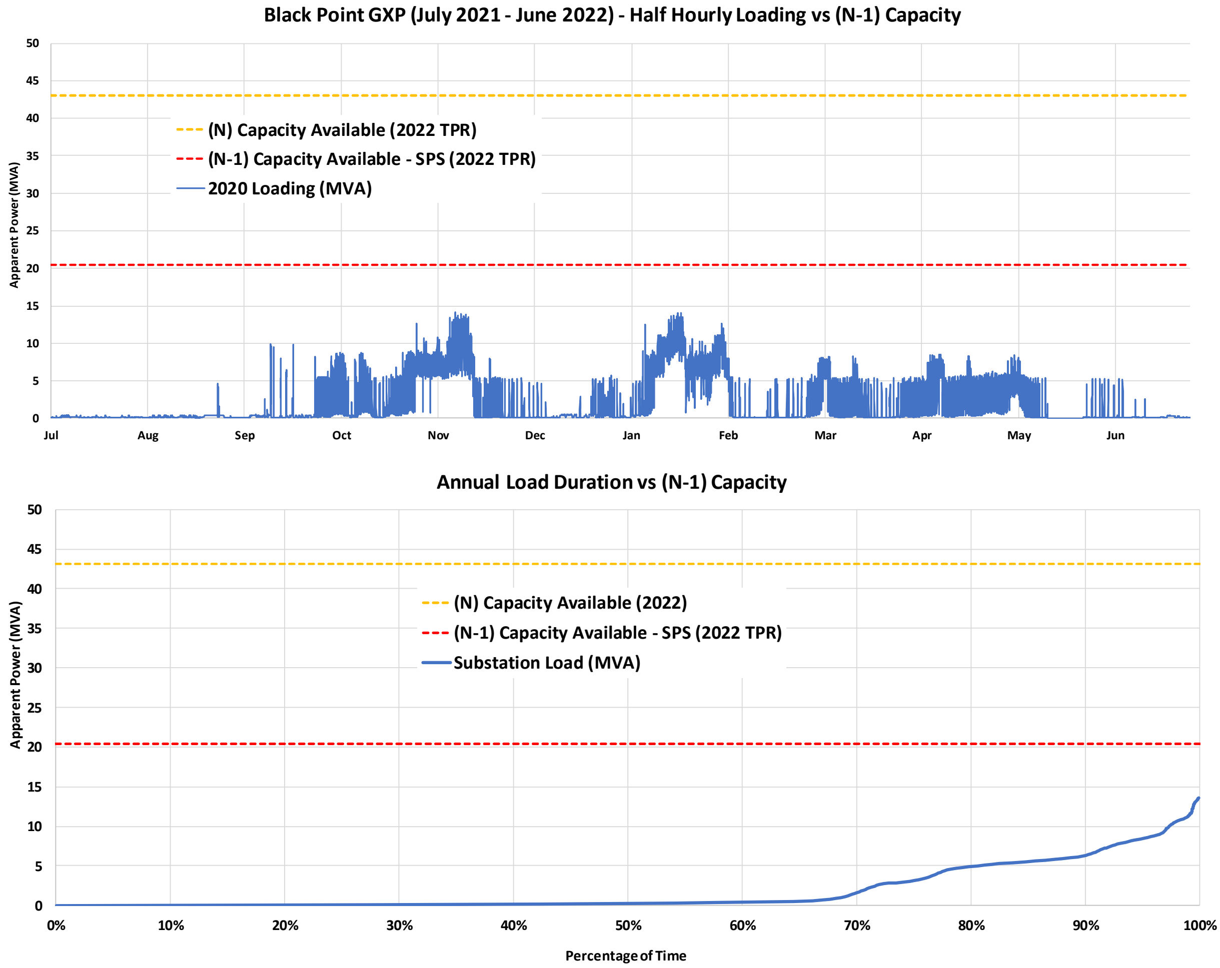


Figure 20 Black Point GXP: 2020 Loading: Substation capacity: Incoming 110kV line capacity

6.1.5 Oamaru GXP

Network Waitaki owns and operates the 33kV distribution network supplied from the Oamaru GXP. Transpower's demand forecast (refer Table 3) indicates that the Oamuru GXP is expected to have a 2022 peak demand of 46MW at 0.98pf. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Oamaru GXP experienced a peak load of 35.5MW.

The load on the Oamaru GXP is supplied by:

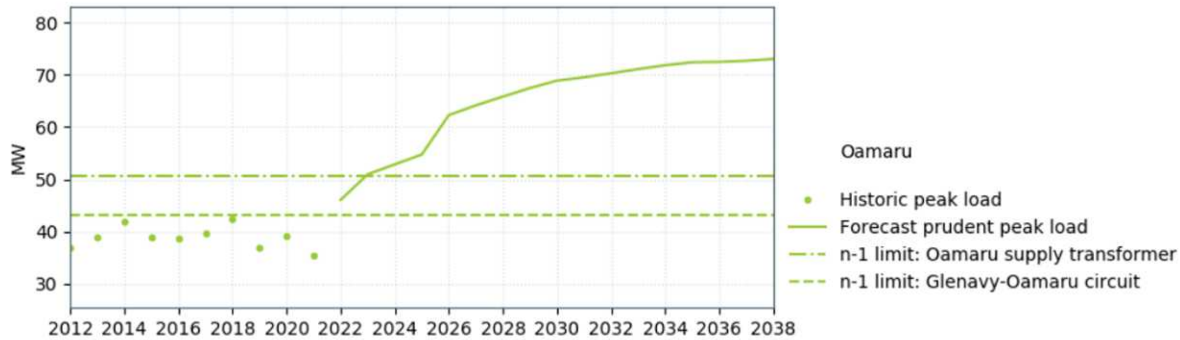
- One 110 kV circuit each from:
  - Waitaki via Bells Pond and Glenavy rated at 52/57 MVA (summer/winter)
  - Waitaki via Black Point rated at 52/56 MVA (summer/winter)
- 2 x 110/33 kV feeder fed (no 110kV circuit breakers) transformers that provide:
  - A total nominal installed capacity of 120 MVA.
  - (N-1) capacity of 65/65 MVA (summer/winter).

Oamaru GXP is configured with no 110 kV bus (each transformer is connected to only one 110 kV circuit). A circuit outage will also remove the corresponding Oamaru transformers from service. The peak load at Oamaru is forecast to exceed:

- The n-1 minimum variable line capacity of the Black Point–Oamaru and Glenavy–Oamaru circuits from summer 2022.
- The n-1 capacity of the supply transformers from summer 2023.
- The n-1 capacity of the Bells Pond–Waitaki and Black Point–Waitaki circuits from summer 2024.

The capacity of the supply transformers is reduced by low voltages at Oamaru when there is a 110 kV circuit outage. However, the capacity of the 110 kV circuits is the limiting factor for the Oamaru load.

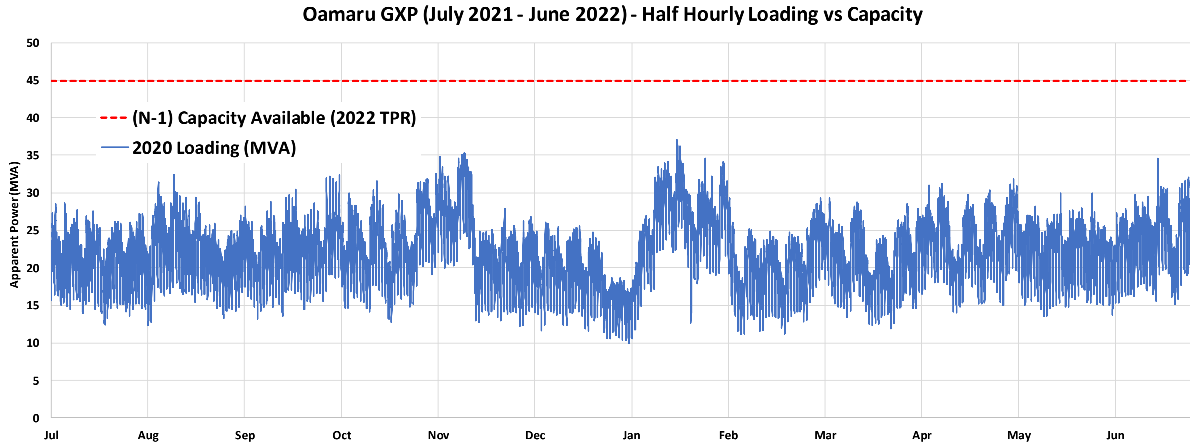
The following graph compares Oamaru GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR).



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.

Transpower's Transmission Planning Report[14] indicates it is in discussions with Network Waitaki regarding the long term options to supply more load at the Oamaru GXP. The following Figure 21 illustrates Oamaru's July 2021 through June 2022 loading in comparison to the available capacity disclosed by Transpower.

[14] https://tpow-corp-content.catalystdemo.net.nz/sites/default/files/publications/resources/2022 Transmission Planning Report.pdf.



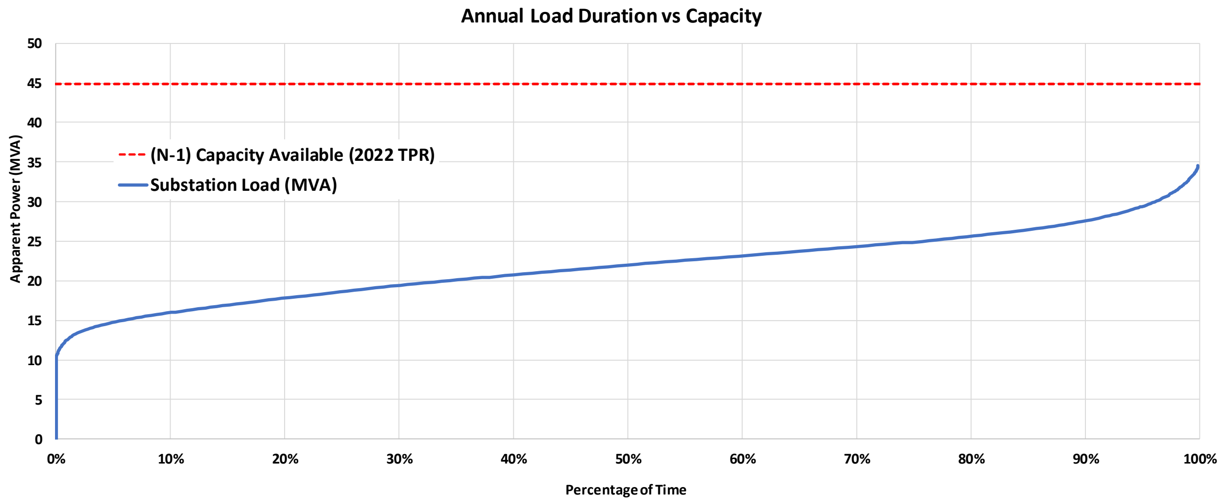


Figure 21 Oamaru GXP: 2020 Loading: Capacity Available

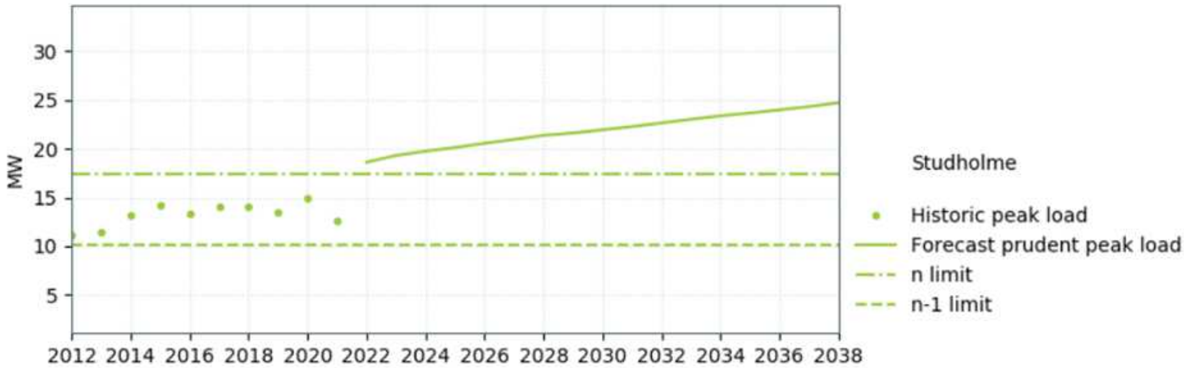
6.1.6 Studholme GXP

Alpine Energy owns and operates the distribution network supplied from the Studholme GXP. The network supplies Fonterra's Studholme Dairy Factory. Transpower's demand forecast (refer Table 3) indicates that the Studholme GXP is expected to have a 2022 peak demand of 19MW at 0.96pf. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Studholme GXP experienced a peak load of 13.3MW.

The GXP is equipped with 2 x 10MVA, 110/11kV transformers with an (N-1) capacity of 11/12 MVA (summer/winter). Transpower's documents indicate it is discussions with Alpine Energy to investigate options to increase the capacity of Studholme GXP.

An additional issue is that the Studholme–Timaru 110kV circuit is opened at Studholme during the dairy off-season (May to September), and Studholme is supplied by the Oamaru–Studholme–Bells Pond–Waitaki circuit. Splitting the 110 kV network prevents power flow on the 110 kV circuits from Waitaki to Timaru, reducing the transmission losses by having power flow through the more efficient 220 kV network. This reduction in transmission losses outweighs the benefit of having (N-1) security at Studholme during the dairy off-season. If the Oamaru–Studholme–Bells Pond–Waitaki circuit faults, a Special Protection Scheme automatically transfers Studholme load to the Studholme–Timaru 110kV circuit. There is an approximately 25 second loss of supply at Studholme before the switchover occurs. This brief loss of supply can cause economic loss for the dairy factory at Studholme, so the split is closed for the peak dairy season (October to April).

The following graph compares Studholme GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR).



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

The following Figure 22 illustrates Studholme's July 2021 through June 2022 loading in comparison to available capacity disclosed by Transpower. Also included is the incoming 110kV line capacity, although care should be taken interpreting line capacity as the line may be well loaded with other substation loads and does not consider upstream transmission constraints.

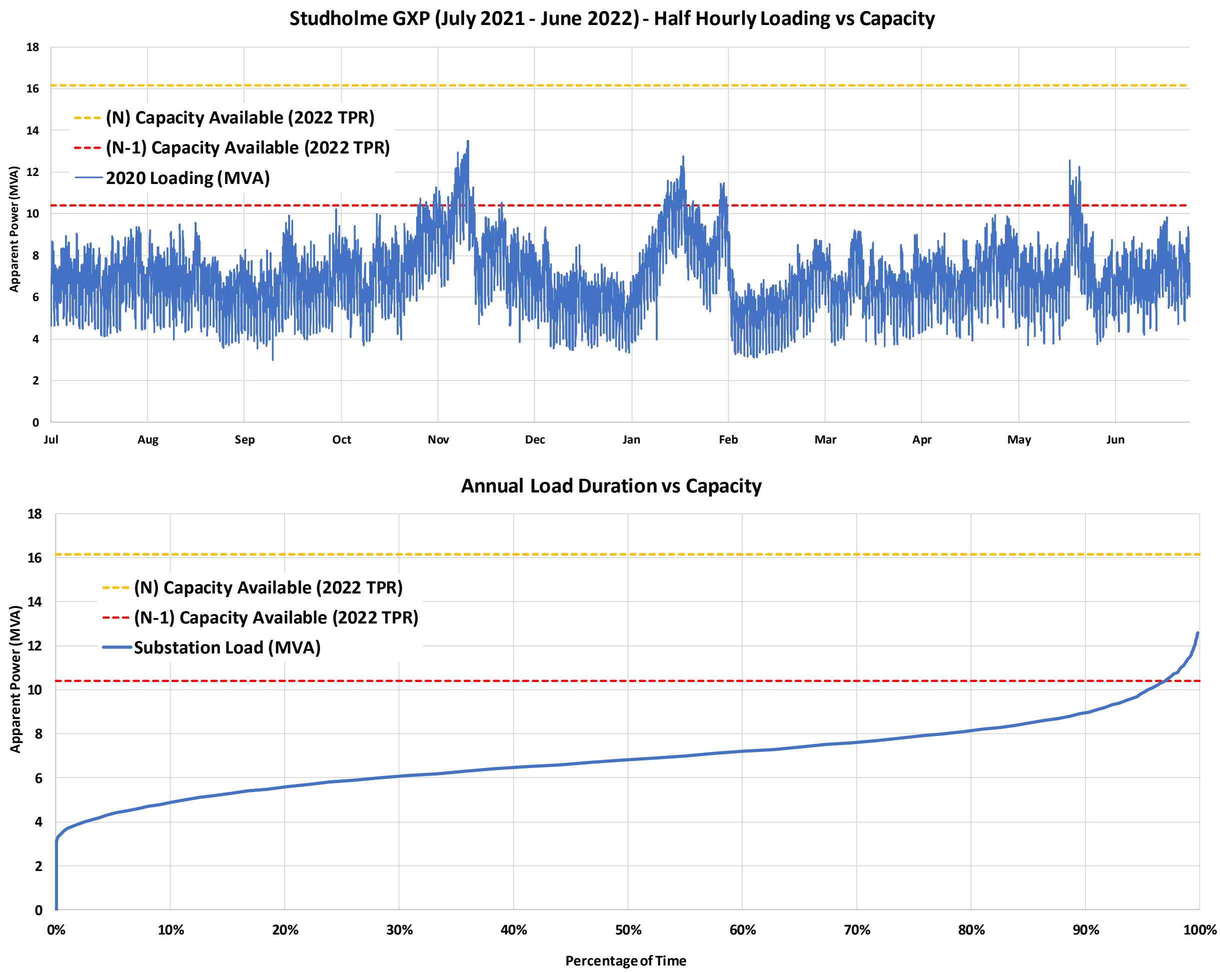


Figure 22 Studholme GXP: 2020 Loading: Capacity Available

6.1.7 Tekapo A GXP

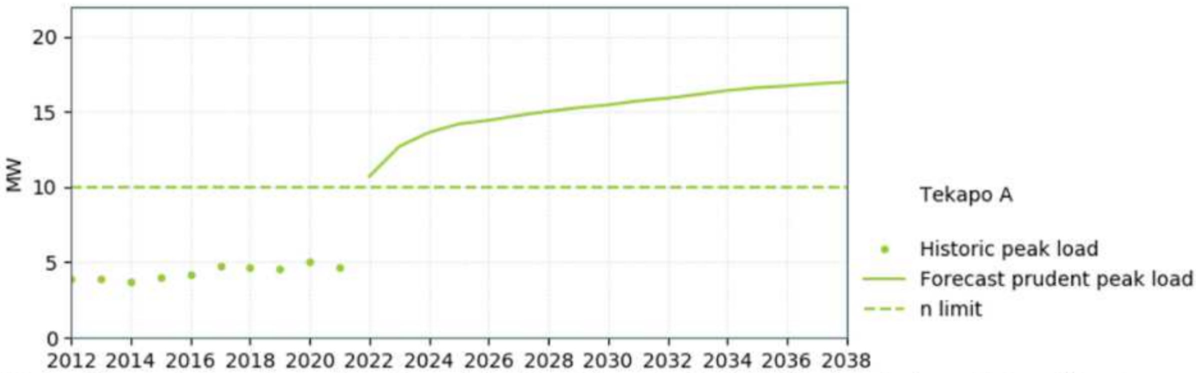
Alpine Energy owns and operates the distribution network supplied from the Tekapo GXP.

Transpower's demand forecast (refer Table 3) indicates that the Tekapo A GXP is expected to have a 2022 peak demand of 11MW at unity power factor. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Tekapo GXP experienced a peak load of 4.7MW. The substation supplies a number of small townships, including Albury, Tekapo and Twizel townships. The area is a tourist and holiday home destination with growing subdivision and hotel accommodation developments.

The Tekapo A GXP is equipped with a single 110/11 kV, 35 MVA transformer (N security) that connects to the following:

- A single 11/33 kV, 10 MVA transformer (T1) that supplies Alpine Energy's 33kV network in the Tekapo region.
- Genesis' Tekapo A hydro power station which houses a single 28MVA generator.

The following graph compares Tekapo A GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR).



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 peak load at Tekapo A is forecast to exceed the continuous rating of the 11/33kV supply transformer in 2022.

The Tekapo GXP is supplied via a single circuit 110kV that is rated to 51MVA/62MVA (summer/winter).

There are no EECA Load Sites close to the substation.

Transpower's Transmission Planning Report[14] indicates:

- It is in discussions, with Alpine Energy and other stakeholders, regarding options to enhance the supply to the region.
- The existing 11/33 kV supply transformer is due for condition-based replacement in the next 10-15 years, allowing a higher-rated transformer to be installed.
- An option could be to install a second 11/33 kV supply transformer. A second transformer would allow the existing transformer to have a post-contingency rating 1 MVA (10%) above its continuous rating. Transpower's Transmission Planning Report[14] indicates a capital cost of $2.5M.
- The 11 kV indoor switchboard at Tekapo A is due for condition-based replacement in the next five years. This would remove a current transformer limit, allowing the existing transformer to have a post-contingency rating 4.5 MVA (45%) above its continuous rating (only relevant if second transformer was installed).

The following Figure 23 illustrates Tekapo A's July 2021 through June 2022 loading in comparison to the available capacity disclosed by Transpower.

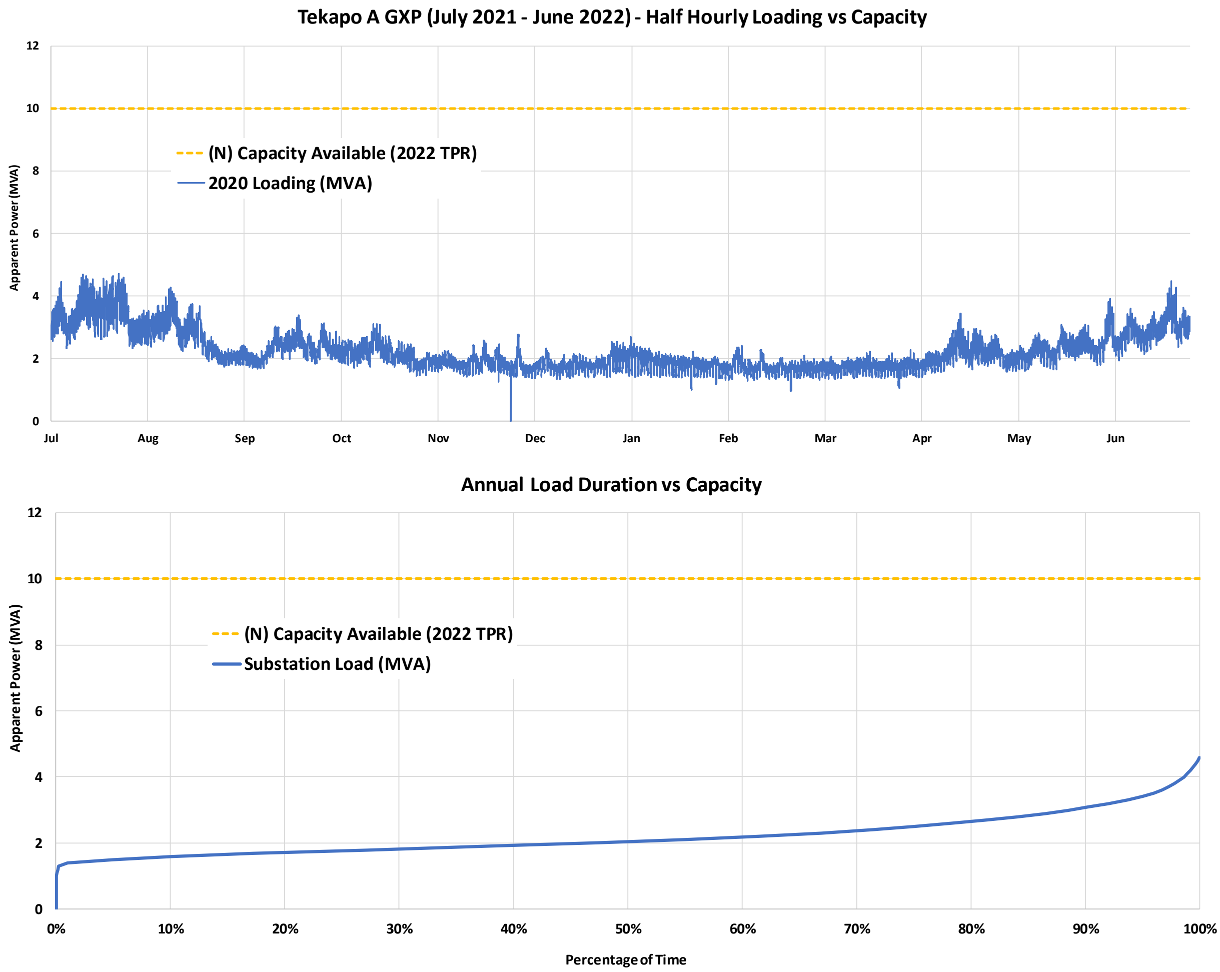


Figure 23 Tekapo GXP: 2020 Loading: Capacity Available

6.1.8 Temuka GXP

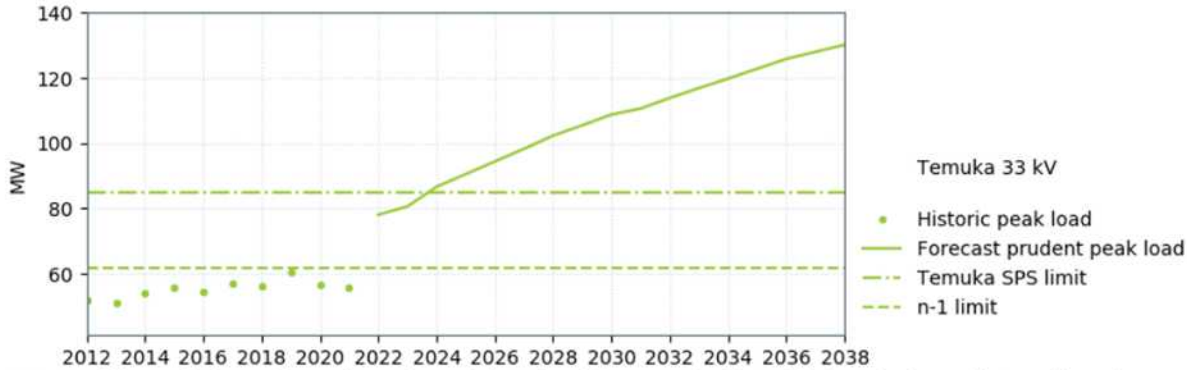
Alpine Energy owns and operates the 33kV distribution network supplied from the Temuka GXP. Transpower's demand forecast (refer Table 3) indicates that the Temuka GXP is expected to have a 2022 peak demand of 78MW at 0.96pf. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Temuka GXP experienced a peak load of 55.6MW. The substation provides supply to a number of townships, the most significant being Temuka and Geraldine. It also includes large areas of irrigation land for dairy farming that is mainly concentrated just south of the Rangitata River. It also provides supply to the largest dairy factory in the South Island, the Fonterra Clandeboye dairy factory.

The Temuka GXP is equipped with 2 x 54 MVA, 110/33kV feeder fed transformers (no 110kV circuit breakers) with post-contingency ratings of 61/63 MVA (summer/winter). There is a Special Protection Scheme at Temuka that allows the load to exceed the (N-1) capacity of the supply transformers. This means that at times some load will be on (N) security and automatically shed if there is a transformer or 110kV circuit outage. This scheme is expected to be effective until the Temuka load exceeds 85 MW. The peak load at Temuka is forecast to exceed:

- The (N-1) capacity of the supply transformers from summer 2022.

- The (N-1) capacity of the circuits from summer 2022.
- The special protection scheme limit from 2024.

The following graph compares Temuka GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR).



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.

Transpower is presently investigating an upgrade, at the request of Alpine Energy, which includes:

- Increasing the supply transformer capacity at Temuka by paralleling the existing transformers and installing one new 120 MVA supply transformer.
- Installing a new 33 kV switchboard.

Transpower's cost estimate for the above projects is $13M.
In future an upgrade of the Temuka–Timaru 110kV circuits may also be justified/required. This may require a transmission line easement to be negotiated. Transpower's cost estimate for the line upgrade is $15M.
Transpower's documents also indicated an alternative solution involving transferring load from the Temuka GXP to a new grid exit point supplied from one or more of the 220 kV circuits west of Temuka, possibly located at Orari. The following Figure 24 illustrates Temuka's July 2021 through June 2022 loading in comparison to the available capacity disclosed by Transpower.

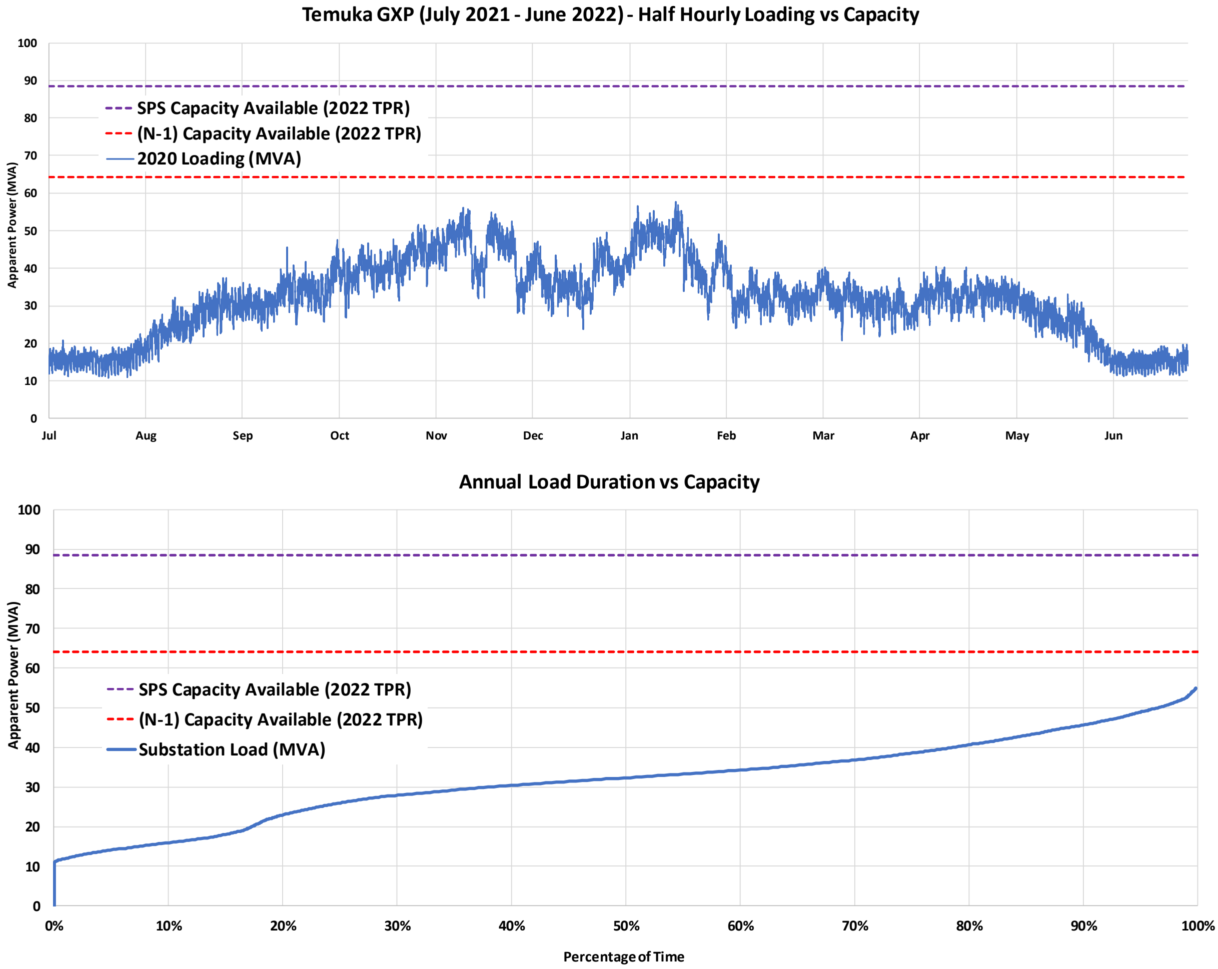


Figure 24 Temuka GXP: 2020 Loading: Capacity Available

6.1.9 Timaru GXP

Alpine Energy owns and operates the 33kV distribution network supplied from the Timaru GXP.

Transpower's demand forecast (refer Table 3) indicates that the Timaru GXP is expected to have a 2022 peak demand of 80MW at 0.99pf. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Timaru GXP experienced a peak load of 65.9MW.

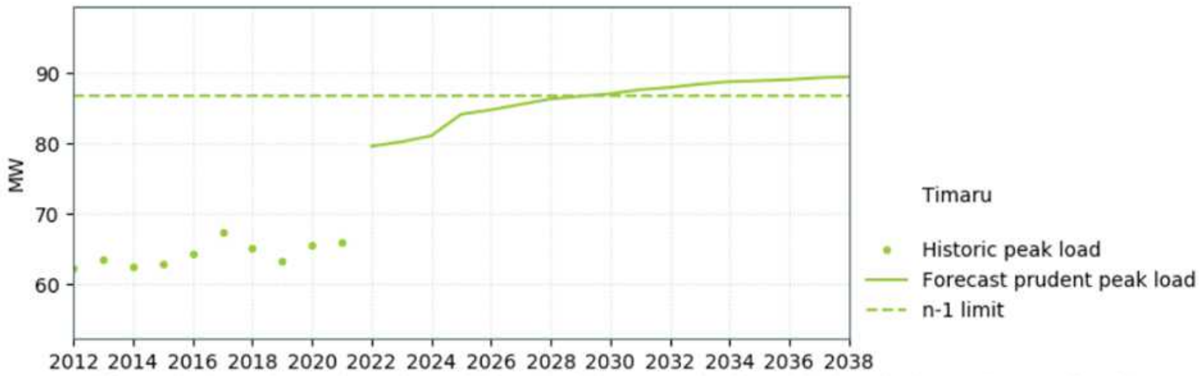
The substation supplies the Timaru City which is the hub of South Canterbury. The GXP serves a CBD, a main residential population, and a range of industries and commercial businesses including two meat processing plants, a container/timber/bulk cement port, a brewery, a wool scour and food processing plants. Most of the load growth in the city comes from industrial development in the Washdyke and port areas.

The Timaru GXP is equipped with 3 x 47.6MVA, 220/11kV transformers with:

- A total nominal installed capacity of 143MVA.
- (N-1) capacity of 94 MVA.

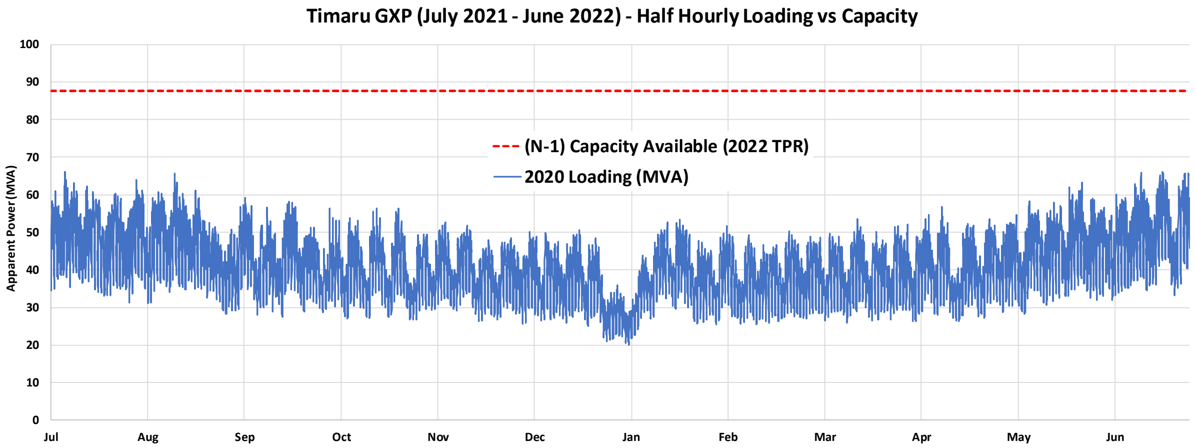
The three Timaru supply transformers are operated with one unit on hot-standby, to ensure that 11 kV fault levels remain within the rating of Alpine Energy's distribution equipment. If one in-service transformer trips out, the remaining transformer is momentarily overloaded before the third transformer is automatically switched into service, resulting in no loss of supply to consumers at Timaru. Because only two transformers can be in service at any time, the load cannot go above the (N-1) limit.

The following graph compares Timaru GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR).



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.

Transpower's Transmission Planning Report[14] indicates that they are in discussions with Alpine Energy regarding an increase in the capacity available at Timaru. These discussions are primarily based on industrial consumers installing electrical boilers. The following Figure 25 illustrates Timaru's July 2021 through June 2022 loading in comparison to the available capacity disclosed by Transpower.



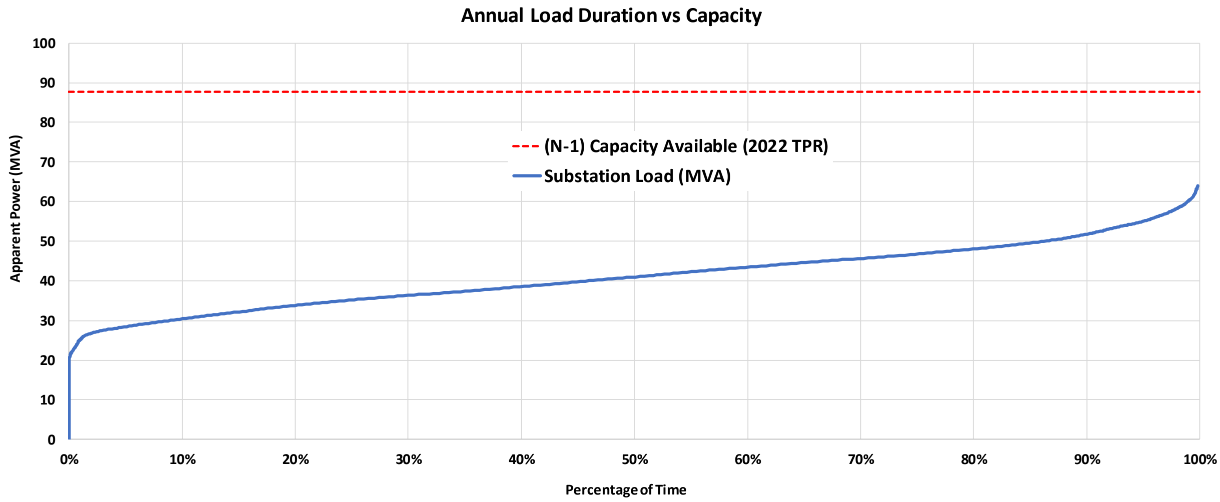


Figure 25 Timaru GXP: 2020 Loading: Capacity available

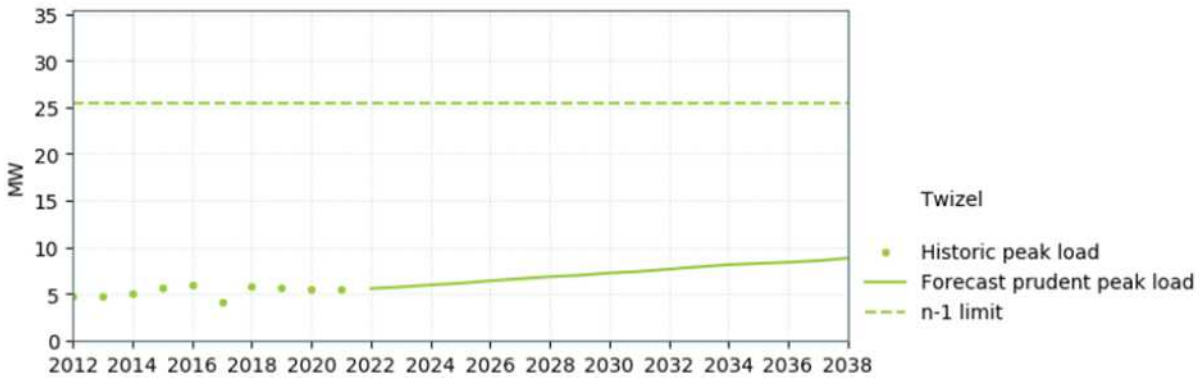
6.1.10 Twizel GXP

Both Alpine Energy and Network Waitaki are supplied at 33kV from the Twizel GXP.
Transpower's demand forecast (refer Table 2) indicates that the Twizel GXP is expected to have a 2022 peak demand of 6MW at 1.00pf. This closely reflects the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Twizel GXP experienced a peak load of 7.0MW.
The substation supplies the Twizel township, which is a popular holiday and tourism centre, being the nearest town to Mt Cook. It also serves as the main service centre in the Mackenzie Basin supporting agriculture, aquaculture, pet food manufacturing and processing and general engineering works.
The GXP is equipped with 2 x 220/33 kV transformers that provide:

- A total nominal installed capacity of 40 MVA.
- Switched (N-1) capacity of 26/27 MVA (summer/winter).

The loads supplied from the Twizel 33 kV grid exit point have single transformer security because the supply bus is operated split (i.e. the bus-coupler is open). Hydro generation control structures in the area (Ohau A, B and C, Tekapo B, Ruataniwha and Pukaki) take their local service supply from the 33kV bus, and it is split to reduce the risk of losing connection to all sites simultaneously for a bus contingency. The bus split can be closed to avoid loss of supply during transformer maintenance, and within a short time following an unplanned transformer outage. Alpine Energy takes 33 kV supply from one side of the split, and Network Waitaki takes supply from the other side of the split. Transpower's Transmission Planning Report[14] indicates that the 33kV bus is in the process of being replaced, which would allow the bus to provide (N-1) security.

The following graph compares Twizel GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR).



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

The following Figure 26 illustrates Twizel's July 2021 through June 2022 loading in comparison to available capacity disclosed by Transpower.

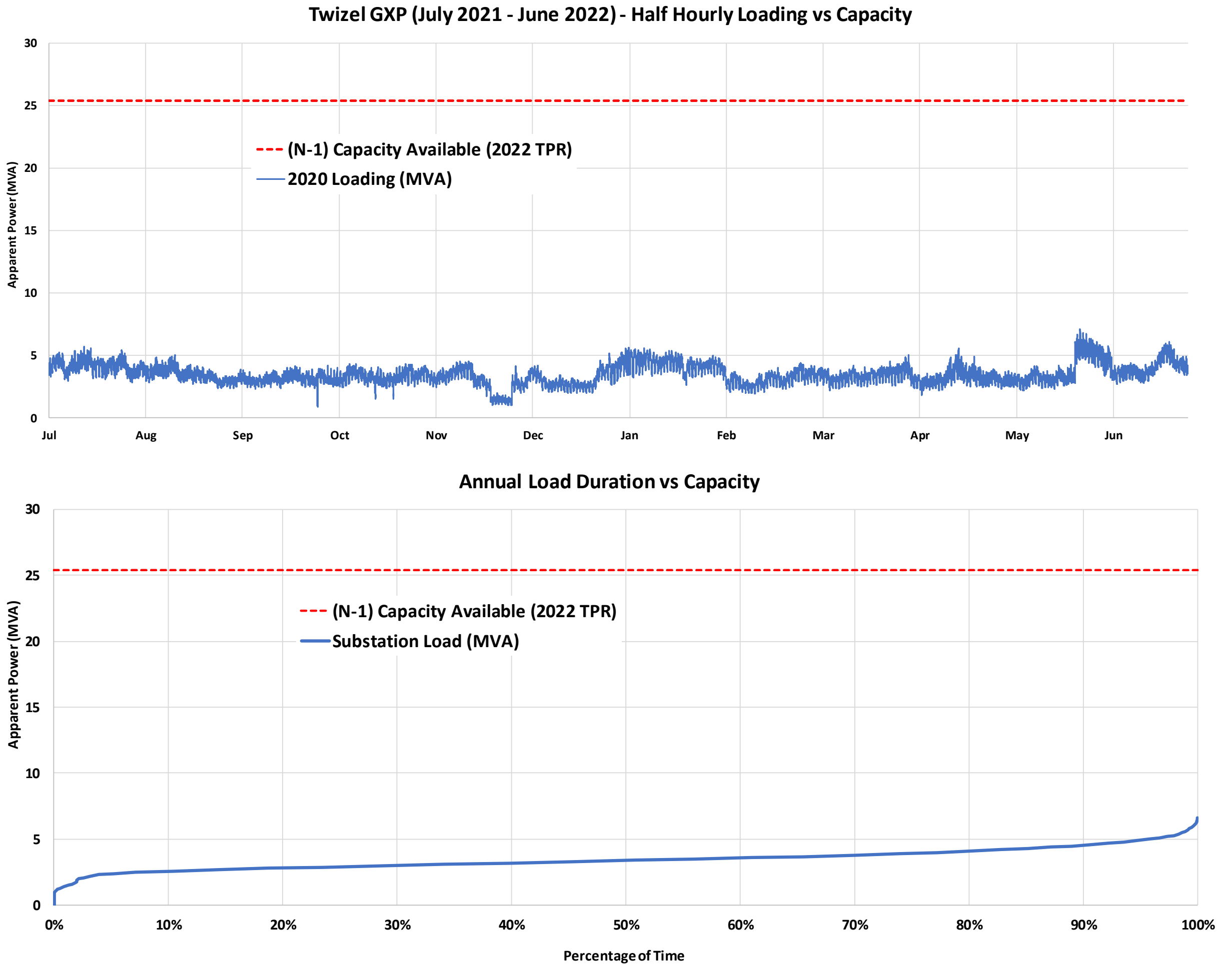


Figure 26 Twizel GXP: 2020 Loading: Capacity available

6.1.11 Waitaki GXP

Network Waitaki owns and operates the 33kV distribution network supplied from the Waitaki GXP. Transpower's demand forecast (refer Table 3) indicates that the Waitaki GXP is expected to have a 2022 peak demand of 15MW at 0.91pf. This contrasts with the historical SCADA data that indicates that, over the July 2021 to June 2022 period, the Waitaki GXP experienced a peak load of 10.9MW.

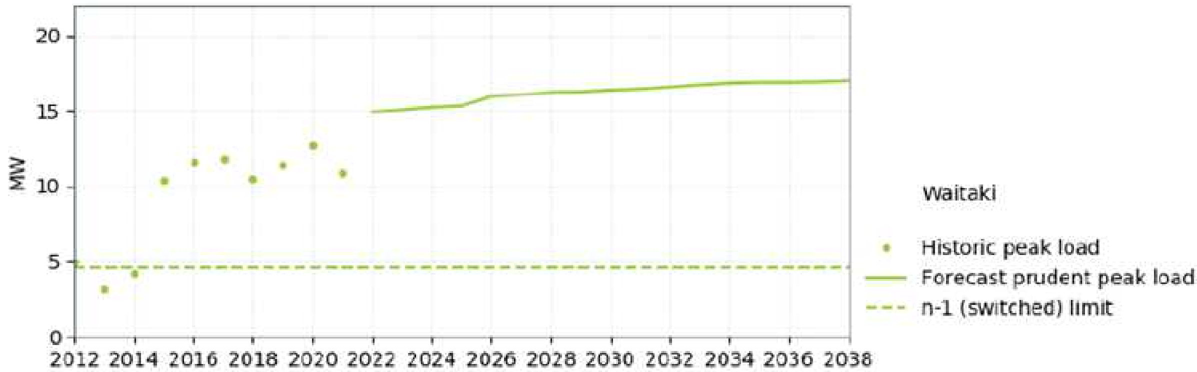
The GXP is equipped with 2 x 220/11 kV transformers that provide:

- A total nominal installed capacity of 140 MVA.
- Switched N-1 capacity of 75/75 MVA (summer/winter).

There are no EECA Load Sites close to the Waitaki GXP substation.

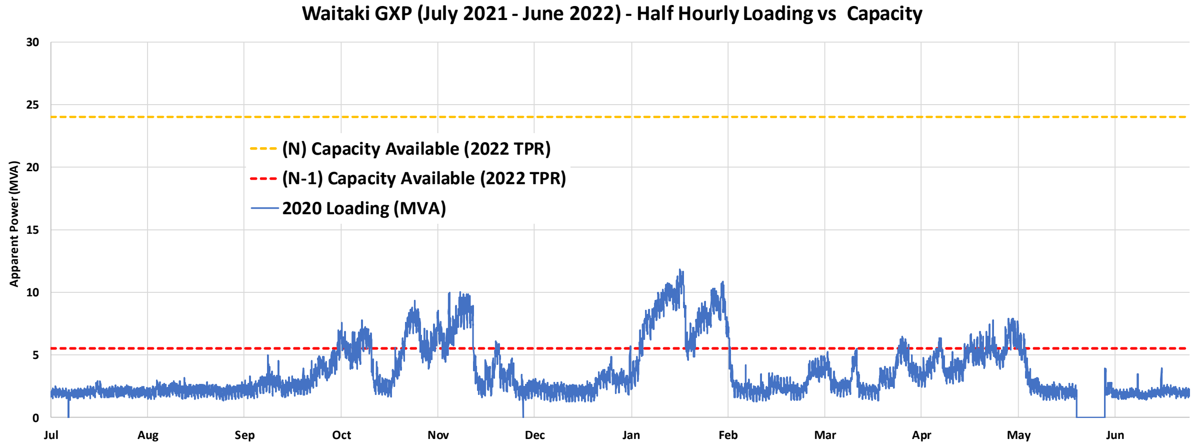
Network Waitaki take supply from the 11 kV generator bus at Waitaki that, in turn, supplies a single 24MVA, 11/33kV transformer. The bus also connects the Waitaki power station generating units. The load has single transformer security because the generator bus is normally split (to manage fault current). The bus split can be closed to avoid loss of supply during transformer maintenance, and within a short time following an unplanned transformer outage. There is also a lower capacity alternate supply through an 11/33 kV, 5.5 MVA step-up transformer owned by Transpower that is too small to supply the peak load and normally has no load connected to it. Transpower's Transmission Planning Report[14] indicates that it is discussing options with Network Waitaki to increase the security-of-supply for the Waitaki GXP.

The following graph compares Waitaki GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR).



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 Waitaki's July 2021 through June 2022 loading in comparison to the available capacity disclosed by Transpower.



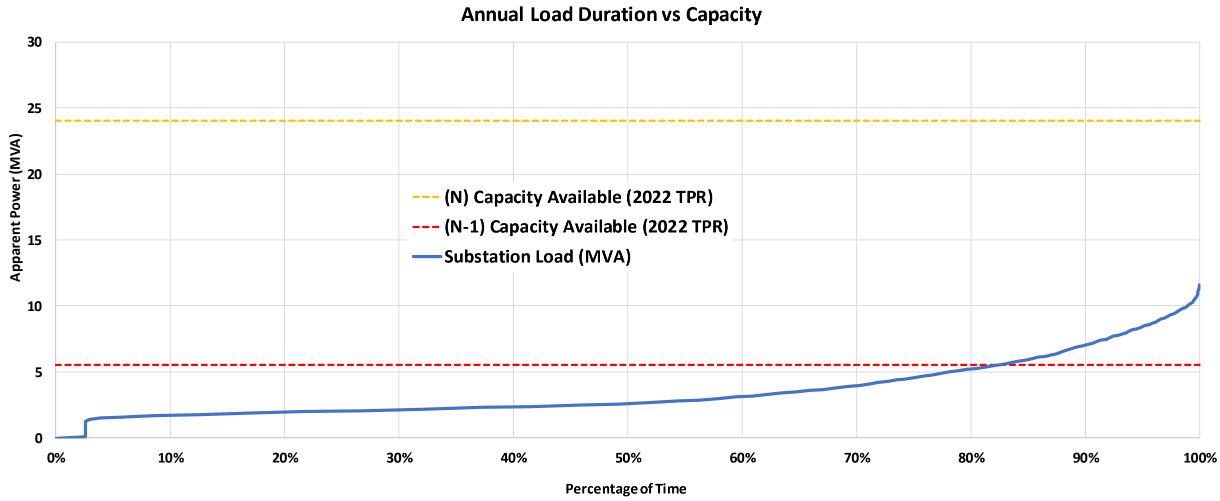


Figure 27 Waitaki GXP: 2020 Loading: Substation capacity

6.2 Summary - Spare Capacity based on Transpower's 2022 Forecast

The following Figure 28 summarises the approximate, all year, (N-1) and (N) spare capacities at each GXP based on the substation capacity and the 2022 forecast load provided in Transpower's 2022 Transmission Planning Report, as discussed in the sections above. Negative values are only possible for (N-1) capacities and indicate that there is no spare (N-1) capacity. The negative amount indicates the capacity increase that is required to achieve a secure firm capacity at the substation. It should be noted that the actual 2021 loading data indicates that the actual loads were lower than the forecast 2021 loads. This could be for various reasons and Ergo has not investigated this in detail.

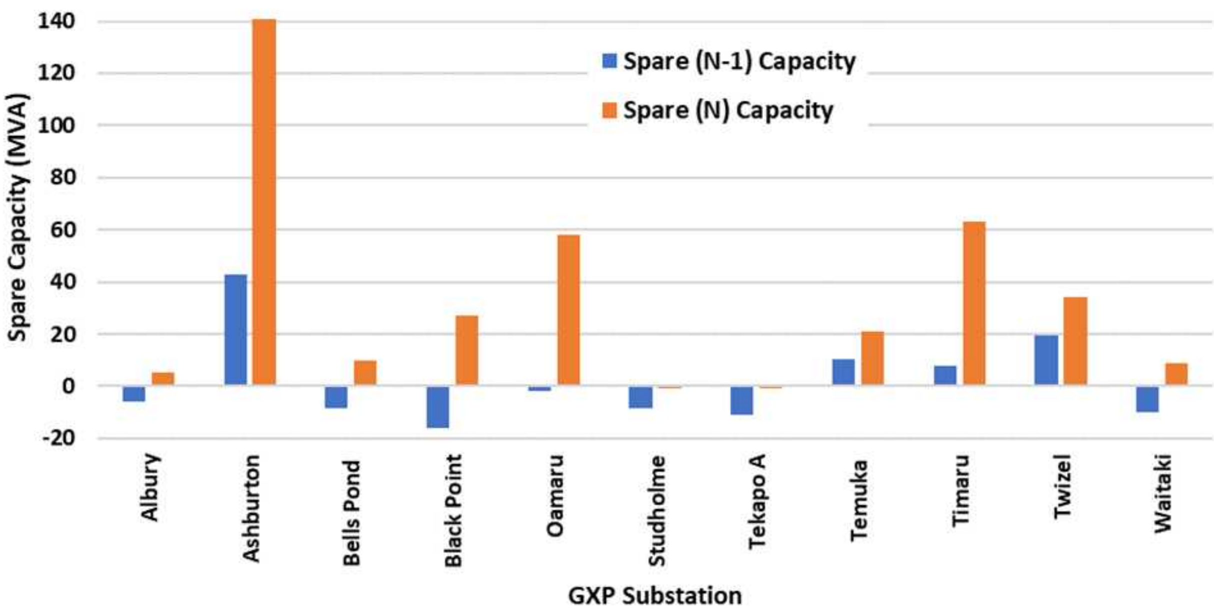


Figure 28 - Summary: GXP Spare Capacity based on Transpower's 2022 Load Forecast

It should be noted that the capacities have been calculated based on the transformer bay ratings disclosed by Transpower and the spare capacities do not include any upstream transmission constraints, which would need to be confirmed by Transpower. We note the following:

- The negative values in Figure 28 indicate that there is no capacity and consumer load cannot be supplied (for (N) and (N-1) conditions). Figure 28 shows that there is very little available capacity at Studholme and Tekapo A.
- During peak loading periods, most of the regional 110kV lines are operating close to 100% and there are multiple Special Protection Schemes (SPS) installed to prevent lines/transformers overloading post-contingency. In many cases large increases in electrical demand on GXPs supplied via the 110kV network will trigger significant investment.

7. Spare Capacity – Zone Substations

In determining the (N) and (N-1) spare capacities for the zone substation, Ergo reviewed the EDB 2021 disclosure data and the historical substation loading data for 2021.

Actual loading data was provided by Alpine Energy and Network Waitaki. However, at this stage, EA Networks were unable to supply historical loading data.

7.1 EA Networks

Table 4 EA Networks: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity (MVA)	Spare (N-1) Capacity (MVA)
		Disclosure Data	Disclosure Data[15]
1	Ashburton 66/11kV [ASH]	21.0	3.0
2	Carew 66/22kV [CRW]	20.0	2.0
3	Coldstream 66/22kV [CSM]	7.0	-13.0
4	Dorie 66/22kV [DOR]	4.0	-11.0
5	Eiffelton 66/22kV [EFN]	11.0	-9.0
6	Fairton 66/22/11kV [FTN]	32.0	14.0
7	Hackthorne 66/22kV [HTH]	5.0	-15.0
8	Highbank 66/11kV [HBK]	24.0	-8.0
9	Lagmhor 66/22kV [LGM]	6.0	-9.0
10	Lauriston 66/22kV [LSN]	5.0	-15.0
11	Methven 66/22/11kV [MTV]	35.0	3.0
12	Methven 66/33kV [MTV]	0.0	-5.0
13	Mt Somers 66/22kV [MSM]	17.0	2.0
14	Mt Hutt 33/11kV [MHT]	8.0	-2.0
15	Montalto 33/11kV [MON]	0.5	-2.0
16	Northtown 66/11kV [NTN]	26.0	8.0
17	Overdale 66/22kV [OVD]	6.0	-14.0
18	Pendarves 66/22kV [PDS]	24.0	6.0
19	Seafield 66/11kV [SFD66]	7.0	-3.0
20	Wakanui 66/22kV [WNU]	2.0	-13.0

15 Negative values indicate the relevant power transformer is likely overloaded from time to time. EDBs often disclose capacity in terms of the transformers ONAN capacity, but transformers can often be overloaded for short periods or have an ONAF capacity (i.e. fan cooled). The exact transformer ratings are very specific.

7.2 Alpine Energy

Table 5 Alpine Energy: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity[16]	Spare (N-1) Capacity
		Disclosure Data	Disclosure Data
1	Albury (ABY)	3.2	-4.3
2	Old Man Rage (OMR)	-0.38	-0.38
3	Bells Pond (BPD)	44.95	4.95
4	Clandeboye 1 (CD1)	26.04	6.04
5	Clandeboye 2 (CD2)	29.93	4.93
6	Cooney's Road (CNR)	10.36	-4.64
7	Fairlie (FLE)	3.27	-2.98
8	Geraldine (GLD)	8.13	-6.87
9	Haldon Lilybank (HLB)	0.52	-0.48
10	Pareora (PAR)	20.32	5.32
11	Pleasant Point (PLP)	1.29	-4.96
12	Rangitata (RGA)	19.36	-0.64
13	Studholme (STU)	7.87	-5.13
14	Tekapo Village (TEK)	1.6	-4.65
15	Temuka (TMK)	35.45	10.45
16	Timaru 11/33 kV (TIM)	33.36	-16.64
17	Twizel Village (TVS)	5.26	-3.99
18	Unwin Hut (UHT)	0.48	-1.02

[16] Negative values indicate the relevant power transformer is likely overloaded from time to time. EDBs often disclose capacity in terms of the transformers ONAN capacity, but transformers can often be overloaded for short periods or have an ONAF capacity (i.e. fan cooled). The exact transformer ratings are very specific.

7.3 Network Waitaki

Table 6 Network Waitaki: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity[17] Disclosure Data	Spare (N-1) Capacity Disclosure Data
1	Chelmer Street	42.0	14.0
2	Duntroon	3.0	-4.0
3	Eastern Road	4.0	-3.0
4	Enfield	5.0	-2.0
5	Five Forks	5.0	-2.0
6	Hampden	6.0	-1.0
7	Kurow	22.0	5.0
8	Maheno	3.0	-4.0
9	Ngapara	1.0	-6.0
10	Ohau	2.0	-1.0
11	Omarama	1.0	-2.0
12	Otematata	2.0	-1.0
13	Papakaio	1.0	-6.0
14	Parsons Road	8.0	-4.0
15	Pukeuri	15.0	3.0
16	Redcastle	21.0	6.0
17	Ruataniwha	1.0	-1.0

[17] Negative values indicate the relevant power transformer is likely overloaded from time to time. EDBs often disclose capacity in terms of the transformers ONAN capacity, but transformers can often be overloaded for short periods or have an ONAF capacity (i.e. fan cooled). The exact transformer ratings are very specific.

7.4 Summary

7.4.1 EA Networks

7.4.1.1 (N-1) Capacity Summary

The following Figure 29 illustrates the approximate (N-1) spare capacities at EA Networks' zone substations, for the disclosed 2021 peak demand estimates[18]. It should be noted that these have been calculated based on the transformer ratings disclosed by EA 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 either a single bank transformer or that the (N-1) rating is already exceeded at times throughout the year. Most rural irrigation substations are afforded with N security with significant switched back-up available on via the 22kV network. EA Networks maintain two spare 10/20MVA transformers that can be relocated withing 72 hours.

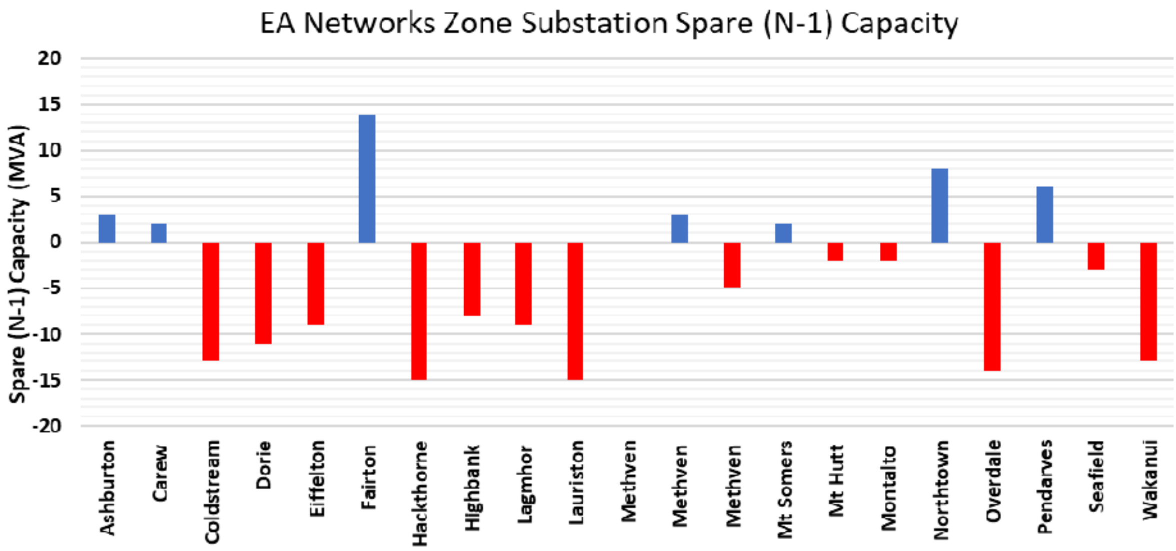


Figure 29 Summary: Approximate (N-1) spare capacity at EA Networks' zone substations

7.4.1.2 (N) Capacity Summary

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

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.

[18] EA Network' 2021 information disclosure (https://www.eanetworks.co.nz/disclosures/).

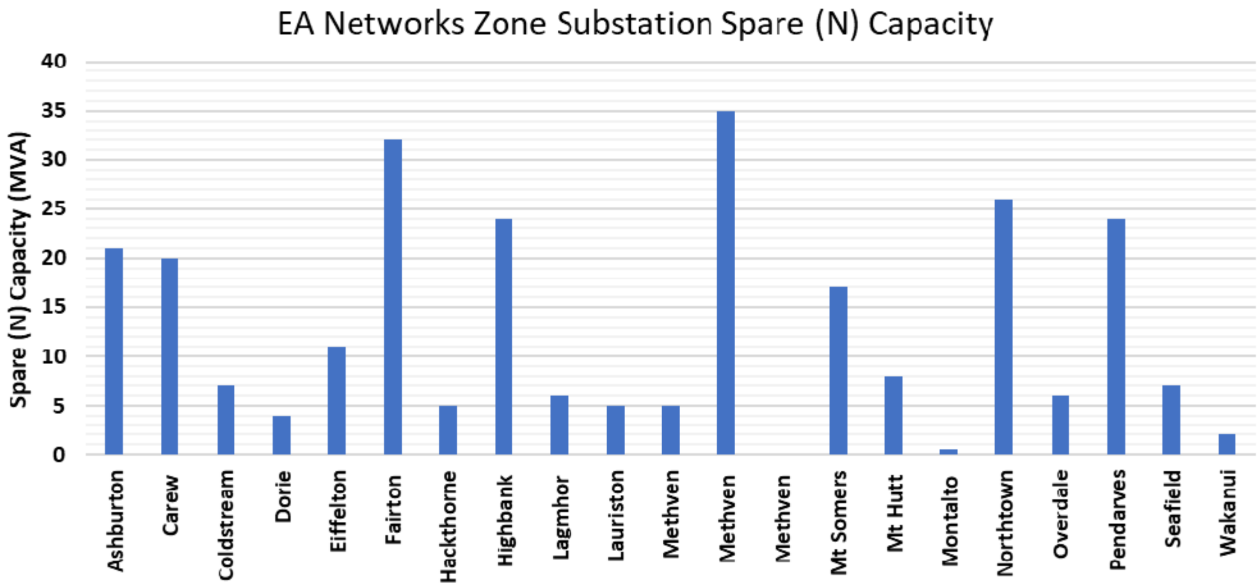


Figure 30 Summary: Approximate (N) spare capacity at EA Networks' zone substations

7.4.2 Alpine Energy

7.4.2.1 (N-1) Capacity Summary

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

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 either a single bank transformer or that the (N-1) rating is already exceeded at times throughout the year.

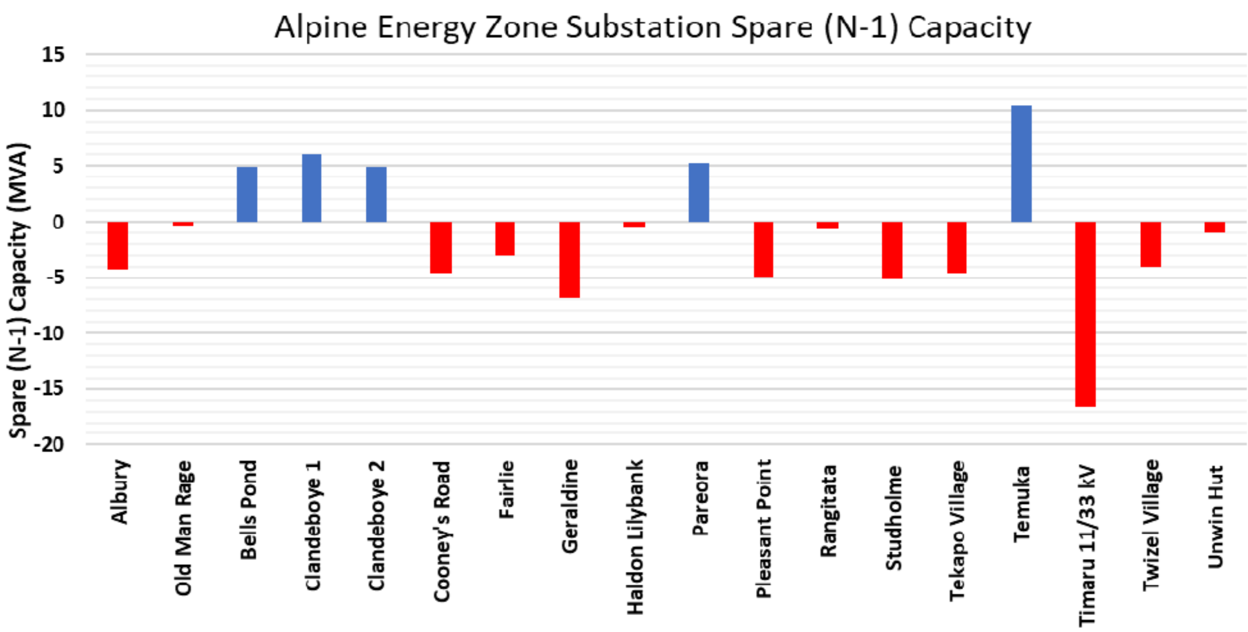


Figure 31 Summary: Approximate (N-1) spare capacity at Alpine Energy's zone substations

7.4.2.2 (N) Capacity Summary

The following Figure 32 illustrates the approximate (N) spare capacities at Alpine Energy's zone substations, for the disclosed peak demand estimates[19]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Alpine Energy.

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

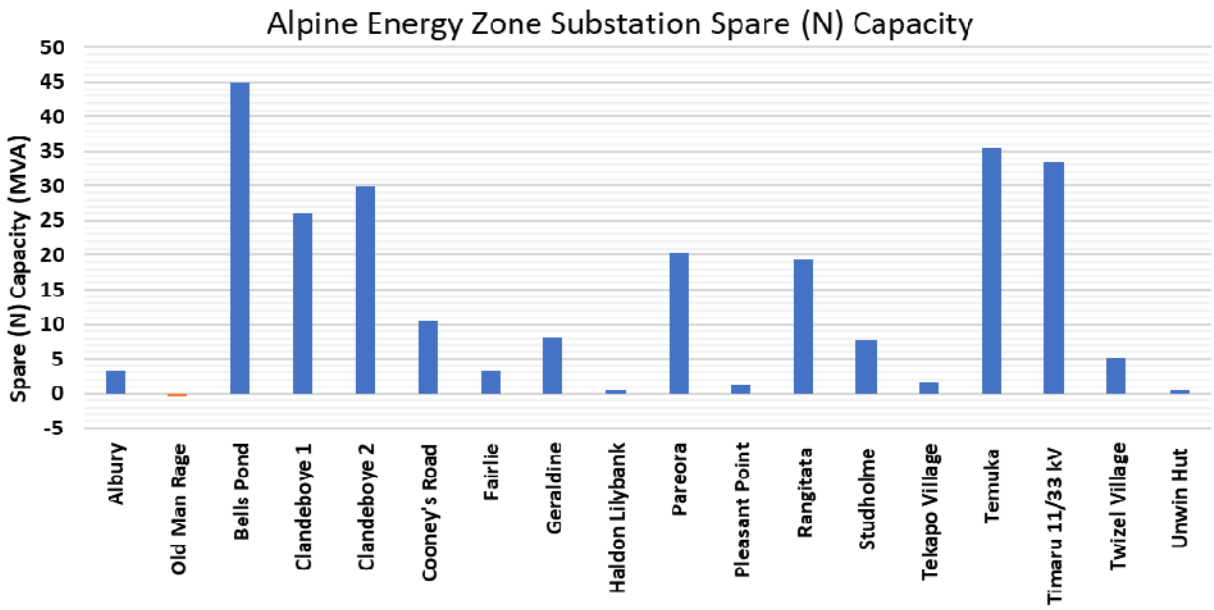


Figure 32 Summary: Approximate (N) spare capacity at Alpine Energy's zone substations

7.4.3 Network Waitaki

7.4.3.1 (N-1) Capacity Summary

The following Figure 33 illustrates the approximate (N-1) spare capacities at Network Waitaki's zone substations, for the disclosed peak demand estimates[20]. It should be noted that these have been calculated based on the transformer ratings disclosed by Network Waitaki.

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.

[19] Alpine Energy's 2021 information disclosure (https://www.alpineenergy.co.nz/corporate/disclosures/information-disclosures2).

[20] Network Waitaki 2021 information disclosure (https://powernet.co.nz/disclosures/).

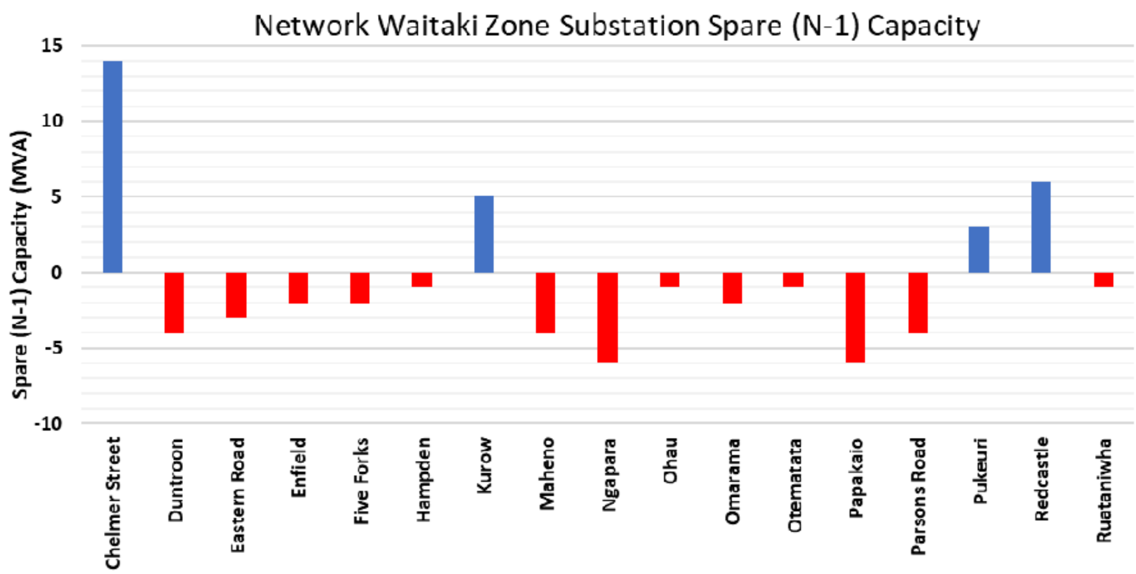


Figure 33 Summary: Approximate (N-1) spare capacity at Network Waitaki's zone substations

7.4.3.2 (N) Capacity Summary

The following Figure 34 illustrates the approximate (N) spare capacities at Network Waitaki's zone substations, for the disclosed peak demand estimates[21]. It should be noted that these have been calculated based on the transformer ratings disclosed by Network Waitaki.

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.

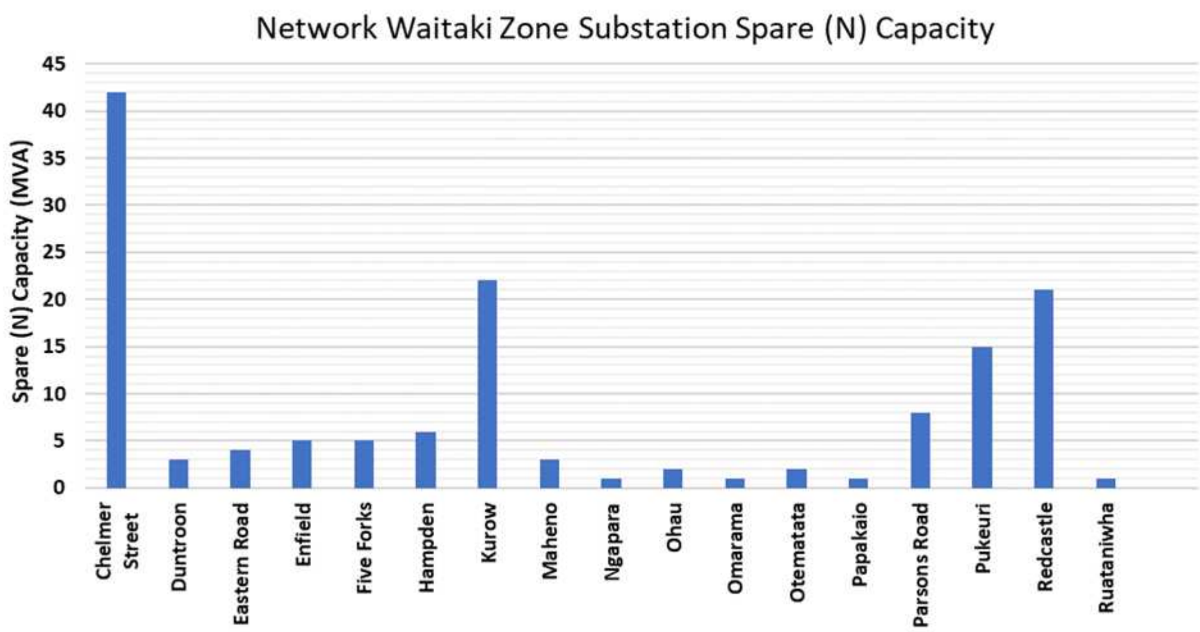


Figure 34 Summary: Approximate (N) spare capacity at Network Waitaki's zone substations

[21] Network Waitaki 2021 information disclosure (https://www.networkwaitaki.co.nz/company/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 EA Networks/Alpine Energy/Network Waitaki zone substations (33/11kV and 66/22kV substations shaded yellow and red in diagrams).

Figure 35 illustrates a high level overview of the substations and Load Sites.

The purpose of this section is to provide a high-level assessment to 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 EA Networks/Alpine Energy/Network Waitaki. This would likely entail powerflow modelling, optioneering and concept designs to provide more refined cost estimates.

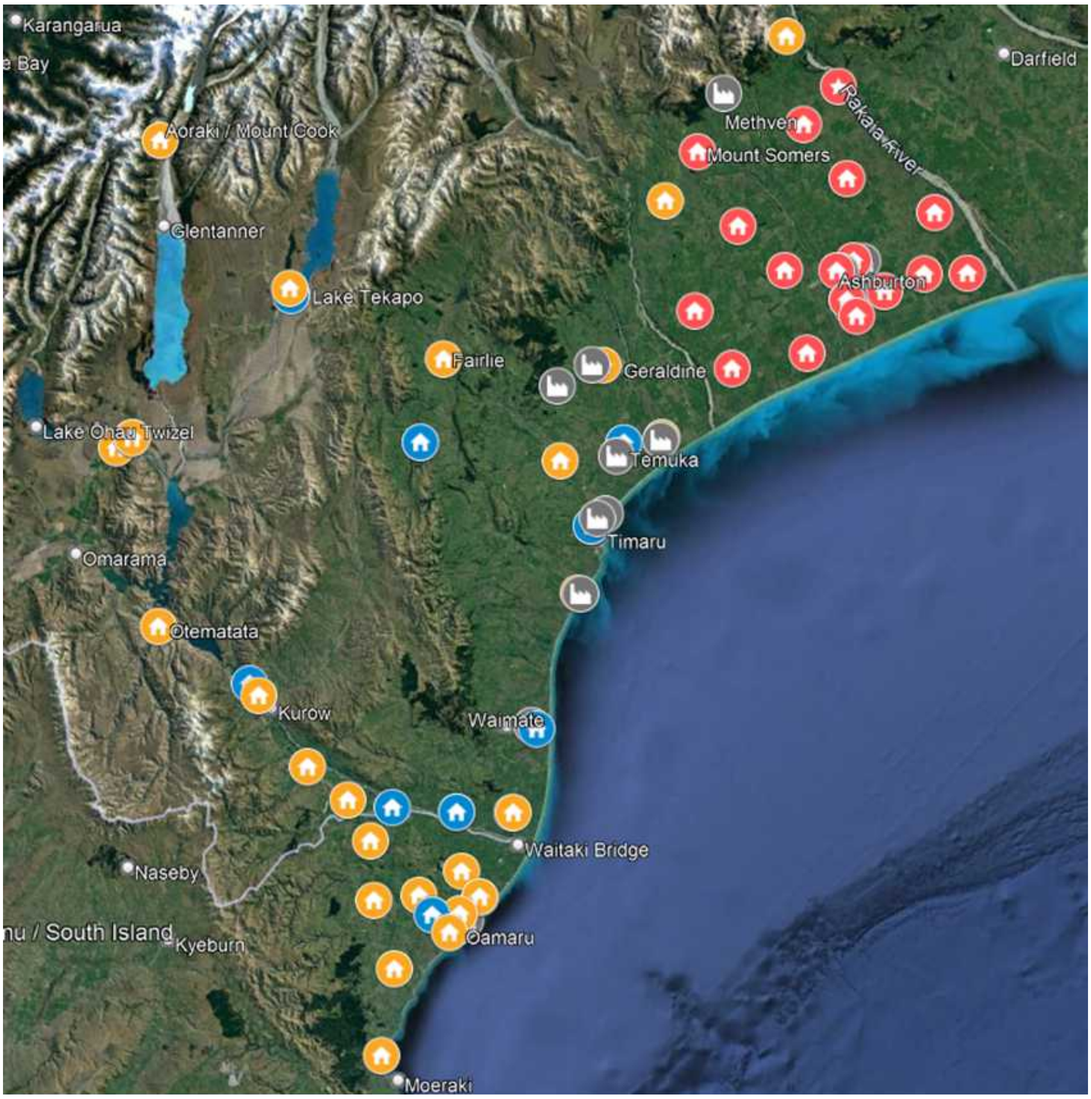


Figure 35 GXP substations (blue), 33/11kV substations (yellow), 66/22kV substations (red) and Load Sites (grey).

8.1 Assessment Methodology

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

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

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

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

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

- **Minor** – The "as designed" electrical system can likely connect the Load Site with minor distribution level changes and without the need for substantial infrastructure upgrades costs
- **Moderate** – The "as designed" electrical system requires some infrastructure upgrades including new connections into the local zone substation and/or upgrades at the local zone substation or sub-transmission network
- **Major** – The "as designed" electrical system requires substantial upgrades at both the transmission and distribution level, likely requiring significant investment

8.2 Engineering Assumptions:

Specific engineering assumptions in this section include:

- We have used the spare capacities of both the GXP and zone substations based on the publicly disclosed loading and capacity information (instead of the 2021 loading data provided by Transpower, Alpine Energy and Network Waitaki). Ergo's view is that these are typically more conservative than the actual loading and are therefore appropriate for this sort of high level assessment.
- We have assumed the existing site security should be maintained (unless otherwise stated). For example, if the site currently presently has (N-1) security, we have recommended infrastructure upgrades to maintain this.
- The upgrades and costs of individual Load Sites are considered in isolation of the adjacent Load Sites. We have not considered the scope and costs associated with connecting multiple Load Sites at this stage. The consideration of multiple sites is a complex task that would require the use of an integrated distribution, sub-transmission and transmission network model to undertake powerflow studies that establish the capacity and voltage constraints.
- 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 33kV and 11kV 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[22] accuracy - suitable for concept screening. Appendix 2 outlines accuracy of the cost estimates and the general assumptions.
- Cost estimates exclude land purchase, easements and consenting. These costs are difficult to estimate without undertaking a detailed review of the available land (including a site visit) and the local council rules in relation to electrical infrastructure. For example, the upgrade of existing overhead lines or new lines/cables across private land does require utilities to secure easements to protect their assets. Securing easements can be a very time consuming and costly process. For this reason, Ergo's estimates for new electrical circuits are generally based on assuming they are installed in road reserve and involve underground cables in urban locations and overhead lines in rural locations. We note that, as a general rule, 110kV and 220kV lines cannot be installed in road reserve due to wide corridor requirements. In some locations the width of the road reserve is such that 66kV and 33kV 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 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.

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

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

8.3 Albury GXP

None of the Load Sites identified by EECA are geographically close to the Albury GXP. Hence, Ergo is of the view that the Albury GXP is not a viable option for supplying Load Sites, and thus we have not considered the upgrade of the GXP or any zone substations.

8.4 Ashburton GXP (220/66kV)

The EECA Load Sites include:

- Talleys Ashburton (11MW or 14MW)
- Ashburton Meat Processors (0.98MW)
- Canterbury Dried Fruits (2.25MW)
- ANZCO Canterbury (10.12MW)
- Mt Hutt Lime (Adrian James Harmer) (1.72MW)

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

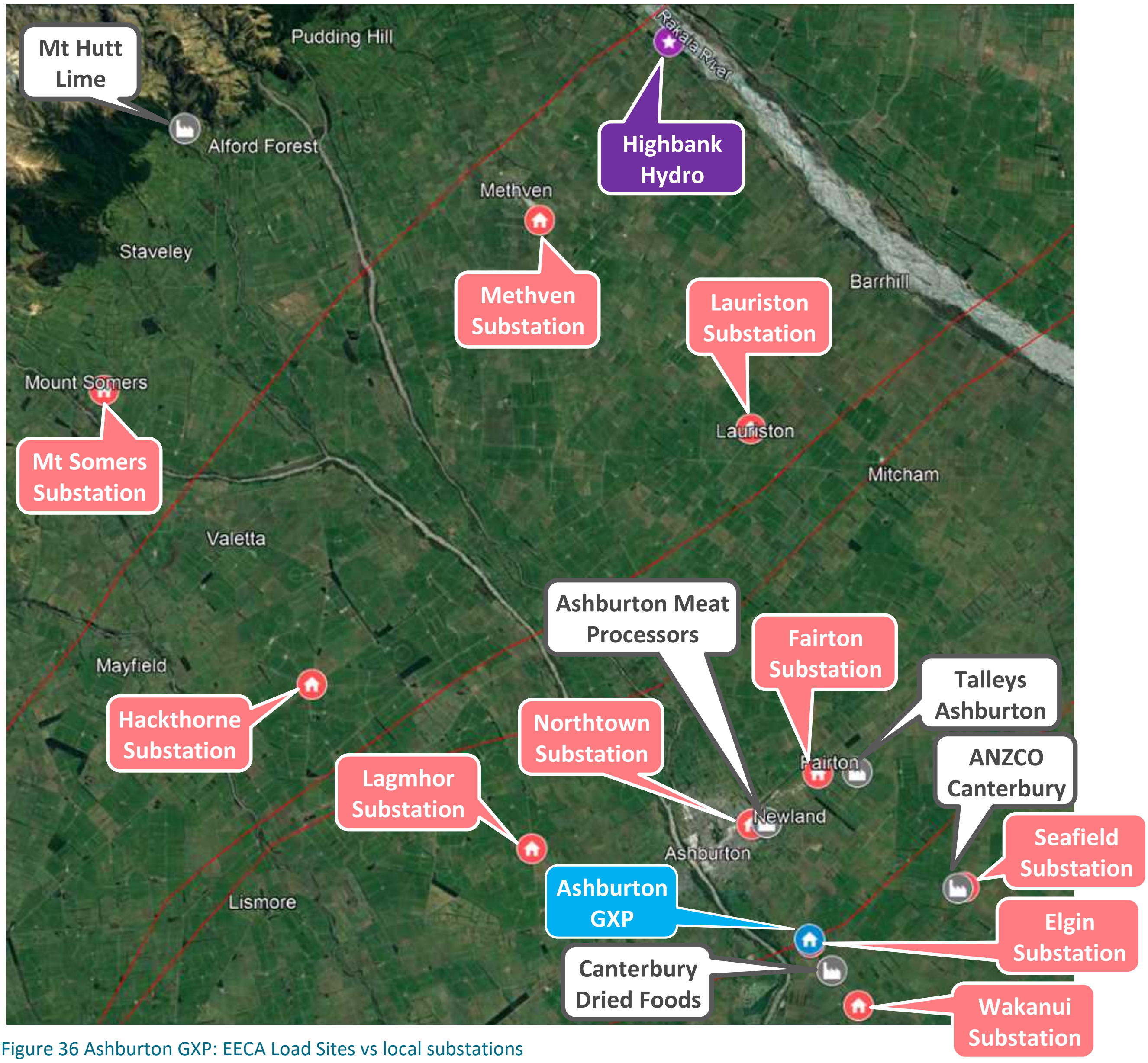


Figure 36 Ashburton GXP: EECA Load Sites vs local substations

8.4.1 Ashburton GXP Upgrade

Based on Transpower's demand forecast the Ashburton GXP has ≈43MVA of (N-1) spare capacity and significant (N) capacity.[23] This aligns with EA Networks view who indicated to Ergo that the Ashburton GXP has an (N-1) spare capacity of ≈40MVA.

Based on Transpower's forecast the combined load requirements of the Load Sites in the Ashburton region will not exceed the GXP's spare capacity. Having said this, if additional (N-1) capacity is required, the long term solution would be to install a new 220/66kV GXP (as discussed in 6.1.2). This approach would diversify the risk associated with the existing Ashburton GXP that supplies a significant load, although it would make the operation of the EA Networks' subtransmission network less flexible and would reduce existing asset utilisation levels. The new GXP is shown diagrammatically at the top of Figure 16 (an excerpt from Transpower's 2022 Planning Report).

For this report Ergo has assumed that, if the new GXP is required, it would connect into the Benmore-Islington A 220kV line, be located between Lauriston and Mitcham, and would involve:

- A new outdoor 220kV switchyard to accommodate three 220kV circuit breakers.
- 2 x 60MVA, 220/66kV power transformers.
- A new indoor switchroom to accommodate a 66kV switchboard (9 circuit breakers) that would initially "break into" two existing EA Networks 66kV circuits, creating four 66kV feeders. The lines would need to be diverted from their present path to the new GXP.

Ergo has not included the costs to divert the Roxburgh-Islington_A 220kV line to the new GXP (a distance of ≈3km) in order to bus the two lines. This decision is based on the assumption that the busing of the two lines would not be required to supply the load conversion opportunities, although may be required in the future for the wider operation of south island grid.

Ergo's capital cost estimates for the option presented are outlined in the following Table 7.

Table 7 Capital cost estimate for offloading Ashburton GXP[24] via the installation of a new GXP. [24]

Network Asset	Equipment	Number and Capital Cost ($M)	
Transmission	Large GXP	1.00	$20.00
Distribution	Single overhead 66kV line	6.00	$2.10
		TOTAL	**$22.10**

In terms of timeframes, Ergo estimates the above works, excluding land purchase and consenting times, would take around 36 - 48 months.

[23] If the supply from the embedded generators (Highbank and Montalto) can be relied upon the spare capacity is larger. However, as indicated in Section 6.1.1, EA Networks indicate that the generator's capacity cannot be relied upon.

[24] Given the preliminary nature of the costs they are considered to be Class 5 estimates as discussed in Appendix 2.

8.4.2 Talleys Ashburton

		TALLEYS ASHBURTON
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	11MW or 14MW	Ashburton

Existing Electrical Supply to the Plant

The Talleys Ashburton plant is supplied from EA Networks' Fairton zone substation (refer to Figure 37 below) via the Newlands 22kV feeder. The plant is ≈2.5km from the substation. The existing security of supply to the plant is (N-1), (N-1) and (N) at the transmission, sub-transmission and distribution level.

Figure 37 Talleys Ashburton geographic location in relation to the Fairton substation

Supply Option(s) for New Load

Transmission Network

According to Transpower, the Ashburton GXP currently has approximately 43 MVA of (N-1) capacity, and should have no issues supplying the Load Site (refer to discussion in Section 8.4.1).

EDBs Network

The Fairton zone substation presently has 32MVA of spare (N) capacity and 14MVA of spare (N-1) capacity. The substation is supplied via two 66kV lines from the Ashburton GXP and have sufficient capacity to cope with 11MW or 14MW of additional load.

We expect the supply of 11MW or 14MW of new load at the Talleys' site to require the following:

- A new 22kV feeder (≈2.5km) from Fairton zone substation to the Talleys' site. Ergo has assumed this would consist of a 1.7km overhead line from the Fairton substation along Company Road to Fairfield Road followed by a 1.0km underground cable along Fairfield Road and into the plant. EA Networks has indicated a more cost effective construction methodology could involve mole-ploughing a 400Amp, 22kV underground cable along the entire route.

- A new indoor 22 kV circuit breaker, which we have assumed can be accommodated in the existing switchroom at the Fairton substation.
- A new 22kV RMU at the entry to the factory site.
- Some transformer/switchgear reconfiguration would also be required as the spare capacity at the Fairton substation is split between 11kV and 22kV voltage levels.

The security-of-supply to the site would be (N-1) for the transmission system (Ashburton GXP) and sub-transmission system (Fairton zone substation), but the distribution system (22kV feeder level) into the site would have (N) security-of-supply. The distribution system could be afforded with (N-1) security with the installation of a second 22kV feeder from Fairton substation to the site.

Capital Cost Estimate[24]

Table 8 Talleys Ashburton: Capital cost estimate to supply the Load Site[24,25]

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 overhead 22kV line	1.70	$0.34
Distribution	Single underground 22kV cable	1.00	$0.45
Distribution	Distribution switches - RMU	1.00	$0.05
		TOTAL	**$0.94**

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N-1)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	22kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double overhead 22kV line	1.70	$0.51
Distribution	Double underground 22kV cable	1.00	$0.80
Distribution	Distribution switches - RMU	2.00	$0.10
		TOTAL	**$1.61**

This does not include the costs to install distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 12 - 18 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes consenting, if required.

[25] The green, yellow and blue shaded titles are intended to indicate the security-of-supply that the cost estimate would deliver.

8.4.3 Ashburton Meat Processors

ASHBURTON MEAT PROCESSORS		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	0.98MW	Ashburton
Existing Electrical Supply to the Plant		
The Ashburton Meat Processors' plant is ≈1.0km from EA Networks' Northtown zone substation (refer to Figure 38 below) and is presently fed via an existing 11kV feeder (mainly overhead line). The existing security of supply to the plant is (N-1), (N-1) and (N) at the transmission, sub-transmission and distribution level.		

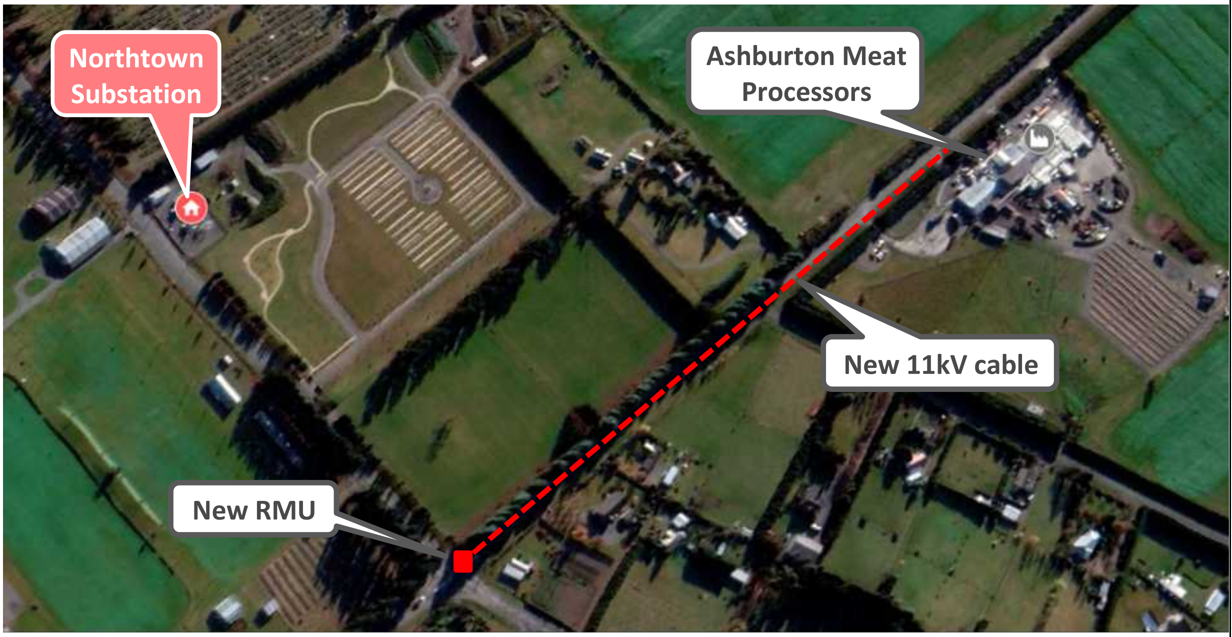


Figure 38 Ashburton Meat Processors geographic location in relation to the Northtown substation

Supply Option(s) for New Load

Transmission Network

The Ashburton GXP could supply the additional load.

EDB Network

The Northtown zone substation has sufficient (N-1) capacity to accommodate the new load. However, the existing 11kV overhead spur line along Bridge street is equipped with a very small conductor, and in order to supply the additional load, Ergo expect that a new ≈0.6km underground 11kV cable would need to be installed along Bridge street and terminated directly on the existing overhead line on Seafield Road (and which is supplied from the Northtown zone substation). We have also assumed that a new 11kV RMU would need to be installed close-in to the factory site to provide switching capability between the new cable and the existing overhead line (and possibly supply a distribution transformer).

Capital Cost Estimate[24]

Table 9 Ashburton Meat Processors: Capital cost estimate to supply the Load Site[24]

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single underground 11kV cable	0.60	$0.24
Distribution	Distribution switches - RMU	1.00	$0.05
		TOTAL	**$0.29**

This estimate does not include the costs to install any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 3 - 6 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes consenting, if required.

8.4.4 Canterbury Dried Foods

CANTERBURY DRIED FOODS		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	2.25MW	Ashburton

Existing Electrical Supply to the Plant

The Canterbury Dried Foods' plant is ≈2.8km from EA Networks' Elgin and Wakanui zone substation (refer to Figure 39 below) and is presently fed from the Elgin substation via an existing 22kV feeder (mainly overhead line). The existing security of supply to the site is (N-1), (N) and (N) at the transmission, sub-transmission and distribution level.

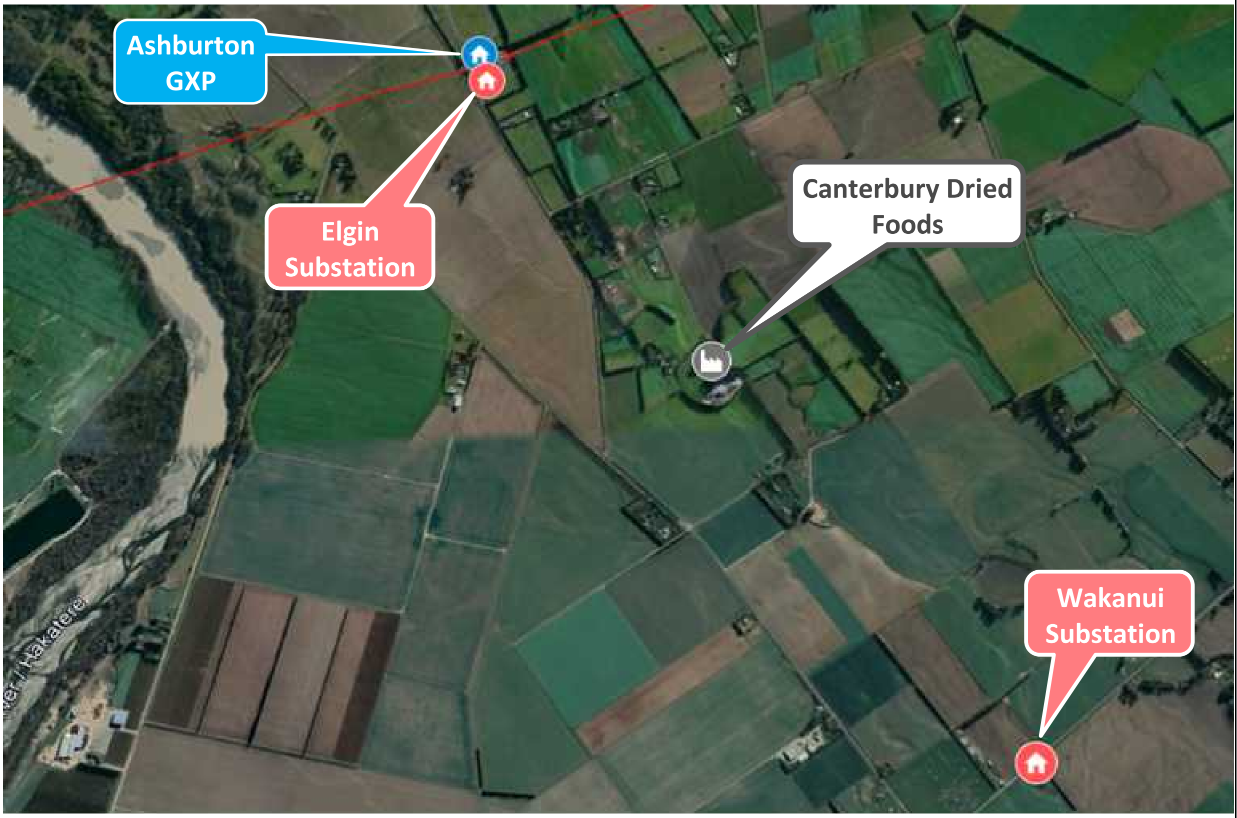


Figure 39 Canterbury Dried Foods' geographic location in relation to the Elgin zone substation and the Ashburton GXP

Supply Option(s) for New Load

Transmission Network

The Ashburton GXP could supply the additional load.

EDB Network

The 20MVA, 66/22 kV transformer at Elgin substation is very lightly loaded and can comfortably accommodate the additional load of 2.25MW (59Amps). The 2.2km, 22 kV circuit from Elgin to the Canterbury Dried Food site also has sufficient capacity to supply the additional load. Alternatively, the load could also be supplied from Wakanui substation at most times of the year (irrigation season may be slightly limiting). EA Networks has not identified any other significant loads seeking to connect to the Elgin and Wakanui substations, although there is the potential for some solar generation (<10 MW) into the Elgin 22 kV bus.

CANTERBURY DRIED FOODS
Ergo has assumed that a single RMU (or air break switch) would be required close-in to the site to sectionalise/supply the additional load.
Capital Cost Estimate[24]

Table 10 Canterbury Dried Foods: Capital cost estimate to supply the Load Site[24]

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Distribution switches - RMU	1.00	$0.05
		TOTAL	**$0.05**

This estimate does not include any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 3 - 6 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes consenting, if required.

8.4.5 ANZCO Canterbury

ANZCO CANTERBURY		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	10.12MW	Ashburton
Existing Electrical Supply to the Plant		
The ANZCO plant is located immediately adjacent to EA Networks' Seafield 66/11kV zone substation (refer to Figure 40 below) and takes supply from a single 11kV feeder from the Seafield substation. The existing ANZCO load is around 6MW. There is a backup/alternative to ANZCO via a 22 kV feeder from the Wakanui zone substation. The 22kV feeder supplies a 5MVA, 22/11 kV auto-transformer at the Seafield 22/11kV zone substation. The 22 kV alternative supply is on the same pole line as the 11 kV supply from Seafield 66/11 kV zone substation. The existing security of supply to the site is (N-1), (N) and (N) at the transmission, sub-transmission and distribution level.		

Figure 40 ANZCO geographic location in relation to the Seafield substation and the Ashburton GXP

Supply Option(s) for New Load

Transmission Network

The Ashburton GXP could supply the additional load.

EDB Network

The ANZCO plant has a dedicated 66/11 kV substation (Seafield) with an existing transformer that has a 10/15MVA capacity. The existing substation does not have the capacity to supply the additional 10.12MW boiler load.

The options to supply the additional load include the following:

- **Option 1:** Install a second 10/15MVA transformer bank.
- **Option 2:** Upgrade the existing transformer to 20MVA. This would provide ANZCO with (N) security of supply.
- **Option 3:** Upgrade the existing transformer to 20MVA and install a second new 20MVA unit (N-1).

In addition ANZCO would need to upgrade the 11 kV supply configuration in order to supply 10.12MW/550 amps to the new boiler. The 66 kV sub-transmission can cope with the additional load with all circuits in service, but the loss of a 66 kV circuit from Elgin would cause significant thermal overloading on the remaining 66 kV circuit in the Elgin-Wakanui-Seafield-Pendarves-Elgin ring. We have assumed that the existing site load together with the new Load Site would continue to have (N) security of supply at the sub-transmission level.

For the purposes of this report Ergo has assumed that Option 2 would be satisfactory.

Capital Cost Estimate[24]

Table 11 ANZCO Canterbury: Capital cost estimate to supply the Load Site[24]

Transmission => (N-1)	Subtransmission => (N)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Large supply transformer (ZSS)	1.00	$1.50
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	0.50	$0.21
		TOTAL	**$1.91**

This estimate does not include distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 24 - 36 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes consenting, if required.

8.4.6 Mt Hutt Lime (Adrian James Harmer)

		MT HUTT LIME
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	1.72MW	Ashburton
Existing Electrical Supply to the Plant		

The Mt Hutt Lime plant is presently fed at 11kV via a feeder from EA Networks' Methven Substation (refer to Figure 41 below). The plant is ≈24km (line length) from the substation, and line to the site is equipped with three different conductor types with different ratings (14km of Dog, 1.1km of Magpie, and 9km of Flounder). The existing security of supply to the site is (N-1), (N-1) and (N) at the transmission, sub-transmission and distribution level.

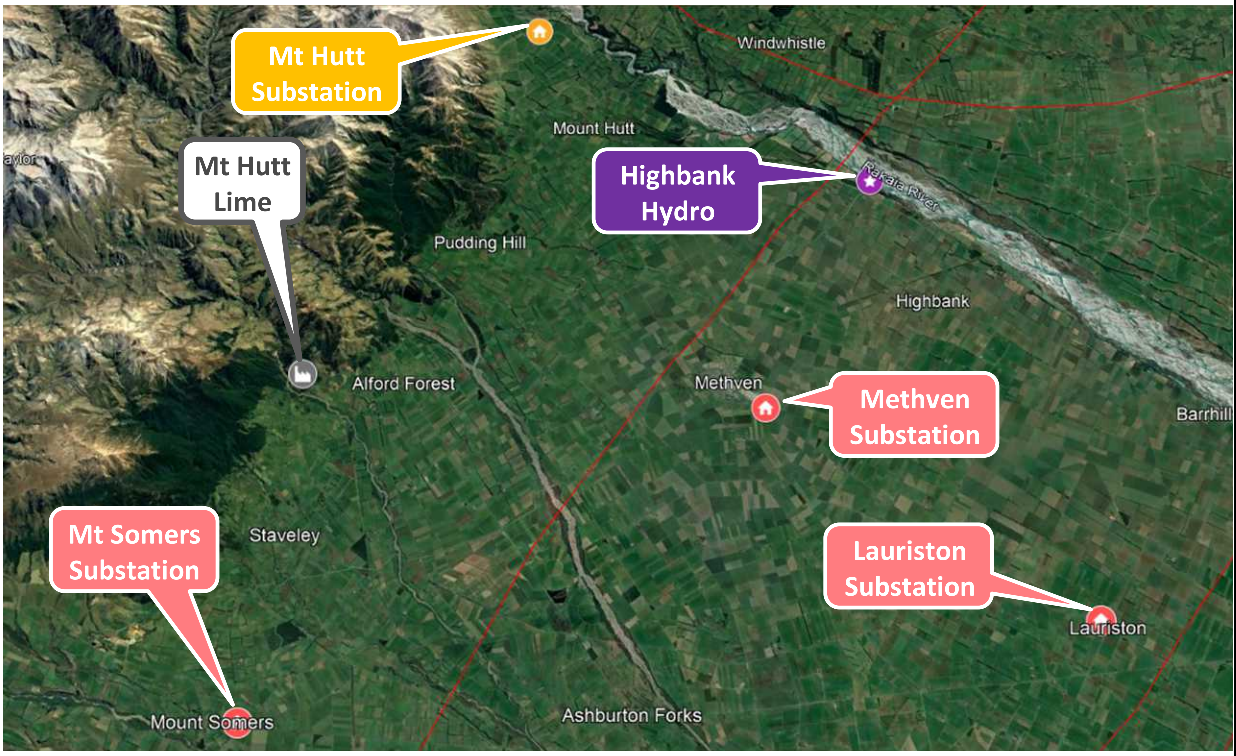


Figure 41 Mt Hutt Lime geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Transmission Network

The Ashburton GXP could supply the additional load.

EDB Network

The Methven 66/22 kV substation is more than capable of supplying the additional load. However, the existing overhead 11kV line to the site would not be capable of supplying an additional 1.72MW.

EA Networks are in the process of converting the line from 11kV to 22 kV. However, once complete with the new Load Site connected the 22kV voltage delivered to the site is predicted to experience a drop of 7%, and this ignores the existing load. Ergo suspect that the deliver voltage may not be acceptable. Solutions to resolving the deliver voltages to the site include:

- **Option 1:** Installing a voltage regulator.

- **Option 2:** Installing a set of capacitor banks.
- **Option 3:** Rebuilding the existing sections of line that are equipped with Magpie and Flounder conductor with Dog conductor. With this option the delivery voltage to the site are estimated to only drop by 3% which together with the existing load should be acceptable.

For this report Ergo has assumed Option 3 is chosen.

Capital Cost Estimate[24]

Table 12 Mt Hutt Lime: Capital cost estimate to supply the Load Site[24]

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	Equipment	Number and Capital Cost ($M)	
Distribution	Reconductor 22kV line (larger)	10.10	$1.52
		TOTAL	**$1.52**

The estimate does not include distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 12 - 18 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes consenting, if required.

8.5 Bells Pond GXP

The EECA Load Sites include:

- Oceana Dairy (1.63MW and 8.0MW or 24.47MW)

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

Figure 42 Bells Pond GXP: EECA Load Sites vs local substations

8.5.1 Bells Pond GXP Upgrade

Transpower's demand forecast indicates that Bells Pond GXP has exceeded its (N-1) capacity and has ≈10MVA of (N) spare capacity. The single incoming 110kV circuit has a 34/80MVA rating (summer/winter), and ≈6MVA of spare (N-1) capacity on the 110kV lines that supply the substation (this is discussed in more detail in Section 6.1.3).

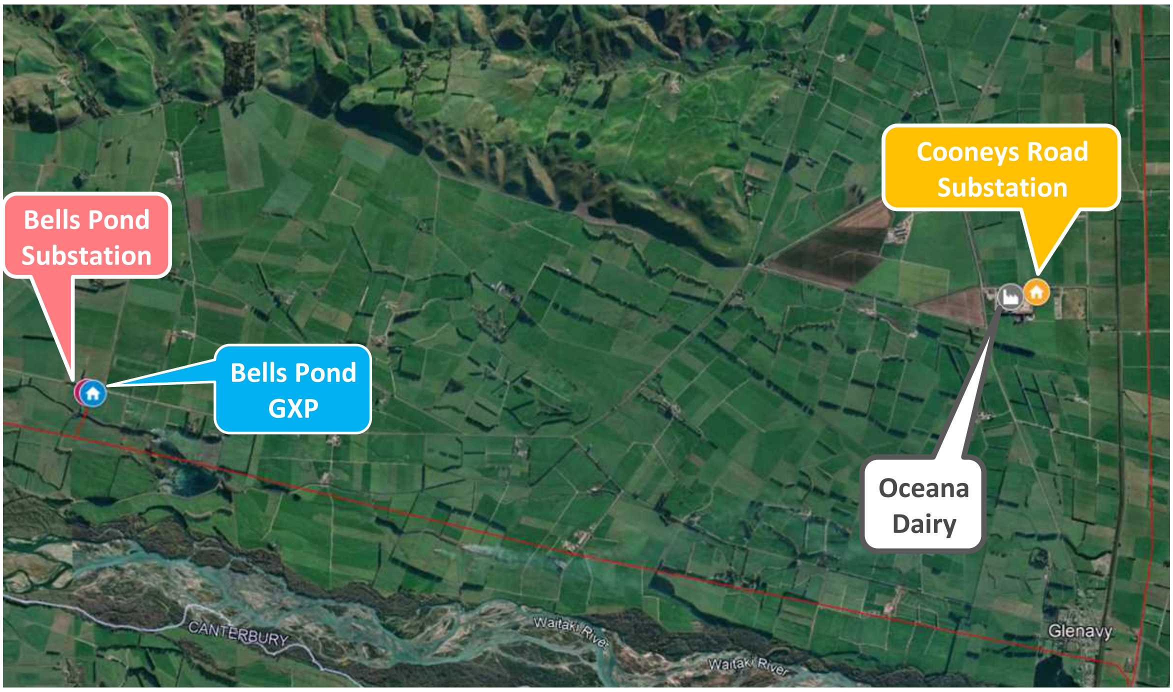
The 110kV supply to the Bells Pond GXP also supplies the Black Point, Oamaru and Studholme GXPs. The 110kV network has been equipped with a number of features to maximise the use of the existing network capacity, which include:

- Allowing the 110kV delivery voltages to the Oamaru GXP drop to 0.875p.u.
- Implementing a demand response scheme.
- Implementing a circuit overload protection scheme on the Oamaru-Waitaki circuit.
- Variable line ratings on the Glenavy-Oamaru circuits.

Transpower's 2022 Planning Report indicates it is in discussions with Network Waitaki regarding the implementation of a special protection scheme (at a cost of NZ$0.3M) to overcome an impending (N-1) constraint at the Oamaru GXP. However, the supply of significant additional electrical load at Bells Pond would require the construction of a new 220/110kV GXP that is proposed between Livingstone and the Waitaki River, which is shown at the bottom of Figure 16. Additionally, Network Waitaki is proposing the installation of new 110kV overhead line between the new GXP and the existing Oamaru GXP. If installed, the new GXP and 110kV line could supply the existing Oamaru and Black Point substations, remove their loads from the existing Oamaru-Waitaki circuits and deliver additional capacity to both Network Waitaki and Alpine Energy (via the existing 110kV network). In conjunction with the new GXP the existing 110kV circuits on the 110kV line between Waitaki and Glenavy are proposed to be bonded together as shown in Figure 16.

Transpower's 2022 Planning Report estimates that the new 220/110kV GXP, and associated works, would cost NZ$35M. In addition, Network Waitaki's Asset Management Plan indicates that the proposed construction of a new 110kV overhead line from the Oamaru GXP to the new 220/110kV GXP would cost ≈$26M.

8.5.2 Oceania Dairy

OCEANA DAIRY		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
Two new electrical boilers	1.63MW and 24.47MW or 8MW	Bells Pond
Existing Electrical Supply to the Plant		
The Oceania Dairy plant is presently fed from Alpine Energy's Cooneys Road zone substation that is immediately adjacent to the plant (refer to Figure 43 below). The plant and zone substation are ≈12km from the Bells Pond GXP. The plant is fed directly off the Cooneys Road substation 11 kV bus, via four 11kV feeders (refer to Figure 11). The plant presently has (N) security for transmission, (N-1) security for sub-transmission, and (N) security for distribution.  Figure 43 Oceania Dairy geographic location in relation to the surrounding zone substations		
Supply Option(s) for New Load		
Transmission Network There is not enough capacity in the 110kV lines feeding the GXP for an additional 8 MW of load for the reasons discussed in Section 6.1.3. *EDB Network* If one is only considering Alpine's Network, Cooneys Road zone substation operates on N security, and the substation and lines feeding it are capable of supplying both a 1.63 MW boiler and an 8 MW boiler. These comprise **Options 1 and 2** of the costing below. Ergo has assumed some minor cable upgrades and switchgear would be required. The existing two sub-transmission circuits between Bells Pond and Cooneys Road are insulated for 110kV but operate at 33kV. During normal operating conditions only one of the 33kV circuits supplies the plant with the other 33kV circuit disconnected but readily available as a switched back-up. This gives rise to two potential options for connecting the 24.47 MW boiler (plus the 1.63 MW boiler):		

- **Option 3:** Supply the plant using both 33kV existing circuits. That is, remove the link between the two 33kV lines at the Cooneys Road end, install a second incoming line breaker and a second 33/11 kV transformer feeding the Cooneys Road 11 kV bus, to supply the additional load. Also, two additional 11kV circuit breakers and cable feeders.
- **Option 4:** Operate the sub-transmission circuits to Cooneys Road at 110 kV together with new 110kV circuit breakers installed at Transpower's Bells Pond substation. It would also require a new 110kV circuit breaker and 110/11 kV transformer at Cooneys Road. If (N-1) security of supply is required, a second 110/11 kV transformer and 110 kV circuit breaker would be required at Cooneys Road. For the below costings, it is assumed that (N-1) security is required.

Installation of the 24.47 MW of new boiler load would likely require expansion of the 11 kV switchboard at Cooneys Road zone substation and new cable runs to the new boilers. In addition, the GXP upgrade discussed in Section 8.5.1 would need to be implemented.

Capital Cost Estimate[24]

Table 13 Oceania Dairy: Capital cost estimate to supply the Load Site[24, 25, 26]

Option 1 –1.63 MW boiler load

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Distribution switches - RMU	1.00	$0.05
Distribution	Single underground 11kV cable	0.20	$0.08
		TOTAL	**$0.13**

Option 2 –8 MW and 1.63MW boiler load

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Distribution switches - RMU	4.00	$0.20
Distribution	Single underground 11kV cable	0.40	$0.16
		TOTAL	**$0.36**

Option 3 –24.47 MW and 1.63 MW boiler load

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Large supply transformer (ZSS)	1.00	$1.50
Distribution	33kV circuit breaker (ZSS)	1.00	$0.15
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Single underground 11kV cable	2.00	$0.80
		TOTAL	**$2.65**

[26] Note the transmission security is assumed to be returned to (N-1) following the upgrades mentioned earlier.

Option 4 –24.47 MW and 1.63 MW boiler load

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	110kV circuit breaker bay	4.00	$1.20
Distribution	Large supply transformer (ZSS)	2.00	$3.00
Distribution	11kV circuit breaker (ZSS)	1.00	$0.10
Distribution	Single underground 11kV cable	2.00	$0.80
		TOTAL	**$5.10**

Does not include the costs to upgrade the transmission infrastructure (discussed further above), or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 12 - 18 months for Options 1 and 2, 24- 36 months for Option 3 and 36-48 months for Option 4.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes land acquisition and consenting, if required.

8.6 Black Point GXP

None of the Load Sites identified by EECA are geographically close to the Black Point GXP. Hence, Ergo is of the view that the Black Point GXP is not a viable option for supplying any of the Load Sites, and thus we have not considered the upgrade of the GXP or any zone substations.

8.7 Oamaru GXP

The EECA Load Sites include:

- Canterbury Spinners (3.22 MW)
- Oamaru Meats (1.08 MW)
- Alliance Pukeuri (8.75 MW)
- Moeraki electric car charging station (initially 1.5MW, increasing to 4.5MW)

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

Figure 44 - Oamaru GXP, local zone substations and the Load Sites

8.7.1 Oamaru GXP Upgrade

Transpower's demand forecast indicates that Oamaru GXP has no (N-1) spare capacity and ≈58MVA of (N) spare capacity. However, the 110kV supply to the Oamaru GXP also supplies the Bells Pond, Black Point and Studholme GXPs, and as discussed in Section 8.5.1:

- The 110kV network supplying the Oamaru GXP is close to reaching its limitations.
- Transpower is in discussions with Network Waitaki regarding the implementation of a special protection scheme (at a cost of NZ$0.3M) to overcome an impending (N-1) constraint at the Oamaru GXP.

- The supply of significant additional electrical load at Oamaru would require the construction of a new 220/110kV GXP, which Transpower estimates would cost NZ$35M. Ergo understands the new GXP will be called the North Otago GXP and located ≈1km west of the existing Black Point GXP.

8.7.2 Canterbury Spinners

		CANTERBURY SPINNERS
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	3.22 MW	Oamaru
Existing Electrical Supply to the Plant		
The Canterbury Spinners plant is presently supplied by Network Waitaki's Chelmer St zone substation (via the Reed St 11kV feeder) and Redcastle zone substation (via the Woolen Mills 11kV feeder). The plant is ≈2km (straight line) from both Redcastle and Chelmer Street zone substations. The existing security of supply to the plant is (N-1), (N-1) and (N) at the transmission, sub-transmission and distribution level.		

Figure 45 Canterbury Spinners geographic location in relation to the surrounding zone substations

CANTERBURY SPINNERS
Supply Option(s) for New Load
Transmission Network The transmission network could not supply the additional load whilst maintaining (N-1) security, as the Oamaru GXP has breached its (N-1) capacity (refer to Section 8.7.1). *EDB Network* The Chelmer St substation and Redcastle substations both have sufficient (N-1) spare capacity to accommodate the additional load of 3.22MW. However the two existing 11kV feeders supplying the site, which consist of a mix of overhead and underground cable, are highly loaded with peak loads of ≈5MW each at times throughout the year and are therefore unlikely able to supply the additional load Based on this, Ergo is of the view a new dedicated 11kV supply to the site would be required. This could be supplied from either of the Chelmer St or Redcastle substations and due to the urban topography, would likely require underground cabling. A suitable cable route is likely to require ≈3km of underground cabling.
Capital Cost Estimate[24]

Table 14 Canterbury Spinners: Capital cost estimate to supply the Load Site[24, 25]

Canterbury Spinners

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	3.00	$1.20
		TOTAL	**$1.30**

Does not include the costs to install a new GXP substation (discussed in Section 8.7.1 above), or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure
Estimated to take 12 - 18 months. To Plan, Design, Procure, Construct and Commission the works. Excludes the work required to establish the Load Sites. Excludes land acquisition and consenting, if required.

8.7.3 Oamaru Meats

OAMARU MEATS		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	1.08 MW	Oamaru
Existing Electrical Supply to the Plant		
The Oamaru Meats plant is presently fed from Network Waitaki's Redcastle zone Substation (refer to Figure 46 below) via an overhead 11kV feeder (Redcastle Rd feeder). The plant is ≈1.7km from the substation. The existing security of supply to the plant is (N-1), (N-1) and (N) at the transmission, sub-transmission and distribution level.  Figure 46 Oamaru Meats geographic location in relation to the surrounding zone substations		
Supply Option(s) for New Load		
Transmission Network The transmission network could not supply the additional load whilst maintaining (N-1) security, as the Oamaru GXP has breached its (N-1) capacity (refer to Section 8.7.1). *EDB Network* The Redcastle Rd Feeder consists of a short length of underground cable from the substation to an overhead line which runs straight down Redcastle Road to the site. Both the cable (3c 300mm^2 XLPE) and overhead line (AAAC Weta) are capable of carrying upwards of 8MVA. Historical loading profiles suggest these are relatively lightly loaded (≈2.1MW peak). Therefore, it is likely the additonal load could be supplied from the existing connection.		
Capital Cost Estimate[24]		
Not Applicable.		
Timeframe to Establish New Electrical Infrastructure		
Not Applicable		

8.7.4 Alliance Pukeuri

ALLIANCE PUKEURI		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	8.75 MW	Oamaru

Existing Electrical Supply to the Plant

The Alliance Pukeuri plant is presently fed from Network Waitaki's Pukeuri zone substation that is immediately adjacent to the plant (refer to Figure 47 below). The plant and zone substation are ≈12km from the Oamaru GXP. The existing security of supply to the plant is (N-1), (N-1) and (N) at the transmission, sub-transmission and distribution level.

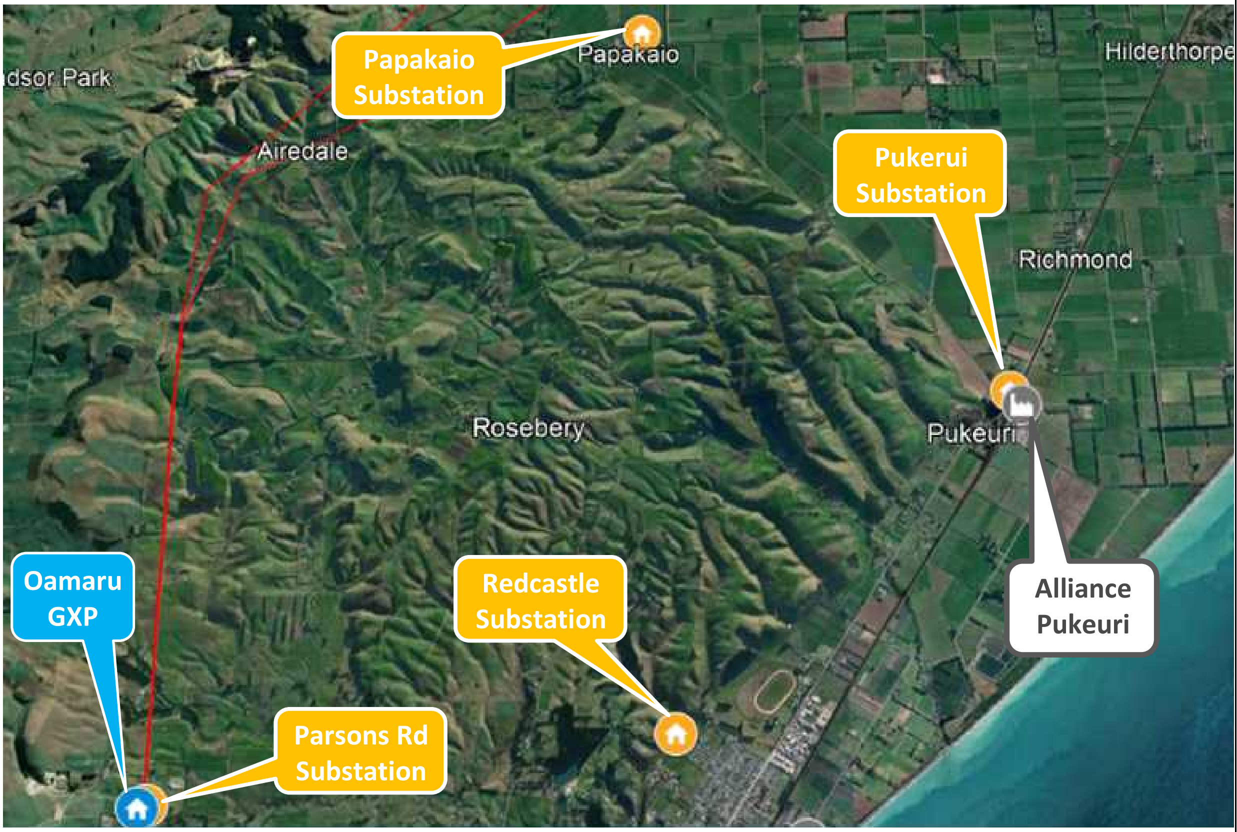


Figure 47 Alliance Pukeuri geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Transmission Network

The transmission network could not supply the additional load whilst maintaining (N-1) security of supply, and would need to be upgraded as discussed in Section 8.7.1.

EDB Network

Pukeuri zone substation currently has ≈3MVA of spare (N-1) capacity and would therefore not be able to supply the required 8.75MW. However, the two incoming 33kV subtransmission circuits (from the GXP and Redcastle respectively) appear to be adequately sized to be able to carry the additional load.

Therefore, Ergo expects the upgrade would consist of:

- Replacing the existing transformers with 2 x 33/11kV 20MVA equivalents.
- Installing two new 11kV circuit breaker feeder panels to supply the load.

- Cabling to the plant (we have assumed a double circuit cable 500m in length).

Capital Cost Estimate[24]

Table 15 Oamaru Pukeuri: Capital cost estimate to supply the Load Site[24, 25]

Transmission => (N-1)	Subtransmission => (N-1)	Distribution =>	(N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Large supply transformer (ZSS)	2.00	$3.00
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	0.50	$0.35
		TOTAL	**$3.55**

This estimate does not include the costs to install a new GXP substation (discussed in Section 8.7.1 above), or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 24 - 36 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes land acquisition and consenting, if required.

8.7.5 Moeraki Charging Station

OMARAMA CHARING STATION		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
Charging station for electric cars	Initial load of 1.5MW increasing to 4.5MW	Oamaru

Existing Electrical Supply to the Plant

The following Figure 47 illustrates a potential location for the charging station on the northern fringe of the Hampden a township and close to Network Waitaki's Hampden substation.

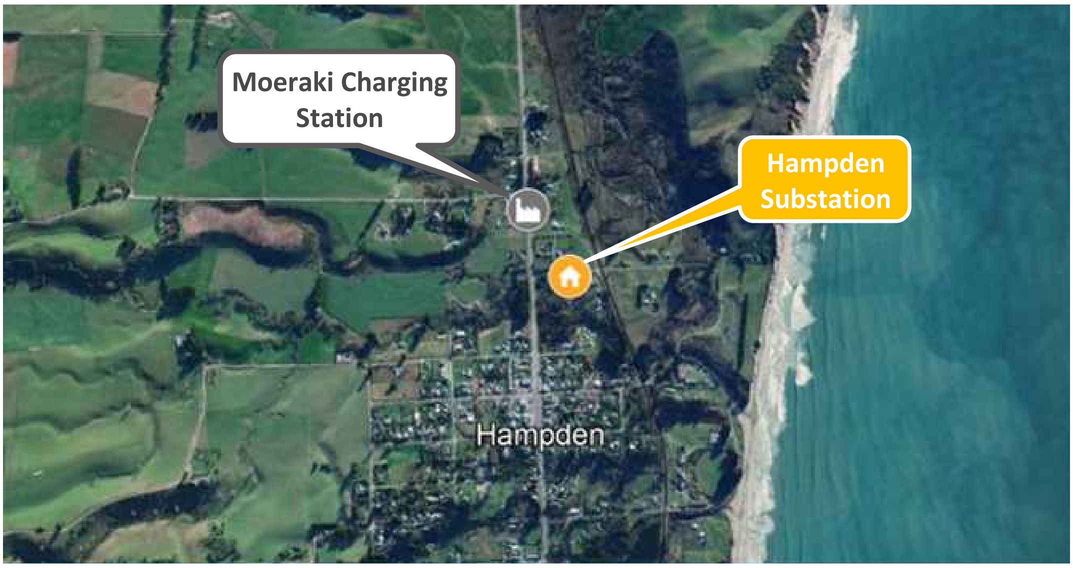


Figure 48 Moeraki charging station, location in relation to the surrounding zone substation

Supply Option(s) for New Load

Transmission Network

The transmission network could not supply the additional load whilst maintaining (N-1) security of supply, and would need to be upgraded as discussed in Section 8.7.1.

EDB Network

The Hampden zone substation has a total capacity of 7MVA and has sufficient spare capacity to supply the initial and ultimate load of the charging station.

Therefore, Ergo has estimated the capital costs in two stages, as follows:

- **Stage 1 – Supply of 1.5MW:** This could be supplied via the existing network and Ergo has assumed it would require the installation of distribution switchgear and 2 x 1MVA transformers.
- **Stage 2 – Supply of 4.5MW:** This would require the following:
  - Installation of a dedicated 11kV circuit breaker at the Hampden substation.
  - Installation of 0.3km of undergournd 11kV cable from the Hampden substation to the charging station.
  - Installation of distribution switchgear and 5 x 1MVA transformers.

The Stage 2 cost estimate includes the Stage 1 costs.

OMARAMA CHARING STATION

Capital Cost Estimate[24]

Table 16 Moeraki Charging Station: Capital cost estimate to supply the Load Site[24, 25]

Stage 1 – Supply of 1.5MW

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Distribution switches - RMU	2.00	$0.10
Distribution	1000kVA distribution tx	2.00	$0.52
		TOTAL	**$0.62**

Stage 2 – Supply of 4.5MW

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	0.20	$0.08
Distribution	Distribution switches - RMU	5.00	$0.25
Distribution	1000kVA distribution tx	2.00	$0.52
		TOTAL	**$0.95**

The above estimates do not include the costs to upgrade the GXP substation, as discussed in Section 8.12.1 above. We also note that the supply of the additional 4.5MW of load may result in voltage constraints on Network Waitaki's 33kV network and may require the installation of voltage support equipment (i.e. capacitor banks).

Timeframe to Establish New Electrical Infrastructure

Stage 1 estimated to take 6 months and Stage 2 estimated to take 12 - 18 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes land acquisition and consenting, if required.

8.8 Studholme GXP

The EECA Load Sites include:

- Fonterra Studholme (16.0 MW)

The geographic location of the Load Sites are shown on the following Figure 49 in relation to the local transmission substation. There are no zone substations in the local vicinity.

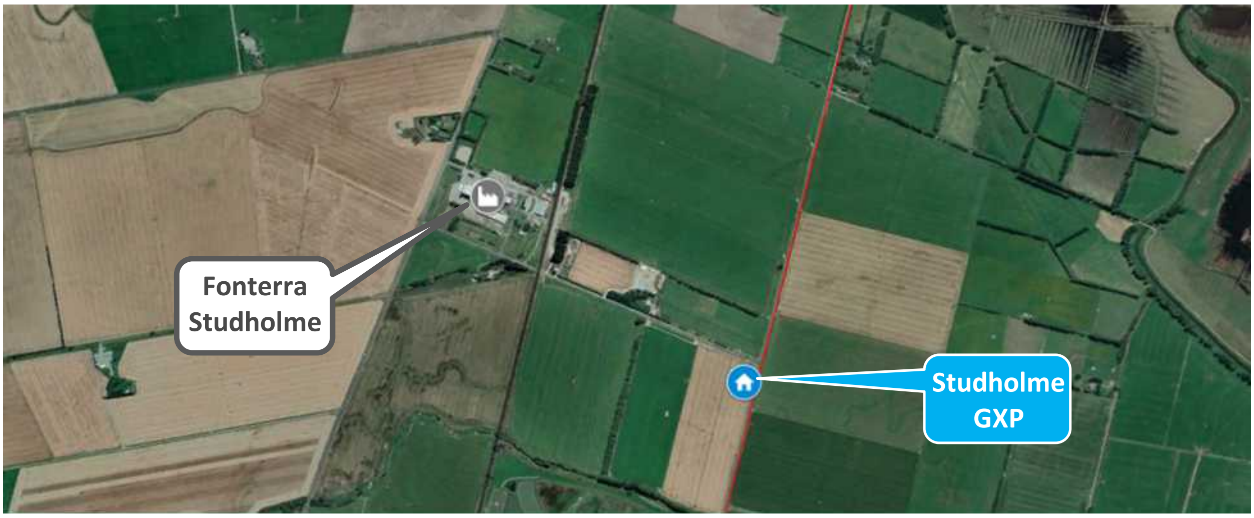


Figure 49 Studholme GXP: Local GXP substation and Load Site

8.8.1 Studholme GXP Upgrade

Transpower's demand forecast indicates that Studholme has no (N-1) or (N) spare capacity (i.e. the substation is fully loaded during periods of peak demand). The 110kV supply to the Studholme GXP also supplies the Bells Pond, Black Point and Oamaru GXPs, and as discussed in Section 8.5.1:

- The 110kV network supplying the GXP substation is close to reaching its limitations.
- The supply of significant additional electrical load at any of the substations would require the construction of a new 220/110kV GXP, which Transpower estimates would cost NZ$35M. Network Waitaki is in advanced discussions with Transpower regarding the installation of GXP near the Black Point GXP, which has the potential to off-load the existing regional 110kV network.

Transpower's 2022 Planning Report indicates the following in relation to the Studholme GXP:

- A remote 110kV switch and protection upgrade is proposed for installation at the Studholme GXP to reduce restoration times when Studholme is supplied from the Timaru GXP (the Studholme-Glenavy 110kV circuit is "operated in an open circuit configuration" during the dairy peak season and Studholme is supplied from Timaru). Transpower's cost estimate for the automated switching is NZ$0.5M.
- The Studholme 2 x 10MVA, 110/11kV supply transformers are due for replacement in 2025/2027. If required larger capacity transformers could be installed, with a marginal increase in cost.

8.8.2 Fonterra Studholme

		FONTERRA STUDHOLME
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	16.0 MW	Studholme

Existing Electrical Supply to the Plant

The Fonterra Studholme plant is presently fed from the Transpower's Studholme GXP that is ≈1km to the east of the plant (refer to Figure 51 below). There are two main lines to the site, one of which is predominantly medium to large conductors, overhead and underground, with the other a mix of small and medium underground conductors. The existing security of supply to the plant is (N) and (N-1) at the transmission and distribution level (there is no sub-transmission network).

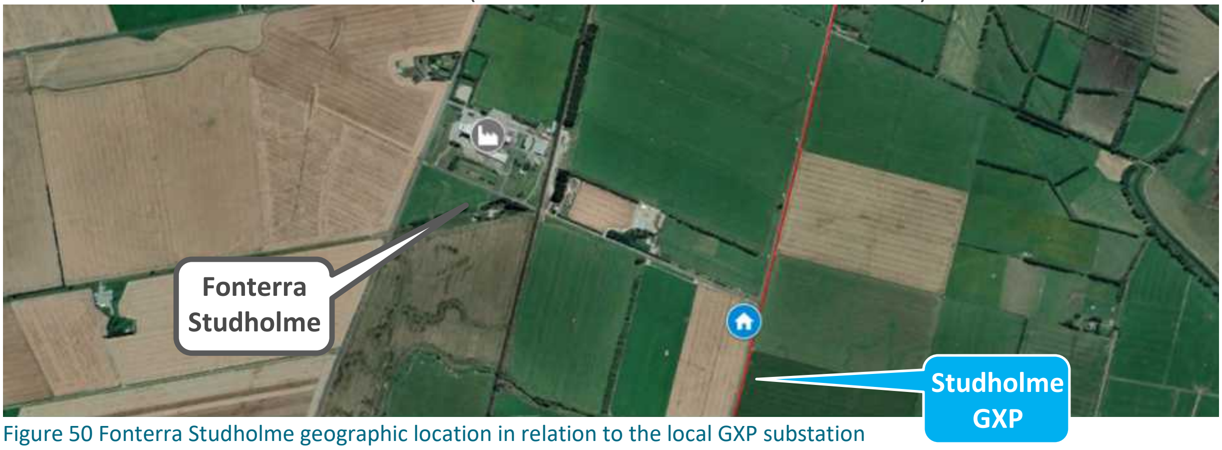


Figure 50 Fonterra Studholme geographic location in relation to the local GXP substation

Supply Option(s) for New Load

Transmission Network

Installation of this additional load would trigger the upgrade of the GXP, but the Studholme GXP transformers due to be replaced due to their age/condition (discussed in Section 8.8.1). This means the upgrade would simply accelerate the replacement of the transformers.

Ergo has assumed the early replacement and upgrade of the GXP transformers (2 x 20MVA units) translates to a capital contribution of $0.4M, which is 20% of the costs of the transformers (i.e. Transpower would pay the remaining cost out of its transformer replacement programme budget).

EDB Network

A further three dedicated 11 kV underground cable feeders would need to be installed from the Studholme GXP's 11kV bus to the Fonterra plant.

Capital Cost Estimate[24]

Table 17 Fonterra Studholme: Capital cost estimate to supply the Load Site[24, 25]

Transmission => (N)	Subtransmission => (N)	Distribution => (N-1)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Small supply transformer (GXP)	0.40	$1.00
Distribution	11kV circuit breaker (ZSS)	3.00	$0.30
Distribution	Single underground 11kV cable	4.50	$1.80
		TOTAL	**$3.10**

FONTERRA STUDHOLME
Does not include the costs to upgrade the regional 110kV and install a new GXP substation (discussed in Section 8.8.1 above), or any distribution transformers/switchgear on the plant site.
Timeframe to Establish New Electrical Infrastructure
Estimated to take 36-48 months. To Plan, Design, Procure, Construct and Commission the works. Excludes the work required to establish the Load Site. Excludes land acquisition and consenting, if required.

8.9 Tekapo A GXP & Hydro

None of the Load Sites identified by EECA are geographically close to the Tekapo A GXP. Hence, Ergo is of the view that the Tekapo A GXP is not a viable option for supplying any of the Load Sites, and thus we have not considered the upgrade of the GXP or any zone substations.

8.10 Temuka GXP

The EECA Load Sites include:

- Barkers Fruit Processing (1.29 MW)
- Ravensdown Lime, Geraldine Quarry (1.29 MW)
- Synlait, Talbot Forest Cheese (1.30MW)
- Fonterra Clandeboye (91MW)

The geographic location of the Load Sites are shown on the following Figure 51 in relation to the local transmission and distribution substations.

Figure 51 Temuka GXP: Local zone substations and Load Sites

8.10.1 Temuka GXP Upgrade

Transpower's demand forecast indicates that the Temuka GXP has ≈11MVA of (N-1) spare capacity and ≈21MVA of (N) spare capacity.

As discussed in Section 6.1.8 Transpower is, in consultation with Alpine Energy, considering the following two options to increase the capacity at the Temuka GXP:

- **Option 1:** Paralleling the existing 110/33kV transformers, installing a 120MVA 110kV transformer, installing a new 33kV switchboard and upgrading the incoming 110kV lines. Transpower's estimates to upgrade the substation and the 110kV lines are NZ$13M and NZ$15M[27] respectively.

[27] Excludes the costs of line easements.

- **Option 2:** Installing a new 220/33kV GXP at the future planned Orari 220kV switching station (shown at the top of Figure 16). Transpower's 2022 Planning Report indicates that the Orari 220kV switching station will only be required by 2030, but that the Commerce Commission approved the enabling works[28] for the switching station and they are complete.

The supply of additional electrical load at Temuka (together with load supplied to the Albury, Timaru and Tekapo A GXPs) will exacerbate "an upstream constraint" involving the 110kV system that is forecast (by Transpower) to exceed its voltage stability limit by 2023/2024 (this voltage constraint is discussed in 8.11.1). Transpower's 2022 Planning Report indicates it is considering one of the following options to resolve the voltage constraint:

- Constructing a 220kV bus at the Timaru GXP at a cost of NZ$6M (Transpower estimate).
- Replacing one of the existing 220/110kV transformers at a cost of NZ$5M (Transpower estimate).

The costs to resolve the 110kV voltage constraint would only be applicable if the above-mentioned Option 1 involving an upgrade of the Temuka GXP is chosen.

[28] Detailed design for the works and procuring the necessary designations, easements and property.

8.10.2 Barkers Fruit Processing

BARKERS FRUIT PROCESSING		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	1.29 MW	Temuka

Existing Electrical Supply to the Plant

The Barkers Fruit Processing plant is presently fed from Alpine Energy's Geraldine zone substation that is ≈1km to the east of the plant (refer to Figure 52 below). The 11kV line to the site is equipped with three different types of overhead conductor, ranging from light to medium in size, and continues beyond the site (i.e. supplies other consumers). Note the line length (≈7.5km) is much higher than the distance as the crow flies (≈1km) because the lines travel south and across the river, before returning north to the plant. The plant presently has (N) security for sub-transmission, and distribution. The existing security of supply to the plant is (N-1), (N) and (N) at the transmission, sub-transmission and distribution level.

Figure 52 Barkers Fruit Processing plant geographic location in relation to the local zone substation

Supply Option(s) for New Load

Transmission Network

The transmission network could supply the additional load.

EDB Network

Geraldine 33/11 kV substation is capable of supplying the 1.29MW additional load, at (N) security, including the 33 kV lines feeding the substation. The peak load on the 11 kV feeder supplying the site is unknown (to Ergo). However, we assume that the supply of the additional load would require an upgrade of 7.5km of existing light conductor 11 kV overhead lines to a medium conductor or larger.

Note that the same 11kV feeder supplies Barkers Fruit and Ravensdown Lime (refer to Section 8.10.3). The connection of both Load Sites would require an integrated network upgrade solution to be developed and the capital costs to connect are likely to be higher.

Capital Cost Estimate[24]

Table 18 Barkers Fruit Processing Plant: Capital cost estimate to supply the Load Site[24, 25, 29]

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Reconductor 11kV line (larger)	7.50	$1.13
		TOTAL	**$1.13**

Does not include the costs to upgrade the Temuka GXP substation or install a new GXP (discussed in Section 8.10.1), or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 12 - 18 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes land acquisition and consenting, if required.

[29] Note transmission security for costings at Temuka GXP is assumed to be (N-1), with the GXP upgrades mentioned earlier.

8.10.3 Ravensdown Lime

RAVENSDOWN LIME		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	1.29 MW	Temuka

Existing Electrical Supply to the Plant

The Ravensdown Lime plant is presently fed from Alpine Energy's Geraldine zone substation that is ≈10km to the east of the plant (refer to Figure 53 below). The 11kV line to the site is equipped with four different conductor types with different ratings (2.4 km of Mink, 3.9 km of Dog, 5.4 km of Ferret, and 1 km of Magpie), and continues beyond the site (i.e. supplies other consumers). The plant presently has (N) security for sub-transmission, and distribution. The existing security of supply to the plant is (N-1), (N) and (N) at the transmission, sub-transmission and distribution level.

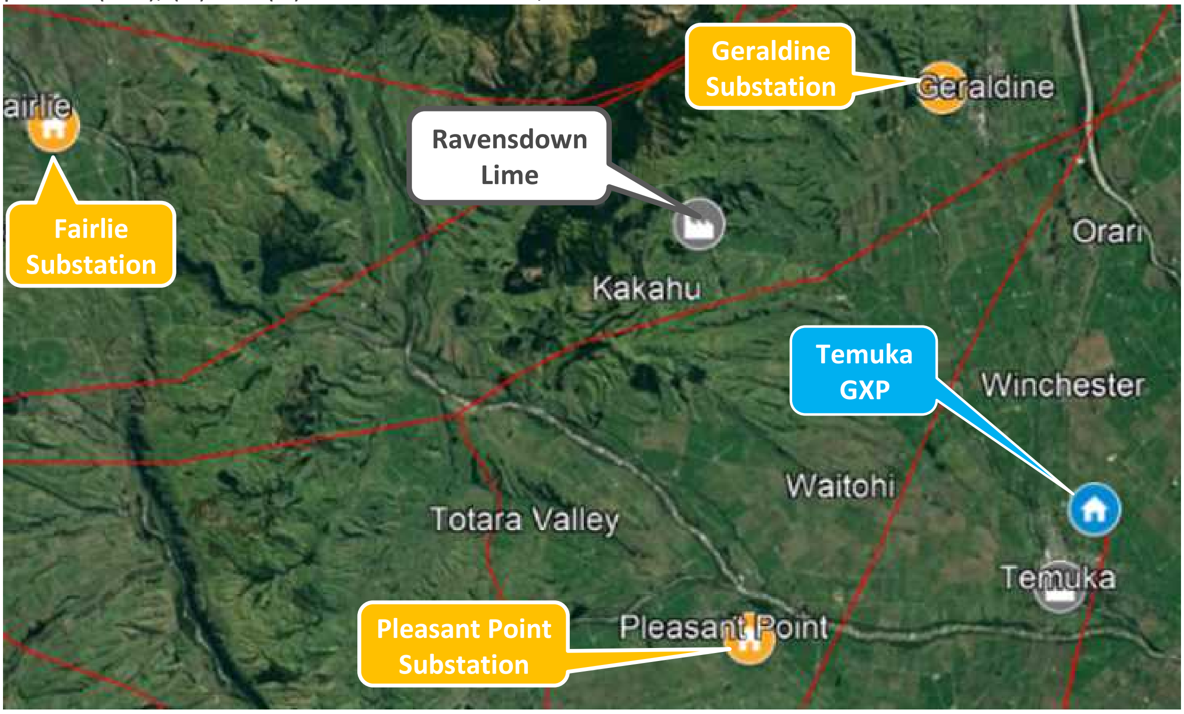


Figure 53 Ravensdown Lime geographic location in relation to the local zone and GXP substations

Supply Option(s) for New Load

Transmission Network

The transmission network could supply the additional load.

EDB Network

The Geraldine 33/11 kV substation is capable of supplying the additional load of 1.29MW, at (N) security, including the 33 kV lines feeding the substation. The present load on the feeder supplying the site is unknown (to Ergo). However, we expected that the new connection will require an upgrade of 7.8km of lines/cables on the existing 11 kV feeder that supplies the site to accommodate the increased load (mostly involving overhead line sections that are equipped with Mink and Ferret conductors).

Note that the same 11kV feeder supplies Ravensdown Lime and Barkers Fruit (refer to Section 8.10.2). The connection of both Load Sites would require an integrated network upgrade solution to be developed and the capital costs to connect are likely to be higher.

RAVENSDOWN LIME
Capital Cost Estimate[24]

Table 19 Ravensdown Lime: Capital cost estimate to supply Load Site[24, 25, 29]

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Reconductor 11kV line (larger)	7.80	$1.17
		TOTAL	**$1.17**

Does not include the costs to upgrade the Temuka GXP or install a new GXP (discussed in Section 8.10.1), or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 12 - 18 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes land acquisition and consenting, if required.

8.10.4 Synlait Talbot Forest Cheese

SYNLAIT TALBOT FOREST CHEESE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler	1.3 MW	Temuka
Existing Electrical Supply to the Plant		
The Talbot Forest Cheese plant is presently fed from the Alpine Energy's Temuka zone substation that is ≈2.8km to the northeast of the plant and adjacent to Transpower's Temuka GXP (refer to Figure 54 below). The 11kV feeder that supplies the site involves overhead lines and underground cables that are a mix of types with different ratings, which range from medium to high. Some of the overhead lines are equipped with small copper conductors that Ergo understand to be assets nearing replacement/end-of-life. The plant presently has (N-1) security for sub-transmission, and (N) for distribution. The existing security of supply to the plant is (N-1), (N-1) and (N) at the transmission, sub-transmission and distribution level.  Figure 54 Talbot Forest Cheese plant's geographic location in relation to the local GXP substation		
Supply Option(s) for New Load		
Transmission Network The transmission network could supply the additional load. *EDB Network* Temuka zone substation has more than enough (N-1) capacity to supply this load. However, the existing lines/cables from the Temuka zone substation to the cheese plant site are relatively old, and due to their age and size we expect that ≈3.0km of aging copper aerial conductors and ≈0.75km of 95 mm^2 AL cables (PILC or XLPE) along the route would need to be upgraded. These upgrades should		

deliver sufficient network capacity to supply the additional load, whilst at the same maintaining acceptable delivery voltages to consumers supplied via the feeder.

It is understood that Alpine Energy have a program in place for replacing small copper conductor in their overhead lines, but we have not considered this in our capital cost estimates.

Capital Cost Estimate[24]

Table 20 Talbot Forest Cheese: Capital cost estimate to supply Load Sites[24, 25, 29]

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Reconductor 11kV line (larger)	3.00	$0.45
Distribution	Single underground 11kV cable	0.75	$0.30
		TOTAL	**$0.75**

Does not include the costs to upgrade the Temuka substation or installation of a new GXP (discussed in Section 8.10.1), or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 12 -18 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes land acquisition or consenting, if required.

8.10.5 Fonterra Clandeboye

		FONTERRA CLANDEBOYE
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers and heat pump	Total of 91 MW 1 x 7MW heat pump 1 x 29MW boiler 1 x 25MW Boiler 2 x 21MW boilers	Temuka

Existing Electrical Supply to the Plant

The Fonterra Clandeboye plant is presently fed from two zone substations on the plant's site. The zone substations are fed at 33kV from the Temuka GXP that is ≈7.5km to the west of the plant (refer to Figure 55 below). The plant presently has (N-1) transmission security, and (N-1) subtransmission and distribution security (the plant is not supplied at the distribution level). We note a solar farm is proposing to connect (via a 33kV tee) to one of the existing overhead 33kV lines between Temuka and Clandeboye.

Figure 55 Fonterra Clandeboye geographic location in relation to the local GXP substation

Supply Option(s) for New Load

It is understood that Fonterra wishes to stage the installation of a heat pump and the new boilers to represent a realistic project timeline. In order to assess the electrical supply options Ergo has overlaid EECA's estimated load profile for the Load Site onto the historical 2021 Temuka GXP load. The load profile graphs are at the end of this Load Site Section 8.10.5. They indicate that:

- The 7MW heatpump would increase Temuka GXP loading by 5.5MW.
- The 29MW boiler would increase the Temuka GXP loading by 25.5MW.
- The 7MW heatpump and 29MW boiler would increase the Temuka loading by 32MW.
- The total combined heat pump and boiler would be 90.6MW

There is sufficient capacity on Clandeboye substation 1 (CD1) to supply the heat pump whilst maintaining (N-1) security on the 33kV supply network. Furthermore, the load on the Temuka GXP is indicated to be well below the 85MW load limit on the GXP's Special Protection System (SPS).

Although this finding does not consider the Transpower's forecast that indicates a significant increase in the Temuka's GXP load in 2022 (refer to Section 6.1.8).

The supply of the heat pump together with the 29MW boiler would not be possible using the existing supply network and would require the establishment of a new 33/11kV zone substation (i.e. Clandeboye 3) and the installation of a dedicated new double circuit, 33kV cable from Temuka GXP to the Clandeboye site (Option 1). In addition, the Temuka GXP would need to be upgraded as discussed in Section 8.10.1.

It is expected that the connection of the remaining three replacement boilers would require connection to the proposed future Orari 220kV switching station (discussed in Section 8.10.1), at either 110 kV or 220 kV, involving roughly 16 km of double circuit overhead lines, and the installation of a new substation at Clandeboye with two large power transformers, and a new 11kV switchboard and associated cabling.

Ergo has assumed (Option 2) the following:

- Two 220kV circuit breaker bays are installed at the Orari switching station.
- A new 220kV double circuit overhead line is installed to the Clandeboye site.
- A new 220/11kV substation is installed adjacent to the Clandeboye site that is equipped with 2 x 100MVA transformers. An alternative could involve 2 x 100/50/50MVA, 220/11/11kV three winding transformers.
- The heat pump and four boilers would each be independently supplied from four 11kV switchboards (i.e Clandeboye 3, 4, 5 and 6). This assumption is based on the existing architecture of the Clandeboye site as Ergo has not received any details of how the heat pump and boilers will connect to the electrical network.

A third potential option (to supply all four boilers) would be to establish a new 110kV supply from Orari which runs to Clandeboye and then onto Temuka. This option would have the double benefit of supplying the new boilers with an (N-1) supply (via Temuka and Orari) and also serve to reduce the existing constraint at Temuka. To do this, Ergo has assumed the connection would require:

- A 220/110kV, 100MVA interconnecting transformer and 110kV bay at Orari.
- A high capacity, 110kV single circuit, overhead line from Orari to Clandeboye (≈16km).
- A 110/11kV GXP at Clandeboye.
- A high capacity, 110kV single circuit, overhead line from Clandeboye to Temuka (≈11km).
- Installation of an 110kV bus and new 110kV circuit breaker bay at Temuka.
- Upgrade of the Timaru-Temuka 110kV lines (discussed in Section 8.10.1).

Capital Cost Estimate[24]

Table 21 Fonterra Clandeboye: Capital cost estimate to supply Load Site[24, 25]

Option 1 – For heat pump and one boiler[30]

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N-1)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Double underground 33kV cable	11.00	$11.00
Distribution	Large zone substation	1.00	$10.00
		TOTAL	**$21.00**

[30] Excludes the cost to upgrade the Temuka GXP (discussed in Section 8.10.1) in order to deliver (N-1) capacity at the transmission level.

This does not include the costs to upgrade the Temuka GXP (discussed in Section 8.10.1), or any distribution transformers/switchgear on the plant site.

Option 2 – For heat pump and all four boilers

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N-1)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	220kV circuit breaker bay	2.00	$1.00
Transmission	220kV double cct line	16.00	$32.00
Transmission	Large GXP	1.00	$20.00
		TOTAL	**$53.00**

This does not include the costs to install the proposed new Orari 220kV switching station (discussed in Section 8.10.1), or any distribution transformers/switchgear on the plant site.

Option 3 – For heat pump and all four boilers

Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N-1)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	220kV circuit breaker bay	1.00	$0.50
Transmission	Large supply transformer (GXP)	1.00	$4.50
Transmission	110kV circuit breaker bay	1.00	$0.30
Transmission	110kV single cct line	16.00	$12.80
Transmission	Large GXP	1.00	$20.00
Transmission	110kV single cct line	11.00	$8.80
Transmission	110kV Bus Reconfiguration	1.00	$5.00
		TOTAL	**$51.90**

This does not include the costs to upgrade the Timaru-Temuka 110kV lines, or to install the proposed new Orari 220kV switching station (discussed in Section 8.10.1), or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 24-36 months for supply of heat pump and one boiler or 48 - 60 months for the supply of heat pump and all four boilers.

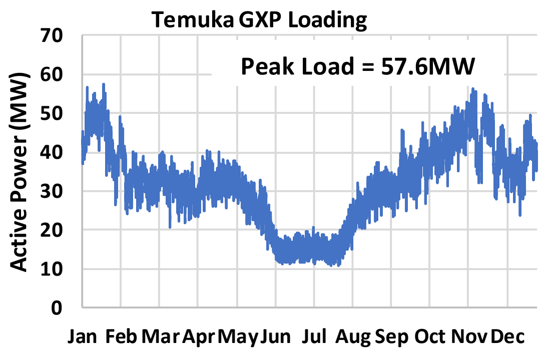
To Plan, Design, Procure, Construct and Commission the works.

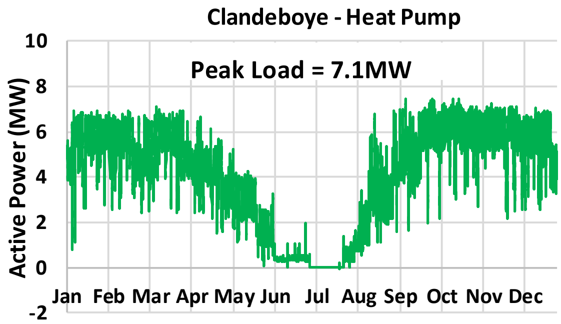
Excludes the work required to establish the Load Site.

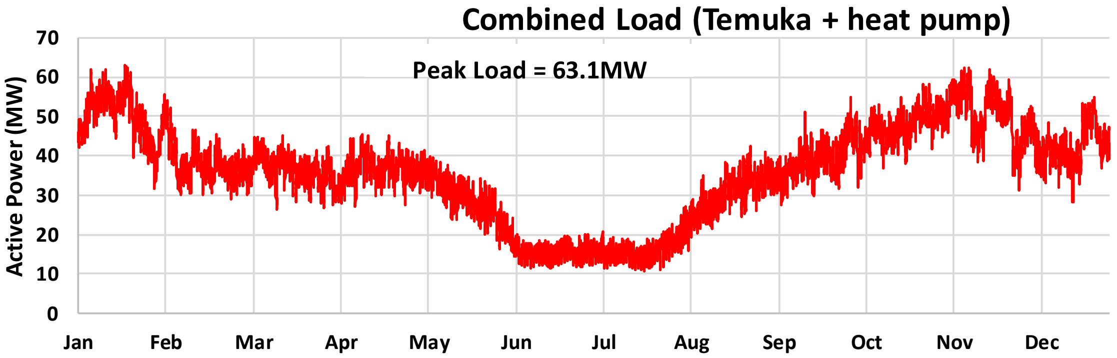
Excludes land acquisition, easements and consenting, if required.

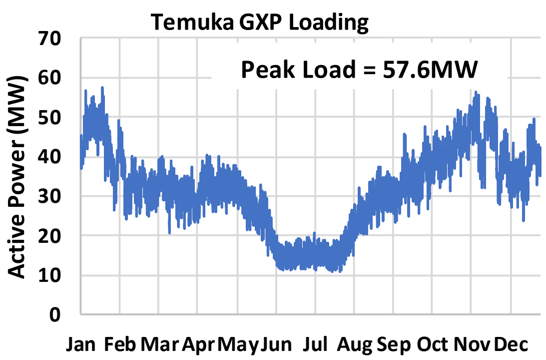
FONTERRA CLANDEBOYE

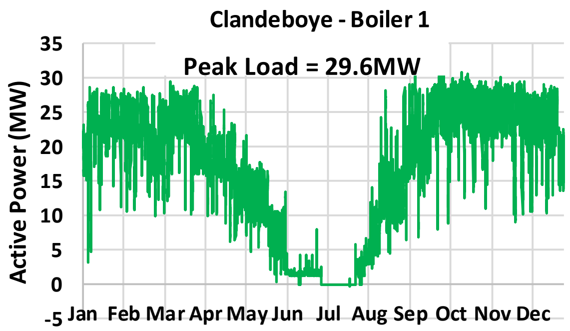
Load Profiles

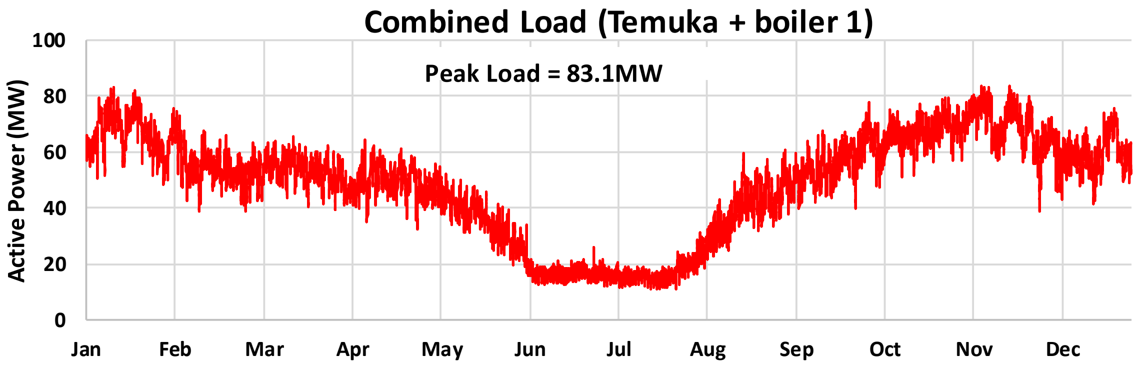




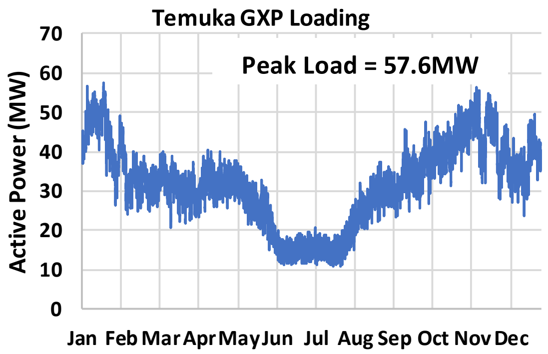


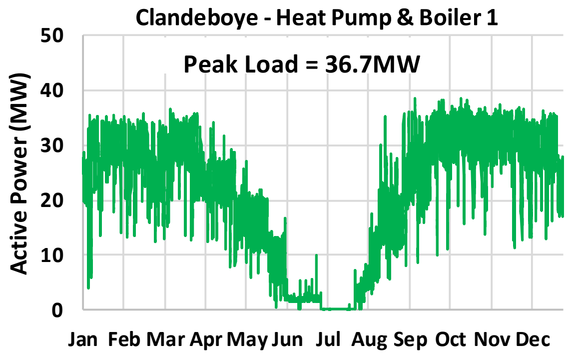


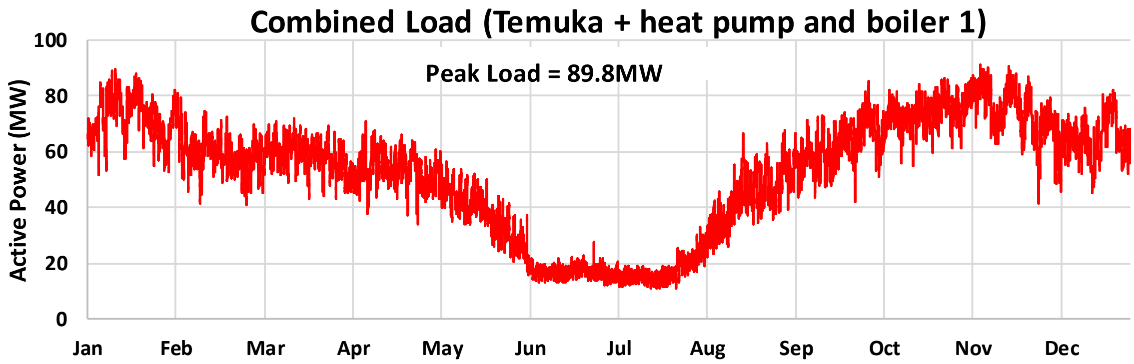


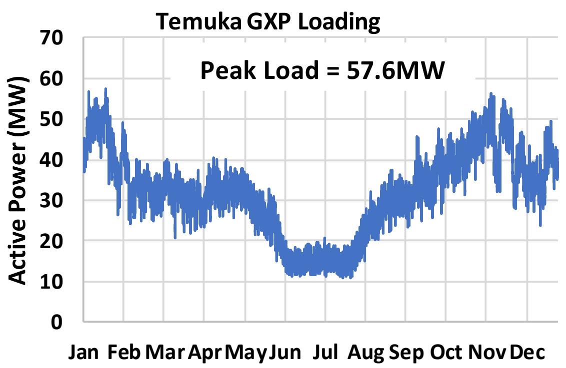


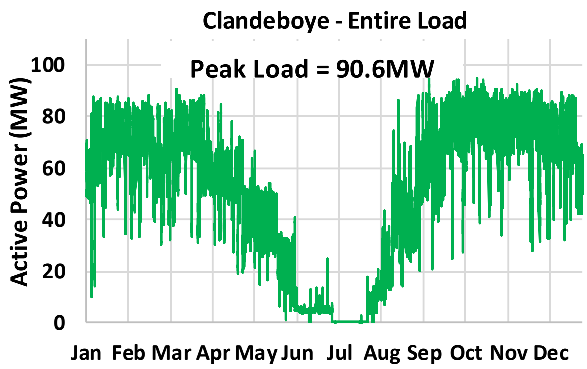
FONTERRA CLANDEBOYE

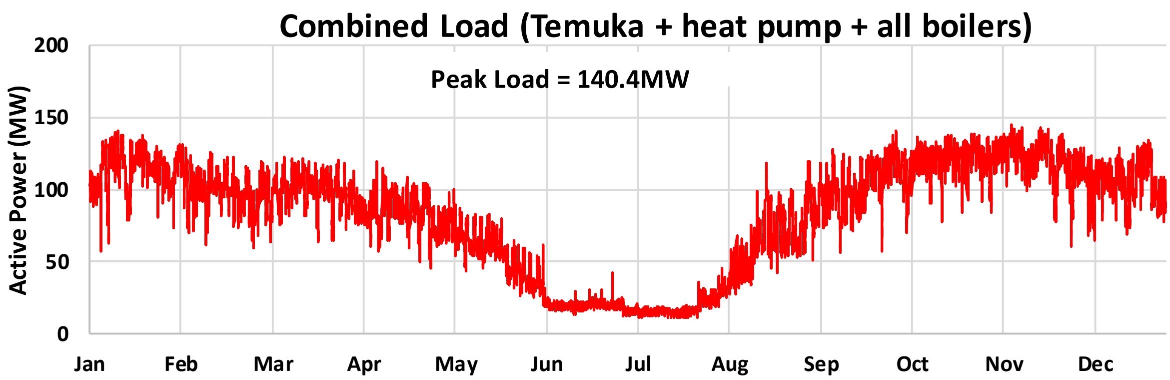












8.11 Timaru GXP

The EECA Load Sites include:

- South Canterbury By Products (7.0 MW)
- McCain Foods (8MW to 17MW)
- Silver Fern Farms Pareora (7.91MW)
- Alliance Smithfield (5.85MW)
- Woolworks Washdyke (9.0MW)
- Timaru Charging Station (1.1MW to 6.1MW)

The geographic location of the Load Sites are shown on the following Figure 56 in relation to the local transmission and distribution substations.

Figure 56 Timaru GXP: Local zone substations and Load Sites

8.11.1 Timaru GXP Upgrade

Transpower's demand forecast indicates that the Timaru GXP has ≈8 MVA of (N-1) spare capacity and ≈63MVA of (N) spare capacity. Transpower's 2022 Planning Report indicates it has no planned investments to upgrade the capacity at Timaru.

There are a number of options for the supply of significant additional (N-1) spare capacity at Timaru which include the following:

- **Option 1:** Installation of a fourth 47.6MVA, 110/11kV transformer, a new 11kV switchboard/room, new 11kV feeders and reconfiguration of the existing 11kV feeders that are

supplied from the existing switchroom. The idea being to create two independent 110/11kV substations at Timaru.
- **Option 2:** Installation of 60MVA, 220/33kV transformer, in order to begin the development of a 33kV supply to Alpine Energy that would supply new Alpine 33/11kV zone substations (as they are required). The exact location of the Alpine zone substations would depend on the location of the emerging load.
- **Option 3:** The installation of a third 220/110kV interconnecting transformer, which is associated with the "upstream constraint" discussed below, but with an 11kV or 33kV tertiary winding that supplies the emerging demand in the manner discussed in Options 1 and 2 above.

In a similar manner to that discussed in Section 8.10.1, increases in electrical demand at Timaru (together with load supplied to the Albury, Temuka and Tekapo A GXPs) would exacerbate the voltage stability limit on the 110kV supply network. Transpower's 2022 Planning Report indicates that limit would be breached by 2023/2024, and it is considering one of the following options to resolve the issue:

- Constructing a 220kV bus at the Timaru GXP at a cost of NZ$6M (Transpower estimate).
- Replacing one of the existing 220/110kV interconnecting transformers at a cost of NZ$5M (Transpower estimate).

For the purposes of this report Ergo has chosen Option 1 on the basis that Transpower will proceed to construct a 220kV bus at the Timaru GXP, which would facilitate the installation of an additional 220kV circuit breaker bay to supply a new 220/33kV transformer.

Ergo's capital cost estimates for Option 2 presented above are outlined in the following Table 22, which includes Transpower's 220kV busbar cost but excludes Alpine 33/11kV zone substations.

Table 22 Timaru GXP: Capital cost estimate for upgrading the Timaru GXP[24]

Network Asset	Equipment	Number and Capital Cost ($M)	
Transmission	220kV Busbar (Transpower estimate)	1.00	$6.00
Distribution	Small GXP	1.00	$10.00
		TOTAL	**$16.00**

In terms of timeframes, Ergo estimates the above works, excluding land acquisition and consenting times, would take around 36 – 48 months.

8.11.2 South Canterbury By-Products

SOUTH CANTERBURY BY-PRODUCTS		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	8.5 MW or 18.5MW	Timaru

Existing Electrical Supply to the Plant

The South Canterbury By-Products plant is presently fed via one of Alpine's 11kV feeders that takes supply from the 11 kV switchboard at Transpower's Timaru GXP (refer to Figure 57 below). The plant is ~3.6 km to the north east of the GXP and zone substation. The 11kV feeder that supplies the site consists of a mix of overhead line and underground cable of different types and different ratings (ranging from medium to high). The plant presently has (N-1) security at the transmission/sub-transmission level, and (N) security at the distribution level.

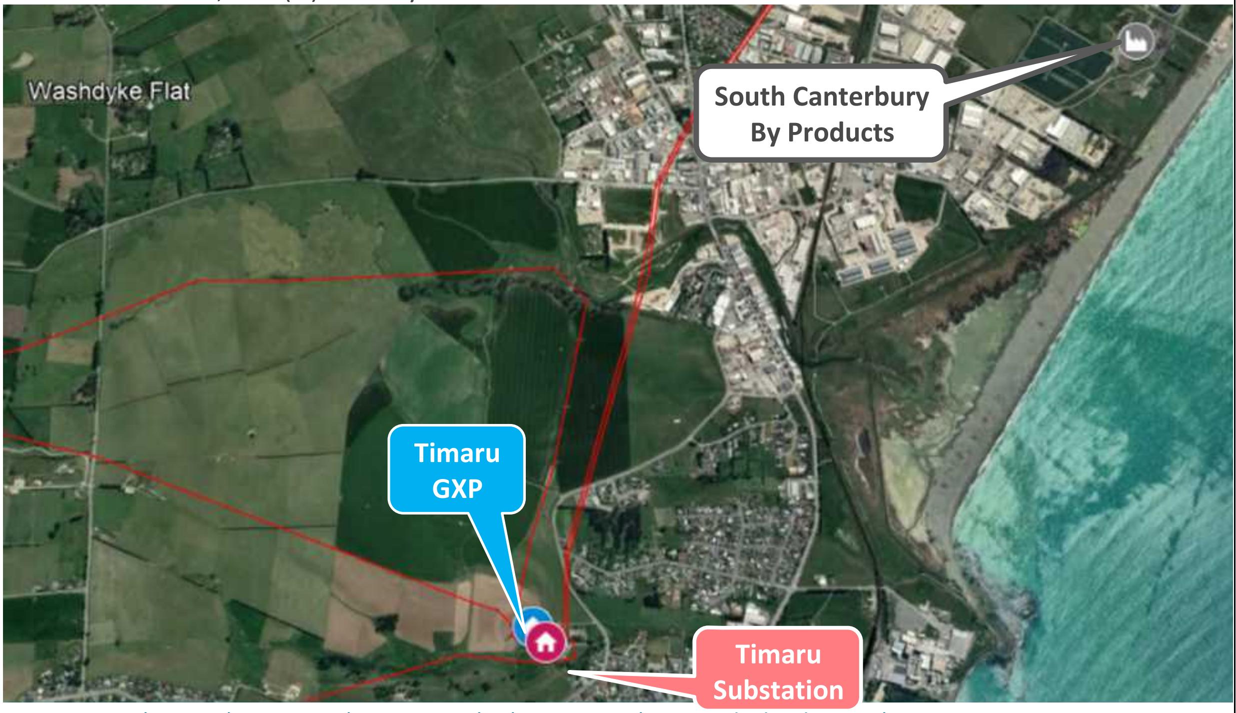


Figure 57 South Canterbury By Products geographic location in relation to the local GXP substation

Supply Option(s) for New Load

Transmission Network

The Timaru GXP presently has enough (N) capacity to supply an increase of 8.5MW, and enough (N-1) capacity, provided that the other opportunities on this GXP do not proceed.

The supply of 18.5MW would be within the (N) capacity of the Timaru GXP but would exceed the (N-1) capacity, and trigger the upgrade of the GXP.

In order to assess whether the above statements are correct, Ergo has overlaid EECA's estimated load profile for the Load Site onto the historical 2021 Timaru GXP load. The load profile graphs are at the end of this Load Site Section 8.11.2. They indicate that the connection of the 18.5MW load would result in an increase of 14MW on the Timaru GXP load. Also, that both 8.5MW and 18.5MW could be supplied whilst maintaining (N-1) security (i.e. below the 85MW trip setting of the Timaru GXP's SPS). However, this conclusion does not factor in the recent increase in load that is forecast to occur in 2022 by Transpower, which if the case, would require the Timaru GXP to be upgraded to accommodate the South Canterbury By-Products Load Site. The potential GXP upgrade solutions and cost is in Section 8.11.1.

EDB Network

Ergo has assumed that following options for the supply of the load site:

- **Option 1 – Supply of 8.5MW.** The supply of the additional load would require the installation of two additional dedicated, 4.65km, 11kV feeders from the Timaru GXP to the plant. We have looked at potential routes and have assumed 1.15km would be via double circuit overhead line and the remaining 3.5kms via double circuit underground cable.
- **Option 2 – Supply of 18.5MW**. The supply of the additional load would require the upgrade of the Timaru GXP to include a 33kV supply to Alpine (discussed in Section 8.11.1). Furthermore, an 18.5MW load would require the installation of a new 33/11kV zone substation close-in to the South Canterbury By-Product's site that is supplied at 33kV from the Timaru GXP. We have examined the route and assumed that the 33kV supply would involve 2.0km of double circuit overhead line and 2.7km of double circuit underground cable (supplied via two 33kV circuit breakers installed at an upgraded Timaru GXP).

Capital Cost Estimate[24]

Table 23 South Canterbury By-Products: Capital cost estimate to supply the Load Site[24, 25]

Option 1 – Supply of 8.5MW

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 overhead 11kV line	1.15	$0.35
Distribution	Double underground 11kV cable	3.50	$2.45
		TOTAL	**$3.00**

Option 2 – Supply of 18.5MW

Transmission => (N)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Medium zone substation	1.00	$8.00
Distribution	33kV circuit breaker bay	2.00	$0.50
Distribution	Double overhead 33kV line	2.70	$1.08
Distribution	Double overhead 33kV line	2.00	$0.80
		TOTAL	**$10.38**

Does not include the costs of the Timaru GXP transmission upgrades discussed above in Section 8.11.1, or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 11 - 18 months for option 1, or 24 – 36 months for option 2.

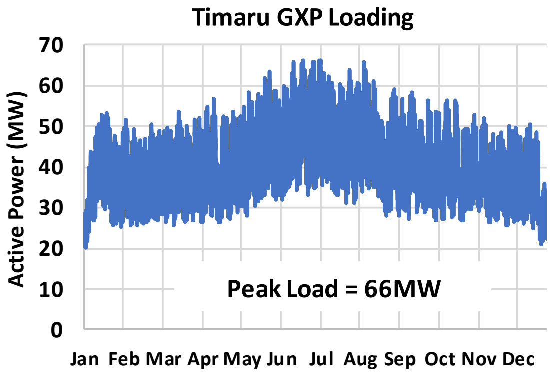
To Plan, Design, Procure, Construct and Commission the works.

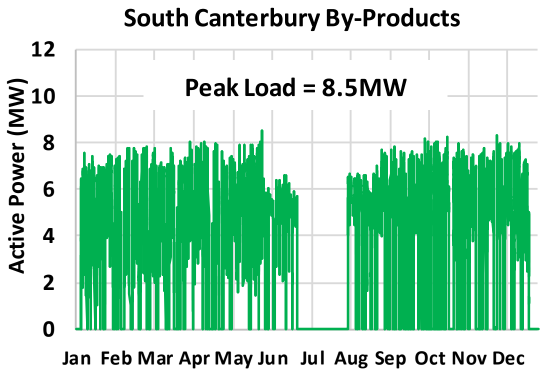
Excludes the work required to establish the Load Site.

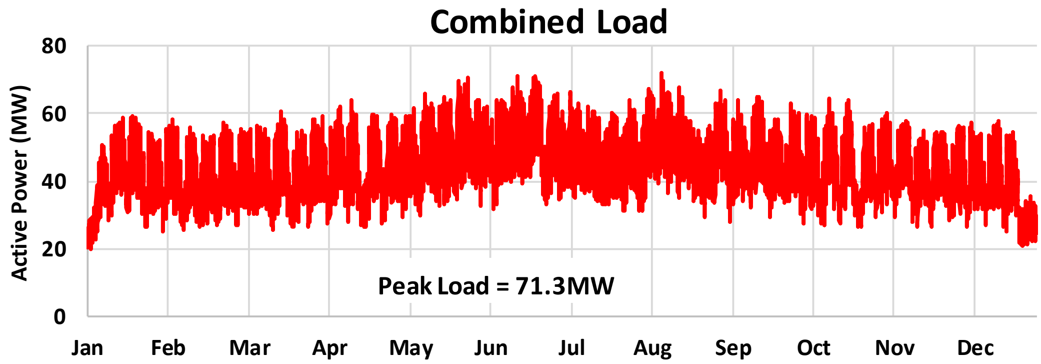
Excludes land acquisition, easements and consenting, if required.

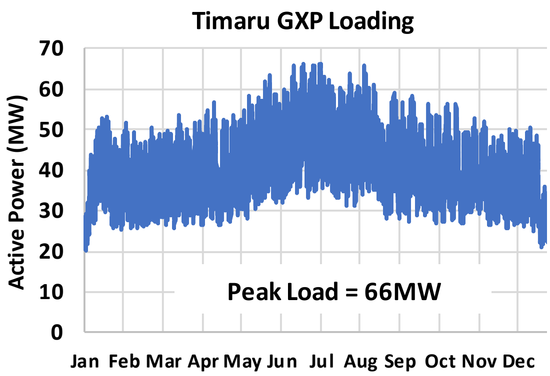
SOUTH CANTERBURY BY-PRODUCTS

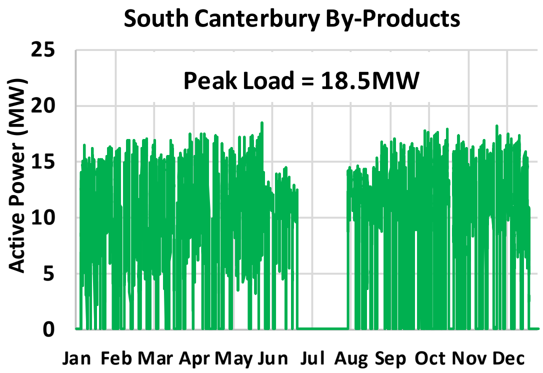
Load Profiles

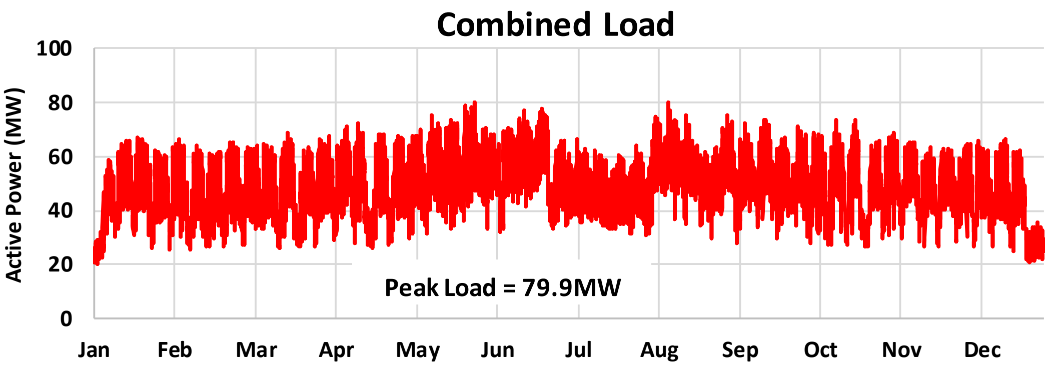












8.11.3 McCain Foods

		MCCAIN FOODS
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	8MW to 17MW	Timaru
Existing Electrical Supply to the Plant		

The McCain Foods plant is presently fed via Alpine's 11kV network that takes supply from the 11 kV switchboard at Transpower's Timaru GXP (refer to Figure 58 below). The plant is ~2.5 km to the north east of the GXP and zone substation. The 11kV feeder that supplies the site consists of a mix of overhead line and underground cable of different types and different ratings (ranging from medium to high). The plant presently has (N-1) security at the transmission/sub-transmission level, and (N) security at the distribution level.

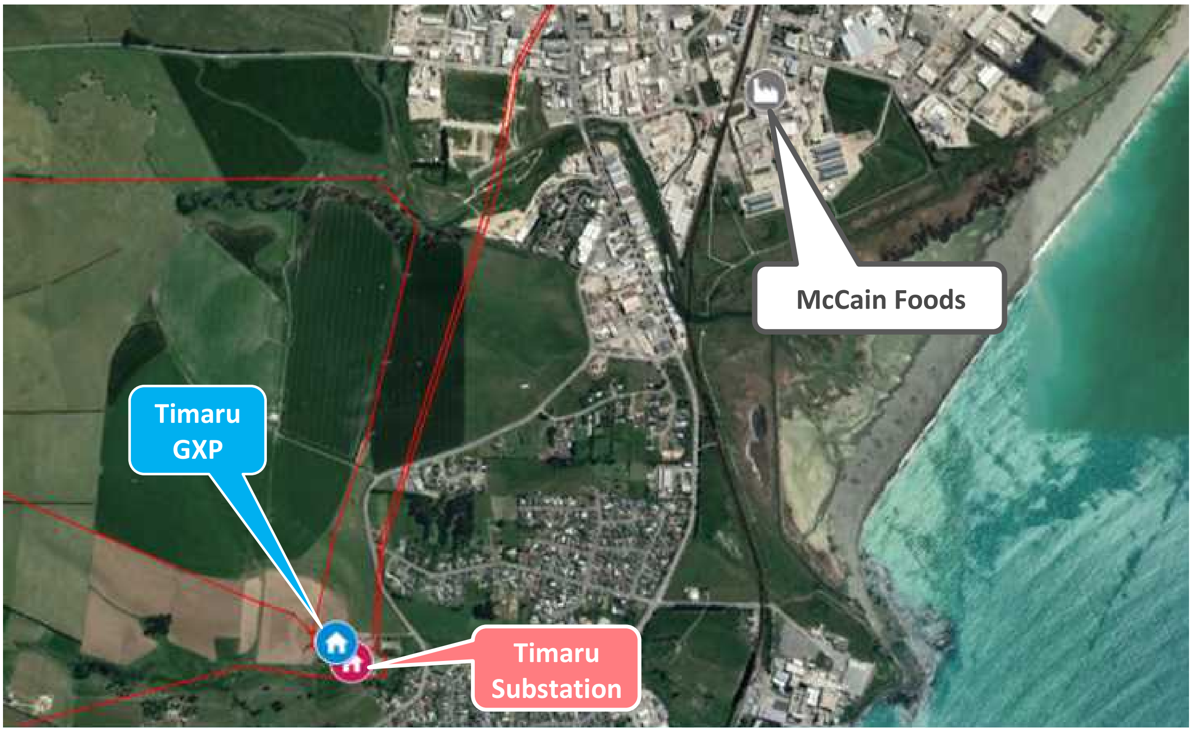


Figure 58 McCain Foods geographic location in relation to the local GXP substation

Supply Option(s) for New Load

Transmission Network

The Timaru GXP presently has sufficient (N) capacity to supply an additional 8 to 12MW to the McCain Foods plant, provided that the other Load Sites on this GXP do not proceed to connect. A load of 8MW could be supplied without breaching the GXP's (N-1) capacity, but a 17MW load would result in the GXP's (N-1) capacity being exceeded. The potential upgrade options are discussed in Section 8.11.1.

In order to assess whether the above statements are correct, Ergo has overlaid EECA's estimated load profile for the Load Site onto the historical 2021 Timaru GXP load. The load profile graphs are at the end of this Load Site Section 8.11.3. They indicate that the connection of 17MW of McCain Foods Load Site would increase the Timaru GXP load by 15.7MW (i.e. there is diversity between the loads). Also, the connection of the 17MW McCain load onto the Timaru GXP would be possible (i.e. below the 85MW trip setting of the Timaru GXP's SPS). However, this conclusion does not factor in the increase in load that Transpower is forecasting to occur in 2022 on the Timaru GXP, which if the case would require the Timaru GXP to be upgraded to maintain (N-1) to accommodate the McCain Foods Load Site.

Further, there is a voltage stability constraint on the 110kV network that supplies the Albury, Timaru, Tekapo and Temuka GXPs, which would likely also need to be addressed. The solutions and costs are discussed in Section 8.11.1.

EDB Network

The existing distribution network would not be capable of supplying an additional load of 8 to 12MW.

Ergo has assumed that the supply of the additional load would require the following:

- **Option 1 – Supply of 8MW:** The installation of two additional dedicated, 3.0km, 11kV feeders from the Timaru GXP to the plant. We have looked at potential routes and have assumed 1.5km would be via double circuit overhead line and the remaining 1.5kms via double circuit underground cable.
- **Option 2 – Supply of 17MW:** The installation of two additional dedicated, 3.0km, 11kV feeders from the Timaru GXP to the plant. We have looked at potential routes and have assumed 1.5km would be via a double circuit overhead line and an underground cable and the remaining 1.5kms via three underground cable circuits. We note that it may be more economic to supply 12MW using a set of 33kV circuits coupled with a 33/11kV substation, but this would only be possible if the Timaru GXP upgraded to include a 33kV supply as discussed in Section 8.11.1.

Capital Cost Estimate[24]

Table 24 McCain Foods: Capital cost estimate to supply the Load Site[24, 25]

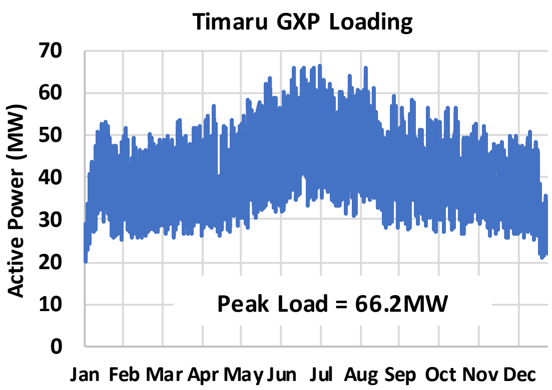
Option 1 – Supply of 8MW

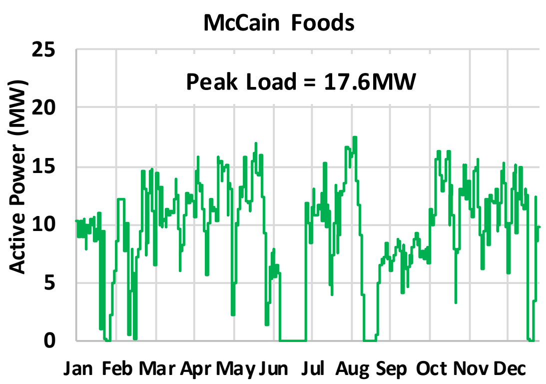
Transmission => (N-1)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double overhead 11kV line	1.50	$0.45
Distribution	Double underground 11kV cable	1.50	$1.05
Distribution	Distribution switches - RMU	2.00	$0.10
		TOTAL	**$1.80**

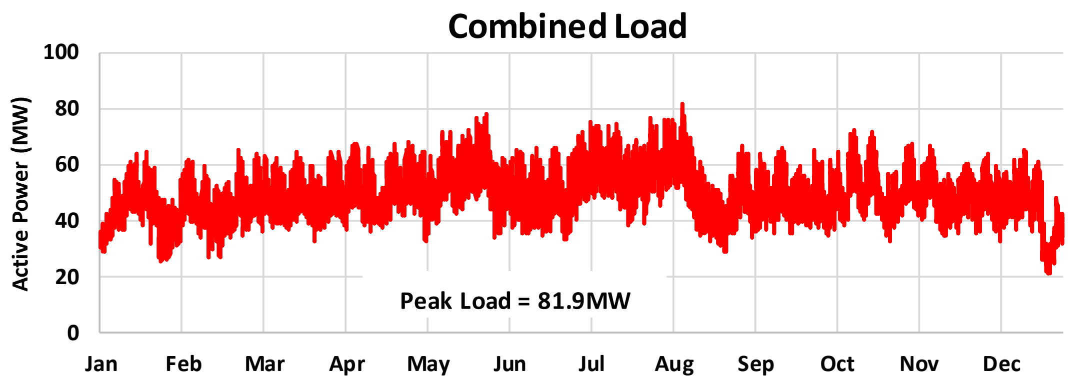
Option 2 – Supply of 17MW

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 overhead 11kV line	1.50	$0.45
Distribution	Double underground 11kV cable	1.50	$1.05
Distribution	Single underground 11kV cable	3.00	$1.20
Distribution	Distribution switches - RMU	3.00	$0.15
		TOTAL	**$3.15**

MCCAIN FOODS
This does not include the costs of the Timaru GXP transmission upgrades discussed above in Section 8.11.1 (if required), or any distribution transformers/switchgear on the plant site.
Timeframe to Establish New Electrical Infrastructure
Estimated to take 18 - 24 months. To Plan, Design, Procure, Construct and Commission the works. Excludes the work required to establish the Load Site. Excludes land acquisition, easements and consenting, if required.
Load Profiles







8.11.4 Silver Ferns Farms Pareora

SILVER FERNS FARMS PAREORA		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	7.91MW	Timaru

Existing Electrical Supply to the Plant

The Silver Fern Farms Pareora plant is presently supplied from Alpine Energy's Pareora zone substation that is ≈0.5km to the east of the plant (refer to Figure 59 below). The 33kV supply circuits to the plant are medium sized, underground cables. The plant presently has (N-1) security for transmission, sub-transmission, and distribution.

Figure 59 Silver Ferns Farms Pareora geographic location in relation to the local zone substation

Supply Option(s) for New Load

Transmission Network

The GXP presently has enough (N) capacity to supply an additional 7.91MW to the plant, and enough (N-1) capacity (provided the other Load Sites do not connect).

EDB Network

Pareora zone substation, and the 33kV circuits feeding it, have sufficient (N) capacity, but has ≈5 MW of (N-1) capacity. This means that the addition of the 7.91MW of additional load could potentially result in the (N-1) capacity being marginally breached. In order to assess whether this would be the case, Ergo has overlaid EECA's estimated load profile for the Load Site onto the historical 2021 Pareora substation load. The results are shown in the graphs at the end of this Load Site Section 8.11.4, which predicts a combined load of 15.0MW, which is an increase of 6.3MW (i.e. there is diversity between the two loads).

The Pareroa substation is equipped with 2 x 15MVA transformers and thus likely has sufficient capacity to supply the additional Load Site. However, other consumer loads may seek to connect to the Pareroa substation and thus Ergo has costed the following two main options to supply the plant:

- **Option 1:** Two new 11kV breakers should be installed on the Pareora zone substation's 11kV switchboard, with new 11kV cabling to the plant.
- **Option 2:** Installation of a third 33kV circuit between Timaru zone substation and Pareora zone substation, with a third 33/11kV transformer installed at Pareora zone substation, together with two new 11kV feeders supplying the plant. This option would deliver a subtransmission network with (N-1) security of supply to the site.

Capital Cost Estimate[24]

Table 25 Silver Ferns Farms Pareora: Capital cost estimate to supply the Load Site[24, 25]

Option 1 – Two new 11kV feeders

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	0.06	$0.04
		TOTAL	**$0.24**

Option 2 – Upgrade of the Pareora zone substation and two new 11kV Feeders

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Single overhead 33kV line	15.00	$3.75
Distribution	Medium supply transformer (ZSS)	1.00	$1.00
Distribution	33kV circuit breaker (ZSS)	4.00	$0.60
Distribution	11kV circuit breaker (ZSS)	2.00	$0.20
Distribution	Double underground 11kV cable	0.06	$0.04
		TOTAL	**$5.59**

This does not include the costs to install a new GXP substation (discussed above), or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

Estimated to take 18 - 24 months for Option 1, or 24 – 36 months for Option 2.

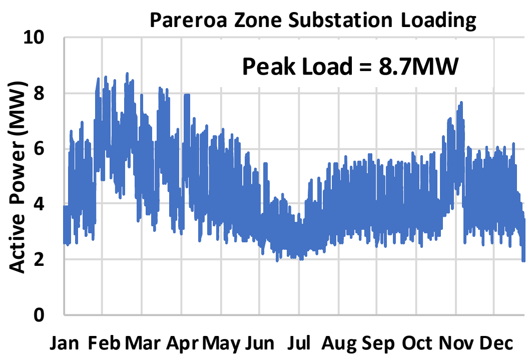
To Plan, Design, Procure, Construct and Commission the works.

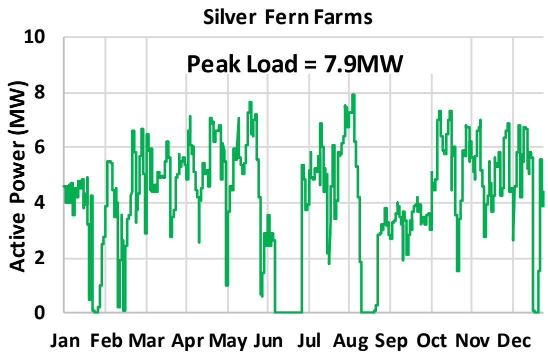
Excludes the work required to establish the Load Site.

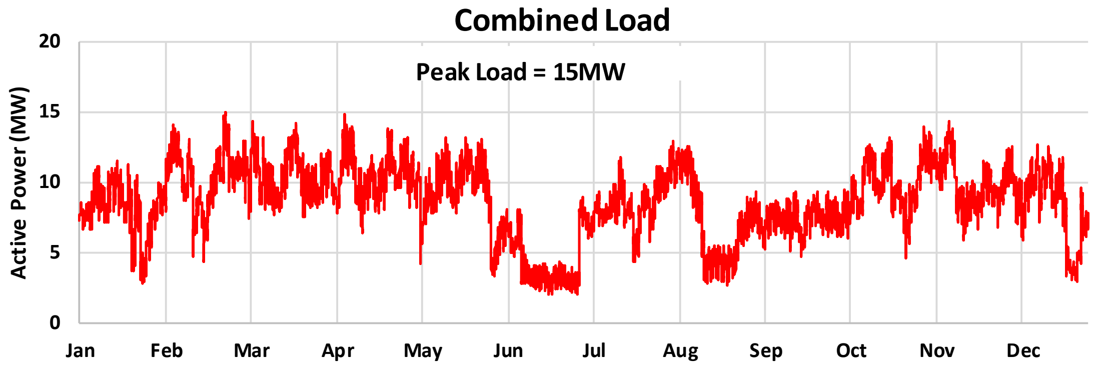
Excludes land acquisition, easements and consenting, if required.

SILVER FERNS FARMS PAREORA

Load Profiles







8.11.5 Alliance Smithfield

		ALLIANCE SMITHFIELD
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	5.85 MW	Timaru
Existing Electrical Supply to the Plant		

The Alliance Smithfield plant presently fed via Alpine's 11kV network that takes supply from the 11 kV switchboard at Transpower's Timaru GXP (refer to Figure 60 below). The plant is ≈1.5 km to the east of the GXP and zone substation. The 11kV feeder that supplies the site consists of a mix of overhead line and underground cable (mostly overhead). The plant presently has (N-1) security at the transmission/sub-transmission level, and (N) security at the distribution level. There is an adjacent 11kV feeder available to provide switched backup.

Figure 60 Alliance Smithfield geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

The Timaru GXP presently has enough (N) and (N-1) capacity to supply an increase of 5.85MW, provided that the other Load Sites on this GXP do not proceed.

In order to assess whether the above statement is correct, Ergo has overlaid EECA's estimated load profile for the Load Site onto the historical 2021 Timaru GXP load. The load profile graphs are at the end of this Load Site Section 8.11.5. They indicate that there is diversity between the existing Timaru GXP load and the Load Site, and the Timaru GXP load will only increase by 4.1MW, to 70.3MW.

EDB Network

The existing distribution network would not be capable of supplying an additional load of 5.85MW.

Ergo has assumed that the supply of the additional load would require the installation of an additional, high capacity 2.0km long 11kV feeder from the Timaru GXP to the plant. We have looked at potential routes, which are all in the Timaru suburbs and have assumed the entire route would involve an underground cable.

Capital Cost Estimate[24]

Table 26 Alliance Smithfield: Capital cost estimate to supply the Load Site[24, 25]

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	2.00	$0.80
Distribution	Distribution switches - RMU	1.00	$0.05
		TOTAL	**$0.95**

This estimate does not include the costs to install a new GXP substation (discussed in Section 8.7.1 above) if required, or any distribution transformers/switchgear on the plant site.

Timeframe to Establish New Electrical Infrastructure

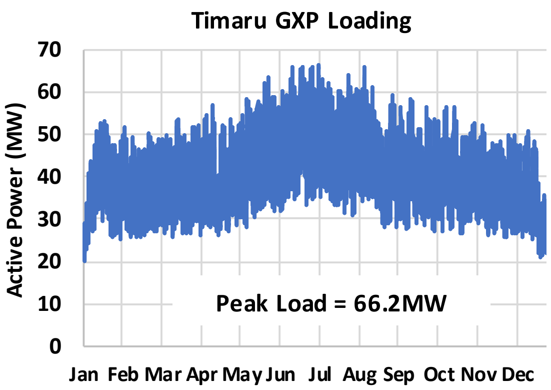
Estimated to take 18 - 24 months.

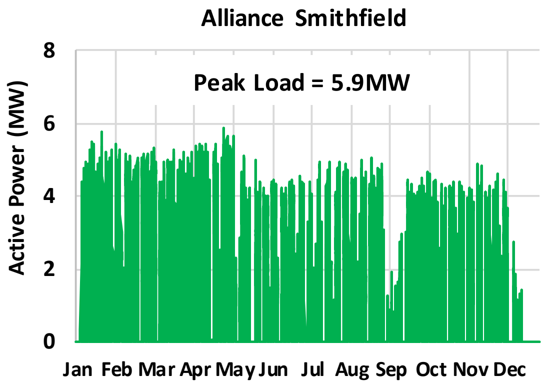
To Plan, Design, Procure, Construct and Commission the works.

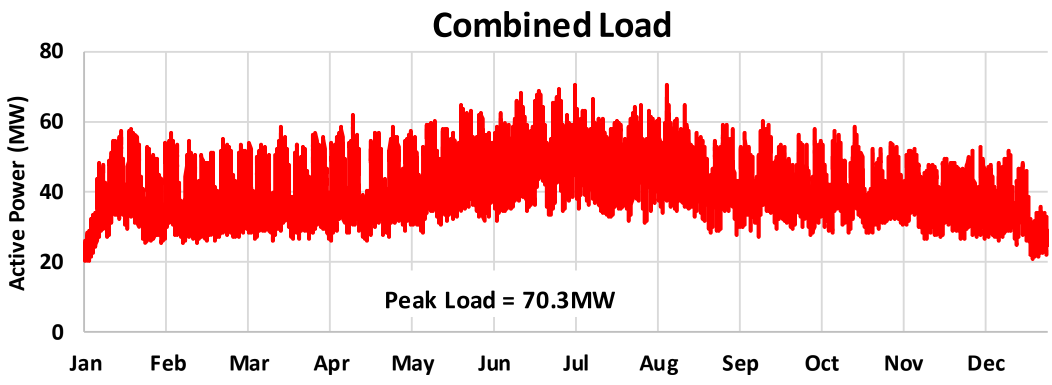
Excludes the work required to establish the Load Site.

Excludes land acquisition and consenting, if required.

Load Profiles







8.11.6 Woolworks Washdyke

WOOLWORKS WASHDYKE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boilers	9.0 MW	Timaru

Existing Electrical Supply to the Plant

The Woolworks Washdyke plant is presently fed via one of Alpine's 11kV feeders that takes supply from the 11 kV switchboard at Transpower's Timaru GXP (refer to Figure 61 below). The plant is ≈1.9 km to the north east of the GXP and zone substation. The line to the site consists of a mix of overhead and underground conductors of different types with different ratings, including (which range from medium to high). The plant presently has (N-1) security at the transmission/sub-transmission level, and (N) security at the distribution level.

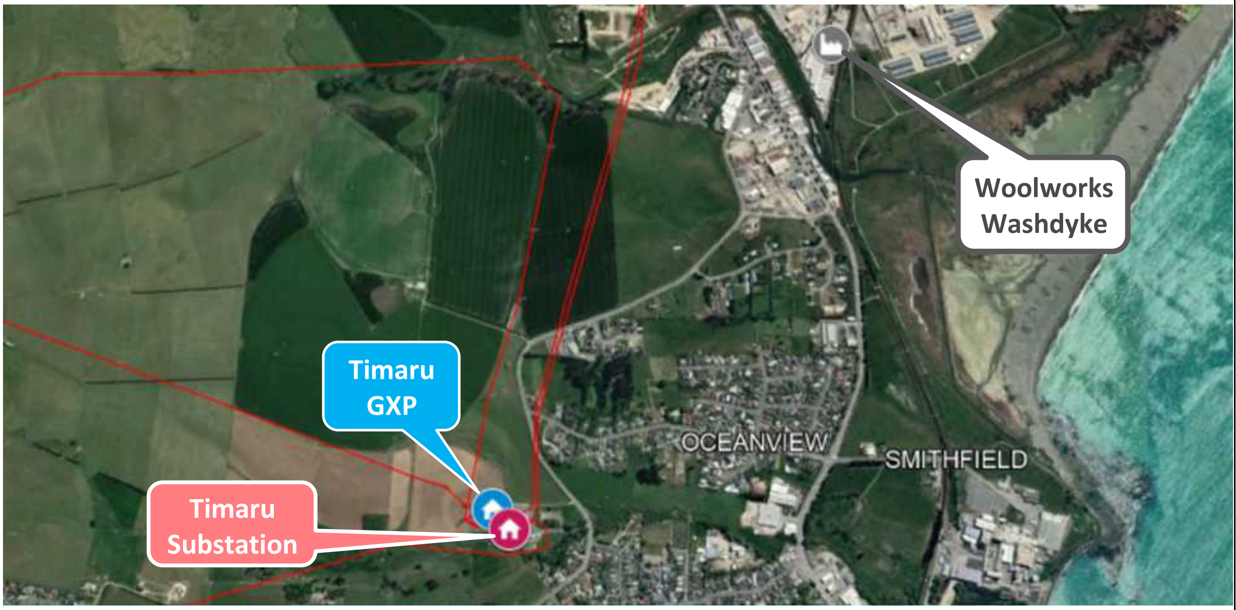


Figure 61 Woolworks Washdyke geographic location in relation to the local GXP substation

Supply Option(s) for New Load

The GXP presently has enough (N) and (N-1) capacity, provided that the other Load Sites on this GXP do not connect. If multiple Load Sites connect and desire (N-1) transmission security, the cost for GXP and network improvements could be shared by the connecting parties.

Ergo has overlaid EECA's estimated load profile for the Load Site onto the historical 2021 Timaru GXP load. The load profile graphs are at the end of this Load Site Section 8.11.6. They indicate that there is a small amount of diversity between the existing Timaru GXP load and the Load Site, and the Timaru GXP load will only increase by 7.8MW, to 74MW.

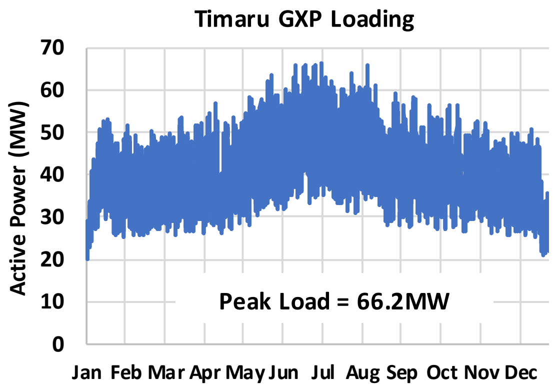
Ergo understand that this Load Site is progressing to connect and thus we have not considered the connection options available.

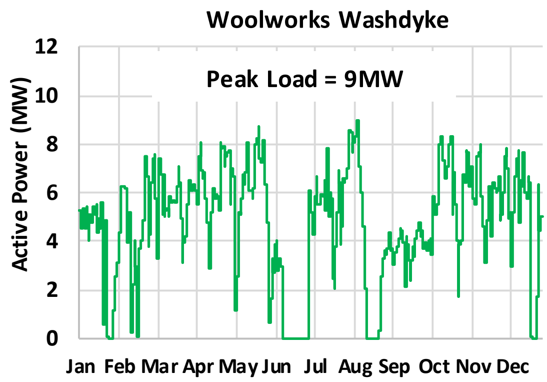
Capital Cost Estimate[24]

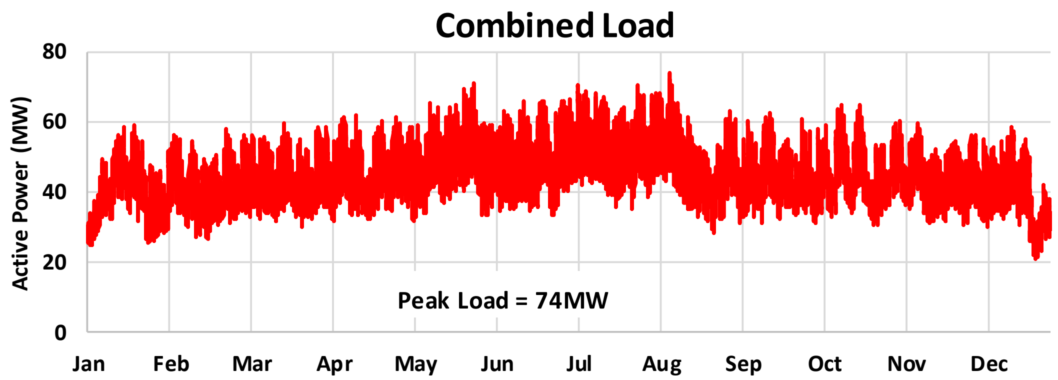
No capital cost estimate is included as the Load Site has committed and a detailed cost estimate has been developed by others.

Timeframe to Establish New Electrical Infrastructure

WOOLWORKS WASHDYKE
No time frame is included as the Load Site is proceeding to connect.
Load Profiles







8.11.7 Timaru Charging Station

TIMARU CHARING STATION		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
Charging station for electric cars	Initial load of 1.1MW increasing to 6.1MW	Timaru
Existing Electrical Supply to the Plant		

The following Figure 62 illustrates a potential location[31] for the charging station adjacent to SH1 and a petrol station. Also, a reasonable distance from the Timaru GXP.

Figure 62 Timaru charging station, location in relation to the surrounding zone substation

Supply Option(s) for New Load

Transmission Network

The GXP presently has enough (N) capacity to supply this plant, and enough (N-1) capacity, provided that the other Load Sites on this GXP do not connect. If multiple Load Sites connect and desire (N-1) transmission security the cost for GXP and network improvements could be shared by the connecting parties.

EDB Network

The existing distribution network should be capable of supplying the initial 1.1MW of load but would not be capable of supplying the final load projection of 6.1MW.

Ergo has assumed that the supply of the ultimate load of 6.1MW would require the installation of an additional, high capacity, dedicated, 1.3km, 11kV feeder from the Timaru GXP to the charging station. We have looked at potential routes, which are all within the Timaru suburbs and have thus assumed the entire route would involve an underground cable.

[31] This location was chosen by Ergo in the absence of a site location being provided.

Capital Cost Estimate[24]

Table 27 Timaru Charging Station: Capital cost estimate to supply the Load Site[24,25]

Stage 1 – Supply of 1.1MW

Transmission => (N-1)	Subtransmission => (N-1)	Distribution =>	(N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Distribution switches - RMU	1.00	$0.05
Distribution	2000kVA distribution tx	1.00	$0.35
		TOTAL	**$0.40**

Stage 2 – Supply of 6.1MW

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	1.30	$0.52
Distribution	Distribution switches - RMU	2.00	$0.10
Distribution	2000kVA distribution tx	3.00	$1.05
		TOTAL	**$1.77**

The above estimates do not include the costs to upgrade the GXP substation, as discussed in Section 8.11.1 above.

Timeframe to Establish New Electrical Infrastructure

Stage 1 estimated to take 6 months and Stage 2 estimated to take 12 - 18 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes land acquisition and consenting, if required.

Load Profiles

No load profile for this Load Site has been supplied. Ergo recognises the loading would vary depending on the number of cars being charged but in the absence of firm information we have conservatively assumed the loading is constant.

8.11.8 Effect of all Load Sites Connecting to Timaru GXP

The following Figure 63 illustrates the Timaru 2021 load profile together with the load profiles of all the Load Sites within the Timaru GXP region.[32] Also shown in Figure 63 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the load on the Timaru GXP would increase to 117MW, a 51MW increase. Given that the independent sum of the individual loads is 126.0MW there is a modest diversity factor of 0.94 between the loads.
- The Timaru GXP's (N-1) limit of 85MW (discussed in Section 6.1.9) would be exceeded for significant periods of time.

Clearly, if (N-1) security of supply is required at the Timaru GXP and multiple Load Sites connect, the Timaru GXP would need to be upgraded via one of the options discussed in Section 8.11.1. Alternatively, there is the possibility to operate with (N) security and in the event of an equipment outage multiple Load Sites would need to be tripped by an SPS.

[32] The Combined Load graph includes a constant 1.1MW Timaru Charging Station load but the the graph for this Load Site is not presented.

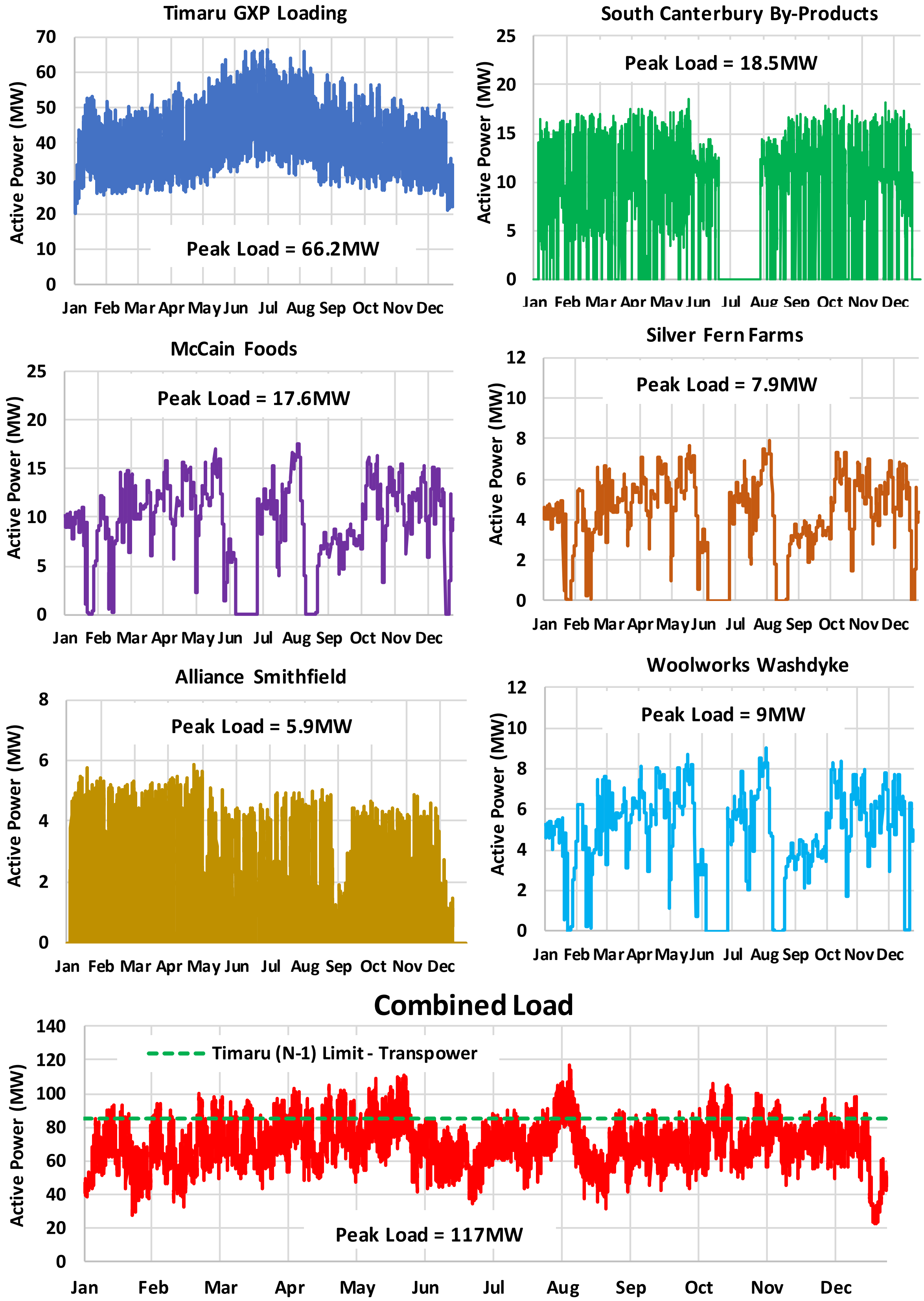


Figure 63 Loading Profiles: Timaru GXP 2021 historical loading: Load Site Profiles: Combined Load (sum of all profiles) [33].

[33] The Combined Load graph includes a constant 1.1MW Timaru Charging Station load but the graph for this Load Site is not presented.

8.12 Twizel GXP & Hydro

The EECA Load Sites include:

- Omarama charging station (initially 0.9 MW increasing to 2.3MW)

The geographic location of the Load Site is shown on the following Figure 49 in relation to the local zone and GXP substations.

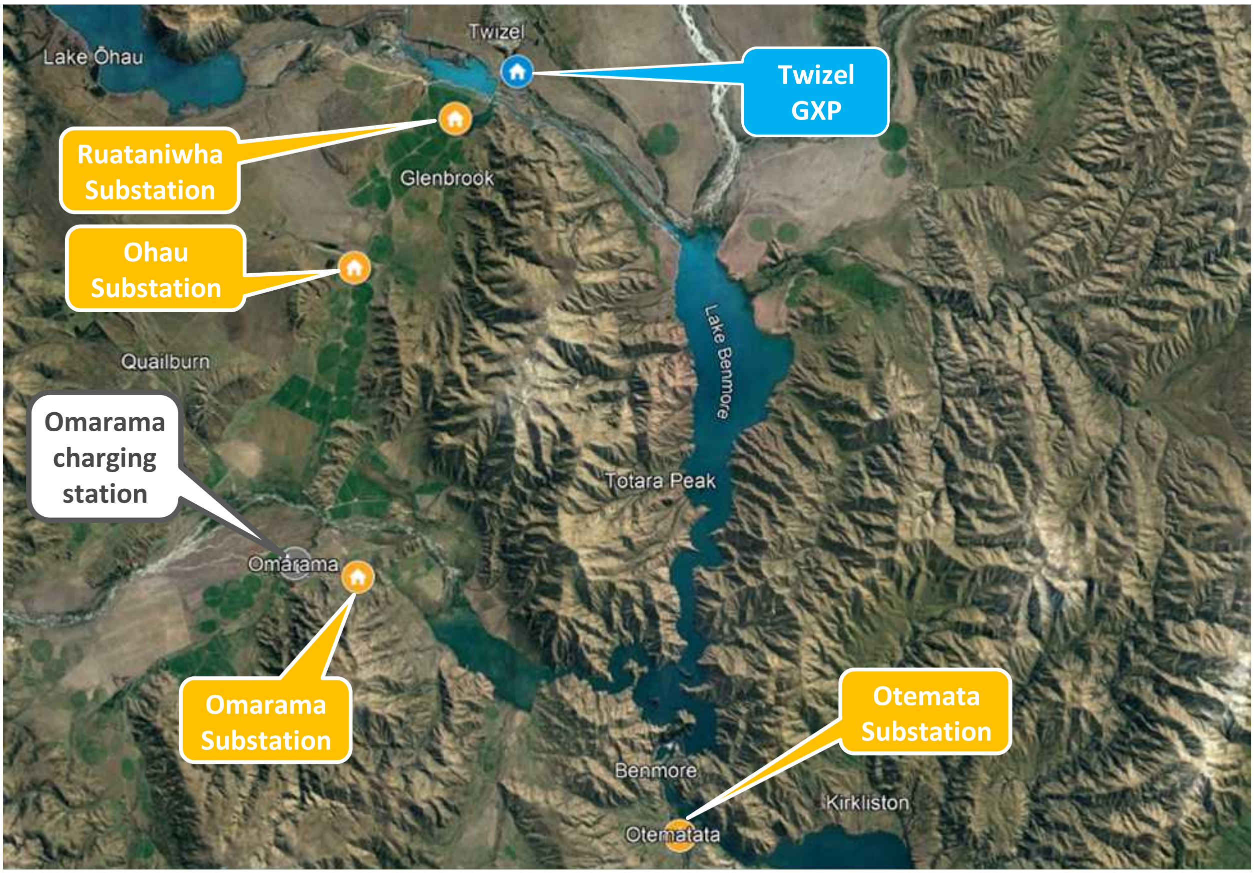


Figure 64 Tekapo GXP: Local GXP and zone substations and Load Site

8.12.1 Twizel GXP Upgrade

Alpine Energy, Network Waitaki, Meridian Energy, and Genesis Energy consider the present level of security can be managed operationally, and there are no plans to upgrade the substation.

8.12.2 Omarama Charging Station

OMARAMA CHARING STATION		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
Charging station for electric cars	Initial load of 0.9MW increasing to 2.3MW	Twizel
Existing Electrical Supply to the Plant		

The following Figure 47 illustrates a potential location for the charging station on the main street of the Omarama township. The station would be located ≈3km from the existing Omarama zone substation (owned by Network Waitaki).

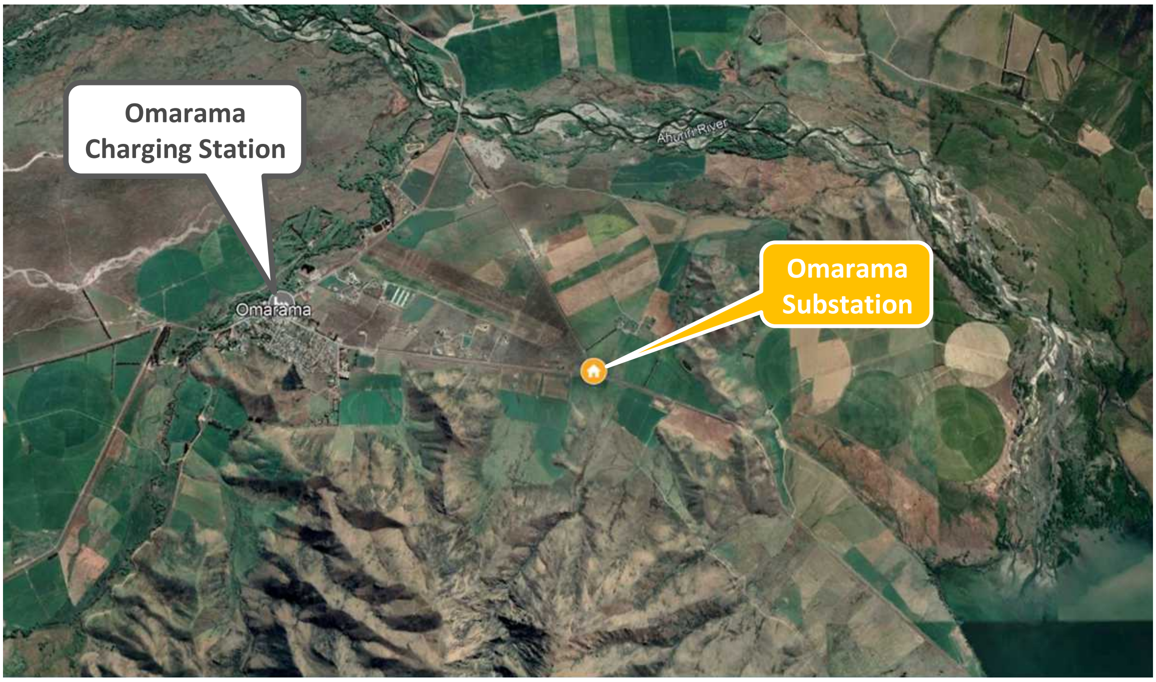


Figure 65 Omarama charging station, location in relation to the surrounding zone substation

Supply Option(s) for New Load

Transmission Network

The transmission network has sufficient capacity to supply the additional load.

EDB Network

The Omarama zone substation has a total capacity of 3MVA and could supply the initial charging station load of 0.9MW. Furthermore, there is an existing 11kV feeder that supplies the Omarama township that could be used to supply the charging station.

The existing Omarama zone substation would not have sufficient capacity to supply the ultimate charging station load of 2.3MW, and the existing 11kV feeder would likely have to be upgraded.

Therefore, Ergo has estimated the capital costs in two stages, as follows:

- **Stage 1 – Supply of 0.9MW:** This could be supplied via the existing network and Ergo has assumed it would require the installation of distribution switchgear and a 1MVA transformer.
- **Stage 2 – Supply of 2.3MW:** This would require the following:
    - Replace the existing 3MVA, 33/11kV transformer with a 5MVA transformer.

- Reconductoring of 3km of 11kV overhead line from the Omarara substation to the charging station site.
- Installation of distribution switchgear and 3 x 1MVA transformers.

The Stage 2 cost estimate includes the Stage 1 costs

Capital Cost Estimate[24]

Table 28 Omarama Charging Station: Capital cost estimate to supply the Load Site[24, 25]

Stage 1 – Supply of 0.9MW

Transmission => (N)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Distribution switches - RMU	1.00	$0.05
Distribution	1000kVA distribution tx	1.00	$0.26
		TOTAL	**$0.31**

Stage 2 – Supply of 2.3MW

Transmission => (N)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Small supply transformer (ZSS)	1.00	$0.50
Distribution	Distribution switches - RMU	2.00	$0.10
Distribution	1000kVA distribution tx	2.00	$0.52
Distribution	Reconductor 11kV line (larger)	3.00	$0.45
		TOTAL	**$1.57**

The above estimates do not include the costs to upgrade the GXP substation, as this would not be required (as discussed in Section 8.12.1 above). We also note that supply of the additional 2.3MW of load may result in voltage constraints on Network Waitaki's 33kV network and may require the installation of voltage support equipment (i.e. capacitor banks).

Timeframe to Establish New Electrical Infrastructure

Stage 1 estimated to take 6 months and Stage 2 estimated to take 12 - 18 months.

To Plan, Design, Procure, Construct and Commission the works.

Excludes the work required to establish the Load Site.

Excludes land acquisition and consenting, if required.

8.13 Waitaki GXP & Hydro

None of the Load Sites identified by EECA are geographically close to the Waitaki GXP. Hence, Ergo is of the view that the Waitaki GXP is not a viable option for supplying the Load Sites, and we have not considered the upgrade of the GXP or any zone substations.

9. Conclusions

9.1 Network Spare Capacity

The following Figure 1 illustrates the (N) and (N-1) spare capacity at the Transpower GXP substations in the South Canterbury Region.

South Canterbury Region: GXP Substations: Spare (N) and (N-1) Capacity

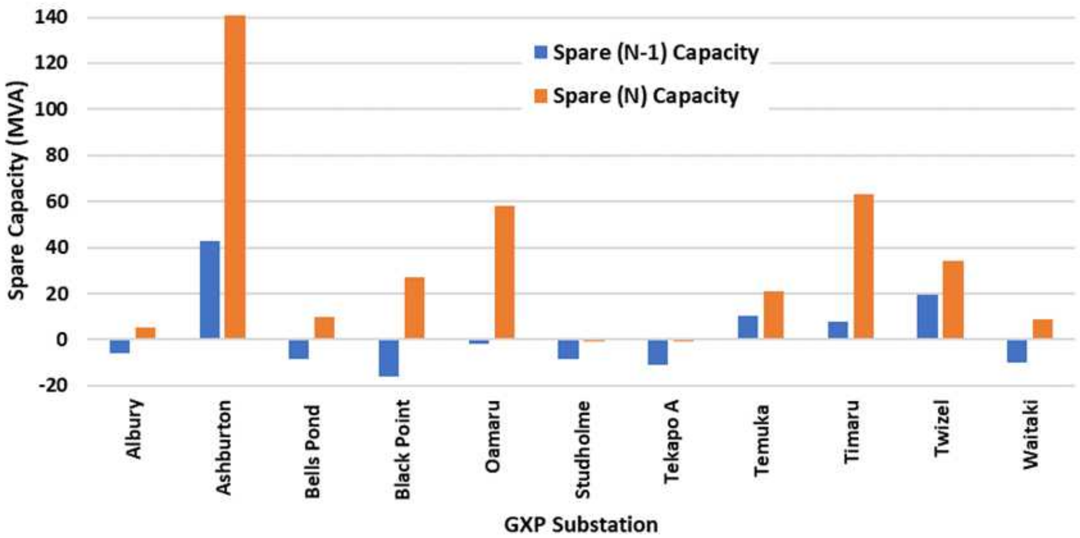


Figure 66 Summary: Approximate (N) and (N-1) spare capacity at GXP substations

The following figures illustrate the (N) and (N-1) spare capacity at the EDB Zone Substations in the South Canterbury Region. These figures are based off the maximum loadings and the EDB 2021 disclosures.

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

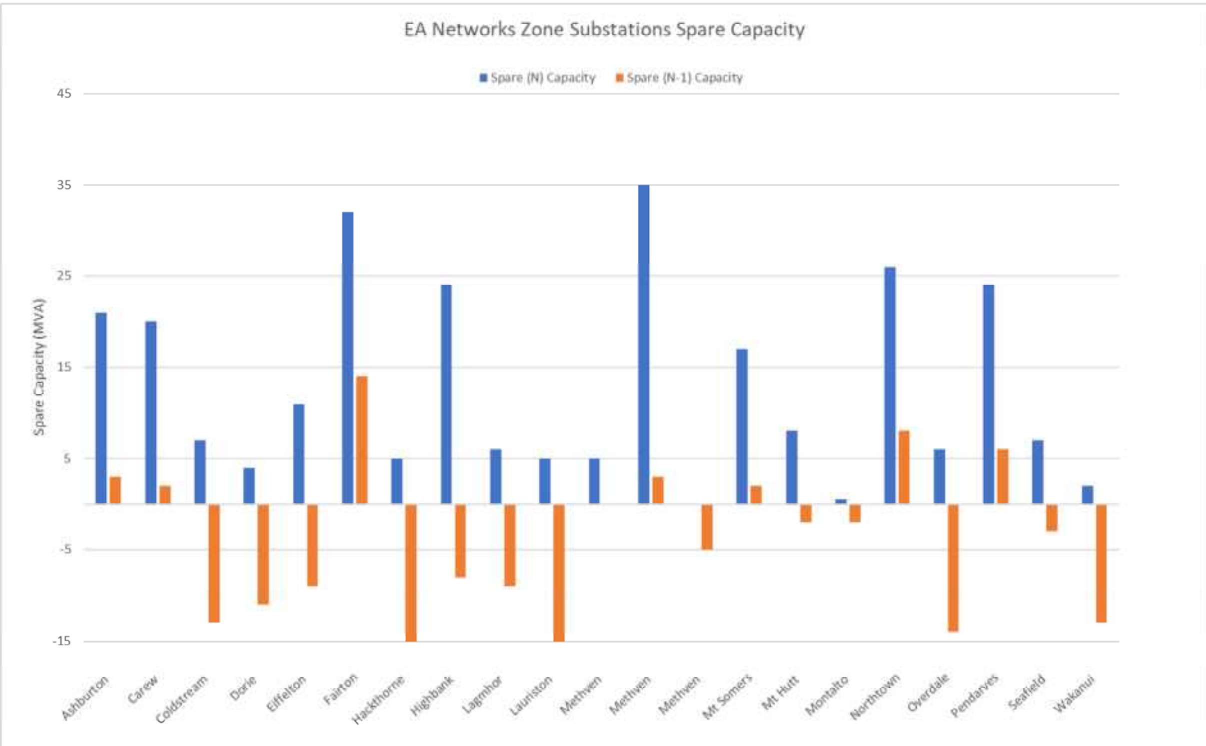


Figure 67 Summary: Approximate (N) and (N-1) spare capacity at EA Networks' zone substations

Alpine Energy Zone Substations: Spare (N) and (N-1) Capacity

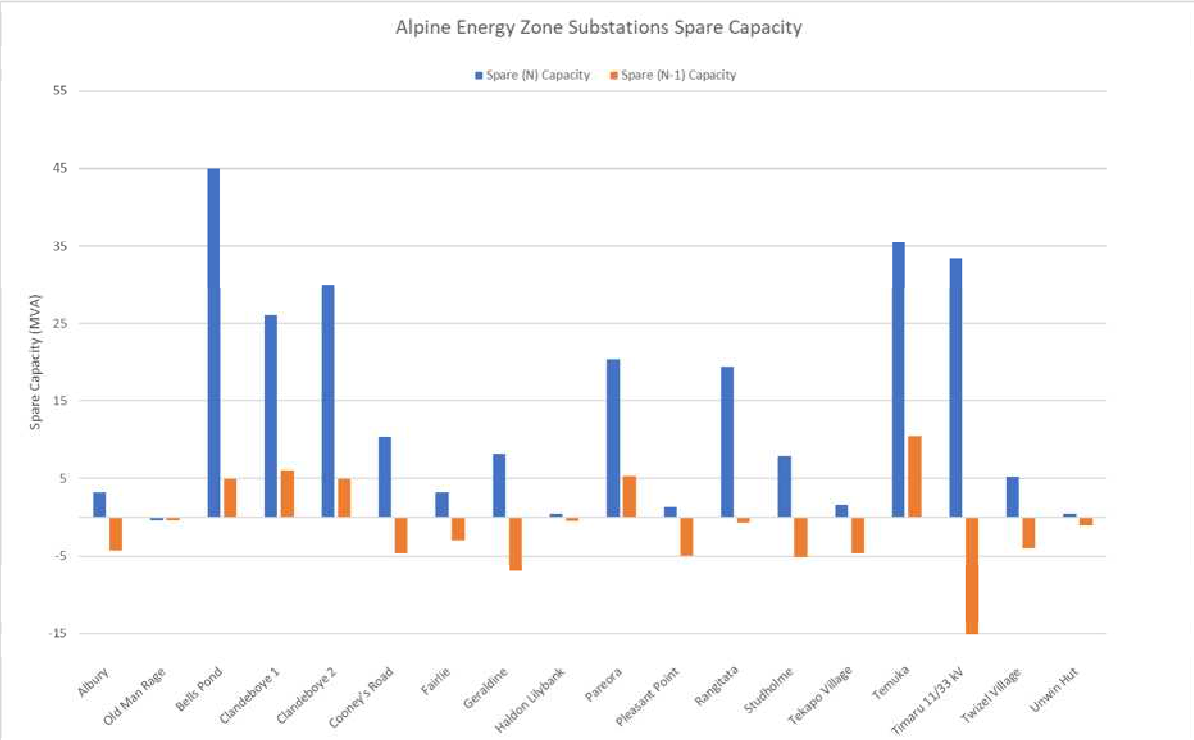


Figure 68 Summary: Approximate (N) and (N-1) spare capacity at Alpine Energy's zone substations

Network Waitaki Zone Substations: Spare (N) and (N-1) Capacity

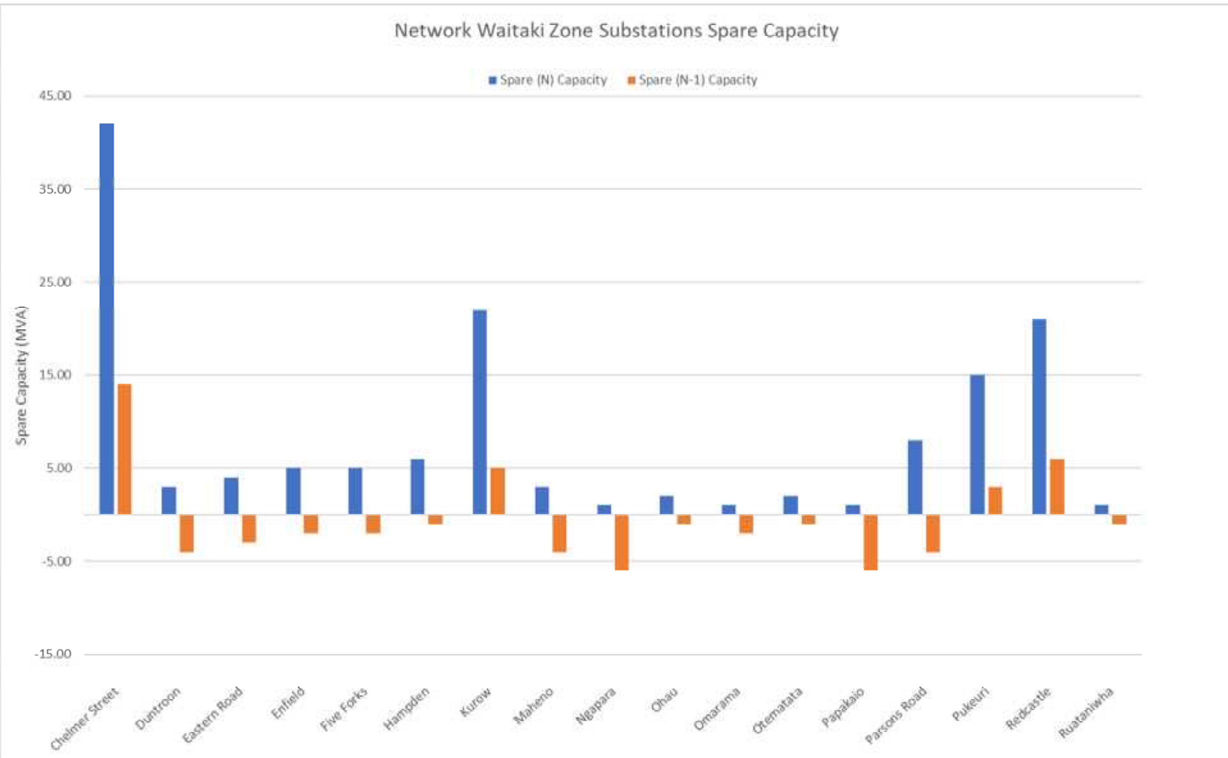


Figure 69 Summary: Approximate (N) and (N-1) spare capacity at Network Waitaki's zone substations

The above figures do not consider the spare capacity of the network of lines/cables that supply the associated GXP or zone substations. This is due to the fact that in most cases multiple substations are supplied via the same lines/cables and the spare capacity is a function of both load current and network voltage. This means that detailed load-flow studies are required to establish the spare capacity of the lines/cables that supply the substations. Having said this, the line/cable networks that supply the three EDB networks have a number of key features, as follows:

- The majority of zone substations in EA Networks are supplied at 66kV and distribute power to consumers at 22kV. EA Networks' 66kV and 22kV networks are generally lightly loaded, not subject to voltage constraints and well placed to supply additional load.
- EA Networks is supplied via the single Ashburton 220/66kV GXP that, in turn, is supplied by a high capacity 220kV network. The GXP supplies a significant load, is afforded with a significant amount of (N) spare capacity and is at risk from a high impact low probability (HILP) event. Transpower's demand forecast infers that the Ashburton GXP has a relatively low level of spare (N-1) capacity, but EA Networks has indicated there could be as much as 40MVA available. The connection of significant additional load on Ashburton will bring forward the planned installation of a second GXP to supply EA Networks.
- The majority of Alpine's zone substations are supplied at 33kV and distribute power to consumers at 11kV. In some locations Alpine takes supply at 11kV from Transpower (i.e. GXP afforded with 110/11kV transformers), steps voltages up to 33kV (i.e. 33/11kV transformers) in order to supply its 33kV network.
- The majority of Network Waitaki's zone substations are supplied at 33kV and distribute power to consumers at 11kV. Many of the 33kV supply lines supply multiple 33/11kV zone substations.
- Both Alpine and Network Waitaki take supply from GXP's that are supplied via a shared 110kV network that is capacity constrained and afforded with a special protection system (SPS) to manage network outages. Network Waitaki is proposing the installation of a new 220/110kV GXP west of the existing Black Point GXP, coupled with the construction of a new 110kV line from the new GXP to the existing Oamaru GXP. If installed the new GXP and 110kV line could be used to off-load the existing 110kV network which, in turn, would deliver additional capacity to both Network Waitaki and Alpine Energy. The connection of a modest amount of additional load to the Alpine and Network Waitaki networks will bring forward the need to install the GXP (or implement an alternative solution).

9.2 Load Characteristics

The substation load characteristics are documented in detail in the main body of the report (and the supplementary document 22108-RPT-0002) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Albury GXP* – Predominantly rural loading with summer peaks, likely due to irrigation in the area. GXP loading is impacted by the presence of a 7MW embedded generator.
- *Ashburton GXP* – Significant summer peaks due to large irrigation load in the area. GXP loading is somewhat impacted by the intermittent nature of the two embedded hydro generators.
- *Bells Pond GXP* – Mix of dairy and irrigation load results in summer peaks. Winter loading is relatively flat throughout the day.
- *Black Point GXP* – GXP supplies a large irrigation scheme which results in intermittent loading, predominantly from September to May.
- *Oamaru GXP* - A typical mix of residential and commercial/industrial loads. The load tends to peak in the mornings and evenings and is lower during weekends.

- Studholme GXP – GXP supplies a dairy factory which results in a relatively flat load profile with a summer peak.
- *Tekapo A GXP* – Largely residential load with typical winter peak. Winter peak increases over weekends, likely due to the large number of holiday houses in the area.
- *Temuka GXP* – Loading is a mix of residential, irrigation and dairy loading. This results in a summer with a relatively flat load profile throughout the day and week.
- *Timaru GXP* - A typical mix of residential and commercial/industrial loads. The load tends to peak in the mornings and evenings and is lower during weekends.
- *Twizel GXP* - Largely residential load with typical winter peak. Winter peak increases over weekends, likely due to the large number of holiday houses in the area.
- *Waitaki GXP* - Significant summer peaks due to large irrigation load in the area. The load profile throughout the day and week is relatively flat.

Zone Substations:

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

9.3 EECA Load Sites

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

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

The costs are preliminary and Ergo is of the view that they have an accuracy of Class 5[34], which is only suitable for concept screening. (Refer to the assumptions outlined in Section 8.2 for more details)

Summary: Load Sites vs transmission/distribution capital cost estimates

Table 29 Summary of Load Sites and estimated capital costs

No.	Load Site Name	Load (MW)	Transmission Details		Distribution		TOTAL	Cost Efficiency ($M/MW)	Complexity of Connection	Refer to notes
			GXP Substation	Upgrade Costs ($M)	Zone Substation	Upgrade Costs ($M)	Upgrade Costs ($M)			
1	Talleys - Ashburton (with N-1 Supply)	14.00	Ashburton	$0.00	Fairton	$1.61	$1.61	$0.12	Minor	1,2,3
2	Ashburton Meat Processors	0.98	Ashburton		Northtown	$0.29	$0.29	$0.30	Minor	3
3	Canterbury Dried Foods	2.25	Ashburton		Elgin	$0.05	$0.05	$0.02	Minor	3
4	ANZCO Canterbury	10.12	Ashburton		Seafield	$1.91	$1.91	$0.19	Minor	3
5	Mt Hutt Lime	1.72	Ashburton		Methven	$1.52	$1.52	$0.88	Minor	3
6	Oceania Dairy Ltd (Option 4 - 110kV Supply)	26.10	Bells Pond	$1.20	Cooneys Road	$3.90	$5.10	$0.20	Moderate	5
7	Canterbury Spinners	3.22	Oamaru	$0.00	Chelmer St/Redcastle	$1.30	$1.30	$0.40	Minor	3
8	Oamaru Meats	1.08	Oamaru		Redcastle	$0.00	$0.00	$0.00	Minor	3
9	Alliance Pukerui	8.75	Oamaru		Pukerui	$3.55	$3.55	$0.41	Moderate	4
10	Moeraki Charging Station (Option 1 - 1.5MW)	1.50	Oamaru		Hampden	$0.62	$0.62	$0.41	Minor	3
11	Fonterra Studholme	16.00	Studholme	$1.00	Studholme	$2.10	$3.10	$0.19	Moderate	5
12	Barkers Fruit Processing	1.29	Temuka	$0.00	Geraldine	$1.13	$1.13	$0.87	Minor	3
13	Ravensdown Lime	1.29	Temuka		Geraldine	$1.17	$1.17	$0.91	Minor	3
14	Synlait Talbot Forest Cheese	1.30	Temuka		Temuka	$0.75	$0.75	$0.58	Minor	3
15	Fonterra Clandeboye (Option 3 - heat pump and 4 boilers)	91.00	New	$51.90	New	$0.00	$51.90	$0.57	Major	6
16	South Canterbury By Products (Option 1 - 8.5MW)	8.50	Timaru	$0.00	Timaru	$3.00	$3.00	$0.35	Minor	3
17	McCain Foods (Option 1 - 8MW)	8.00	Timaru		Timaru	$1.80	$1.80	$0.23	Minor	3
18	Woolworks Washdyke	9.00	Timaru		Timaru	Load Site committed			Minor	3,7
19	Silver Fern Farms Pareora (N Supply)	7.91	Timaru		Paerora	$0.24	$0.24	$0.03	Minor	3
20	Alliance Smithfield	5.85	Timaru		Timaru	$0.95	$0.40	$0.07	Minor	3
21	Timaru Charging Station (Option 1 - 1.1MW)	1.10	Timaru		Timaru	$0.40	$0.40	$0.36	Minor	3
22	Omarama Charging Station (Option 1 - 1.5MW)	1.50	Twizel	$0.00	Omarama	$0.31	$0.31	$0.21	Minor	3
	TOTAL =>	222.5	TOTAL =>	$54.1	TOTAL =>	$26.59	$80.14			

1 Load Site requirement was indicated by EECA to be 11 - 14MW. Option 2 (N-1) costs are assumed
2 Assuming a 14MW load, Ergo has used the (N-1) supply option costing
3 Transmission upgrade is unlikely required for supply of individual Load Sites, but connection of multiple sites could require transmission upgrade
4 Ergo understands Network Waitaki are planning a new GXP by 2027 which will be required to connect this Load Site
5 Assumes Network Waitaki's new GXP removes the upcoming constraint on the 110kV line so connection would be limited to after 2027
6 Assumes "Option 3" providing a 110kV connection between Orari-Clandeboye-Temuka
7 Load site is committed/proceeding and costs have been estimated in detail by others

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 be used for final budgeting purposes in order to connect the respective Load Sites.

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

Appendix

Appendix 1 Glossary

ABY	Albury GXP/substation
ALP	Alpine Energy
BPD	Bells Pond GXP/substation
BPT	Black Point GXP/substation
CT	Current transformer
DG	Distributed generator
EDB	Electrical Distribution Business
EIPC	Electricity Industry Participation Code
EAN	EA Networks
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
NTW	Network Waitaki
OAM	Oamaru GXP/substation
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
STU	Studholme GXP/substation
TKA	Tekapo A GXP/substation and hydro-station
TIM	Timaru GXP/substation
TMK	Temuka GXP/substation
TWZ	Twizel GXP/substation and hydro-station
WTK	Waitaki GXP/substation and hydro-station

Appendix 2 Accuracy of Cost Estimates and Assumptions

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

Table 30 Cost estimate classification matrix[35]

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.

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