West Coast Network

Spare Capacity and Load Characteristics Report

EECA

22132 / 22132-EE-RPT-0001 / Revision F / 27-Jul-2023

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Revision details

Revision	Details
A	Stage 1 - Draft for client review/comment
B	Stage 2 - Draft for client review/comment
C	Updated following feedback from Lumen/EECA
D	Updated following feedback from Transpower
E	Updated following feedback from EECA
F	Finalised report with minor updates from WM Advisory

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1. Executive Summary

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

Two Electrical Distribution Businesses (EDB's), Westpower Ltd and Buller Electricity Ltd 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 Regional Energy Transition Accelerator (RETA)[1]. The program is targeted at large energy-using businesses and public sector organisations that are committed to reducing carbon emissions.

EECA contracted Ergo to determine the following (for the West Coast region):

- The existing spare supply capacity at the major electrical substations.
- The load characteristics at the major electrical substations (to be completed).

1.1 Network Spare Capacity

The following Figure 1 illustrates the (N) and (N-1) spare capacity at the GXP substations in the West Coast Region. Transpower does not own all the GXP substations and some are owned wholly (or partly) owned, by Westpower and Buller.

West Coast Region: GXP Substations: Spare (N) and (N-1) Capacity

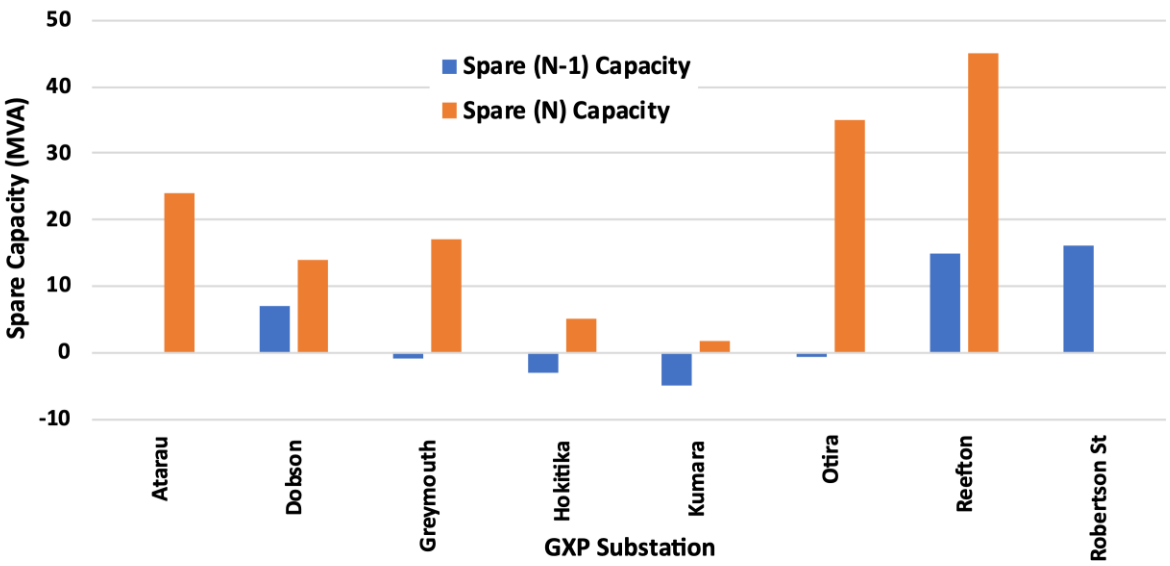


Figure 1 Summary: Approximate (N) and (N-1) spare capacity at GXP substations

[1] https://www.eeca.govt.nz/co-funding/regional-decarbonisation/about-reta/

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

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

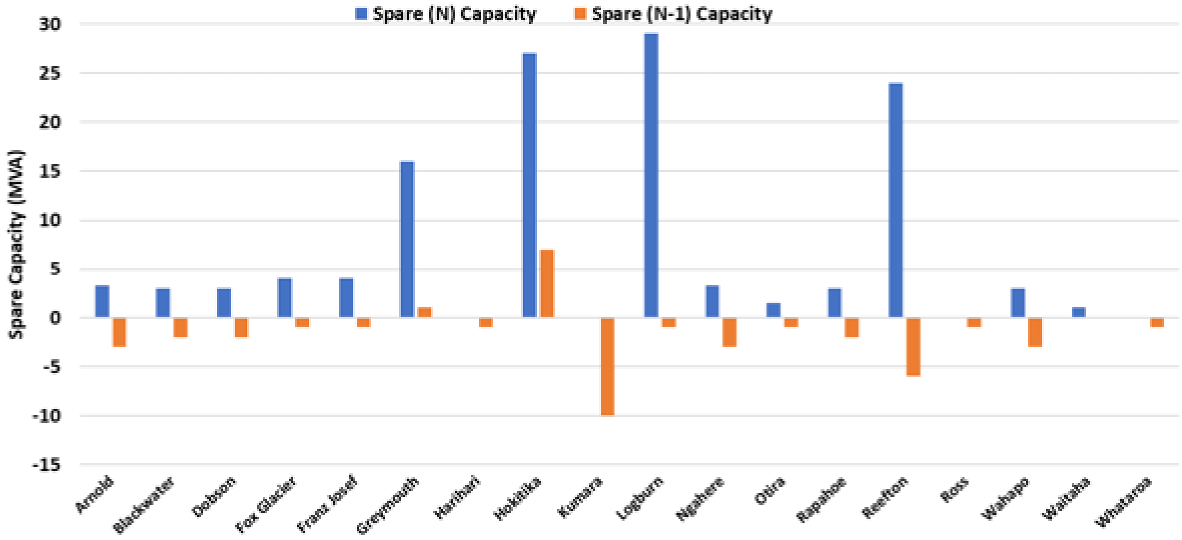


Figure 2 Summary: Approximate (N) and (N-1) spare capacity at Westpower's zone substations

Buller Electricity Zone Substations: Spare (N) and (N-1) Capacity

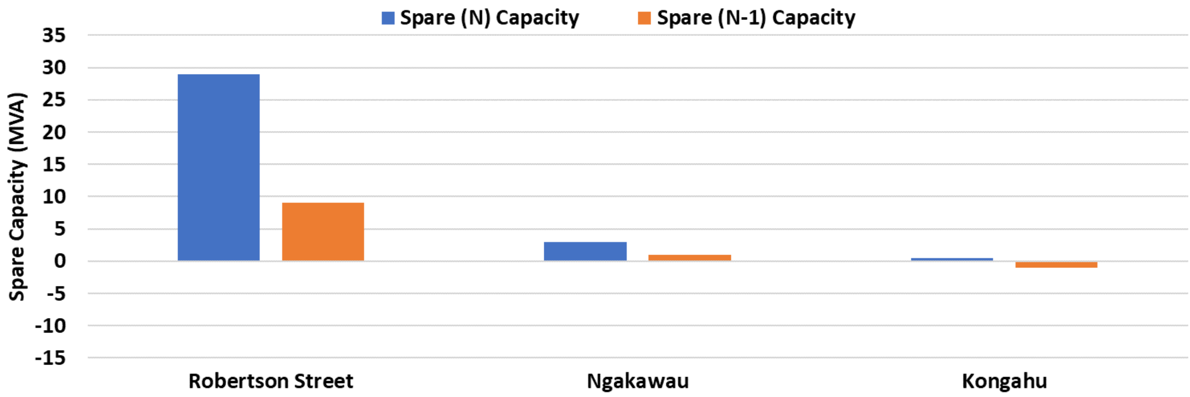


Figure 3 Summary: Approximate (N) and (N-1) spare capacity at Buller Electricity's zone substations

1.2 Load Characteristics

The substation load characteristics are documented in detail in the main body of the report (and the supplementary document 22132-RPT-0002) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Dobson GXP* – GXP loading is impacted by the presence of a 3MW embedded generator. High weekday loading throughout the year suggests loading is largely industrial/commercial.
- *Greymouth GXP* – A typical mix of residential and commercial/industrial loads with winter peaks. The load tends to peak in the mornings and evenings and is lower during weekends.
- *Hokitika GXP* – Mix of industrial, dairy and tourist related loads. Summer peaks but with relatively flat daily loading profiles and inconsistent peak periods.
- *Kumara GXP* – Loading is significantly influenced by the embedded hydro generation with the substation predominantly acting as a Grid Injection Point.
- *Otira GXP* – Relatively small load with intermittent loading, likely associated with the Otira tunnel fans influencing the GXP loading.
- *Reefton GXP* – GXP loading is relatively consistent throughout the year and with typical morning and evening peaks. Loading is largely residential with some industrial/commercial.
- *Robertson Street GXP* – A mix of residential and commercial/industrial loads with winter peaks. Daily loading profiles vary significantly, likely due to the influence of the various industrial/commercial loads.

Zone Substations:

- The load characteristics of the zone substations vary widely depending on the connected consumers/generators. The historical loading graphs for the zone substations are included in the supplementary document **22132-RPT-0002**.

1.3 EECA Load Sites

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

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

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

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

Table 1 Summary of Load Sites and estimated capital costs

No.	Load Site Name	Load (MW)	Transmission Details		Distribution		TOTAL	Cost Efficiency ($M/MW)	Complexity of Connection	Refer to notes
			GXP Substation	Upgrade Costs ($M)	Zone Substation	Upgrade Costs ($M)	Upgrade Costs ($M)			
1	ANZCO Kokiri	1.85	Dobson		Arnold	$0.03	**$0.03**	**$0.02**	Minor	
2	Runanga School	0.05	Dobson	$0.00	Rapahoe	$0.00	**$0.00**	**$0.00**	Minor	1
3	Value Proteins	13.30	Dobson		Arnold	$15.34	**$15.34**	**$1.15**	Major	
4	Westimber	0.28	Dobson		Ngahere	$0.00	**$0.00**	**$0.00**	Minor	1
5	Westland Recreation Centre	0.28	Greymouth		Greymouth	$0.00	**$0.00**	**$0.00**	Minor	1
6	Greymouth High School	0.52	Greymouth		Greymouth	$0.29	**$0.29**	**$0.56**	Minor	
7	Greymouth Hospital	0.76	Greymouth	$0.00	Greymouth	$0.41	**$0.41**	**$0.54**	Minor	
8	Cobden School	0.03	Greymouth		Greymouth	$0.00	**$0.00**	**$0.00**	Minor	1
9	Grey Main School	0.12	Greymouth		Greymouth	$0.00	**$0.00**	**$0.00**	Minor	1
10	Scenicland Laundry	0.40	Greymouth		Greymouth	$0.00	**$0.00**	**$0.00**	Minor	1
11	Westland Milk Products Hokitika	41.70	Hokitika	$21.90	Hokitika	$5.90	**$27.80**	**$0.67**	Major	2
12	Silver Fern Farms Hokitika	0.19	Hokitika	$0.00	Hokitika	$0.00	**$0.00**	**$0.00**	Minor	1
13	Ngai Tahu Franz Josef Hot Pools	0.19	Hokitika		Franz	$0.00	**$0.00**	**$0.00**	Minor	1
14	Westland Produce (electric boiler option)	2.13	Hokitika	$0.50	Harihari	$1.15	**$1.65**	**$0.77**	Minor	
15	Franz Josef EV Charging Station	0.60	Hokitika	$0.00	Franz	$0.00	**$0.00**	**$0.00**	Minor	1
16	Kumara EV Charging Station	2.30	Kumara	$0.00	Kumara	$0.40	**$0.40**	**$0.17**	Minor	
17	International Panel & Lumber	1.50	Kumara		Kumara	$0.40	**$0.40**	**$0.27**	Minor	
18	Reefton Area School	0.16	Reefton	$0.00	Reefton	$0.00	**$0.00**	**$0.00**	Minor	1
19	Reefton Hospital	0.30	Reefton		Reefton	$0.00	**$0.00**	**$0.00**	Minor	
20	Karamea Tomatoes (electric boiler option)	2.73	Robertson St		Robertson St	$0.90	**$0.90**	**$0.33**	Minor	
21	Westport Hospital	0.54	Robertson St		Robertson St	$0.00	**$0.00**	**$0.00**	Minor	1
22	Buller High School	0.22	Robertson St	$0.00	Robertson St	$0.00	**$0.00**	**$0.00**	Minor	1
23	Westport North School	0.10	Robertson St		Robertson St	$0.00	**$0.00**	**$0.00**	Minor	1
24	Westport South School	0.07	Robertson St		Robertson St	$0.00	**$0.00**	**$0.00**	Minor	1
	TOTAL =>	**70.3**	**TOTAL =>**	**$22.4**	**TOTAL =>**	**$24.82**	**$47.22**			

Notes

1 Table doesn't include distribution transformer costs for Load Sites (details provided in body of report)

2 Includes the costs of stage 1 and stage 2

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. For the larger Load Sites Ergo recommend proceeding with a Concept Design Report (CDR) to improve the accuracy of the respective cost estimate.

2. Introduction

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

- Westpower Ltd – 18 zone substations
- Buller Electricity Ltd - 3 zone substations

The franchise areas of the EDBs are shown in Figure 4.

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

As part of the RETA program, EECA contracted Ergo to determine the existing spare supply capacity and the load characteristics at the major electrical substations within the West Coast Region.

Ergo previously developed a similar report for the Southland and South Canterbury Regions.[4,5]

Figure 4 Electrical Distribution Business (EDB) franchise areas[6]

[3] https://www.eeca.govt.nz/co-funding/regional-decarbonisation/about-reta/

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

[5] 22108-RPT-0001 [D] South Canterbury Electrical Network - Spare Capacity and Load Characteristics.

[6] 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 West Coast Region. This included reviewing both the GXP's and local distribution zone substations along with their associated lines/cables within the West Coast Region.

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

- Transpower's 2022 Planning Report.
- Westpower's 2022 Disclosures and Asset Management Plan.
- Buller Electricity's 2022 Disclosures and Asset Management Plan.
- SCADA substation loading data provided by Westpower and Buller Electricity.
- GXP metering data extracted from the Electricity Authority's website[7].
- Network diagrams provided by Westpower and Buller Electricity.
- Geographic Information System (GIS) asset and location data provided by Transpower, Westpower and Buller Electricity. This was mostly supplied in the form of *.kmz files.

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

4. West Coast Network

The following sections describe (at a high level), the locations of the relevant substations and lines. For the purposes of this document the franchise areas supplied by Westpower and Buller Electricity are referred to as the West Coast Region.

4.1 Transmission/GXP Substations

The following Figure 5 illustrates the relevant transmission substations (GXPs) within the West Coast Region, which include the following:

- Atarau GXP.[8]
- Dobson GXP.
- Greymouth GXP.[9]
- Hokatika GXP. [9]
- Kumara GXP.[9]
- Otira GXP.
- Reefton GXP.[9]
- Robertson Street GXP.[10]

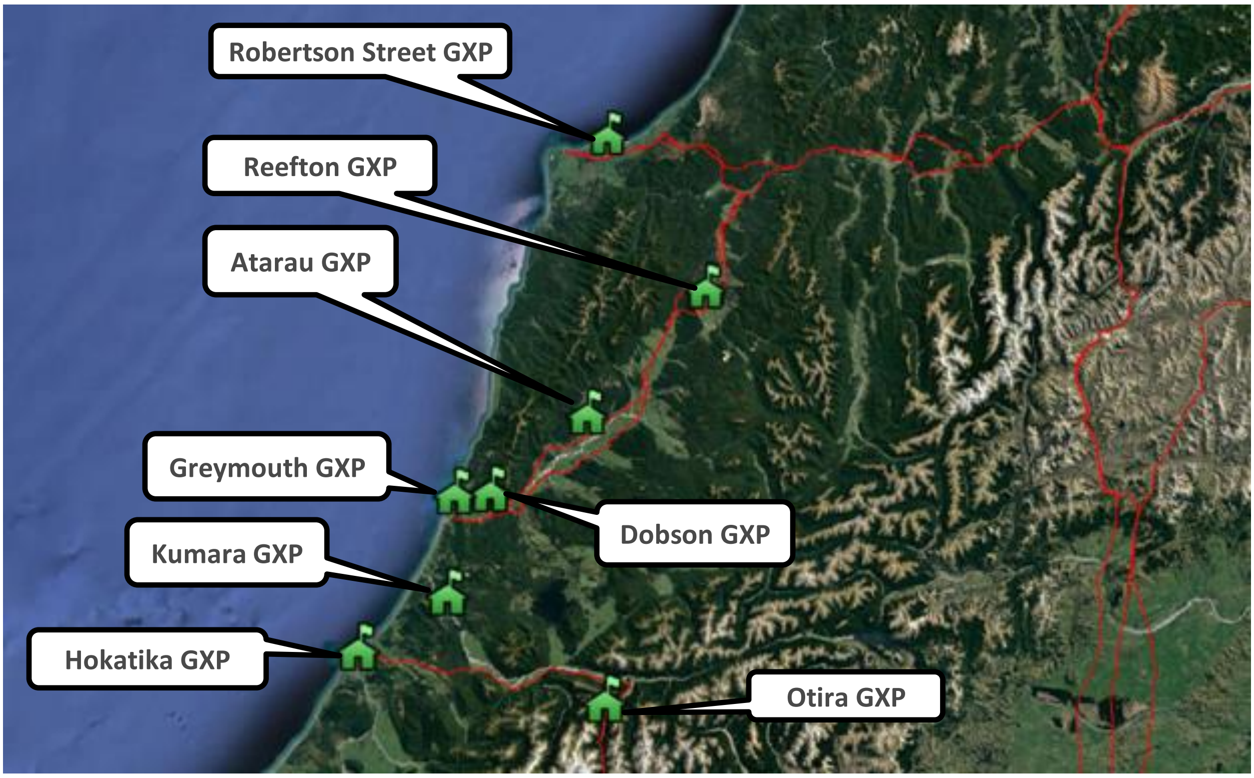


Figure 5 Transmission/GXP substations (red lines are Transpower's transmission lines)

8 Substation was providing supply to the Pike River Recovery Agency whose operation has come to an end. The substation has been decommissioned and is to be dismantled.

9 Transformers and low voltage switchgear owned by Westpower.

10 Transformers and low voltage switchgear owned by Buller Electricity.

The transmission network in the West Coast Region is also shown diagramatically in Figure 6 and Figure 7. The network is comprised of 110 kV and 66 kV transmission circuits supplying relatively small substations, with two 220/110kV interconnecting transformers at Kikiwa (only one permanently in service). A key feature of the region is that the transformers and low voltage switchgear at many of the GXP substations are owned and operated by the relevant EDB.

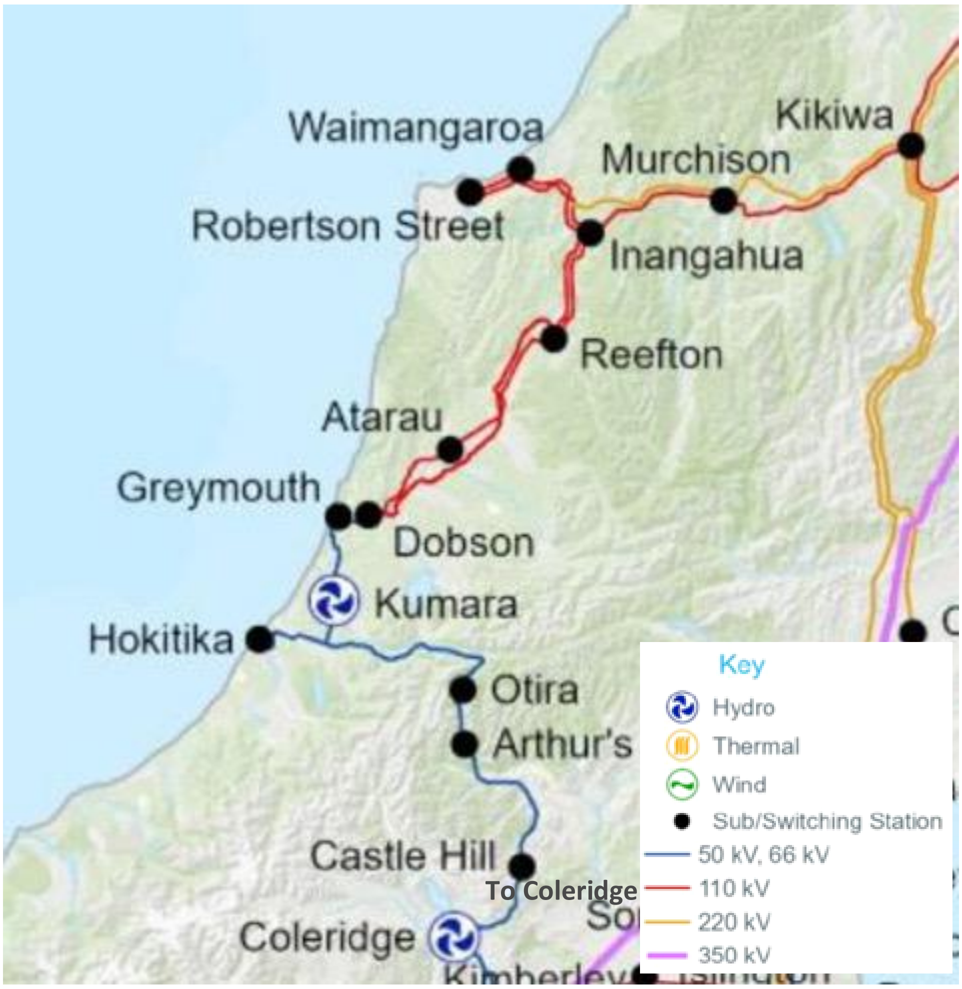


Figure 6 Transmission/GXP substations[11]

[11] https://www.transpower.co.nz//Transmission Planning Report 2022.

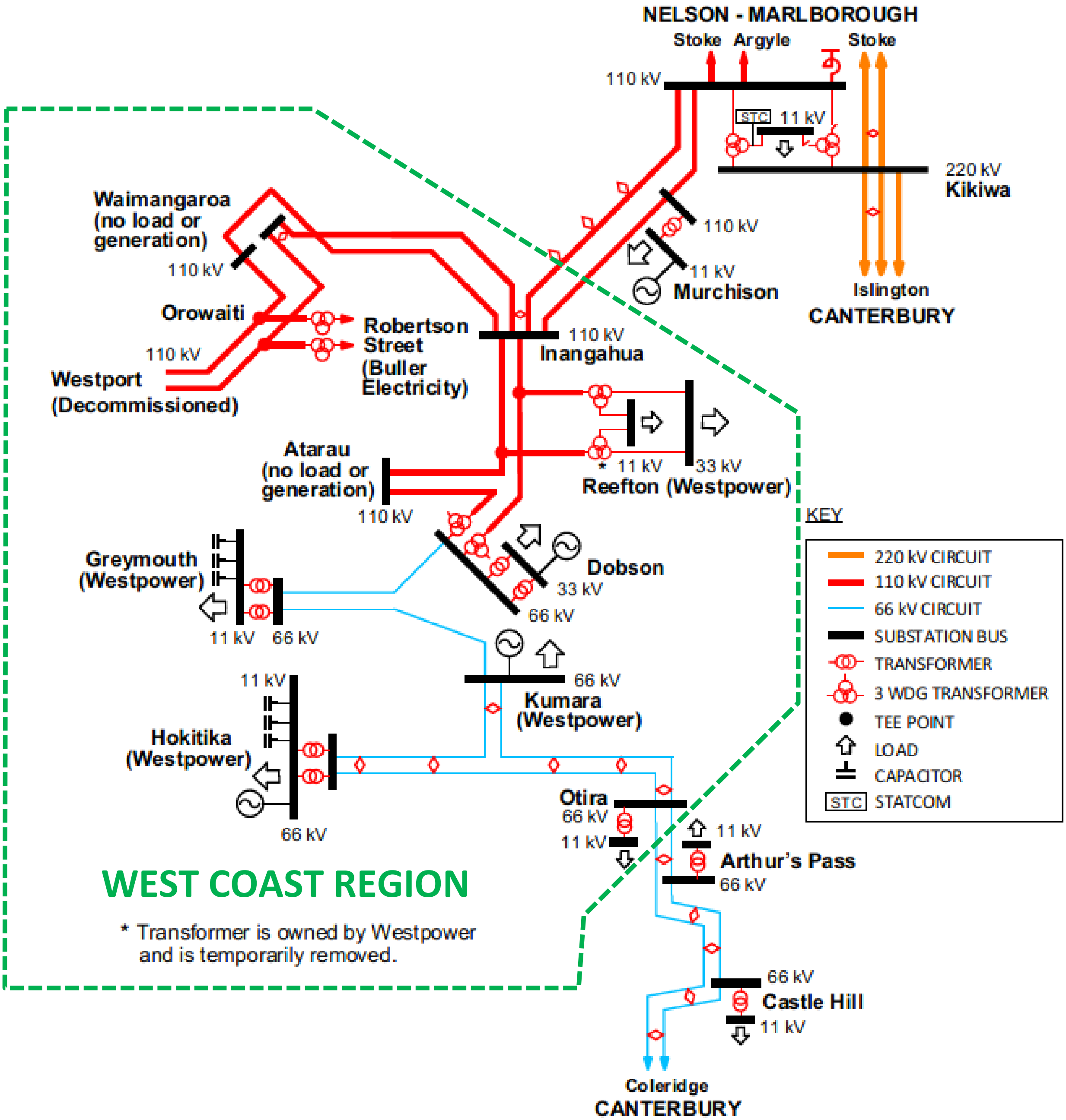


Figure 7 Existing transmission/GXP substations[11]

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 two relevant EDB's – Westpower and Buller Electricity. Table 2 below provides 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
Westpower	WPR	18	7
Buller Electricity	BUL	3	1

4.2.1 Westpower

The following Figure 8 through Figure 10 shows the zone substations on Westpower's network diagrammatically. The substations include:

- Arnold 33/11kV zone substation
- Blackwater 33/11kV zone substation
- Dobson 33/11kV zone substation
- Fox Glacier 33/11kV zone substation
- Franz Josef 33/11kV zone substation
- Greymouth 66/11kV zone substation
- Harihari 33/11kV zone substation
- Hokitika 66/11kV zone substation
- Kumara 66/11kV zone substation
- Logburn 110/11kV zone substation
- Ngahere 33/11kV zone substation
- Otira 66/11kV zone substation
- Rapahoe 33/11kV zone substation
- Reefton 110/11kV zone substation
- Ross 33/11kV zone substation
- Wahapo 33/11kV zone substation
- Waitaha 33/11kV zone substation
- Whataroa 33/11kV zone substation

Figure 8 Westpower: Northern Zone Substation Geospatial Sub-transmission and Distribution Diagram[12]

[12] https://westpower.co.nz/asset-management-plan

Figure 9 Westpower: Southern Zone Substation Geospatial Sub-transmission and Distribution Diagram[12]

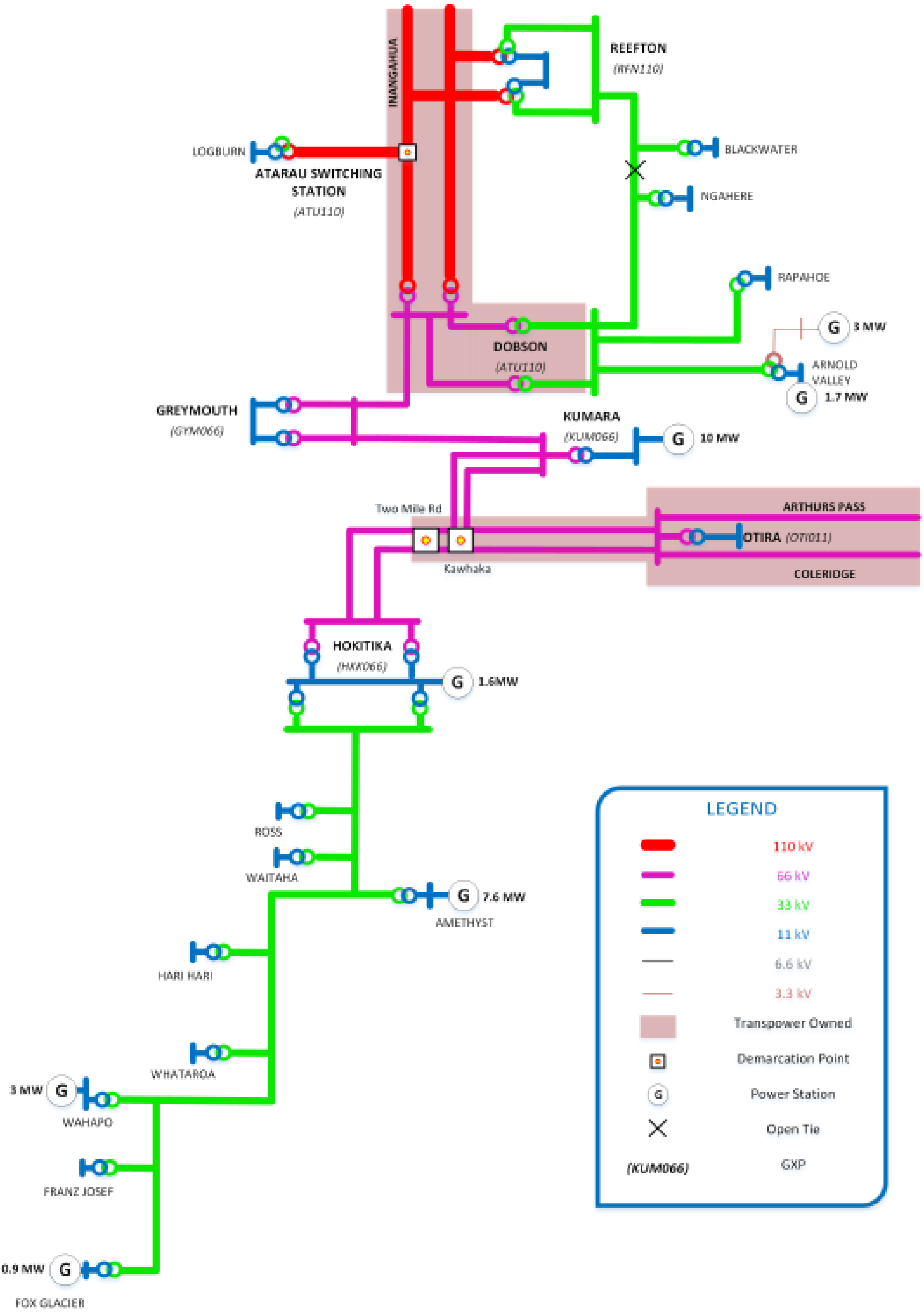


Figure 10 Westpower's Zone Substation One-line Sub-transmission Diagram[12]

4.2.2 Buller Electricity

The following Figure 11 shows zone substations on Buller Electricity's network diagrammatically. The substations include:

- Robertson Street 110/33/11kV zone substation (also referred to as the Orowaiti GXP)
- Ngakawau 33/11kV zone substation,
- Kongahu 33/11kV zone substation.

The Robertson Street substation is in Westport and is supplied via two ≈1.0km 110kV circuits that are tee'd onto Transpower's Inangahua-Waimangaroa-Westport 110kV line (referred to as Orowaiti tee). The substation is equipped with two three winding 110/33/11kV transformers. The 33kV windings supply the Ngakawau and Kongahu zone substations.

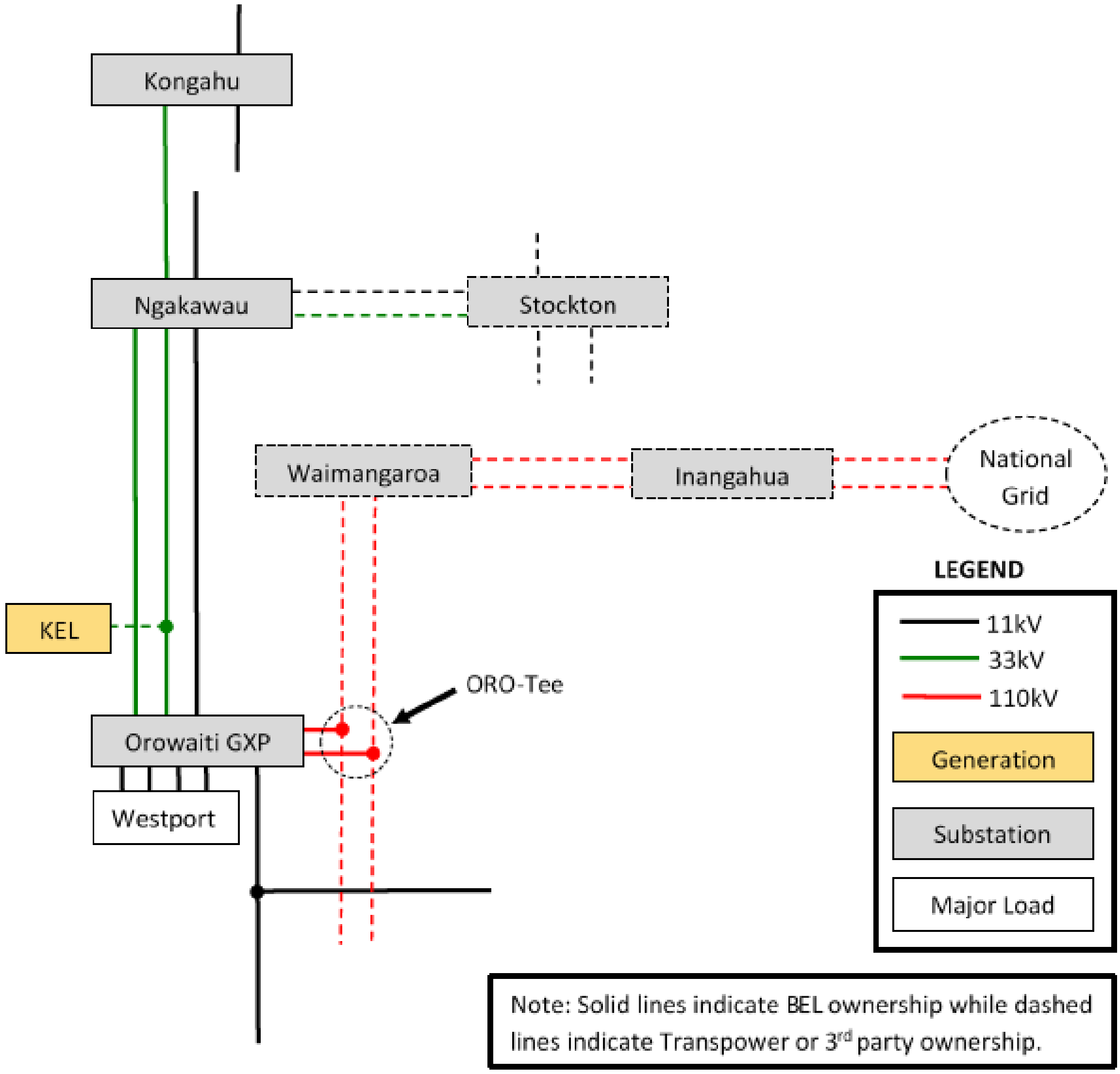


Figure 11 Buller Electricity's Zone Substation Sub-transmission Diagram[13]

[13] https://bullerelectricity.co.nz/asset-management-plan/

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)[14]. 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 Transpower points of supply discussed in this report are considered connection assets and therefore decisions around their security classifications lie with their end customers (i.e. Westpower or Buller Electricity). 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.

[14] 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[15]. 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 GXP's that take supply from within the West Coast Region.

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

- Most of the West Coast load is supplied through the northern transmission circuits, with power flowing through the region on the 110 kV circuits from Kikiwa to Dobson via Inangahua, and the 110 kV spur from Inangahua to Robertson Street and Westport (which no longer supplies any load). Some loads are fed from the south via low capacity 66 kV circuits from Coleridge, which also provide significant voltage support to the region. Reactive support for the region (and grid backbone) is provided by a STATCOM and shunt reactor at Kikiwa and capacitor banks at Greymouth and Hokitika.
- There are single 110kV bus sections at the Kikiwa and Inangahua substations. This means that a bus outage will disconnect both 110kV circuits that supply the region. This will result in low voltages on all 110kV and 66kV buses, or potential voltage collapse during peak loading periods.
- An outage of Kikiwa 220kV bus sections that connects the Kikiwa 220/110kV interconnecting transformer will also result in low voltages on all 110kV and 66kV buses, or potentially result in voltage collapse.
- There is no bus protection at the Coleridge and Otira substations. This means that 66kV bus faults will be cleared by the connected 66kV circuits remote end protection. In particular, the two 66kV circuits between Coleridge and Otira will trip with the following result:
    - The loss of supply to the Arthurs Pass and Castle Hill substations.
    - The peak load on the Dobson-Greymouth 66kV circuit will exceed its summer capacity from 2025.

Figure 12 below illustrates Transpower's view of a possible 2037 configuration for the West Coast Regions transmission network. Ergo notes that many of these improvements are not planned as yet. It includes:

- Dismantling of equipment at the historical Waimangaroa, Westport and Atarau substations (confirmed).
- Upgrade of the Dobson-Greymouth-Kumara 66kV line (upgrades to be considered at EDB request for more security).

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

- A new 66kV line between Kumara and Dobson (upgrades to be considered at EDB request for more security).
- A new double circuit 66kV line between Hokitika and Kumara. The existing two lines are to be bonded together and operated as a single circuit (in discussion between Transpower and Westpower).
- Upgrade of the Otira-Kumara 110kV line (upgrades to be considered at EDB request for more security).
- Resolution of the transformer protection limits presently limiting the Dobson (N-1) capacity (planned for a grid need date of 2025).
- Additional capacitor banks at the Hokitika substation (in discussion between Transpower and Westpower).

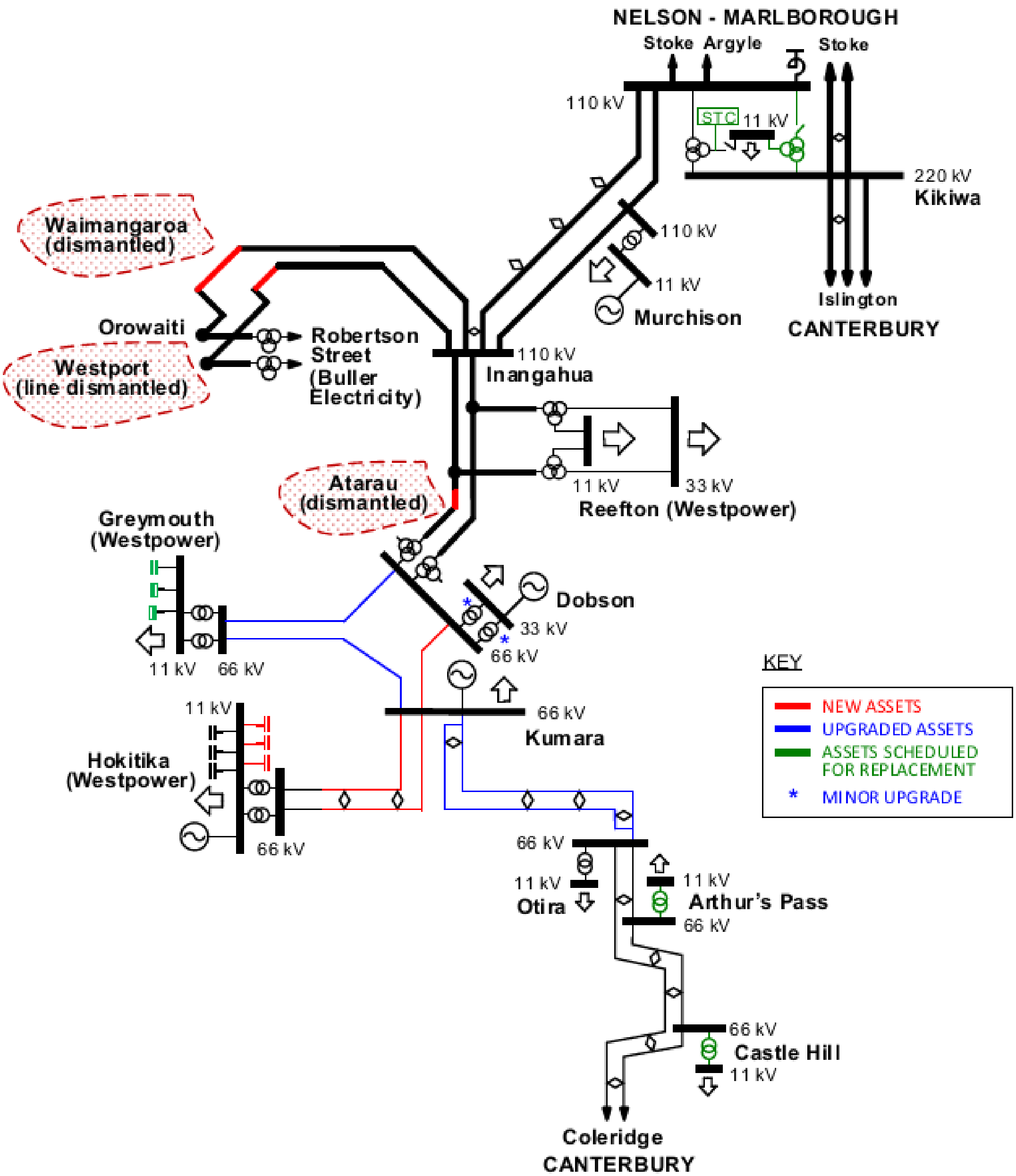


Figure 12 Existing transmission/GXP substations together with future proposed upgraded/new assets[11]

6.1 Demand Forecast

The following Table 3 illustrates Transpower's forecast demand at the transmission substations in the West Coast Region from its 2022 Annual Planning Report[11]. The forecast predicts the demand growing at an average of 4% per annum over the next fifteen years which is greater than the national average.

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	Atarau	0.97	0	0	0	0	0	0	0	0	0	0	0	0
2	Dobson	0.97	10	10	14	16	16	16	17	17	18	18	18	18
3	Greymouth	0.99	16	16	16	17	18	19	19	20	20	21	21	23
4	Hokitika	0.97	23	24	25	26	27	28	29	30	30	31	32	47
5	Kumara	0.99	5	5	5	5	5	5	5	5	5	6	6	6
6	Otira	0.77	0.7	0.7	0.7	0.7	0.8	0.8	1.7	1.7	2.2	2.2	2.2	2.4
7	Reefton	0.97	5	5	5	6	6	6	7	7	7	7	7	7
8	Robertson Street	1.00	13	13	13	14	14	14	15	15	15	15	16	17
		TOTAL	**73**	**74**	**79**	**85**	**87**	**89**	**94**	**96**	**97**	**100**	**102**	**120**

1. The loading at Hokitika assumes no embedded generation.

6.1.1 Dobson GXP

Transpower's demand forecast (refer Table 3) indicates that the Dobson GXP is expected to have a 2022 peak demand of 10MW at 0.97pf. This value contrasts with the historical SCADA data that indicates the Dobson GXP experienced a peak load of 7.5MVA during the 2021 year (refer to Figure 13).

Pertinent details of the GXP include:

- Transpower owns the 2 x 20 MVA 66/33 kV supply transformers at Dobson GXP. The transformers currently have a rating of 17/17/17 MVA[16] . This is due to protection limits on the low voltage (LV) and high voltage (HV) sides limiting the operating ratings.
- If both protection limits are resolved the supply transformers can be operated at its thermal rating of 20/23/24 MVA.
- Dobson substation is connected by three transmission circuits:
  - 110 kV Dobson – Reefton tee circuit rated at 116/111/105 MVA [17].
  - 110 kV Atarua – Dobson circuit rated at 70/64/57 MVA.
  - 66 kV Dobson – Greymouth circuit rated at 36/33/30 MVA.
- This information indicates that the Dobson capacity is limited by the transformers and associated protection.
- (N) limit is 34 MVA while (N-1) limit is 17 MVA.

Westpower owns and operates the distribution network in the Dobson area which supplies a wide area with a mix of farming, industrial, residential and holiday home load, but relatively little commercial load.

The Dobson 33 kV supply point provides capacity to supply Westpower's network northwards to Ngahere substation and the Roa Coal Mine. East of Dobson is the Arnold substation, which supplies the ANZCO Foods meat processing works at Kokiri, a large farming area, and allows for the connection of Manawa Energy's 3 MW Arnold generation. The north-western section of the Dobson GXP connects to

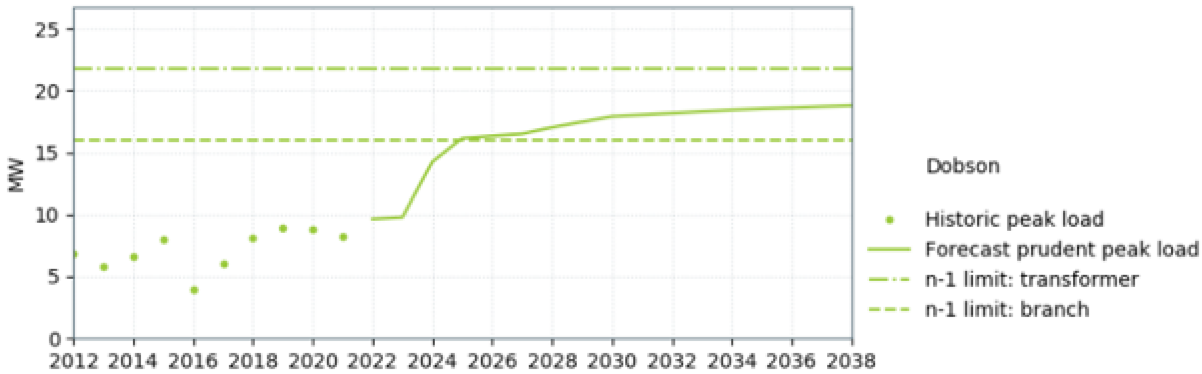
[16] Transformer ratings in the format of continuous rating / 24hr N-1 post-contingency summer rating / 24hr N-1 post-contingency winter rating.

[17] Transmission circuits ratings in the format of winter / shoulder / summer ratings.

the Rapahoe substation, which supplies the Coast Road area. These substations are supplied by the Dobson GXP's three 33 kV feeders.

The Dobson 11kV supply point provides capacity to Westpower's local 11kV network that consists of two 11 kV feeders providing supply to Dobson, Kaiata, Taylorville, Stillwater and Coal Creek.

The following graph compares Dobson 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 13 illustrates Dobson's 2021 loading in comparison to its 66/33kV substation capacity. The 66/33kV transformer capacities are limited to 17MVA ("branch limit") by a LV and HV protection limit. Transpower plans to resolve this issue in 2025 (at a cost of NZ$0.1M), after which the branch capacity will increase to 23/24 MVA (summer/winter).

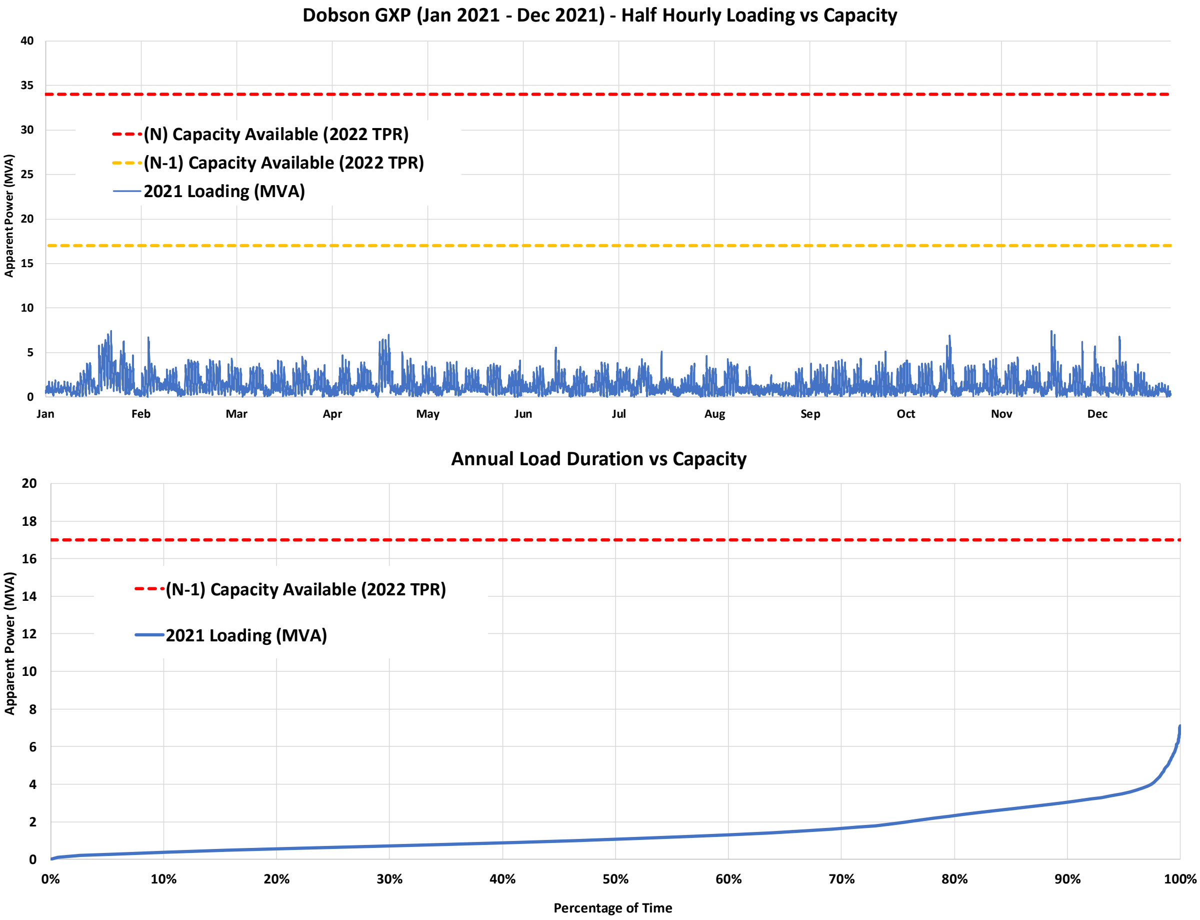


Figure 13 Dobson GXP: 2021 Loading: Available capacity

6.1.2 Greymouth GXP

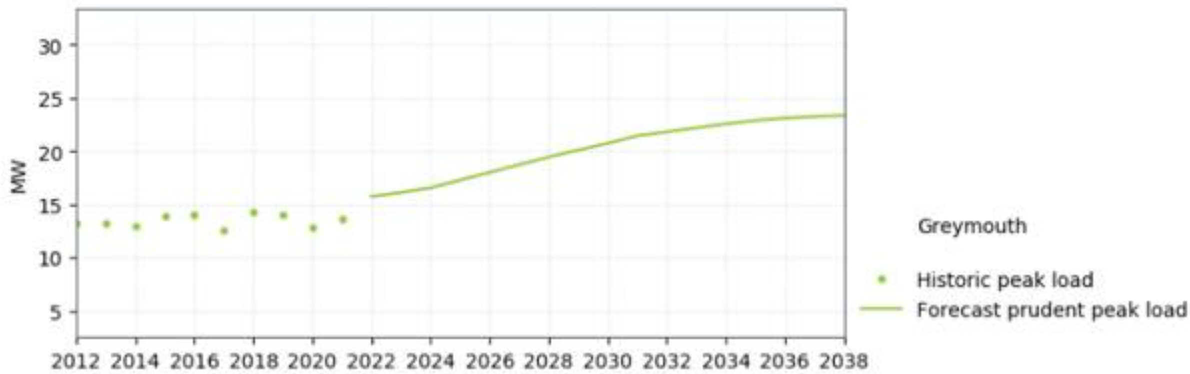
Transpower's demand forecast (refer Table 3) indicates that the Greymouth GXP is expected to have a 2022 peak demand of 16MW at 0.99pf. This contrasts with the historical SCADA data that indicates that, in 2021 the Greymouth GXP experienced a peak load of 13.8MVA (refer to Figure 14).

The Greymouth GXP supplies the town of Greymouth and the satellite townships of Cobden and Blaketown, as well as South Beach, Rutherglen and Paroa to the south. The load is mainly domestic, commercial and light industrial. The GXP supplies (via seven 11 kV feeders) the largest domestic load on the West Coast, as well as significant industrial loads such as engineering, fishing and timber milling.

Pertinent details of the GXP include:

- Westpower owns the 2 x 15 MVA, 66/11kV supply transformers at Greymouth GXP.
- Greymouth substation is connected by two transmission circuits:
    - 66 kV Dobson – Greymouth circuit rated at 36/33/30 MVA.
    - 66 kV Greymouth – Kumara circuit rated at 34/32/39 MVA.
- This information indicates that Dobson capacity is limited by the Westpower owned supply transformers.
- The (N) limit is 30 MVA while (N-1) limit is 15 MVA.

The following graph compares Greymouth GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR). As Transpower does not own the GXP, there are no (N) or (N-1) capacities shown on the graph.



The following Figure 14 illustrates Greymouth's 2021 loading in comparison to its substation capacity and the incoming 66kV lines. Care should be taken interpreting line capacity as it does not consider upstream transmission constraints or the power supplied to other GXP substations. The electrical load on the Greymouth GXP peaks during the winter.

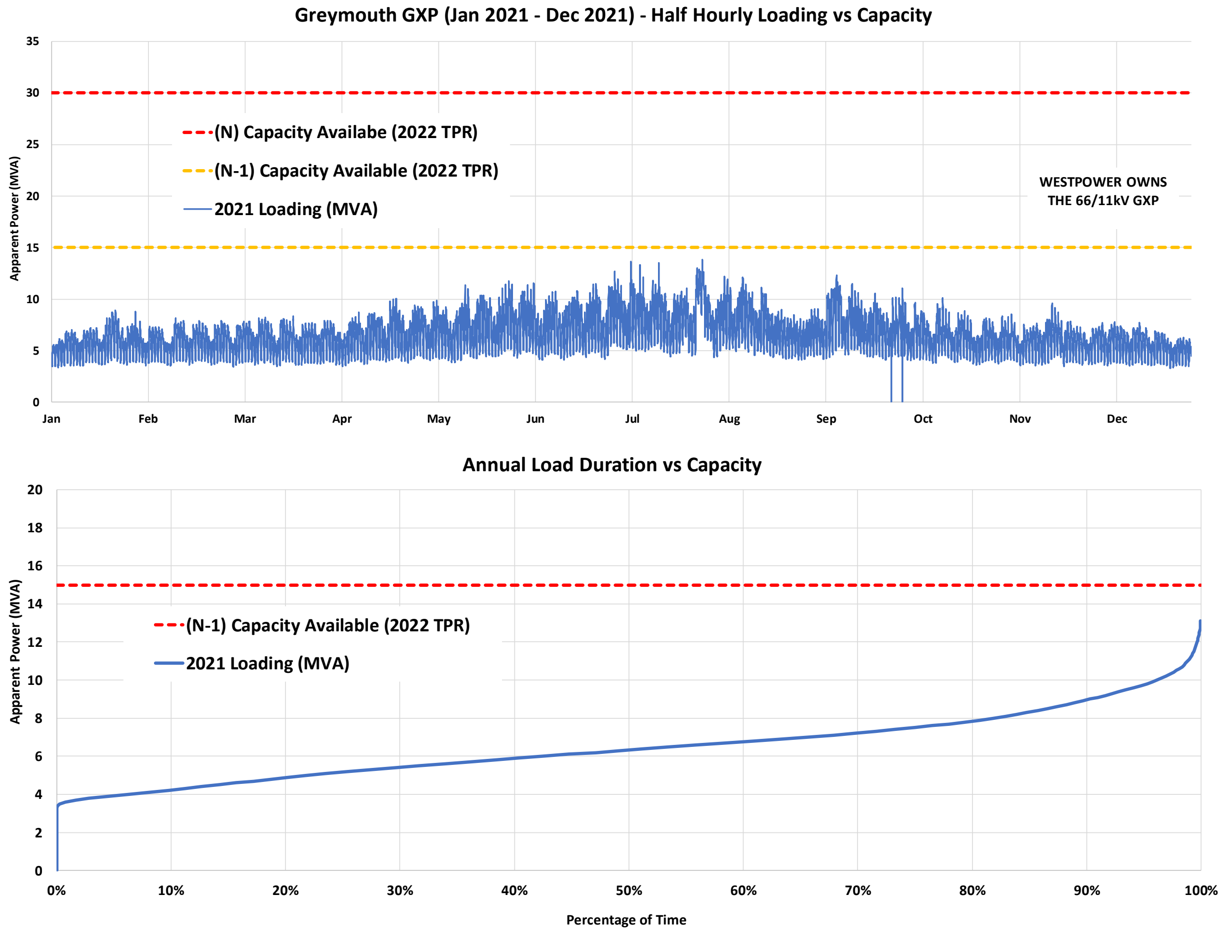


Figure 14 Greymouth GXP: 2021 Loading: Available capacity

6.1.3 Hokitika GXP

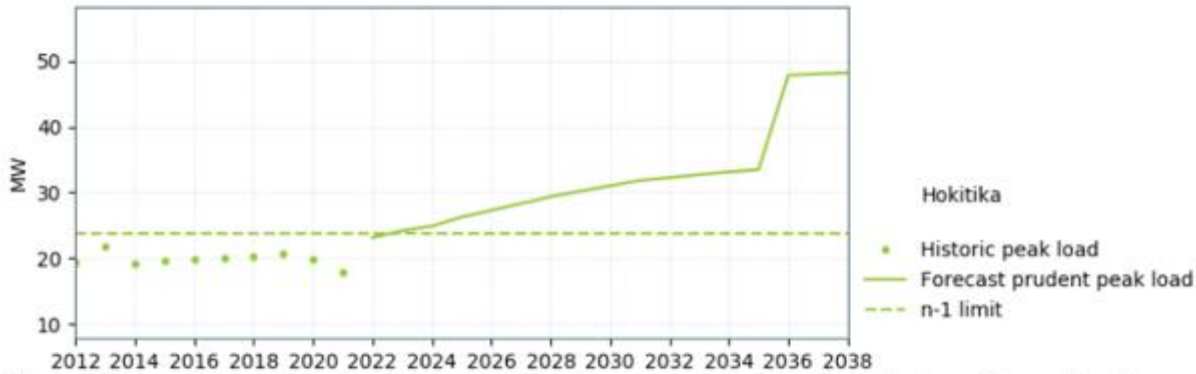
Transpower's demand forecast (refer Table 3) indicates that the Hokitika GXP is expected to have a 2022 peak demand of 23MW at 0.97pf. This contrasts with the historical SCADA data that indicates that during 2021 the Hokitika GXP experienced a peak load of 15.4MVA (refer to Figure 15).

The pertinent details of the GXP include:

- Westpower owns the 2 x 20 MVA, 66/11kV supply transformers at Hokitika GXP.
- Hokitika substation is connected by two transmission circuits:
  - 66 kV Hokitika - Otira circuit rated at 32/30/27 MVA.
  - 66 kV Hokitika – Kumara circuit rated at 32/30/27 MVA.
- This indicates that Hokitika capacity is limited by the Westpower owned supply transformers.
- (N) limit is 40 MVA while (N-1) limit is 20 MVA.

Westpower who also own/operate the local distribution network. The GXP supplies the greater Hokitika domestic load, as well as a large numbers of industrial, dairy farming and tourism-driven loads. Included in these is the Westland Milk Products factory. South of Whataroa, the load is predominantly driven by the tourist centres at Franz Josef and Fox Glaciers. This network connected to the GXP is geographically the largest in the Westpower area, supplying the South Westland area to Paringa (some 200 km away) and the flats of the Kokatahi-Kowhitirangi area. The GXP supplies ten 11 kV feeders and one 33 kV feeder that supplies South Westland.

The following graph compares Hokitika GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR). Ergo notes that the (N-1) limit shown in the graph is 24MW, which relates to the continuous incoming Transpower owned line capacity of 27MVA with a powerfactor of ≈0.9. Ergo notes that the Transformers are owned by Westpower which provides an (N-1) limit of 20MVA.



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

The following Figure 15 illustrates Hokitika GXP's 2021 loading in comparison to its substation capacity.

A wider voltage agreement at Hokitika 66 kV bus allows a post contingent operating voltage band of between 0.9 p.u. and 1.10 p.u. With high load at Hokitika and without any contribution from embedded generation, a Hokitika–Kumara 66kV line outage may cause:

- The 66kV voltage to drop below 0.9 p.u.
- The Hokitika load to exceed the voltage stability limit.
- The Hokitika–Otira 66kV circuit to exceed its n-1 capacity.

The 66 kV line from Coleridge to Kumara is predominantly strung with a copper conductor, so it cannot be thermally upgraded.

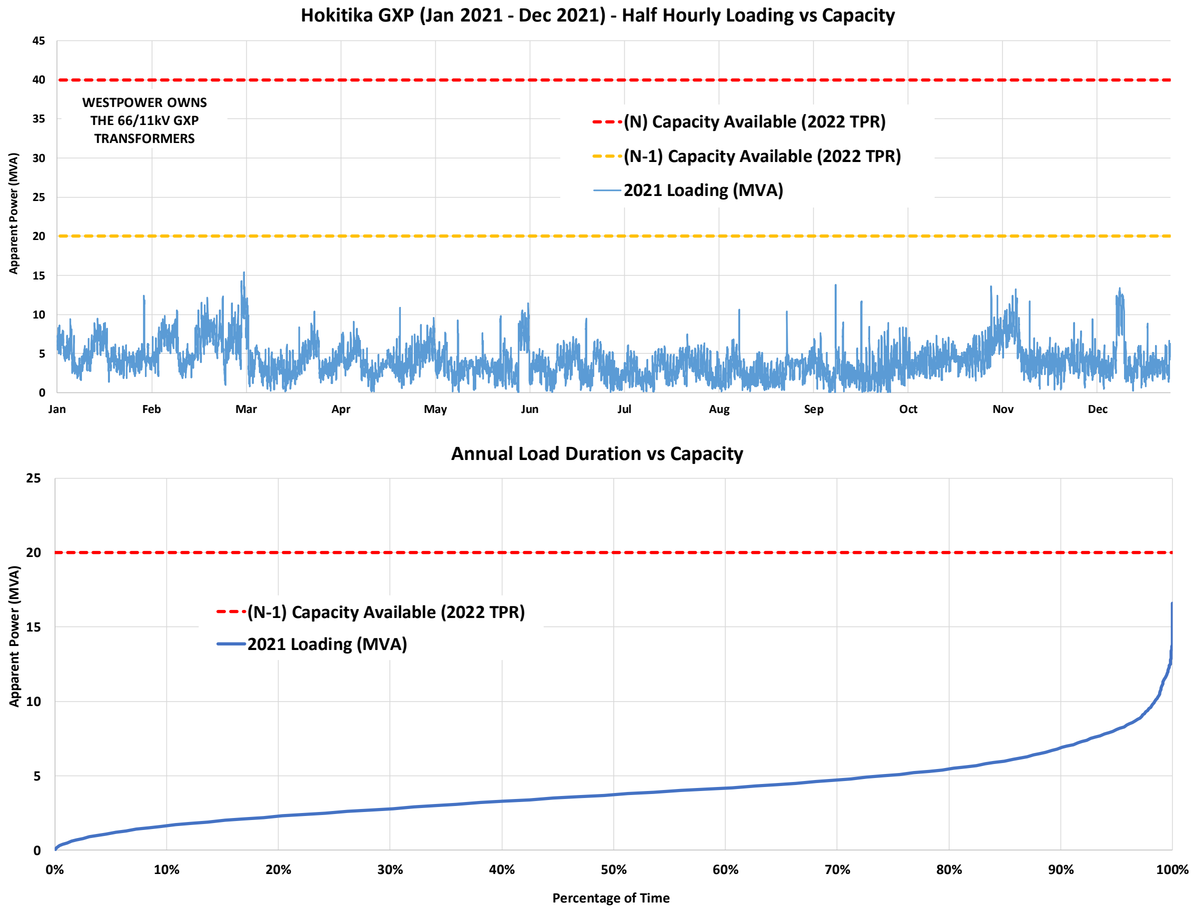


Figure 15 Hokitika GXP: 2021 Loading: Available capacity

6.1.4 Kumara GXP

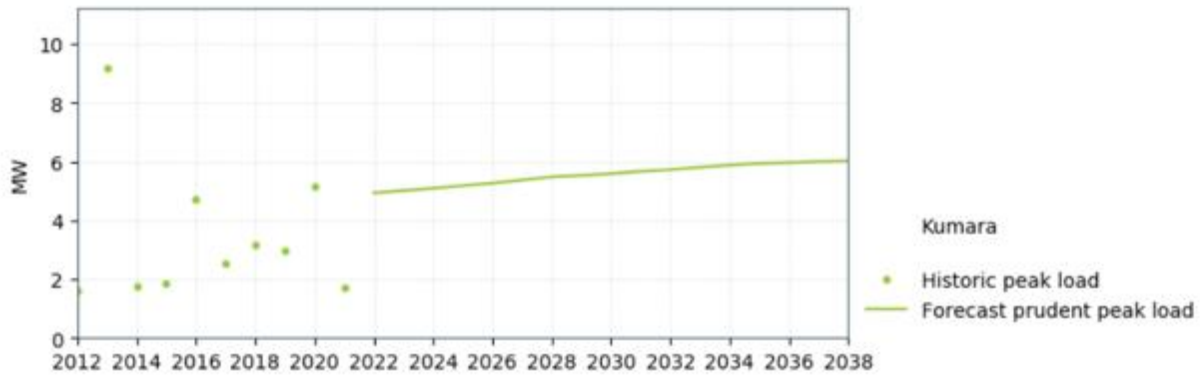
Transpower's demand forecast (refer Table 3) indicates that the Kumara GXP is expected to have a 2022 peak demand of 5MW at 0.99pf. This contrasts with the historical SCADA data that indicates that, during 2021, the Kumara GXP experienced a peak load of 10.3MVA (refer to Figure 16).

The Kumara GXP is mainly required to provide a Grid Injection Point (GIP) for Manawa Energy's 10 MW Kumara hydro scheme, but also supplies local load, via two 11 kV feeders, in the area between Gladstone in the north, Jacksons in the east and Duffers in the south. When the generation is not running, a peak demand of less than 2 MW is provided from this GXP substation. Apart from the significant generation, the load type is mainly farming and rural residential, although the IPL Plywood mill at Gladstone dominates the load.

The pertinent details of the GXP include:

- Westpower owns the single 10 MVA, 66/11kV supply transformer at Kumara GXP.
- Kumara substation is connected by three transmission circuits:
  - 66 kV Greymouth – Kumara circuit rated at 34/32/39 MVA.
  - 66 kV Kumara - Otira circuit rated at 32/30/27 MVA.
  - 66 kV Hokitika – Kumara circuit rated at 32/30/27 MVA.
- Kumara is therefore an (N) security site with a limit of 10 MVA, as there is only one connection from the Westpower distribution network to the transmission grid at Kumara.
- There is no N-1 limit.

The following graph compares Kumara GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR). The (N) capacity limit is not shown on the graph as Transpower does not own the GXP transformer.



The GXP is equipped with a single 10MVA, 66/11kV transformer that is owned by Westpower.
The following Figure 16 illustrates Kumara GXP's 2021 loading in comparison to its substation capacity. The sporadic nature of the generation is clearly evident in Figure 16. Also included is the incoming 66kV line capacity, although care should be taken interpreting line capacity as it does not consider upstream transmission constraints, load supplied to other GXPs and voltage constraints.

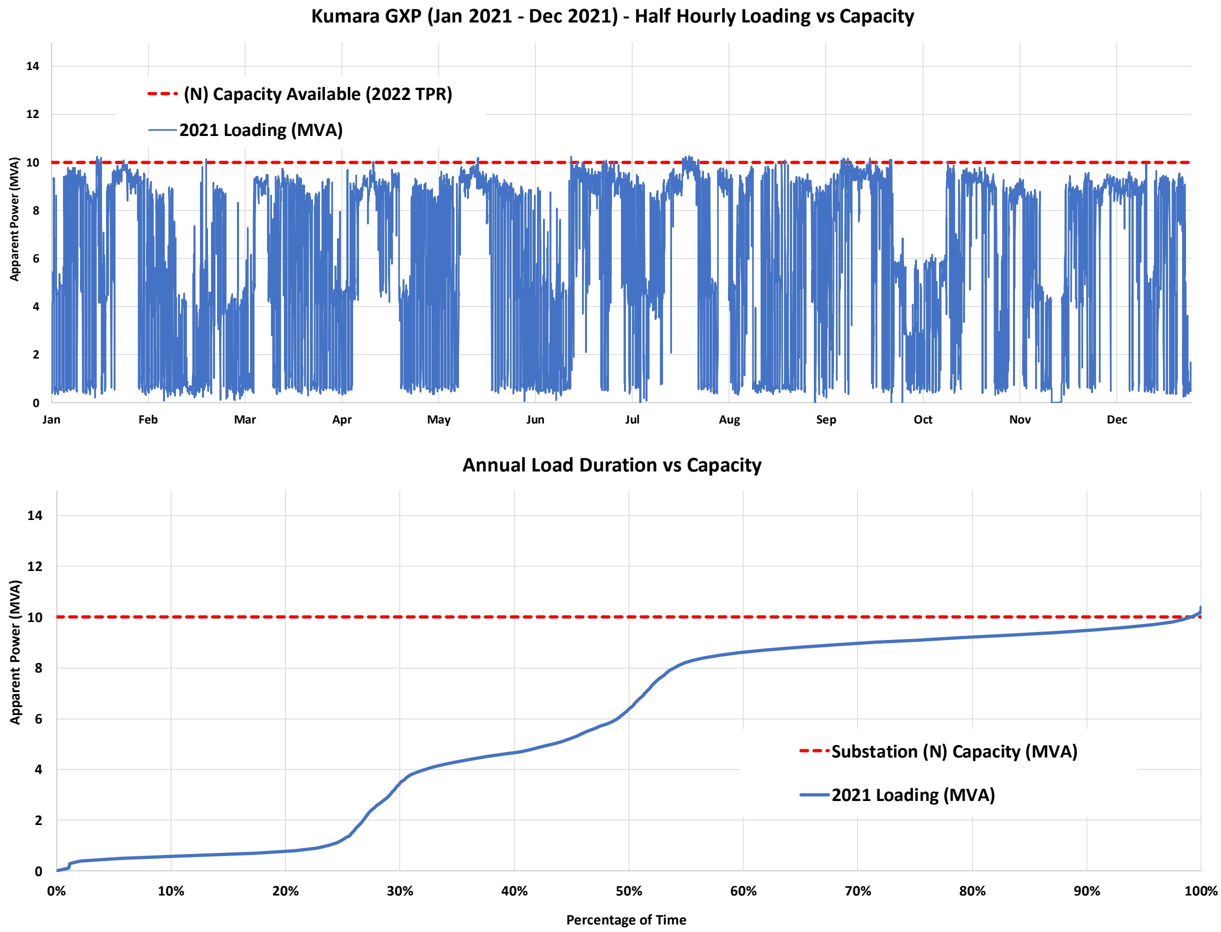


Figure 16 Kumara GXP: 2021 Loading: Available capacity

6.1.5 Otira GXP

Transpower's demand forecast (refer Table 3) indicates that the Otira GXP is expected to have a 2022 peak demand of 0.7MW at 0.77pf. This value closely resembles the historical SCADA data that indicates that during 2021 the Otira GXP experienced a peak load of 0.7MVA (refer to Figure 17).

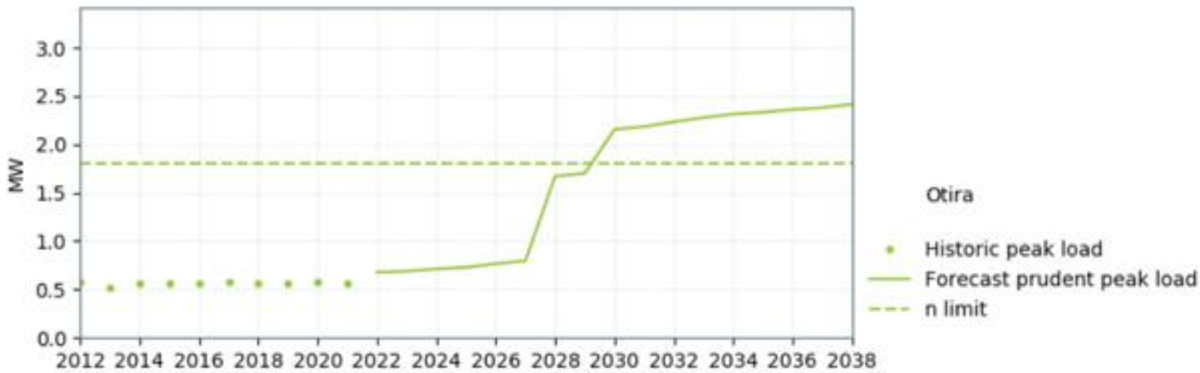
The load at Otira is totally isolated from other GXPs, and, apart from a small hotel and a few houses, most of the load consists of the fan motors for the Otira rail tunnel. This load is supplied from a single 11 kV feeder. Although the load in Otira is relatively small, the isolation of the area from other parts of the distribution network means that the Otira GXP is critical to the supply of the area. This includes a critical tunnel load that supports the coal export trade from West Coast coal operations and Westland Milk Product's operations, with no alternative source being available.

The pertinent details of the GXP include:

- Transpower owns the single 2.5 MVA, 66/11kV supply transformer at Otira GXP.
- Otira substation is connected by four transmission circuits:
  - 66 kV Kumara - Otira circuit rated at 32/30/27 MVA.
  - 66 kV Hokitika – Otira circuit rated at 32/30/27 MVA.
  - 66 kV Arthur's Pass – Otira circuit rated at 32/30/27 MVA.
  - 66 kV Coleridge – Otira circuit rated at 32/30/27 MVA.
- Otira is therefore an (N) security site with a limit of 2.5 MVA, as there is only one connection from Westpower distribution network to the transmission grid at Kumara.
- There is no N-1 limit.

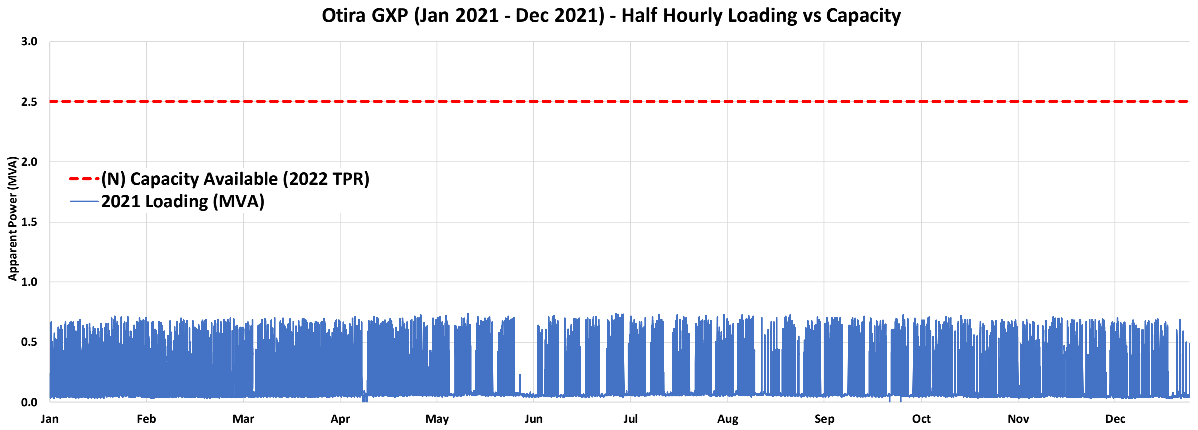
The peak load on the substation is forecast to exceed the transformer capacity around 2030.

The following graph compares Otira 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 17 illustrates the Otari GXP's 2021 loading in comparison to its substation capacity.



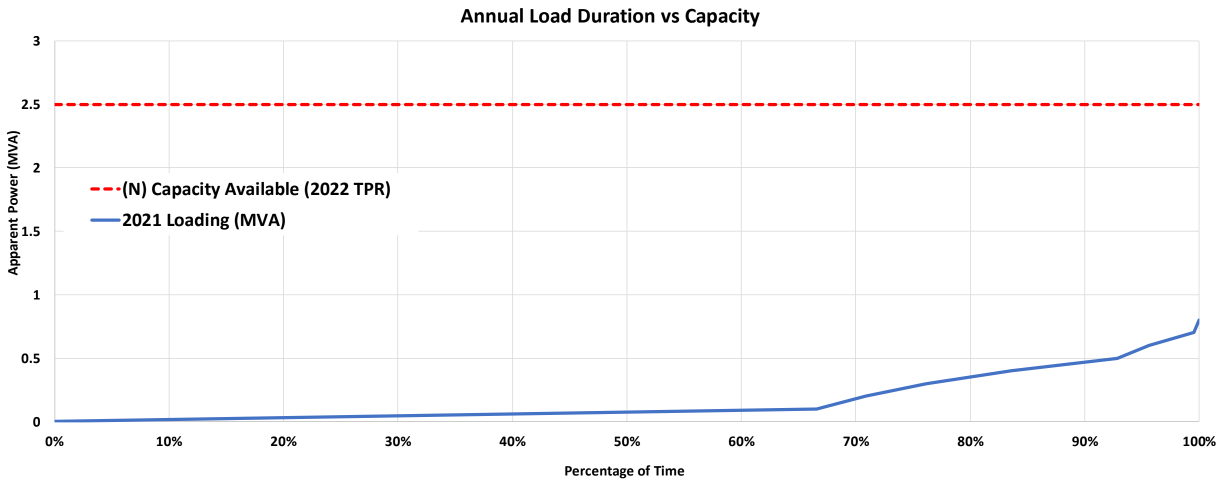


Figure 17 Otira GXP: 2021 Loading: Available capacity

6.1.6 Reefton GXP

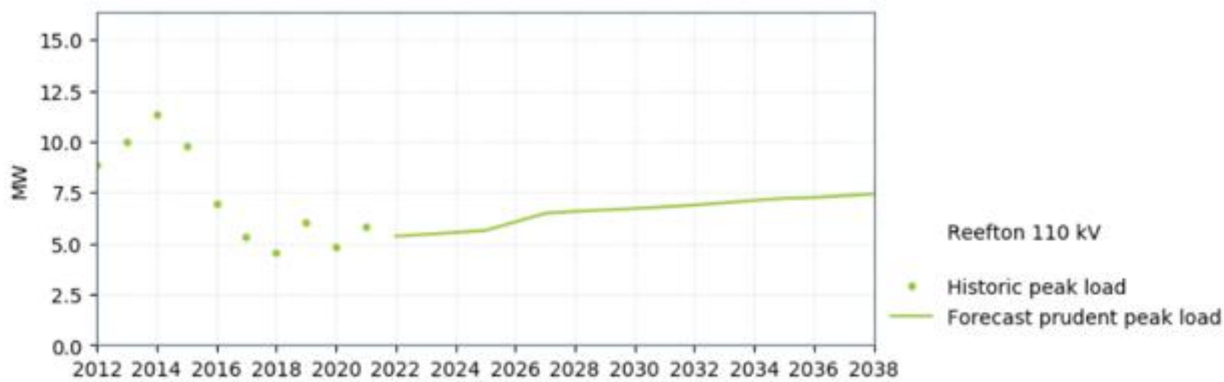
Transpower's demand forecast (refer Table 3) indicates that the Reefton GXP is expected to have a 2022 peak demand of 5MW at 0.97pf. This aligns well with the historical SCADA data that indicates that during 2021 the Reefton GXP experienced a peak load of 5.8MVA (excluding temporary back-feed events).

The pertinent details of the GXP include:

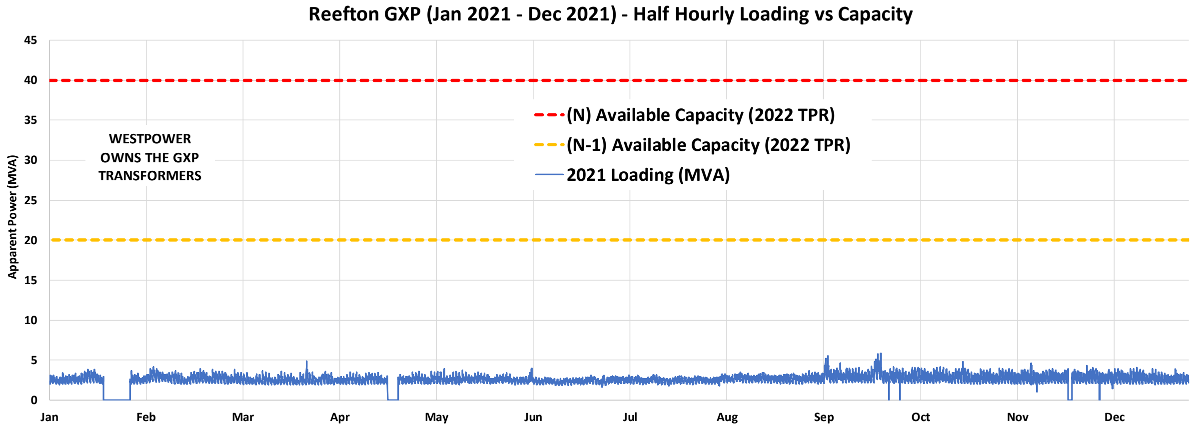
- Westpower owns and operates the 2 x 20/20/20MVA, 110/33/11kV supply transformers at Reefton GXP.
- Reefton substation is connected by two teed circuits:
  - 110 kV Reefton tee off Atarau to Inangahua circuit rated at 29/29/29 MVA.
  - 110 kV Reefton tee off Dobson to Inangahua circuit rated at 29/29/29 MVA.
- This information indicates that the Reefton capacity is limited by the Westpower owned supply transformers.
- (N) limit is 40 MVA while (N-1) limit is 20 MVA.

The GXP provides supply to two 11 kV feeders that, in turn, supply consumers between Lyell and Berlins in the north, and Blackwater to the south. The load is characterised mainly by dairy farming and domestic load, although there is some mining and commercial load in the town of Reefton. The Reefton GXP also provides supply, at 33kV, to Westpower's Blackwater zone substation which is to the south.

The following graph compares Reefton GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR). Capacity limits are not shown on the graph as Transpower does not own the GXP transformers.



The following Figure 18 illustrates Reefton's historical 2021 loading in comparison to its substation capacity. 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 GXP loads, and does not consider voltage constraints or upstream transmission constraints.



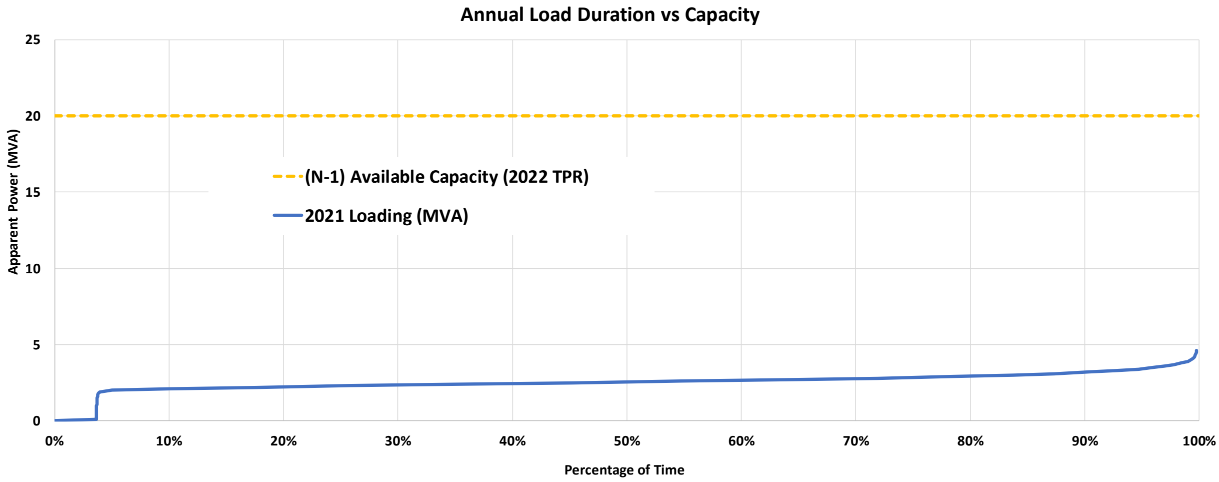


Figure 18 Reefton GXP: 2021 Loading: Substation capacity: Incoming 110kV line capacity

6.1.7 Robertson Street GXP (Orowaiti)

Transpower's demand forecast (refer Table 3) indicates that the Robertson Street GXP is expected to have a 2022 peak demand of 13MW at unity power factor. This contrasts with the historical SCADA data that indicates that during 2021 the Robertson Street GXP experienced a peak load of 10.7MVA (refer to Figure 19).

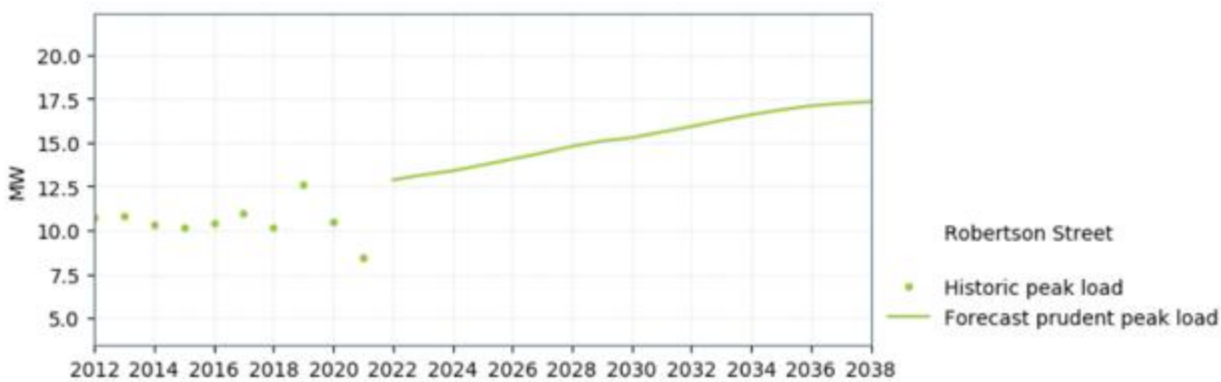
The pertinent details of the GXP include:

- Buller Electricity owns and operates the 2 x 40/20/20MVA, 110/33/11kV supply transformers at Robertson Street GXP.
- Robertson Street substation is connected by two teed circuits at Orowaiti:
    - 110 kV Orowaiti tee off Inangahua to Westport 1 circuit rated at 29/29/29 MVA.
    - 110 kV Orowaiti tee off Inangahua to Westport 2 circuit rated at 29/29/29 MVA.
- The teed circuits are constrained by protection limits.
- With this information we can see that Robertson Street capacity is limited by the teed circuits its connected too and their associated protection limits.
- (N) limit is 58 MVA while (N-1) limit is 29 MVA.

Buller Electricity owns/operates the local distribution network.

The GXP supplies the city of Westport that includes commercial, light industrial and domestic consumers. It also supplies an open cast coal mine at Stockton mine, fish processing plant (Talleys Fisheries) and rural farms in the Charles to Karamea regions (mainly dairy).

The following graph compares Robertson St GXP's supply capacity with the historical loading and Transpower's demand forecast (sourced from Transpower's 2022 TPR). Capacity limits are not shown on the graph as Transpower does not own the GXP transformers.



The following Figure 19 illustrates Robertson Street GXP's 2021 loading in comparison to its substation capacity. 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 GXP loads, and does not consider voltage constraints or upstream transmission constraints.

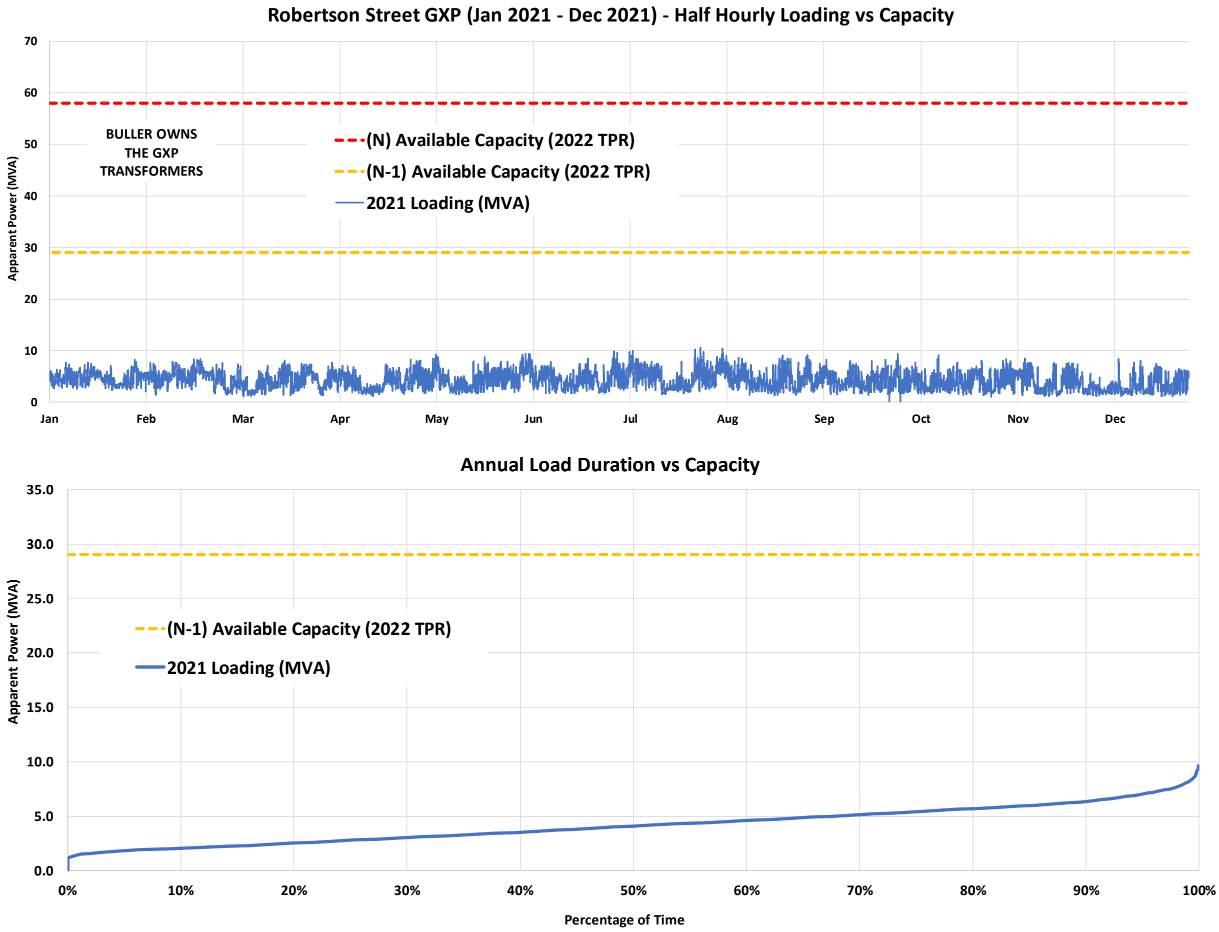


Figure 19 Robertson Street GXP: 2021 Loading: Substation capacity: 110kV line capacity

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

The following Figure 20 summarises the approximate, all year, (N-1) and (N) spare capacities at each GXP based on:

- The substation capacity disclosed in Transpower's 2022 Transmission Planning Report or disclosed in the asset management plan of the relevant EDB.
- The 2022 forecast load provided in Transpower's 2022 Transmission Planning Report (refer to Table 3).

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. Also, note that some of the GXP substations are owned (or partly owned) by the local EDBs Westpower and Buller.

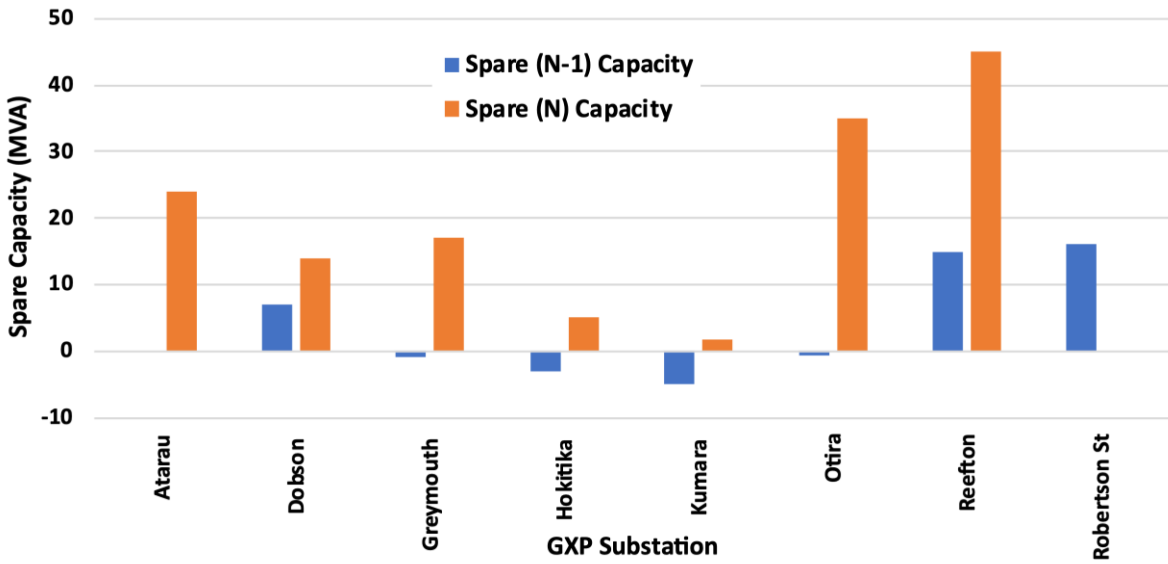


Figure 20 - Summary: GXP Spare Capacity based on Transpower's 2022 Load Forecast

It should be noted that the capacities have been calculated based on the transformer bay ratings disclosed by Transpower and information in the EDB asset management plans. Also, the spare capacities do not include any voltage constraints or upstream transmission constraints, which would need to be confirmed by Transpower or the relevant EDB. We note the following:

- Figure 20 infers that there are relatively high levels of spare capacity at Dobson, Reefton and Robertson Street, but we note that these values do not consider the transmission line capacity and voltage constraints.

7. Spare Capacity – Zone Substations

In determining the (N) and (N-1) spare capacities for the zone substation, Ergo reviewed the EDB 2022 disclosure data. Westpower did not provide historical loading data to Ergo, thus we have not determined the spare capacities based on historical data.

7.1 Westpower

Table 4 Westpower: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity (MVA)		Spare (N-1) Capacity (MVA)	
		Disclosure Data	Historical Data	Disclosure Data[18]	Historical Data
1	Arnold	3.25	TBC	-3.0	TBC
2	Blackwater	3.00	TBC	-2.0	TBC
3	Dobson	3.00	TBC	-2.0	TBC
4	Fox Glacier	4.00	TBC	-1.0	TBC
5	Franz Josef	4.00	TBC	-1.0	TBC
6	Greymouth	16.00	TBC	1.0	TBC
7	Harihari	0.00	TBC	-1.0	TBC
8	Hokitika	27.00	TBC	7.0	TBC
9	Kumara	0.00	TBC	-10.0	TBC
10	Logburn	29.00	TBC	-1.0	TBC
11	Ngahere	3.25	TBC	-3.0	TBC
12	Otira	1.50	TBC	-1.0	TBC
13	Rapahoe	3.00	TBC	-2.0	TBC
14	Reefton	24.00	TBC	9	TBC
15	Ross	0.00	TBC	-1.0	TBC
16	Wahapo	3.00	TBC	-3.0	TBC
17	Waitaha	1.00	TBC	0.0	TBC
18	Whataroa	0.00	TBC	-1.0	TBC

[18] 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 Buller Electricity

Table 5 Buller Electricity: Spare capacity for each Zone Substation

No.	Substation Name	Spare (N) Capacity		Spare (N-1) Capacity	
		Disclosure Data	Historical Data	Disclosure Data	Historical Data
1	Robertson Street	29.00	32.7	9.0	12.7
2	Ngakawau	3.00	2.8	1.0	0.8
3	Kongahu	0.50	0.3	-1.0	-1.2

7.3 Summary

7.3.1 Westpower

7.3.1.1 (N-1) Capacity Summary

The following Figure 21 illustrates the approximate (N-1) spare capacities at Westpower's zone substations, for the disclosed 2021 peak demand estimates[19]. It should be noted that these have been calculated based on the transformer ratings disclosed by Westpower.

The spare capacities shown do not include any upstream or downstream lines, cables or other equipment thermal constraints.

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.

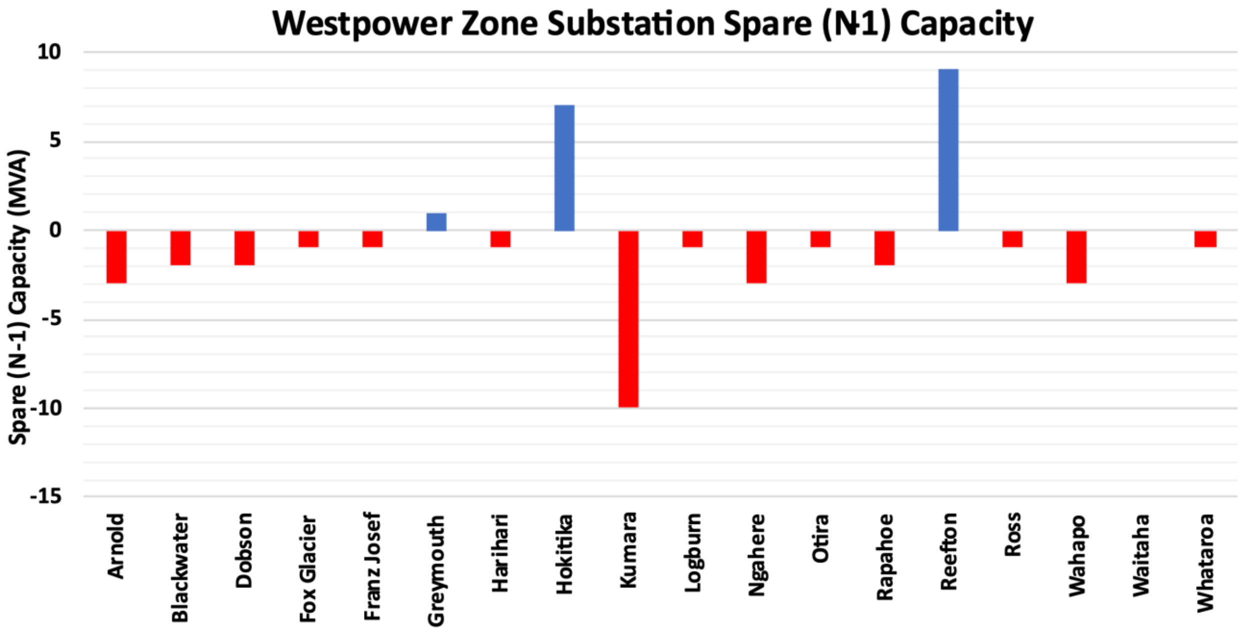


Figure 21 Summary: Approximate (N-1) spare capacity at Westpower's zone substations

7.3.1.2 (N) Capacity Summary

The following Figure 22 illustrates the approximate (N) spare capacities at Westpower's zone substations, for the disclosed peak demand estimates. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Westpower.

The spare capacities shown do not include any upstream or downstream conductor or other equipment thermal constraints.

[19] Westpower's 2022 information disclosure (https://www.westpower.co.nz/information-disclosures).

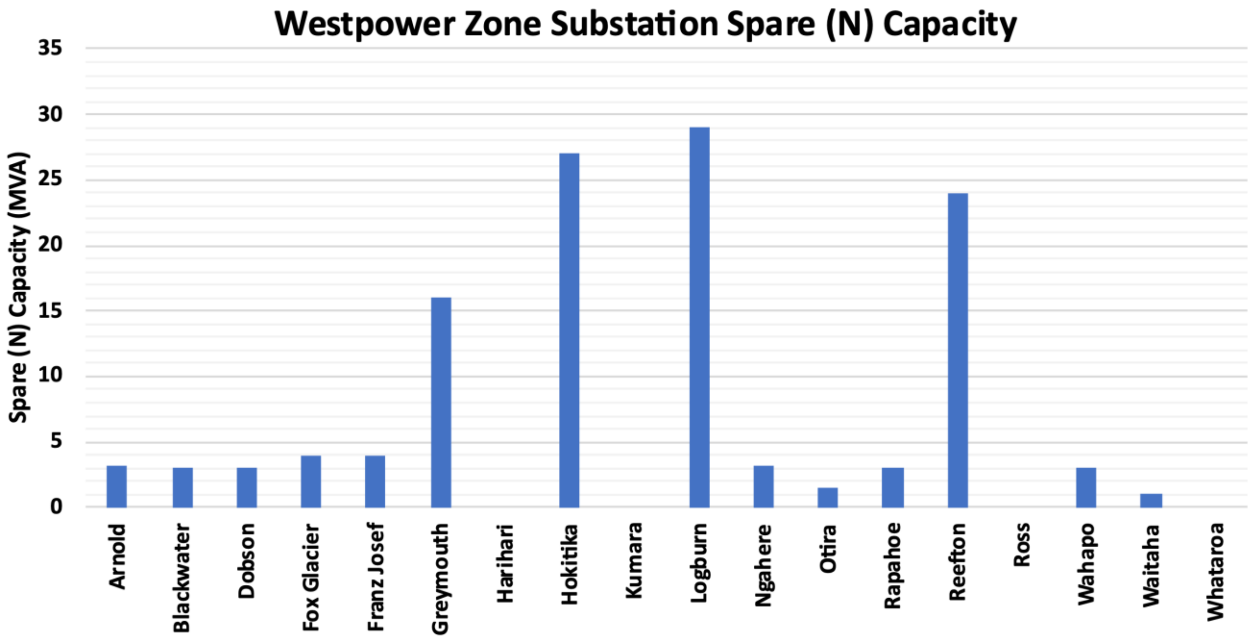


Figure 22 Summary: Approximate (N) spare capacity at Westpower's zone substations

7.3.2 Buller Electricity

7.3.2.1 (N-1) Capacity Summary

The following Figure 23 illustrates the approximate (N-1) spare capacities at Buller Electricity'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 Buller Electricity.

The spare capacities shown do not include any upstream or downstream conductor or other equipment thermal constraints.

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.

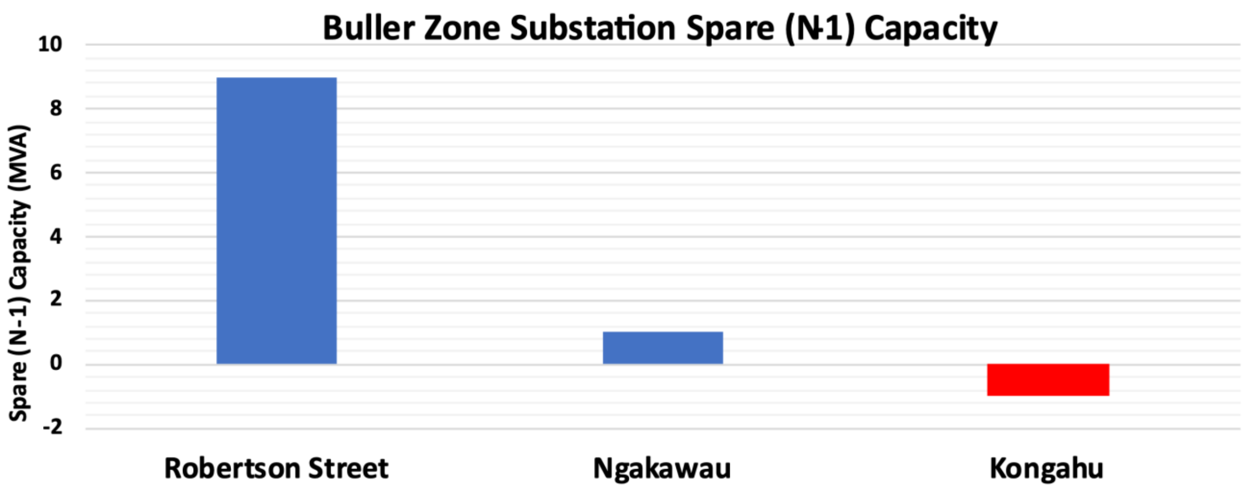


Figure 23 Summary: Approximate (N-1) spare capacity at Buller Electricity's zone substations

7.3.2.2 (N) Capacity Summary

The following Figure 24 illustrates the approximate (N) spare capacities at Buller Electricity's zone substations, for the disclosed peak demand estimates[20]. Again, it should be noted that these have been calculated based on the transformer ratings disclosed by Buller Electricity.

The spare capacities shown do not include any upstream or downstream lines, cables or other equipment thermal constraints.

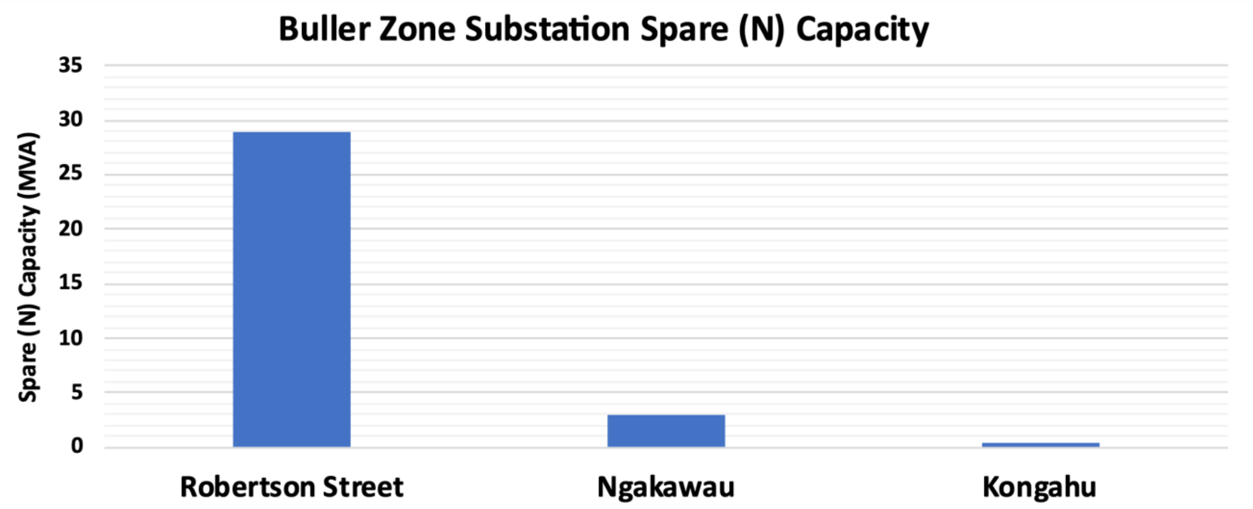


Figure 24 Summary: Approximate (N) spare capacity at Buller Electricity's zone substations

[20] Buller Electricity's 2022 information disclosure (https://bullerelectricity.co.nz/information-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 Westpower and Buller Electricity zone substations (shaded yellow in diagrams).

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 Westpower / Buller Electricity. This would likely entail powerflow modelling, optioneering and concept designs to provide more refined cost estimates.

8.1 Assessment Methodology

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

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

The spare capacity across each asset type has been determined using the information 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, Westpower and Buller Electricity). 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 green, yellow and blue shaded titles above each cost estimate are intended to indicate the security-of-supply that the cost estimate would deliver. For example:

Transmission =>	**(N-1)**	**Subtransmission =>**	**(N)**	**Distribution =>**	**(N)**

- The upgrades and costs of individual Load Sites are considered in isolation of the adjacent Load Sites. We have not considered the scope and costs associated with connecting multiple Load Sites at this stage.
- The Load Site loads will have unity power factor which is reasonable considering the preliminary nature of the assessment.
- Unless otherwise stated, we have assumed the existing incoming sub-transmission line/cable capacities exceed the capacity of the existing zone substation(s) they supply.
- Unless capacity information is available, we assumed existing 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.
- 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.
- Cost estimates have a Class 5[21] 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 sites are not included).

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

8.3 Dobson GXP

The EECA Load Sites include:

- ANZCO Kokiri (1.85 MW)
- Runanga School (0.05 MW)
- Value Proteins (13.3 MW)
- SPP Stillwater (no load provided so connection options not considered)
- Westimber (0.28 MW)

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

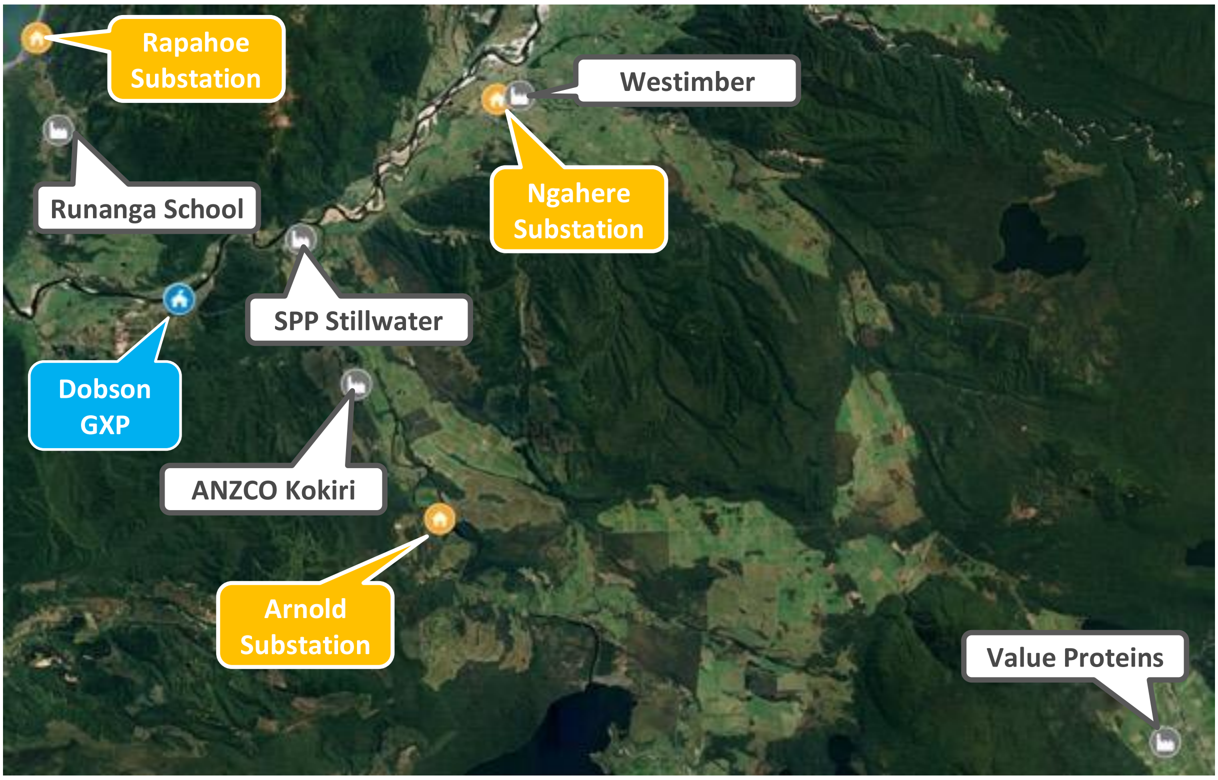


Figure 25 Dobson GXP: EECA Load Sites vs local substations

8.3.1 Dobson GXP Upgrade

Based on Transpower's demand forecast the Dobson GXP has ≈10MVA of (N-1) spare capacity and ≈30MVA of (N) spare capacity.[22] As shown in Section 8.3.6, the combined load requirements of the Load Sites in the Dobson region would increase the maximum load at Dobson to 20.9 MVA for short periods. The planned protection limit upgrade for the Dobson GXP transformers will bring the (N-1) rating up to 20 MVA continuously, with summer/winter 24-hr ratings of 23/24MVA as discussed in Section 6.1.1.

Once the protection upgrades are complete (presently scheduled for a grid need date of 2025, at a cost of $0.1M), Ergo expects that the (N-1) capacity of the GXP will be sufficient to supply the proposed Load Sites. The peaks to 20.9 MVA are considered short and infrequent enough that they will not present

[22] If the supply from the embedded generator (Arnold) can be relied upon the spare capacity is larger.

overload issues, particularly considering the ample (N) capacity at the GXP combined with the increased 24-hr (N-1) capacity.

8.3.2 ANZCO Kokiri

ANZCO KOKIRI		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler and high temperature heat pump	1.85	Dobson
Existing Electrical Supply to the Plant		
The ANZCO Kokiri plant is supplied from Westpower's Arnold zone substation (refer to Figure 26 below) via the Arnold 3 feeder. The plant is ≈5.54 km from the substation.		

Figure 26 ANZCO Kokiri geographic location in relation to the Arnold substation

Supply Option(s) for New Load
Dobson GXP has ample (N-1) capacity for this additional load, as discussed in Section 8.3.1. The Arnold zone substation presently has 3.25 MVA of spare (N) capacity. The Arnold zone substation is supplied via one 33 kV line from the Dobson GXP which likely does have capacity for the additional load given its existing load of ≈3 MVA. The 11kV feeder from the zone substation to the plant has a variety of overhead conductors, including Iodine, Mink, Ferret, and Mullet. We expect the supply of 1.85 MW of new load to require the following:

- Reconductoring of the ~0.2 km of Mullet conductor on the 11 kV feeder

The security-of-supply to the site would be (N-1) for the transmission system (Dobson GXP), while the subtransmission and distribution systems have (N) security. The subtransmission and distribution systems could be afforded with (N-1) security with the installation of a second 33 kV line from Dobson to Arnold, and a second transformer at Arnold.

Capital Cost Estimate

Table 6 ANZCO Kokiri: Capital cost estimate to supply the Load Site

Transmission => (N-1)	Subtransmission => (N)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Reconductor 11kV line (larger)	0.20	$0.03
		TOTAL	**$0.03**

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

Timeframe to Establish New Electrical Infrastructure

Estimated to take 6 - 12 months.

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

Excludes the work required to establish the Load Site.

Excludes consenting and land acquisition, if required.

8.3.3 Runanga School

RUNANGA SCHOOL		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.05	Dobson

Existing Electrical Supply to the Plant

Runanga school is supplied from Westpower's Rapahoe zone substation (refer to Figure 27 below) via the Rapahoe 3 feeder. The school is ≈3.3 km from the substation.

Figure 27 Runanga school geographic location in relation to the Rapahoe substation

Supply Option(s) for New Load

Dobson GXP has ample (N-1) capacity for this additional load, as discussed in Section 8.3.1. The Rapahoe zone substation presently has 3 MVA of spare (N) capacity. The substation is supplied via one 14 km 33 kV line (Dog conductor double circuit) from the Dobson GXP, which has capacity for the additional load.

The feeder from the zone substation to the school has a variety of overhead and underground conductors, including Iodine, Ferret, 19/.064" Cu, and 150 mm^2 Al.

We expect that there would be no network upgrades required for connection of this additional load.

The security-of-supply to the site would be (N-1) for the transmission system (Dobson GXP), while the subtransmission and distribution systems have (N) security. The subtransmission and distribution systems could be afforded with (N-1) security with the installation of a second 33 kV line from Dobson to Rapahoe, and a second transformer at Rapahoe.

RUNANGA SCHOOL
Capital Cost Estimate
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$40k.
Timeframe to Establish New Electrical Infrastructure
Expected 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 and land acquisition, if required.

8.3.4 Value Proteins

		VALUE PROTEINS
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electric boiler and high temperature heat pump	13.3	Dobson
Existing Electrical Supply to the Plant		
Value Proteins is supplied from Westpower's Arnold zone substation (refer to Figure 28 below) via the Arnold 4 feeder. The plant is ≈26.4 km from the substation.  Figure 28 Value Proteins geographic location in relation to the Arnold substation		
Supply Option(s) for New Load		
Dobson GXP has spare (N-1) capacity for this additional load, as discussed in Section 8.3.1. The Arnold zone substation presently has 3.25 MVA of spare (N) capacity. The Arnold zone substation is supplied via one 33 kV line from the Dobson GXP which likely does not have capacity for the additional load given its existing load of ≈3 MVA - the existing line between Dobson GXP and Arnold Zone Substation was installed in the 1930's and is 7/0.80" copper. The feeder from the zone substation to the plant has a variety of overhead conductors, including Mullet, Squirrel, Iodine, Ferret, and Mink. With the size of the proposed installation, it is expected that the volt-drop over the line/s supplying the site at 11 kV would be too great even with voltage support at the site. As such, it is expected that a new transformer and 11 kV switchboard at/near the site would be required. Additionally, voltage support would be required at the site, in the form of a 33 kV capacitor bank. We expect the supply of 13.3 MW of new load to require the following: • Installation of a 33 kV line between Arnold Zone Substation and the site, approximately 37 km, with 33 kV circuit breakers required at Arnold ZS and at the site. • Reconductoring of the existing 33 kV line between Dobson GXP and Arnold Zone Substation, approximately 17 km. • Installation of a 33kV capacitor bank at the site. • Installation of a 33/11 kV transformer at the site, with accompanying 11 kV switchboard.		

VALUE PROTEINS

The security-of-supply to the site would be (N-1) for the transmission system (Dobson GXP), while the subtransmission and distribution systems have (N) security. The subtransmission and distribution systems could be afforded with (N-1) security with the installation of a second 33 kV line from Dobson to Arnold, and a second 33 kV line from Arnold to the Load Site.

Capital Cost Estimate

Table 7 Value Proteins: Capital cost estimate to supply the Load Site

Transmission => (N-1)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Subtransmission	Reconductor single overhead 33kV line	17.00	$3.19
Subtransmission	Single overhead 33kV line	37.00	$9.25
Subtransmission	33kV Capacitor Bank	1.00	$0.40
Distribution	Medium supply transformer (ZSS)	1.00	$1.00
Distribution	Small switchroom (ZSS)	1.00	$1.50
		TOTAL	**$15.34**

This does not include the costs to install 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 and land acquisition, if required.

8.3.5 Westimber

		WESTIMBER
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electric boiler and high temperature heat pump	0.28	Dobson
Existing Electrical Supply to the Plant		
Westimber is supplied from Westpower's Ngahere zone substation (refer to Figure 28 below) via the Ngahere 3 feeder. The plant is ≈0.8 km from the substation.		

Figure 29 Westimber geographic location in relation to the Ngahere substation

Supply Option(s) for New Load

Dobson GXP has ample (N-1) capacity for this additional load, as discussed in Section 8.3.1. The Ngahere zone substation presently has 3.25 MVA of spare (N) capacity. The Ngahere zone substation is supplied via one 33 kV line from the Dobson GXP which likely does not have capacity for the additional load given its existing load of ≈3 MVA - the existing line between Dobson GXP and Ngahere Zone Substation was installed in the 1930's and is 7/0.80" copper.

The feeder from the zone substation to the plant has a variety of overhead conductors and underground cable, including 7/.064 Cu, Dog, and 150 mm^2 Al.

We expect the supply of 0.28 MW of new load would not require any network upgrades.

The security-of-supply to the site would be (N-1) for the transmission system (Dobson GXP), while the subtransmission and distribution systems have (N) security. The subtransmission and distribution systems could be afforded with (N-1) security with the installation of a second 33 kV line from Dobson to Ngahere, and a second transformer at Ngahere.

WESTIMBER
Capital Cost Estimate
There is no cost expected for this installation. This does not include the costs to install 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 and land acquisition, if required.

8.3.6 Effect of all Load Sites Connecting to Dobson GXP

The following Figure 30 illustrates the Dobson 2021 load profile together with the load profiles of all the Load Sites within the Dobson GXP region. Also shown in Figure 30 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the load on the Dobson GXP would increase to 20.9 MVA, a 13.4 MVA increase. Given that the independent sum of the individual loads is 23.0 MVA there is a modest diversity factor of 0.91 between the loads.
- The Dobson GXP's present (N-1) limit of 17 MVA (discussed in Section 6.1.1) is expected to be exceeded. Once the protection limits at the GXP are resolved, the continuous (N-1) capacity of the GXP will be 20 MVA, meaning the GXPs (N-1) limit would be expected to be exceeded only marginally during April.

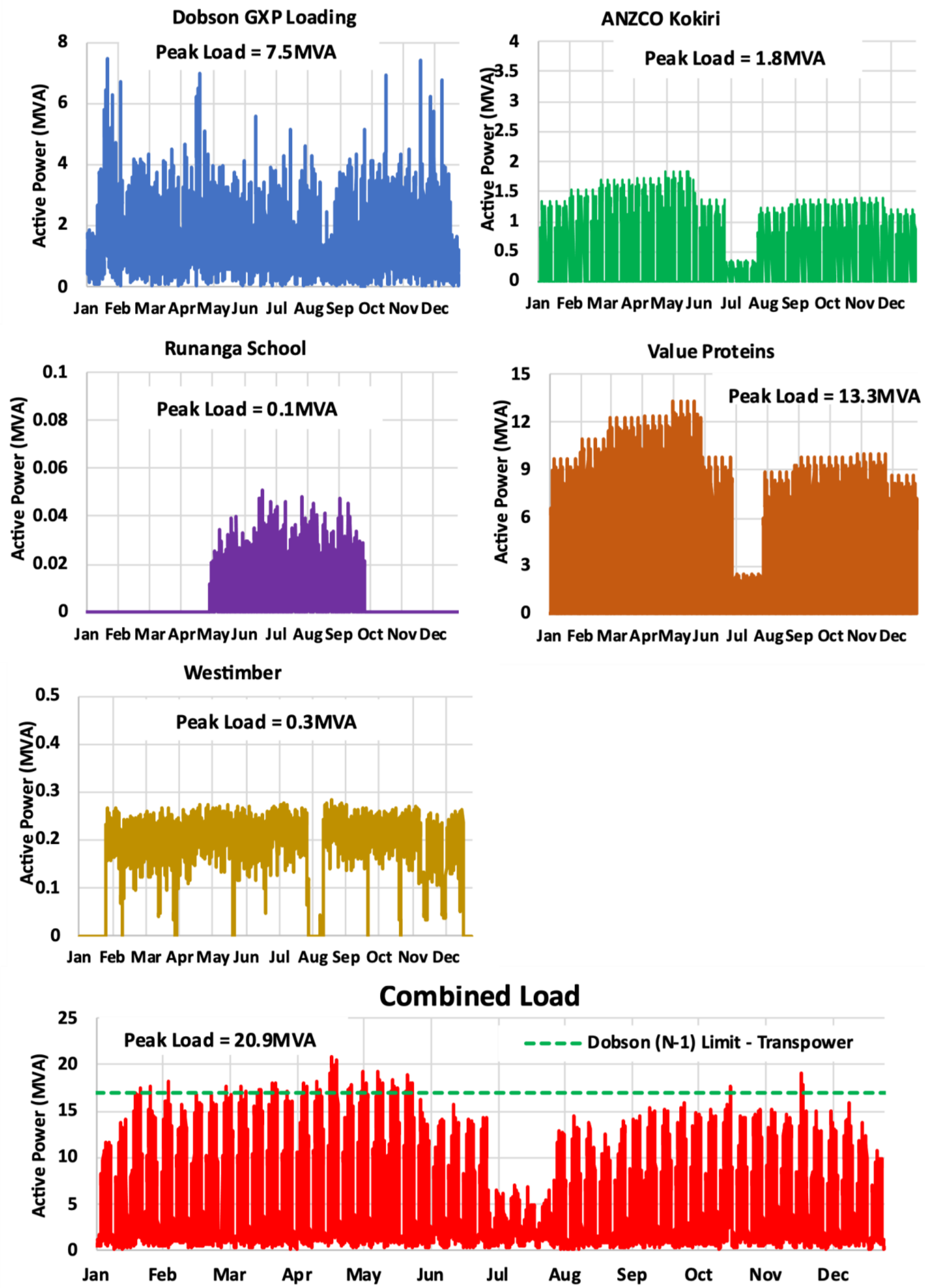


Figure 30 Loading Profiles: Dobson GXP 2021 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.4 Greymouth GXP

The EECA Load Sites include:

- Westland Recreation Centre (0.28 MW)
- Greymouth High School (0.52 MW)
- Greymouth Hospital (0.76 MW)
- Cobden School (0.03 MW)
- Grey Main School (0.12 MW)
- Scenicland Laundry (0.40 MW)

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

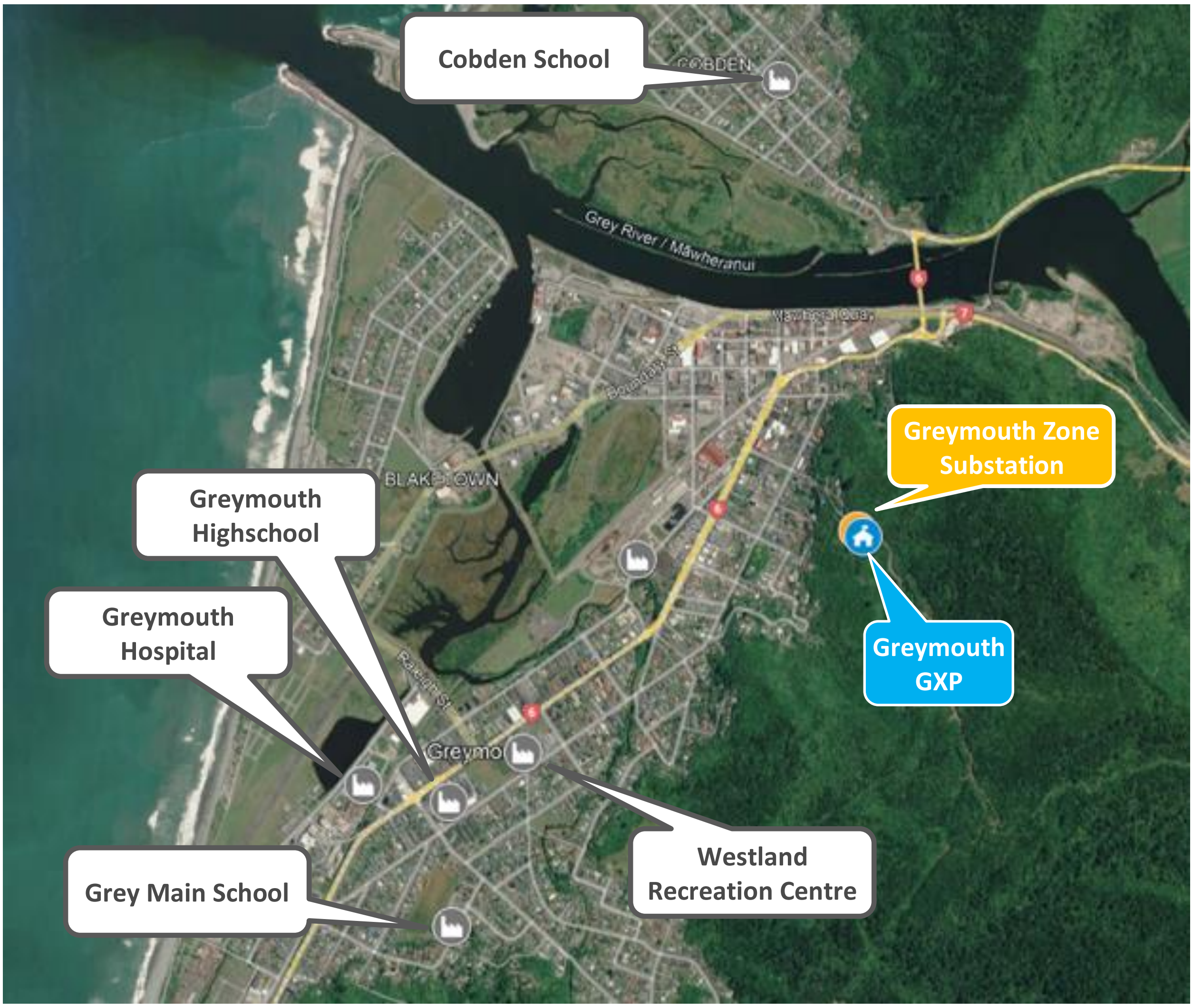


Figure 31 Greymouth GXP: EECA Load Sites vs local substations

8.4.1 Greymouth GXP Upgrade

The combined load requirements of the Load Sites (estimated new peak of 14.7MVA) in the Greymouth region are below the (N-1) capacity of the GXP and incoming lines, so upgrades at the Greymouth GXP are not considered.

8.4.2 Westland Recreation Centre

WESTLAND RECREATION CENTRE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.28	Greymouth
Existing Electrical Supply to the Plant		
Westland Recreation Centre is presently fed from Greymouth zone substation via an 11kV feeder (GYM11 – Outer Ring). GYM11 has a winter peaking load profile with peak demand ≈3.8MVA and appears to be equiped witha mix of Iodine, Neon and Weke conductors.  Figure 32 Westland Recreation Centre geographic location in relation to the surrounding zone substations		
Supply Option(s) for New Load		
Greymouth zone substation has sufficient (N-1) capacity to supply the additional load and it is likely the 11kV feeder (GYM11), based on the identified conductor types, could supply the modest load increase in load		
Capital Cost Estimate		
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$100k.		
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 and land acquisition, if required.		

8.4.3 Greymouth High School

GREYMOUTH HIGH SCHOOL		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.52	Greymouth
Existing Electrical Supply to the Plant		
Greymouth High School is presently fed from Greymouth zone substation via an 11kV feeder (GYM11. GYM11 has a winter peaking load profile with peak demand ≈3.8MVA and appears to be equiped with Iodine, Neon and Weke conductors.		

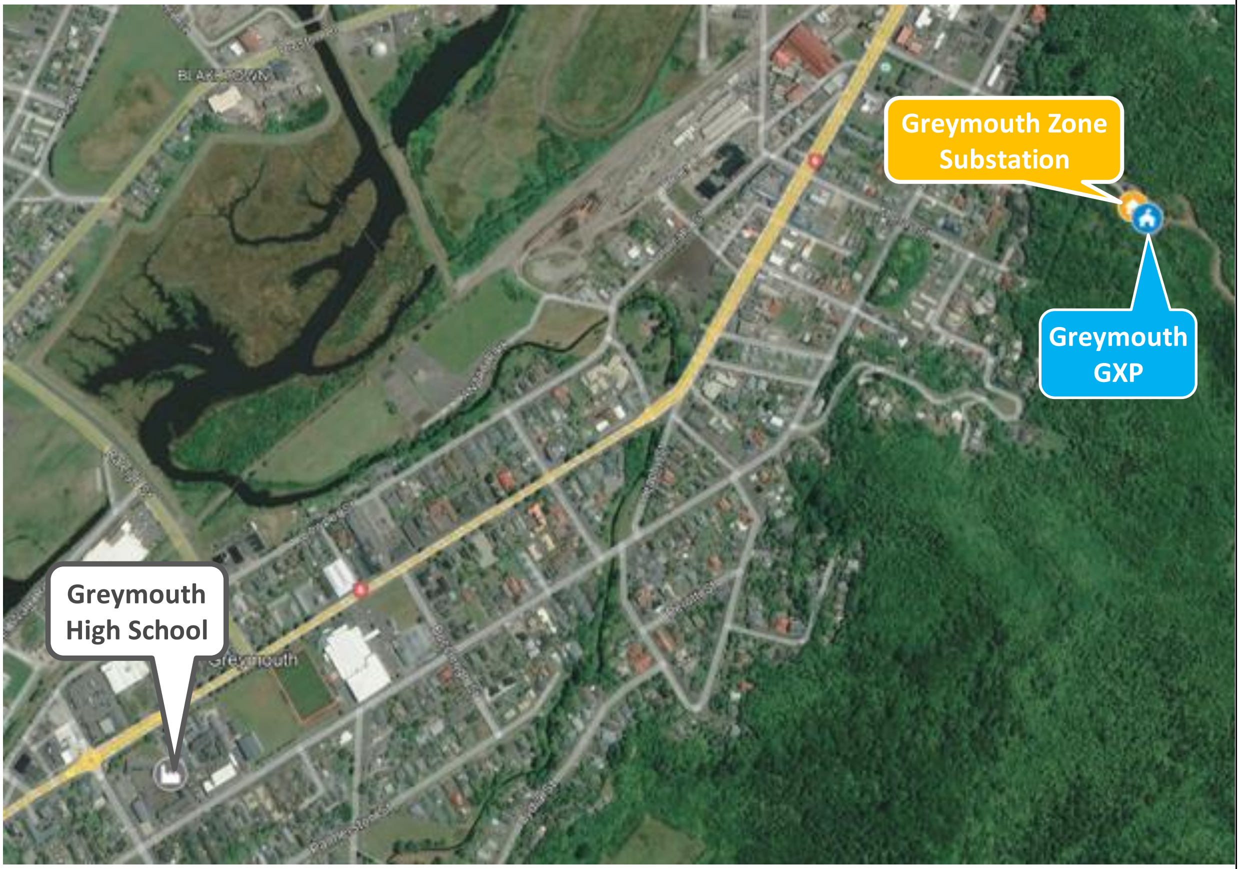


Figure 33 Greymouth High School geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load	

Greymouth zone substation has sufficient (N-1) capacity to supply the additional load. However, due to the current loading on GYM11, it is possible the additional load could overload the existing feeder.

The adjacent feeder GYM12 (Inner Ring) has a lower peak load of ≈2.3MVA and appears to consist of Iodine, Ferret and 19/0.080Cu 19/0.064Cu conductor. GYM12 is more likely able to supply the additional load.

To enable this, a new 11kV underground cable could be installed from the current open point between GYM11 and GYM12 at the intersection of Raleigh St and Cowper St. The cable would need to run a distance of ≈600m westward down Cowper St and then Southward down Marlborough St.

GREYMOUTH HIGH SCHOOL

Capital Cost Estimate

Table 8 Greymouth High School: Capital cost estimate to supply the Load Site

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	Single underground 11kV cable	0.60	$0.24
		TOTAL	**$0.29**

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

Timeframe to Establish New Electrical Infrastructure

Estimated to take 6 - 12 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.

8.4.4 Greymouth Hospital

		GREYMOUTH HOSPITAL
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.76	Greymouth
Existing Electrical Supply to the Plant		

Greymouth Hospital is presently fed from Greymouth zone substation via an 11kV feeder (GYM11) with two points of supply (one to the North and one to the South of the site). GYM11 has a winter peaking load profile with peak demand ≈3.8MVA.

Figure 34 Greymouth Hospital geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

Greymouth zone substation has sufficient (N-1) capacity to supply the additional load. However, due to the current loading on GYM11, it is likely the additional load would overload the existing 11kV feeder.

The adjacent feeder GYM12 (Inner Ring) has a lower peak load of ≈2.3MVA and appears to consist of Iodine, Ferret and 19/0.080Cu 19/0.064Cu conductor. GYM12 is more likely able to supply the additional load.

To enable this, a new 11kV underground cable could be installed from the current open point between GYM11 and GYM12 at the intersection of Raleigh St and Cowper St. The cable would need to run a distance of ≈900m southward down Raleigh St and then westward down High St.

Capital Cost Estimate

Table 9 Greymouth Hospital: Capital cost estimate to supply the Load Site

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	Single underground 11kV cable	0.90	$0.36
		TOTAL	**$0.41**

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

8.4.4.1 Cobden School

		COBDEN SCHOOL
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.03	Greymouth

Existing Electrical Supply to the Plant

Cobden School is presently fed from the 11kV feeder GYM13. The modest (30kW) connection could likely be supplied from the same feeder.

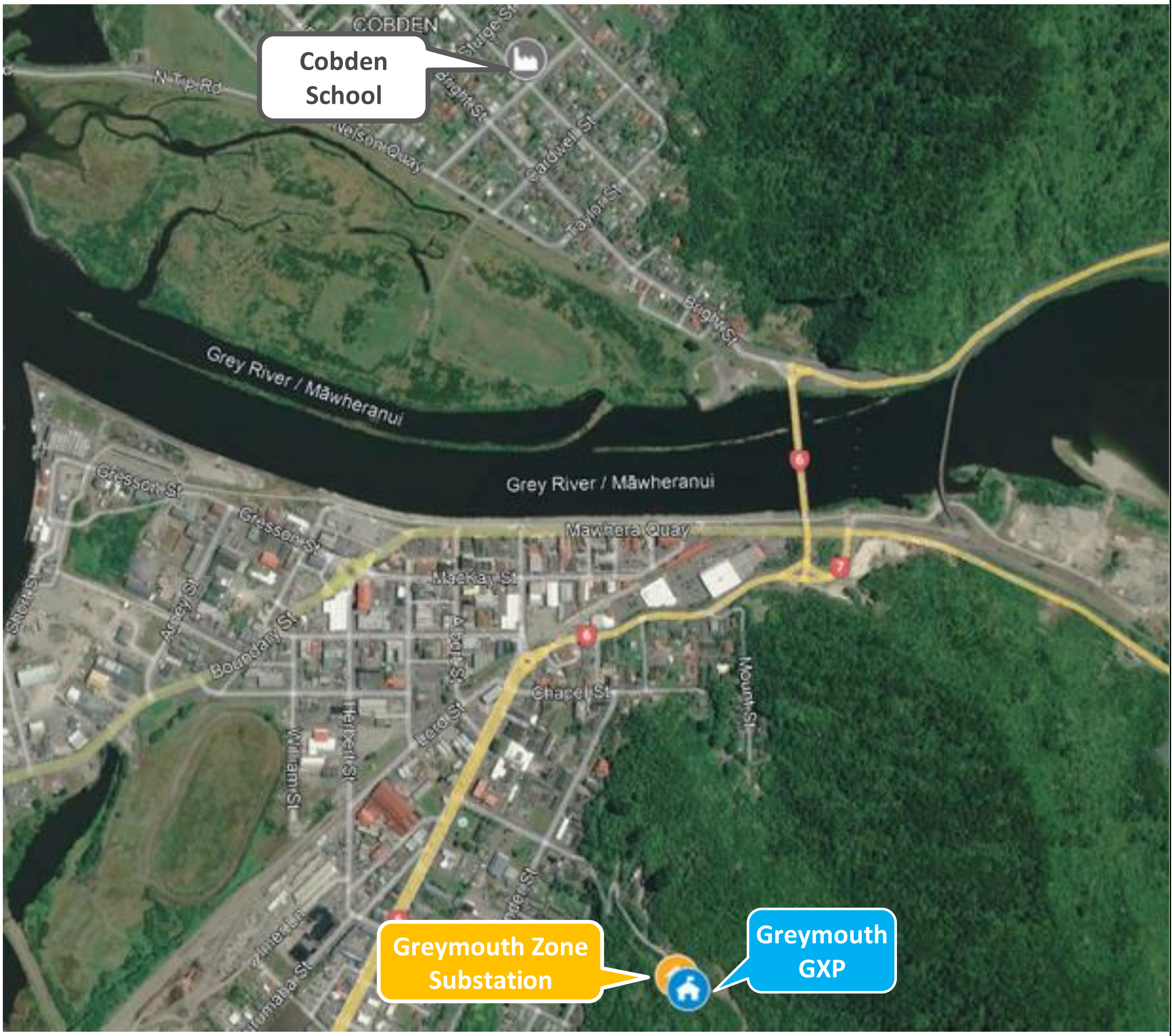


Figure 35 Cobden School geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

The modest (30kW peak) connection for this Load Site could likely be supplied from the same 11kV feeder.

Capital Cost Estimate

There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$40k.

COBDEN SCHOOL
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 and land acquisition, if required.

8.4.4.2 Grey Main School

		GREY MAIN SCHOOL
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.12	Greymouth
Existing Electrical Supply to the Plant		
Grey Main School is currently fed from three 230V supplies coming off the 11kV feeder, GYM11.		

Figure 36 Cobden School geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load
The modest (120kW peak) connection for this Load Site could likely be supplied via a new 11kV supply taken from GYM11 which traverses the sites south eastern boundary
Capital Cost Estimate
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$100k. This does not include the costs to install distribution transformers/switchgear on the site.
Timeframe to Establish New Electrical Infrastructure
Estimated to take 3-6 months.

GREY MAIN SCHOOL
To Plan, Design, Procure, Construct and Commission the works. Excludes the work required to establish the Load Site. Excludes consenting and land acquisition, if required.

8.4.5 Scenicland Laundry

<table>
<tr><th colspan="3">SCENICLAND LAUNDRY</th></tr>
<tr><th>Load Site Description</th><th>Electrical Demand (MW)</th><th>Transpower GXP</th></tr>
<tr><td>New high temperature heat pump and electric boiler</td><td>0.40</td><td>Greymouth</td></tr>
<tr><th colspan="3">Existing Electrical Supply to the Plant</th></tr>
<tr><td colspan="3">Scenicland Laundry is presently fed from Greymouth Zone substation via an 11kV feeder (GYM12). GYM12 (Inner Ring) has a peak load of ≈2.3MVA and appears to consist of Iodine, Ferret and 19/0.080Cu 19/0.064Cu conductor.

Figure 37 Scenicland Laundry and Lumber geographic location in relation to the surrounding zone substations</td></tr>
<tr><th colspan="3">Supply Option(s) for New Load</th></tr>
<tr><td colspan="3">Greymouth Zone Substation has sufficient (N-1) capacity to supply the additional load and it is likely the 11kV feeder (GYM12) has also has sufficient capacity to supply the load.</td></tr>
<tr><th colspan="3">Capital Cost Estimate</th></tr>
<tr><td colspan="3">There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$130k.</td></tr>
<tr><th colspan="3">Timeframe to Establish New Electrical Infrastructure</th></tr>
<tr><td colspan="3">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 and land acquisition, if required.</td></tr>
</table>

8.4.6 Effect of all Load Sites Connecting to Greymouth GXP

The following Figure 38 illustrates the Greymouth 2021 load profile together with the load profiles of all the Load Sites within the Greymouth GXP region. Also shown in Figure 38 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the load on the Greymouth GXP would increase to 14.7 MVA, a 0.9 MVA increase. Given that the independent sum of the individual loads is 15.6 MVA there is a modest diversity factor of 0.93 between the loads.
- The Greymouth GXP's (N-1) limit of 15 MVA (discussed in Section 6.1.2) is not expected to be exceeded.

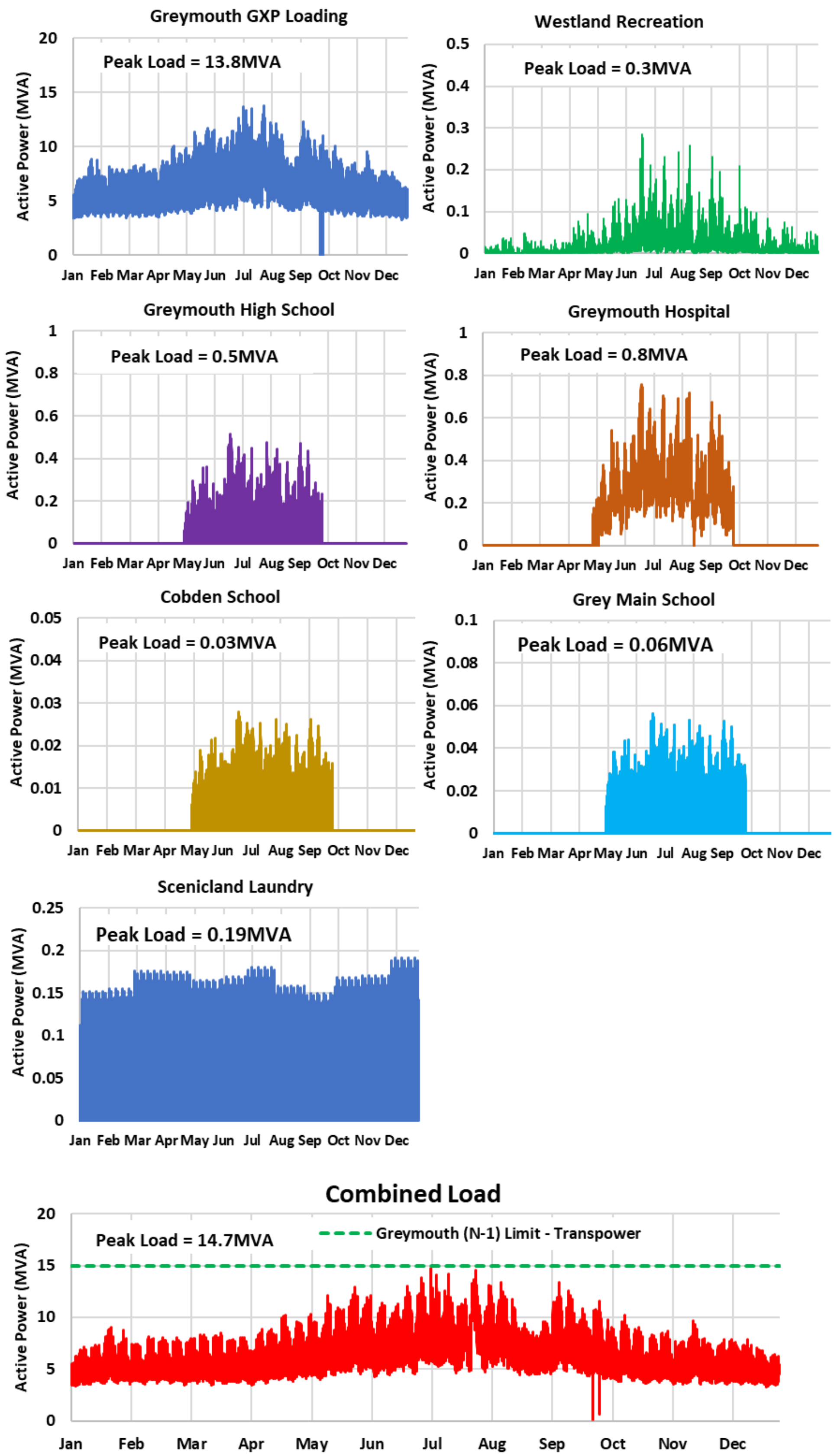


Figure 38 Loading Profiles: Greymouth GXP 2021 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.5 Hokatika GXP

The EECA Load Sites include:

- Westland Milk Products Hokitika (Stage 1: 12.12 MW, Stage 2: 29.6 MW, Total: 41.7 MW)
- Silver Fern Farms Hokitika (0.19 MW)
- Ngai Tahu Franz Josef Hot Pools (0.19 MW)
- Westland Produce (0.44 or 2.13 MW)
- Westco Lumber (no load provided)
- Franz Josef EV Charging Station (0.3 MW to 0.6 MW)

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

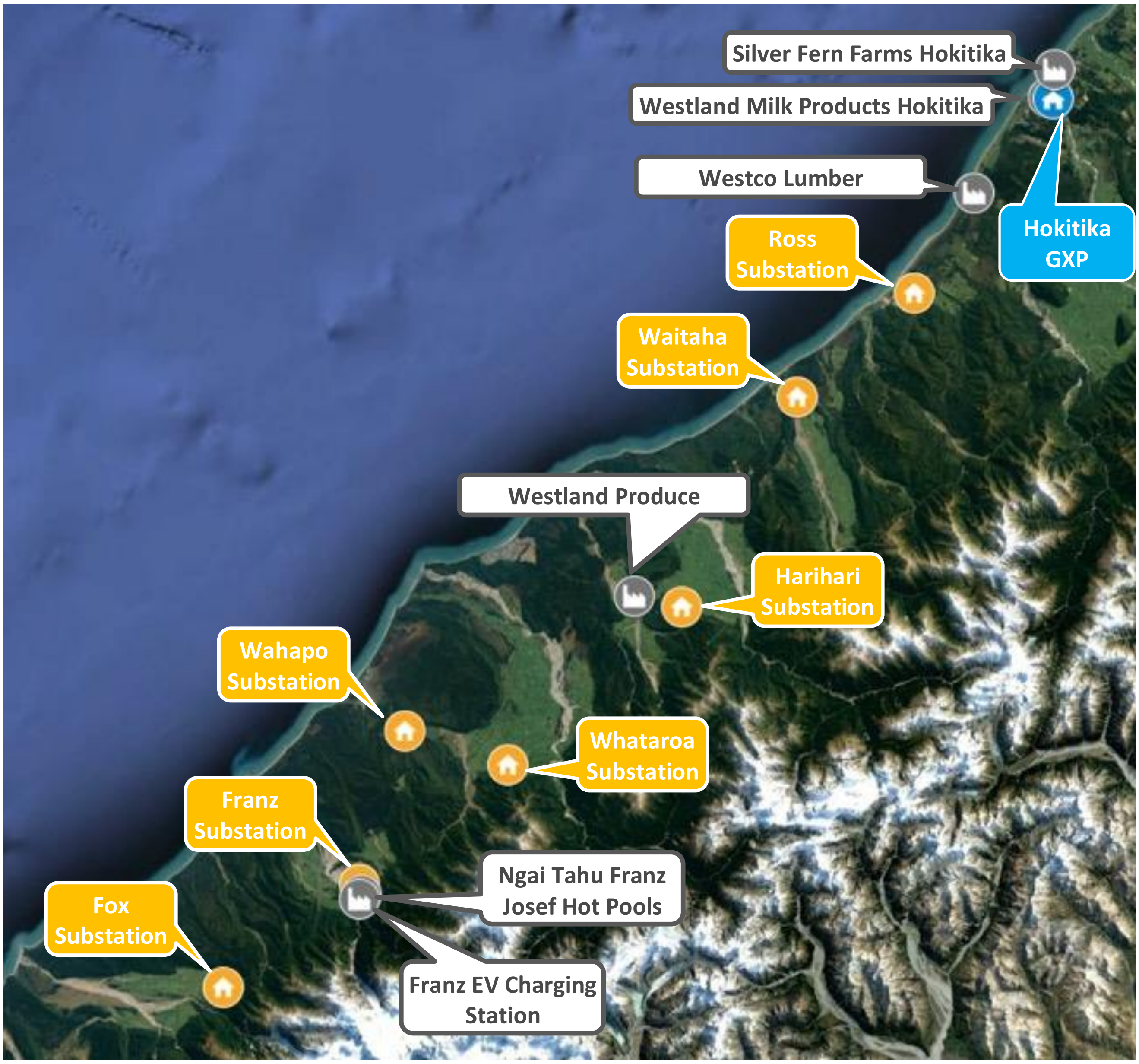


Figure 39 Hokitika GXP: EECA Load Sites vs local substations

8.5.1 Hokitika GXP Upgrade

Transpower's demand forecast indicates that Hokitika GXP has exceeded its (N-1) capacity and has ≈17 MVA of (N) spare capacity. The two incoming 66 kV circuits have a 32.4/26.5 MVA rating (summer/winter) each, meaning there is an impending constraint on the lines as well (≈3.5 MVA of (N-1) spare capacity, ≈30 MVA of (N) spare capacity) (this is discussed in more detail in Section 6.1.3).

Transpower's 2022 Planning Report indicates it is in discussions with Westpower regarding the implementation of a special protection scheme (at a cost of NZ$0.5M) to protect the two incoming lines to Hokitika GXP (regarding (N-1) constraints); as well as there being discussions of new capacitor installations at Hokitika to provide voltage support (cost not specified by Transpower). Transpower also suggests additional bonding of circuits and building of a third line to Hokitika to support additional load, with no cost specified for this, at this stage (Ergo have estimated the costs of this line in Section 8.5.2).

Transpower estimates that capacitors for voltage support will be required in 2023, and a special protection scheme will be required by 2025. No time frame is given for the installation of a third line to Hokitika at this stage though Ergo expects that this would be accelerated if additional load were to connect.

Ergo additionally notes that, according to Westpower's Asset Management Plan, there is a new generation plant being proposed (Waitaha hydro generation) which would connect into the Hokitika GXP. This would potentially reduce the effect of the proposed load on the transmission lines into Hokitika.

8.5.2 Westland Milk Products Hokitika

WESTLAND MILK PRODUCTS HOKITIKA		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New electrical boiler and high temperature heat pump	Stage 1: 12.12 MW Stage 2: 29.6 MW (total 41.7 MW)	Hokitika
Existing Electrical Supply to the Plant		
The Westland Milk Products Hokitika plant is supplied from Westpower's Hokitika zone substation (refer to Figure 40 below) via the Hokitika 5, 9, and 11 feeders. The plant is ≈0.5 km from the substation.		

Figure 40 Westland Milk Products Hokitika geographic location in relation to the Hokitika substation

Supply Option(s) for New Load

The existing Hokitika 66/11 kV substation has (N) capacity for the proposed stage 1 load for the Westland Milk Products plant. The installation would likely require the following:

- A new 11kV switchboard and building, equipped with an 11kV incomer and four 11kV feeder circuit breakers – with room for expansion in stage 2.
- Four underground 11kV feeder cables to the Westland Milk Products site.

The proposed stage 2 load for the new Westland Milk Products plant would load the existing Hokitika 66/11kV substation close to or exceeding its existing (N) capacity of 40MVA. Assuming that Transpower's forecast (refer to Table 3) is correct the Hokitika substation would be overloaded and (referring to Section 8.5.1) the connection of the additional Westland Milk Products load would likely require the following:

- The upgrade of the existing 66kV network supplying Hokitika. Figure 12 illustrates Transpower's proposal for the new/upgraded 66kV supply lines to Hokitika, which involves bonding of the two existing Kumara-Hokitika 66kV lines (i.e. operating as one circuit) and the installation of a new ≈50km, 66kV line between Hokitika and Dobson. The new line would terminate on an existing 66kV circuit breaker at Hokitika and require new 66kV circuit breakers at Kumara and Dobson.
- Extension of the existing 66kV bus to accommodate a new transformer circuit breaker bay.
- A third 40MVA, 66/11kV transformer.
- Addition of six further 11kV feeder circuit breakers to the 11kV switchroom installed in stage 1.
- Six underground 11kV feeder cables to the Westland Milk Products site.
- Additional capacitive voltage support (Transpower's estimate being $0.5M).

We note that, after a system wide protection study is undertaken, the need for a special protection system (SPS) may be identified, in order to manage the loading on the wider 66kV network. This system may require the reduction of the Westland Milk Products load during specific line/equipment outages. The security-of-supply into the site would be (N-1) at the local sub-transmission level, (N) at the distribution level and likely (N) at the transmission level.

Note also Transpower has a long-term leasing agreement from Westpower on some of the 66 kV lines in the West Coast. The leased lines are between Greymouth (GYM) to Kumara (KUM), Kumara to Kawhaka Tee (KHA) and from Two Mile River (TMR) to Hokitika (HKK). This means that the network ownership boundaries are not as well defined, and has the potential to complicate (and delay) future development of the regional transmission network.

Capital Cost Estimate

Table 10 Westland Milk Products Hokitika Stage 1: Capital cost estimate to supply the Load Site

Transmission => (N)	Subtransmission => (N)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Small switchroom (ZSS)	1.00	$1.50
Distribution	11kV circuit breaker (ZSS)	5.00	$0.50
Distribution	Single underground 11kV cable	2.80	$1.12
		TOTAL	**$3.12**

Table 11 Westland Milk Products Hokitika Stage 2: Capital cost estimate to supply the Load Site

Transmission => (N)	Subtransmission => (N-1)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Single overhead 66kV line	50.00	$17.50
Transmission	66kV circuit breaker bay	3.00	$0.90
Transmission	Medium supply transformer (GXP)	1.00	$3.50
Distribution	11kV circuit breaker (ZSS)	6.00	$0.60
Distribution	Single underground 11kV cable	4.20	$1.68
Distribution	Capacitor Bank(s)	1.00	$0.50
		TOTAL	**$24.68**

This does not include the costs to install distribution transformers/switchgear on the plant site, or the capital cost of an SPS system[23].

Timeframe to Establish New Electrical Infrastructure

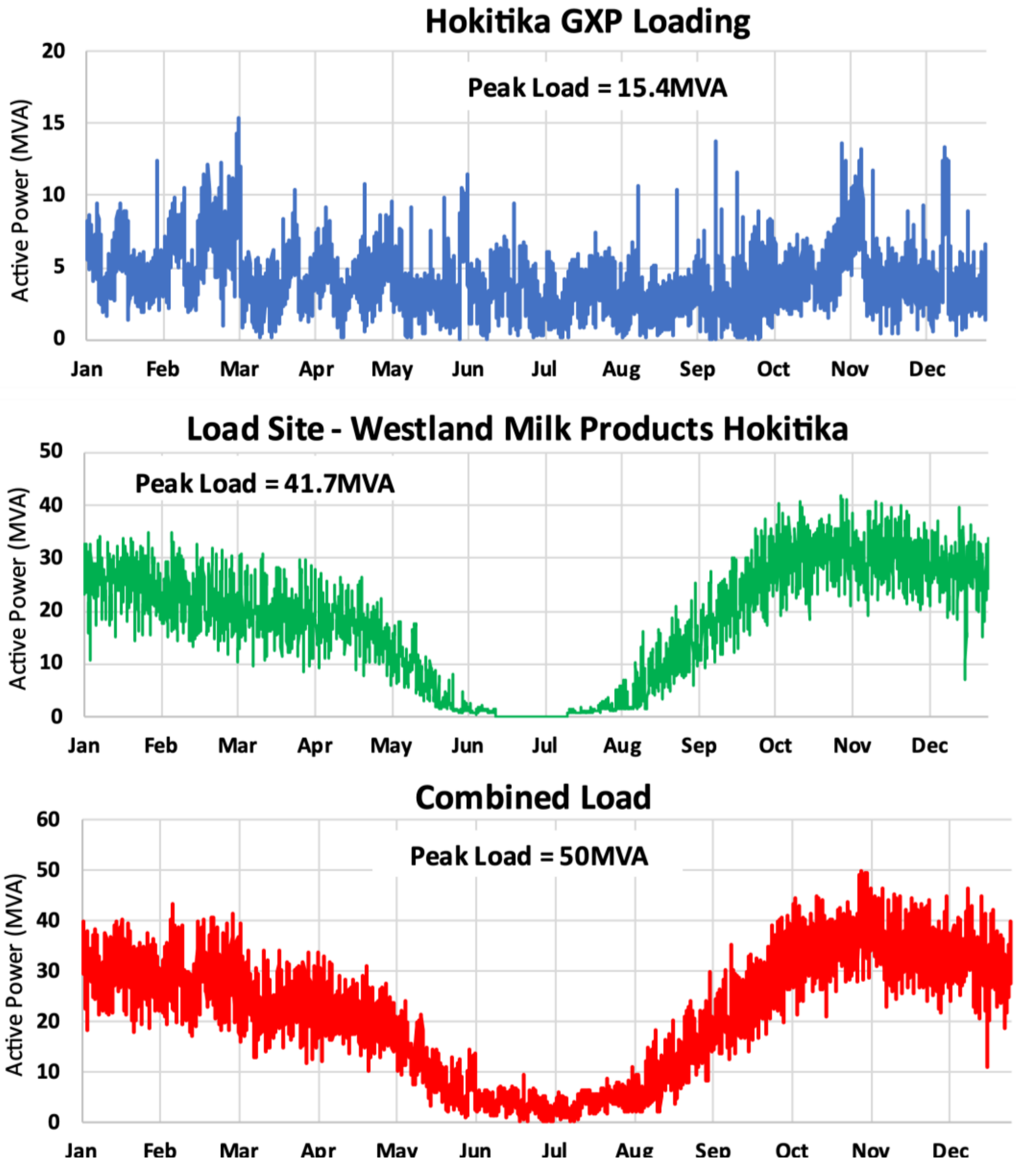
Estimated to take 24-36 months for Stage 1 and 36-60 months for Stage 2.

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

Excludes the work required to establish the Load Site.

Excludes consenting and land acquisition, if required. In particular we note that the consenting of a 50km, 66kV line would involve significant effort.

[23] The capital cost of an SPS system is typically $0.3M.

Load Profiles


8.5.3 Silver Fern Farms Hokitika

SILVER FERN FARMS HOKITIKA		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.19	Hokitika

Existing Electrical Supply to the Plant

Silver Fern Farms Hokitika is supplied from Westpower's Hokitika zone substation (Hokitika GXP) (refer to Figure 41 below) via the Hokitika 4 feeder. The plant is ≈2.8 km from the substation.

Figure 41 Silver Fern Farms Hokitika geographic location in relation to the Hokitika substation

Supply Option(s) for New Load

Hokitika GXP and the lines supplying it have (N) capacity for this load, as discussed in Section 8.5.1.

The 11kV feeder from the zone substation to the plant has a variety of overhead conductors and underground cable, including 7/.104 Cu, Squirrel, and Waxwing, among others.

We expect the supply of 0.19 MW of new load would not require any network upgrades.

SILVER FERN FARMS HOKITIKA
The security-of-supply to the site would be (N) at all levels, which aligns with what is presently available to the site.
Capital Cost Estimate
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$80k.
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 and land acquisition, if required.

8.5.4 Ngai Tahu Franz Josef Hot Pools

NGAI TAHU FRANZ JOSEF HOT POOLS		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.19	Hokitika
Existing Electrical Supply to the Plant		

Ngai Tahu Franz Josef Hot Pools is supplied from Westpower's Franz zone substation (refer to Figure 42 below) via the Franz 1 feeder. The plant is ≈1 km from the substation.

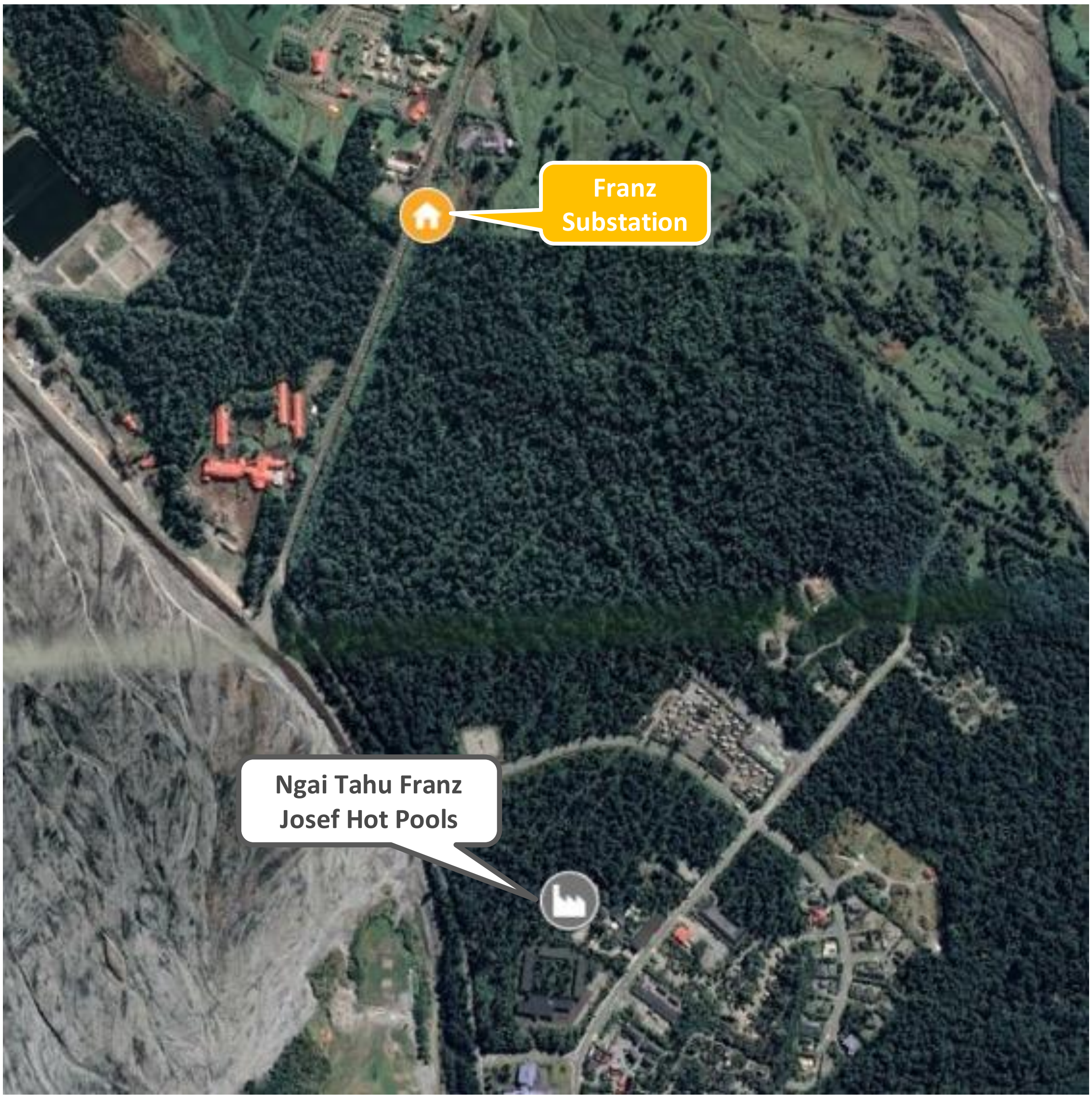


Figure 42 Ngai Tahu Franz Josef Hot Pools geographic location in relation to the Franz substation

Supply Option(s) for New Load

The lines supplying Hokitika GXP, which feeds on to Franz substation at 33 kV, have (N) capacity for this load, as discussed in Section 8.5.1. Franz zone substation has 4 MVA of spare (N) capacity. Most of Westpower's subtransmission lines, including those running between Hokitika and Franz, are a combination of Mink, Dog, Iodine, and insulated (Hendrix Spacer System) overhead conductors.

NGAI TAHU FRANZ JOSEF HOT POOLS
Ergo expects that the additional 0.19 MW of load on the 11 kV feeder from Franz substation, as well as on the substation and the lines supplying it, is small enough to be added without issue. We expect the supply of 0.19 MW of new load would not require any network upgrades. The security-of-supply to the site would be (N) at all levels, which aligns with what is presently available to the site.
Capital Cost Estimate
There are no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$80k.
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 and land acquisition, if required.

8.5.5 Westland Produce

WESTLAND PRODUCE		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump or New electric boiler	0.44 or 2.13	Hokitika

Existing Electrical Supply to the Plant

Westland Produce is supplied from Westpower's Harihari zone substation (refer to Figure 43 below) via the Harihari 3 feeder. The plant is ≈5 km from the substation.

Figure 43 Westland Produce geographic location in relation to the Harihari substation

Supply Option(s) for New Load

The lines supplying Hokitika GXP, which feeds on to Franz substation at 33 kV, have (N) capacity for this load, as discussed in Section 8.5.1. Harihari zone substation has no spare (N) capacity. Most of Westpower's subtransmission lines, including those running between Hokitika and Franz, are a combination of Mink, Dog, Iodine, and insulated (Hendrix Spacer System) cables.

The 11kV feeder from the zone substation to the plant has a variety of overhead conductors and underground cables, including Mullet, Squirrel, Ferret, Mink, 7/.080 Cu, and 25mm^2 Cu.

We expect the supply of 0.44 MW of new load to require the following:

- Replacement of the existing 1 MVA with a 2 MVA transformer at Harihari substation.

We expect the supply of 2.13 MVA of new load to require the following:

- Installation of an SPS at Hokitika GXP
- Replacement of the existing 1 MVA with a 4 MVA transformer at Harihari substation.
- Replacement of the existing ~4.2 km of Mullet, Squirrel and Ferret overhead conductors to the site; as well as 0.05 km of existing 25 mm^2 Copper cables.

WESTLAND PRODUCE

Capital Cost Estimate

Table 12 Westland Produce: Capital cost estimate to supply the Load Site (0.44 MW)

Transmission => (N)	Subtransmission => (N)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	Small supply transformer (ZSS)	1.00	$0.50
		TOTAL	**$0.50**

Table 13 Westland Produce: Capital cost estimate to supply the Load Site (2.13 MW)

Transmission => (N)	Subtransmission => (N)	Distribution => (N)	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Transmission	Special protection system (GXP)	1.00	$0.50
Distribution	Small supply transformer (ZSS)	1.00	$0.50
Distribution	Reconductor 11kV line (larger)	4.20	$0.63
Distribution	Single underground 11kV cable	0.05	$0.02
		TOTAL	**$1.65**

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 and land acquisition, if required.

8.5.6 Franz Josef EV Charging Station

FRANZ JOSEF EV CHARGING STATION		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
Chargers for electric vehicles	Initial load of 0.3 MW increased to 0.6 MW	Hokitika

Existing Electrical Supply to the Plant

The following Figure 44 illustrates a potential location for the charging station near the centre of Franz township (close to the heliport and hotel) and ~1.4 km from Franz substation. The location is fed by the Franz 3 feeder.

Figure 44 Franz Josef EV Charging Station geographic location in relation to the Franz substation

Supply Option(s) for New Load

The lines supplying Hokitika GXP, which feeds on to Franz substation at 33 kV, have (N) capacity for this load, as discussed in Section 8.5.1. Franz zone substation has 4 MVA of spare (N) capacity. Most of Westpower's subtransmission lines, including those running between Hokitika and Franz, are a combination of Mink, Dog, Iodine, and insulated (Hendrix Spacer System) overhead conductors.

We expect that the additional 0.3 to 0.6 MW of load on the 11 kV feeder from Franz substation, as well as on the substation and the lines supplying it, is small enough to be added without issue.

FRANZ JOSEF EV CHARGING STATION
We expect the supply of 0.3 to 0.6 MW of new load would not require any network upgrades. The security-of-supply to the site would be (N) at all levels, which aligns with what is presently available to the site.
Capital Cost Estimate
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$150k.
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 and land acquisition and land acquisition, if required.

8.5.7 Effect of all Load Sites Connecting to Hokitika GXP

The following Figure 45 and Figure 46 illustrate the Hokitika 2021 load profile together with the load profiles of all the Load Sites within the Hokitika GXP region, at stage 1 and stage 2 of the Westland Milk Products installation, respectively.[24] Also shown in Figure 45 and Figure 46 are:

- After stage 1 of the Westland Milk Products installation:
    - The cumulative sum of all the loads (Combined Load), which forecasts that the load on the Hokitika GXP at would increase to 28.6 MVA, a 13.2 MVA increase. Given that the independent sum of the individual loads is 29.2 MVA there is a diversity factor of 0.97 between the loads.
- After stage 2 of the Westland Milk Products installation:
    - The cumulative sum of all the loads (Combined Load), which forecasts that the load on the Hokitika GXP at would increase to 51.0 MVA, a 22.4 MVA increase from Westland Milk stage 1. Given that the independent sum of the individual loads is 58.8 MVA there is a diversity factor of 0.87 between the loads.
    - The 66kV lines supplying the Hokitika GXP (N-1) limit would be exceeded for significant periods of time.
    - The Hokitika GXP comprises 2x 20 MVA transformers (refer to Section 6.1.3). The load exceeding this for significant periods of time, would trigger a major GXP upgrade.

[24] The Combined Load graph includes a constant 0.9MW Franz Josef Charging Station load but the graph for this Load Site is not presented.

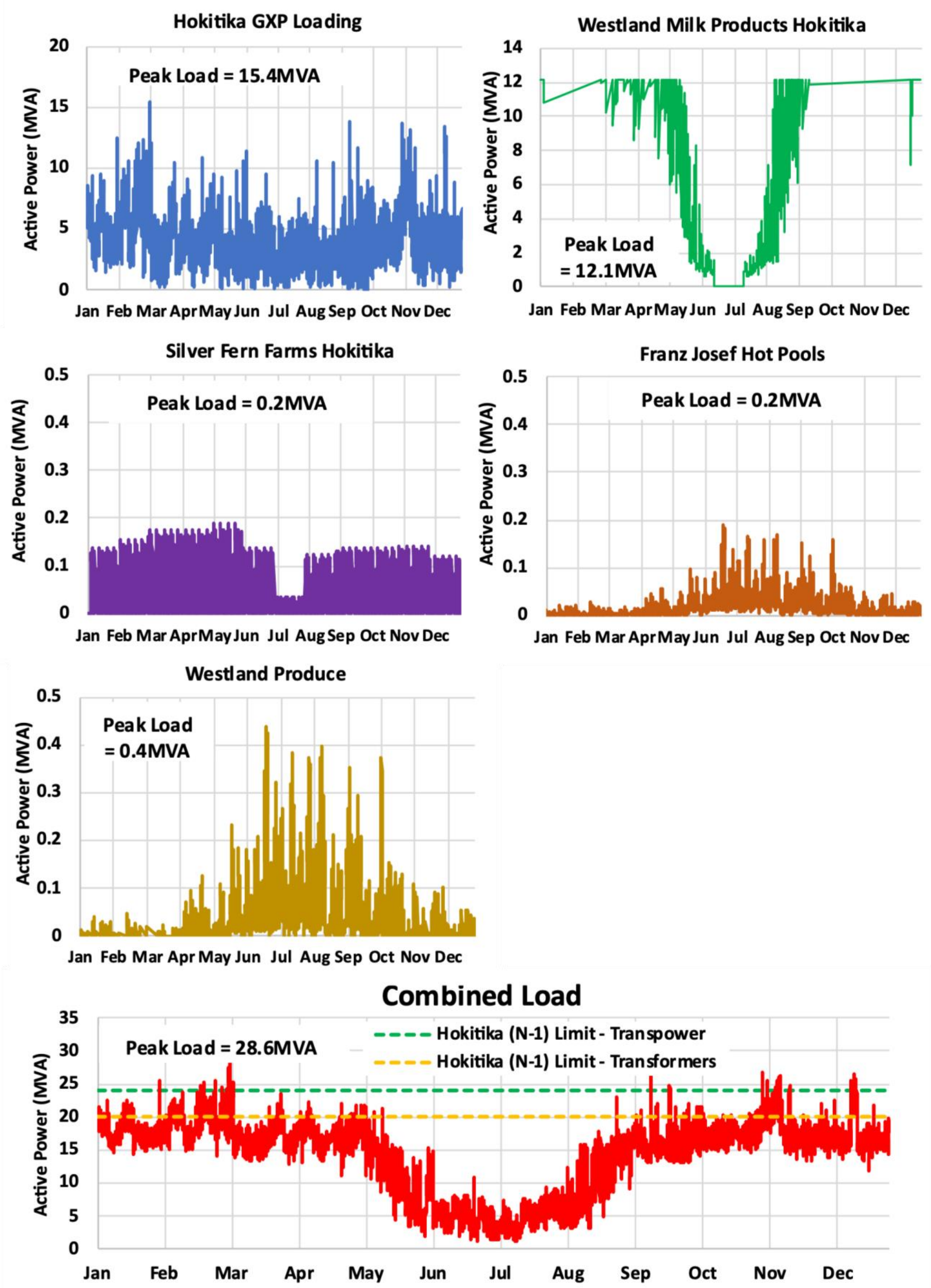


Figure 45 Loading Profiles: Hokitika GXP 2021 historical loading: Load Site Profiles: Combined Load (sum of all profiles – Westland Milk stage 1)

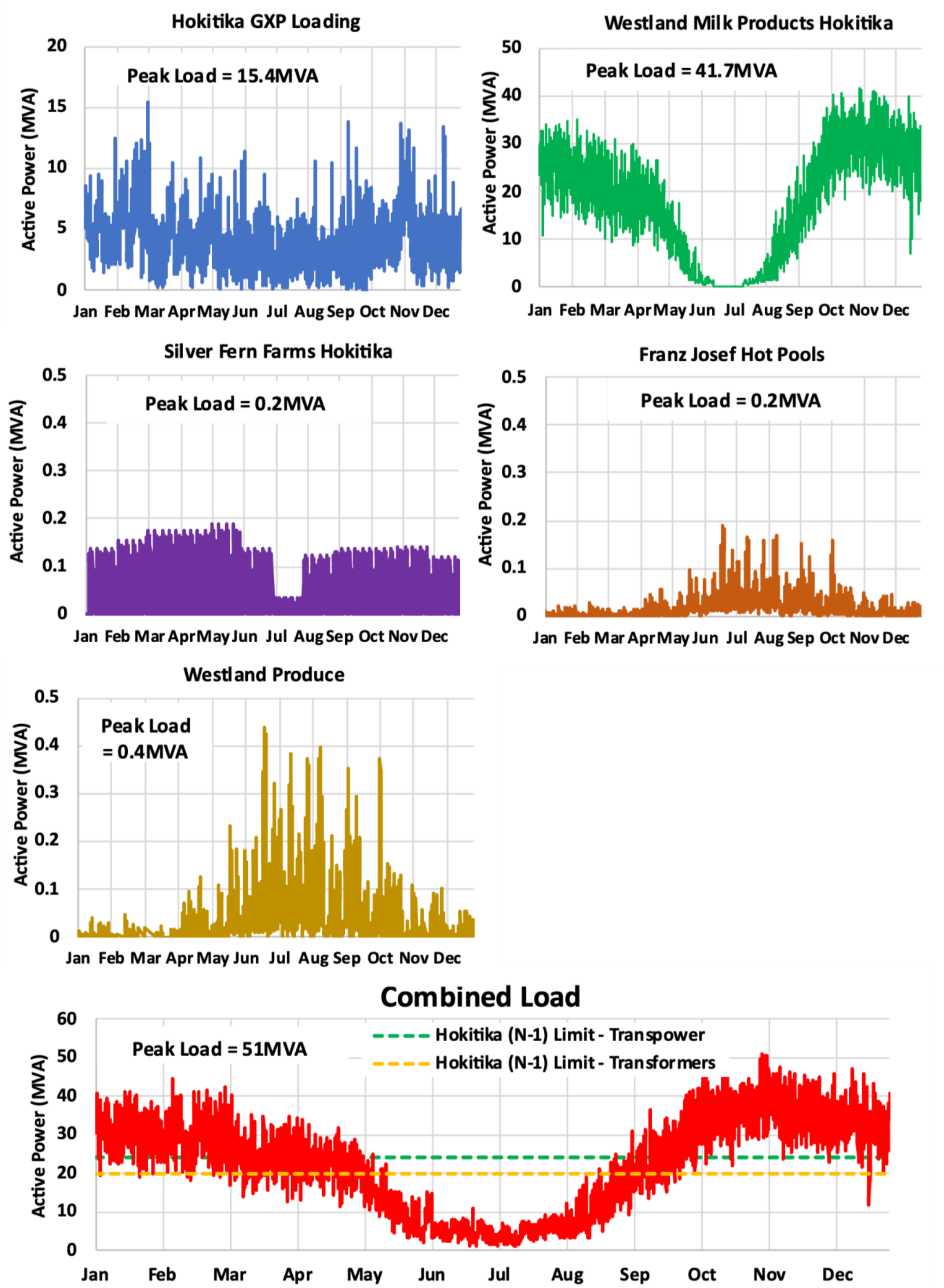


Figure 46 Loading Profiles: Hokitika GXP 2021 historical loading: Load Site Profiles: Combined Load (sum of all profiles – Westland Milk stage 2)

8.6 Kumara GXP

The EECA Load Sites include:

- Kumara Junction EV Charging Station (0.9 MW to 2.3 MW)
- International Panel & Lumber (1.5 MW)

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

Figure 47 Kumara GXP: EECA Load Sites vs local substations

8.6.1 Kumara GXP Upgrade

As Kumara GXP is predominantly a grid injection point, as discussed in Section 6.1.4. With a present peak demand of less than 2 MW when Manawa's Kumara hydro scheme is not generating, the GXP and lines supplying it have ample capacity for new load. Upgrades of Kumara GXP are therefore not considered.

It is considered that when the connected generation is operating, if additional load is connected, it will decrease the overall load on the substation, by using some of the power which would otherwise be exported to the South Island grid via the substation.

The transmission lines for the GXP operate on (N-1) security, though the site itself has (N) security of supply as there is only one transformer on site.

8.6.2 Kumara Junction EV Charging Station

KUMARA JUNCTION EV CHARGING STATION		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
Chargers for electric vehicles	Initial load of 0.9 MW increased to 2.3 MW	Kumara

Existing Electrical Supply to the Plant

The following Figure 48 illustrates a potential location for the charging station in Kumara Junction (close to the cafe) and ~7.8 km from Kumara substation. The location is fed by the Kumara 1 11kV feeder.

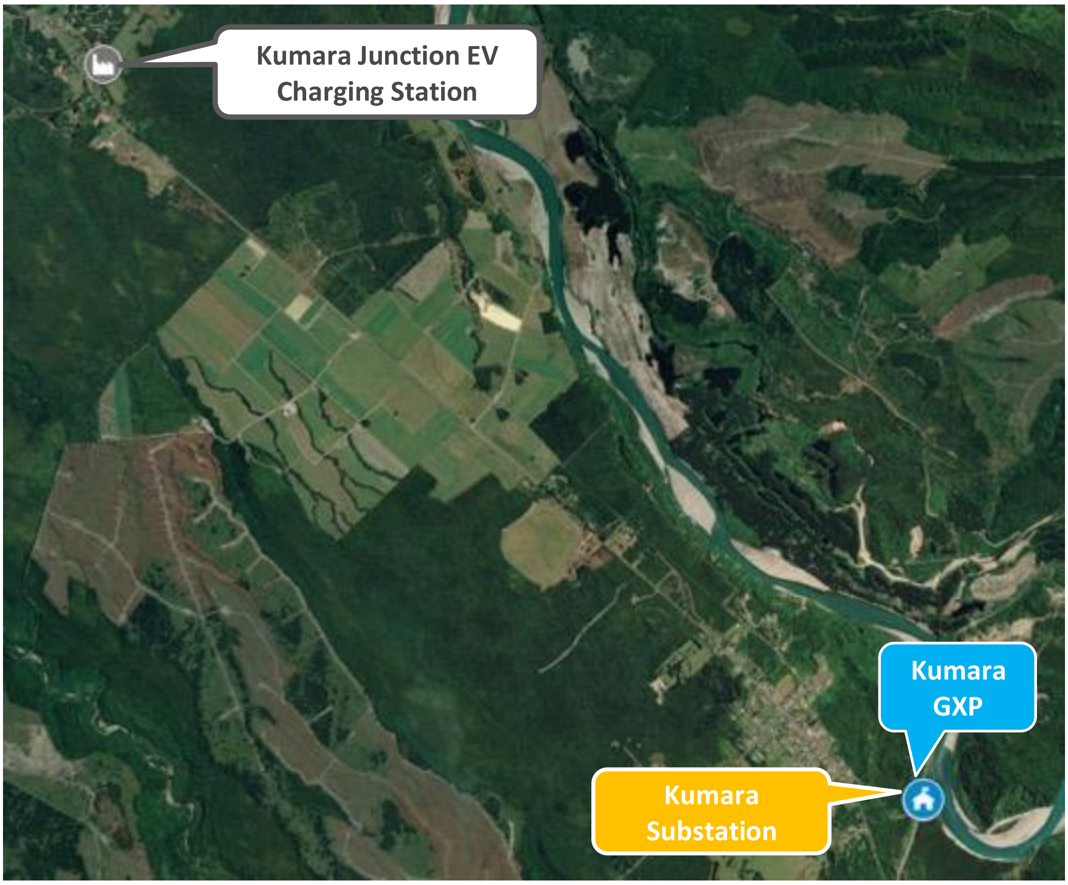


Figure 48 Kumara Junction EV Charging Station geographic location in relation to the Kumara substation

Supply Option(s) for New Load

The 66kV lines supplying Kumara GXP, have sufficient (N-1) capacity to supply the additional load; and Kumara zone substation has ample spare (N) capacity, as discussed in Section 8.6.1. Westpower's subtransmission lines in the area are a combination of Dog and Iodine.

The 11kV lines supplying the site from the zone substation comprise of Iodine and Dog conductors. There is a pole mounted capacitor on the Kumara 1 feeder, near Kumara junction, which will provide some voltage support. The Kumara 1 feeder presently has a loading of ~1.5 MVA. It is expected that the lines have capacity for the 2.3 MW of additional load but some additional voltage support would be required.

KUMARA JUNCTION EV CHARGING STATION

Capital Cost Estimate

Table 14 Kumara Junction EV Charging Point: Capital cost estimate to supply the Load Site

Transmission => (N-1)	Subtransmission => (N-1)		Distribution => (N)
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11kV Voltage Regulator	1.00	$0.40
		TOTAL	**$0.40**

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 and land acquisition, if required.

8.6.3 International Panel & Lumber

		INTERNATIONAL PANEL & LUMBER
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump and electric boiler	1.50	Kumara
Existing Electrical Supply to the Plant		
International Panel & Lumber is currently supplied from the Kumara GXP and zone substation via a 15km 11kV overhead line consisting of mainly Iodine and Dog. A secondary supply is provided from Greymouth Zone Substation but we suspect this feeder is unable to supply the sites full load.		

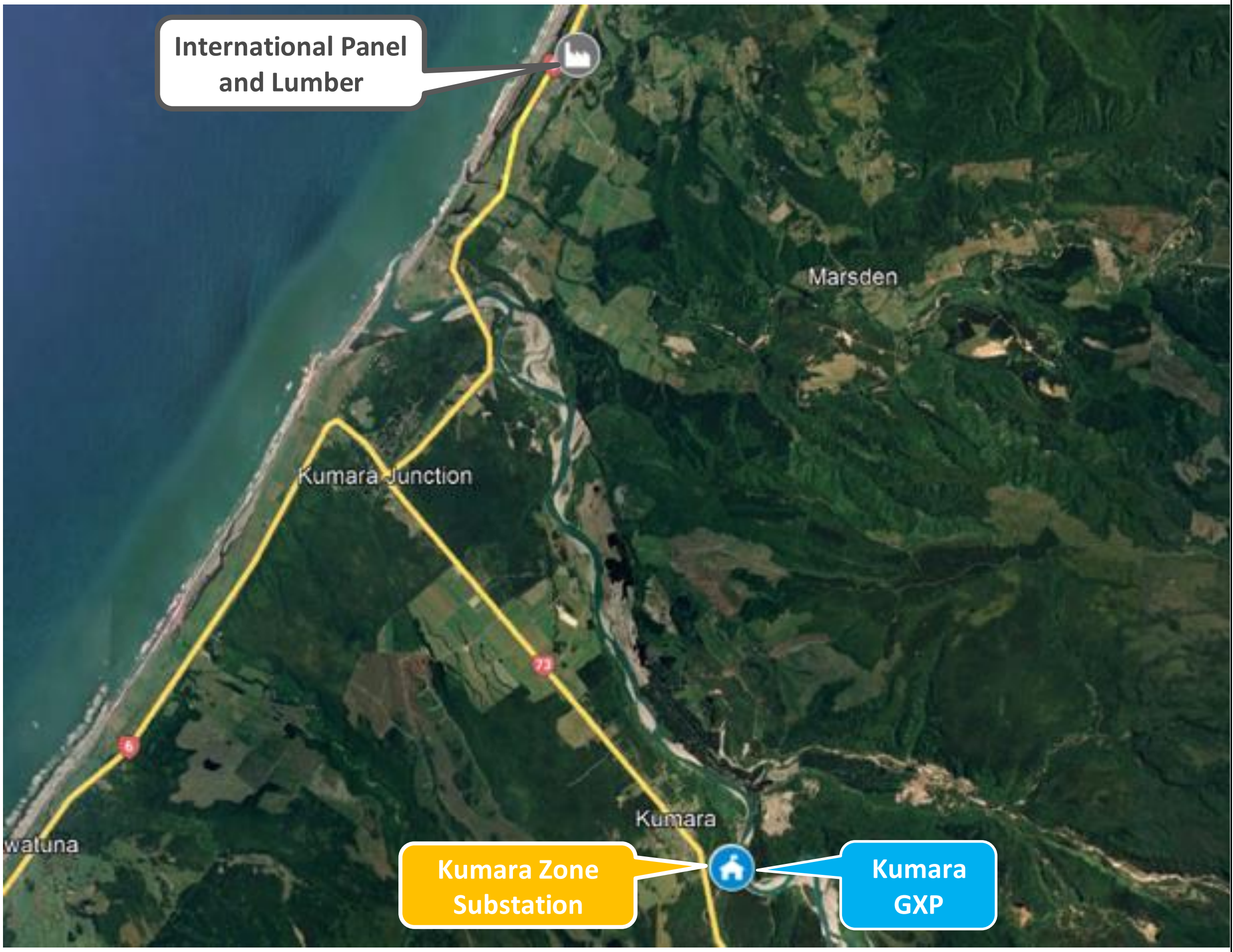


Figure 49 International Panel and Lumber geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load	
Kumara GXP and zone substation has ample (N) capacity for this additional load (as the site is predominantly a Grid Injection Point, as discussed in Section 8.6.1. The 11kV Feeder (KUM1) from the zone substation to the plant consists of overhead conductors, including Iodine and Dog. These are relatively high-capacity conductors and the current loading on KUM1 is relatively low at ≈1.5MVA. As a result, we expect the additional load could be supplied via the existing 11kV supply but would likely require the installation of a voltage regulator on the 11kV feeder.	

INTERNATIONAL PANEL & LUMBER			
Capital Cost Estimate			

Transmission => **(N-1)**	**Subtransmission =>** **(N-1)**	**Distribution =>** **(N)**	
Network Asset	**Equipment**	**Number and Capital Cost ($M)**	
Distribution	11kV Voltage Regulator	1.00	$0.40
		TOTAL	**$0.40**

This does not include the costs to install distribution transformers/switchgear on the 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 and land acquisition, if required.

8.6.4 Effect of all Load Sites Connecting to Kumara GXP

The following Figure 50 illustrates the Kumara 2021 load profile together with the load profiles of all the Load Sites within the Kumara GXP region.[25] Also shown in Figure 50 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the maximum load on the Kumara GXP would decrease to 7.2 MVA, a difference of 2.4 MVA.
- The Kumara GXP's (N) limit of 10 MVA (discussed in Section 6.1.4) is not expected to be exceeded.

As discussed in Section 8.6.1, because the substation's main load is embedded generation, when shown directionally[26], the highest absolute loads on the substation occur during periods when power is flowing into the South Island grid rather than from it. Hence, adding loads at Kumara lowers the overall loading on the substation, by offsetting the connected generation.

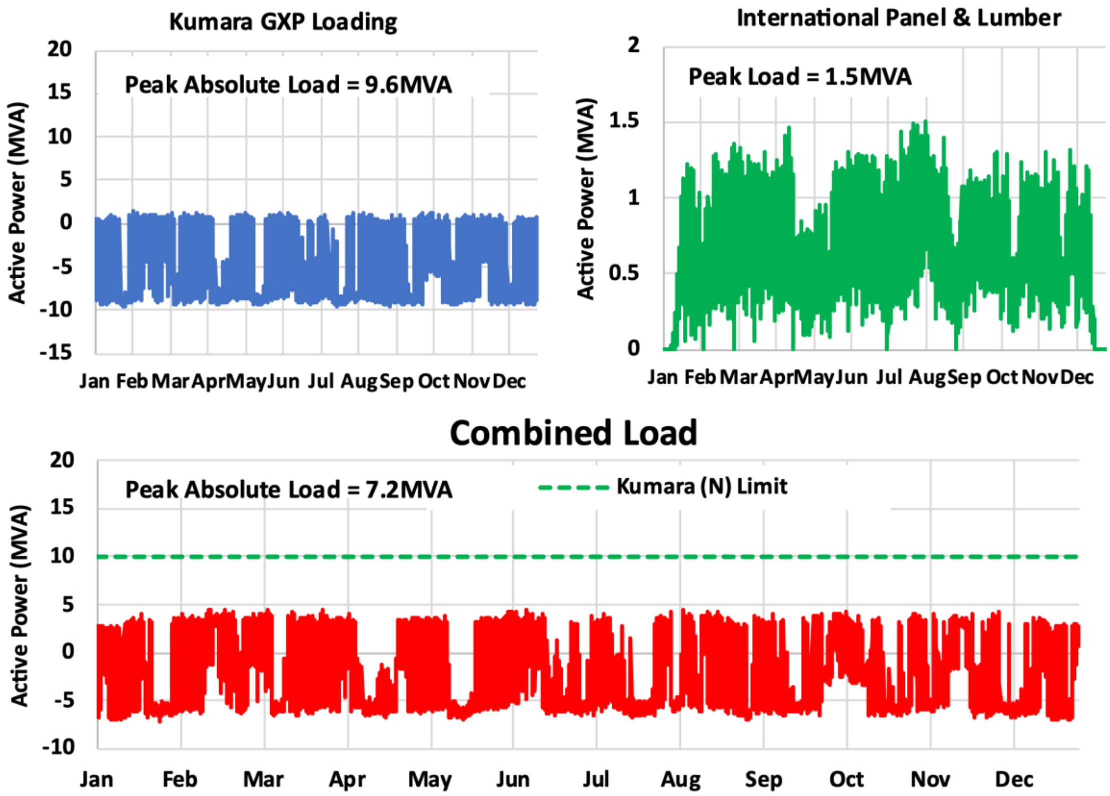


Figure 50 Loading Profiles: Kumara GXP 2021 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

[25] The Combined Load graph includes a constant 2.3 MW Kumara Junction Charging Station load but the graph for this Load Site is not presented.

[26] For this substation, in order to provide a view of directionality, MW values of loading have been used, assuming a unity power factor to convert to MVA.

8.7 Otira GXP

None of the Load Sites identified by EECA are geographically close to the Otira GXP. Hence, Ergo is of the view that the Otira 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.

8.8 Reefton GXP

The EECA Load Sites include:

- Reefton Area School (0.16 MW)
- Reefton Hospital (0.30 MW)

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

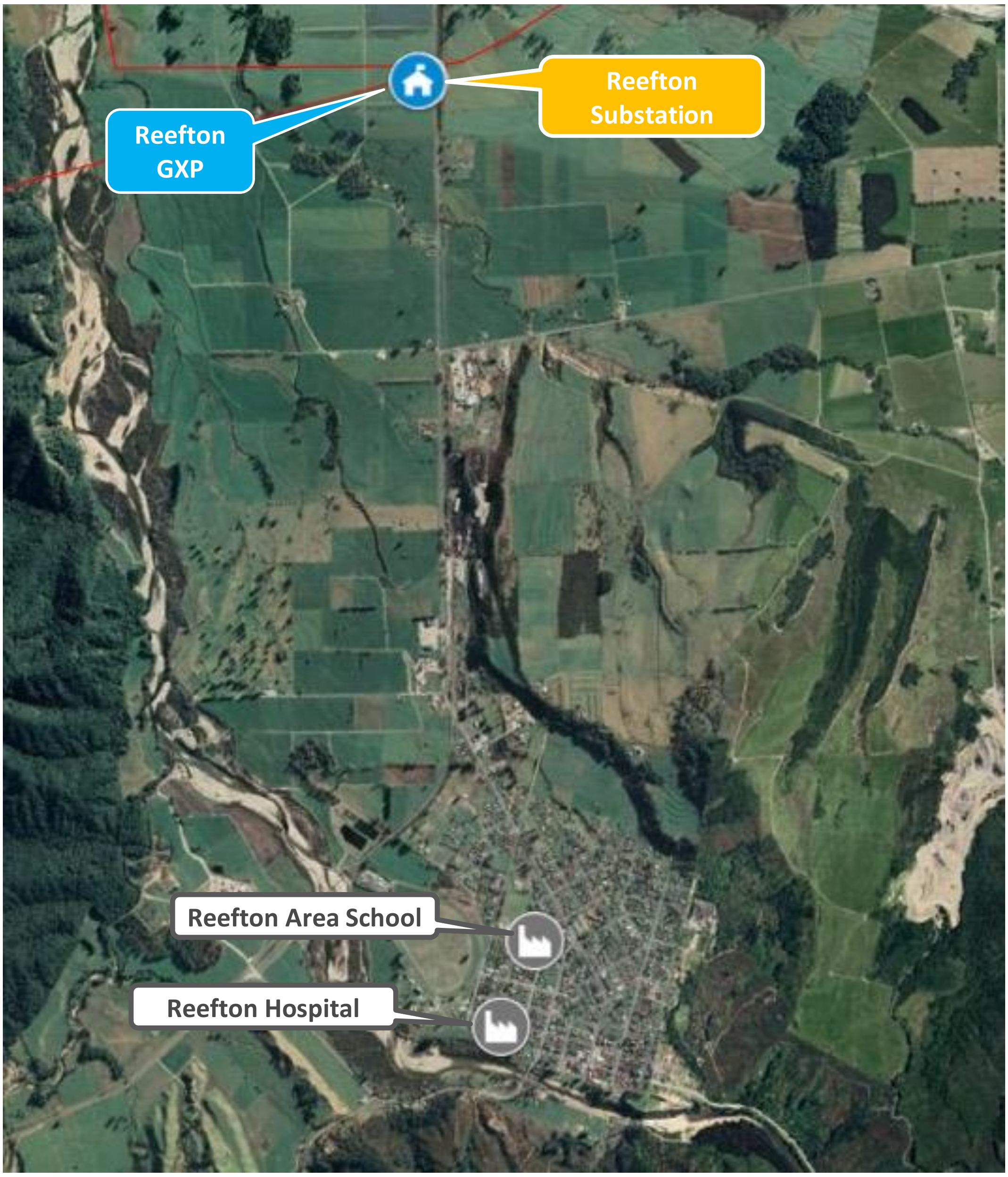


Figure 51 Reefton GXP: EECA Load Sites vs local substations

8.8.1 Reefton GXP Upgrade

Based on Transpower's demand forecast the Reefton GXP has ≈24 MVA of (N-1) spare capacity and ≈9 MVA of (N) spare capacity. The combined load requirements of the Load Sites in the Reefton region are well below this spare capacity, so upgrades at the Reefton GXP are not considered.

8.8.2 Reefton Area School

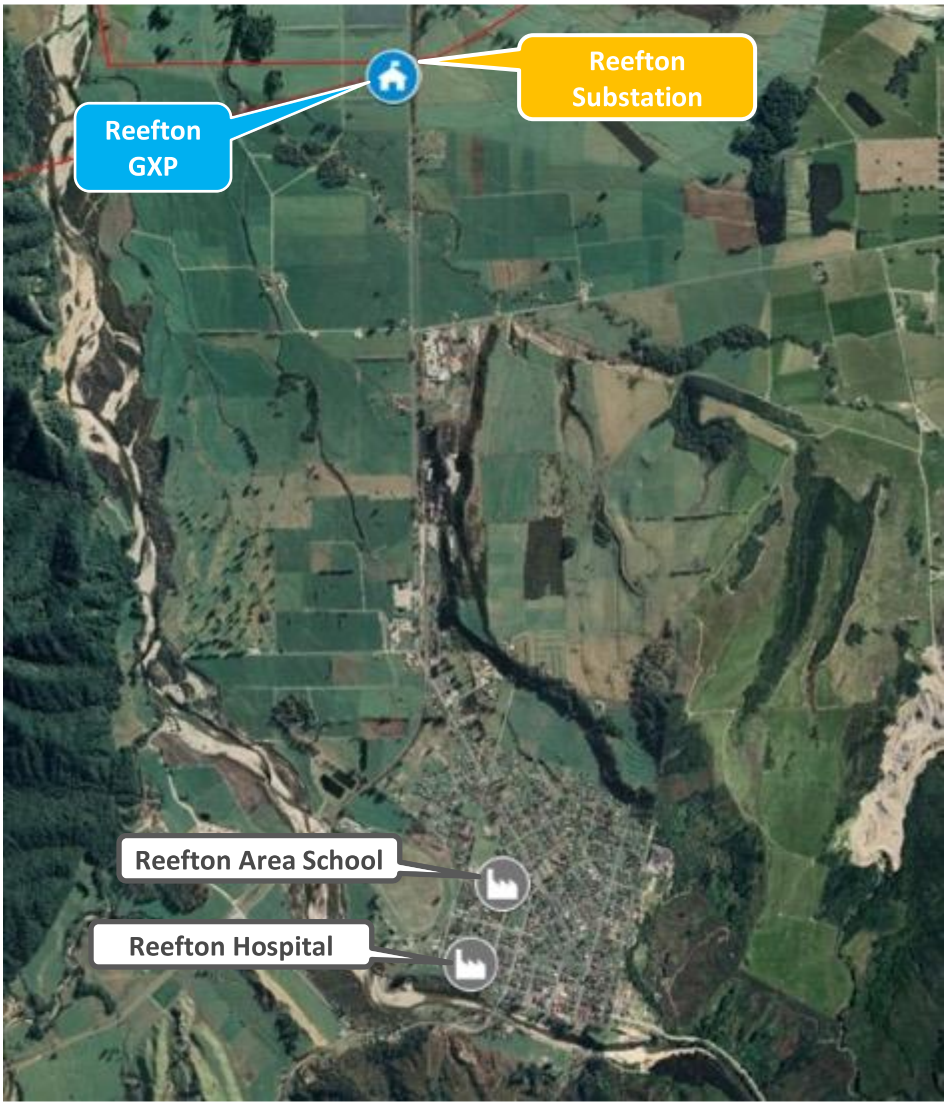
REEFTON AREA SCHOOL		
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.16	Reefton
Existing Electrical Supply to the Plant		
Reefton Area School is supplied from Westpower's Reefton zone substation (refer to Figure 52 below) via the Reefton town feeder. The plant is ≈4 km from the substation.		

Figure 52 Reefton Area School geographic location in relation to the Reefton substation

Supply Option(s) for New Load
The 11kV lines supplying Reefton GXP, and Reefton zone substation have ample spare (N-1) capacity for this additional load, as discussed in Section 8.8.1.

REEFTON AREA SCHOOL
The 11 kV lines supplying the site from the zone substation comprise of Iodine conductor and a short length of underground 16 mm^2 Copper cable between a pole and the 200 kVA transformer which presently supplies the school and some other nearby ICPs. Ergo expects that the additional 0.16 MW of load on the 11 kV feeder from Reefton substation, as well as on the substation and the lines supplying it, is small enough to be added without issue. We expect the supply of 0.16 MW of new load would not require any network upgrades. The security-of-supply to the site would be (N-1) at the transmission and subtransmission levels, and (N) at the distribution level, which aligns with what is presently available to the site.
Capital Cost Estimate
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$80k.
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 and land acquisition, if required.

8.8.3 Reefton Hospital

		REEFTON HOSPITAL
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.30	Reefton
Existing Electrical Supply to the Plant		
Reefton Hospital is supplied from Westpower's Reefton zone substation (refer to Figure 53 below) via the Reefton town feeder. The plant is ≈4.3 km from the substation.  Figure 53 Reefton Hospital geographic location in relation to the Reefton substation		
Supply Option(s) for New Load		
The lines supplying Reefton GXP, and Reefton zone substation have ample spare (N-1) capacity for this additional load, as discussed in Section 8.8.1. The 11 kV lines supplying the site from the zone substation comprise of Iodine conductor.		

REEFTON HOSPITAL
Ergo expects that the additional 0.30 MW of load on the 11 kV feeder from Reefton substation, as well as on the substation and the lines supplying it, is small enough to be added without issue. We expect the supply of 0.30 MW of new load would not require any network upgrades. The security-of-supply to the site would be (N-1) at the transmission and subtransmission levels, and (N) at the distribution level, which aligns with what is presently available to the site.
Capital Cost Estimate
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$130k.
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 and land acquisition, if required.

8.8.4 Effect of all Load Sites Connecting to Reefton GXP

The following Figure 54 illustrates the Reefton 2021 load profile together with the load profiles of all the Load Sites within the Reefton GXP region. Also shown in Figure 54 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the load on the Reefton GXP would increase to 5.9 MVA, a 0.1 MVA increase. Given that the independent sum of the individual loads is 6.26 MVA there is a diversity factor of 0.94 between the loads.
- The Reefton GXP's (N-1) limit of 20 MVA (discussed in Section 0) is not expected to be exceeded.

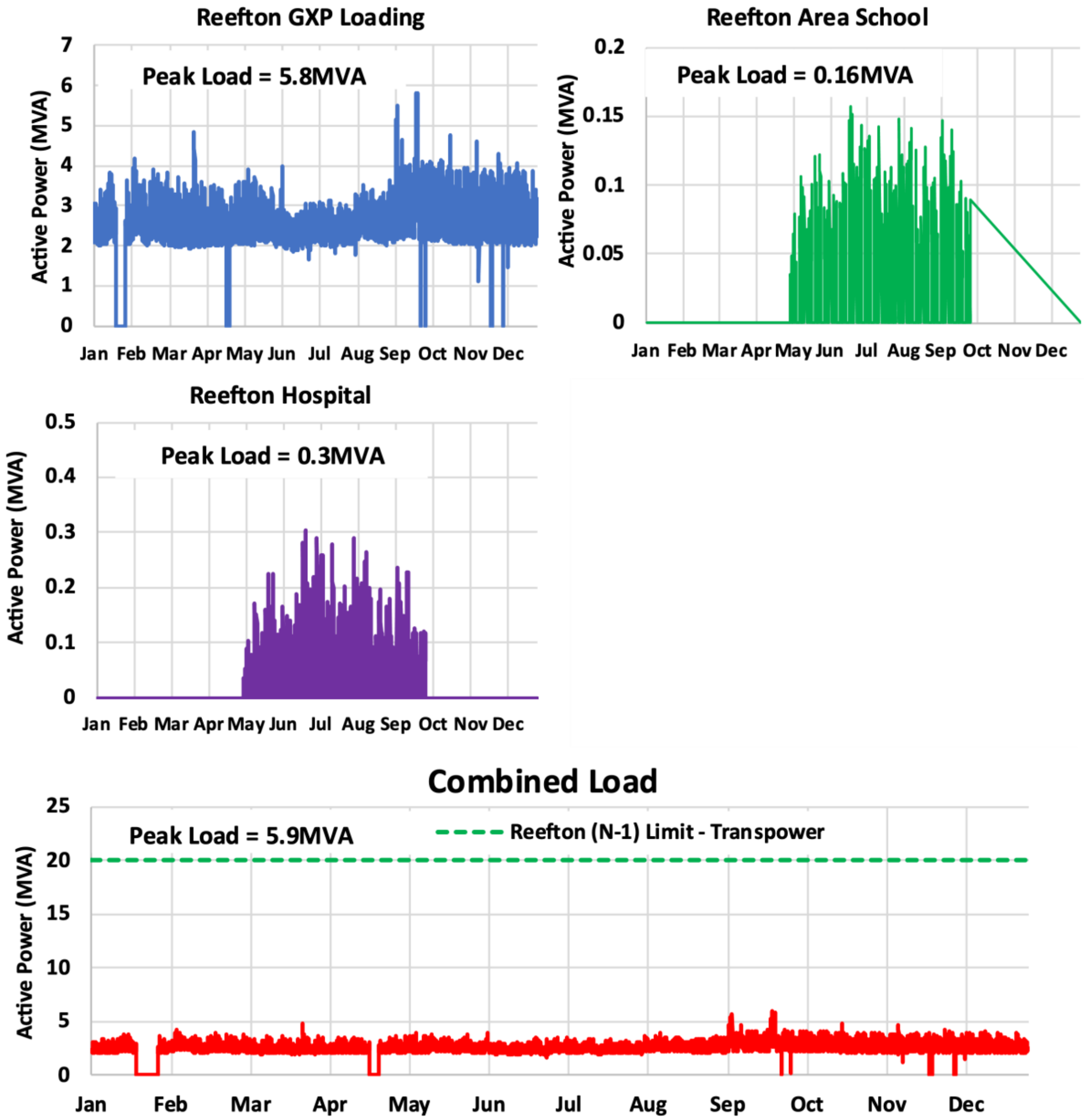


Figure 54 Loading Profiles: Reefton GXP 2021 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

8.9 Robertson Street GXP

The EECA Load Sites include:

- Karamea Tomatoes (1.14 MW or 2.73 MW)
- Westport Hospital (0.54 MW)
- Buller High School (0.22 MW)
- Westport North School (0.10 MW)
- Westport South School (0.07 MW)

The geographic locations of the Load Sites are shown on the following Figure 55 in relation to the local transmission and distribution substations.

Figure 55 Robertson Street GXP: Local zone substations and Load Sites (excluding Karamea Tomatoes)

Figure 56 Robertson Street GXP: Local zone substations and Load Site (Karamea Tomatoes only)

8.9.1 Robertson Street GXP Upgrade

The combined load requirements of the Load Sites in the Robertson St region are well below the spare capacity of the GXP and incoming lines, so upgrades at the Robertson St GXP are not considered.

8.9.2 Karamea Tomatoes

		Karamea Tomatoes
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump or New electrical boiler	1.14 or 2.73	Robertson St
Existing Electrical Supply to the Plant		
Karamea Tomatoes are currently supplied by an 11kV feeder from Kongahu zone substation which is ≈10km to the south of the Load Site. Kongahu Zone substation is supplied by a single 33kV line and is equiped with a 33/11kV 1.5MVA transformer and two small generators (0.7 and 0.5MW) which are likely used for back-up supply in the event of a 33kV outage. The 33kV supply to Kongahu originates at Robertson St substation and passes through Ngakawau Substation. The distance between Robertson St GXP and Karamea Tomatoes is ≈75km.		

Figure 57 Karamea Tomatoes geographic location in relation to the local zone substations and GXP

Supply Option(s) for New Load

Karamea Tomatoes

Supply of both the 1.13MW and 2.73MW loads would require an upgrade to the existing 1.5 MVA transformer to 3 or 5 MVA respectively at Kongahu substation. The modest existing loading on the both the incoming 33kV supply to Kongahu and the 11kV feeder (which is Mink conductor) to Karamea Tomatoes means the existing line infrastructure is likely capable of supplying the additional load but due to the long distances. However, a 3MVAr 33kV capacitor bank would likely be required at Kongahu substation to support voltage for the 2.73 MW option

Capital Cost Estimate

Option 1 – 1.13 MW

Table 15 Karamea Tomatoes: Capital cost estimate to supply the Load Site

Transmission => (N)	Subtransmission => (N)	Distribution => (N)	
Network Asset	Equipment	Number and Capital Cost ($M)	
Distribution	Small supply transformer (ZSS)	1.00	$0.50
		TOTAL	**$0.50**

Option 2 – 2.73 MW

Table 16 Karamea Tomatoes: Capital cost estimate to supply the Load Site

Transmission => (N)	Subtransmission => (N)	Distribution => (N)	
Network Asset	Equipment	Number and Capital Cost ($M)	
Distribution	33kV Capacitor Bank	1.00	$0.40
Distribution	Small supply transformer (ZSS)	1.00	$0.50
		TOTAL	**$0.90**

This does not include the costs for 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.

8.9.3 Westport Hospital

		WESTPORT HOSPITAL
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.54	Roberston St
Existing Electrical Supply to the Plant		
Westport Hospital is presently fed from Roberston St substation via an 11kV feeder (Pakington St Feeder).		

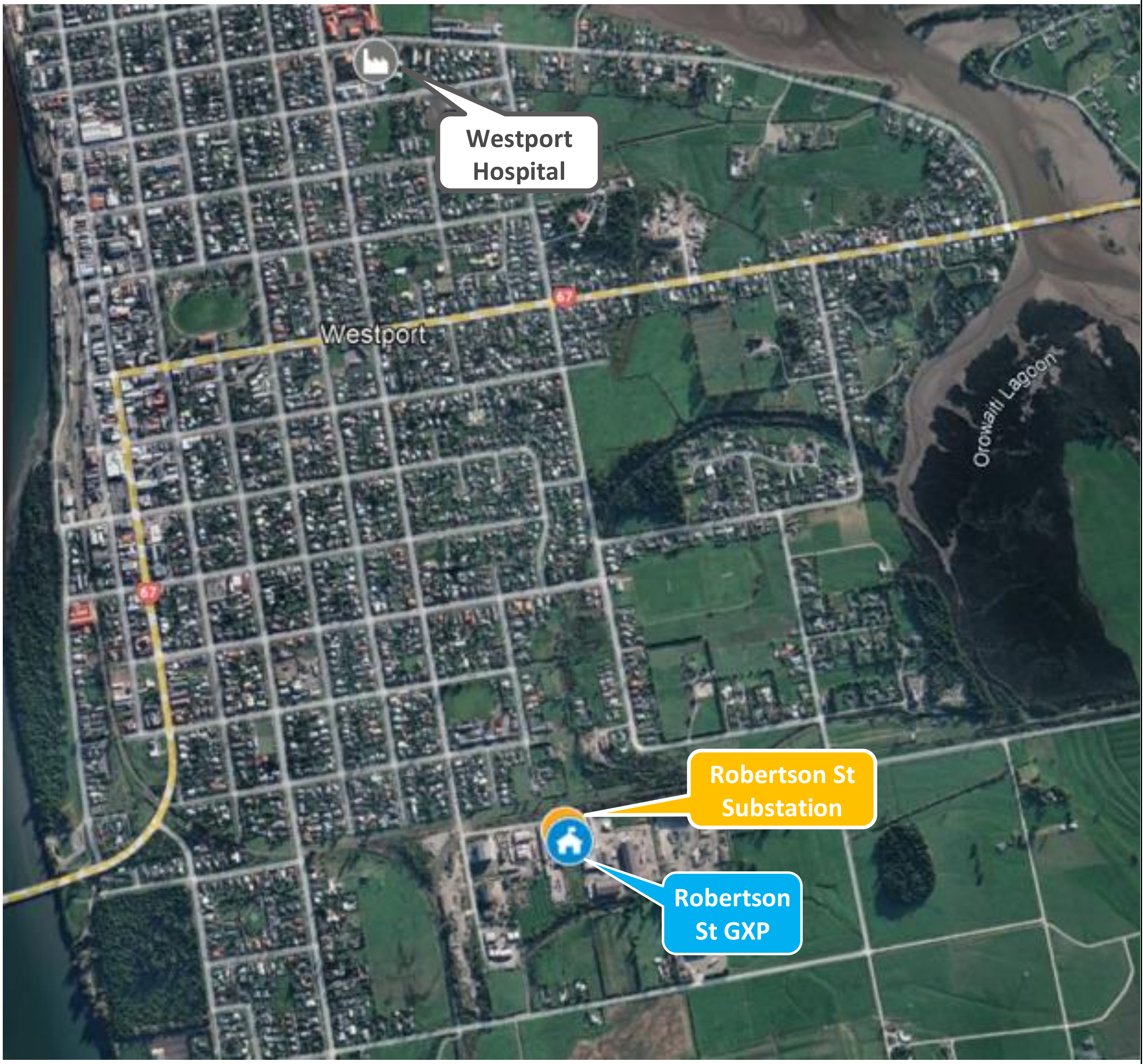


Figure 58 Westport Hospital geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

WESTPORT HOSPITAL
The 11kV Pakington St feeder has a peaking load of ≈2.0MVA. While Ergo has not been able to assess the capacity of the specific feeder, it is noted that Buller Electricity's Asset Management Plan [27] are not forecasting any capacity constraints on their 11kV feeders. Therefore, it is likely that: 1) The additional load could be supplied from the existing feeder 2) Otherwise, load could be transferred to adjacent feeders to provide the necessary capacity
Capital Cost Estimate
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$130k. This does not include the costs to install distribution transformers/switchgear on the 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 and land acquisition, if required.

[27] https://bullerelectricity.co.nz/asset-management-plan/

8.9.4 Buller Highschool

		Buller Highschool
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.22	Roberston St

Existing Electrical Supply to the Plant

Buller Highschool is presently fed from Roberston St substation via an 11kV feeder (Derby St Feeder).

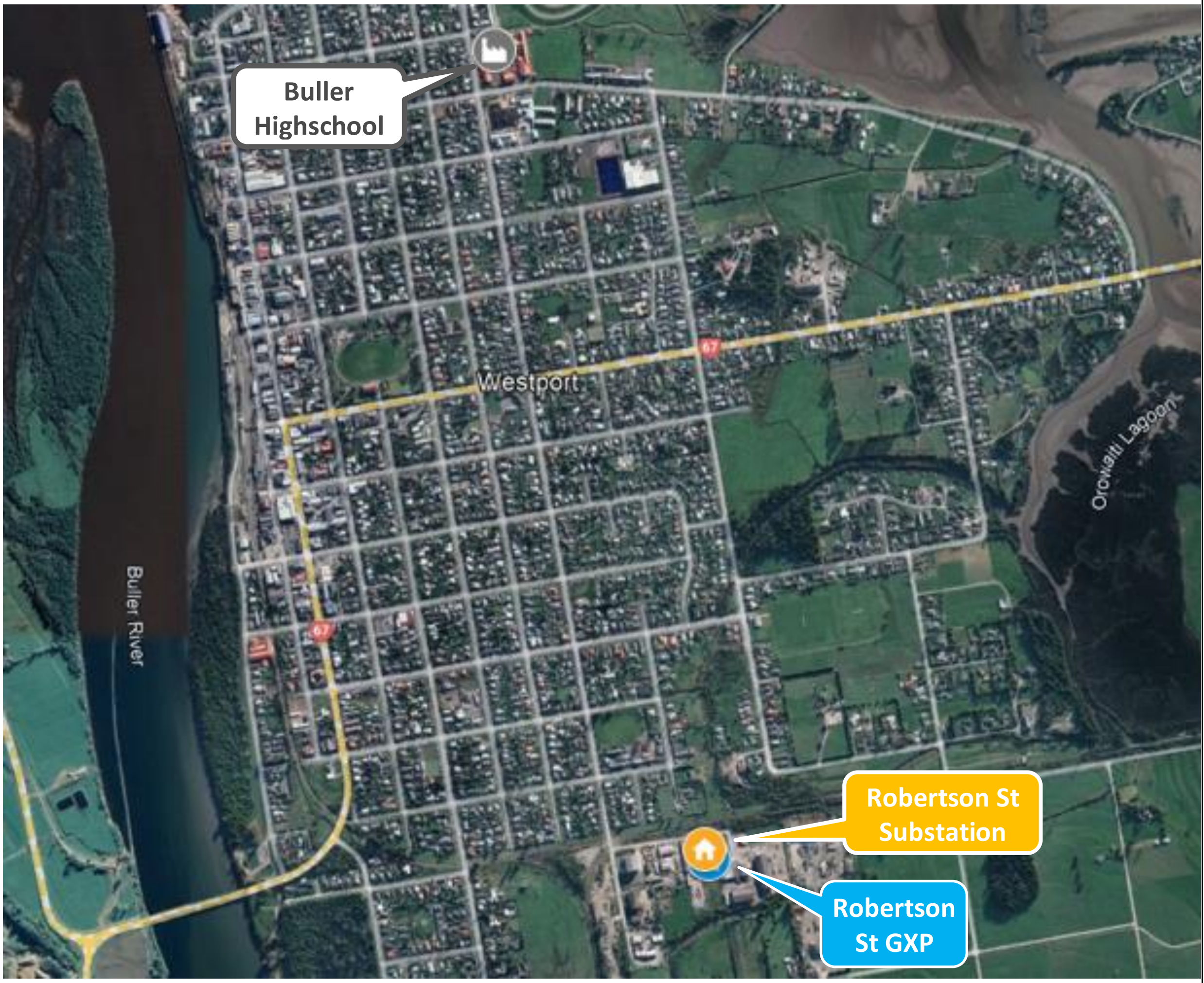


Figure 59 Buller Highschool geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load

The 11kV Derby St feeder has a peaking load of ≈2.0MVA. While Ergo has not been able to assess the capacity of the specific feeder, it is noted that Buller Electricities Asset Management Plan [28] are not forecasting any capacity constraints on their 11kV feeders. Therefore, it is likely that:

1. The additional load could be supplied from the existing feeder
2. Otherwise, load could be transferred to adjacent feeders to provide the necessary capacity

[28] https://bullerelectricity.co.nz/asset-management-plan/

Buller Highschool
Capital Cost Estimate
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$80k.
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 and land acquisition, if required.

8.9.5 Westport North School

		Westport North School
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.10	Roberston St
Existing Electrical Supply to the Plant		
Westport North is presently fed from Roberston St substation via an 11kV feeder (Domett St Feeder).		

Figure 60 Westport North School geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load
The 11kV Domett St feeder has a peaking load of ≈1.8MVA. While Ergo has not been able to assess the capacity of the specific feeder, it is noted that Bullers Asset Management Plan [29]are not forecasting any capacity constraints on their 11kV feeders. Therefore, it is likely that: 1) The additional load could be supplied from the existing feeder 2) Otherwise, load could be transferred to adjacent feeders to provide the necessary capacity
Capital Cost Estimate
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$50k.

[29] https://bullerelectricity.co.nz/asset-management-plan/

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 and land acquisition, if required.

8.9.6 Westport South School

		Westport South School
Load Site Description	**Electrical Demand (MW)**	**Transpower GXP**
New high temperature heat pump	0.07	Roberston St
Existing Electrical Supply to the Plant		
Westport South is presently fed from Roberston St substation via an 11kV feeder (Derby St Feeder).		

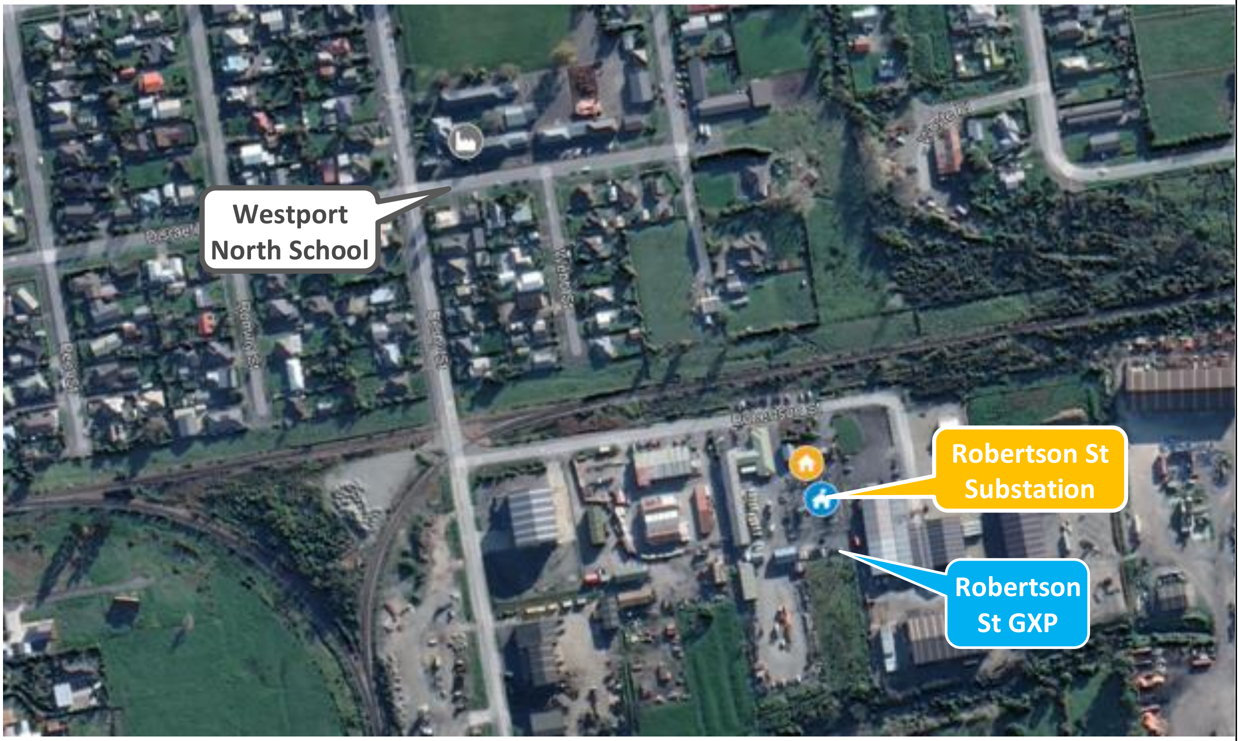


Figure 61 Westport South School geographic location in relation to the surrounding zone substations

Supply Option(s) for New Load	
The 11kV Derby St feeder has a peaking load of ≈2.0MVA. While Ergo has not been able to assess the capacity of the specific feeder, it is noted that Bullers Asset Management Plan [30]are not forecasting any capacity constraints on their 11kV feeders. Therefore, it is likely that: 1. The additional load could be supplied from the existing feeder 2. Otherwise, load could be transferred to adjacent feeders to provide the necessary capacity	
Capital Cost Estimate	
There is no upgrade costs expected for this site, other than the installation of a distribution transformer which could be ≈$50k.	

[30] https://bullerelectricity.co.nz/asset-management-plan/

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 and land acquisition, if required.

8.9.7 Effect of all Load Sites Connecting to Robertson St GXP

The following Figure 62 illustrates the Robertson St 2021 load profile together with the load profiles of all the Load Sites within the Robertson St GXP region. Also shown in Figure 62 is:

- The cumulative sum of all the loads (Combined Load), which forecasts that the load on the Robertson St GXP would increase to 11.2 MVA, a 0.5 MVA increase. Given that the independent sum of the individual loads is 12.6 MVA there is a diversity factor of 0.89 between the loads.
- The Robertson St GXP's (N-1) limit of 20 MVA (discussed in Section 6.1.7) is not expected to be exceeded.

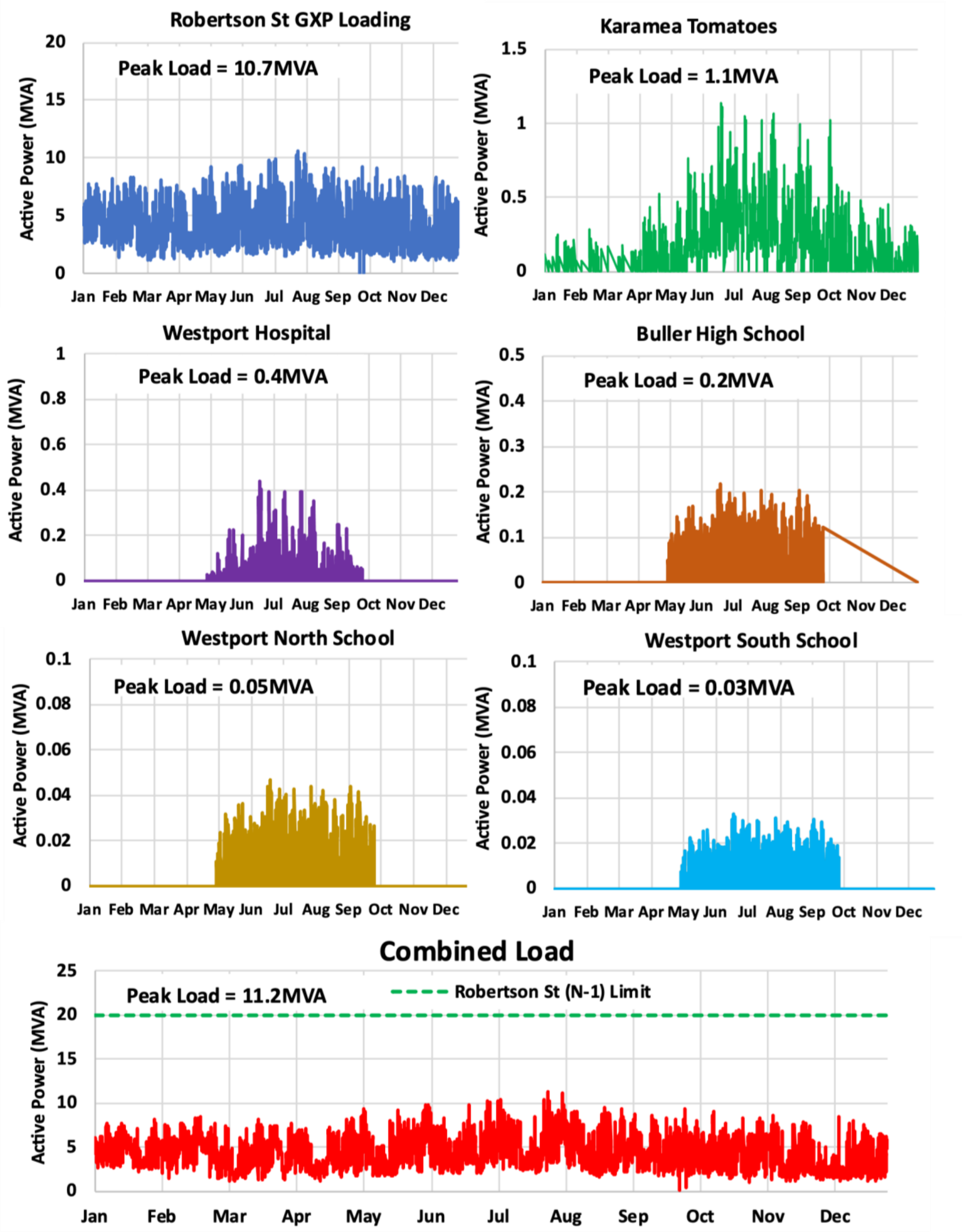


Figure 62 Loading Profiles: Robertson St GXP 2021 historical loading: Load Site Profiles: Combined Load (sum of all profiles)

9. Conclusions

9.1 Network Spare Capacity

The following Figure 1 illustrates the (N) and (N-1) spare capacity at the GXP substations in the West Coast Region. Note that Transpower does not own all the GXP substation and some of the substations are wholly (or partly) owned by Westpower and Buller.

West Coast Region: GXP Substations: Spare (N) and (N-1) Capacity

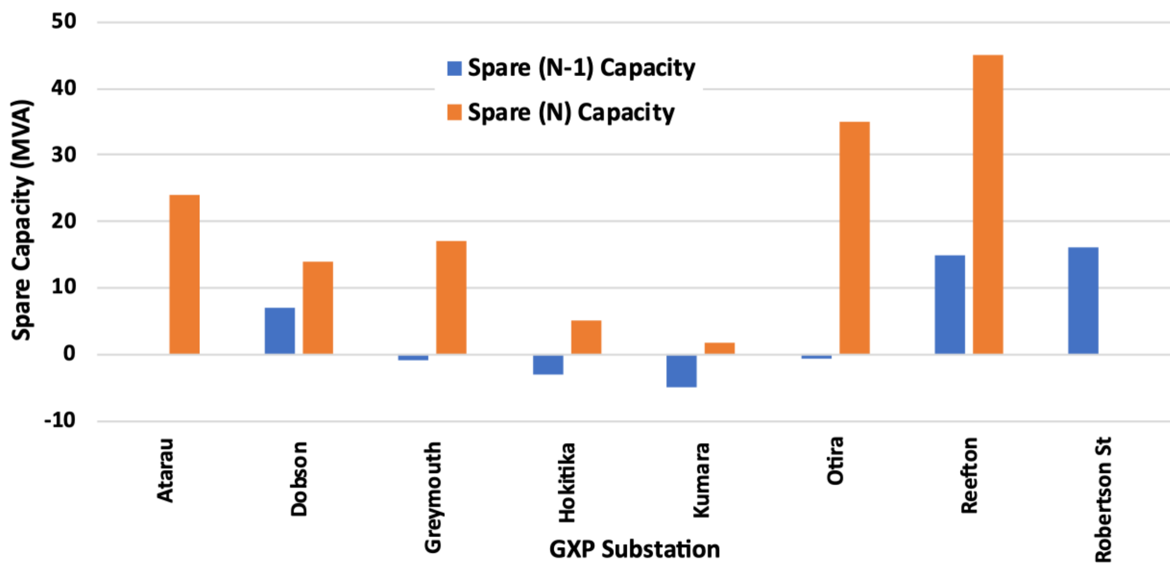


Figure 63 Summary: Approximate (N) and (N-1) spare capacity at GXP substations

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

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

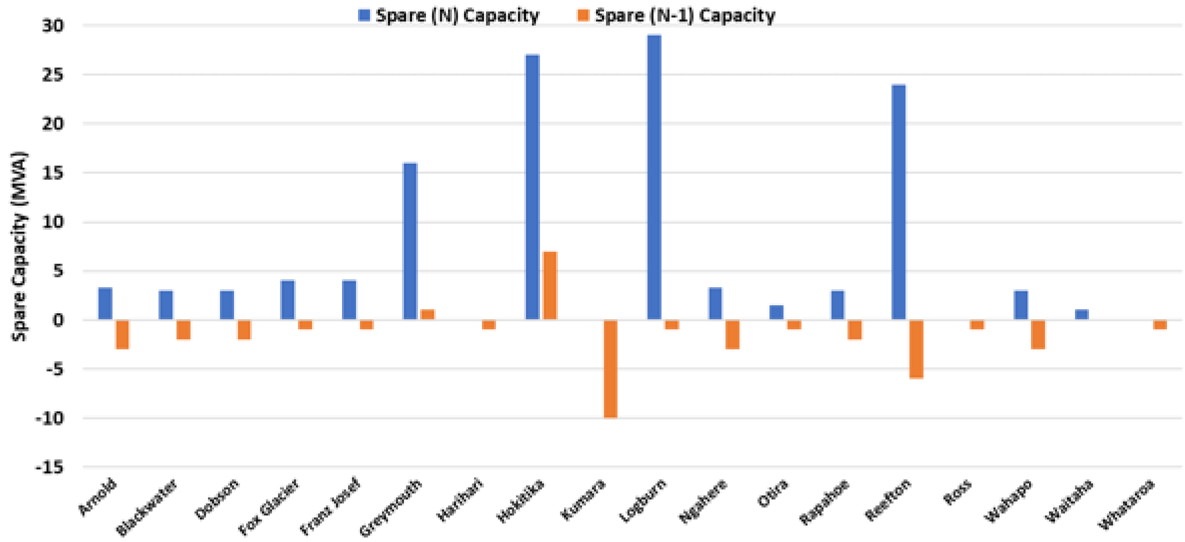


Figure 64 Summary: Approximate (N) and (N-1) spare capacity at Westpower's zone substations

Buller Electricity Zone Substations: Spare (N) and (N-1) Capacity

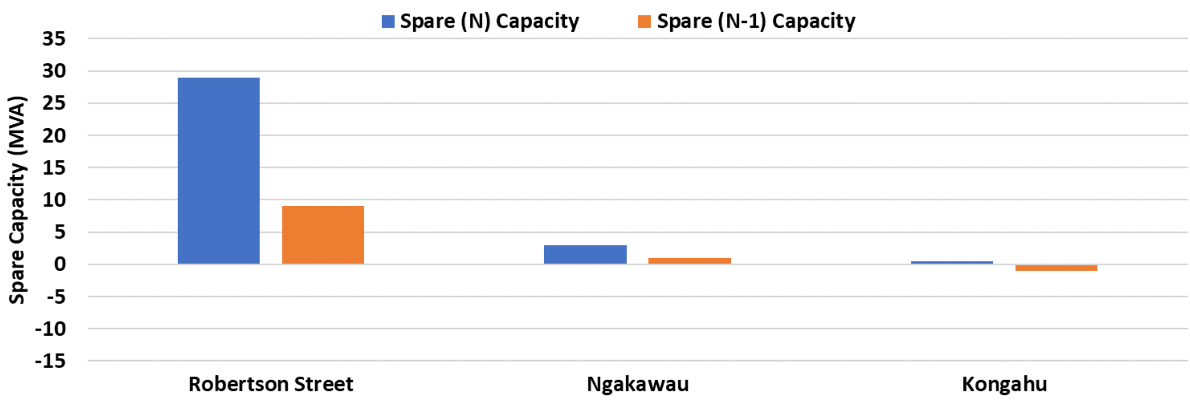


Figure 65 Summary: Approximate (N) and (N-1) spare capacity at Buller Electricity's zone substations

9.2 Load Characteristics

The substation load characteristics are documented in detail in the main body of the report (and the supplementary document 22132-RPT-0002) and vary widely. However, at a high level, the general characteristics of the substation loads are as follows:

GXP substations:

- *Dobson GXP* – GXP loading is impacted by the presence of a 3MW embedded generator. High weekday loading throughout the year suggests loading is largely industrial/commercial.
- *Greymouth GXP* – A typical mix of residential and commercial/industrial loads with winter peaks. The load tends to peak in the mornings and evenings and is lower during weekends.
- *Hokitika GXP* – Mix of industrial, dairy and tourist related loads. Summer peaks but with relatively flat daily loading profiles and inconsistent peak periods.
- *Kumara GXP* – Loading is significantly influenced by the embedded hydro generation with the substation predominantly acting as a Grid Injection Point.
- *Otira GXP* – Relatively small load with intermittent loading, likely associated with the Otira tunnel fans influencing the GXP loading.
- *Reefton GXP* – GXP loading is relatively consistent throughout the year and with typical morning and evening peaks. Loading is largely residential with some industrial/commercial.
- *Robertson Street GXP* – A mix of residential and commercial/industrial loads with winter peaks. Daily loading profiles vary significantly, likely due to the influence of the various industrial/commercial loads.

Zone Substations:

- The load characteristics of the zone substations vary widely depending on the connected consumers/generators. The historical loading graphs for the zone substations are included in the supplementary document **22132-RPT-0002**.

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

Table 17 Summary of Load Sites and estimated capital costs

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

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	ANZCO Kokiri	1.85	Dobson	$0.00	Arnold	$0.03	**$0.03**	**$0.02**	Minor	
2	Runanga School	0.05	Dobson		Rapahoe	$0.00	**$0.00**	**$0.00**	Minor	1
3	Value Proteins	13.30	Dobson		Arnold	$15.34	**$15.34**	**$1.15**	Major	
4	Westimber	0.28	Dobson		Ngahere	$0.00	**$0.00**	**$0.00**	Minor	1
5	Westland Recreation Centre	0.28	Greymouth	$0.00	Greymouth	$0.00	**$0.00**	**$0.00**	Minor	1
6	Greymouth High School	0.52	Greymouth		Greymouth	$0.29	**$0.29**	**$0.56**	Minor	
7	Greymouth Hospital	0.76	Greymouth		Greymouth	$0.41	**$0.41**	**$0.54**	Minor	
8	Cobden School	0.03	Greymouth		Greymouth	$0.00	**$0.00**	**$0.00**	Minor	1
9	Grey Main School	0.12	Greymouth		Greymouth	$0.00	**$0.00**	**$0.00**	Minor	1
10	Scenicland Laundry	0.40	Greymouth		Greymouth	$0.00	**$0.00**	**$0.00**	Minor	1
11	Westland Milk Products Hokitika	41.70	Hokitika	$21.90	Hokitika	$5.90	**$27.80**	**$0.67**	Major	2
12	Silver Fern Farms Hokitika	0.19	Hokitika	$0.00	Hokitika	$0.00	**$0.00**	**$0.00**	Minor	1
13	Ngai Tahu Franz Josef Hot Pools	0.19	Hokitika		Franz	$0.00	**$0.00**	**$0.00**	Minor	1
14	Westland Produce (electric boiler option)	2.13	Hokitika	$0.50	Harihari	$1.15	**$1.65**	**$0.77**	Minor	
15	Franz Josef EV Charging Station	0.60	Hokitika	$0.00	Franz	$0.00	**$0.00**	**$0.00**	Minor	1
16	Kumara EV Charging Station	2.30	Kumara	$0.00	Kumara	$0.40	**$0.40**	**$0.17**	Minor	
17	International Panel & Lumber	1.50	Kumara		Kumara	$0.40	**$0.40**	**$0.27**	Minor	
18	Reefton Area School	0.16	Reefton	$0.00	Reefton	$0.00	**$0.00**	**$0.00**	Minor	1
19	Reefton Hospital	0.30	Reefton		Reefton	$0.00	**$0.00**	**$0.00**	Minor	
20	Karamea Tomatoes (electric boiler option)	2.73	Robertson St	$0.00	Robertson St	$0.90	**$0.90**	**$0.33**	Minor	
21	Westport Hospital	0.54	Robertson St		Robertson St	$0.00	**$0.00**	**$0.00**	Minor	1
22	Buller High School	0.22	Robertson St		Robertson St	$0.00	**$0.00**	**$0.00**	Minor	1
23	Westport North School	0.10	Robertson St		Robertson St	$0.00	**$0.00**	**$0.00**	Minor	1
24	Westport South School	0.07	Robertson St		Robertson St	$0.00	**$0.00**	**$0.00**	Minor	1
	TOTAL =>	**70.3**	**TOTAL =>**	**$22.4**	**TOTAL =>**	**$24.82**	**$47.22**			

Notes

1 Table doesn't include distribution transformer costs for Load Sites (details provided in body of report)

2 Includes the costs of stage 1 and stage 2

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. For the larger Load Sites Ergo recommend proceeding with a Concept Design Report (CDR) to improve the accuracy of the respective cost estimate.

Appendix 1 Glossary

CT	Current transformer
DG	Distributed generator
DOB	Dobson GXP/substation
EDB	Electrical Distribution Business
EIPC	Electricity Industry Participation Code
ENA	Electricity Network Association
ESA	Electricity Supply Authority
GXP	Grid exit point substation
GYM	Greymouth GXP/substation
HKK	Hokatika GXP/substation
KUM	Kumara GXP/substation
kV	Kilovolts
MW	Megawatts
MVArs	Mega volt amps reactive
MVA	Mega volt amps
NTW	Network Waitaki
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)
OTI	Otira GXP/substation
RFN	Reefton GXP/substation
ROB	Robertson Street GXP/substation
SCADA	Supervisory control and data acquisition

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 18 Cost estimate classification matrix[32]

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.

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