

The system operator's 2016 annual assessment of security of supply

7 March 2016

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 2016 annual assessment and ask questions that may help to establish whether the SRC has advice to offer the Authority.

The SRC has received reporting at its 22 October 2015 and 15 March 2016 meetings that directly addresses the impact of thermal generation decommissioning announcements. Those papers give more context and surrounding analysis, making this a useful companion paper to those other reports. The system operator's report to the 22 October 2015 meeting used the same methodology as the 2016 annual assessment of security of supply. As such, the content is similar though the 2016 annual assessment is based on the most up-to-date data.

The security standards represent an efficient level of generation

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 the North Island (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.

The results against the margins help inform stakeholders whether an efficient level of energy or capacity generation supply exists now and in future forecasts. Results outside the efficient margins (especially results exceeding the margins) are not necessarily problematic. They are a single measure and need to be examined in a broader context before conclusions can be reliably drawn. There are no legislative consequences for generators not meeting the efficient margins; they are intended to inform. By contrast, measures like the customer compensation scheme and scarcity pricing are explicitly designed to provide incentives that augment spot price signals to better promote reliability.

The system operator is obliged to annually publish an assessment of security of supply against the NZ-WEM, SI-WEM and WCM margins.

The Authority has also opted to provide assumptions that the system operator must use when preparing the annual assessment.¹ These assumptions are published in the Security Standards Assumptions Document (SSAD).² The system operator can use alternative assumptions if it provides reasons for doing so and still notes the results of using the Authority's assumptions.

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.

The thermal generation decommissioning announcements have substantially altered the outlook

After a period of several years of oversupply, the annual assessment now forecasts undersupply in many situations. The closure of the Otahuhu and Southdown generation stations has reduced supply in all years in all scenarios. The signalled closure of the Huntly Rankine units shows up as a large step-change between 2018 and 2019 results in all scenarios (except the 'Huntly decision reversal scenario').

The future of New Zealand Aluminium Smelters' (NZAS) operations at Tiwai Point has a substantial impact on all of the NZ-WEM and SI-WEM scenarios, but negligible impact on WCM.

The annual assessment scenarios do a good job of illustrating the sensitivity of results against the margins to a few key assumptions.

The annual assessment has had to make some assumptions about when to model future generation options as being built

Perhaps owing to the sensitivity to assumptions about the Huntly Rankine units and NZAS, generators were less able to provide dates by which their future generation options would come online. As such, the system operator has had to assume a tranche of this 'undated' generation coming online in 2021 and a second tranche in 2023.

Accordingly, the timing of results over these years has an artificial element to it. In reality, the timing of generation projects will largely be conditional on key assumptions about the future of the Huntly Rankine units and NZAS.

The system operator is using the 25% national wind contribution factor to derive other contribution factors

The Authority's SSAD recommends a *national* wind contribution factor of 25% for the purposes of WCM, but allows for a factor in the range of 20%-25%. The SSAD does not provide default WCM assumptions for *North and South Island* wind contribution factors, or contribution factors for geothermal, run-of-river hydro or cogeneration.

However, the system operator has no direct need for a national wind contribution factor but does need all of the other above assumptions that are not present in the SSAD. To do this, the system operator uses the

¹ The reasons for this decision were to ensure consistency and provide transparency. Results against the margins should be calculated in a way that is consistent with the derivation of the margins. Sufficient information about the methodology and input assumptions should be provided for the Authority and other stakeholders to have confidence that results are being calculated appropriately.

² Available from <http://www.ea.govt.nz/operations/wholesale/security-of-supply/security-of-supply-policy-framework/security-standards-assumptions/>

25% national wind contribution factor to derive the other assumptions, by working out what the capacity factors of those other generation types has been at peak times for an equivalent percentage of time the generation exceeds the a national wind capacity factor of 25%. Figure 29 in the 2016 annual assessment illustrates this approach.

Authority and system operator staff agree that this approach is sub-optimal and will be working closely to identify whether there is a superior approach that is cost-effective.

The Authority will consider when to schedule an update to the SSAD

The Authority's review of the system operator's 2016 annual assessment identified some opportunities for improving the assumptions in the SSAD. These opportunities include updating the SSAD to:

- provide North and South Island contribution factors for wind, run-of-river hydro, geothermal and cogeneration (WCM only)
- provide North and South Island contribution factors for all thermal generators rather than just combined-cycle gas turbines (NZ-WEM and SI-WEM only)
- account for the reductions in frequency-keeping bands
- verify whether transmission loss assumptions are still optimal.

Between the identified opportunities for improvement and the fact that the SSAD hasn't been updated since November 2012, it is fairly clear that an update is warranted. The Authority will need to consider *when* to schedule an update for by assessing the expected benefits against those of competing priorities.

The SRC may wish to consider the following questions.

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| Q1. | Does the SRC have any suggestions for how to avoid or lessen the system operator's having to make assumptions about when future generation is modelled to come online? |
| Q2. | What further information, if any, does the SRC wish to have provided to it by the secretariat? |
| Q3. | What advice, if any, does the SRC wish to provide to the Authority? |

Security of Supply Annual Assessment 2016

February 2016

TRANSPower



Version	Date	Change
1.0	29/02/2016	Final publication

	Position	Date
Prepared By:	Bennet Tucker – Senior Analyst, Market Operations	February 2016

IMPORTANT

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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>

1. EXECUTIVE SUMMARY

Transpower in its role as system operator has completed the 2016 Security of Supply Annual Assessment, as required by Part 7 of the Electricity Industry Participation Code 2010 (the Code). This report contains detailed supply, demand and security of supply forecasts for the next 10 years.

The security of supply margins are currently exceeding the three security of supply standards set by the Electricity Authority. These security of supply margins are the New Zealand and South Island Winter Energy Margins (WEMs) and the North Island Winter Capacity Margins (WCMs).

This assessment includes a base-case forecast, and a range of scenarios that explore the uncertainty within key supply and demand variables. Using base-case assumptions, all three margins are forecast to remain above or within their respective security standards through the winter of 2018 but are forecast to fall below them from 2019.¹

The base-case assumptions are Transpower's demand forecast, continued demand from New Zealand Aluminium Smelter (NZAS), Huntly Rankine units being decommissioned as announced, and new generation options made available to Transpower via industry survey.

Assuming the Huntly Rankine units are decommissioned as announced at the end of 2018, the New Zealand WEMs, South Island WEMs and the North Island WCMs are all forecast to fall below the security standards. With no additional generation investment these three margins are forecast to remain below the standard from 2019 until beyond the end of our assessment period in 2025.

Future margin calculations are based on generation information currently made available to Transpower via industry survey. In the base-case², and a number of other scenarios, there are insufficient future generation options (including low likelihood options) to maintain the three security of supply margins within the range of their relevant standards. This largely applies in the two years following the announced Huntly decommissioning (2019 and 2020). If this decommissioning does not take place, or NZAS closes the Tiwai smelter then this outcome is not observed.

All of the winter margins calculated this year are lower than the same measures calculated in the 2015 Annual Assessment. This is due to generation decommissioning in late 2015 and early 2016 and the announced exit of the remaining Huntly Rankine units. Transpower, in its capacity as grid owner and system operator, is also investigating the wider potential impacts of thermal generator decommissioning. Further information, including the latest results of this investigation, can be found on the system operator website.

¹ It is important to note that falling below the standards does not equate to electricity shortage. It simply implies that investment in new generation would be an economically rational exercise according to the winter margin assessment.

² In the base-case scenario this observation is limited to the New Zealand WEMs. The South Island WEMs and North Island WCMs have sufficient future generation options to maintain margins within the standards. See sections 5.2 and 6.2 for more information.

2. INTRODUCTION

The Code requires that Transpower, in its role as system operator, publishes a medium to long-term security of supply assessment at least annually³. A security of supply assessment was last published by Transpower in February 2015.

This assessment is intended to provide a set of metrics with which to gauge the security of supply outlook in the medium-term. These metrics should 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 WCMs for the period 2016 to 2025.

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2.1 INVITATION TO COMMENT

Transpower welcomes feedback on this report, including any additional information for analysis that may lead to this report being updated or any suggestions on the report structure and format. Comment and additional information may be given in confidence, if marked accordingly. Please direct all responses to:

Bennet Tucker
Senior Analyst, Market Operations
System Operations Division
Transpower NZ Limited.
PO Box 1021
Wellington 6140

Or email: bennet.tucker@transpower.co.nz

³ See Part 7, clause 7.3 of the Electricity Industry Participation Code 2010 for more information

3. BACKGROUND

3.1 ASSESSMENT CONTEXT AND INTERPRETATION

As set out in the SoSFIP, Transpower, in its role as 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 five or more years. The security standards used in this assessment were determined by the Electricity Authority (the Authority) and are documented within the Code.⁴ 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 Authority derived the above standards using a probabilistic analysis⁵. 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 minimises 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 Authority 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 justified by the reduction in shortage costs at times of insufficient capacity.
- A North Island WCM between 630 and 780 MW indicates an approximate 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 WEM security of supply standards should be interpreted in a similar fashion.

The Authority's security of supply standards are expressed in terms of winter requirements, as this is when New Zealand's power system is most stressed.

⁴ See Part 7, clause 7.3 of the Electricity Industry Participation Code 2010 for more information

⁵ <http://www.ea.govt.nz/development/work-programme/wholesale/security-of-supply-standards/consultations/#c13932>

3.2 OTHER TRANSPOWER SECURITY OF SUPPLY FUNCTIONS

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

- short-term monitoring and information provision, such as the weekly reporting of hydro levels relative to the Hydro Risk Curves⁶
- implementation of emergency measures where necessary, in accordance with the Emergency Management Policy, the System Operator Rolling Outage Plan, and the emergency provisions under Parts 7 and 9 of the Code.

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3.3 OTHER RELATED WORK WITHIN TRANSPOWER

Transpower in its capacity as grid owner and system operator is investigating the potential impacts of thermal generator decommissioning. More information on this investigation can be found on the system operator website: <https://www.systemoperator.co.nz/activities/current-projects/impact-thermal-generator-decommissioning>.

3.4 PREVIOUS SECURITY ASSESSMENTS

For similar assessments by the Electricity Commission prior to 2011, refer <http://www.ea.govt.nz/about-us/what-we-do/our-history/archive/operations-archive/security-of-supply/asa/>.

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

⁶ <http://www.systemoperator.co.nz/security-supply/sos-weekly-reporting/hydro-risk-curves>

4. INPUT ASSUMPTIONS

4.1 FRAMEWORK

The main model parameters used in this 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 4.2, and the alternative assumptions used in the sensitivity scenarios are set out in Section 4.3.

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” likelihood generation
- Existing, committed, “high” and “medium” likelihood generation
- Existing, committed, “high”, “medium” and “low” likelihood generation

High, medium and low likelihood generation is classified based on the responses of the industry survey. Broadly speaking each of these classifications represent 75%, 50% and 25% likelihood of generation projects going ahead respectively – however, it should be noted that a number of factors influence generation investment decisions and as such these numbers should be used as a guideline only. All scenarios cover the period from 2016 to 2025.

The methodology for the calculation of WEMs and WCMs is covered in Sections 5.1 and 6.1.

4.2 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)⁷. The SSAD outlines the assumptions and formulas which the Security of Supply Annual Assessment calculations were based on. This section describes many of these in addition to other assumptions that are drawn from other sources. For a complete and detailed set of assumptions refer to the appendices (Sections 8 and 9).

Assumptions about generation were largely based on information received from the major generators on a confidential basis. Transpower thanks all contributors including Genesis Energy, Meridian Energy, Contact Energy, Mighty River Power, Trustpower and Nova Energy for the information provided. Some publicly available information is also used.

⁷ <http://www.ea.govt.nz/dmsdocument/14134>

Demand assumptions are based on Transpower's long-term electricity demand forecast produced in 2015 and adjusted to account for embedded generation and transmission losses.

4.2.1 Monitoring Input Assumptions

It is possible that the WCMs and WEMs 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 in early 2017.

4.2.2 Existing Generation Assumptions

All existing generation is expected to remain operationally available throughout the assessment period (2016 – 2025), with the exception of generation that has a publicly notified decommissioning date. Existing generation is subject to normal limitations (for example the variability of intermittent generation, the dependence of hydro plants on inflows, and the outage rates of thermal and hydro plants).

It is also assumed that thermal fuel, or operational limitations, will for the most part not constrain the production of electricity, with the exception of Whirinaki diesel generator. Whirinaki's energy contribution is limited to 15 GWh per year in the derivation of the WEMs.

See Section 8 for further detail on base-case assumptions about existing generation.

4.2.3 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 Transpower cannot disclose any detailed information on future generation options.

In this year's survey a number of generation projects did not have planned commissioning dates. In response this assessment has adopted a twofold classification system:

- where generation has a planned commissioning date, this date is used and generation is treated as a *dated project*
- where generation does not have a planned commissioning date, then assumed commissioning dates of 2021 and 2023 for medium and low likelihood projects are used, respectively, and the generation is treated as a *non-dated project*

In the presentation of all results, including WEMs, WCMs and any supporting information, the distinction is made between results or information that include only dated generation projects and results or information that includes all generation projects.

Figure 1 shows the new generation data in aggregate form.

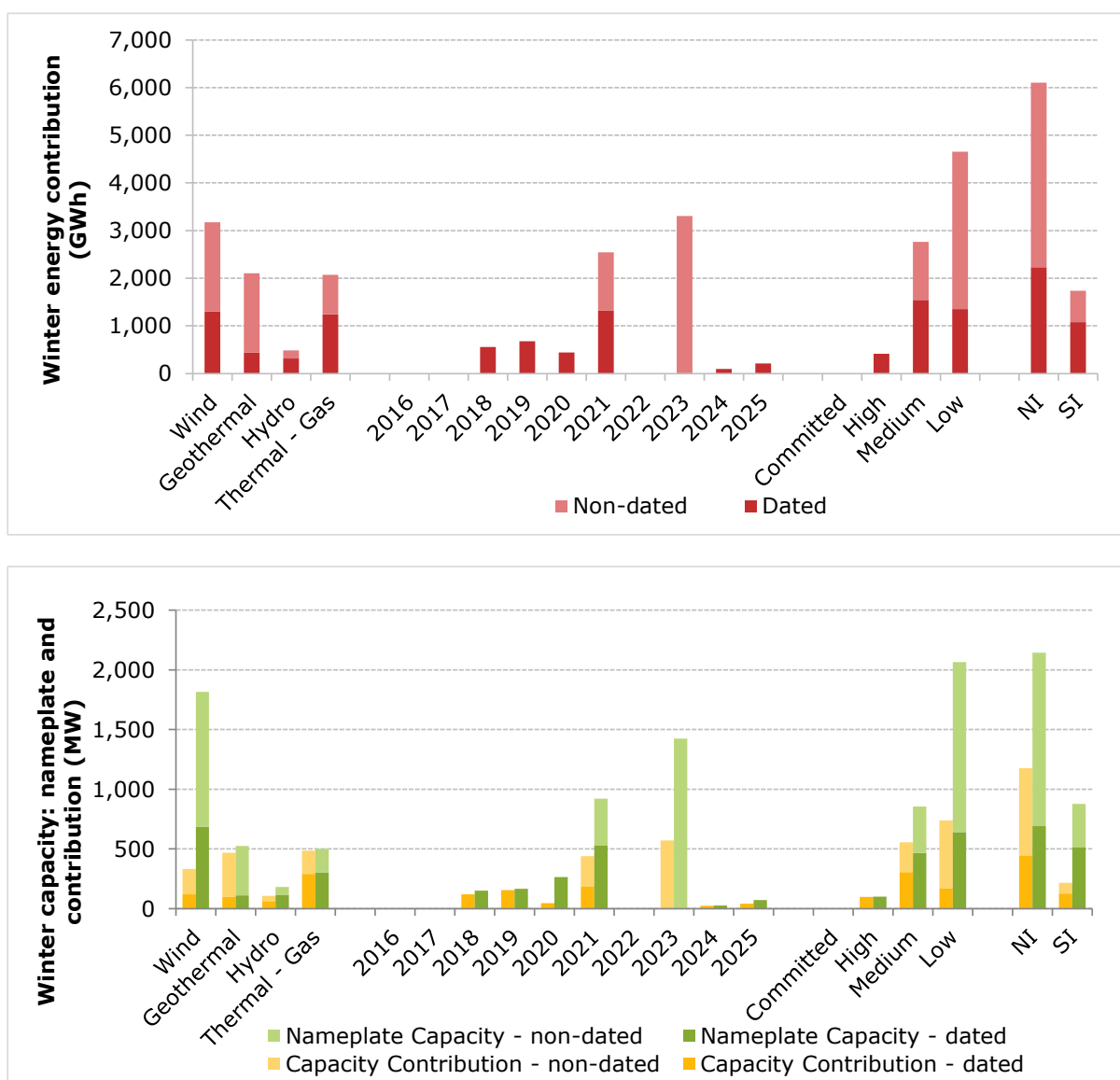


Figure 1: New generation assumptions (all projects)

4.2.4 Demand Forecast Assumptions

This assessment based its demand forecast on Transpower's long-term electricity demand forecast, produced in 2015. Transpower's long-term electricity demand forecast is demand for electricity at the Grid Exit Point (GXP). Ideally any security of supply assessment should include all major sources of generation, and the demand that is served by these generators, where possible. Therefore in this assessment the following modifications have been made to the base demand forecast:

- demand that is served by embedded generation has been added onto the demand forecast
- transmission losses have been explicitly estimated⁸ and added on to the demand forecast.

Figure 2 shows expected peak and energy demand out to 2025 and includes the high and low demand sensitivity scenarios.

⁸ Or in the case of the 2015 year, actual loss information was used.

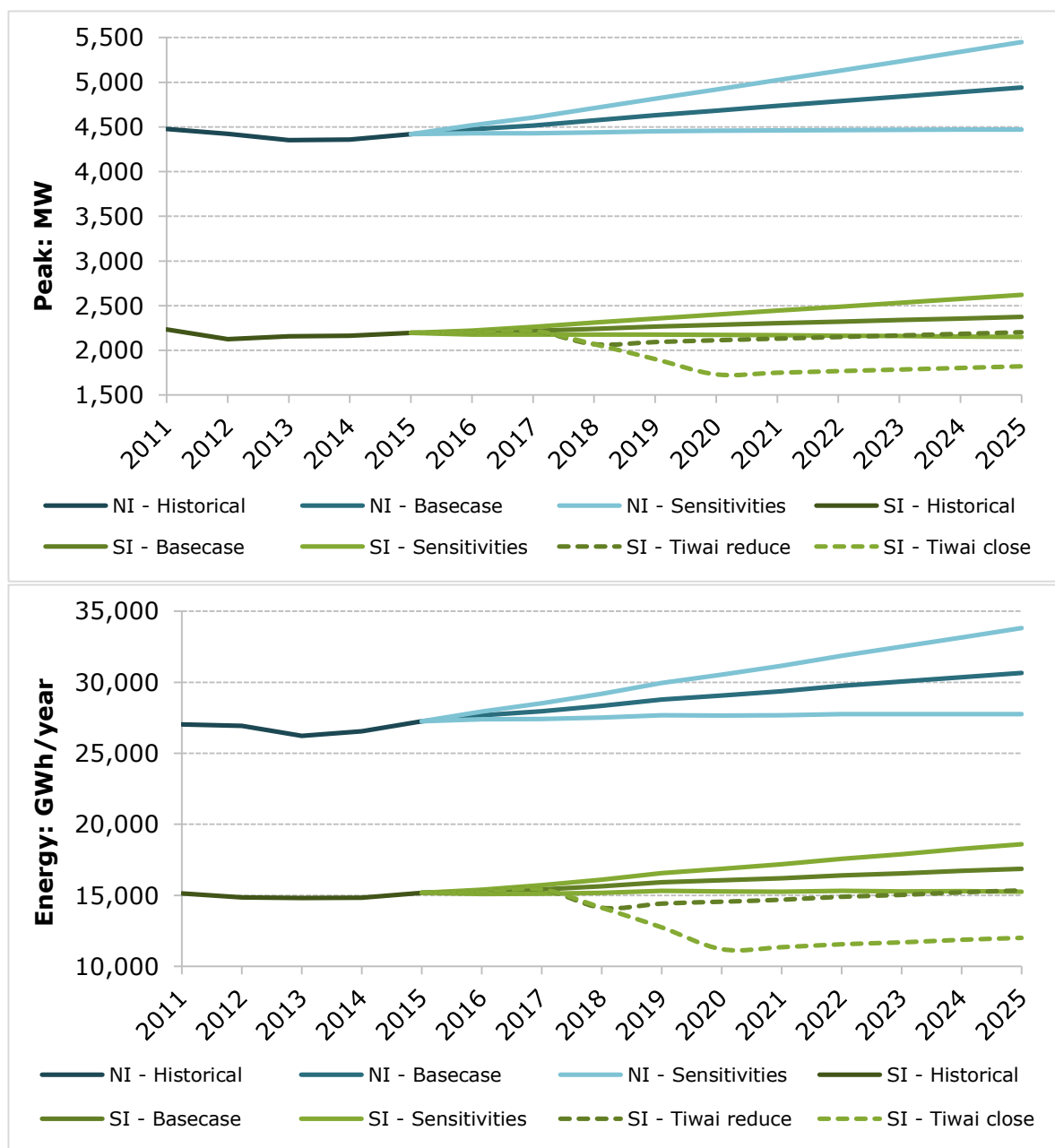


Figure 2: Expected demand – both Peak and Energy

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

4.2.5 Inter-island Transmission Assumptions

The assessment of the WEMs and WCMs 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 South Island capacity that can be used to meet North Island peak demand.

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

4.3 SCENARIOS

The security of supply 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 of supply 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 New Zealand Aluminium Smelter (NZAS) 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 delayed due to market conditions or physical, technical or regulatory limitations.	Projects, other than committed, are uniformly delayed by 1 year.
De-rating of generation	Yes	Yes	This scenario explores the sensitivity of the WCMs and WEMs to a reduction in electricity supply. This scenario is designed to indirectly account for internal and external influences that may reduce the output of electricity generation. External influences include effects such as shifting rainfall patterns due to climate change and reduction in geothermal field pressure. Internal influences include effects such as statistical errors in historical generation data and forecast errors for new generation.	In the calculation of energy margins, all non-thermal generation energy contribution is reduced by 5%. In the calculation of capacity margins, all non-thermal generation capacity factors are reduced by 5%.
Limited south transfer	Yes (only South Island WEMs)	No	The base-case assumption is that southward transfer can rise to an average of 480 MW – but 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 WEMs to limited HVDC transfer.	Inter-island transfer is limited to 1,314 GWh in the South Island WEMs (equivalent to an average of 300 MW).
NZAS shutdown (two scenarios)	Yes	Yes	NZAS aluminium smelter may reduce its output or shutdown due to economic conditions.	The base-case assumption is that NZAS's load remains at current levels. There are two scenarios in which NZAS reduces its load. 1. NZAS reduces its average load to 400 MW from 2018. 2. NZAS reduces its load in stages beginning in 2015 until it shuts down in 2018.
Huntly decommissioning decision reversal	Yes	Yes	In August 2015 Genesis Energy publically announced their intention to decommission the remaining Huntly Rankine units prior to 2019. Included in the announcement was the caveat that the units may not be decommissioned if market conditions change significantly. This scenario explores the situation where the Huntly Rankine units remain available after 2018.	Huntly Rankine units are not decommissioned at the end of 2018 and are available for the entire duration of the assessment (2016-2025)

5. ENERGY MARGIN ASSESSMENT

5.1 METHODOLOGY

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

The New Zealand Winter Energy Margin:

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

The South Island Winter Energy Margin:

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

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

Table 2: Summarising the New Zealand WEM components

Component	Comprises of	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.
	Mean Hydro GWh	Expected winter (1 April to 30 September) hydro generation based on mean 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)	NZ Energy Demand GWh	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)	Mean Hydro GWh	Expected winter (1 April to 30 September) hydro generation based on mean 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)	SI Energy Demand GWh	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 primary fuel supply is based on industrial processes and thus is not controlled in the same way major thermal generators are.

5.2 ENERGY MARGIN RESULTS

This section summarises the results of the WEM assessment, based on the input assumptions summarised in Section 4 and described in detail in the appendices (Sections 8 and 9).

Forecasts of the New Zealand WEMs and South Island WEMs from 2016 – 2025 under the base-case scenario are shown in Figure 3 and Figure 4. Sensitivity results are presented following the base-case results.

Energy margin results are summarised below.

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- In the base-case scenario, the New Zealand and South Island WEMs are forecast to remain above or within the security standard until 2018 with existing and committed generation.
- Following the modelled decommissioning of the remaining Huntly Rankine units at the end of 2018 the New Zealand and South Island WEMs are forecast to reduce below the security standard. With no additional generation investment the WEMs are forecast to remain below the standard from 2019 until the end of this assessment period.
- In all scenarios, with the exception of the de-rating of generation scenario, existing and committed generation provide sufficient energy supply to keep the New Zealand and South Island WEMs above or within their respective security standard until the end of 2017 and 2018 respectively.
- In the de-rating of generation scenario committed and existing generation provide sufficient energy supply to keep the New Zealand and South Island WEMs above or within their respective security standard until the end of 2016 and 2018 respectively.
- The high demand and de-rated generation scenarios significantly reduce the WEMs compared to the base-case. In both of these scenarios the margins are forecast to become negative if there is no new generation built (and Huntly Rankine units are decommissioned as announced).
- All scenarios, except for a full NZAS closure scenario and Huntly decommissioning decision reversal scenario, reduce existing and committed generation below the lower limit of the security standard at some point during the forecast period. The main cause of the observation is the Huntly Rankine decommissioning.
- If the decommissioning does not progress as planned then the New Zealand and South Island WEMs are forecast to remain above or within the margin with only high likelihood generation until 2020 and 2022 respectively.
- In a number of scenarios there is insufficient new generation options (based on the information made available to Transpower), regardless of likelihood, to maintain the WEMs within the range of the security standard. This observation is mostly limited to the two years following the announced Huntly Rankine decommissioning (2019 and 2020) where there are limited generation options available. Again if the decommissioning does not take place, or NZAS closes, this outcome is not observed.
- The New Zealand and South Island WEMs in the 2016 Security of Supply Annual Assessment are lower than those derived in the 2015 Security of Supply Annual Assessment. This is due to generation plant that was decommissioned late 2015 and early 2016 and the announced Huntly Rankine unit decommissioning.

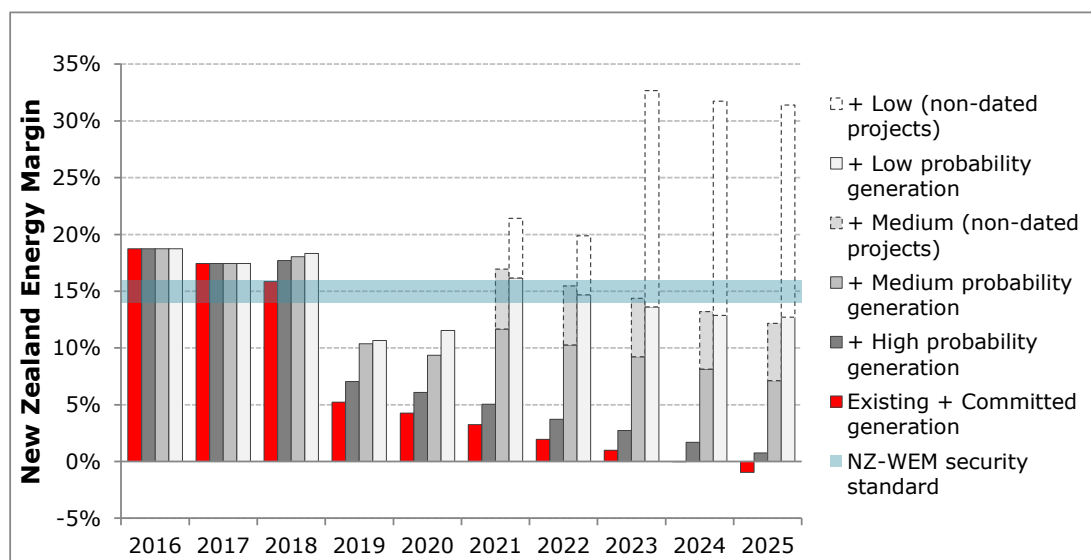


Figure 3: New Zealand Winter Energy Margin 2016 to 2025 – Base-case

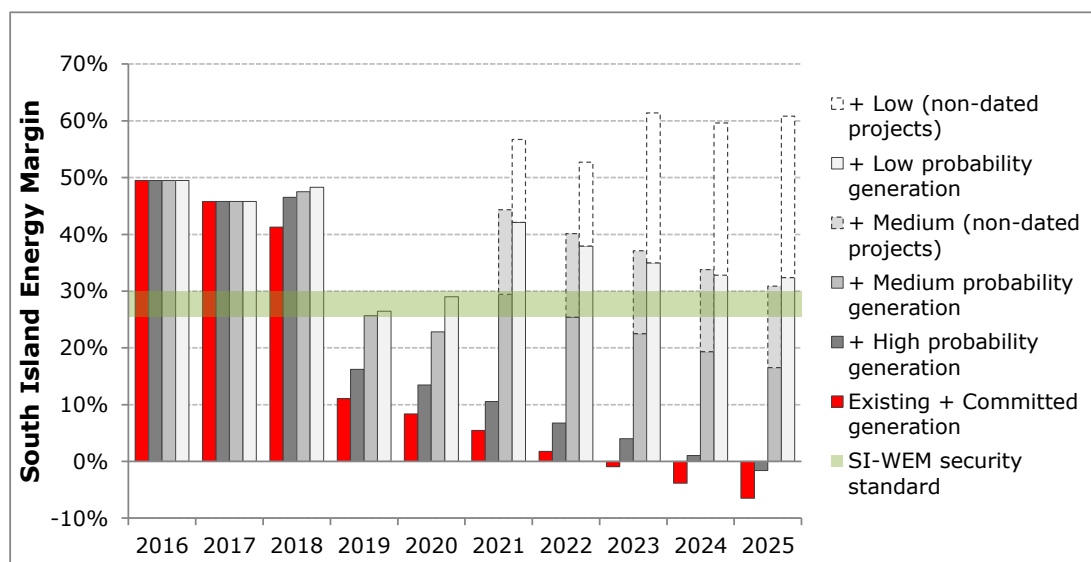


Figure 4: South Island Winter Energy Margin 2016 to 2025 – Base-case

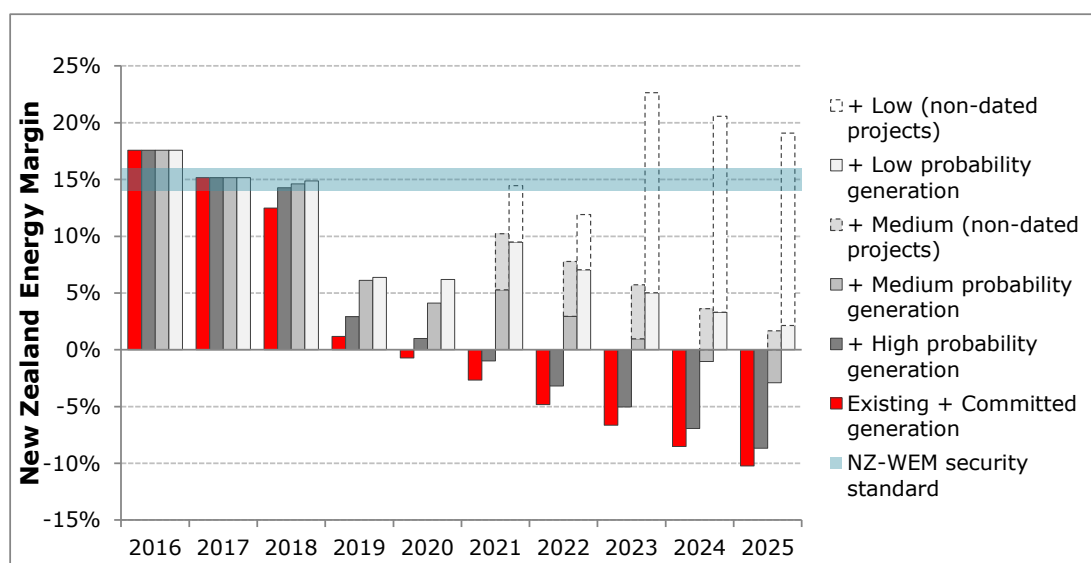


Figure 5: New Zealand Winter Energy Margin 2016 to 2025 – High demand scenario

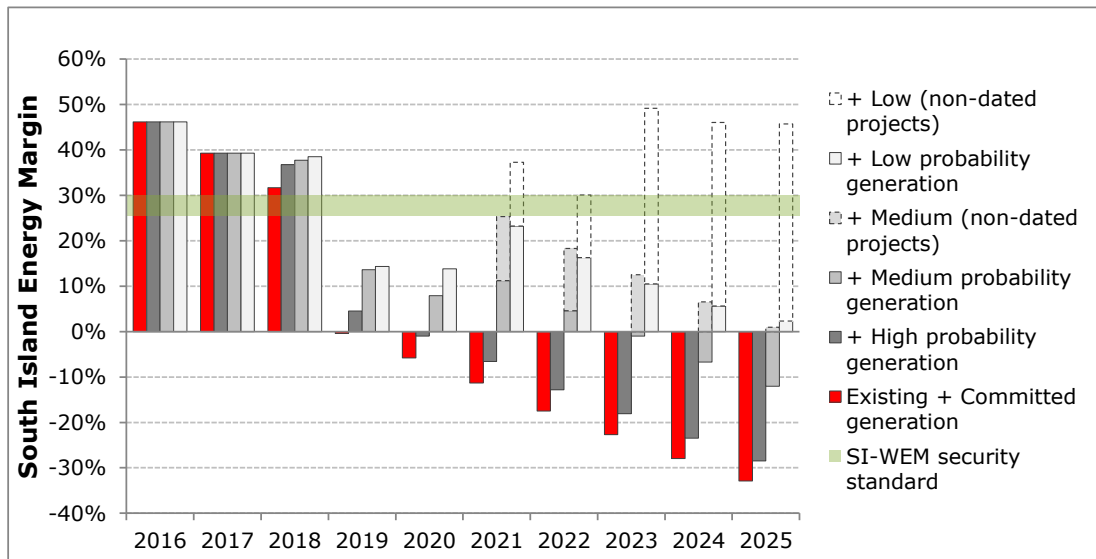


Figure 6: South Island Winter Energy Margin 2016 to 2025 – High demand scenario

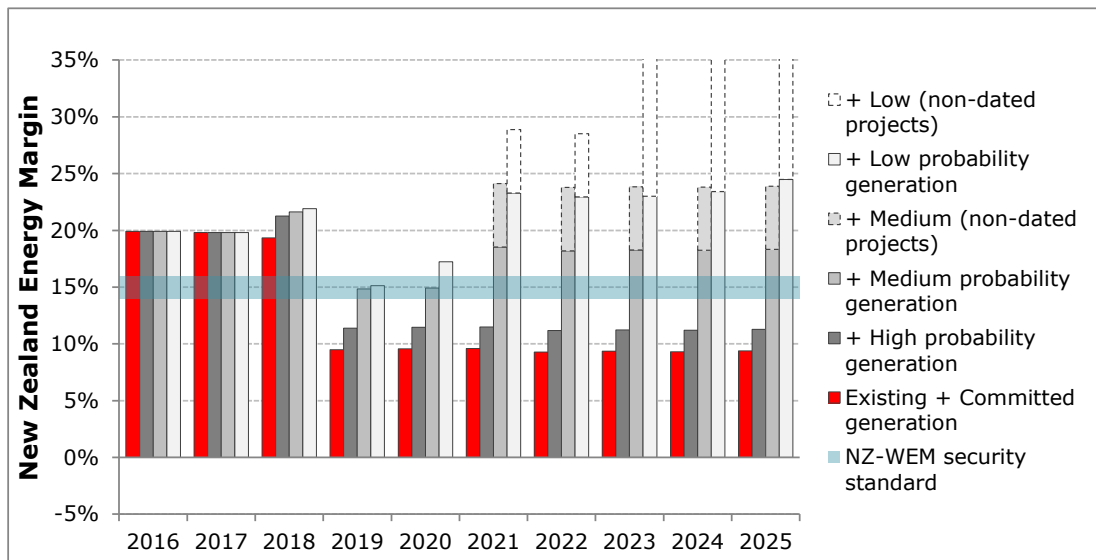


Figure 7: New Zealand Winter Energy Margin 2016 to 2025 – Low demand scenario

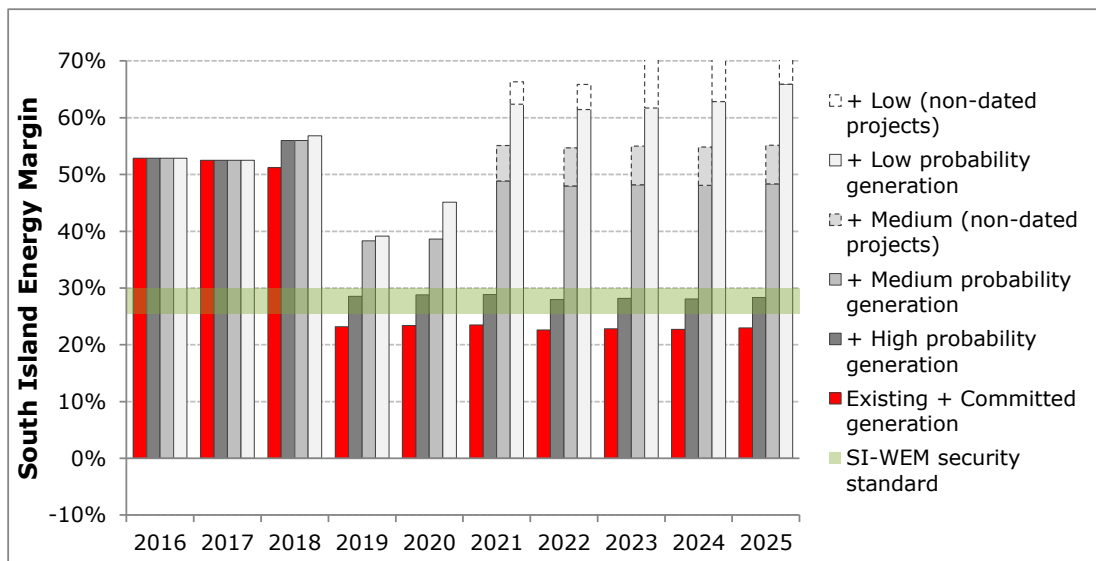


Figure 8: South Island Winter Energy Margin 2016 to 2025 – Low demand scenario

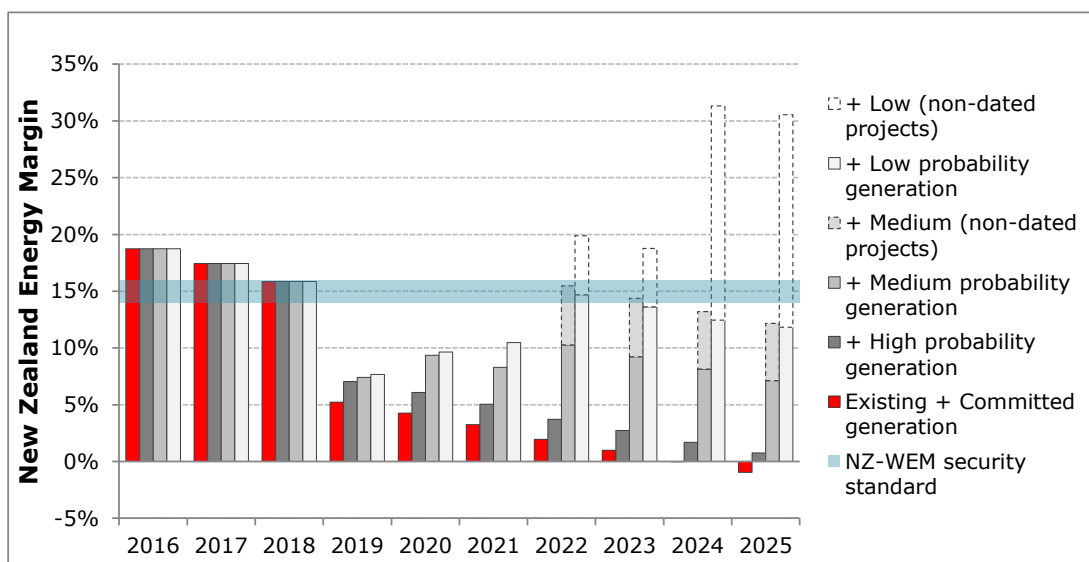


Figure 9: New Zealand Winter Energy Margin 2016 to 2025 – Delayed build scenario

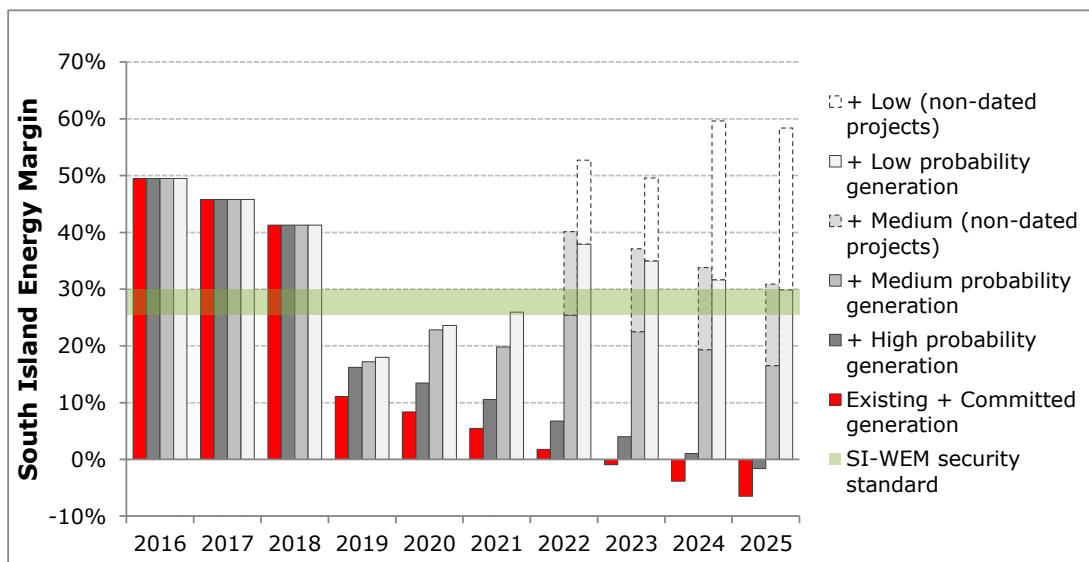


Figure 10: South Island Winter Energy Margin 2016 to 2025 – Delayed build scenario

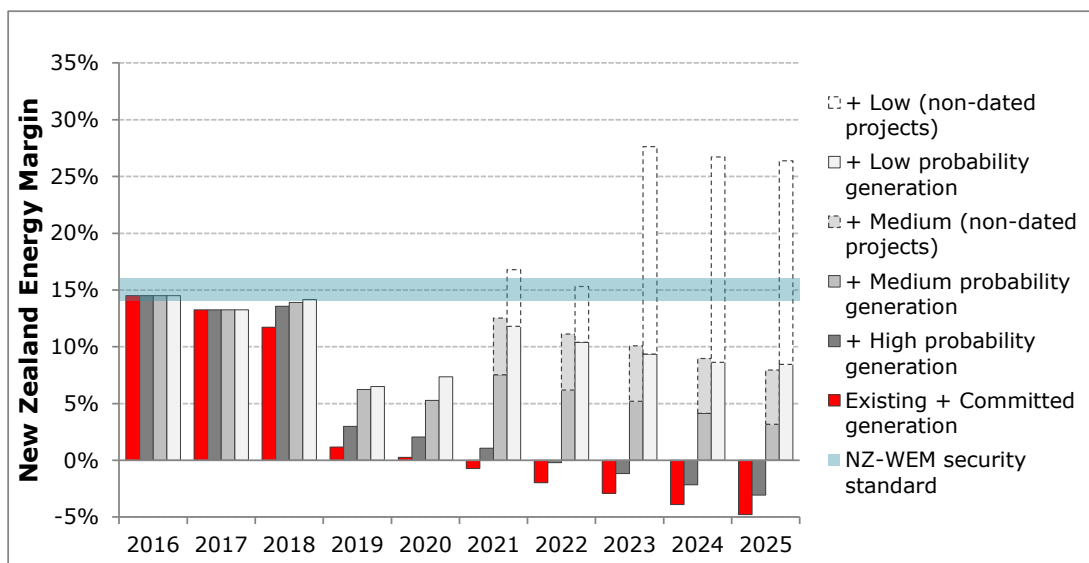


Figure 11: New Zealand Winter Energy Margin 2016 to 2025 – De-rated non-thermal generation scenario

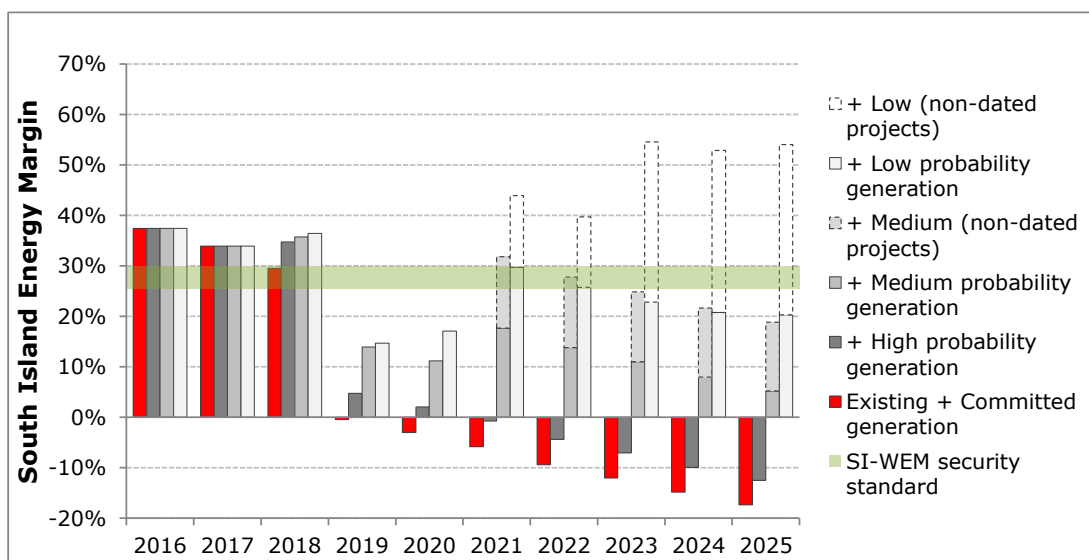


Figure 12: South Island Winter Energy Margin 2016 to 2025 – De-rated non-thermal generation scenario

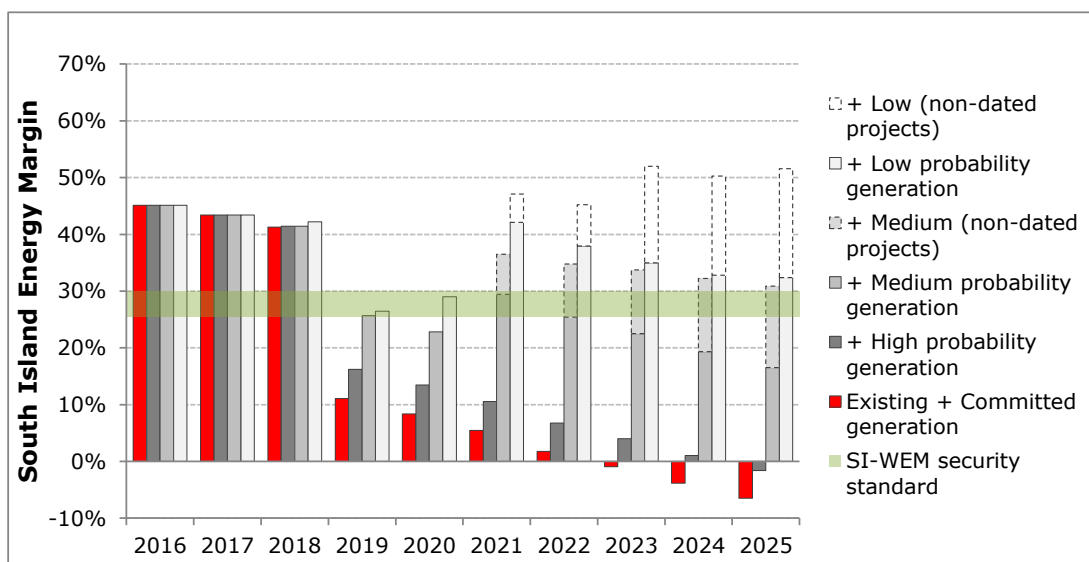


Figure 13: South Island Winter Energy Margin 2016 to 2025 – Limited HVDC south scenario

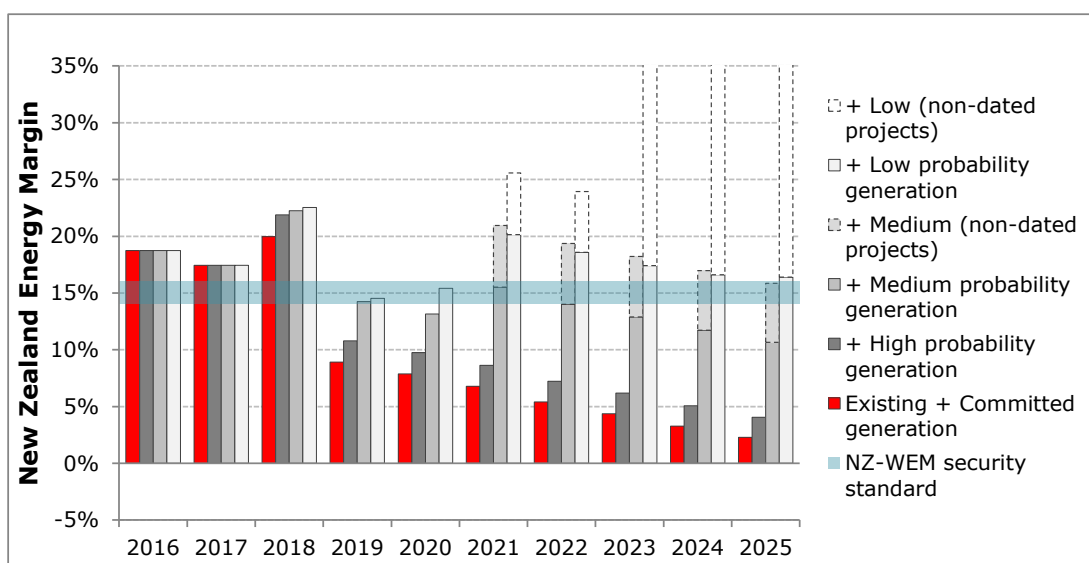


Figure 14: New Zealand Winter Energy Margin 2016 to 2025 – NZAS scenario 1 (reduce)

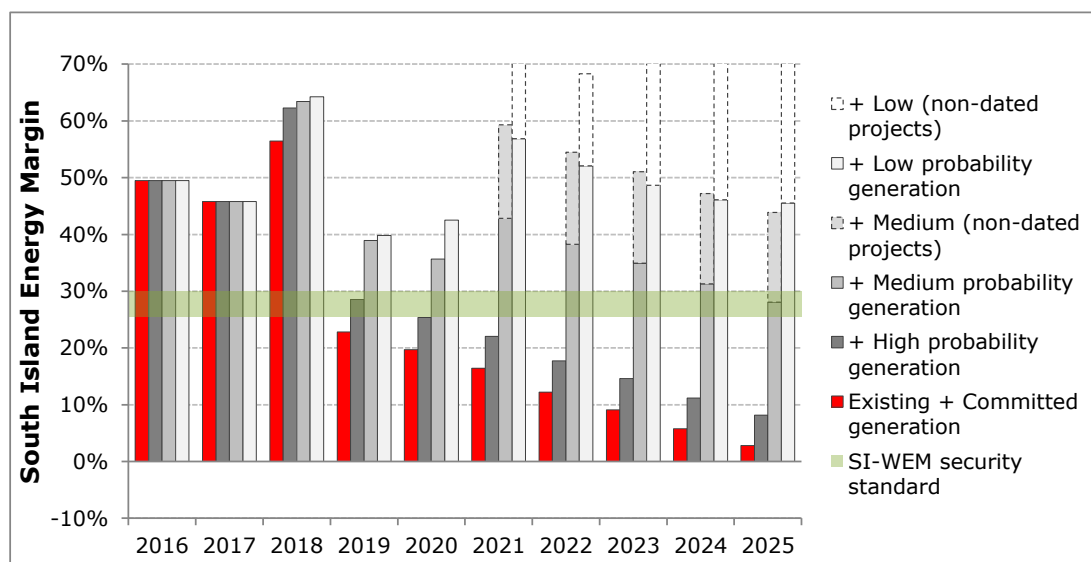


Figure 15: South Island Winter Energy Margin 2016 to 2025 – NZAS scenario 1 (reduce)

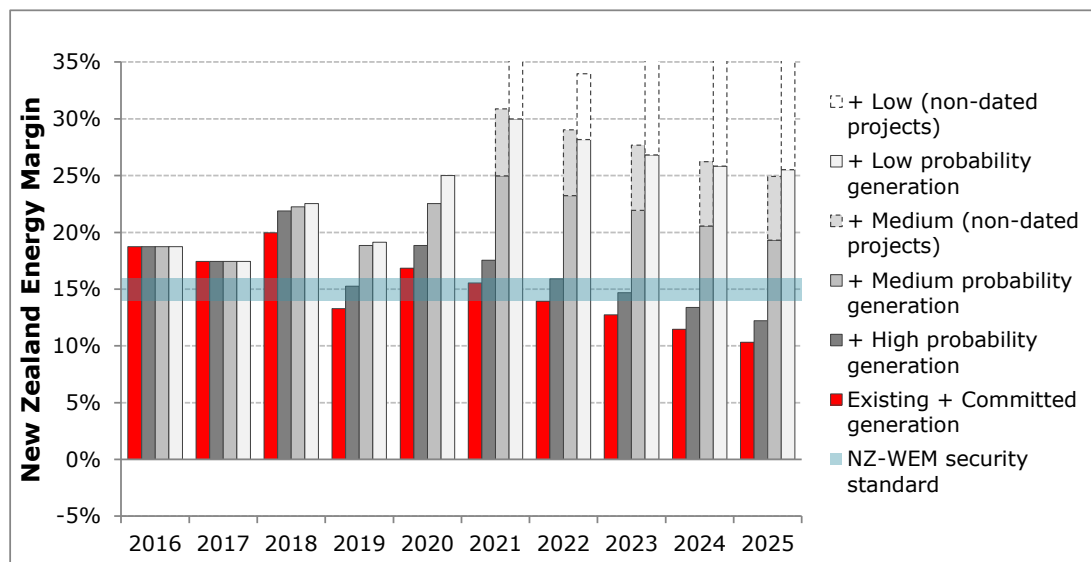


Figure 16: New Zealand Winter Energy Margin 2016 to 2025 – NZAS scenario 2 (close)

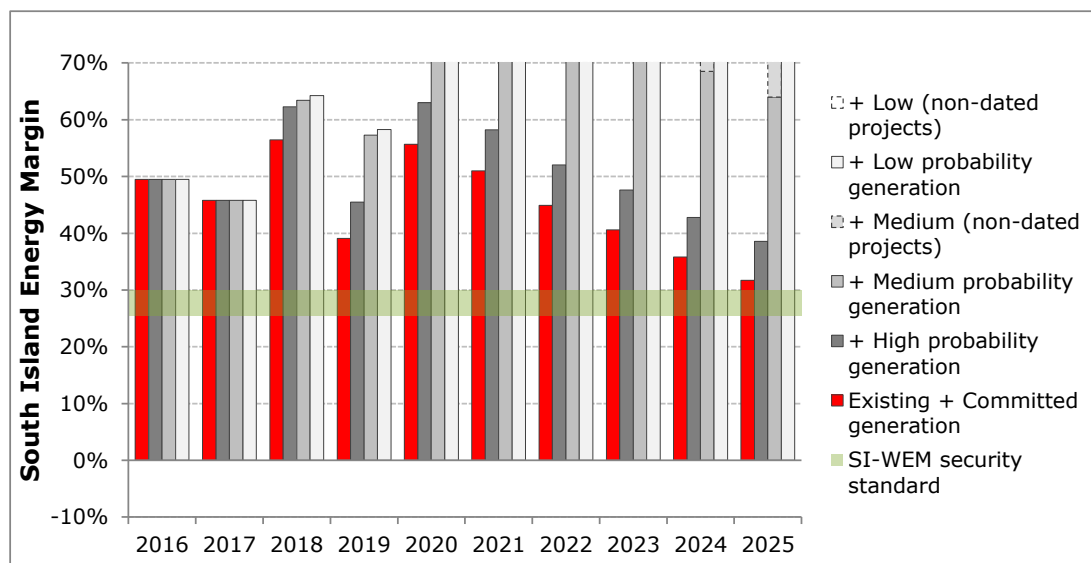


Figure 17: South Island Winter Energy Margin 2016 to 2025 – NZAS scenario 2 (close)

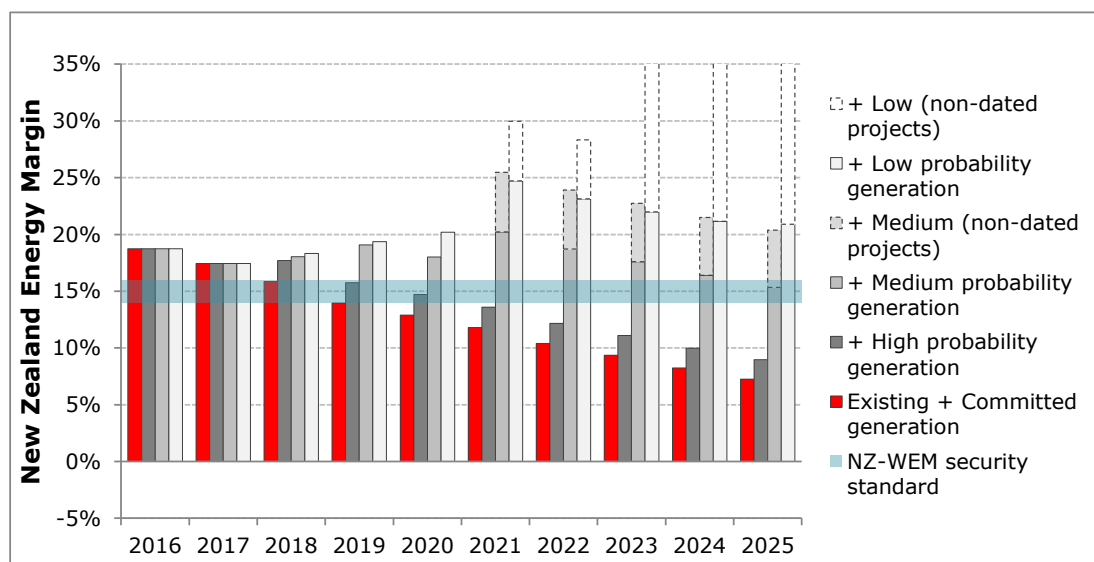


Figure 18: New Zealand Winter Energy Margin 2016 to 2025 – Huntly decision reversal scenario

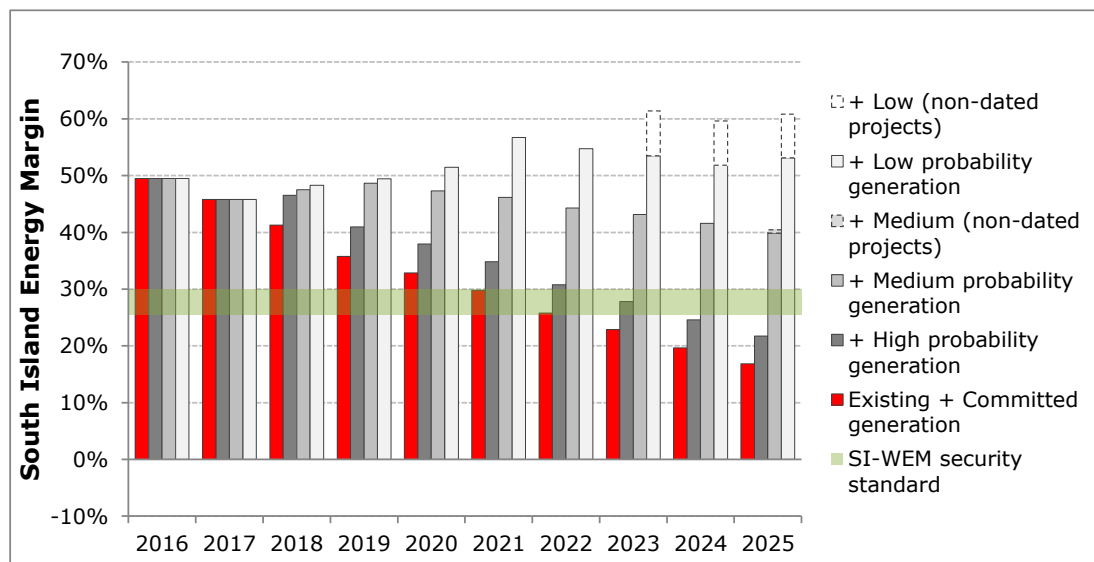


Figure 19: South Island Winter Energy Margin 2016 to 2025 – Huntly decision reversal scenario

6. CAPACITY MARGIN ASSESSMENT

6.1 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:

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

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 peak generation 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 during winter peak.
North Island expected demand (MW)	NI Peak Demand MW	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 supply to 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.

6.2 CAPACITY MARGIN RESULTS

This section summarises the results of the North Island WCM assessment, based on the input assumptions summarised in Section 4 and described in detail in the appendices (Sections 8 and 9).

The forecast of the North Island WCMs from 2016 – 2025 under the base-case scenario is shown in Figure 20. Sensitivity results are presented following the base-case results.

Capacity margin results are summarised below.

- In the base-case scenario, the North Island WCMs are forecast to remain above the security standard until 2018 with existing and committed generation.
- Following the modelled decommissioning of the Huntly Rankine units at the end of 2018 the North Island WCMs are forecast to reduce below the security standard. With no additional generation investment the North Island WCMs are forecast to remain below the standard from 2019 until the end of this assessment period.

- In all scenarios existing and committed generation provide sufficient capacity supply to keep the North Island WCMs above or within the security standard until the end of 2018.
- The high demand and de-rated generation scenarios significantly reduce the North Island WCMs compared to the base-case. In both of these scenarios the North Island WCMs are forecast to become negative if there is no new generation built (and Huntly Rankine units are decommissioned as announced).
- All scenarios, with the exception of the low demand scenario, reduce existing and committed generation below the lower limit of the security standard at some point during the forecast period.
- In a number of scenarios there is insufficient new generation options (based on the information made available to Transpower), regardless of likelihood, to maintain the North Island WCMs within the range of the security standard. This observation is mostly limited to the two years following the announced Huntly Rankine decommissioning (2019 and 2020) where there are limited generation options available.
- If the decommissioning does not progress as planned then the North Island WCMs are forecast to remain above or within the margin with only high likelihood generation until 2024.
- Overall, North Island WCMs in the 2016 Security of Supply Annual Assessment are lower than those derived in the 2015 Security of Supply Annual Assessment. This is due to generation plant that was decommissioned late 2015 and early 2016 and the announced Huntly Rankine unit decommissioning.

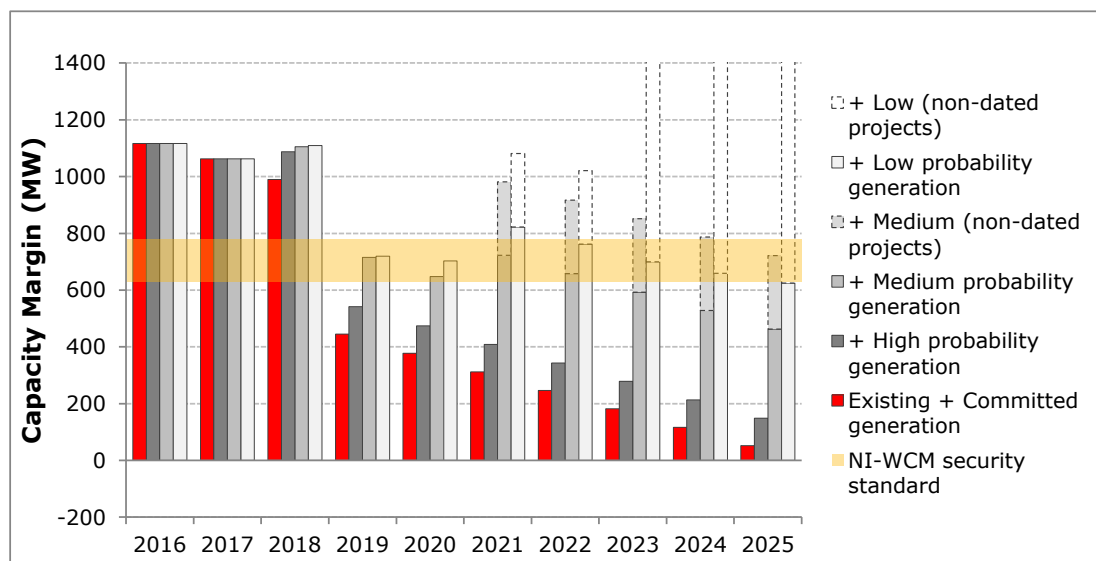


Figure 20: North Island Winter Capacity Margin 2016 to 2025 – Base-case

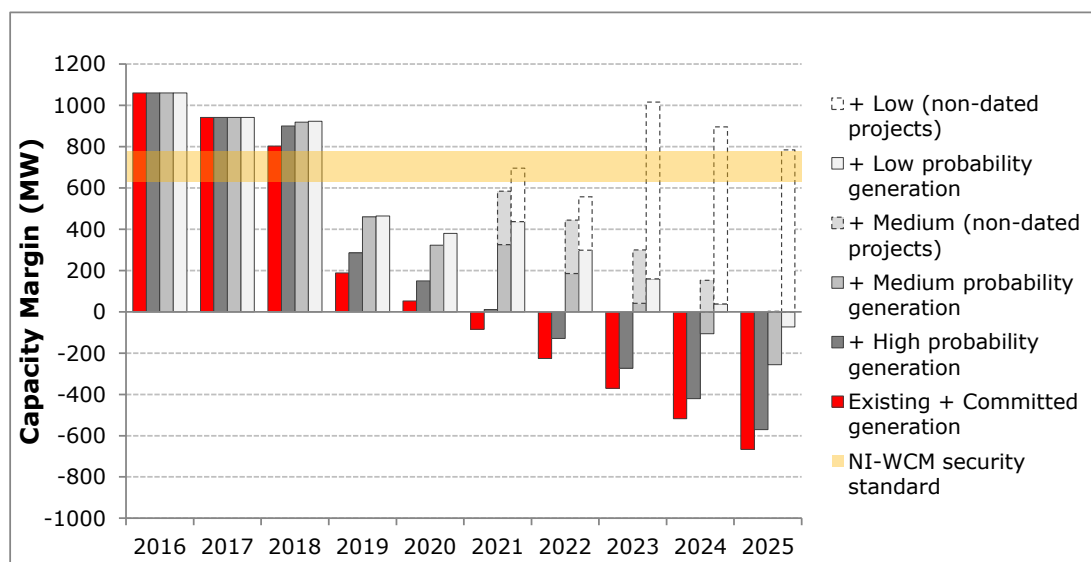


Figure 21: North Island Winter Capacity Margin 2016 to 2025 – High demand scenario

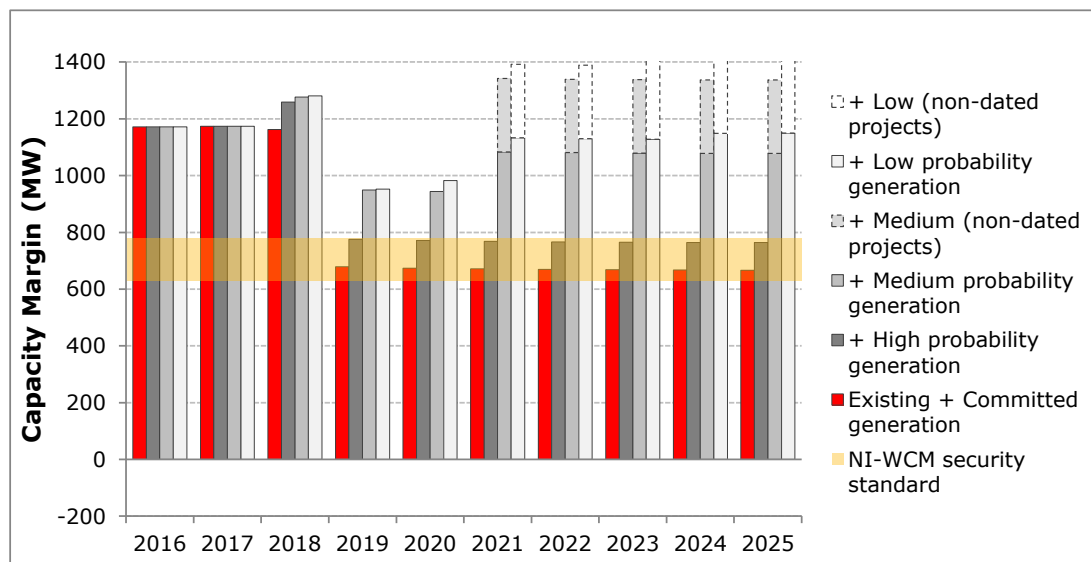


Figure 22: North Island Winter Capacity Margin 2016 to 2025 – Low demand scenario

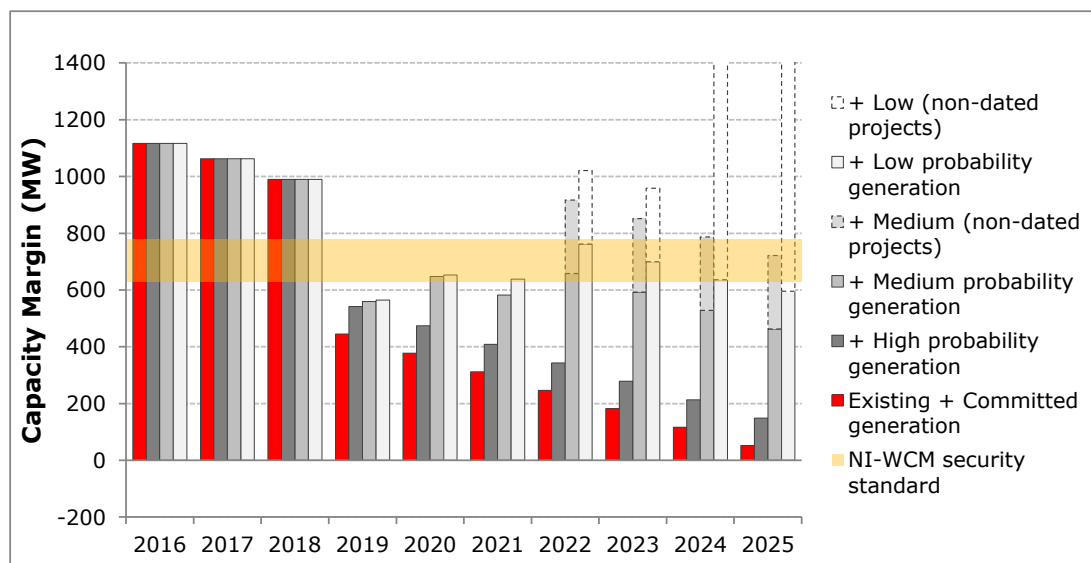


Figure 23: North Island Winter Capacity Margin 2016 to 2025 – Delayed build scenario

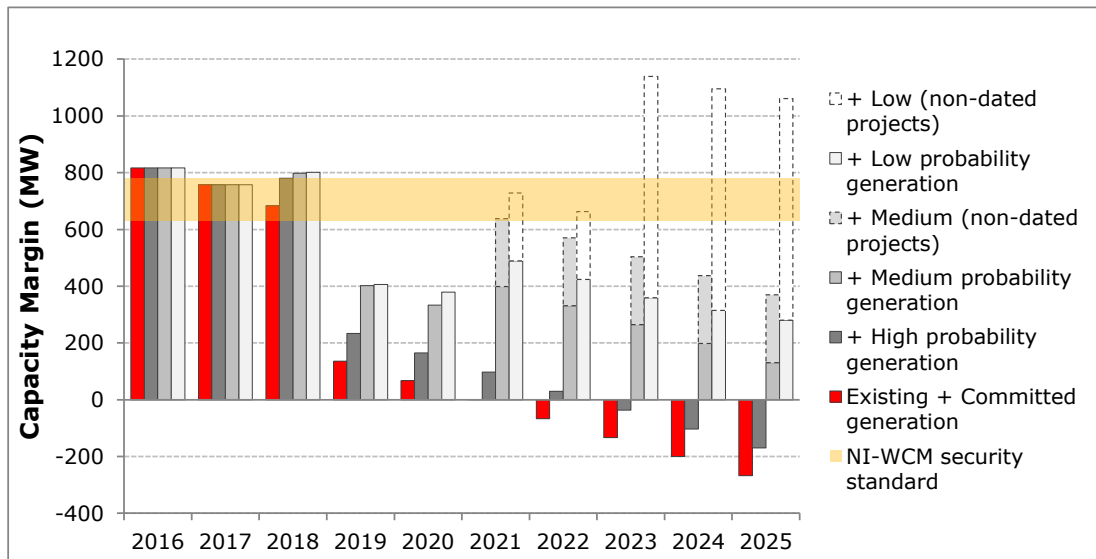


Figure 24: North Island Winter Capacity Margin 2016 to 2025 – De-rated non-thermal generation scenario

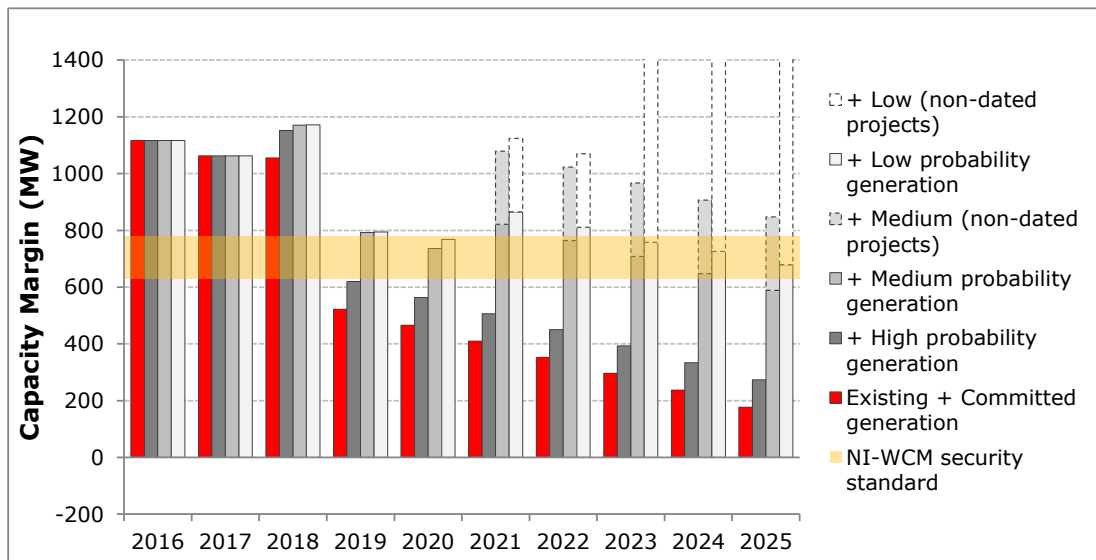


Figure 25: North Island Winter Capacity Margin 2016 to 2025 – NZAS scenario 1 (reduce)

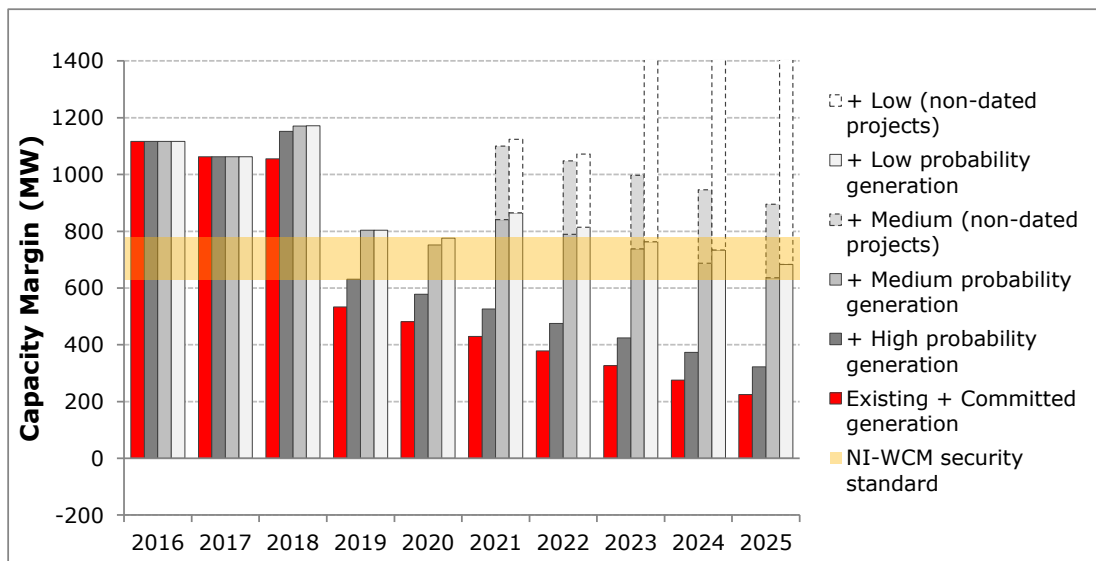


Figure 26: North Island Winter Capacity Margin 2016 to 2025 – NZAS scenario 2 (close)

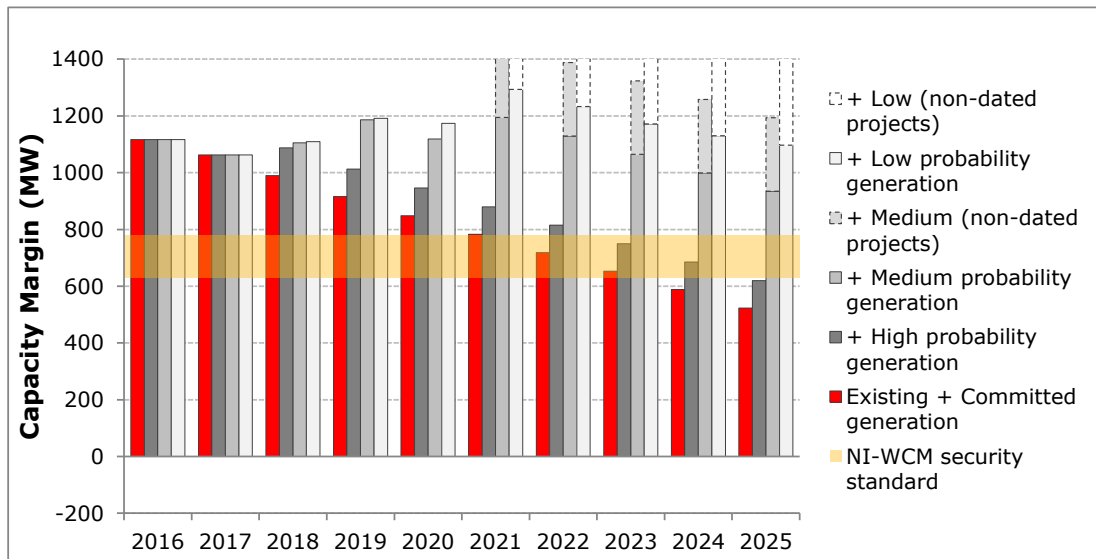


Figure 27: North Island Winter Capacity Margin 2016 to 2025 – Huntly decision reversal scenario

7. CONCLUSIONS

7.1 ENERGY MARGIN CONCLUSIONS

The New Zealand and South Island WEMs are forecast to remain above or within the security standard until 2018 without any new generation in the base-case scenario.

In the medium to long-term the WEM forecasts are very sensitive to the future plans of the Huntly Rankine units, and, to a lesser extent, the future of the NZAS. The base-case scenario assumes that the Huntly Rankine units will be decommissioned at the end of 2018, and in this scenario the New Zealand and South Island WEMs are very likely to be reduced to a level below the standard. However, it is still quite possible that circumstances will change and the Huntly Rankine units will not be decommissioned in the manner that has been announced. The future of the NZAS also adds to this uncertainty.

7.2 CAPACITY MARGIN CONCLUSIONS

The North Island WCMs are forecast to remain above or within the security standard until 2018 without any new generation in the base-case scenario.

Similar to the WEMs, the medium to long-term outlook is very sensitive to the future of the Huntly Rankine units. However, unlike the WEM forecasts the future of the NZAS has little impact on the WCMs.

7.3 INTERPRETATION OF THE MARGINS AGAINST THE STANDARDS

The base-case New Zealand WEMs, South Island WEMs and North Island WCMs are forecast to remain above or within the efficient level, as determined by the Electricity Authority, until 2018. 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 appears to have resulted in surplus generation investment in the short to medium-term.

If demand grows as forecast, generation is decommissioned as announced, NZAS demand remains, and only high likelihood generation is built, from 2019 all of the security of supply margins indicate that the New Zealand electricity system will experience undersupply¹⁰.

The undersupply is due to the decommissioning of the Huntly Rankine units and as such comes associated with a degree of uncertainty. In their decommissioning announcement, Genesis Energy stated that if market conditions change significantly they will consider the option of retaining the Huntly Rankine units in service.

¹⁰ It is important to note that undersupply does not equate to electricity shortage. It simply implies that investment in new generation would be an economically rational exercise according to the Winter Margin metrics.

In addition to the obvious implications this situation shows, it highlights the sensitivity of the New Zealand electricity industry to changes in the generation portfolio.

8. APPENDIX 1: DETAILED SUPPLY ASSUMPTIONS

8.1 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 SSAD¹¹ published by the Electricity Authority.

Prior to the 2015 Security of Supply Annual Assessment only grid connected generation was modelled. This assessment uses a similar approach to the 2015 assessment in that it includes modelling of embedded generation. See the 2015 Security of Supply Annual Assessment for more information.

8.2 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 included¹².

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)
Aniwhenua	Hydro	25	58	14
Arapuni	Hydro	192	See Waikato scheme*	*
Aratiatia	Hydro	78	See Waikato scheme*	*
Atiamuri	Hydro	74	See Waikato scheme*	*
Glenbrook	Thermal - Cogen	74	207	42
Huntly Rankines	Thermal - Coal	486	1986	471
Huntly U5	Thermal - Gas	385	1595	373
Huntly U6	Thermal - Gas	48	199	47
Kaimai	Hydro	41	81	31
Kaitawa	Hydro	36	See Waikaremoana scheme*	*
Kapuni	Thermal - Cogen	25	86	14
Karapiro	Hydro	96	See Waikato scheme*	*
Kawerau	Geothermal	104	433	94
Kawerau Onepu	Geothermal	60	216	54
Kinleith	Thermal - Cogen	40	126	21
Mangahao	Hydro	42	69	23
Maraetai	Hydro	352	See Waikato scheme*	*
Matahina	Hydro	80	154	66

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)
McKee	Thermal - Gas	100	414	97
Mill Creek	Wind	60	119	15
Mokai	Geothermal	112	461	101
Nga Awa Purua	Geothermal	134	564	120
Ngatamariki	Geothermal	82	348	74
Ohaaki	Geothermal	50	175	45
Ohakuri	Hydro	106	See Waikato scheme*	*
Patea	Hydro	32	55	26
Piripaua	Hydro	42	See Waikaremoana scheme*	*
Poihipi	Geothermal	55	222	49
Rangipo	Hydro	120	311	71
Rotokawa	Geothermal	35	142	31
Stratford Peaker	Thermal - Gas	200	829	194
Tararua I and II	Wind	68	134	17
Tararua III	Wind	93	183	23
Taranaki Combined Cycle	Thermal - Gas	377	1562	366
Te Āpiti	Wind	91	151	22
Te Huka	Geothermal	28	117	25
Te Mihi	Geothermal	166	669	149
Te Rapa	Thermal - Cogen	44	164	25
Te Rere Hau	Wind	49	58	12
Te Uku	Wind	64	107	16
Tokaanu	Hydro	240	375	216
Tuai	Hydro	60	See Waikaremoana scheme*	*
Waipapa	Hydro	54	See Waikato scheme*	*
Wairakei incl. binary	Geothermal	132	549	119
West Wind	Wind	142	243	35
Whakamaru	Hydro	100	See Waikato scheme*	*
Whareroa	Thermal - Gas	70	290	68
Wheao	Hydro	26	51	20
Whirinaki	Thermal - Diesel	155	15	150

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)
Aviemore	Hydro	220	See Waitaki scheme*	*
Benmore	Hydro	540	See Waitaki scheme*	*
Branch	Hydro	11	27	6
Clyde	Hydro	400	See Clutha scheme*	*

Cobb	Hydro	32	94	31
Coleridge	Hydro	40	135	39
Deep Stream	Hydro	6	11	5
Highbank/Montalto	Hydro	30	51	23
Kumara/Dillmans	Hydro	11	23	8
Mahinerangi Wind 1	Wind	36	58	8
Manapouri	Hydro	800	2683	784
Ohau A	Hydro	264	See Waitaki scheme*	*
Ohau B	Hydro	212	See Waitaki scheme*	*
Ohau C	Hydro	212	See Waitaki scheme*	*
Paerau/Patearoa	Hydro	12	31	7
Roxburgh	Hydro	280	See Clutha scheme*	*
Tekapo A	Hydro	27	See Waitaki scheme*	*
Tekapo B	Hydro	154	See Waitaki scheme*	*
Waipori	Hydro	84	73	64
Waitaki	Hydro	90	See Waitaki scheme*	*
Whitehill	Wind	58	95	13

* 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	2312	1031
Waikaremoana	NI	242	135
Waitaki	SI	2759	1685
Clutha	SI	1409	666
Start storage	NI	350	n/a
Start storage	SI	2400	n/a

8.3 NEW SUPPLY

The tables below list the aggregated quantities of new generation that is included in this assessment. This is the supporting data for Figure 1.

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)
2016	0	0	0
2017	0	0	0
2018	150	555	122
2019	165	679	155
2020	264	441	60
2021	919	2,543	469

2022	0	0	0
2023	1,424	3,307	623
2024	25	99	22
2025	72	211	42

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	1,119	3,175	425
Geothermal	525	2,104	472
Hydro	180	485	113
Thermal	500	2,072	485

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	854	2,764	573
Low	2,065	4,657	824

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	2,144	6,101	1,230
SI	876	1,734	264

8.4 HISTORICAL COMPARISON OF SUPPLY ASSUMPTIONS

Compared to the 2015 annual assessment the total amount of new generation projects has significantly reduced, as shown in Figure 28. This is due to a number of projects that have been permanently put on hold or have had their consents expire.

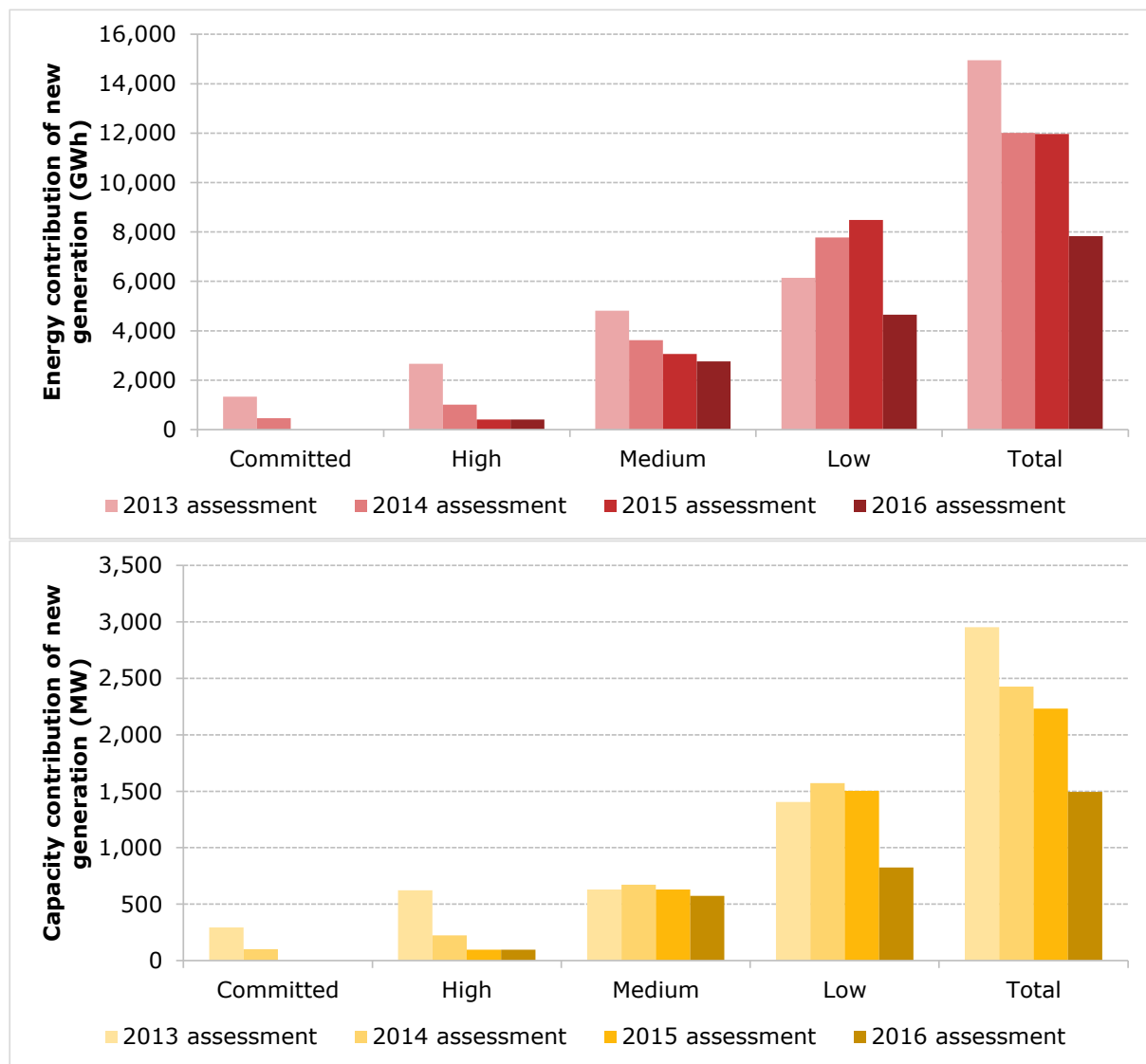


Figure 28: New Generation – 2016 Annual Assessment compared with previous annual assessments

8.5 OTHER KEY ASSUMPTIONS FOR GENERATION

8.5.1 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 WEMs, South Island WEMs and North Island WEMs. Unless otherwise stated these assumptions are as per the SSAD.

- For combined cycle gas turbine generation a de-rating of 5.4% was applied to the nameplate capacity when calculating the New Zealand WEMs and South Island WEMs (net energy contribution factor of 94.6%). This assumption was also applied to open cycle gas turbines, although this application is not explicitly contained with the SSAD (the SSAD only refers to combined cycle gas turbine generation).
- For the coal-fired Huntly units a de-rating of 6.7% is applied to the nameplate capacity when calculating the New Zealand WEMs and South Island WEMs (net energy contribution factor of 93.3%).

- The New Zealand WEMs and South Island WEMs 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 WCMs (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 WCMs.
- 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 – note that these generators are *not* treated as run-of-river hydro).
 - Matahina de-rated by 13 MW for the North Island WCMs
 - Patea de-rated by 5 MW for the North Island WCMs
 - Tokaanu de-rated by 20 MW for the North Island WCMs.
- All other Hydro stations (non-controllable) are treated as run-of-river and assumed to contribute either 59% or 76% of nameplate capacity to the North Island WCMs depending on the level of peaking ability observed in their historical generation datasets (see Section 8.5.2). These assumptions are derived using current data and are not contained within the SSAD.
- All geothermal generation is assumed to contribute 90% of nameplate capacity to the North Island WCMs (see Section 8.5.2). This assumption is derived using current data and are not contained within the SSAD.
- All North Island wind generation is assumed to contribute 24% of nameplate capacity, and all South Island wind generation 22% of nameplate capacity to the North Island WCMs (see Section 8.5.2). These assumptions are derived from a national wind capacity contribution of 25% which is based on the recommendations contained within the SSAD. The North Island and South Island wind generation values are derived by de-aggregating to an island level contribution using current data and are not explicitly contained within the SSAD.

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

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

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

This assessment used a national wind capacity contribution of 25%. However, in order to derive the WCMs a national level contribution must first be de-aggregated into North Island and South Island capacity contributions.

The capacity contribution of run-of-river hydro, cogeneration, geothermal, North Island wind generation and South Island wind generation at the winter peak has been determined by direct comparison with New Zealand wind generation in order to de-rate the nameplate capacity of these generation types on the same basis and de-aggregate North and South Island wind capacity contributions. 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 29 shows the percentage of time the capacity contribution of each generation type is greater than the corresponding level, based on this data.

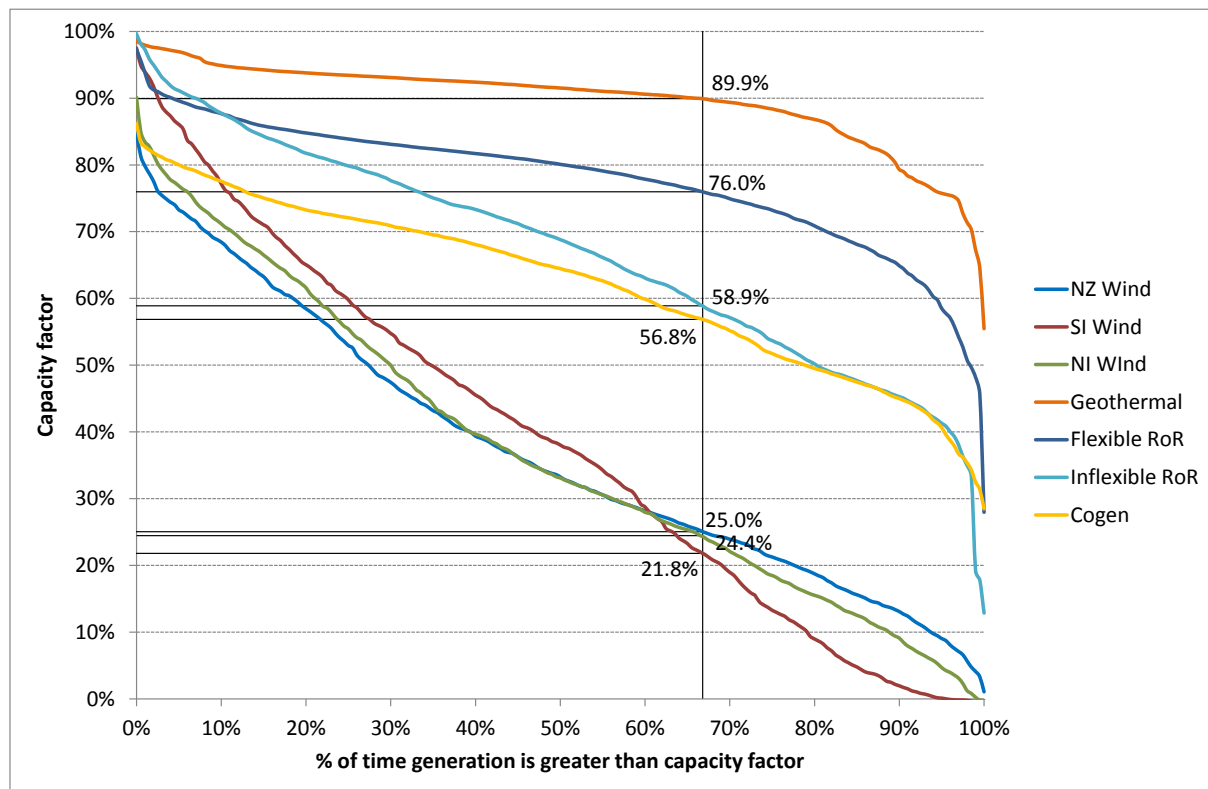


Figure 29: Capacity factor duration curves for wind, run-of-river hydro, geothermal, and cogeneration plant during peak periods.

Wind generation in New Zealand was shown to contribute greater than 25% of their nameplate capacity for 67% of the peak periods analysed. North Island wind, South Island wind, flexible run-of-river hydro, inflexible run-of-river hydro, geothermal, and cogeneration plants contributed greater than 24%, 22%, 76%, 59%, 90%, and 57% of their nameplate capacity for 67% of these peak periods respectively. These values are used to de-rate nameplate capacity when calculating the North Island WCMs.

8.5.3 Thermal Fuel and Operational Limitations

It is also assumed that thermal fuel, or operational limitations, will for the most part not constrain the production of electricity, with the exception of Whirinaki diesel generator. Whirinaki's energy contribution is limited to 15 GWh per year in the derivation of the WEMs.

This assumption is designed to reflect the limited fuel of the plant. This limitation has the net effect of reducing the WEMs by directly reducing the amount of energy available during the winter period.

8.5.4 Start Storage

To account for start storage levels in the hydro catchments an amount of freely usable energy (GWh) is assumed. These assumptions are as per the SSAD. In the calculation of the WEMs the following values for start storage are used:

- The start storage level is 2750 GWh in the New Zealand WEMs
- The start storage level is 2400 GWh in the South Island WEMs.

8.5.5 Huntly rankine unit decommissioning

It is assumed that two coal-fired Huntly rankine units are available for the derivation of the WEMs and WCMs up to, and including, winter 2018. From winter 2019 onwards it is assumed that no Huntly rankine units will be available¹³ (in the base-case – there is a scenario that assesses the impact of these two units not being decommissioned).

8.6 TRANSMISSION

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

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

8.6.1 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 WEMs, 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 Review¹⁴ discusses some of the reasons for this. This assessment includes a scenario with considerably lower 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 WEMs to HVDC transfer limits.

¹³ See <https://nzx.com/companies/GNE/announcements/268005> for more information

¹⁴ <http://www.ea.govt.nz/about-us/what-we-do/our-history/archive/dev-archive/consultations/security-of-supply-consultations/review-of-2008-winter/>

8.6.2 HVDC: Northwards Flow

It is assumed that during winter the South Island has the potential to supply the North Island with capacity.

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 WCMs. 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.

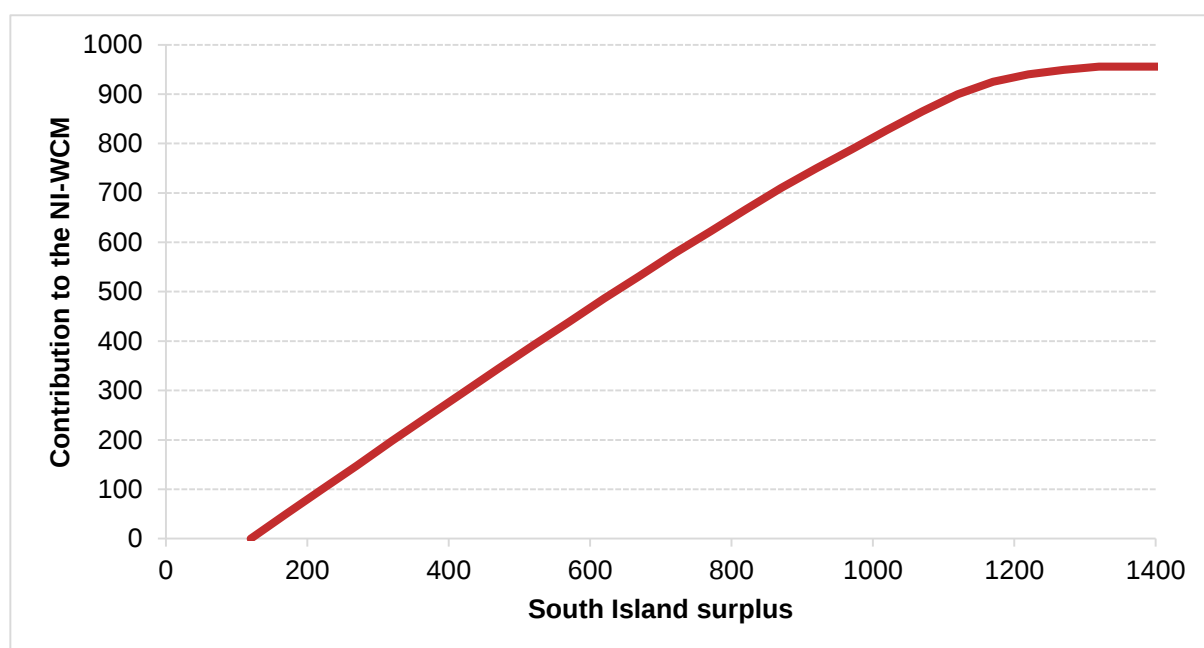


Figure 30: Relationship between South Island surplus and its contribution to the North Island WCMs

8.6.3 AC Transmission Assumptions

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

9. APPENDIX 2: DETAILED DEMAND FORECAST ASSUMPTIONS

9.1 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 in 2015, hereafter referred to as the underlying demand forecast. The underlying 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, and account for transmission losses and demand response.

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9.2 TREATMENT OF GENERATION

The underlying demand forecast predicts demand at GXP level, with *all* embedded generation netted off. This approach is used internally as it best suits the purposes of modelling grid asset requirements. 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 underlying demand forecast wherever possible¹⁵.

9.3 SPECIFIC DEMAND ASSUMPTIONS

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

- grossing on transmission losses
- grossing on embedded generation
- allowing for demand response
- converting annual demand to winter demand.

These steps are carried out in the order outlined above. Transmission losses are only applied to net GXP demand, and demand response and conversion to winter demand are applied to gross demand (inclusive of transmission losses and embedded generation).

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

For capacity margin calculations the underlying demand forecast is applied proportionality to a known H100 demand value for 2015 (that is percentage growth rates are applied to determine 2016 onwards). This removes the need to adjust for embedded generation and transmission losses or convert from single highest peak demand to H100 peak demand. However, the forecast demand is still adjusted to allow for demand response.

¹⁵ It is impossible to gross on generation for which there is no historical data available. 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.

9.3.1 Demand Response

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

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

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 forced rationing.

9.3.2 Transmission Losses - WEMs

For the baseline year (2015) 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 underlying 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, which has a flow on effect for all future years. The net effect of this assumption in the 2016 Annual Assessment is to increase demand slightly (20-70 GWh) and therefore decrease the WEMs slightly.

9.3.3 H100 Demand (peak demand forecast)

The underlying 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.

This assessment has derived a H100 demand that is consistent with the supply assumptions by determining demand for generation in 2015¹⁶. This is achieved by firstly identifying the H100 peak demand periods using aggregate data for the North and South Islands. Then generation from each generator (that was modelled including embedded generation) during those peaks is aggregated to determine demand for generation for each of those peak periods. Finally these aggregate values were averaged to determine a single H100 figure for 2015.

The percentage growth from the underlying demand forecast was then applied to the 2015 H100 figure to determine an H100 forecast out to 2025.

This removed the need to explicitly account for transmission losses. This methodology for calculating demand is not expected have a material impact on the WCM results. The main purpose of this methodology was to make the derivation of H100 less resource intensive, less prone to errors and easier to align with supply assumptions.

¹⁶ Demand for generation is demand measured at the point of generation. This eliminates the need to adjust for embedded generation (as you measure and aggregate all generation you are modelling on the supply side) and transmission losses (as they are implicitly included).

9.4 DEMAND DATA

9.4.1 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)
2015	42,439	27,265	15,174
2016	42,918	27,675	15,243
2017	43,387	27,966	15,421
2018	43,986	28,349	15,637
2019	44,720	28,792	15,928
2020	45,133	29,070	16,063
2021	45,578	29,375	16,203
2022	46,160	29,750	16,410
2023	46,597	30,056	16,541
2024	47,077	30,352	16,725
2025	47,514	30,656	16,858

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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)
2015	4,418	2,196
2016	4,473	2,197
2017	4,516	2,219
2018	4,573	2,242
2019	4,630	2,265
2020	4,683	2,285
2021	4,735	2,303
2022	4,786	2,321
2023	4,837	2,339
2024	4,888	2,357
2025	4,939	2,375

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