Security and Reliability Council

The system operator’s annual assessment of security of supply

9 March 2015

Note: This paper has been prepared for the purpose of the Security and Reliability Council (SRC). Content should not be interpreted as representing the views or policy of the Electricity Authority.

Background

The Security and Reliability Council (SRC) functions under the Electricity Industry Act 2010 (Act) include providing advice to the Electricity Authority (Authority) on security of supply matters.

The Act also mandates that Transpower is the system operator and is responsible for managing security of supply emergencies and publishing forecasting of security of supply. Forecasting of short-term energy security is achieved by the system operator's risk meter and hydro risk curves. Forecasting of medium-term energy and capacity security is achieved through the system operator's annual assessment of security of supply (annual assessment).

The purpose of this paper is to provide the SRC with a copy of the system operator's annual assessment and ask questions that may help to establish whether the SRC has advice to offer the Authority.

The security standards represent an efficient level of generation

The system operator must use assumptions provided by the Authority when preparing the annual assessment. The Authority has opted to provide such assumptions and does so by publication of the Security Standards Assumptions Document[1].

The key standards set by the Authority are:

- a winter energy margin for New Zealand (NZ-WEM) of 14-16% greater than forecast energy consumption
- a winter energy margin for the South Island (SI-WEM) of 25.5-30% greater than forecast energy consumption
- a winter capacity margin for New Zealand (NZ-WCM) of 630-780 MW greater than forecast peak demand (in MW).

The margins set reflect that if under-supply occurs, there is a rapid increase in costs to the country through loss of production and loss of load events. When over-supply occurs, there is a cost to consumers through cost recovery for the unrequired generation. While the risks are asymmetric, the margins represent an efficient level of generation supply that minimises overall cost to the country.

Matters highlighted by the annual assessment that the SRC should consider

While there are potentially other matters highlighted by the annual assessment, the following seem to be among the relevant matters the SRC should consider.

Transpower has revised its demand forecasts downwards, but the task of forecasting demand has become far harder due to growing uncertainty about trends in demand

Total electricity consumption in New Zealand has fallen slightly since 2010. This change is part of a global trend and has created plenty of uncertainty about predicting future trends in demand: will demand continue to fall, stabilise or recover?

Transpower is predicting continued growth, but has revised the starting point downwards to reflect the last few years in which demand has fallen. The impact of this is that:

- the North Island winter peak forecast reduced by at least 300 MW (Figure 34)

[1] Available from http://www.ea.govt.nz/operations/wholesale/security-of-supply/security-of-supply-policy-framework/security-standards-assumptions/

- the South Island winter peak forecast reduced by at least 100 MW (Figure 35)
- the North Island energy forecast reduced by at least 5% (Figure 36)
- the South Island demand forecast reduced in the short term, but higher than the 2014 forecast in the longer term (Figure 37).

These changes have a major effect on WCM and WEM – largely countering the change in assumed thermal plant availability (see below). System operator staff anticipate that the demand forecasts that the annual assessment of security of supply are based on will be published by Transpower in March 2015. This will enable external parties to examine the methodology in detail.

The system operator has assumed that Taranaki CC will be largely unavailable

There is presently an over-supply of generation. It seems inevitable that one or more major thermal generating units will reduce in availability.

Following discussions with Contact Energy, the system operator has assumed that from 2015 onwards, Taranaki CC:

- will not contribute to meeting peak demand
- will contribute only 55% of its nominal ability to meet energy demand.

However, the system operator's base case scenario assumes that Otahuhu B, Huntly e3p and the two remaining coal-fired Huntly units will continue to be fully available.

These assumptions have a major effect on WCM and WEM.

The SRC may wish to consider the following questions.

Q1.	What advice, if any, does the SRC have to give to the Authority with respect to security of supply?
Q2.	Does the SRC consider that there is enough information to form a view on the change in the demand forecast used in the annual assessment? If so, does the SRC consider that the substantial decrease in peak and North Island energy forecasts is reasonable?
Q3.	Does the SRC consider that the assumptions about the availability of major thermal generating units in the annual assessment are reasonable?

SYSTEM OPERATOR REPORT

Security of Supply

Annual Assessment 2015

TRANSPOWER

IMPORTANT

Contact Details

Address: Transpower New Zealand Ltd
96 The Terrace
PO Box 1021
Wellington
New Zealand

Telephone: +64 4 495 7000

Fax: +64 4 498 2671

Email: system.operator@transpower.co.nz

Website: http://www.systemoperator.co.nz

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	Name	Date
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1. EXECUTIVE SUMMARY

The 2015 Security of Supply Annual Assessment has been completed by the System Operator in accordance with the requirements set out in the Security of Supply Forecasting and Information Policy (SoSFIP)[1]. This report provides an assessment of the power system's ability to meet winter energy and peak requirements over the period 2015 to 2025.

The assessment forecasts the Winter Capacity Margin (WCM) and the Winter Energy Margin (WEM) in accordance with the SoSFIP, and compares them with the security of supply standards set by the Electricity Industry Participation Code 2010[2]. The standards are:

- a WEM of 14-16% for New Zealand
- a WEM of 25.5-30% for the South Island
- a WCM of 630-780 MW for the North Island.

The key conclusions and results of this report are documented below.

- Under the base-case assumptions, the New Zealand WEM and the South Island WEM are forecast to remain above or within each security standard with just existing generation until at least 2025. See Figure 1 and Figure 2 below.
- Under the base-case assumptions, the North Island WCM is forecast to remain above or within the security standard with just existing generation until at least 2024. See Figure 3 below.
- The New Zealand WEM is higher than that derived in the 2014 Security of Supply Annual Assessment. This is due to the lower demand forecast.
- The South Island WEM is lower than that derived in the 2014 Security of Supply Annual Assessment. This is predominantly due to using a larger system relative to a consistent South Island energy surplus, which in turn is due to modelling embedded generation where it was previously was not modelled.
- The North Island WCM is, at times, both higher and lower than that derived in the 2014 Security of Supply Annual Assessment. The upwards pressure on the North Island WCM is due to a decrease in demand, the downwards pressure on the North Island WCM is due to the removal of generation capacity from the system.
- There is sufficient potential capacity and energy from future generation projects to respond to all supply or demand scenarios assessed in this report. Under no single scenario is there a point where the summation of all available generation projects (ie existing, committed, high, medium and low probability projects) is not equal to or greater than the security standards.

[1] http://www.systemoperator.co.nz/security-supply/security-supply-policies/security-supply-forecasting-and-information-policy

[2] See Part 7, clause 7.3(2) (a) and (b).

- In the most aggressive[3] scenarios generation with a high and medium likelihood of construction is required to keep the New Zealand WEM above or within the security standards for the full forecast period.
- In the most aggressive scenarios generation with a high, medium and low likelihood of construction is required to keep the North Island WCM and the South Island WEM above or within the security standards for the full forecast period.
- Unless there is a rapid change to either supply or demand, it is unlikely the New Zealand electricity system will suffer supply shortages in the medium term, even in a moderately low inflow year.
- Assessed against the security standards set by the Electricity Authority, the New Zealand electricity system is currently oversupplied in generation following recent generation investment. This was likely due to recent low demand growth in the industry.

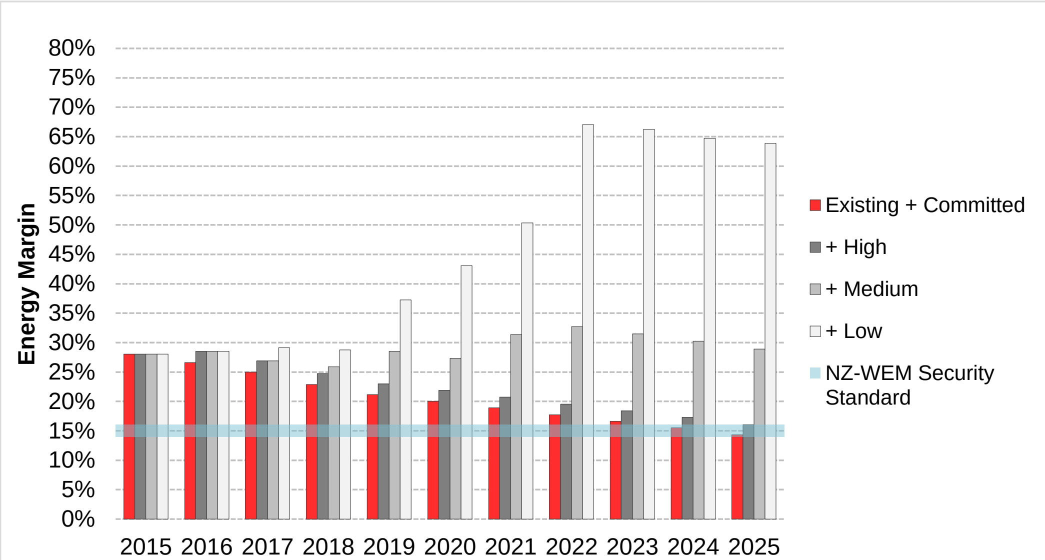

Figure 1: New Zealand Winter Energy Margin 2015 to 2025 – Base-case

[3] The most aggressive scenarios are those that put the most strain, or downwards pressure, on the security margins, eg. high demand, low thermal, etc.

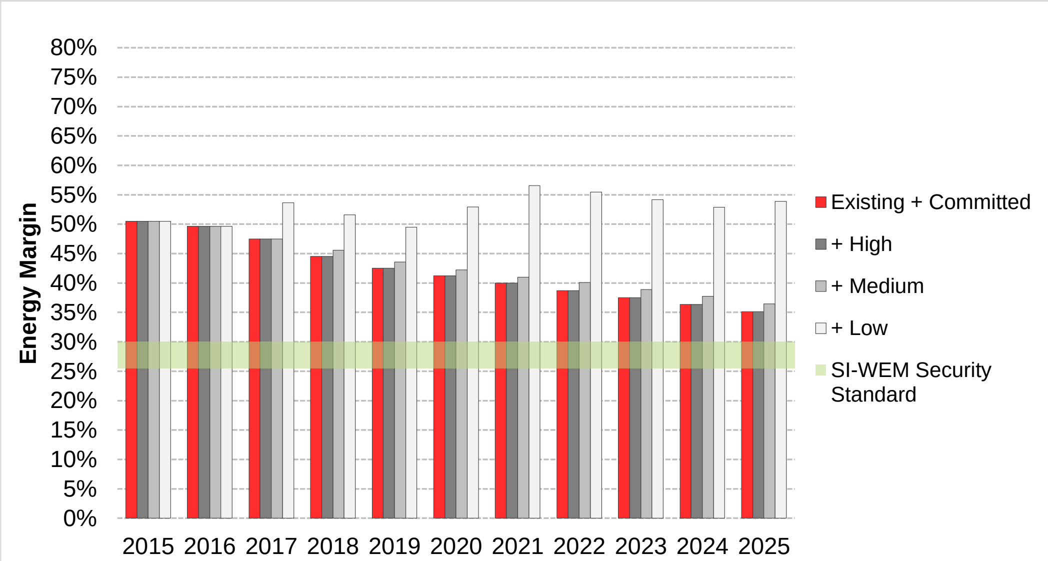

Figure 2: South Island Winter Energy Margin 2015 to 2025 – Base-case

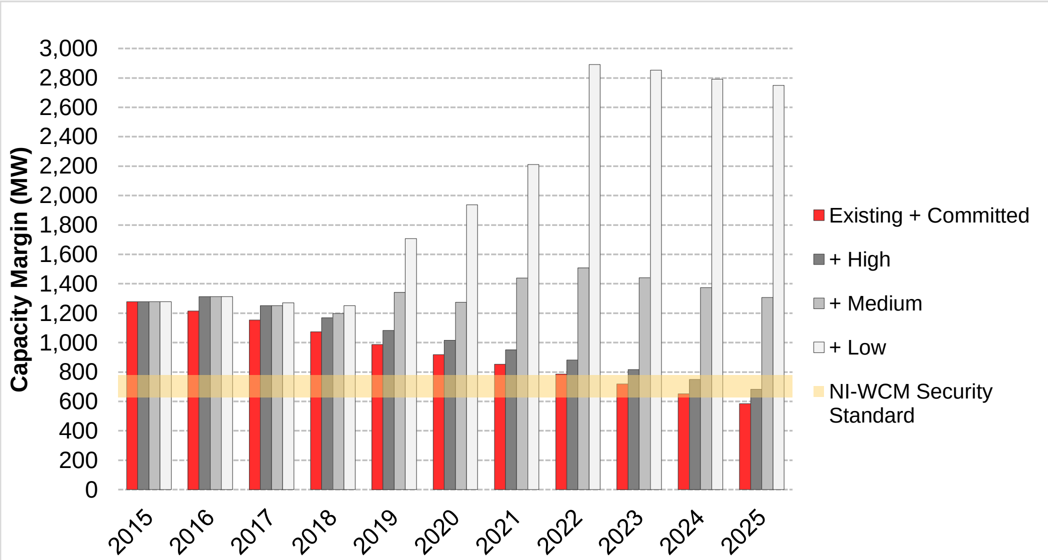

Figure 3: North Island Winter Capacity Margin 2015 to 2025 – Base-case

2. Glossary

Term	Description
The Code	The Electricity Industry Participation Code 2010 sets out industry participant responsibilities and duties
EA	Electricity Authority
GXP	Grid Exit Point. This is the boundary between the national grid and the distribution networks
SoSFIP	Security of Supply Forecasting and Information Policy
SSAD	Security Standards Assumption Document
WEM	Winter Energy Margin
WCM	Winter Capacity Margin

3. Introduction

The annual publication of a medium to long-term security of supply assessment is required by the Code and the SoSFIP, and is part of the system operator's security of supply role. A security assessment was last published by the System Operator in February 2014. This document fulfils the obligations set out in Part 7, clause 7.3(2) (a) and (b) of the Code.

This assessment is intended to provide a metric in which to gauge the security of supply outlook in the medium term to enable participants to assess the risk of supply shortages, and to assist potential investment decision making.

This report assesses the New Zealand and South Island WEMs and the North Island WCM, terms defined in the SoSFIP, for the period 2015 to 2025.

3.1 Invitation to Comment

The System Operator welcomes feedback on this report, including any additional information for analysis that may lead to this report being updated. Comment and additional information, which if marked accordingly may be given in confidence, should be:

Emailed to the attention of Bennet Tucker at *bennet.tucker@transpower.co.nz*

Or a hard copy may be sent to the attention of:

Bennet Tucker
Transpower
PO Box 1021
Wellington 6140

4. Background

4.1 Assessment Context and Interpretation

As set out in the System Operator's SoSFIP, the System Operator must prepare and publish a security of supply assessment that enables interested parties to compare projected winter energy and capacity margins over the next 5 or more years. The security standards used in this assessment were determined by the Electricity Authority (EA) and have subsequently been incorporated into the Code. The standards are summarised below.

- a WEM of 14-16% for New Zealand
- a WEM of 25.5-30% for the South Island
- a WCM of 630-780 MW for the North Island.

The EA derived the above standards using a probabilistic analysis[4]. The analysis sought to determine:

- the efficient level of North Island peaking capacity; defined as the level that minimises the sum of the expected societal cost of capacity shortage plus the cost of providing peaking generation capacity
- the efficient level of national winter energy supply; defined as the level that minimizes the sum of the expected societal cost of energy shortage plus the cost of providing thermal firming capacity
- equivalently, the efficient level of South Island winter energy supply.

The EA has suggested that the security of supply capacity standard should be interpreted as follows.

- A North Island WCM below the lower standard of 630 MW indicates an inefficiently low level of capacity; the cost of adding more capacity would be more than justified by the reduction in shortage costs at times of insufficient capacity.
- A North Island WCM between 630 and 780 MW indicates a roughly efficient level of capacity.
- A North Island WCM above the upper standard of 780 MW indicates a capacity level that is inefficiently high in terms of the trade-off between supply costs and the cost of shortage at times of insufficient capacity (but may still be efficient for other reasons).

The energy security of supply standards should be interpreted in a similar fashion.

The Security of Supply Annual Assessment only includes New Zealand energy and capacity margins for winter. This is because at a national and island level, the New Zealand electricity system is most stressed in winter due to high demand and low inflows. Therefore, the winter energy and capacity margins are the best measure of energy and capacity risk for New Zealand.

[4] *http://www.ea.govt.nz/development/work-programme/wholesale/security-of-supply-standards/consultations/#c13932*

4.2 Other System Operator Security of Supply Functions

The System Operator performs other security of supply related functions that are covered in the SoSFIP and the Emergency Management Policy. These include:

- shorter-term monitoring and information provsion such as the weekly reporting of hydro levels relative to the Hydro Risk Curves[5]
- where necessary, implementing emergency measures in accordance with the Emergency Management Policy, the System Operator Rolling Outage Plan, and the emergency provisions under Part 7 of the Code.

4.3 Previous Security Assessments

For the Electricity Commission's similar assessments up until 2010, refer *http://www.ea.govt.nz/about-us/what-we-do/our-history/archive/operations-archive/security-of-supply/asa/*.

For the assessments undertaken by the system operator from 2011, refer *http://www.systemoperator.co.nz/security-supply/annual-security-assessments*.

[5] *http://www.systemoperator.co.nz/security-supply/sos-weekly-reporting/hydro-risk-curves*

5. INPUT ASSUMPTIONS

5.1 FRAMEWORK

The main input assumptions of the assessment were:

- electricity generation (existing and proposed new projects)
- electricity demand (including demand response)
- inter-island transmission capability.

The assessment included a base-case scenario and a range of sensitivity scenarios designed to test the effect of a variety of credible but less probable alternatives from the base-case. The base-case assumptions are set out in Section 5.2, and the alternative assumptions used in the sensitivity scenarios are set out in Section 5.3.

New generation development options under consideration by investors may or may not proceed for a variety of reasons. Accordingly, new generation projects have been allocated to four categories: committed, "high" probability, "medium" probability, and "low" probability. Each scenario includes four cases.

- Existing and committed generation only
- Existing, committed and "high" probability generation
- Existing, committed, "high" and "medium" probability generation
- Existing, committed, "high", "medium" and "low" probability generation

All scenarios cover the period from 2015 to 2025.

The methodology for the calculation of the WEM and the WCM is covered in Sections 6.1 and 7.1.

5.2 BASE-CASE ASSUMPTIONS

The basis for the Security of Supply Annual Assessment methodology, including assumptions used in modelling, is the Electricity Authority's Security Standards Assumptions Document (SSAD)[6]. The SSAD outlines the high level assumptions and formulas in which the Security of Supply Annual Assessment calculations were based on. This section describes many of these and other non-prescribed assumptions that are drawn from other sources. For a complete and detailed set of assumptions refer to the appendices (Sections 9 and 10).

Assumptions about generation were largely based on information received from the major Generators on a confidential basis. The System Operator thanks all contributors including: Genesis Energy, Meridian Energy, Contact Energy, Mighty River Power and TrustPower for the information provided. Some publicly available information is also used.

Demand assumptions are based on Transpower's long-term electricity demand forecast produced by the Grid Development team in 2014 and adjusted to account for embedded generation and transmission losses.

[6] *http://www.ea.govt.nz/dmsdocument/14134*

5.2.1 Monitoring Input Assumptions

It is possible that the WCM and WEM may change as a result of new information. All assumptions that inform this assessment will be reviewed and if necessary adjusted as part of the next annual assessment process due in early 2016.

5.2.2 Existing Generation Assumptions

All existing generation is expected to remain operationally available throughout the assessment period (2015 – 2025), subject to normal limitations (eg the variability of intermittent generation, the dependence of hydro plants on inflows, the outage rates of thermal and hydro plants).

It is also assumed that thermal fuel, or operational limitations, will in the most part not constrain the production of electricity. Specifically, thermal generating plant is assumed to be unconstrained by primary fuel or operational limitations with the following exceptions:

- Whirinaki's energy contribution is limited in the derivation of the WEMs
- Taranaki Combined Cycle energy contribution is limited in the derivation of the WEMs, and is unable to contribute to the WCM

These assumptions are designed to reflect the limited fuel and available operating hours of the plant.

See Section 9 for further detail on base-case assumptions about existing generation.

5.2.3 Future Generation Assumptions

Information provided by the Generators has been aggregated for publication in order to preserve confidentiality. There are currently no projects that are classified as committed so unlike previous Security of Supply Annual Assessments the System Operator cannot disclose any detailed information on future generation options.

Figure 4 shows the new generation data in aggregate form.

Figure 4: New generation assumptions (all projects)

5.2.4 Demand Forecast Assumptions

This assessment based its demand forecast on Transpower's long-term electricity demand forecast, produced by the Grid Development team in 2014. The forecast used to derived the margins is equivalent to forecasts used in previous Security of Supply Annual Assessments with the following exceptions:

- generation from embedded generators has been grossed onto the demand forecast to account for demand served by embedded generation
- transmission losses have been explicitly estimated[7] and grossed on to the demand forecast.

This is a change from previous versions of the Security of Supply Annual Assessment where embedded generation was not modelled, and transmission losses were estimated using a static loss factor. It was decided that the inclusion of embedded generation presented a more complete analysis and therefore it should be included. Transmission losses were explicitly estimated as this produced a more accurate demand initial

[7] Or in the case with the 2014 year, actual loss information was used.

condition (ie. a more accurate 2014 demand data point). Figure 5 shows expected peak and energy demand out to 2025 and includes the high and low demand sensitivity scenarios.

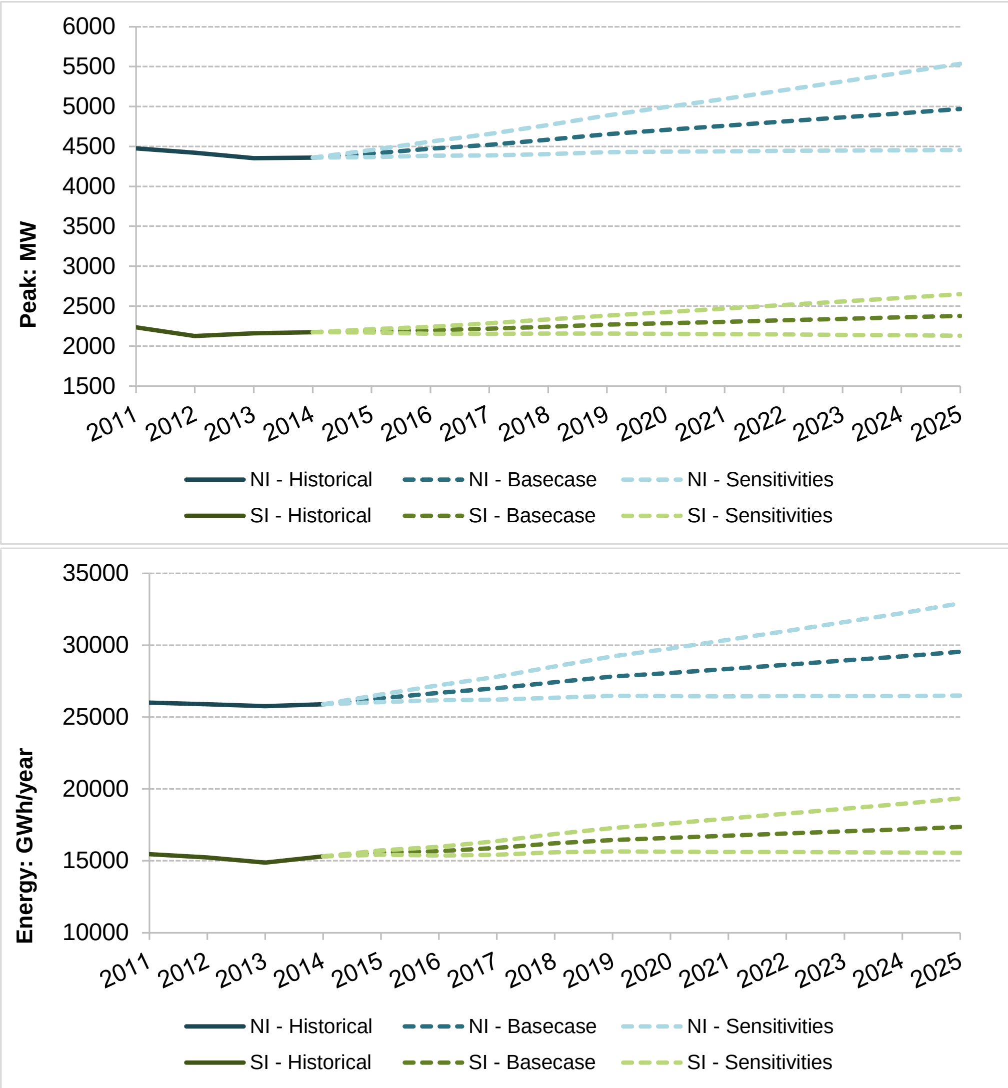

Figure 5: Expected demand – both Peak and Energy

See Section 10 for more detailed assumptions about the electricity demand forecast used in the base-case scenario.

5.2.5 Inter-island Transmission Assumptions

The assessment of the WEMs and WCM does not incorporate detailed modelling of transmission. However, there are assumptions made about the amount of energy that can be transferred from the North Island to the South Island during winter and the capacity that can be transferred from the South Island to the North Island during periods of peak demand.

See Section 9 for detailed assumptions about inter-island transmission.

5.3 SCENARIOS

The security margins are sensitive to a number of potential system changes and developments. As part of this assessment a range of possible future scenarios were analysed to determine the impact each of these scenarios will have on the security margins. This section describes these scenarios.

Note that the outcomes described are not necessarily mutually exclusive and some scenarios may be coupled. For example, it is likely that planned generation would be deferred if Tiwai significantly reduces its load or shuts down. However, the scope of this study has been limited to assessing each scenario individually.

Table 1: Sensitivity scenarios

Scenario	Affects Energy	Affects Capacity	Rationale	Assumptions Made
High demand	Yes	Yes	Demand may exceed the base-case forecast.	+1% demand growth pa on base-case.
Low demand	Yes	Yes	Demand may fall below the base-case forecast.	-1% demand growth pa on base-case.
Delayed Builds	Yes	Yes	Generation investment may be postponed due to market conditions.	Projects, other than committed, are uniformly delayed by 1 year if they are originally assumed to be built prior to 2018, and delayed by 2 years for those projects assumed to be built after or during 2018.
Low inflows	Yes	No	This scenario explores the sensitivity of the WEMs to hydro inflow assumptions.	In the calculation of energy margins, all hydro generation is reduced by 10% (equivalent to approximately the 20th percentile of historical hydro inflows).
Reduced thermal generation	Yes	Yes	It is possible that thermal generation may be limited by a number of factors in the future. This could result in a halt in new thermal generation commissioning.	No new thermal generation is commissioned.
Reduced capacity factors	No	Yes	Capacity factors may be lower than assumed.	All capacity factors are reduced by 5%.
Limited south transfer	Yes	No	The base-case assumption is that southward transfer can rise to an average of 480 MW – but, as noted in the Winter Review[8], various factors can combine to prevent this. During June-August 2008, the average net southward transfer over the HVDC link was approximately 300 MW. Although this limit may no longer be relevant this scenario is still considered to be meaningful as it illustrates the sensitivity of the South Island WEM to HVDC transfer limits.	Inter-island transfer is limited to 1,314 GWh in the South Island WEM (equivalent to an average of 300 MW).

8 http://www.ea.govt.nz/about-us/what-we-do/our-history/archive/dev-archive/consultations/security-of-supply-consultations/review-of-2008-winter/

Scenario	Affects Energy	Affects Capacity	Rationale	Assumptions Made
Tiwai shutdown	Yes	Yes	Tiwai aluminium smelter may reduce its output or shutdown due to economic conditions.	The base-case assumption is that Tiwai's load remains at current levels. There are two scenarios in which Tiwai reduces its load. 1. Tiwai reduces its average load to 400 MW from 2017. 2. Tiwai reduces its load in stages beginning in 2015 until it shuts down in 2017.

6. Energy Margin Assessment

6.1 Methodology

The assessment of Energy Margins follows the methodology set out in the SSAD. There are two metrics:

The New Zealand Winter Energy Margin:

$$NZ\ WEM = \left(\frac{New\ Zealand\ expeted\ energy\ supply}{New\ Zealand\ expected\ energy\ demand} - 1\right) \times 100\%$$

The South Island Winter Energy Margin:

$$SI\ WEM = \left(\frac{South\ Island\ expected\ energy\ supply + expected\ HVDC\ transfers\ south}{South\ Island\ expected\ energy\ demand} - 1\right) \times 100\%$$

Components to these equations are described in Table 2 and Table 3.

Table 2: Summarising the New Zealand WEM components

Component	Comprises	Description
New Zealand expected energy supply (GWh)	Thermal GWh	Maximum expected thermal generation available to meet winter (1 April to 30 September) energy demand allowing for forced and scheduled outages, available fuel supply and operational and transmission constraints.
	Median Hydro GWh	Expected winter (1 April to 30 September) hydro generation based on median inflows and expected 1 April start storage of 2,750 GWh.
	Other GWh	Expected winter (1 April to 30 September) energy available from cogeneration[9], geothermal and wind generation based on long-run average supply.
New Zealand expected energy demand (GWh)	n/a	Expected winter demand, allowing for the normal demand response to periods of high spot prices (excluding any response due to savings campaigns or forced rationing).

Table 3: Summarising the South Island WEM components

Component	Comprises	Description
South Island expected energy supply (GWh)	Median Hydro GWh	Expected winter (1 April to 30 September) hydro generation based on median inflows and assumed 1 April start storage of 2,400 GWh.
	Other GWh	Expected winter (1 April to 30 September) wind generation based on long-run average supply.
Expected HVDC transfers south (GWh)	HVDC GWh	Expected winter (1 April to 30 September) HVDC transfers received in the South Island.
South Island expected energy demand (GWh)	n/a	Expected winter demand, allowing for the normal demand response to periods of high spot prices (excluding any response due to savings campaigns or forced rationing).

[9] Cogeneration has not been treated as thermal generation as it is assumed that the level of generation is based on industrial processes and thus is not controlled in the same way major thermal generators are.

6.2 ENERGY MARGIN RESULTS

This section summarises the results of the WEM assessment, based on the input assumptions summarised in Section 5 and described in detail in the appendices (Sections 9 and 10).

Forecasts of the New Zealand WEM and South Island WEM from 2015 – 2025 under the base-case scenario are shown in Figure 6 and Figure 7. Sensitivity results are presented following the base-case results.

Energy margin results are summarised below.

- In the base-case scenario, the New Zealand and South Island WEMs are forecast to remain above or within the security standard for the full forecast period (2015 – 2025) with just existing and committed generation.
- In all scenarios, existing and committed generation are enough to keep the New Zealand and South Island WEMs above or within their respective security standard until at least 2019 and 2021 respectively.
- The high demand, low inflows, and reduced thermal generation scenarios significantly reduce the WEMs compared to the base-case.
- Under all scenarios, with the exception of the limited south transfer scenario, the South Island WEM is higher than the New Zealand WEM, compared to their respective security standard.
- The scenarios that reduce existing and committed generation below the lower limit of the security standard during the forecast period are the high demand, reduced thermal generation and low inflows.
- These three scenarios require generation with a high and medium likelihood of construction to keep the New Zealand WEM above or within the security standard for the full forecast period.
- These three scenarios require generation with a high, medium and low likelihood of construction to keep the South Island WEM above or within the security standard for the full forecast period.
- The WEMs are particularly sensitive to the high demand scenario. However there are sufficient generation options to keep both the WEMs above the security standards in the forecast period.
- In the event of a Tiwai shutdown, it would take several years for both the New Zealand and South Island WEMs to return to pre-shutdown levels.
- There are no scenarios in which the WEMs fall below zero in the forecast period.
- The 2015 New Zealand WEMs are higher than those derived in the 2014 Security of Supply Annual Assessment. On average, the 2015 New Zealand WEM is 7% higher than the base-case scenario in the 2014 Security of Supply Annual Assessment. This increase is due to lower New Zealand demand.
- The 2015 South Island WEMs are lower than those derived in the 2014 Security of Supply Annual Assessment. On average, the 2015 South Island WEM is 8% lower

than the base-case scenario in the 2014 Security of Supply Annual Assessment. This decrease is due to a larger system in the South Island[10] while the surplus has remained relatively constant; therefore the surplus, as a percentage of the total system, is smaller. Additionally South Island demand has increased in the later years of the forecast period.

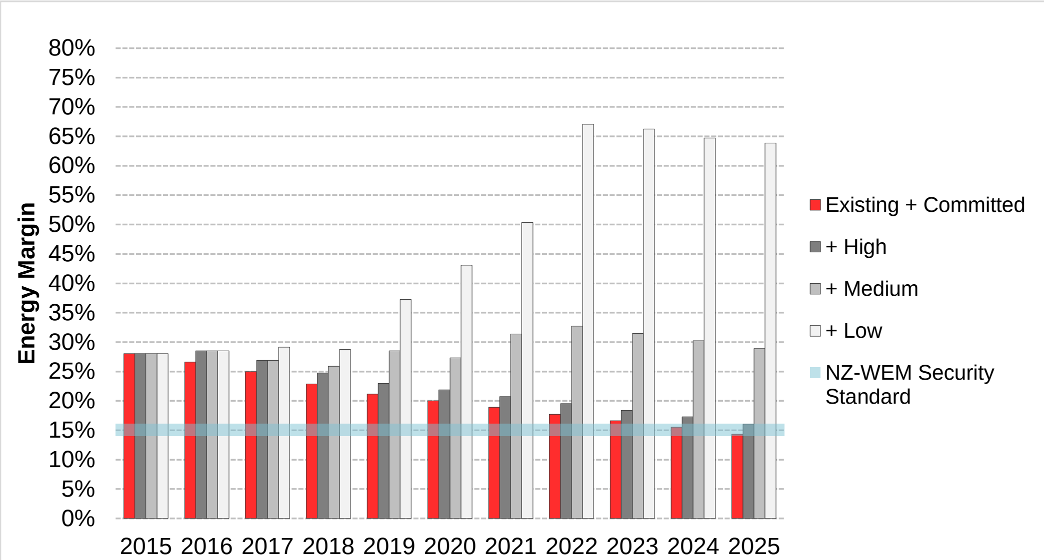

Figure 6: New Zealand Winter Energy Margin 2015 to 2025 – Base-case

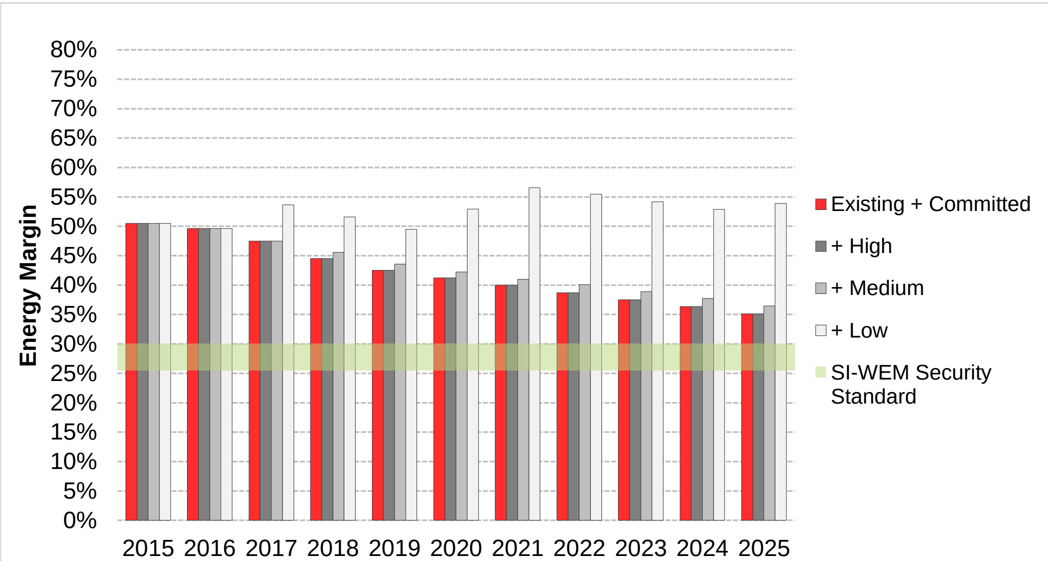

Figure 7: South Island Winter Energy Margin 2015 to 2025 – Base-case

[10] Embedded generation has added approximately 400 GWh additional energy to both supply and demand

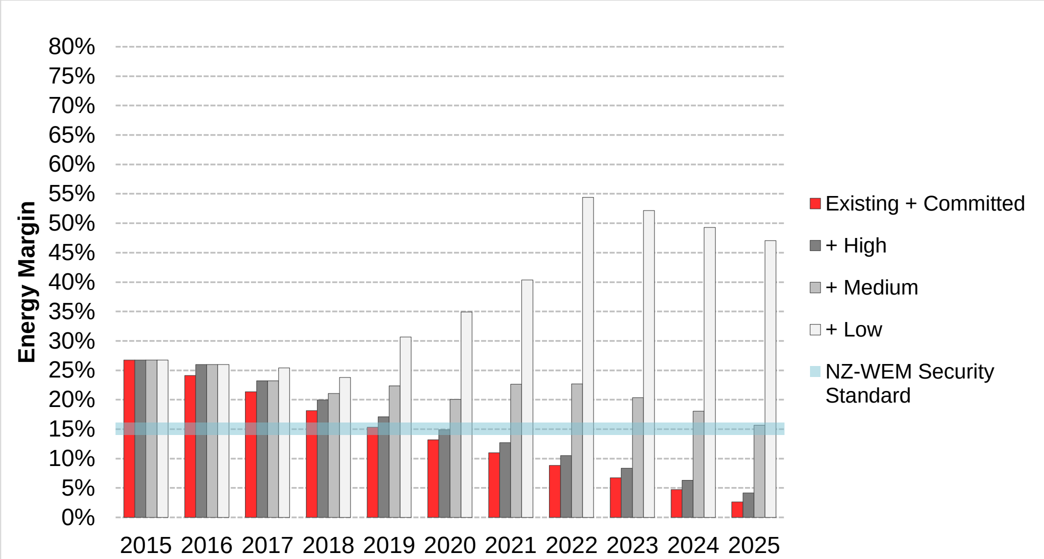

Figure 8: New Zealand Winter Energy Margin 2015 to 2025 – High Demand Scenario

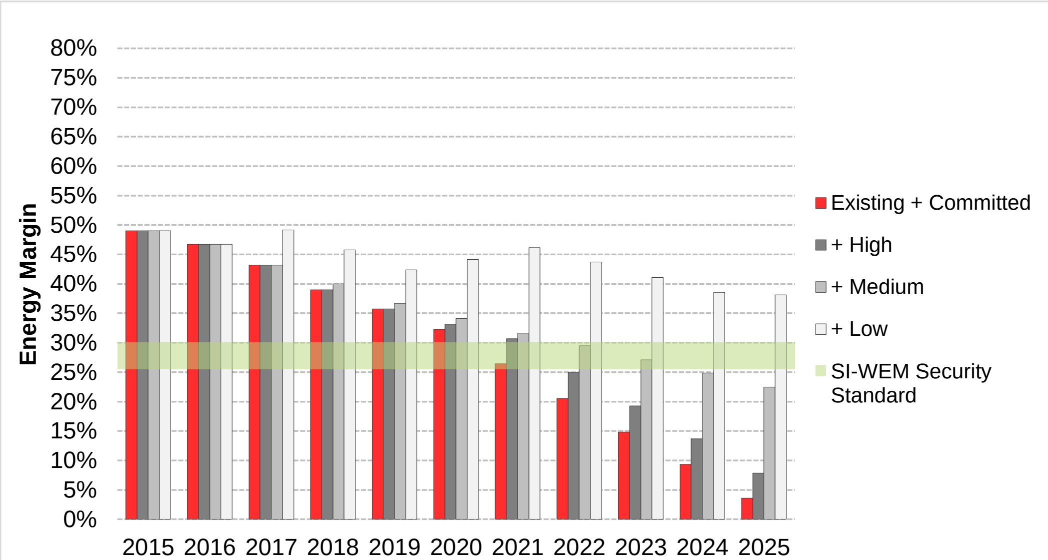

Figure 9: South Island Winter Energy Margin 2015 to 2025 – High Demand Scenario

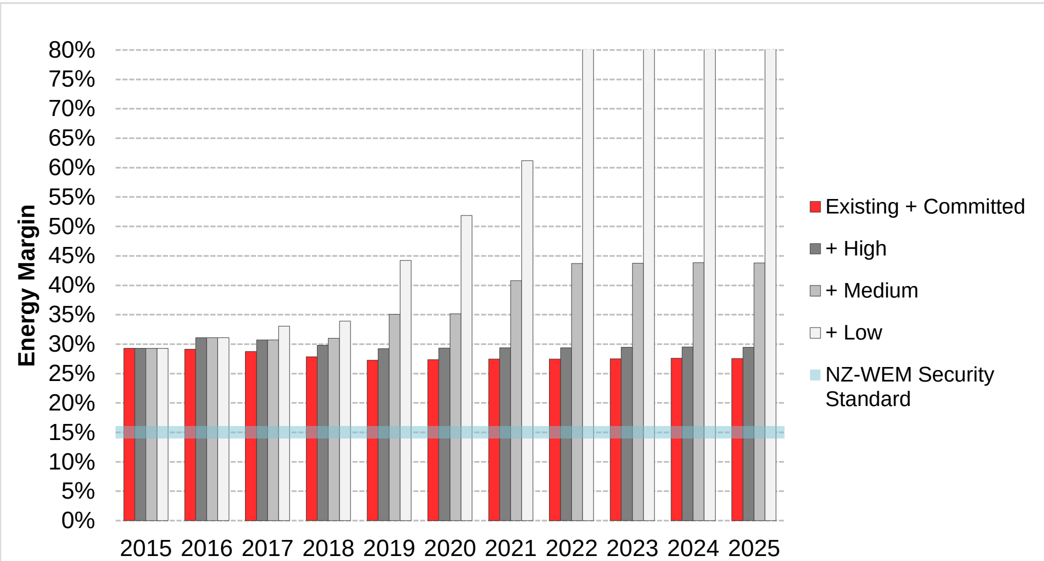

Figure 10: New Zealand Winter Energy Margin 2015 to 2025 – Low Demand Scenario

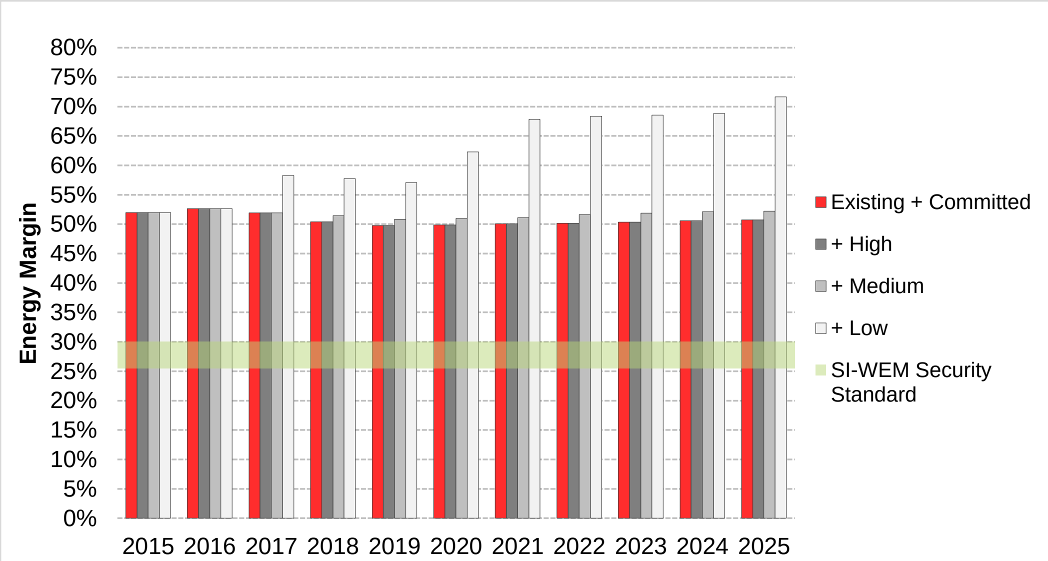

Figure 11: South Island Winter Energy Margin 2015 to 2025 – Low Demand Scenario

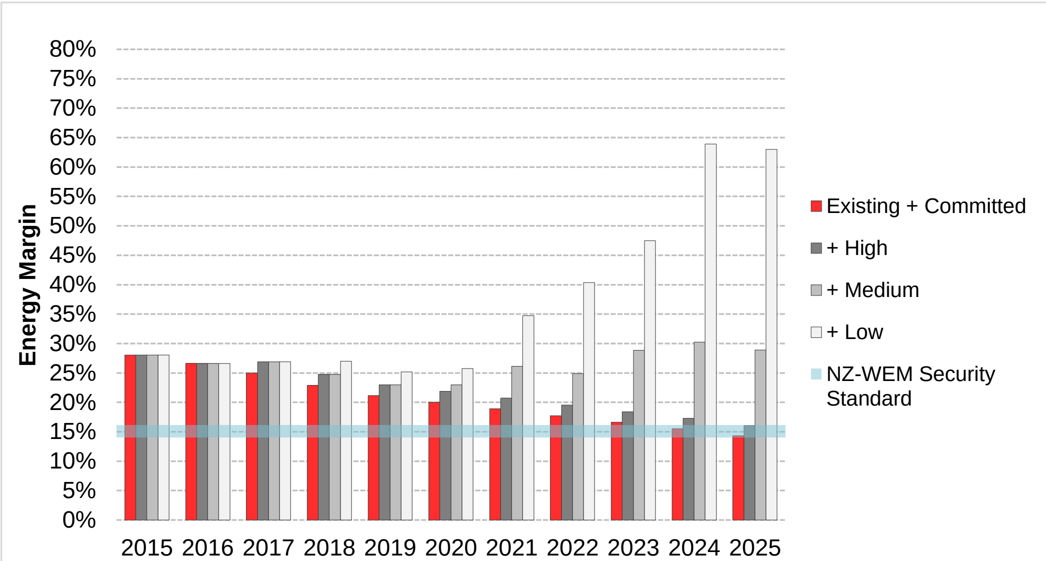

Figure 12: New Zealand Winter Energy Margin 2015 to 2025 – Delayed Build Scenario

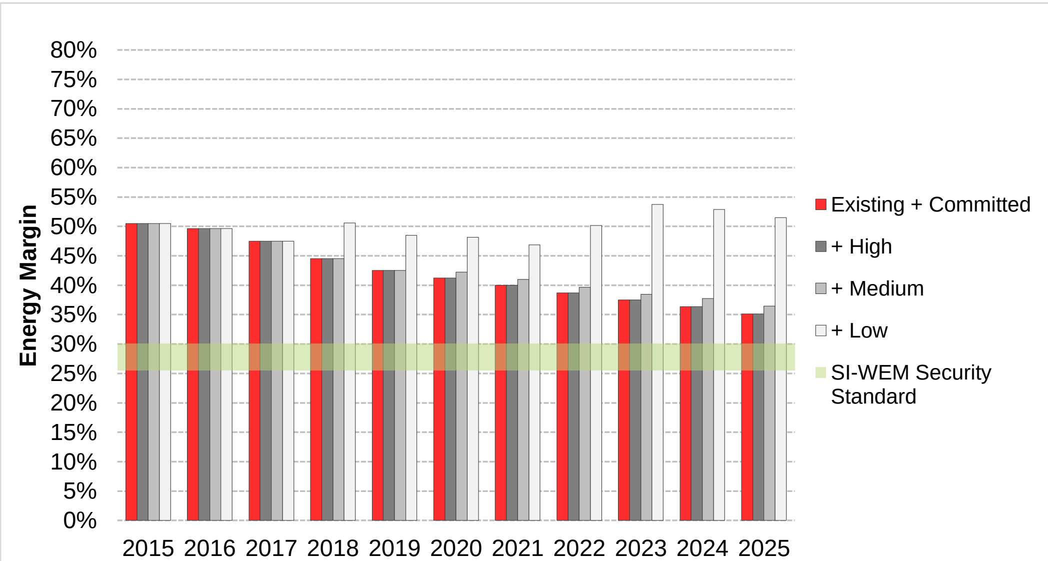

Figure 13: South Island Winter Energy Margin 2015 to 2025 – Delayed Build Scenario

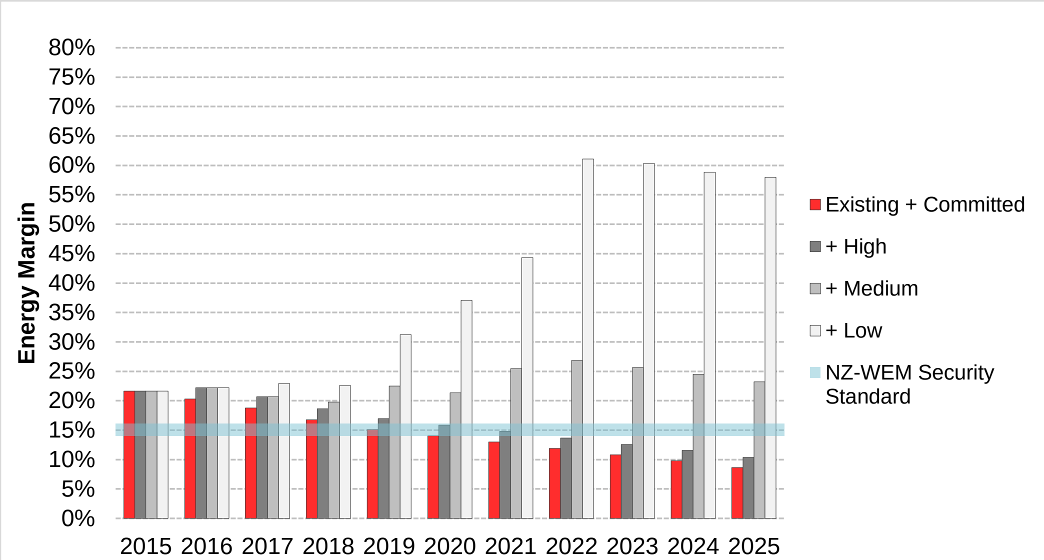

Figure 14: New Zealand Winter Energy Margin 2015 to 2025 – Low Inflows Scenario

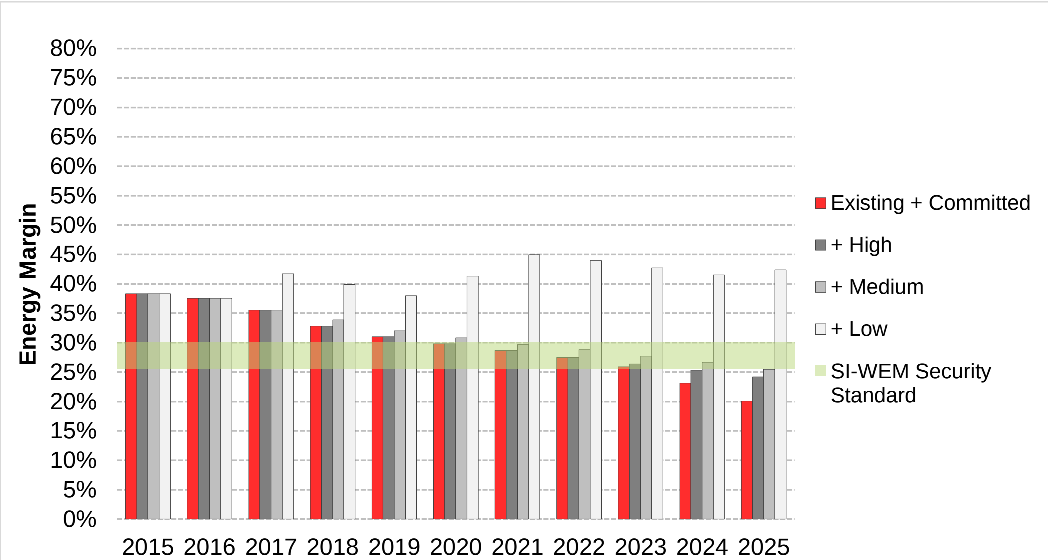

Figure 15: South Island Winter Energy Margin 2015 to 2025 – Low Inflows Scenario

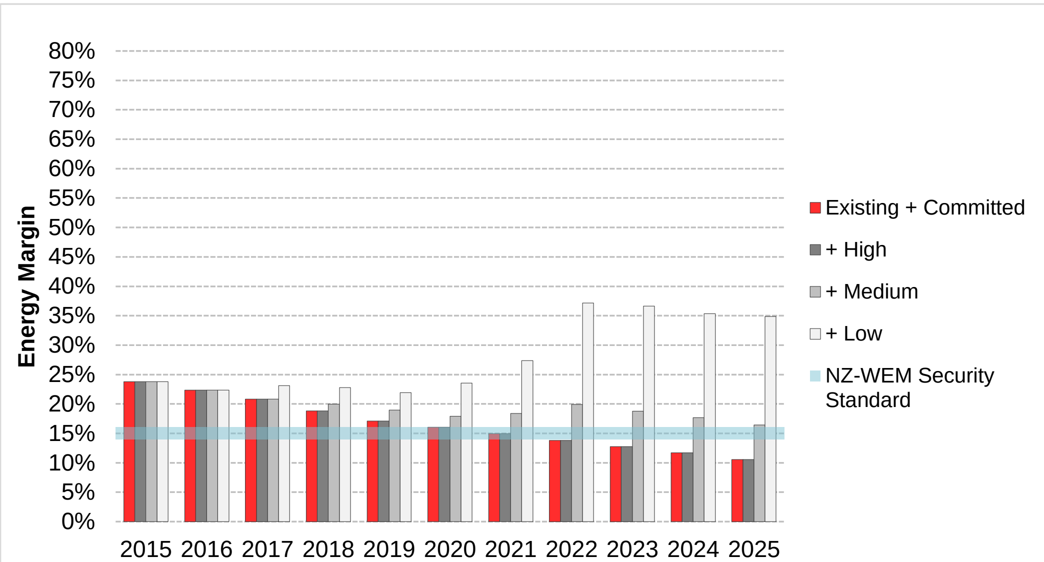

Figure 16: New Zealand Winter Energy Margin 2015 to 2025 – Reduced Thermal Generation Scenario

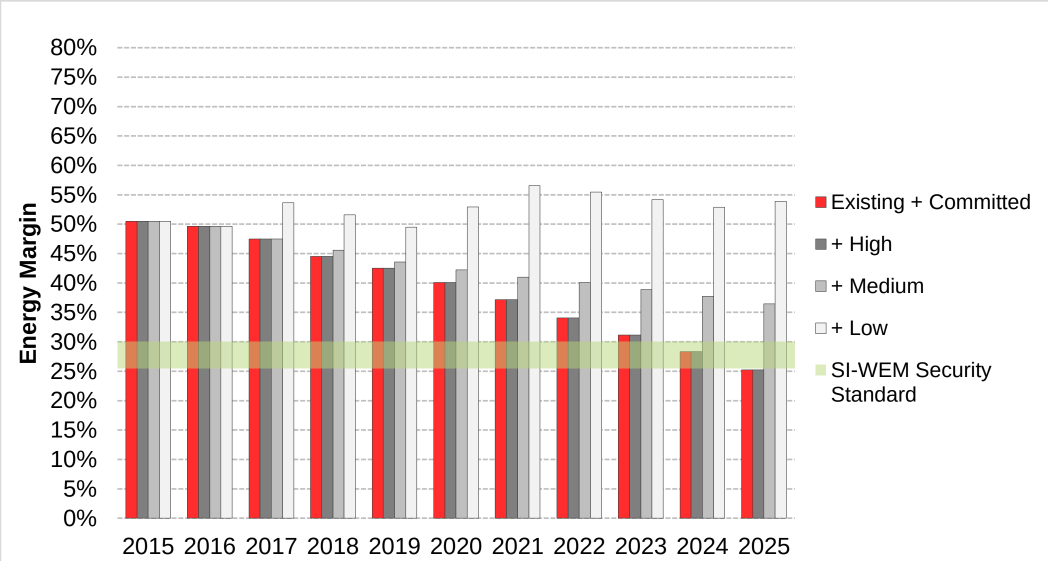

Figure 17: South Island Winter Energy Margin 2015 to 2025 – Reduced Thermal Generation Scenario

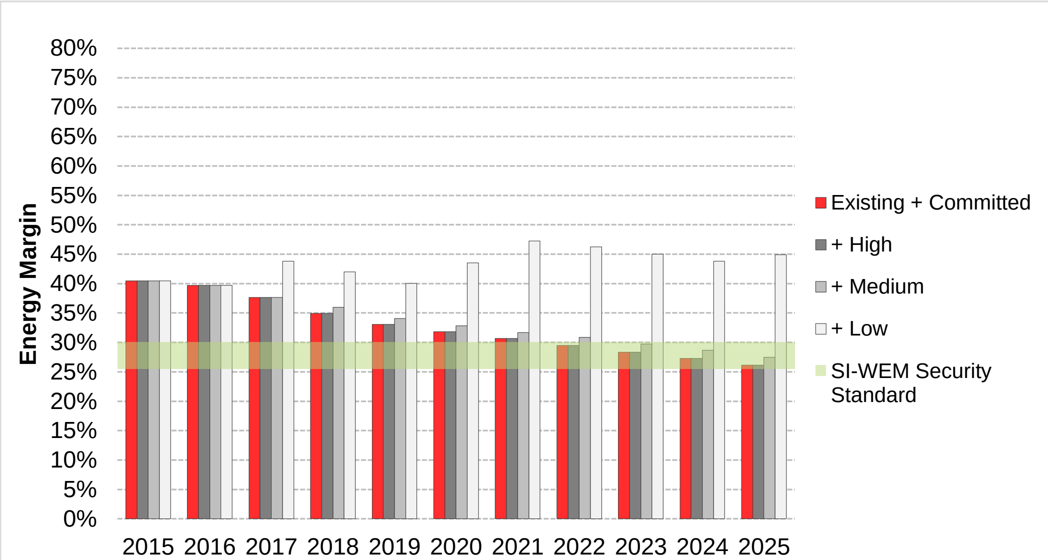

Figure 18: South Island Winter Energy Margin 2015 to 2025 – Limited South Transfer Scenario

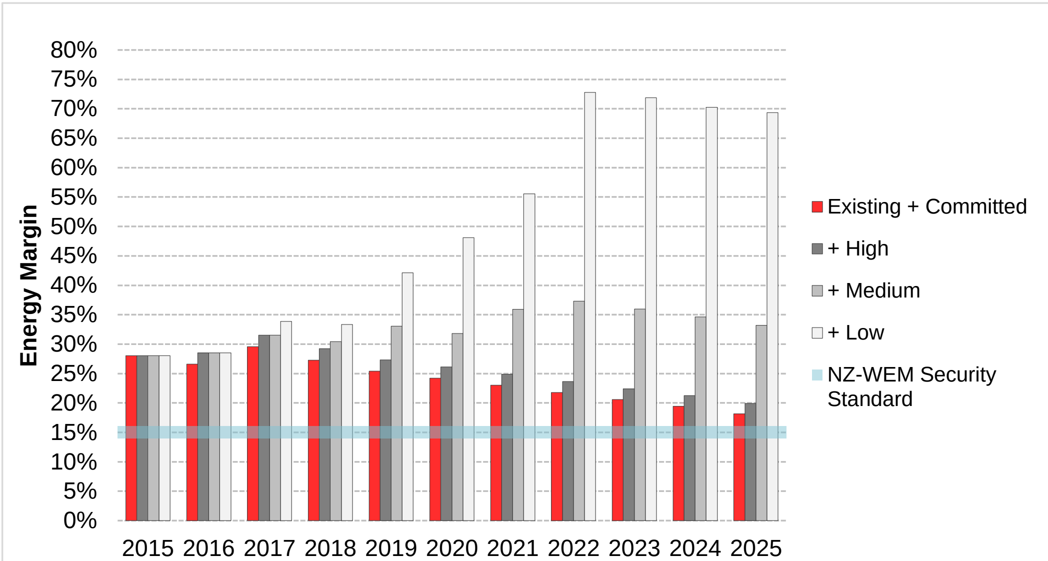

Figure 19: New Zealand Winter Energy Margin 2015 to 2025 – Tiwai Shutdown Scenario 1

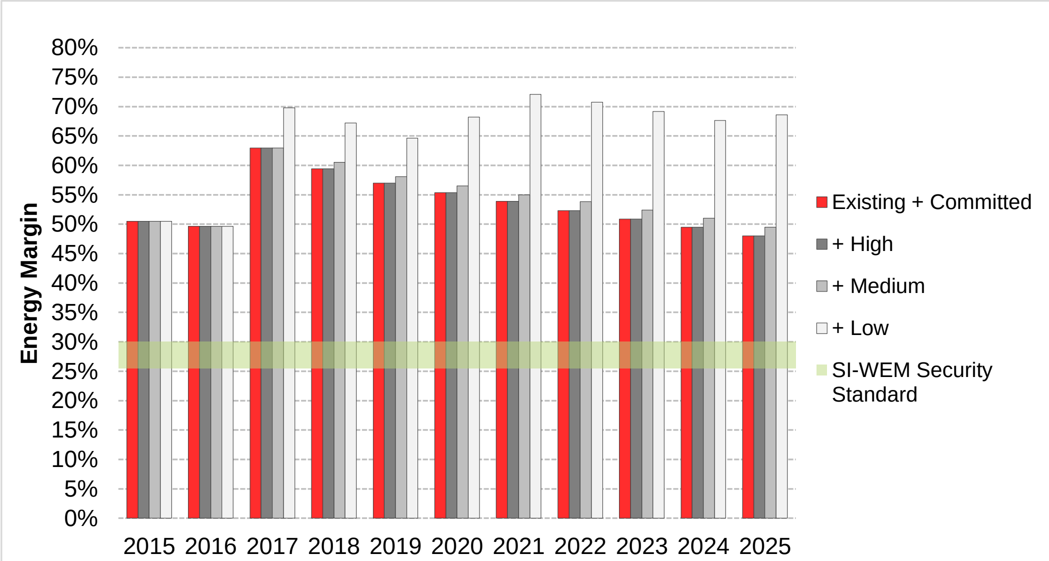

Figure 20: South Island Winter Energy Margin 2015 to 2025 – Tiwai Shutdown Scenario 1

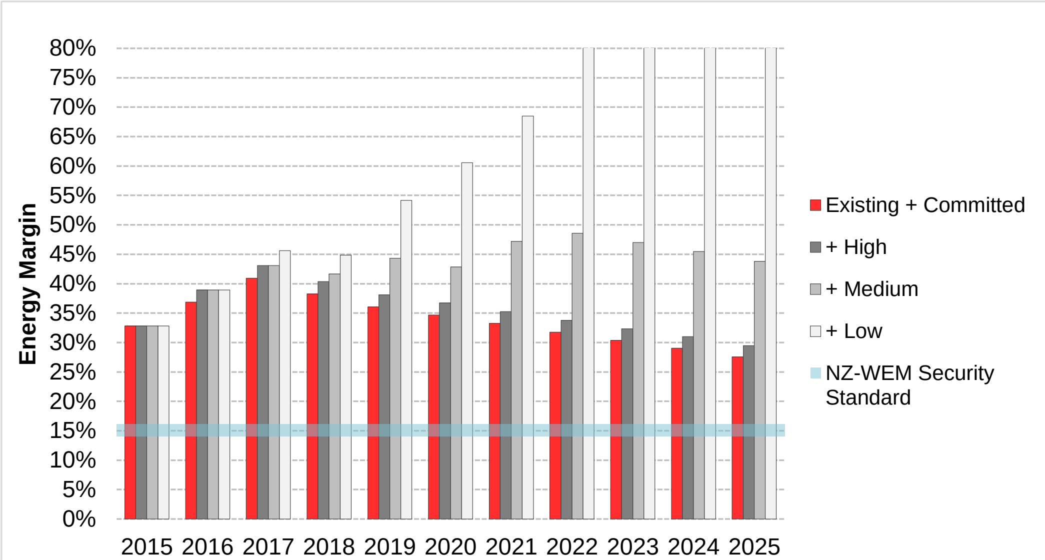

Figure 21: New Zealand Winter Energy Margin 2015 to 2025 – Tiwai Shutdown Scenario 2

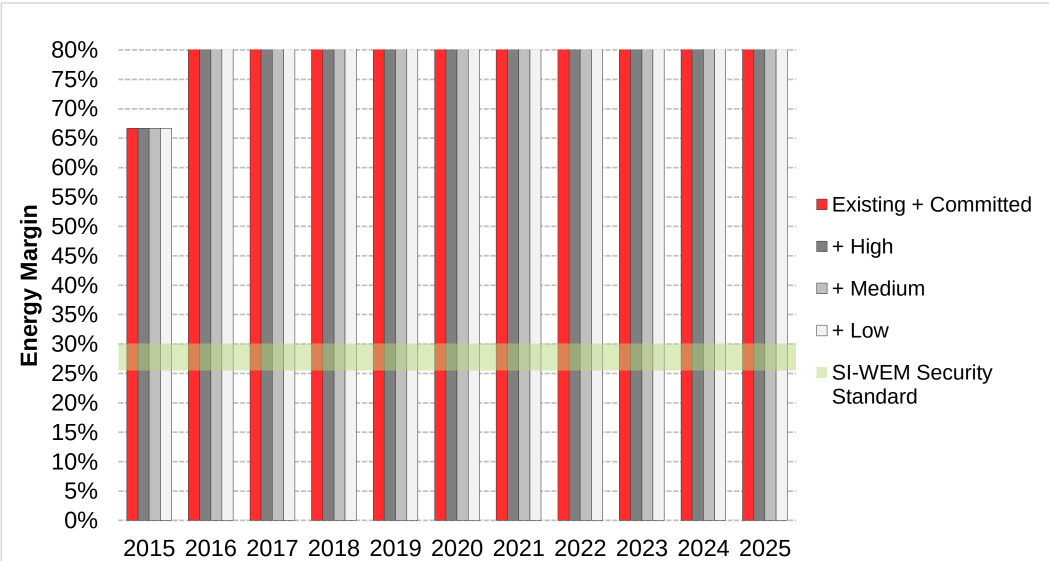

Figure 22: South Island Winter Energy Margin 2015 to 2025 – Tiwai Shutdown Scenario 2

7. Capacity Margin Assessment

7.1 Methodology

The assessment of Winter Capacity Margin follows the methodology set out in the SSAD. There is a single metric; the North Island Winter Capacity Margin:

$$NI\ WCM = North\ Island\ expected\ capacity - North\ Island\ expected\ demand + expected\ HVDC\ transfer\ north\ (function\ of\ SI\ capacity - SI\ demand)$$

The input factors that comprise the WCM calculation are summarised in Table 4.

Table 4: Summarising the North Island WCM Components

Component	Comprises	Description
North Island expected capacity (MW)	NI Thermal MW	Installed capacity of North Island thermal generation sources allowing for forced and scheduled outages, available fuel supply and operational and transmission constraints.
	NI Hydro MW	Installed capacity of North Island controllable hydro schemes allowing for forced and scheduled outages and de-rated to account for energy and other constraints which affect output during peak times.
	NI Other MW	Expected winter daytime (1 April – 31 October between 7am and 10pm) generation available from geothermal, wind, cogeneration and uncontrolled hydro scheme generation.
	NI Demand Response and Interruptible Load MW	Expected demand response and interruptible load over the highest 200 half hours of demand in winter daytime (1 April – 31 October between 7am and 10pm).
North Island expected demand (MW)	n/a	Expected average of the highest 200 half hours (or 100 hours) of demand in winter inclusive of losses. This is referred to as H100 NI demand.
Expected HVDC transfer north	South Island MW	The net amount of MW the South Island can provide the North Island during peak periods. This is a similar calculation to above (supply capacity minus H100 NI demand); however, also takes into account HVDC transfer capability.

7.2 Capacity Margin Results

This section summarises the results of the North Island WCM assessment, based on the input assumptions summarised in Section 5 and described in detail in the appendices (Sections 9 and 10).

The forecast of the North Island WCM from 2015 – 2025 under the base-case scenario is shown in Figure 23. Sensitivity results are presented following the base-case results.

Energy margin results are summarised below.

- In the base-case scenario, the North Island WCM is forecast to stay above or within the security standard for until 2024 with just existing and committed generation.
- In all scenarios, existing and committed generation are enough to keep the North Island WCM above or within the security standard until at least 2019.
- The scenarios that reduce existing and committed generation below the lower limit of the security standard during the forecast period are the high demand, reduced thermal generation, and reduced capacity factor scenarios.
- The base-case and delayed generation build scenarios require generation with a high likelihood of construction to keep the North Island WCM above or within the security standard for the full forecast period.
- The reduced thermal generation and de-rated capacity factor scenarios require generation with a high and medium likelihood of construction to keep the North Island WCM above or within the security standard for the full forecast period.
- The high demand scenario requires generation with a high, medium and low likelihood of construction to keep the North Island WCM above or within the security standard for the full forecast period.
- The high demand scenario results in the North Island WCM becoming negative in 2024 with only existing and committed generation, and becoming negative in 2025 with existing, committed and high likelihood generation. No other scenarios result in a negative North Island WCM.
- The minimum North Island WCM is observed in the high demand scenario where, with no additional generation being built, the WCM drops to -216 MW in 2025.
- A Tiwai shutdown has less of an effect on the North Island WCM than the WEMs. It would take approximately a year for the North Island WCM to return to pre-shutdown levels.
- The 2015 North Island WCM is, at times, both higher and lower than that derived in the 2014 Security of Supply Annual Assessment. The upwards pressure on the North Island WCM is due to a decrease in demand, the downwards pressure on the North Island WCM is due to the removal of generation capacity from the system.

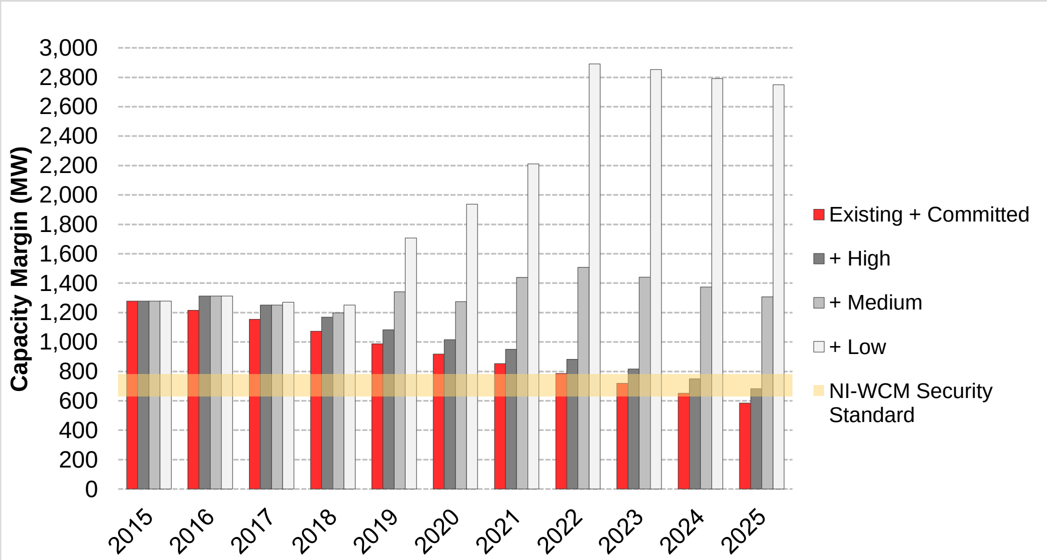

Figure 23: North Island Winter Capacity Margin 2015 to 2025 – Base-case

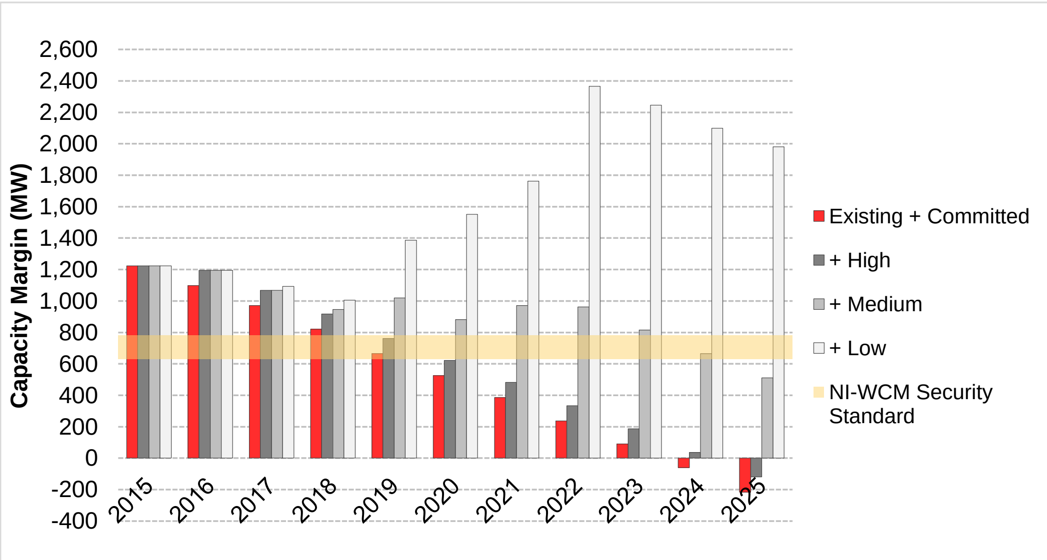

Figure 24: North Island Winter Capacity Margin 2015 to 2025 – High Demand Scenario

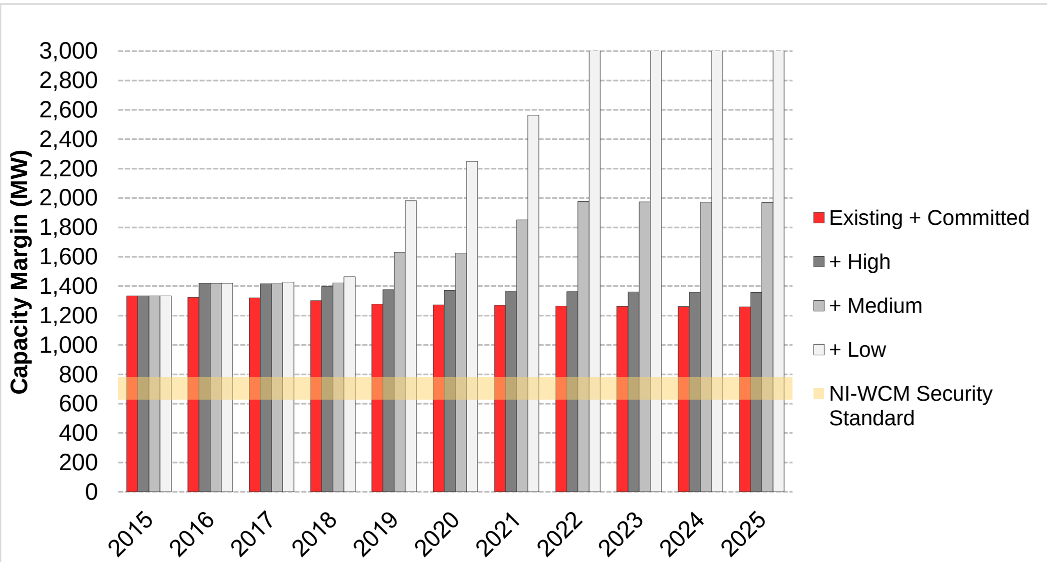

Figure 25: North Island Winter Capacity Margin 2015 to 2025 – Low Demand Scenario

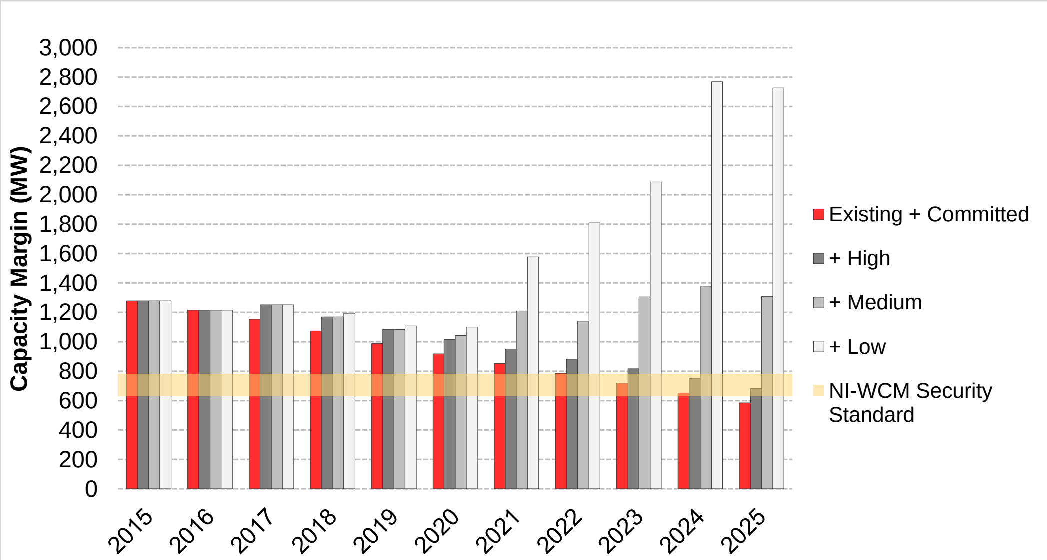

Figure 26: North Island Winter Capacity Margin 2015 to 2025 – Delayed Build Scenario

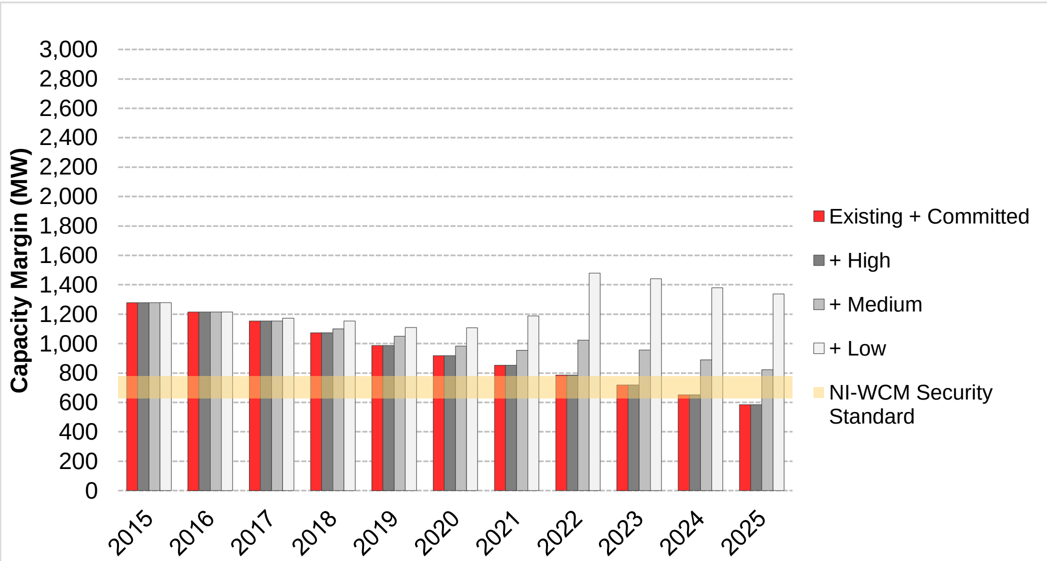

Figure 27: North Island Winter Capacity Margin 2015 to 2025 – Reduced Thermal Scenario

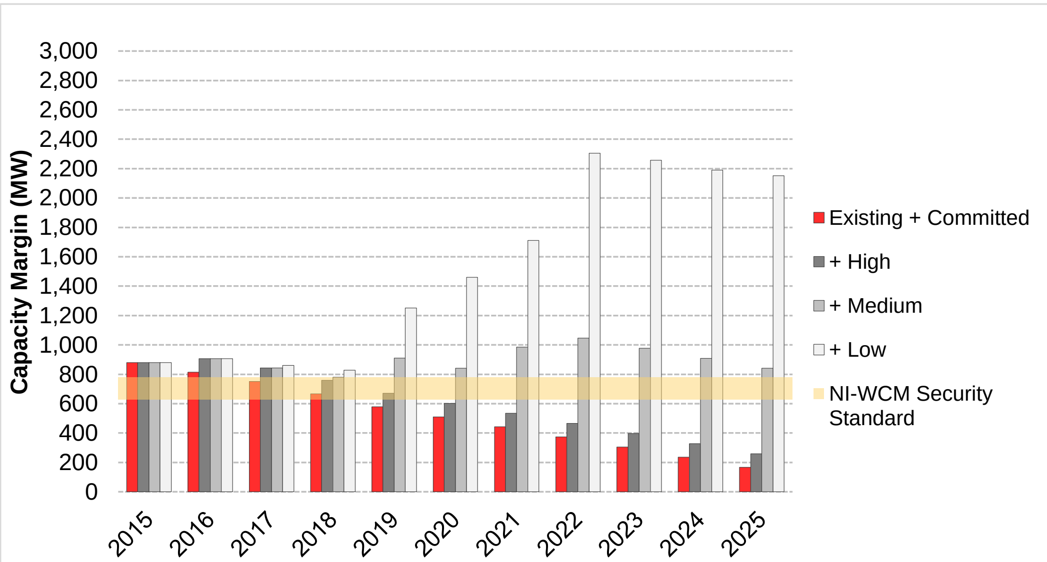

Figure 28: North Island Winter Capacity Margin 2015 to 2025 – Reduced Capacity Factors Scenario

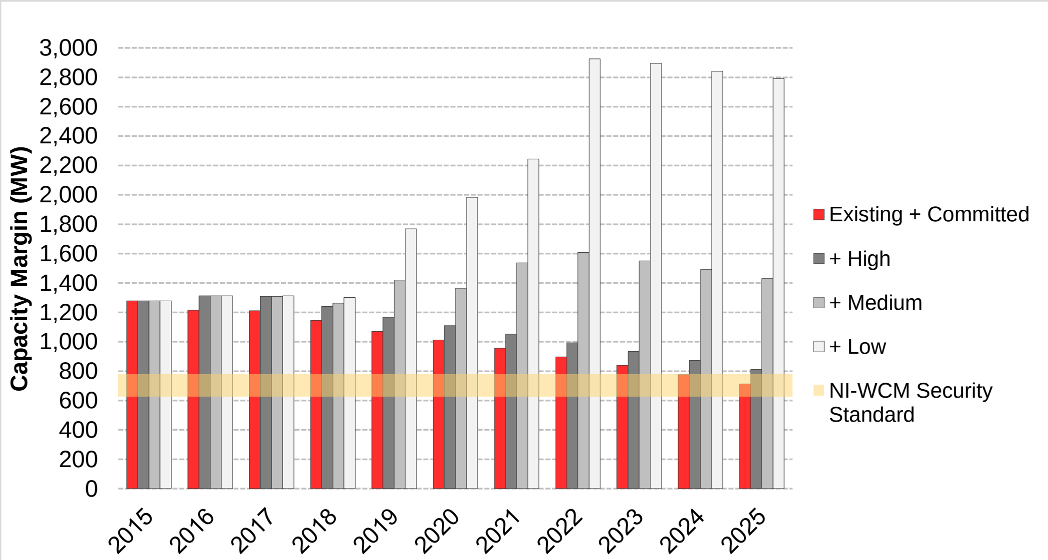

Figure 29: North Island Winter Capacity Margin 2015 to 2025 – Tiwai Shutdown Scenario 1

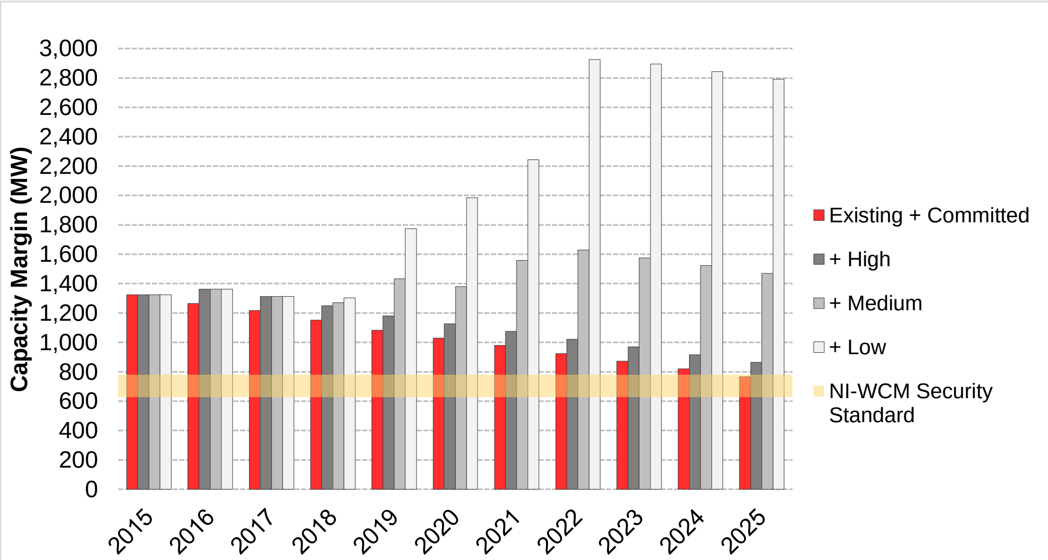

Figure 30: North Island Winter Capacity Margin 2015 to 2025 – Tiwai Shutdown Scenario 2

8. CONCLUSIONS

8.1 ENERGY MARGIN CONCLUSIONS

The New Zealand and South Island WEMs are forecast to remain above or within the security standard until 2025, ie the full forecast period, without any new generation in the base case scenario.

Therefore it is unlikely New Zealand will suffer major energy supply shortages in the medium term, even in a moderately low inflow year.

There are three possible scenarios that could significantly reduce energy security.

- High demand growth
- Reduced thermal generation
- Low inflows

These scenarios are significant departures from the base-case assumptions and the reduction in energy security is expected. In all cases the WEMs do not fall below the security standards until 2019 at the earliest, and never fall below zero.

Any significant deviation from the base-case scenario is likely to be signaled in advance; therefore it is unlikely that sub-standard security margins will be observed in the system for any extended period. Additionally there are enough potential generation options to keep the WEMs within the security standards if these significant deviations do eventuate.

Therefore these scenarios, or other continuous supply or demand trends of a similar magnitude, do not pose a major supply risk.

Despite this, the most likely energy supply risk for New Zealand is low hydro inflows. As explored in the low inflows sensitivity, the New Zealand electricity system is not at a high risk of shortages during a moderately low inflow year (10% lower than median). However there is always the possibility an exceptionally low inflow year may result in energy supply shortages.

8.2 CAPACITY MARGIN CONCLUSIONS

The North Island WCMs are forecast to remain above or within the security standard until 2024 without any new generation.

Therefore, it is unlikely the North Island (or New Zealand) will suffer major capacity supply shortages in the medium term.

There are three possible scenarios that could reduce capacity security.

- High demand growth
- Reduced thermal generation
- Reduced capacity factors

Similarly to energy security, there are sufficient potential generation options to keep the North Island WCM within the security standard if these scenarios or other continuous supply or demand trends of a similar magnitude do eventuate.

Note this conclusion does not exclude the possibility of short term, regional capacity shortages due to transmission constraints, generation outages or other unplanned events. These events are outside of the scope of this assessment, which assesses security at a relatively high level in the medium to long term.

8.3 Interpretation of the Margins Against the Standards

The base-case New Zealand WEM and South Island WEM are forecast to remain above or within the efficient level, as determined by the Electricity Authority, in the base-case for the full forecast period (ie until 2025). The base-case North Island WCM is forecast to remain above or within the efficient level in the base-case until 2024. This suggests the New Zealand electricity system is currently in a period of oversupply.

This oversupply is likely a result of the lower than expected demand since approximately 2007. As generation projects are planned and constructed over several years, the need for additional generation has to be assessed against a forecast of demand. Demand forecasts are inherently uncertain, and the downturn in demand has appeared to have resulted in surplus generation investment in the short to medium term.

It should be noted that the expected commissioning dates of projects have been moved to later years and the probability of construction has dropped compared to last year's Security of Supply Annual Assessment, as shown in Figure 31. This is typical behavior from a competitive market that is oversupplied with generation, and indicates participants are responding to low demand.

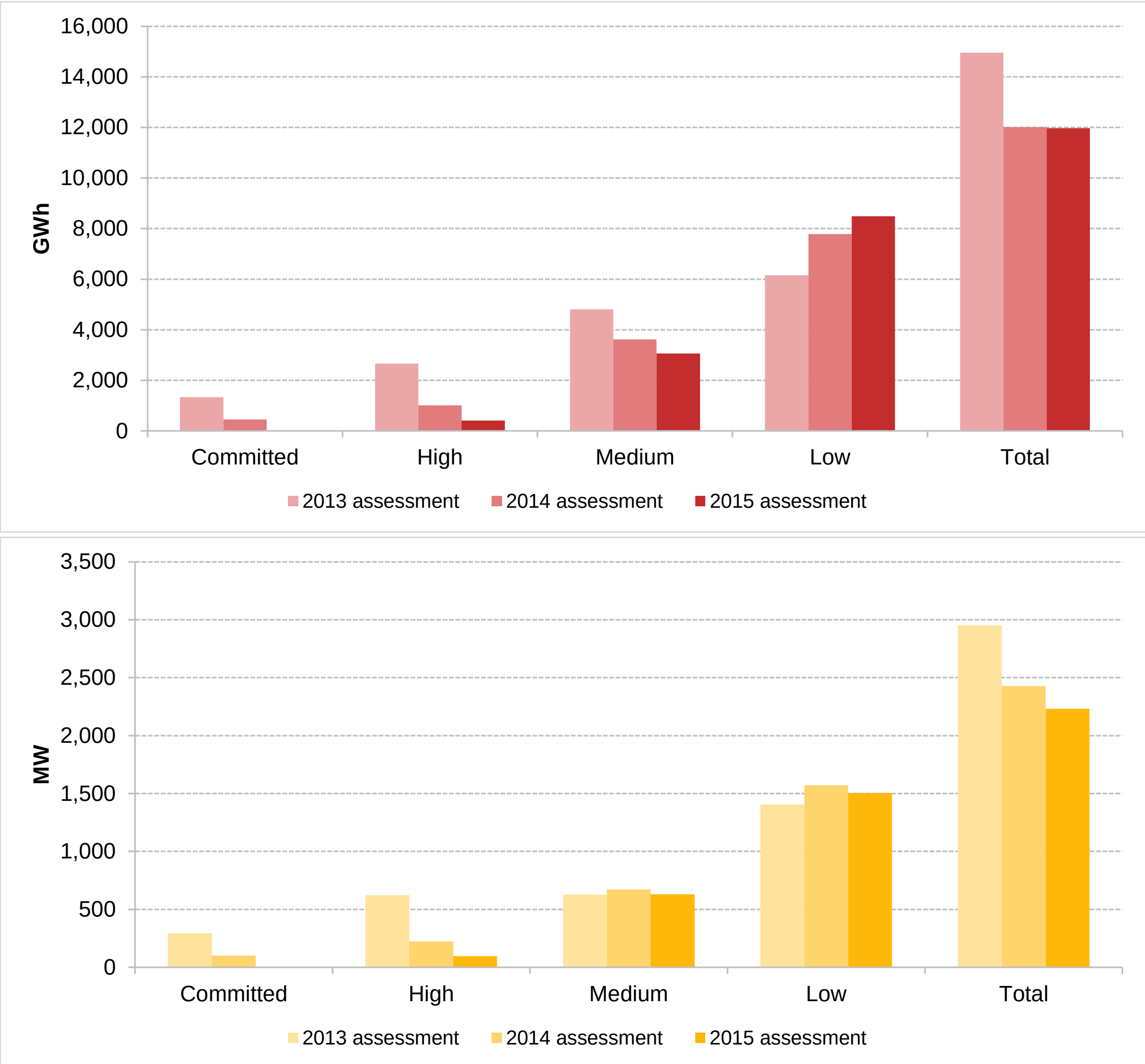

Figure 31: New Generation – 2015 Annual Assessment compared with 2013 and 2014 Annual Assessments

9. APPENDIX 1: DETAILED SUPPLY ASSUMPTIONS

9.1 INTRODUCTION

This appendix sets out the key supply assumptions used in the energy and capacity margin assessments. Many of the assumptions discussed are based on the SSAD[11] published by the Electricity Authority.

It should be noted that embedded generation has been modelled in this assessment in contrast to assessments from previous years. This has had the net effect of increasing both supply and demand. This approach was taken as it portrays a more complete analysis of the New Zealand electricity system. See Table 5 and Table 6 below for more information on which generators were not modelled in previous annual assessments.

9.2 EXISTING GENERATION

The following tables summarise the existing generation that is used in the model.

Note that while embedded generation has been included, only embedded generation sources that have a historical data set were included[12].

Table 5: Existing North Island Supply

Plant	Type	MW	Assumed Contribution to Energy Margins (potential GWh over April - Sep)	Assumed Contribution to Capacity Margins (MW)	Modelled in 2014 Annual Assessment ?
Arapuni	Hydro	192	See Waikato scheme*	*	Yes
Aratiatia	Hydro	78	See Waikato scheme*	*	Yes
Atiamuri	Hydro	74	See Waikato scheme*	*	Yes
Glenbrook	Thermal - Cogen	74	206	39	No
Huntly Rankines	Thermal - Coal	486	1986	471	Yes
Huntly U5	Thermal - Gas	385	1595	373	Yes
Huntly U6	Thermal - Gas	48	199	47	Yes
Kaimai	Hydro	41	81	30	
Kaitawa	Hydro	36	See Waikaremoana scheme*	*	Yes
Kapuni	Thermal - Cogen	24	85	13	No
Karapiro	Hydro	96	See Waikato scheme*	*	Yes
Kawerau	Geothermal	100	386	91	Yes
Kawerau Onepu	Geothermal	60	212	54	No
Kinleith	Thermal - Cogen	40	130	21	No

[11] http://www.ea.govt.nz/dmsdocument/14134

[12] Otherwise supply would not be comparable with demand. The Transpower SCADA system was used to gather data on embedded generators, if no SCADA data was available for a generator it was not included in the modelling

Plant	Type	MW	Assumed Contribution to Energy Margins (potential GWh over April - Sep)	Assumed Contribution to Capacity Margins (MW)	Modelled in 2014 Annual Assessment ?
Whareroa	Thermal - Gas	64	265	62	No
Mangahao	Hydro	42	98	23	Yes
Maraetai	Hydro	352	See Waikato scheme*	*	Yes
Matahina	Hydro	80	154	66	Yes
McKee	Thermal - Gas	100	414	97	Yes
Mill Creek	Wind	60	119	12	No
Mokai	Geothermal	112	444	101	Yes
Nga Awa Purua	Geothermal	138	582	125	Yes
Ngatamariki	Geothermal	82	347	74	Yes
Ohaaki	Geothermal	50	175	45	Yes
Ohakuri	Hydro	106	See Waikato scheme*	*	Yes
Otahuhu B	Thermal - Gas	400	1657	388	Yes
Patea	Hydro	32	55	26	Yes
Piripaua	Hydro	42	See Waikaremoana scheme*	*	Yes
Poihipi	Geothermal	55	222	50	Yes
Rangipo	Hydro	120	311	64	Yes
Rotokawa	Geothermal	35	142	31	No
Southdown	Thermal - Gas	140	580	136	Yes
Stratford Peaker	Thermal - Gas	200	829	194	Yes
Tararua I and II	Wind	68	134	14	No
Tararua III	Wind	93	183	19	Yes
Taranaki Combined Cycle	Thermal - Gas	377	908	0	Yes
Te Āpiti	Wind	91	151	18	Yes
Te Huka	Geothermal	28	117	25	No
Te Mihi	Geothermal	166	669	150	Yes
Te Rapa	Thermal - Cogen	44	182	43	No
Te Rere Hau	Wind	49	58	10	No
Te Uku	Wind	64	107	13	No
Tokaanu	Hydro	240	375	216	Yes
Tuai	Hydro	60	See Waikaremoana scheme*	*	Yes
Waipapa	Hydro	54	See Waikato scheme*	*	Yes
Wairakei incl. binary	Geothermal	132	549	119	Yes
West Wind	Wind	142	243	28	Yes
Whakamaru	Hydro	100	See Waikato scheme*	*	Yes
Wheao	Hydro	26	51	19	Yes

Plant	Type	MW	Assumed Contribution to Energy Margins (potential GWh over April - Sep)	Assumed Contribution to Capacity Margins (MW)	Modelled in 2014 Annual Assessment ?
Whirinaki	Thermal - Diesel	155	15	150	Yes

Table 6: Existing South Island supply

Scheme	Type	MW	Assumed Contribution to Energy Margin's(potential GWh over April - Sep)	Assumed Contribution to Capacity Margins (MW)	Modelled in 2014 Annual Assessment ?
Aviemore	Hydro	220	See Waitaki scheme*	*	Yes
Benmore	Hydro	540	See Waitaki scheme*	*	Yes
Branch	Hydro	11	27	6	Yes
Clyde	Hydro	400	See Clutha scheme*	*	Yes
Cobb	Hydro	32	94	31	Yes
Coleridge	Hydro	40	135	39	Yes
Deep Stream	Hydro	6	11	4	No
Highbank/Montalto	Hydro	30	51	22	No
Kumara/Dillmans	Hydro	11	23	8	No
Mahinerangi Wind 1	Wind	36	58	5	No
Manapouri	Hydro	800	2565	784	Yes
Ohau A	Hydro	264	See Waitaki scheme*	*	Yes
Ohau B	Hydro	212	See Waitaki scheme*	*	Yes
Ohau C	Hydro	212	See Waitaki scheme*	*	Yes
Paerau/Patearoa	Hydro	12	31	7	No
Roxburgh	Hydro	280	See Clutha scheme*	*	Yes
Tekapo A	Hydro	25	See Waitaki scheme*	*	Yes
Tekapo B	Hydro	154	See Waitaki scheme*	*	Yes
Waipori	Hydro	90	78	66	No
Waitaki	Hydro	90	See Waitaki scheme*	*	Yes
Whitehill	Wind	58	95	8	No

* Energy and capacity contributions of this plant are detailed in the aggregated hydro schemes shown in Table 7

Table 7: Existing NZ controllable hydro supply

Scheme	Island	Assumed Contribution to Energy Margins (potential GWh over April - Sep)	Assumed Contribution to Capacity Margins (MW)
Waikato	NI	2314	1031
Waikaremoana	NI	242	135
Waitaki	SI	2758	1683
Clutha	SI	1404	666
Start storage	NI	350	n/a

Start storage	SI	2400	n/a

9.3 New Supply

The tables below list the aggregated quantities of new generation that is added to the system. This is the supporting data for Figure 4.

Table 8: New Generation Aggregated by Year

Year	Nameplate MW	Assumed Contribution to Energy Margin's(potential GWh over April - Sep)	Assumed Contribution to Capacity Margins (MW)
2015	0	0	0
2016	100	414	97
2017	240	494	34
2018	201	392	62
2019	575	2,333	540
2020	568	1,619	315
2021	690	1,975	359
2022	1,676	4,218	751
2023	117	182	23
2024	0	0	0
2025	72	211	39

Table 9: New Generation Aggregated by Type

Type	Nameplate MW	Assumed Contribution to Energy Margin's(potential GWh over April - Sep)	Assumed Contribution to Capacity Margins (MW)
Wind	1,637	4,163	432
Geothermal	508	2,038	459
Hydro	180	485	104
Thermal	1,275	5,283	1,237

Table 10: New Generation Aggregated by Probability

Probability	Nameplate MW	Assumed Contribution to Energy Margin's(potential GWh over April - Sep)	Assumed Contribution to Capacity Margins (MW)
Committed	0	0	0
High	100	414	97
Medium	953	3,066	631
Low	3,279	8,489	1,504

Table 11: New Generation Aggregated by Island

By Island	Nameplate MW	Assumed Contribution to energy Margin's(potential GWh over April - Sep)	Assumed Contribution to Capacity Margins (MW)
NI	3,419	10,194	2,023
SI	912	1,776	209

9.4 OTHER KEY ASSUMPTIONS FOR GENERATION

9.4.1 Outage Modelling and De-ratings

In order to allow for forced and scheduled outages the following assumptions were made in the calculation of the New Zealand WEM, South Island WEM and North Island WCM.

- For thermal generation, other than the coal fired Huntly units, Whirinaki and Taranaki Combined Cycle, a de-rating of 5.4% was applied to the nameplate capacity when calculating the New Zealand WEM and South Island WEM (net energy contribution factor of 94.6%).
- For the coal-fired Huntly units a de-rating of 6.7% is applied to the nameplate capacity when calculating the New Zealand WEM and South Island WEM (net energy contribution factor of 93.3%).
- The New Zealand WEM and South Island WEM have been reduced by 303 GWh in the North Island to reflect spinning reserve and frequency keeping requirements.
- For all thermal generation a de-rating of 3% is applied to the nameplate capacity when calculating the North Island WCM (net capacity contribution factor of 97%).
- For all controllable hydro generation a de-rating of 2% is applied to the nameplate capacity when calculating the North Island WCM.
- In addition to this 2% de-rating, the following further de-ratings are applied to certain hydro generation in order to account for limited short term storage ability (Matahina, Patea and Tokaanu) or chronological flow constraints on peaking ability (Waikato).
    - Matahina de-rated by 13 MW for the North Island WCM
    - Patea de-rated by 5 MW for the North Island WCM.
    - Tokaanu de-rated by 20 MW for the North Island WCM.
- All other Hydro stations (non-controllable) are treated as run-of-river and assumed to contribute either 54% or 73% of nameplate capacity to the North Island WCM depending on the level of peaking ability observed in their historical generation datasets (see Section 9.4.2).
- All geothermal generation is assumed to contribute 91% of nameplate capacity to the North Island WCM (see Section 9.4.2).
- All North Island wind generation is assumed to contribute 20% of nameplate capacity, and all South Island wind generaiton 14% of nameplate capacity to the North Island WCM (see Section 9.4.2).

Note it is also recommended in the SSAD, and has been assumed in previous versions of the annual assessment, that the Waikato hydro scheme be de-rated by 60 MW in the derivation of the North Island WCM. However after discussion with Mighty River Power it was determined that this no longer applies and the net available capacity, including allowances for river constraints, is 1052 MW. Therefore this assumption was not used in the derivation of the North Island WCM.

Removing this assumption directly increased the WCM by 60 MW in all scenarios.

9.4.2 Wind, Run-of-River Hydro, Cogeneration and Geothermal Capacity Contribution

In the calculation of the North Island WCM it was recommended by the Electricity Authority that the wind capacity contribution be in the range of 20-25% of nameplate capacity.

Due to the conservative nature of this assessment and the relative unknowns of how wind capacity contribution will evolve as more wind is added to the New Zealand system, this assessment used a wind capacity contribution of 20%. The only exception to this is South Island wind farms that have a demonstrably lower capacity contribution when compared to their North Island counterparts and therefore a wind capacity contribution of 14% was used for South Island wind farms.

The capacity contribution of run-of-river hydro, cogeneration, geothermal and South Island wind generation at the winter peak has been determined by direct comparison with North Island wind generation in order to de-rate the nameplate capacity of these generation types on the same basis. A significant difference was observed between some run-of-river hydro generators and therefore two different classifications have been used: Flexible and Inflexible run-of-river.

These capacity contributions were derived from the outputs of each modelled plant during peak periods. This was then sorted to determine the distribution of capacity contribution for each generation type over this period. Figure 32 shows the percentage of time the capacity contribution of each generation type is greater than the corresponding level, based on this data.

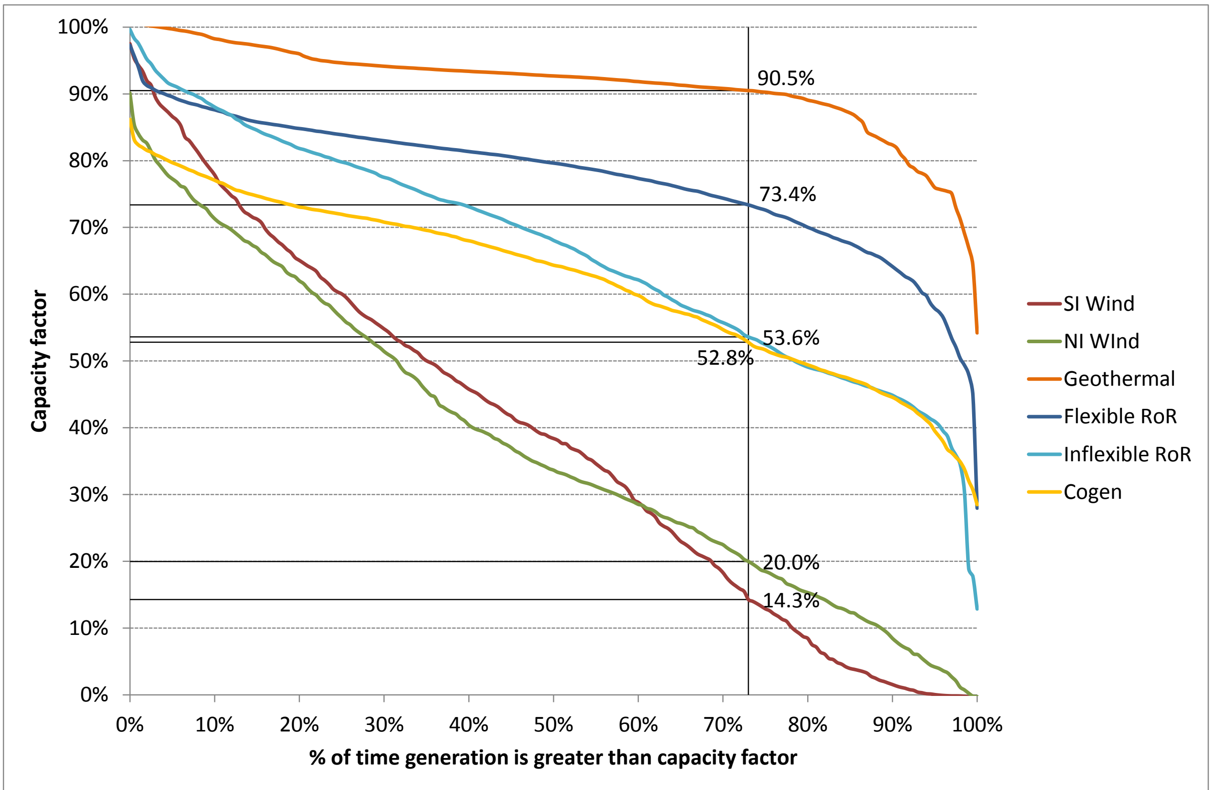

Figure 32: Capacity factor duration curves for wind, run-of-river hydro, geothermal, and cogeneration plant during peak periods.

The wind farms modelled in the North Island WCM contributed greater than 20% of their nameplate capacity for 73% of the peak periods analyzed. South Island wind, flexible run-of-river hydro, inflexible run-of-river hydro, geothermal, and cogeneration plants contributed greater than 14%, 73%, 54%, 91%, and 53% of their nameplate capacity for 73% of these peak periods respectively. These values are used to de-rate nameplate capacity in the North Island WCM.

The adoption of a 14% South Island capacity contribution is in contrast to the recommended assumption in the SSAD (which recommends 20%). The 14% assumption was used because, as the chart above shows, there is a significant difference between North Island and South Island wind capacity contribution at peak times.

This assumption had little effect on the results. The net effect of the change was lowering the WCM by approximately 3 MW in all scenarios assuming only existing and committed generation, up to 17 MW in all scenarios when all generation development options were built (ie. existing, committed, "high", "medium" and "low" probability generation).

9.4.3 Thermal Fuel and Operational Limitations

It is assumed that thermal fuel, or operational limitations, will in the most part not constrain the production of electricity, unless there are physical limitations that cannot easily be offset with commercial arrangements.

Specifically, thermal generating plant is assumed to be unconstrained by primary fuel or operational limitations with the following exceptions:

- Whirinaki's energy contribution is limited to 15 GWh of generation p.a. in the derivation of the WEMs
- Taranaki Combined Cycle is constrained to an overall energy contribution factor of 55% for the derivation of the WEMs (compared to the standard gas-fueled thermal plant assumption of 94.6% - see section 9.4.1), and is unable to contribute to the Winter Capacity Margin

These assumptions are designed to reflect the limited fuel and available operating hours of the plant. Both these fuel and operating hour limitations have the net effect of reducing the WEMs and WCM by directly reducing the amount of energy and capacity available during the winter period.

9.4.4 Start Storage

In the calculation of the WEMs an amount of freely usable energy (GWh) is assumed. This is to account for the start storage levels in the hydro catchments.

- For the calculation of the New Zealand WEM the start storage level is 2750 GWh.
- For the calculation of the South Island WEM the start storage level is 2400 GWh.

9.4.5 Huntly Units in Long-term Storage

It is assumed that only two coal-fired Huntly units are available for the derivation of the WEMs and WCM.

9.5 Transmission

Inter-island transmission assumptions are required for the assessments of the South Island WEM and the North Island WCM. North Island energy supply can meet some of the South Island's energy demand in the assessment of the South Island WEM. Similarly, South Island's capacity can meet some of the North Island's demand in the assessment of the North Island WCM.

The base-case assumption of this assessment is that the HVDC capability will be the combined capability of Pole 2 and Pole 3.

9.5.1 HVDC: Southwards Flow

It is assumed that the North Island will be able to supply the South Island with 2102 GWh (480 MW average transfer) of energy during the winter period. Note that this energy transfer is dependent on the North Island having the required surplus energy available. To allow for this restriction the lesser value of 2102 GWh or the net NI energy surplus, which is determined in the same way as the South Island WEM, is used.

It should be noted that actual southward transfer during June-August in the 2008 dry year was less than that assumed above. The Winter Review[13] discusses some of the reasons for this. This assessment includes a scenario with considerably less southward transfer (300 MW compared with 480 MW).

This scenario may no longer be relevant in light of the current capacity of the HVDC. Despite this, the scenario is meaningful as it illustrates the sensitivity of the South Island WEM to HVDC transfer limits.

9.5.2 HVDC: Northwards Flow

It is assumed that during winter the South Island has the potential to supply the North Island with capacity. This is only used in the calculation of the North Island WCM.

The contribution of South Island capacity to meeting North Island demand is a function of the surplus capacity available in the South Island, which is determined in the same way as the North Island WCM. The function used in this process was derived using simulation analysis, taking account of:

- HVDC capacity
- transmission losses
- North Island instantaneous reserve requirements
- the low probability of forced outages on the HVDC link.

This assessment assumes that both Pole 2 and Pole 3 are available at all times, and in all scenarios.

[13] http://www.ea.govt.nz/about-us/what-we-do/our-history/archive/dev-archive/consultations/security-of-supply-consultations/review-of-2008-winter/

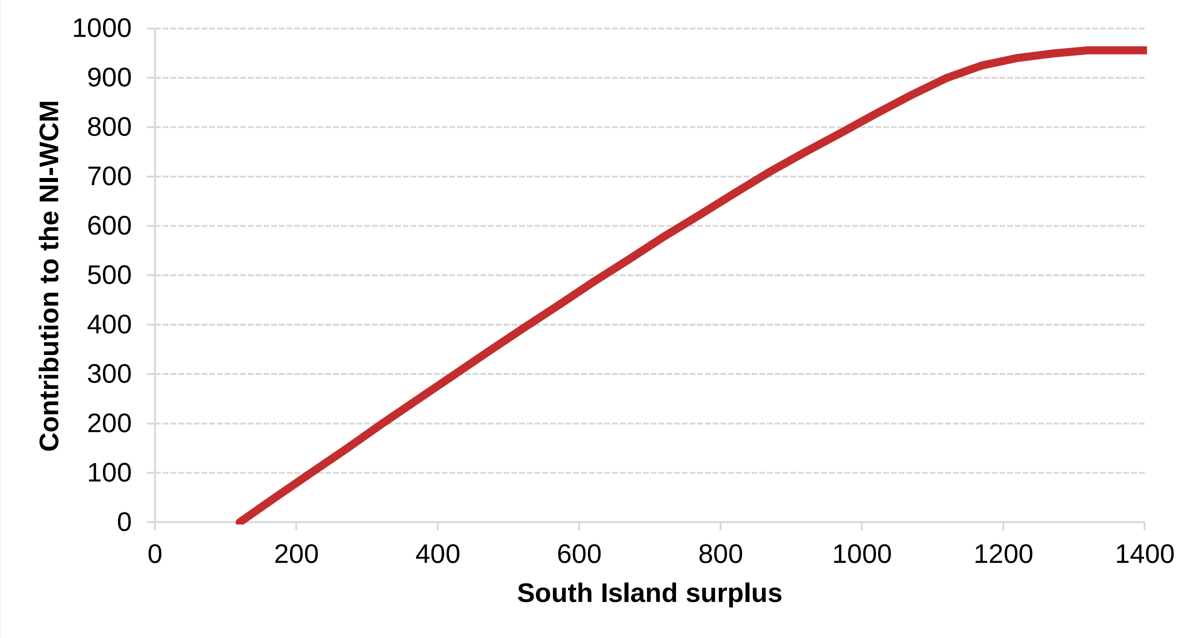

Figure 33: Relationship between South Island surplus and its contribution to the North Island WCM

9.5.3 AC Transmission Assumptions

This assessment does not explicitly model AC transmission constraints. The implicit assumption is that AC constraints will not systematically reduce inter-island transfers below the limits specified above.

10. Appendix 2: Detailed Demand Forecast Assumptions

10.1 Introduction

This appendix sets out the key demand assumptions used in the energy and capacity margin assessments.

This assessment based its demand forecast on Transpower's long-term electricity demand forecast, produced by the Grid Development team in 2014, hereafter referred to the Grid Development demand forecast. The Grid Development demand forecast does not include embedded generation as it is derived at the GXP level. Therefore, some post processing has been done to allow for the modelling of embedded generation.

10.2 Treatment of Generation

The underlying demand forecast predicts demand at GXP level, with *all* embedded generation netted off (see section 10.4.2). This approach is used internally as it best suits the purposes of Transpower's core business. Ideally the Security of Supply Annual Assessment should include all electricity generation regardless of its connection status and therefore embedded generation has been grossed on to the Grid Development demand forecast wherever possible[14].

10.3 Specific Demand Assumptions

For the energy margin calculations, the Grid Development demand forecast is adjusted by:

- grossing on embedded generation
- grossing on transmission losses
- allowing for demand response

Similarly for capacity margin calculations the Grid Development demand forecast is adjusted by:

- grossing on embedded generation
- grossing on tranmission losses
- smoothing the initial growth from 2014 to 2015[15]
- converting from single highest peak demand to H100 peak demand
- allowing for demand response.

[14] It is impossible to gross on generation for which there is no historical data available. The Tanspower SCADA system was used to gather data on embedded generators; if no SCADA data was available for a generator it was not included in the modelling.

[15] This was done as the Grid Development demand forecast contained a 5.9% peak demand growth rate from 2014 to 2015. This is a result of the volatility found in peak demand year on year (peak demand in 2014 was significantly below an expected long run average). This same volatility is not present in the H100 demand data and therefore assuming a 5.9% growth rate for that year would be incorrect. A long run average growth of 1.2% was used for the H100 demand growth between 2014 and 2015, with growth rates based on the Grid Development demand forecast from 2015.

For all energy margin calculations winter demand (1st April – 30th September) is assumed to be 52.0% of national annual demand, and 51.5% of South Island annual demand.

10.3.1 Demand Response

Energy demand forecasts have been reduced by 2% to allow for voluntary demand response.

This includes voluntary demand response resulting from high spot prices or retailer pricing initiatives, but excludes reductions in demand as a result of savings campaigns or calls for conservation.

Additionally peak demand projections in the North Island have been reduced by 176 MW to account for demand response at peak times.

10.3.2 Transmission Losses

For the baseline year (2014) actual transmission losses are added onto net Grid Exit point (GXP) demand. For all forecast years a historical linear relationship between demand and transmission losses is used to derive transmission losses, which are then added to the Grid Development demand forecast.

This is in contrast to a static percentage assumption that is recommended in the SSAD. The reason this approach has been taken is it gives a more accurate baseline year, this has a flow on effect for all future years and therefore it is important to be as accurate as possible. The net effect of this assumption in the 2015 Annual Assessment is negligible[16].

10.3.3 H100 Demand

The Grid Development demand forecast models the single highest half-hourly demand in a year. For the Security of Supply Annual Assessment the EA recommends use of the H100 demand, which is an average of the 100 highest hours (or 200 half hours) of demand falling between 7am and 10pm, 1st of April and 31st of October.

The peak demand from the Grid Development demand forecast was converted to H100 peak demand using a ratio based on historical data.

10.4 Demand Data

10.4.1 Demand Data used for the 2015 Annual Assessment

The base-case energy demand is shown in Table 12.

Table 12: Base-case forecast of annual energy demand for generation

Calendar Year	New Zealand Demand (GWh)	North Island Demand (GWh)	South Island Demand (GWh)
2014	41,190	25,885	15,304
2015	41,885	26,308	15,577
2016	42,359	26,693	15,666
2017	42,898	27,002	15,896

[16] This is because the actual 2014 transmission losses were very similar to what the SSAD assumption would have produced. However this will not always be the case therefore this approach is recommended for future annual assessments.

2018	43,634	27,416	16,219
2019	44,261	27,814	16,446
2020	44,670	28,072	16,599
2021	45,094	28,349	16,745
2022	45,543	28,639	16,903
2023	45,979	28,930	17,049
2024	46,409	29,218	17,191
2025	46,896	29,545	17,351

The base-case annual H100 demand forecast is shown in Table 13.

Table 13: Base-case forecast of annual H100 demand for generation

Calendar Year	North Island Demand (MW)	South Island Demand (MW)
2014	4,359	2,172
2015	4,412	2,190
2016	4,472	2,197
2017	4,520	2,219
2018	4,584	2,242
2019	4,653	2,267
2020	4,707	2,286
2021	4,758	2,304
2022	4,812	2,322
2023	4,864	2,340
2024	4,916	2,359
2025	4,969	2,377

Note these tables do not include the demand side or winter scaling adjustments.

10.4.2 Underlying Grid Development Demand Forecast and Comparison to 2014 Annual Assessment

The underlying demand forecast and the comparison with the 2014 Annual Assessment underlying demand forecast is shown below. Note that the smoothed line represents the effect of using a long run average growth rate in the first year as described in footnote 15 above. The H100 values were derived using the data from the smoothed data series.

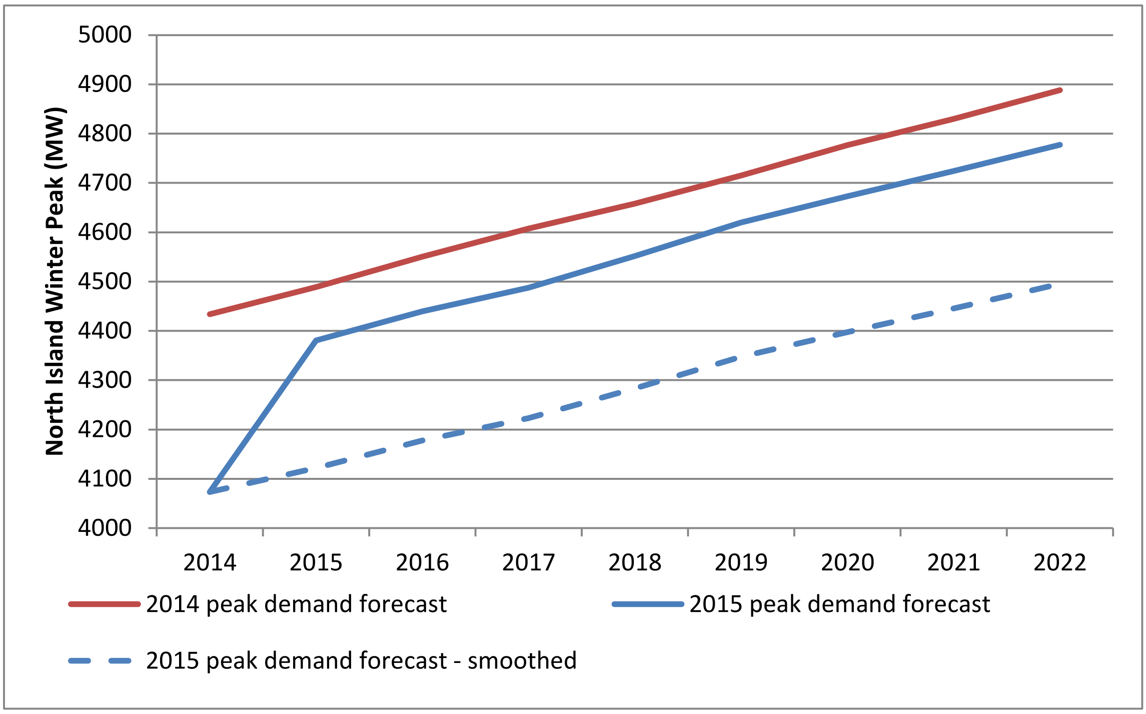

Figure 34: Underlying demand forecast for North Island Winter Peak

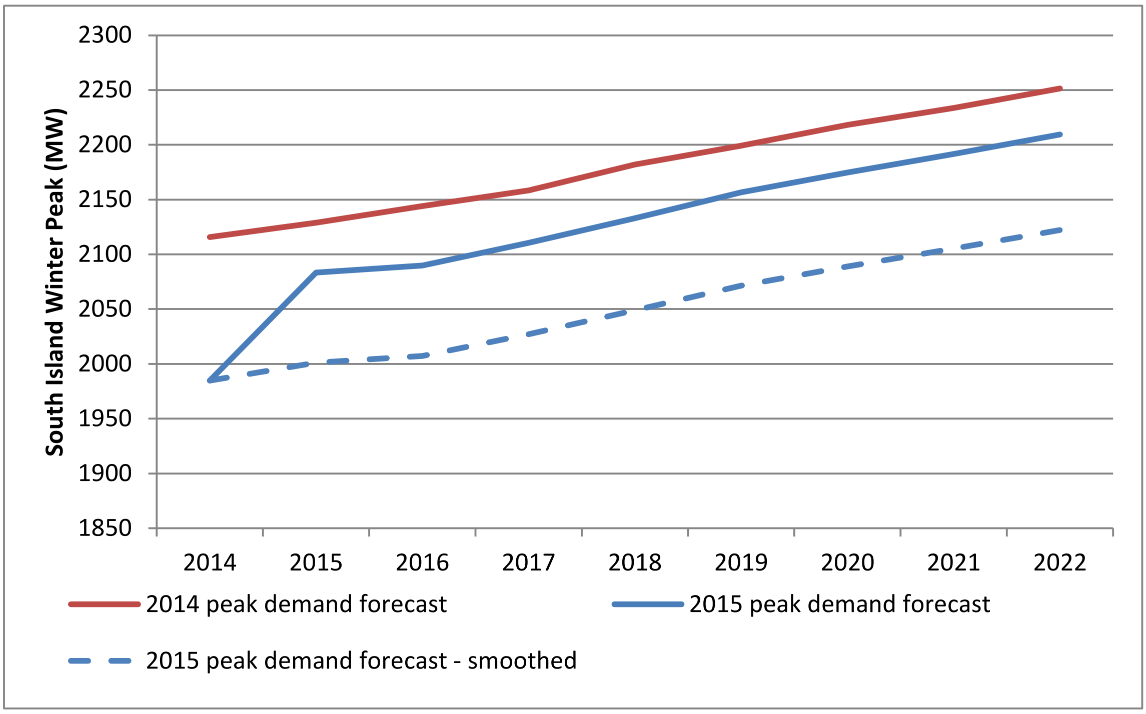

Figure 35: Underlying demand forecast for South Island Winter Peak

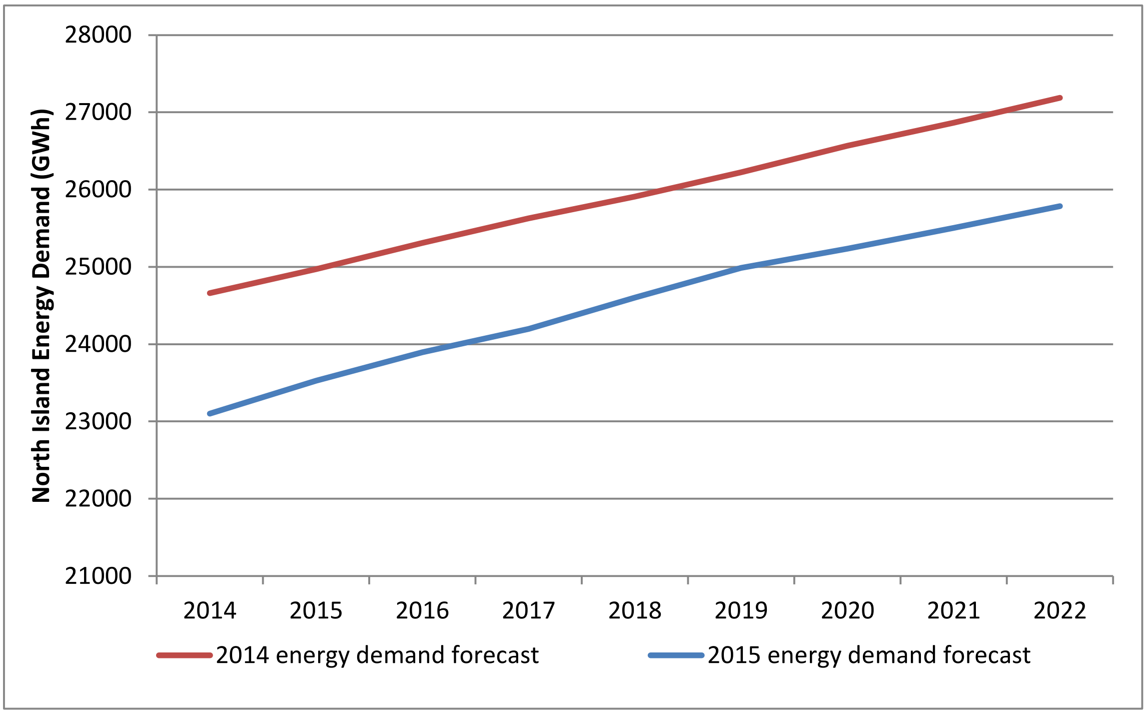

Figure 36: Underlying demand forecast for North Island Energy Demand

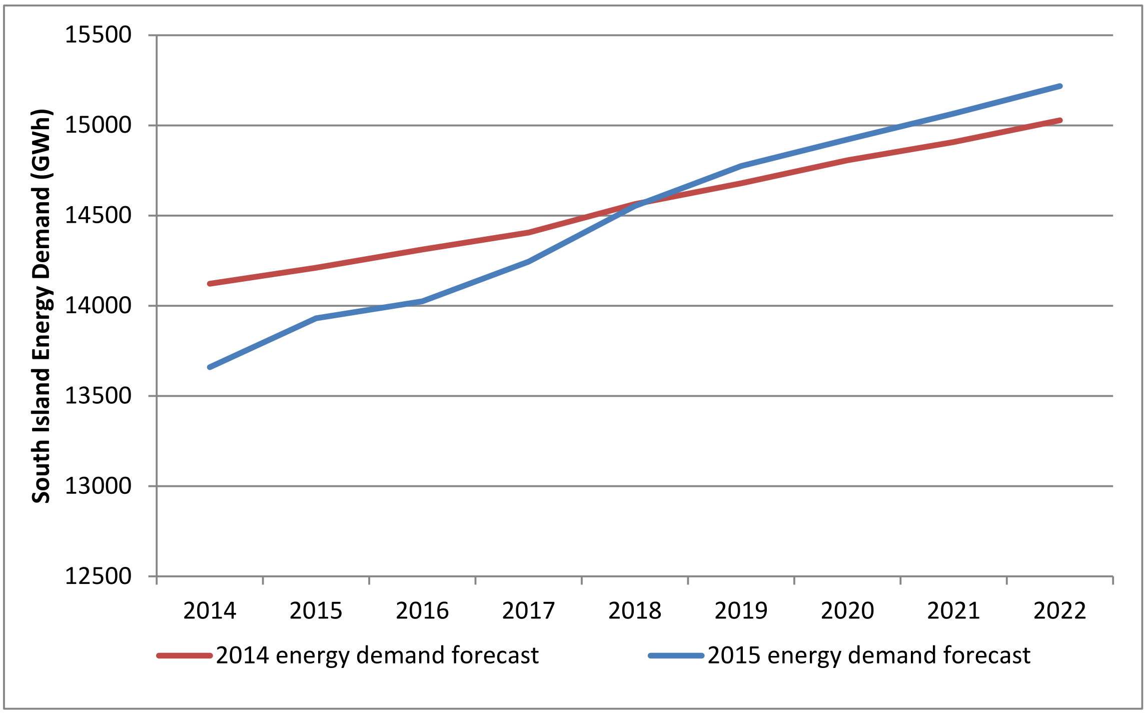

Figure 37: Underlying demand forecast for South Island Energy Demand

The figures above show that while there has been a slight increase in nearly all percentage growth rates, absolute demand has dropped significantly in all cases except for late in the South Island Energy Demand forecast.