14 Wellington Regional Plan

14.1 Regional overview and transmission system

The Wellington region is the major load centre (comprising both residential and Central Business District loads) of the southern North Island. The region includes the large load centre of Wellington City, together with provincial towns and smaller rural localities.

The existing transmission network for the Wellington region is set out geographically in Figure 14-1 and schematically in Figure 14-2.

Figure 14-1: Wellington region transmission network

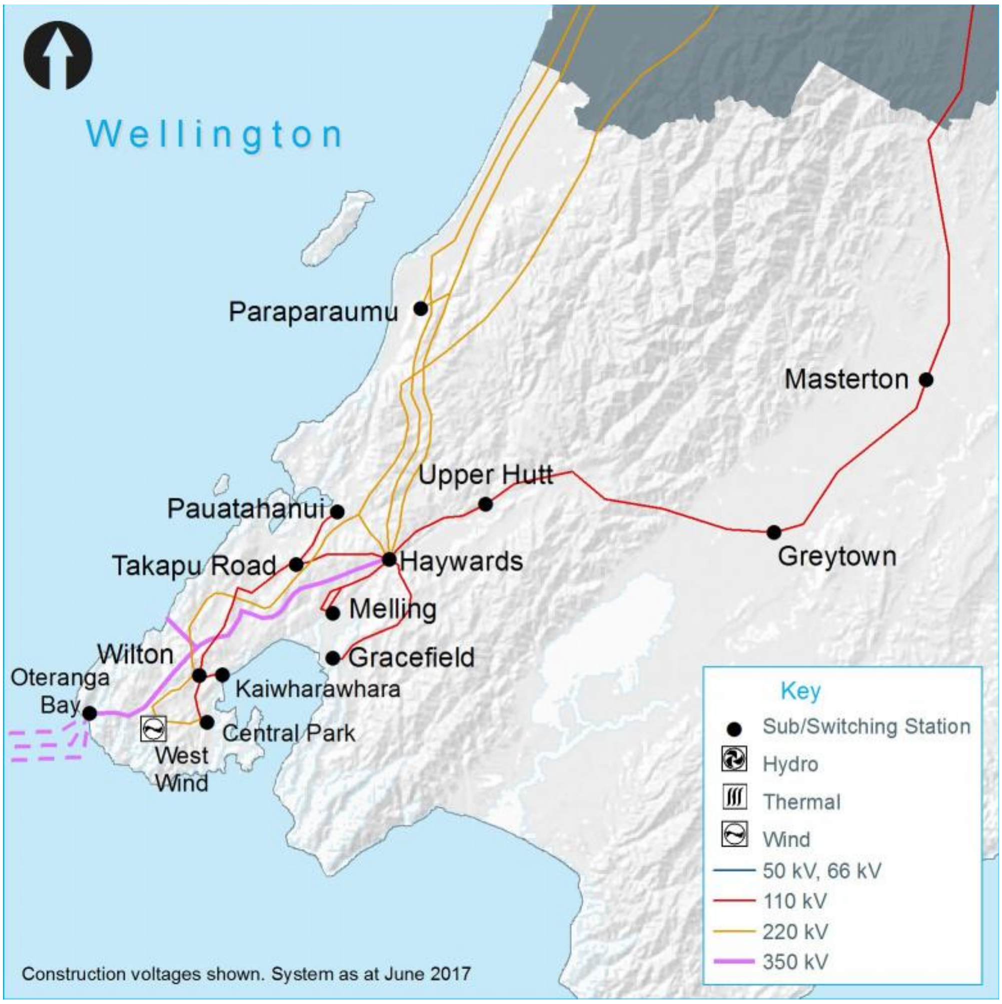
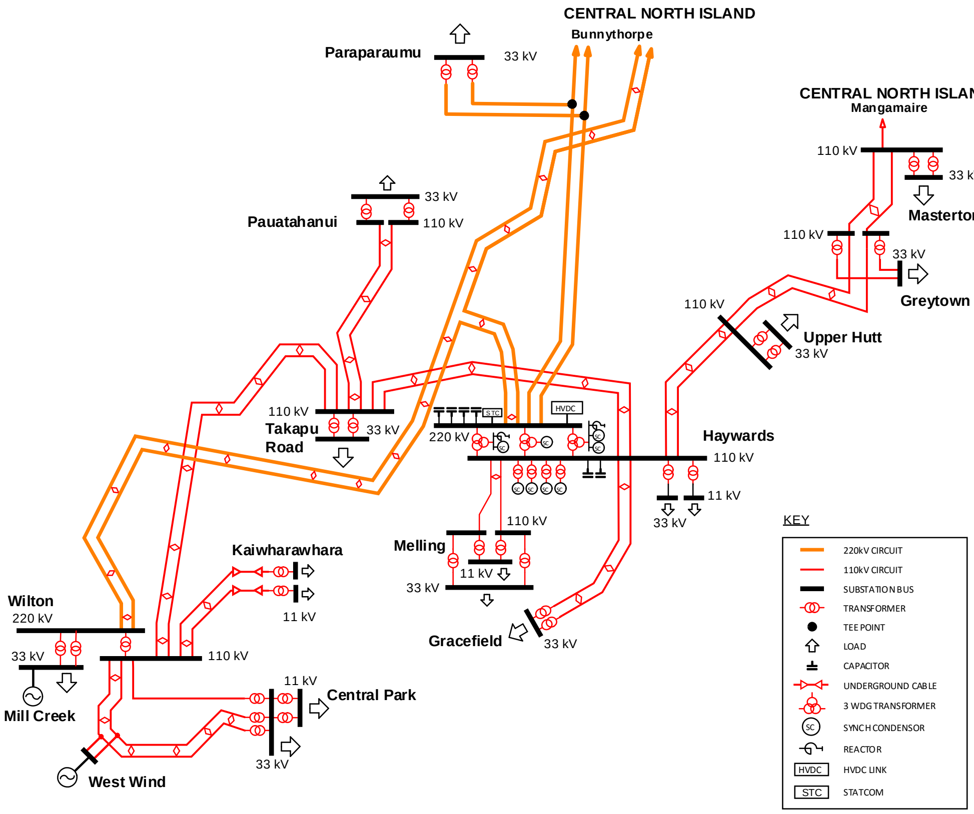


Figure 14-2: Wellington region transmission schematic



14.1.1 Transmission into the region

The Wellington region is connected to the rest of the National Grid through 220 kV circuits from Bunnythorpe and the HVDC inter-island link. It is a main corridor for through-transmission between the North and South Islands. The loading of these circuits is primarily driven by HVDC power flow and Central North Island generation.

The HVDC link's North Island terminal is at Haywards. The HVDC link can transfer up to 850 MW to the South Island (depending on the load and generation in the Wellington region), and up to 1,200 MW from the South Island (see Chapter 6).

As generation capacity in the region is much lower than local load, power is normally imported via the HVDC link (from the South Island) or from the Central North Island.

14.1.2 Transmission within the region

The region has some of the higher load densities in the North Island.

Transmission within the Wellington region comprises:

- 220 kV circuits entering the region from Bunnythorpe
- 110 kV circuits entering the region from Mangamaire
- interconnecting transformers located at Haywards and Wilton.

Reactive support in the region is mainly provided from the Haywards substation, with some contribution from the West Wind and Mill Creek wind generation stations.

14.2 Wellington demand

After diversity maximum demand for the Wellington region is forecast to grow by an average 1.1 per cent per annum over the next 15 years, from 660 MW in 2017 to 776 MW by 2032. This is lower than the national average of 1.4 per cent per annum.

Table 14-1 lists the peak demand forecast (prudent growth[1]) at each grid exit point for the forecast period.

Table 14-1: Forecast annual peak demand (MW) for Wellington grid exit points to 2032

Grid exit point	Power factor	Peak demand (MW)											
		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2032
Central Park 11 kV	0.99	26	26	26	26	26	26	26	26	26	26	26	26
Central Park 33 kV	0.98	169	169	170	171	172	173	174	175	175	176	169	182
Gracefield	0.99	66	67	67	67	68	68	69	69	69	70	66	72
Greytown	1.00	15	15	16	16	16	16	16	16	17	17	15	18
Haywards 11 kV	1.00	20	21	22	22	22	22	23	23	23	23	20	24
Haywards 33 kV	0.99	20	20	21	21	21	21	21	21	21	21	20	22
Kaiwharawhara	0.99	34	35	35	35	35	36	36	36	37	37	34	39
Masterton	0.98	47	48	48	49	49	50	50	51	51	52	47	55
Melling 11 kV	0.99	30	30	30	30	31	31	31	31	31	32	30	33
Melling 33 kV	1.00	41	41	41	41	42	42	42	42	42	43	41	44
Paraparaumu	1.00	78	79	80	81	81	82	83	84	85	86	78	91
Pauatahanui	0.98	21	22	22	22	22	22	22	22	22	22	21	23
Takapu Rd	0.99	105	106	108	109	111	112	114	115	117	119	105	128
Upper Hutt	1.00	33	34	34	34	35	35	35	36	36	36	33	39
Wilton	1.00	59	60	60	61	61	61	62	62	62	63	59	65

14.3 Wellington generation

The Wellington region's generation capacity is currently 227 MW, which is significantly lower than the local load. Most of the generation capacity is from wind generation stations, the largest being West Wind at 143 MW.

Table 14-2 lists the generation forecast for each grid injection point for the forecast period. This includes all known and committed generation stations, including those embedded within the local lines company's networks (Wellington Electricity Lines Limited, Powerco, and Electra).[2]

[1] Our prudent peak forecast has a 10 per cent probability of exceedance forecast for the first seven years of the forecast period. For the rest of the forecast period we assume an expected (or mean) rate of growth. Refer to Chapter 3 for further information on demand forecasting.

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

Further generation may be developed during the period but is not sufficiently advanced to be included in our forecasts. (Refer to section 14.5.6.3 for more information on potential new generation).

Table 14-2: Forecast annual generation capacity (MW) for Wellington grid injection points to 2032 (existing and committed generation)

Grid injection point (location/name if embedded)	Generation capacity (MW)											
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2032
Central Park (Southern Landfill)	1	1	1	1	1	1	1	1	1	1	1	1
Central Park (Wellington Hospital[1])	10	10	10	10	10	10	10	10	10	10	10	10
Greytown (Hau Nui)	9	9	9	9	9	9	9	9	9	9	9	9
Haywards (Silverstream)	3	3	3	3	3	3	3	3	3	3	3	3
Masterton (Kourarau A and B)	1	1	1	1	1	1	1	1	1	1	1	1
West Wind	143	143	143	143	143	143	143	143	143	143	143	143
Wilton (Mill Creek)	60	60	60	60	60	60	60	60	60	60	60	60
Haywards 220 kV (HVDC North transfer[2, 3])	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200

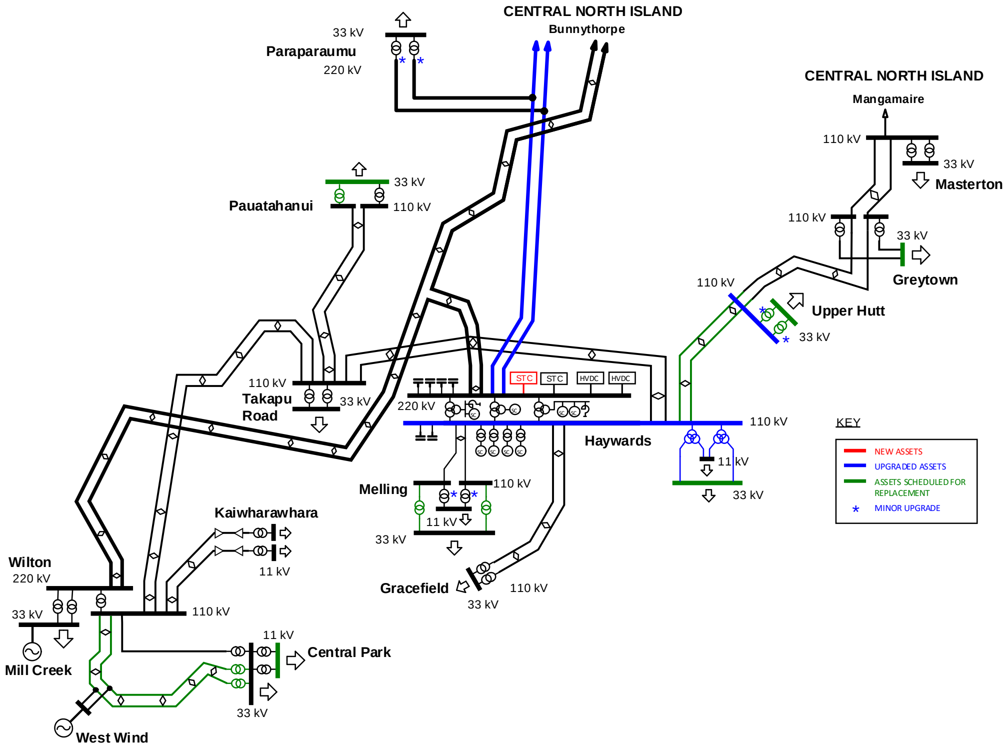
1. The Wellington Hospital generation is standby only.
2. The HVDC link is included as, like generators, it provides power input into the region. Note that unlike generating stations, the HVDC link consumes reactive power, so voltage support equipment associated with the HVDC is required to provide reactive power support.
3. The fourth cable may be installed in future as an additional stage in the HVDC development, increasing the HVDC link capacity to 1,400 MW.

14.4 Grid enhancement approach

14.4.1 Possible future Wellington transmission configuration

Figure 14-3 shows the possible configuration of Wellington transmission in 2032. New assets, upgraded assets, and assets scheduled for replacement within the forecast period (based on potential enhancement approaches set out in the following sections) are shown.

Figure 14-3: Possible Wellington region transmission configuration in 2032



14.4.2 Enhancement approach

We ensure secure transmission into and within the Wellington region into the future. Through the E&D process we assess transmission capacity and reactive support requirements in the region over the next 15 years (while remaining cognisant of longer-term development opportunities). In developing Grid Enhancement Approaches to address identified issues and opportunities we take into account uncertainty in future demand, generation and technological developments.

Transmission issues likely requiring E&D or Customer-funded investments in Wellington over the next 10-15 years are:

Section number	Issue
14.4.2.1	Haywards 110 kV bus security
14.4.2.2	Greytown–Upper Hutt 110 kV transmission capacity
14.4.2.3	Greytown and Masterton bus security
14.4.2.4	Central Park supply transformer capacity
14.4.2.5	Haywards supply transformer capacity
14.4.2.6	Melling supply transformer capacity and low voltage

14.4.2.7	Pauatahanui and Takapu Road supply transformer capacity
14.4.2.8	Paraparaumu supply capacity

14.4.2.1 Haywards 110 kV bus security

There are four interconnecting transformers in the Wellington region, three at Haywards and one at Wilton.

At Haywards, one of the 110 kV bus sections connects two of the Haywards interconnecting transformers. A contingency on this bus section will disconnect two of the three interconnecting transformers leading to the overloading of the remaining transformer at Haywards and causing low voltages during peak load periods. The Haywards bus contingency is also forecast to cause the Wilton interconnecting transformer to exceed its post-contingency winter rating within the next five years.

Enhancement approach:

- We investigated a range of options to manage this bus security risk. The preferred option is to reconfigure the existing Haywards 110 kV bus as this approach would address both the transformer overloading and low voltage issues. This option does not require any capital investment but we need to work through some operational issues before the bus reconfiguration can be implemented.

14.4.2.2 Greytown–Upper Hutt 110 kV transmission capacity

A 110 kV double circuit operates in parallel with the four 220 kV circuits between Bunnythorpe and Haywards via the Wairarapa.

During very high HVDC northward transfer, an outage on either of the Masterton–Greytown–Upper Hutt circuits may cause the loading on the Greytown–Upper Hutt section of the remaining circuit to exceed its capacity.

At present, transfer between Bunnythorpe and Haywards is first limited by the capacity north of Bunnythorpe, in particular the Bunnythorpe–Mataroa circuit. However, the Greytown–Upper Hutt constraint is expected to bind more often once we have invested to relieve the thermal limitations in the central North Island.

Enhancement approach:

- In the short to medium term, this constraint can be resolved by using a temporary grid reconfiguration to open the Mangamaire–Masterton circuit at Mangamaire and enabling the Mangamaire Auto-Changeover Scheme.
- We will continue to monitor the risk of placing the Mangamaire load on n security and consider possible transmission investments if these can be economically justified.

14.4.2.3 Greytown and Masterton bus security

A fault on the Masterton 110 kV bus will result in a loss of supply at Masterton and Greytown. This is because Masterton does not have bus zone protection and there are no line circuit breakers at Greytown.

Enhancement approach:

- We plan to install bus zone protection at Masterton in 2017/2018 (base capex replacement and refurbishment). This will prevent a loss of supply at Greytown for a Masterton bus fault, limiting the loss of supply to Masterton only.
- We investigated the option of installing a bus section breaker at Masterton to further improve bus security and concluded it was uneconomic to do so.

14.4.2.4 Central Park supply transformer capacity

The Central Park load is supplied by three 110 kV lines terminating on three 110/33 kV supply transformers (no 110 kV bus). The load is supplied at two voltage levels, 33 kV and 11 kV (via 33/11 kV supply transformers).

The combined load is forecast to exceed n-1 capacity of the 110/33 kV supply transformers from 2030.

Enhancement approach:

- Two of the three 110/33 kV supply transformers are due for risk based condition replacement within the next 15 years, with the first replacement expected as early as 2023 (base capex replacement and refurbishment).
- We will discuss the need to increase the capacity of the replacement transformers with Wellington Electricity, as increasing transformer capacity will resolve the n-1 capacity issue for the forecast period. There is capability within Wellington Electricity's network to transfer load to Wilton which may defer the n-1 capacity issue.

14.4.2.5 Haywards supply transformer capacity

The Haywards load is supplied by a single 110/33 kV supply transformer and a single 110/11 kV supply transformer. The 33 kV peak load already exceeds the capacity of the supply transformer and the 11 kV load is forecast to exceed the capacity of the supply transformer from 2018.

Some of 33 kV load can be back-fed through Wellington Electricity's network while some of the 11 kV load can be back-fed from the Haywards local service transformer.

Enhancement approach:

- Both Haywards supply transformers are due for risk based condition replacement. We plan to replace them, by 2019, with two new 110/33/11 kV, 60/30/30 MVA transformers, providing n-1 security to both the 11 kV and 33 kV load (base capex replacement and refurbishment). The two replacement transformers will provide sufficient capacity for the remainder of the forecast period.
- We will decommission the two 33/11 kV local service transformers (T16 and T17) and reconfigure the 11 kV local service.
- The outdoor 33 kV bus will be redundant after the existing single 110/33 kV transformer is replaced by two 110/33/11 kV transformers.[3] Therefore, the risk based replacement of the 33 kV outdoor bus will no longer be required.

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[3] The existing arrangement has one transformer connected to two Wellington Electricity feeders via a 33 kV outdoor bus. The new arrangement will have two transformers directly connected to the two 33 kV feeders.

14.4.2.6 Melling supply transformer capacity and low voltage

The Melling load is supplied by two 110/33 kV supply transformers and two 110/11 kV supply transformers.

The 11 kV load already exceeds the n-1 capacity of the supply transformers, and post-contingency 33 kV bus voltage can fall below 0.95 pu (depending on the Haywards 110 kV voltage).

Both Melling 110/33 kV supply transformers will reach their expected risk based condition replacement criteria within the next 10 years.

Enhancement approach:

- The n-1 capacity issue on the 110/11 kV transformers can be managed operationally at present. We plan to resolve the protection limits on these transformers, which will increase the n-1 capacity to 32/34 MVA (summer/winter) and provide n-1 capacity to 2028. We will discuss longer term investment options with Wellington Electricity closer to this need date.
- The low voltage issue on the 33 kV supply bus can be managed operationally at present. The two 110/33 kV supply transformers are due for major refurbishment in 2019 and then risk based condition replacement in 2027. The replacement of these transformers (base capex replacement and refurbishment) will resolve the voltage issue as the replacement transformers will have on-load tap changers allowing the 33 kV voltage to be regulated.

Base E&D Capex investments

Project Name	Melling 110/11 kV supply capacity
Project description:	Resolve protection limits on Melling–T1 and T2
Project's state of completion	Proposed
OAA level completed:	None
Grid need date:	2017
Indicative cost [$ million]:	0.1
Part of the GEIR?	No

14.4.2.7 Pauatahanui and Takapu Road supply transformer capacity

The north-western section of Wellington Electricity's network is supplied from the Pauatahanui and Takapu Road grid exit points. Both grid exit points are forecast to exceed the n-1 capacity of the transformers in the next 15 years – Takapu Road from 2022 and Pauatahanui from 2032.

Wellington Electricity is able to transfer loads between these two grid exit points via its distribution network. Therefore, it is pragmatic to have a combined enhancement approach to maintaining adequate supply capacity for this area.

Enhancement approach:

- The n-1 capacity issue at Takapu Road may be able to be managed by transferring load to Pauatahanui. We will discuss the load transfer capability with Wellington Electricity.
- During peak load periods, the Pauatahanui or Takapu Road supply transformers will exceed their n-1 capacity with load transferred from the other grid exit point.

- We will discuss longer term options with Wellington Electricity. These include operationally managing the loading on the Pauatahanui or Takapu Road supply transformers following load transfers, upgrading the Pauatahanui or Takapu Road supply transformers, or installing a third supply transformer at Takapu Road.

14.4.2.8 Paraparaumu supply capacity

At Paraparaumu, Electra's distribution network is supplied by two 220/33 kV transformers. The Paraparaumu load is forecast to exceed the n-1 capacity of the supply transformers from 2020.

Enhancement approach:

- Resolving the metering accuracy limits on the two supply transformers will increase the n-1 capacity to 168/175 MVA (summer/winter). This provides sufficient capacity for the forecast period.

Base E&D Capex investment

Project Name	Paraparaumu supply transformer capacity
Project description:	Resolve metering limits on Paraparaumu–T1 and T2
Project's state of completion	Possible
OAA level completed:	None
Grid need date:	2020
Indicative cost [$ million]:	0.1
Part of the GEIR?	No

14.5 Asset capability and management

We assess the transmission capacity and reactive support requirements in the region for the next 15 years. When an issue or opportunity exists, we have examined initial options and actions that may be taken to address it. Grid Enhancement Approaches (refer to section 14.4.2) have been developed to address issues or opportunities that require action within the forecast period and where investment is justified.

This section discusses the main inputs to the E&D process. These are:

- transmission capability (taking into account forecast demand and generation and possible technological changes)
- customer requests
- generation proposals and opportunities
- risk-based asset replacements
- significant upcoming work planned over the period
- asset feedback (information on assets or issues submitted through the asset feedback process).

14.5.1 Wellington region significant upcoming work

We integrate our capital project and maintenance works to enable system issues to be resolved, if possible, when assets are replaced or refurbished. Table 14-3 lists the significant upcoming work proposed for the Wellington region during the next 15 years that may significantly impact related system issues or connected parties.

Table 14-3: Proposed significant upcoming work

Description	Tentative year
Central Park 110/33 kV transformer (T3) risk based condition replacement Central Park 110/33 kV transformer (T4) risk based condition replacement Central Park 11 kV switchgear replacement	2023-2025 2031-2032 2028-2029
Central Park–Wilton–2 and 3 circuits reconductoring (zebra section) Central Park–Wilton–1, 2, and 3 circuits reconductoring (chukar section)	2017-2019 2025-2029
Gracefield 33 kV switchgear replacement	2020-2022
Greytown 33 kV outdoor to indoor conversion	2022-2024
Haywards 33 kV outdoor to indoor conversion Haywards supply transformers risk based condition replacement	2017-2019 2019
Haywards-Upper Hutt–1 and 2 circuits reconductoring	2024-2025
Melling 110/33 kV supply transformers risk based condition replacement	2027-2029
Pauatahanui supply transformer–T1 expected risk based condition replacement	2030-2032
Upper Hutt supply transformers risk based replacement Upper Hutt 33 kV outdoor to indoor conversion	2026-2027 2017-2019

14.5.2 Wellington asset feedback

The Asset Feedback Register contains the following entry related to E&D, specific to the Wellington region:

- Masterton 110 kV bus security.

14.5.2.1 Masterton 110 kV bus security

Issue

There is no n-1 security for the loss of Masterton 110 kV bus which causes a loss of supply to Masterton and Greytown.

What next

We are partially addressing this issue as it is uneconomic to resolve it completely. See section 14.4.2.3 for our enhancement approach.

14.5.3 Changes since the 2015 Transmission Planning Report

Table 14-4 lists the specific new issues and those that are no longer relevant within the forecast period (relative to our previous Transmission Planning Report).

Table 14-4: Changes since the 2015 TPR

Issue	Change
Wellington interconnecting transformer capacity	Removed. Updated load forecast means this is no longer an issue.
Paraparaumu transmission security and supply capacity	New issue. Paraparaumu 33 kV supply capacity forecast to be exceeded by 2020 due to metering limitation.
Greytown–Upper Hutt 110 kV transmission capacity	New issue. Greytown-Upper Hutt circuits are forecast to exceed their capacity by 2024.
Pauatahanui supply transformer capacity	Removed. Updated load forecast means this is no longer an issue.
Upper Hutt supply transformer capacity	Removed. Updated load forecast means this is no longer an issue.

14.5.4 Wellington transmission capability

This transmission capability section reports whether the Grid can be reasonably expected to meet (n-1) security requirements over the next 15 years. This section, together with the demand and generation sections, forms part of the Grid Reliability Report (GRR).

Table 14-5 summarises transmission capability issues that were identified for the Wellington region during the next 15 years. In each case we have detected a condition that would constrain the network capacity if action were not taken. Each issue is discussed in more detail below.

This transmission capability section reports whether the Grid can be reasonably expected to meet (n-1) security requirements over the next 15 years. This section, together with the demand and generation sections, forms part of the Grid Reliability Report (GRR).

Table 14-5: Wellington region transmission issues – regional/ site by grid exit point

Section number	Issue
Regional	
14.5.4.1	Greytown–Upper Hutt 110 kV transmission capacity
Site by grid exit point	
14.5.4.2	Central Park supply transformer capacity

14.5.4.1 Greytown–Upper Hutt 110 kV transmission capacity

Issue

The transmission network between Greytown and Masterton consists of the following 110 kV circuits:

- two Greytown–Upper Hutt circuits rated at 63/77 MVA (summer/winter)
- two Greytown–Masterton circuits rated at 88/98 MVA (summer/winter).

With high HVDC north transfer and high wind generation in the Wellington region, an outage on either of the Masterton–Greytown–Upper Hutt circuits may cause the loading on the Greytown–Upper Hutt section of the remaining circuit to exceed its summer capacity.

What next?

The issue can be managed operationally. This may require splitting the 110 kV network at Mangamaire, placing Mangamaire on n security. Refer to section 14.4.2.2 for our enhancement approach.

14.5.4.2 Central Park supply transformer capacity

Issue

At Central Park, Wellington Electricity is supplied at two voltage levels. Three 110/33 kV transformers (one rated 120 MVA and two rated at 100 MVA), each connected directly onto a 110 kV circuit, supply Central Park's 33 kV and 11 kV loads to provide:

- total nominal installed capacity of 320 MVA
- n-1 capacity of 217/223 MVA[4] (summer/winter).

Peak load at Central Park for the combined 33 kV and 11 kV load is forecast to exceed the n-1 winter capacity of the transformers by approximately 1 MW in 2030, increasing to approximately 3 MW in 2032 (see Table 14-6).

Table 14-6: Central Park supply transformer overload forecast

Circuit/grid exit point	Transformer overload (MW)											
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2032
Central Park 33 kV and 11 kV	0	0	0	0	0	0	0	0	0	0	0	3

[4] The transformers' capacity is limited by the LV cable; with this limit resolved, the n-1 capacity will be 217/228 MVA (summer/winter).

What next?

We expect that operational measures will be used to manage this issue. Refer to section 14.4.2.4 for our enhancement approach.

14.5.4.3 Haywards supply transformer capacity and security

Issue

The Haywards grid exit point supplies load at 33 kV and 11 kV:

- One 110/33 kV, 20 MVA transformer supplies the load at the 33 kV bus resulting in n security.
- One 110/11 kV, 20 MVA transformer supplies the load at the 11 kV bus resulting in n security.

The Haywards 33 kV peak load is forecast to exceed the capacity of the transformer by approximately 1 MW in 2017, increasing to approximately 2 MW in 2032 (see Table 14-7). This load can be backfed through the Wellington Electricity network.

The Haywards 11 kV peak load is forecast to exceed the capacity of the transformers by approximately 1 MW in 2018, increasing to approximately 4 MW in 2032 (see Table 14-7). Wellington Electricity can back-feed some load through its network and the Haywards local service transformer.

Table 14-7: Haywards supply transformer overload forecast

Circuit/grid exit point	Transformer overload (MW)											
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2032
Haywards 33 kV	1	1	1	1	1	1	1	2	2	2	2	2
Haywards 11 kV	0	1	2	2	2	3	3	3	3	3	3	4

What next?

We expect to use operational measures until a longer term solution is implemented. Refer to section 14.4.2.5 for our enhancement approach.

14.5.4.4 Kaiwharawhara supply capacity and security

Issue

The Kaiwharawhara load is supplied by:

- two 110 kV circuits from Wilton, each rated at 57/66 MVA[5] (summer/winter)
- two 110/11 kV supply transformers, providing:
    - total nominal installed capacity of 60 MVA
    - n-1 capacity of 38/38 MVA[6] (summer/winter).

The Kaiwharawhara substation is configured with no 110 kV bus (each transformer is connected to only one 110 kV circuit) and the 11 kV bus is also operated split (due to

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[5] The Kaiwharawhara–Wilton circuits are limited by the cable rating; with this limit resolved, the n-1 capacity will be 57/70 MVA (summer/winter).

[6] The transformers' capacity is limited by the 11 kV circuit breaker owned by the local distribution company; with this limit resolved, the n-1 capacity will be 41/43 MVA (summer/winter).

excessive fault levels on the distribution network). Tripping either one of the transformer feeders will result in a loss of supply to half the load.

If this load were transferred to the remaining transformer feeder, the total Kaiwharawhara peak load would be expected to exceed the n-1 winter and summer capacities of the transformers by approximately 1 MW in 2019, increasing to approximately 4 MW in 2032 (see Table 14-8).

Table 14-8: Kaiwharawhara supply transformer overload forecast

Circuit/grid exit point	Transformer overload (MW)											
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2032
Kaiwharawhara	0	0	1	1	1	1	1	2	2	2	3	4

What next?

Wellington Electricity considers that this issue can be managed operationally within its distribution network, for example by transferring excess load to other grid exit points. We are not planning further investments to provide a higher supply capacity at Kaiwharawhara.

14.5.4.5 Melling supply capacity and voltage quality

Issue

The Melling load is supplied by:

- Two 110 kV circuits from Haywards, each rated at 95/101 MVA[7] (summer/winter)
- Two 110/33 kV transformers supplying Melling's 33 kV load, providing:
    - total nominal installed capacity of 100 MVA
    - n-1 capacity of 64/65 MVA[8] (summer/winter)
- Two 110/11 kV transformers supplying Melling's 11 kV load, providing:
    - total nominal installed capacity of 50 MVA
    - n-1 capacity of 28/28 MVA[9] (summer/winter).

The 11 kV peak load is forecast to exceed the n-1 winter capacity of the transformers by 3 MW in 2017, increasing to approximately 7 MW in 2032 (see Table 14-9). The 33 kV bus voltage is forecast to fall below 0.95 pu post-contingency from winter 2017 (depending on the Haywards 110 kV bus voltage).

Table 14-9: Melling supply transformer overload forecast

Circuit/grid exit point	Transformer overload (MW)											
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2032
Melling 11 kV	3	4	4	4	4	5	5	5	5	5	6	7

[7] The Haywards–Melling circuits are limited by the cable rating; with this limit resolved, the n-1 capacity will be 95/105 MVA (summer/winter).

[8] The transformers' winter capacity is limited by the LV current transformers; with this limit resolved, the n-1 capacity will be 64/67 MVA (summer/winter).

[9] The transformers' capacity is limited by protection equipment; with these limits resolved, the n-1 capacity will be 32/34 MVA (summer/winter).

What next?

We expect to use operational measures to manage these issues. Refer to section 14.4.2.6 for our enhancement approach.

14.5.4.6 Paraparaumu transmission security and supply capacity

Issue

Two 220/33 kV transformers supply Paraparaumu's load, providing:

- total nominal installed capacity of 240 MVA
- n-1 capacity of 81/81 MVA[10] (summer/winter).

Peak load at Paraparaumu is forecast to exceed the n-1 winter capacity of the transformers by approximately 1 MW in 2020, increasing to approximately 11 MW in 2032 (see Table 14-10).

Table 14-10: Paraparaumu supply transformer overload forecast

Circuit/grid exit point	Transformer overload (MW)											
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2032
Paraparaumu	0	0	0	1	1	2	3	4	5	6	6	11

What next?

We plan to recalibrate the metering parameters which will provide sufficient n-1 capacity for the forecast period. Refer to section 14.4.2.8 for our enhancement approach.

14.5.4.7 Pauatahanui supply capacity

Issue

The Pauatahanui load is supplied by:

- Two 110 kV circuits from Takapu Road, each rated at 78/78 MVA[11] (summer / winter)
- Two 110/33 kV transformers, providing:
  - total nominal installed capacity of 40 MVA
  - n-1 capacity of 22/24 MVA (summer/winter).

Peak load at Pauatahanui is forecast to exceed the n-1 winter capacity of the transformers from 2032 (see Table 14-11).

Table 14-11: Pauatahanui supply transformer overload forecast

Circuit/grid exit point	Transformer overload (MW)											
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2032
Pauatahanui	0	0	0	0	0	0	0	0	0	0	0	1

[10] The Paraparaumu supply transformers are limited by the metering accuracy limit; with this limit resolved, the n-1 capacity will be 168/175 MVA (summer/winter)

[11] The Pauatahanui-Takapu Road circuits are limited by the Pauatahanui 110 kV bus rating; with this limit resolved, the n-1 capacity will be 95/105 MVA (summer/winter).

What next?

Refer to section 14.4.2.7 for our enhancement approach to maintaining adequate capacity for Wellington Electricity's north-western network.

14.5.4.8 Takapu Road supply capacity

Issue

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

- total nominal installed capacity of 180 MVA
- n-1 capacity of 111/116 MVA (summer/winter).

Peak load at Takapu Road is forecast to exceed the n-1 winter capacity of the transformers by approximately 2 MW in 2022, increasing to approximately 18 MW in 2032 (see Table 14-12).

Table 14-12: Takapu Road supply transformer overload forecast

Circuit/grid exit point	Transformer overload (MW)											
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2032
Takapu Road	0	0	0	0	0	2	3	5	7	8	10	18

What next?

Refer to section 14.4.2.7 for our enhancement approach to maintaining adequate capacity for Wellington Electricity's north-western network.

14.5.5 Wellington bus security

Table 14-13 summarises bus security issues that were identified for the Wellington region for the next 15 years. Each issue is discussed in more detail below.

This section presents issues arising from the outage of a single bus section rated at 66 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 generators). 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).

Table 14-13: Wellington region transmission issues – bus security

Section number	Issue
14.5.5.1	Transmission bus security
14.5.5.2	Wellington interconnecting transformer overloading
14.5.5.3	Greytown and Masterton bus security
14.5.5.4	Wairarapa low voltage

14.5.5.1 Transmission bus security

Table 14-14 lists bus outages that cause voltage issues or a total loss of supply. Generators are 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.

Note that the customers at these grid exit points (Wellington Electricity, Powerco, Electra, and Meridian) have not requested a higher security level. Unless otherwise noted, we do not propose increasing 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.

Table 14-14: Transmission bus outages

Transmission bus outage	Loss of supply	Generation disconnection	Transmission issue	Further information
Haywards 110 kV	Haywards	-	Wellington interconnecting transformer overloading	note 1 14.5.5.2
Masterton 110 kV	Masterton Greytown	-	Masterton bus security	14.5.5.3 14.5.5.3
Upper Hutt 110 kV	Upper Hutt	-	Wairarapa low voltage	14.5.5.4
Wilton 110 kV	Kaiwharawhara	West Wind	-	note 2 note 3

1. Haywards has a single 110/33 kV and a single 110/11 kV supply transformer. A bus outage will disconnect one but not both supply transformers, causing a partial loss of supply. Replacing the transformers with two 110/33/11 kV transformers (see section 14.5.4.3) will provide bus security.
2. An outage of a Wilton bus section may disconnect one of the two Kaiwharawhara circuits. Because Kaiwharawhara has no 110 kV bus, this will cause a partial interruption to the load at Kaiwharawhara (see section 14.5.4.4).
3. An outage of a Wilton bus section may disconnect Central Park–West Wind–Wilton–1 or 2. Because West Wind has no 110 kV bus, this also disconnects half the wind farm.

14.5.5.2 Wellington interconnecting transformer overloading

Issue

The Wellington 110 kV transmission network is predominantly supplied by 220/110 kV interconnecting transformers, with three transformers at Haywards and one at Wilton. The loading of these interconnecting transformers depends on the Wellington regional load, wind generation, and the HVDC transfer level and direction (north or south power flow).

The worst contingency affecting the Wellington 110 kV supply capacity is an outage of a bus section at Haywards that disconnects several components, including the loss of:

- two of the three 220/110 kV transformers
- reactive voltage support (condensers 7 and 8, and filter 1)
- several 110 kV circuits.

The loss of the circuits increases the loading on the remaining circuits which in turn increases the reactive power absorbed, leading to low voltage issues at Melling.

The remaining Haywards–T2 interconnecting transformer may exceed its n-1 winter capacity (depending on the Wellington load, West Wind generation, HVDC transfer magnitude, and direction).

What next?

We are currently working on an operational solution to address the low voltage and Wellington interconnecting transformer overloading issues. Refer to section 14.4.2.1 for our enhancement approach.

14.5.5.3 Masterton bus security

Issue

Masterton does not have bus zone protection and there are no line circuit breakers at Greytown. A fault on the Masterton 110 kV bus will result in a loss of supply at Masterton and Greytown.

What next?

We are planning to install bus zone protection at Masterton in 2018. See section 14.4.2.3 for our enhancement approach.

14.5.5.4 Wairarapa low voltage

Issue

Depending on the availability of wind generation at Te Apiti, an outage of the Upper Hutt 110 kV bus:

- would be expected to cause transmission bus voltages at Greytown and Masterton to fall below 0.90 pu, from winter 2017
- may cause a voltage step of more than 10 per cent at the supply buses at Greytown and Masterton.

What next?

Our high-level investigation indicates that no economic investment options are available to address this issue, so no investment is planned.

14.5.6 Other regional items of interest

14.5.6.1 Central Park resiliency

Issue

Central Park (via Wellington Electricity's distribution network) supplies a large portion of the Wellington's central business district (CBD) as well as the eastern and southern suburbs, including the hospital and airport. Wellington Electricity takes supply at 33 kV and 11 kV, and the combined peak load is around 180 MW, increasing to around 200 MW by 2032.

Central Park is a relatively compact substation and is exposed to a range of potential single points of failure within the substation. In addition, all three Central Park–Wilton circuits are strung on three triple circuit towers entering the substation.

A high impact low probability (HILP) incident at Central Park substation, such as a triple circuit tower failure or cable fire, would result in a loss of supply to a large load, potentially for an extended period. Wellington Electricity has limited capacity to shift CBD load to other grid exit points at Wilton and Kaiwharawhara and there is presently no alternative to supply the remaining load.

What next?

We are working closely with Wellington Electricity to determine the most economic options to reduce the exposure to and mitigate the impact of HILP incidents at Central Park.

- We are working on initiatives to mitigate some of the risks that arise due to the compact nature of the Central Park site.
- We have contingency plans in place for returning supply to the site quickly following a tower failure.
- Investigations have shown that it is unlikely to be economic to establish a new diverse grid exit point for the Wellington CBD. Increasing the capacity of Wellington Electricity's network can reduce the impact of a HILP incident at Central Park by enabling load to be transferred to other grid exit points. We are collaborating with Wellington Electricity to help identify options and progress investigations.

14.5.6.2 Central Park–Wilton–B reconductoring

Issue

This is an approved project that will be completed in the next three years. The existing conductor is being replaced with simplex conductor, providing a small reduction in capacity.

During the reconductoring work:

- Central Park will retain n-1 security[12] except during work to reconfigure the Central Park 110 kV arrangement
- West Wind generation will be connected with n security, except during reconfiguration work at Makara Heights.

14.5.6.3 Wellington generation proposals and opportunities

This section details relevant regional issues for selected generation proposals under investigation by developers and in the public domain, or other generation opportunities.

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

See also Chapter 11 for a discussion about connecting wind generation in the lower North Island.

14.5.6.4 Generation connection options - general

Most of the transmission network in the region is used to supply load rather than connect generation. In general, there are no issues with connecting up to several hundred megawatts of generation to these circuits. Higher generation levels reverse the power flow direction, and approach the circuits' ratings. As a result, depending on

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[12] The Central Park Transformer Overload Protection Scheme will be enabled where necessary. The scheme reduces load at Central Park if one of the supply transformers overloads due to a parallel circuit outage.

where generation is located, some comparatively minor upgrades may be required, such as increasing the 220/110 kV interconnection capacity.

However, the capacity of the grid backbone between regions may constrain the generation (see also Chapter 6).

14.5.6.5 Generation connection to the 110 kV network in the Wairarapa area

There is a 110 kV double-circuit line from Haywards to Upper Hutt, Greytown, and Masterton, and a single-circuit line from Masterton to Mangamaire and Woodville (in the Central North Island region).

The amount of generation that can be installed on this line depends on its location along the 110 kV line, and any line upgrades. Approximately 180 MW of generation can connect at Masterton under normal operating conditions. Other generation locations and upgrade options may result in maximum generation levels ranging from zero to approximately 180 MW.