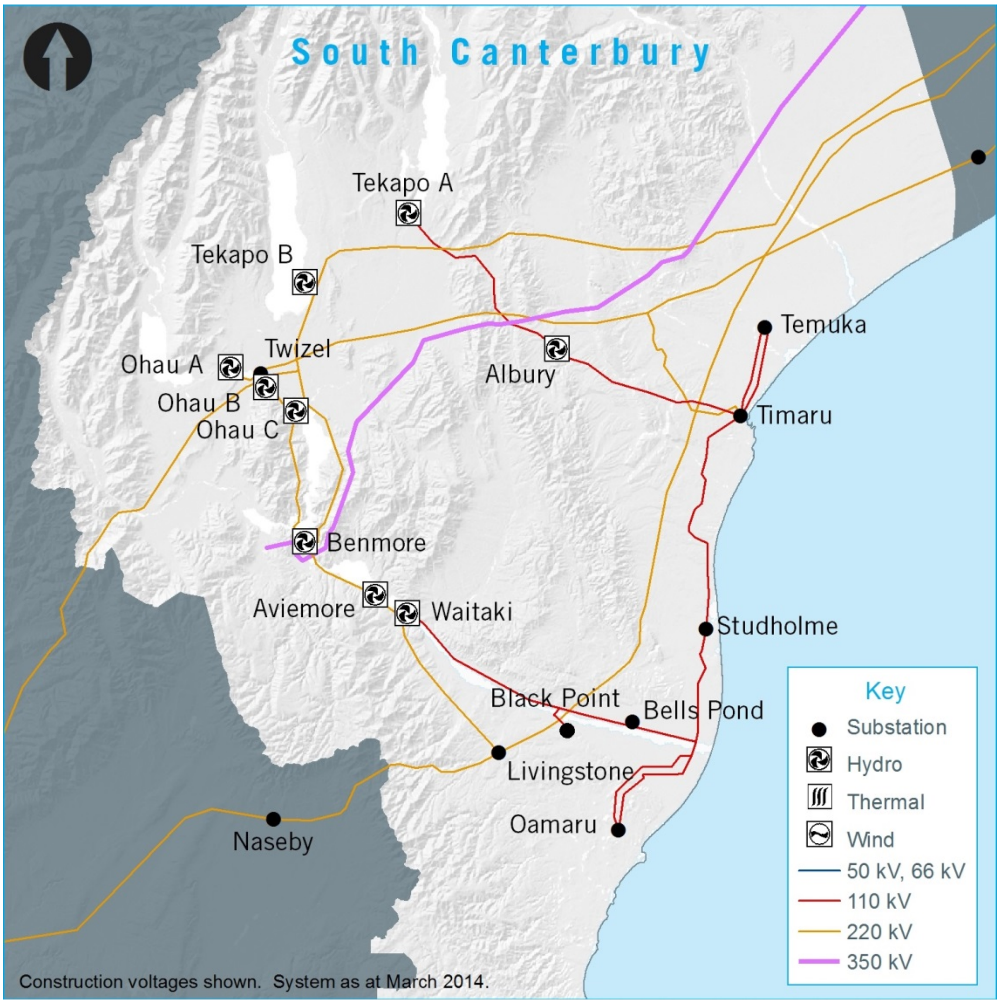
18 South Canterbury Regional Plan

18.1 Regional overview

This chapter details the South Canterbury regional transmission plan. We base this regional plan on an assessment of available data, and welcome feedback to improve its value to all stakeholders.

Figure 18-1: South Canterbury region



The South Canterbury region includes a mix of significant and growing provincial cities (Timaru and Oamaru) and agricultural industries (Bells Pond, Black Point, Studholme, Temuka, and Waitaki).

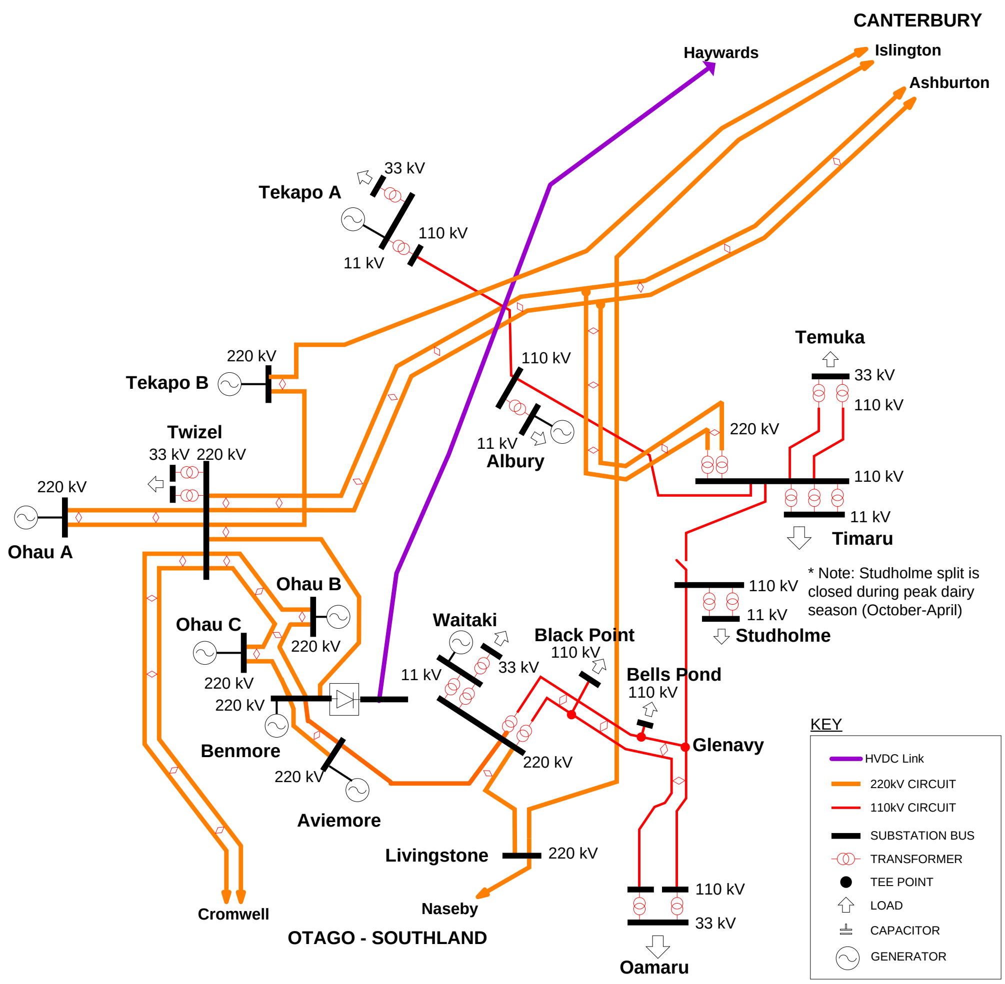
We have assessed the South Canterbury region's transmission needs over the next 15 years while considering longer-term development opportunities. Specifically, the transmission network needs to be flexible to respond to a range of future service and technology possibilities, taking into consideration:

- the existing transmission network
- forecast demand
- forecast generation
- equipment replacement based on condition assessment, and
- possible technological development.

18.2 South Canterbury transmission system

This section highlights the state of the South Canterbury regional transmission network. The existing transmission network is set out geographically in Figure 18-1 and schematically in Figure 18-2.

Figure 18-2: South Canterbury transmission schematic



18.2.1 Transmission into the region

Several major 220 kV lines serve the South Canterbury region, connecting it to Christchurch and the upper South Island to the north, and the Otago Southland region to the south.

This region contributes a major portion of the generation in the South Island, feeding the 220 kV transmission network from the Tekapo, Ohau, and Waitaki Valley generation stations. Peak load in the region (approximately 180 MW in 2014/15) is approximately 10% of the region's generation capacity, so the need for transmission capacity into the region is driven by generation export requirements, and the need to transfer power from the lower South Island to the upper South Island. In dry years with low generation south of Clyde, there may also be need to transfer power to the lower South Island, see chapter 6 Section 6.6.3

18.2.2 Transmission within the region

The South Canterbury regional transmission network comprises 220 kV and 110 kV transmission circuits, with interconnecting transformers at Timaru and Waitaki. Almost all the loads in the South Canterbury region are supplied via the 110 kV transmission network running up the east coast from Oamaru to Temuka.

The 110 kV transmission network is normally split at Studholme, but this split is closed during the peak dairy season (October–April) to increase the supply security to Studholme. The split creates two radial feeds incorporating the:

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

Up to 25 MW of generation is injected directly into the 110 kV transmission network from Tekapo A.

Much of the 110 kV transmission network is reaching its capacity, as are the interconnecting transformers at Timaru. This is mainly due to growth associated with the dairy industry, and irrigation in particular.

We have a number of investigations and projects planned or underway to support demand growth and supply security in the South Canterbury region. These include investigating:

- short- and long-term options to address capacity constraints on the 110 kV system between Waitaki and Timaru, and between Timaru and Temuka
- options to supply significant new loads in the Bells Pond area
- options to address the Timaru 220/110 kV transformer capacity constraints, and
- options to increase the security provided by the Waitaki 220/110 kV transformers.

18.2.3 Longer-term development path

Long-term development plans may include new 220 kV connections to offload the highly loaded 110 kV transmission network.

In the Timaru area, options include upgrading the Timaru 220/110 kV interconnection capacity, or building a new 220 kV connection west of Temuka at Orari.

In the Waitaki Valley, options include upgrading the existing 110 kV supply out of Waitaki, or building a new grid exit point connected to the 220 kV at Waihao (north of the Waitaki River). There may also be a new grid exit point connected to the 110 kV at Saint Andrews. These new grid exit points would allow the Bells Pond and Studholme grid exit points to be decommissioned.

Some demand-side response may be appropriate to allow the economic connection of large rural loads such as irrigation.

18.3 South Canterbury demand

The after diversity maximum demand (ADMD) for the South Canterbury region is forecast to grow on average by 3.3% annually over the next 15 years, from 220 MW in 2015 to 360 MW by 2030. This is higher than the national average demand growth of 1.1% annually.

Figure 18-3 shows a comparison of the 2014 and 2015 TPR forecast 15-year maximum demand (after diversity[145]) for the South Canterbury region. The forecasts are derived using historical data, and modified to account for customer information, where appropriate. The power factor at each grid exit point is also derived from historical data, and is used to calculate the real power capacity for power transformers and transmission lines. See Chapter 4 for more information about demand forecasting.

Figure 18-3: South Canterbury region after diversity maximum demand forecast

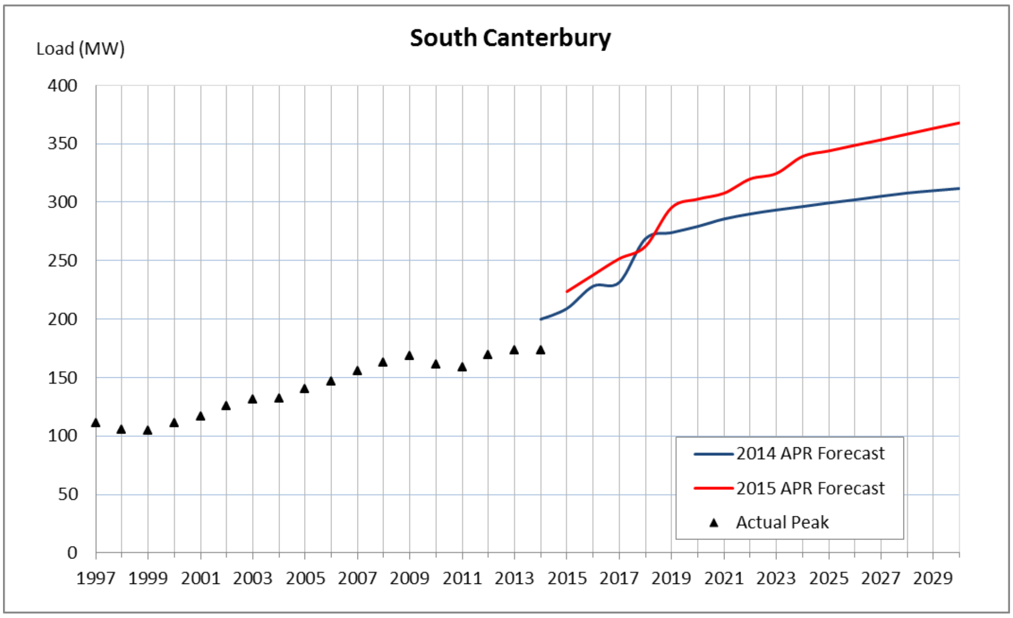


Table 18-1 lists forecast peak demand (prudent growth) for each grid exit point for the forecast period.

Table 18-1: Forecast annual peak demand (MW) at South Canterbury grid exit points to 2030

Grid exit point	Power factor	Peak demand (MW)										
		Next 5 years						6-15 years out				
		2015	2016	2017	2018	2019	2020	2022	2024	2026	2028	2030
Albury	0.95	5	5	5	5	5	5	7	7	7	8	8
Bells Pond[1,2]	0.94	16	20	26	26	32	32	35	38	39	39	40
Black Point[1]	0.85	15	15	15	19	19	19	19	19	20	20	20
Oamaru	0.96	42	43	45	47	48	50	54	55	56	58	59
St Andrews[1,3]	0.99	0	0	0	0	21	21	23	24	25	26	27

[145] The after diversity maximum demand (ADMD) for the region will be less than the sum of the individual grid exit point peak demands, as it takes into account the fact that the peak demand does not occur simultaneously at all the grid exit points in the region.

Grid exit point	Power factor	Peak demand (MW)										
		Next 5 years						6-15 years out				
		2015	2016	2017	2018	2019	2020	2022	2024	2026	2028	2030
Studholme[1,2]	0.96	19	20	20	20	27	27	34	35	36	36	37
Tekapo A	1.00	6	6	7	7	7	7	8	8	9	9	9
Temuka	0.96	67	68	70	71	72	74	77	87	90	93	96
Timaru	0.99	76	77	79	79	77	77	76	77	78	79	80
Twizel	1.00	6	10	12	12	13	13	14	14	14	15	15
Waitaki	0.97	11	12	13	14	14	14	14	14	15	15	15

1. These grid exit points have forecasts that include likely step changes in demand identified in discussions with customers. Loads include irrigation schemes and associated dairy industry development.
2. A significant component of this load growth occurs only if major irrigation schemes are developed. If the irrigation developments occur, the loads at these substations are likely to be supplied from a new grid exit point (Waihao) connected to the 220 kV.
3. St Andrews is our generic name for a possible future grid exit point between Studholme and Timaru.

18.4 South Canterbury generation

The South Canterbury region's generation capacity is 1,731 MW. This represents a major portion of total South Island generation and significantly exceeds local demand. Surplus generation is exported via the National Grid to other demand centres in the South Island, and via the HVDC link to the North Island.

Table 18-2 lists the generation forecast for each grid injection point in the South Canterbury region for the forecast period. This includes all known and committed generation stations including those embedded within the relevant local lines company's network (either Network Waitaki or Alpine Energy).[146]

Table 18-2: Forecast annual generation capacity (MW) at South Canterbury grid injection points to 2030 (including existing and committed generation)

Grid injection point (location if embedded)	Generation capacity (MW)										
	Next 5 years						6-15 years out				
	2015	2016	2017	2018	2019	2020	2022	2024	2026	2028	2030
Albury (Opuha)	8	8	8	8	8	8	8	8	8	8	8
Aviemore	220	220	220	220	220	220	220	220	220	220	220
Benmore	540	540	540	540	540	540	540	540	540	540	540
Ohau A	264	264	264	264	264	264	264	264	264	264	264
Ohau B	212	212	212	212	212	212	212	212	212	212	212
Ohau C	212	212	212	212	212	212	212	212	212	212	212
Tekapo A	25	25	25	25	25	25	25	25	25	25	25
Tekapo B	160	160	160	160	160	160	160	160	160	160	160
Waitaki	90	105	105	105	105	105	105	105	105	105	105

18.5 South Canterbury significant maintenance work

Our capital projects and maintenance works are integrated to enable system issues to be resolved if possible when assets are replaced or refurbished. Table 18-3 lists the significant maintenance-related work[147] proposed for the South Canterbury region

146 Only generators with capacity greater than 1 MW are listed. Generation capacity is rounded to the nearest megawatt.

147 This may include replacement of the asset due to its condition assessment.

for the next 15 years that may significantly impact related system issues or connected parties.

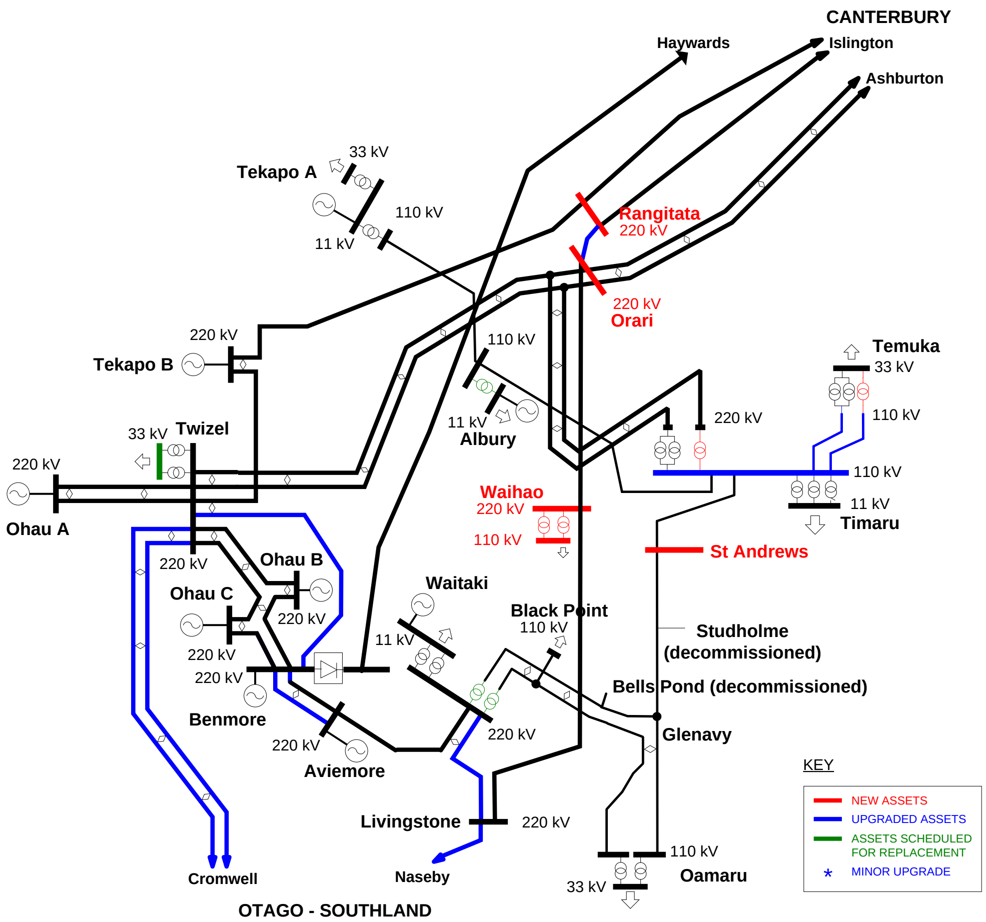
Table 18-3: Proposed significant maintenance work

Description	Tentative year
Albury supply transformer expected end-of-life	2017-2019
Studholme supply transformer expected end-of-life	2018-2020
Timaru 110 kV bus rationalisation	2016-2017
Twizel 33 kV outdoor to indoor conversion	2016-2017
Waitaki interconnecting transformers refurbishment	2016-2017

18.6 Future South Canterbury projects summary and transmission configuration

Figure 18-4 shows the possible configuration of South Canterbury transmission in 2030, with new assets, upgraded assets, and assets undergoing significant maintenance within the forecast period.

Figure 18-4: Possible South Canterbury transmission configuration in 2030



18.7 Changes since the 2014 Transmission Planning Report

Table 18-4 lists the specific issues that are either new or no longer relevant within the forecast period when compared to last year's report.

Table 18-4: Changes since 2014

Issues	Change
Timaru supply transformer capacity	Removed – supply transformers replacement completed.

18.8 South Canterbury transmission capability

Table 18-5 summarises issues involving the South Canterbury region for the next 15 years. For more information about a particular issue, refer to the listed section number.

Table 18-5: South Canterbury region transmission issues

Section number	Issue
Regional	
18.8.1	Oamaru–Waitaki voltage quality and transmission capacity
18.8.2	Timaru interconnecting transformer capacity
18.8.3	Waitaki 220/110 kV interconnecting transformer capacity
Site by grid exit point	
18.8.4	Albury supply security and supply transformer capacity
18.8.5	Albury and Tekapo A transmission security
18.8.6	Bells Pond single supply security
18.8.7	Black Point capacity and single supply security
18.8.8	Oamaru supply transformer capacity
18.8.9	Studholme single supply security
18.8.10	Studholme supply transformer capacity
18.8.11	Tekapo A supply security and supply transformer capacity
18.8.12	Temuka transmission security and supply transformer capacity
18.8.13	Twizel supply security
18.8.14	Waitaki single supply security and supply transformer capacity
Bus security	
18.9.1	Transmission bus security
18.9.2	Timaru 110 kV transmission security

18.8.1 Oamaru–Waitaki voltage quality and transmission capacity

Project Description:	Post-contingency load shedding New grid exit point Upgrade existing 110 kV line
Project status/type:	Load shedding: possible, base capex New grid exit point: possible, customer-specific Line upgrade: possible, Major Capex Project
Indicative timing:	Load shedding: summer 2016/17 New grid exit point: to be advised Line upgrade: to be advised
Indicative cost band:	Load shedding: A New grid exit point: D Line upgrade: D

Issue

Two 110 kV circuits from Waitaki supply the Oamaru, Black Point, Bells Pond, and Studholme grid exit points:

- Oamaru–Black Point–Waitaki–1 circuit (which supplies Black Point via a tee connection), and
- Oamaru–Studholme–Bells Pond–Waitaki–2 circuit (which supplies the Bells Pond and Studholme loads from tee connections).

The underlying load growth forecast for this area is considerably higher than the national average, and is mainly due to irrigation and the dairy industry. A new dairy factory, commissioned in 2014, is supplied from the Bells Pond grid exit point and is anticipated to expand in stages over the next few years.

Expansion of the irrigation scheme supplied from Black Point is committed. Black Point is forecast to expand by 2 MW for summer 2016/17, with a further 6 MW anticipated to be added after that in 2 MW stages. Timing for the additional 6 MW is uncertain but could be as early as summer 2017/18.

Voltage

The load at these four grid exit points peaks in summer. The voltage at the Oamaru 110 kV bus can fall below 0.9 pu with the loss of the:

- Oamaru–Black Point–Waitaki circuit, or
- Oamaru–Studholme–Bells Pond–Waitaki circuit.

There is a wider voltage agreement in place with Network Waitaki, extending the voltage lower range to 0.875 pu. Combined with the improved power factor of the Oamaru load, this has resolved the immediate voltage issue with the thermal limit typically constraining the load first.

If there is a connection to Timaru via Studholme (i.e. the Studholme Split is closed – see Section 18.8.9), significant voltage support is provided to Oamaru from Timaru.

There is also a voltage quality issue with a large voltage step immediately following the outage of either 110 kV circuit. The lack of availability of tap changing at the Waitaki interconnecting transformers limits voltage control flexibility on the 110 kV Oamaru–Waitaki circuits. There are no steady state voltage issues at Oamaru 33 kV, due to the range of the supply transformer on-load tap changers.

In the medium term, there are voltage stability issues. The limits are highly dependent on the location of load growth, the load power factor and the system configuration (particularly whether the system is split between Studholme and Timaru).

As a general guide, voltage stability issues could be expected to occur when the Oamaru load exceeds 48 MW with the Studholme–Timaru circuit out of service, and 55 MW with that circuit in service. This is beyond the present thermal limit, and depends to some extent on the Studholme, Black Point and Bells Pond loads.

Thermal overloading

Thermal n-1 limits on the 110 kV Glenavy–Oamaru section of the Oamaru–Studholme–Bells Pond–Waitaki–2 circuit were exceeded in summer 2014/15. The critical contingency is an outage of the parallel circuit. This has required load management by Network Waitaki.

The thermal limit of the 110 kV Bells Pond–Waitaki section was exceeded in summer 2014/15. Critical contingencies are the parallel 110 kV circuit as well as either 220 kV Ashburton–Timaru–Twizel circuit.

A special protection scheme at Waitaki detects an overload on the 110 kV Bells Pond–Waitaki circuit and splits the 110 kV circuit north or south of Studholme (depending on whether the 110 kV Oamaru–Black Point–Waitaki circuit is in service or not). This will resolve the issue until summer 2016/17.

The thermal limit of the 110 kV Black Point–Waitaki section of the Oamaru–Black Point–Waitaki–1 circuit may be exceeded in summer 2016/17. The critical contingency is an outage of the parallel circuit. This is a marginal overload and depends on voltage operating points and the power factor of the loads at Black Point and Oamaru.

Solution

We are investigating a range of short-term options, and the solution may include one or more of the following:

- pre- or post-contingency load management or standby generation at the Oamaru, Bells Pond, and/or Black Point grid exit points
- implementing a permanent 110 kV system split between Glenavy and Studholme
- load shifting within Network Waitaki's network from Oamaru to Waitaki
- improved load power factors at Oamaru and/or Black Point, and/or
- increasing the operating voltage at Waitaki during peak load periods.

A range of possible long-term options to resolve the capacity issue, include:

- transferring load from Bells Pond (and possibly Studholme) to a new grid exit point near the Islington–Livingstone circuit at Waihao
- transferring load from Oamaru to a new grid exit point at the existing Livingstone switching station (see Section 18.10.1)
- reconductoring and thermally upgrading the existing 110 kV circuits and providing additional reactive support, and
- transferring additional Oamaru load to an upgraded grid exit point at Waitaki.

Easements may be required for the line upgrade work, and will be required for any new lines.

We are discussing development options with the local lines companies (Network Waitaki and Alpine Energy).

18.8.2 Timaru interconnecting transformer capacity

Project description:	Additional interconnecting transformer capacity, or New grid exit point near Orari
Project status/type:	Interconnector capacity: Possible, Base Capex New grid exit point: Possible, customer specific
Indicative timing:	Both: 2018-2020
Indicative cost band:	Interconnector capacity: C New grid exit point: D

Issue

Two 220/110 kV interconnecting transformers at Timaru supply the loads at Timaru, Temuka, Albury and Tekapo A, providing:

- a total nominal installed capacity of 240 MVA, and
- n-1 capacity of 122/127 MVA (summer/winter).

The peak recorded Timaru area load is approximately 108/100 MW (summer/winter), assuming Tekapo A is generating. If Tekapo A is not generating, an outage of one transformer may cause:

- the other transformer to exceed its n-1 capacity during peak summer periods, resulting in load shedding, and
- voltage instability once the Timaru area loads exceed 126 MW.

With Tekapo A at maximum generation, the transformers' n-1 thermal limit will be reached when the Timaru area load is approximately 120 MW. The n-1 voltage stability limit will be approximately 135 MW.

Some development options for the Lower Waitaki Valley area might increase the loading on these transformers (for example, supplying Studholme from Timaru instead of Waitaki - see Section 18.8.1 for more information).

In addition, we recently installed an automatic load shedding scheme that will reduce load at Timaru if either interconnector becomes overloaded. This allows load above the n-1 limit to be supplied as long as both interconnectors are in service.

Solution

The options to address this issue include one or more of the following:

- reducing reactive power flow through the Timaru interconnecting transformers (for example by improving the load power factor or installing 110 kV reactive support)
- shifting load to a new grid exit point (see section 18.8.12 for more information), and/or
- increasing installed capacity using one of several possible configurations of the existing and new interconnecting transformers.

18.8.3 Waitaki 220/110 kV interconnecting transformer capacity

Project description:	Refurbishment of Waitaki interconnecting transformers
Project status/type:	Possible, Base Capex
Indicative timing:	2017-2019
Indicative cost band:	A

Issue

Two 220/110 kV interconnecting transformers (T23 and T24) at Waitaki supply the Waitaki 110 kV loads at Black Point, Bells Pond, Oamaru, and Studholme, providing:

- a total nominal installed capacity of 130 MVA, and
- n-1 capacity of 80/85 MVA (summer/winter).

The loading on the two transformers is unequal because of the system configuration (there is no 110 kV bus at Waitaki and only Oamaru is connected to both circuits). These transformers have a higher capacity than the circuits they supply, so they are not the first constraint. However, under some 110 kV Oamaru–Waitaki transmission upgrade scenarios, the capacity of the Waitaki–Oamaru circuits will exceed the interconnecting transformers' n-1 capacity.

In addition, some of the transformer bushings require replacement and the tap changers on these transformers cannot be operated due to their condition. The lack of operable tap changers worsens voltage issues on the Lower Waitaki 110 kV transmission system (see Section 18.8.1 for more information).

Solution

These transformers have an expected end-of-life within the next 10-15 years if the bushings are replaced. We intend to replace the 110 kV and 220 kV bushings and repair existing oil leaks.

We will consider the appropriate replacement transformer size and configuration when the need arises (this may be driven by load growth, changes in the 110 kV transmission system or transformer condition).

18.8.4 Albury supply security and supply transformer capacity

Project status/type:	This issue is for information only

Issue

A single 110/11 kV, 5 MVA transformer supplies load at Albury resulting in no n-1 security.

In addition, Albury has embedded generation at Opuha, which may export power to the National Grid during periods of low demand.

The peak load at Albury is forecast to exceed the transformer's summer capacity by approximately 1 MW in 2018, increasing to approximately 3 MW in 2030 (see Table 18-6).

Alpine Energy has requested that the Albury 11 kV bus voltage be managed within a narrow range. The transformer taps cannot be operated on-load when there is power flow in the export direction, which affects the ability to manage voltage.

Table 18-6: Albury supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						6-15 years out				
		2015	2016	2017	2018	2019	2020	2022	2024	2026	2028	2030
Albury	0.95	0	0	0	1	1	1	2	3	3	3	3

Solution

The Albury load forecast does not separate Opuha generation from actual load. Therefore, the transformer overload forecast assumes historical generation patterns.

There is some ability for Opuha generation to supply the local load during planned outages. Alpine Energy can supply a limited amount of Albury's load from adjacent substations. In addition, Transpower's mobile substation can be used at Albury to cover a transformer planned outage.

Therefore, the issue can be managed operationally for the forecast period. Future investment will be customer driven.

The supply transformer has an expected end-of-life within the next five years. We have discussed transformer replacement options with Alpine Energy to provide for load growth and coordinating outages to minimise supply interruptions when replacing this transformer. Further investment will be customer driven.

18.8.5 Albury and Tekapo A transmission security

Project status/type:	This issue is for information only

Issue

A single 110 kV Tekapo A–Albury–Timaru circuit connects Tekapo A, Albury, and Opuha to the National Grid. If the circuit trips, demand located at Albury and Tekapo A will lose supply, and generation located at Tekapo A and Opuha will disconnect from the National Grid.

Solution

Albury and Tekapo A demand may be restored by local Opuha and Tekapo A generation. Alpine Energy considers the issue can be managed operationally for the forecast period. Future investment will be customer driven.

18.8.6 Bells Pond single supply security

Project description:	n-1 security at Bells Pond
Project status/type:	Possible, customer-specific
Indicative timing:	See Section 18.8.1
Indicative cost band:	See Section 18.8.1

Issue

Bells Pond has a single 110 kV circuit with a hard-tee connection to Oamaru–Waitaki–2 circuit, resulting in no n-1 security. Additionally, the capacity of the 110 kV circuit between Bells Pond and Waitaki can already be exceeded at peak load periods during an outage of the parallel 110 kV circuit.

Solution

Alpine Energy has requested a higher capacity and security level, and we are discussing possible options. The preferred option is to shift the Bells Pond load to a new 220/110 kV grid exit point connected to the Islington–Livingstone circuit at Waihao, near Waimate (see Section 18.8.1 for more information).

Future investment will be customer driven.

18.8.7 Black Point capacity and single supply security

Project status/type:	This issue is for information only

Issue

Black Point has a single 110 kV circuit with a hard-tee connection to the Oamaru–Waitaki–1 circuit, resulting in no n-1 security.

The Black Point load is forecast to increase over the next three to five years to a level that will see constraints on the section between Black Point and Waitaki (refer to section 18.8.1).

Additionally, there are constraints on maintenance during the irrigation season, which now extends from September to May. These constraints are becoming unmanageable as some maintenance cannot be done during winter.

Solution

We are discussing options with the customer, which include:

- agreement on a more flexible maintenance outage schedule
- a changeover system at the tee point to allow connection to the parallel Oamaru–Waitaki circuit
- a second tee circuit from the parallel Oamaru–Waitaki circuit
- a post-contingency load management scheme, and/or
- improving the load power factor.

18.8.8 Oamaru supply transformer capacity

Project status/type:	This issue is for information only

Issue

Two 110/33 kV transformers supply Oamaru's load, providing:

- a total nominal installed capacity of 120 MVA, and

- n-1 capacity of 63/63 MVA[148] (summer/winter).

Due to voltage drop and power factor considerations at Oamaru, this translates to a load limit approximately 50 MW.

The peak load at Oamaru is forecast to exceed the transformers' n-1 summer capacity by approximately 3 MW in 2022, increasing to approximately 9 MW in 2030 (see Table 18-7).

Table 18-7: Oamaru supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						6-15 years out				
		2015	2016	2017	2018	2019	2020	2022	2024	2026	2028	2030
Oamaru	0.96	0	0	0	0	0	0	3	5	6	8	9

Solution

The 110 kV circuits supplying these transformers have a lower capacity[149] than the transformers (see Section 18.8.1). Therefore, the transformers are not the first constraint on Oamaru load.

The customer is considering options (see Sections 18.8.1 and 18.8.14 for more information):

- to enable load to exceed the existing transmission capacity, and/or
- limit Oamaru load growth or shift load from Oamaru, keeping the Oamaru load within the existing n-1 capacity of the 110 kV circuits.

Future investment will be customer driven.

18.8.9 Studholme single supply security

Project status/type:	See Sections 18.8.1 and 18.8.10 for more information

Issue

The Studholme–Timaru circuit is split during the dairy off-season (May to September), and Studholme is supplied by the Oamaru–Studholme–Bells Pond–Waitaki circuit. This reduces losses that occur when power flows through the 110 kV system from Waitaki to Timaru. If the Oamaru–Studholme–Bells Pond–Waitaki circuit has a fault, the supply to Studholme automatically transfers to the Studholme–Timaru line. This results in approximately a 25 second loss of supply at Studholme before the switching occurs.

Even a brief loss of supply can cause significant economic loss for the dairy factory at Studholme, so the split is closed for the peak dairy season (October to April).

Closing the split increases the loading on the circuits between Waitaki and Studholme, as some power flows from Studholme to Timaru. However, this is to some extent balanced by the voltage support for the Oamaru area that the connection through to Timaru provides.

A special protection scheme at Waitaki detects an overload on the Bells Pond–Waitaki section of the 110 kV Oamaru–Studholme–Bells Pond–Waitaki circuit and splits the 110 kV circuit north or south of Studholme (depending on whether the

[148] The Oamaru transformers' capacity is limited by protection equipment limits, followed by the circuit breaker (71 MVA) limits; with these limits resolved, the n-1 capacity will be 72/76 MVA (summer/winter).

[149] The lowest rated circuit section (Black Point–Oamaru) is rated at 49/60 MVA summer/winter.

110 kV Oamaru–Black Point–Waitaki circuit is in service or not). See Section 18.8.1 for more information.

In the medium term it may be necessary to permanently split the 110 kV system between Studholme and Glenavy, to reduce loading on the Bells Pond–Waitaki circuit. This will leave Studholme normally supplied from Timaru.

Solution

In the short-term, we will investigate the economic benefit of closing the split over winter.

Long-term, the solutions to the Oamaru–Waitaki voltage quality and transmission security issue (see Section 18.8.1 for more information) and the Timaru interconnecting transformer capacity (see Section 18.8.2) will determine the options available at Studholme.

18.8.10 Studholme supply transformer capacity

Project description:	Upgrade transformer capacity or New grid exit point
Project status/type:	Upgrade transformer capacity: possible, customer-specific New grid exit point: possible, customer-specific
Indicative timing:	Upgrade transformer capacity: 2018-20 (subject to Alpine Energy agreement) New grid exit point: to be advised
Indicative cost band:	Upgrade transformer capacity: B New grid exit point: D

Issue

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

- a total nominal installed capacity of 20 MVA, and
- n-1 capacity of 11/12 MVA (summer/winter).

The peak load at Studholme already exceeds the transformers' n-1 summer capacity, and the overload is forecast to increase to approximately 27 MW in 2030 (see Table 18-8). The load forecast is driven by an anticipated dairy factory expansion and new irrigation schemes.

Table 18-8: Studholme supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						6-15 years out				
		2015	2016	2017	2018	2019	2020	2022	2024	2026	2028	2030
Studholme	0.96	9	10	10	10	17	17	24	25	26	26	27

Studholme has an unusual 110 kV bus arrangement, where the two transformers have no dedicated 110 kV circuit breakers. This means that both supply transformers will be tripped to clear a transformer fault, causing a loss of supply at Studholme. Supply can be restored after the faulted transformer is disconnected.

Solution

Possible solutions include:

- replacing the existing transformers with higher-rated units, or
- supplying the load from a new grid exit point south-west of Studholme at Waihao on the 220 kV Islington–Livingstone circuit and decommissioning Studholme (see section 18.8.1), and
- possibly a new grid exit point on the 110 kV Studholme-Timaru circuit near Saint Andrews.

Acquisition of substation land will be required for establishing new grid exit point(s).

Both supply transformers are programmed for replacement within the next five years based on their age and condition assessment. Transformer replacement is unlikely to be economic if irrigation developments are likely to occur, as these developments are expected to result in a new grid exit point. In this case the transformer replacement would be deferred.

If the transformers are to be replaced, we will discuss the transformer capacity with Alpine Energy.

18.8.11 Tekapo A supply security and supply transformer capacity

Project description:	Resolve Tekapo A supply transformer branch limits
Project status/type:	Proposed, Base Capex
Indicative timing:	2015/16
Indicative cost band:	A

Issue

A single 110/11 kV, 35 MVA transformer in series with a single 33/11 kV, 10 MVA[150] transformer supplies load at Tekapo, resulting in no n-1 security.

The peak load at Tekapo A is forecast to exceed the 33/11 kV transformer's winter branch rating by approximately 1 MW from 2018, increasing to 3 MW by 2030 (see Table 18-9).

Table 18-9: Tekapo A supply transformer overload forecast

Circuit/Grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						6-15 years out				
		2015	2016	2017	2018	2019	2020	2022	2024	2026	2028	2030
Tekapo A	1.00	0	0	0	1	1	1	1	2	2	2	3

Solution

Transpower's mobile substation is an option for use at Tekapo A during planned outages, and Alpine Energy considers that the lack of n-1 security can be managed operationally for the forecast period.

We will investigate resolving the CT limit, which will provide sufficient capacity for the forecast period. Future investment will be customer driven.

18.8.12 Temuka transmission security and supply transformer capacity

Project description:	Special protection scheme Additional transformer Upgrade Temuka–Timaru circuit capacity New grid exit point near Orari
Project status/type:	Possible, customer-specific
Indicative timing:	2015–2019
Indicative cost band:	Special protection scheme: A Additional transformer: B Upgrade circuit capacity: to be advised New grid exit point: to be advised

150 The transformer's branch limit of 4.5 MVA (due to a CT rating) prevents the full nominal installed capacity being available.

Issue

Two 110 kV Timaru–Temuka circuits, rated at 71/79 MVA and 73/80 MVA (summer/winter), supply the Temuka 33 kV load. The Clandeboye dairy factory represents approximately half the Temuka 33 kV peak load. This creates the potential for significant economic loss during interruptions at this grid exit point.

An outage of one of these circuits is forecast to cause the other circuit to exceed its thermal capacity during summer peak demand periods by summer 2015/16. There is also no 110 kV bus at Temuka. Therefore, a circuit outage will also result in the loss of the 110/33 kV supply transformer connected to this circuit.

At Temuka, two 110/33 kV transformers supply the 33 kV load, providing:

- a total nominal installed capacity of 108 MVA, and
- n-1 capacity of 61/63 MVA (summer/winter).

The peak load at Temuka is forecast to exceed the transformers' n-1 summer capacity by approximately 14 MW in 2015, increasing to approximately 43 MW in 2030 (see Table 18-10).

Table 18-10: Temuka supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						6-15 years out				
		2015	2016	2017	2018	2019	2020	2022	2024	2026	2028	2030
Temuka	0.96	14	16	17	18	20	21	24	34	37	40	43

Solution

We are discussing options with Alpine Energy. Short-term options include:

- pre-contingency load management
- a demand response scheme, and/or
- a special protection scheme to manage load post-contingency.

Long-term options include:

- paralleling the existing transformers and installing a new 120 MVA transformer, and
- upgrading the 110 kV circuits between Timaru and Temuka, or
- a new connection to one or more of the 220 kV circuits west of Temuka at Orari.

The addition of a new transformer will not raise new property issues as it can be implemented within the existing substation boundary. However, upgrading the capacity of the 110 kV Temuka–Timaru circuits may require easements.

We have begun a project to investigate the full range of long-term options for Temuka along with the Timaru interconnection capacity (see Section 18.8.2).

18.8.13 Twizel supply security

Project status/type:	This issue is for information only

Issue

Two 220/33 kV transformers supply the Twizel load, providing:

- a total nominal installed capacity of 40 MVA, and
- n-1 capacity of 26/27 MVA (summer/winter).

The loads supplied from the Twizel 33 kV bus have 'n' transformer security, because the supply bus is split. Hydro generation and control structures in the area (Ohau A, B and C, Tekapo B, Ruataniwha and Pukaki) take their local supply from this bus, and it is split to reduce the risk of losing connection to all sites simultaneously.

Alpine Energy takes 33 kV supply from one side of the split, and Network Waitaki takes supply from the other side of the split.

The bus split can be closed to avoid loss of supply during transformer maintenance, and in a short time following an unplanned transformer outage.

Solution

Alpine Energy, Network Waitaki, Meridian and Genesis consider that the present level of security can be managed operationally.

The 33 kV switchyard is scheduled to be converted to an indoor switchboard within the next five years, and may include a bus section breaker, which will allow the bus to be run solid while maintaining a high level of security. The design will be confirmed as part of the replacement project.

18.8.14 Waitaki single supply security and supply transformer capacity

Project reference:	Customer to take supply from our 11 kV (generation) bus
Project status/type:	Committed, customer-specific
Indicative timing:	2015
Indicative cost band:	N/A

Issue

A single 33/11 kV, 5.5 MVA transformer supplies load at Waitaki resulting in no n-1 security.

Network Waitaki can supply some of the Waitaki load from Twizel after a short loss of supply. However, the peak Waitaki load is forecast to exceed the continuous supply transformer capacity by approximately 6 MW in 2015, increasing to approximately 10 MW in 2030 (see Table 18-11).

Table 18-11: Waitaki supply transformer overload forecast

Circuit/grid exit point	Power factor	Transformer overload (MW)										
		Next 5 years						6-15 years out				
		2015	2016	2017	2018	2020	2021	2022	2024	2026	2028	2030
Waitaki	0.97	6	7	8	9	9	9	10	10	10	10	10

Solution

Network Waitaki is installing a new 20/24 MVA transformer at Waitaki to increase capacity. The existing 5 MVA transformer will be retained in the short term. In the medium term Network Waitaki may install a second 25 MVA transformer to increase security (enabling decommissioning of the 5 MVA transformer).

This, along with developments in the distribution network, will allow Network Waitaki to meet increased load growth in the Upper Waitaki Valley. (See also section 18.8.1).

18.9 South Canterbury bus security

This section includes issues arising from the outage of a single bus section rated at 50 kV and above for the next 15 years.

Bus outages disconnect more than one power system component (for example, other circuits, transformers, reactive support or generating units). Therefore, bus outages may cause greater issues than a single circuit or transformer outage (although the risk of a bus fault is low, being less common than a circuit or transformer outage).

18.9.1 Transmission bus security

Table 9-16 lists bus outages that cause voltage issues or a total loss of supply. Generation is included only if a bus outage disconnects the whole generation station or causes a widespread system impact. Supply bus outages, typically 11 kV and 33 kV, are not listed.

Table 18-12: Transmission bus outages

Transmission bus outage	Loss of supply	Generation disconnection	Transmission issue	Further information
Albury 110 kV	Albury Tekapo A	Opuha Tekapo A	-	See note 1
Aviemore	-	Aviemore	-	See note 4
Oamaru 110 kV 1	Black Point	-		See note 2
Oamaru 110 kV 2	Bells Pond Studholme	-	-	See note 2
Ohau A	-	Ohau A	-	See note 4
Studholme 110 kV	Studholme	-	-	
Tekapo B	-	Tekapo B	-	See note 4
Timaru 110 kV	Albury Studholme Tekapo A Temuka Timaru	Opuha Tekapo A	-	18.9.2
Waitaki 220 kV-A	Bells Pond Studholme	-	-	See note 3
Waitaki 220 kV-B	Black Point	-	-	See note 3

1. An Albury 110 kV bus outage will disconnect the Albury load and embedded generator (Opuha) and the single circuit to Tekapo A, also disconnecting the generation and load at Tekapo A.
2. This is a minor issue where, without a line breaker, the bus becomes an extension of a long circuit, and adds a small level of additional risk of that circuit tripping.
3. This is a minor issue where loads on n security are at risk from a circuit outage, and that risk extends to an outage of the transformer and 220 kV bus because there is no 110 kV bus.
4. Disconnection of local generation only.

The customers (Alpine Energy, Meridian and Genesis) have not requested a higher security level (excluding the Timaru 110 kV bus). Unless otherwise noted, we do not propose to increase bus security and future investment is likely to be customer driven.

If increased bus security is required, the options typically include bus reconfiguration and/or additional bus circuit breakers.

18.9.2 Timaru 110 kV transmission security

Project reference:	Timaru 110 kV bus rationalisation
Project status/type:	Committed, Base Capex
Indicative timing:	2016–2017
Indicative cost band:	A

Issue

The Timaru 110 kV bus operates as a single zone and supplies the entire loads at Timaru and Temuka, connects directly to Albury and Tekapo A via a single 110 kV circuit, and supplies Studholme when the system is split between Studholme and Glenavy (see Section 18.8.9). A 110 kV bus fault at Timaru will cause:

- a total loss of supply to Timaru and Temuka
- a total loss of supply at Tekapo A and the disconnection of the Tekapo A generation
- the disconnection of Albury, possibly causing a loss of supply to Albury, and the disconnection of Opuha generation if islanding is unsuccessful, and
- a loss of supply to Studholme if the system is split between Glenavy and Studholme.

Solution

We are committed to converting the Timaru 110 kV bus to three zones, which will secure the Timaru area load. This is scheduled for completion by summer 2017/18.

There may still be a loss of supply and generation disconnection at Tekapo A, Albury and Opuha for an outage of the bus section connecting the single Tekapo A–Albury–Timaru circuit. Similarly, there will still be a loss of supply to Studholme (if the system is split between Studholme and Glenavy) for an outage of the bus section connecting the Studholme–Timaru circuit.

18.10 Other regional items of interest

18.10.1 New grid exit points

Development of a 220/110 kV Waihao grid exit point connected to the Islington–Livingstone circuit (see also Sections 18.8.1 and 18.8.6) will supply new irrigation load and also has the potential to shift load from the Bells Pond and Studholme substations. Load at Waihao is not separately listed in the load forecast but is included in the load forecasts for Bells Pond and Studholme (see Section 18.3 for more information).

St Andrews is our generic name for a possible new 110/11 kV grid exit point between Studholme and Timaru. It will supply principally irrigation load. This substation is considered as part of the annual peak demand forecast from 2019. It is likely the load at Bells Pond and Studholme will need to be shifted to Waihao to free up capacity on the 110 kV circuits for Saint Andrews.

Installing supply transformers at the Livingstone switching station is one option to address a number of issues on the south side of the Waitaki River. The issues include:

- Oamaru–Waitaki voltage quality and transmission security (see Section 18.8.1).
- Black Point single supply security (see Section 18.8.7).
- Oamaru supply transformer capacity (see Section 18.8.8).
- Waitaki supply transformer capacity (see Section 18.8.14).

It could also release capacity on the existing 110 kV circuits and allow increased security to load connected to Bells Pond.

Future investment will be customer driven.

18.11 South Canterbury generation proposals and opportunities

This section details relevant regional issues for generation proposals under investigation by developers and in the public domain, or other generation opportunities. The impact of committed generation projects on the grid backbone is dealt with separately in Chapter 6.

The maximum generation that can be connected depends on several factors and usually falls within a range. Generation developers should consult with us at an early stage of their investigations to discuss connection issues.

18.11.1 Wind generation

There are no issues with connecting wind or other generation at existing substations within the Waitaki Valley at 220 kV.

Connecting too much generation to one of the four circuits to Christchurch, however, may cause that circuit to overload and reduce the maximum load that can be supplied across all four circuits.

The maximum generation that can be connected varies with the point of connection and the circuit. Connections close to the Waitaki Valley enable the most generation (approximately equal to the circuit rating). The best-case location and circuit will enable 400–700 MW of generation. The worst-case location and circuit will not support the dispatch of generation.

Unless the 110 kV Tekapo A–Albury–Timaru circuit is upgraded, there is limited opportunity to connect new generation without the risk of constraints. This is because of the existing generation at Tekapo A, and the Opuha generation embedded at Albury.

The other 110 kV circuits in the South Canterbury region can support generation connections up to or slightly higher than the circuit rating.

