Security and Reliability Council

Thermal generation decommissioning

The implications of announcements of thermal generation decommissioning on reliability of supply

22 October 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's (SRC) functions under the Electricity Industry Act 2010 include providing advice to the Electricity Authority (Authority) on reliability of supply.

Since 2011, the market has provided nine new generation stations that added over 740 MW of capacity to the power system. Combined with other factors such as flat demand since 2008, new transmission being built and market developments, it has been apparent that the generation market has been over-supplied.

Market participants have made a number of key announcements during the last three months:

- Genesis Energy confirmed that two of the four 250 MW coal-fired Rankine units at Huntly have already been decommissioned. Until recently it was assumed by the system operator that one of these units was in long-term storage and could be returned to the market if required. This is no longer the case.
- Mighty River Power announced the full closure of its Southdown generator (130 MW) will occur on 31 December 2015.
- Genesis Energy announced that they intend to remove the two remaining Huntly Rankine units (500 MW total) from the market by the end of 2018, subject to market conditions.
- Contact Energy announced that its Otahuhu-B generator (400 MW) would close at the end of September 2015. It generated its last MWh on 21 September 2015 and the plant and site are in the process of being sold.

Collectively, these announcements mean that over 1000 MW of generation is, or is expected to be removed from the market by the end of 2018, offsetting the increase in capacity resulting from the commissioning of new geothermal, wind and gas peaking generation in recent years.

On the demand side, New Zealand Aluminium Smelters (NZAS) and Meridian announced they reached an agreement that would ensure the smelter continues to draw 572 MW until at least 1 January 2018, rather than drop down to 400 MW. NZAS also has the option to exit its electricity supply contract from January 2018 at the earliest (by giving 12 months' notice in January 2017).

These are significant announcements in the context of the industry's supply and demand balance, though the near- to medium-term decommissioning of each of these thermal generators was widely regarded as inevitable.

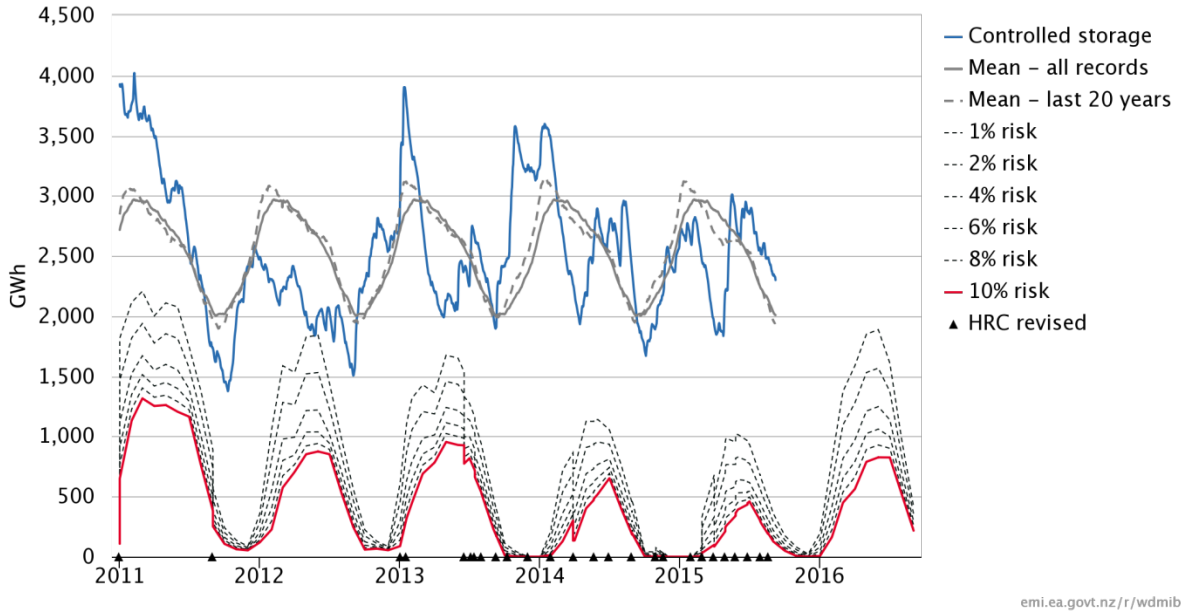
The system operator has undertaken further analysis since the thermal decommissioning announcements

In response to these announcements, the system operator is undertaking analysis of their impact on the power system and security of supply.[1] The system operator has summarised its observations so far into a single report for the SRC. This summary report is appended to this paper.

The system operator has also published hydro risk curves for 2016 based on the latest market information. When compared to the 2015 hydro risk curves, there is a significant increase. However, as seen in the fuller context provided by Figure 1, this increase is better characterised as a return to risks equivalent to those in 2012.

[1] The programme of work is outlined at https://www.systemoperator.co.nz/activites/current-projects/impact-thermal-generator-decommissioning.

Figure 1 - New Zealand hydro risk curves, storage and mean storage since 2011



Source: Electricity Authority

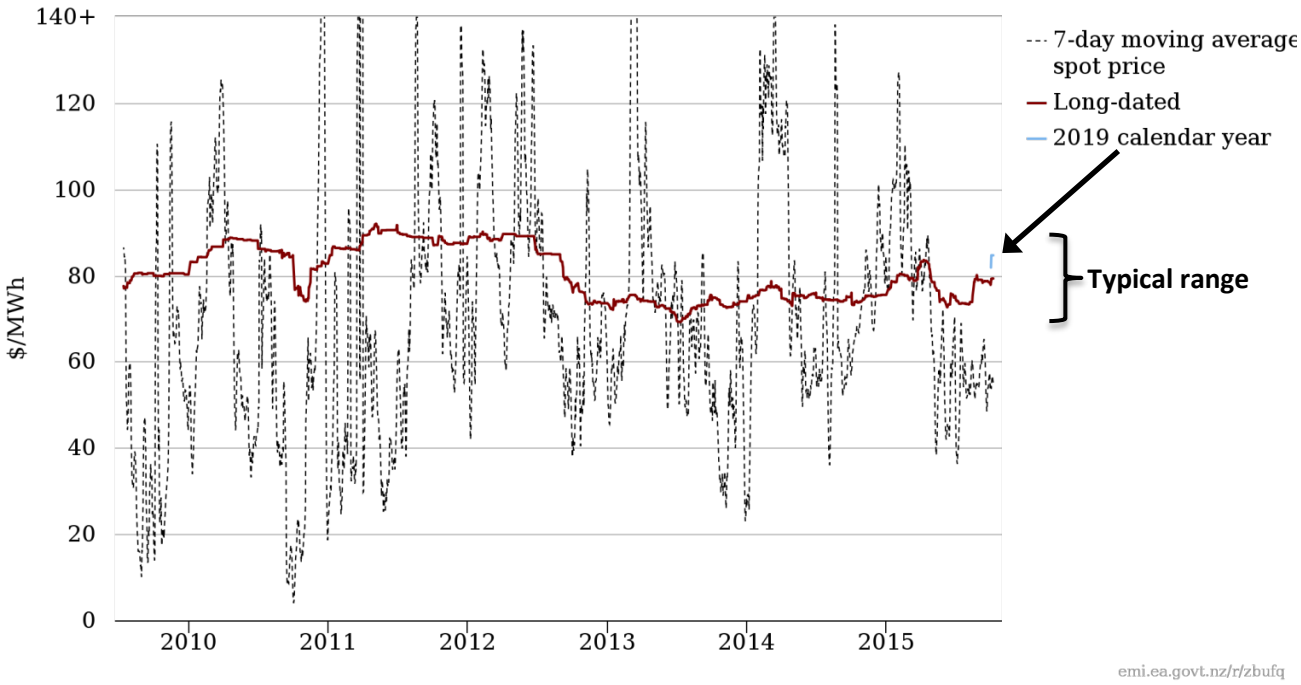
Notes: 1. Source data is available from www.emi.ea.govt.nz

The Authority is anticipating that supply and demand will adjust in the medium-term

The Authority anticipates that, in a workably competitive market, some of the following actions would be expected to occur:

Increases in futures prices: in general, prices for long-dated contracts on the ASX NZ electricity futures market have increased since these announcements. Energy futures for 2019 commenced trading on 1 October 2015, providing some insight into the extent of the market reaction to the recent announcements. This is illustrated in Figure 2 below. Higher futures price improve the commercial returns to generation, or cause higher regret costs for any further closures. Futures for 2019 are currently trading at $85/MWh at Otahuhu. This is within the typical range of prices for long-dated contracts (ie. contracts for periods beyond the next 12 months). Prices for long-dated contracts have typically ranged between $70 to $90/MWh since the market opened in 2009. This price provides no indication that market participants are forecasting electricity shortages in 2019.

Figure 2 - ASX trading for New Zealand electricity futures at Otahuhu



Source: Electricity Authority

Notes: 2. Source data is available from www.emi.ea.govt.nz

Some re-adjustment of risk positions: parties that used to rely on owning their own thermal plant for hedge cover may now reduce their physical sales or purchase more hedge cover through the ASX or the over-the-counter market. The unmatched open interest (UOI) of the ASX is one measure of this activity and recently exceeded 4,000 GWh (10 per cent of physical electricity demand); the highest level since the futures market began.

Changes to water use: hydro generators will need to keep storage at higher levels, and accept a higher risk of spilling water, in order for the market maintain a given level of risk. It is too early to gauge any difference here but this is something the Authority expects to monitor closely.

More flexible fuel contracting arrangements: the Authority understands Meridian negotiated a demand reduction clause with NZAS as part of their hedge renegotiation process in 2013. The contract allows for Meridian to call for demand reduction, between 125 GWh and 250 GWh, depending on when this is called, and provides incentives for NZAS to reduce load in times of low storage.

Greater access to contingent storage: the Authority also understands Meridian can currently access about 40 per cent of the 550 GWh of contingent storage in Lake Pukaki, but will need to undertake significant engineering work to gain access to remainder of storage.[2] If they decide to do this work, it would represent a significant increase in energy available to the market; the full 550 GWh is equivalent to 16 per cent of the total South Island controlled storage and would significantly reduce the chances of New Zealand running out of electricity. However, generator-retailers will want to avoid running their lakes down to the level

[2] Resource consent conditions mean that this storage is 'contingent' on an official conservation campaign being commenced.

where an official conservation campaign occurs because they have to pay $10.50 per week to each residential customer during those campaigns.

Parties executing development options: Parties hold options to develop generation projects for scenarios just like this. 300 MW of flexible peaking generation has been built since 2011, together with the fuel flexibility added at Contact's Ahuroa gas storage facility. There are other options that can be executed in a relatively short time frame; the system operator's annual security of supply assessment assumes 100 MW of highly likely generation, 953 MW of medium, and 3,279 MW of low likelihood generation. Authority figures show in total there is 4,360 MW of consented generation which is yet to commence construction. These are all projects that generators can commence relatively quickly and which have already gone through the necessary Resource Management Act hurdles.

Demand-side innovation: We are only just beginning to see the innovation possible from smart meters and dispatchable demand is only one year into existence. In 2019, demand response could play a more significant role in terms of capacity management than it does currently. The Authority has already been contacted by a demand-side party who is considering installing 50 MW of peaking capacity and offering it to the market via the new dispatchable demand regime.

Retailers are more aware and have more incentive than ever to manage shortages effectively

The Authority has implemented three key initiatives to ensure parties are aware of risks and ensure prices are at efficient levels in times of shortages:

Customer compensation scheme: Retailers must pay $10.50 per week per residential customer if a savings campaign is initiated. For a retailer with 400,000 customers this could amount to a $25m cost for a six week savings campaign.

The stress test: all participants with exposures to the spot market must conduct stress tests every three months, show the results to their boards and their boards must certify to the Authority every year they are aware of the spot exposure risks they are taking.

Scarcity pricing: this ensures prices will have a floor of $10,000/MWh (approximately 150 times the average market price) if there is temporary load disconnection due to island-wide capacity shortfalls.

The Authority is actively reviewing whether further refinements to market arrangements would enhance efficient decision-making by market participants

The Authority is investigating whether current market arrangements best support the market finding efficient outcomes. These investigations include:

a) The lack of an exchange traded cap product may be disadvantaging thermal generators. The Authority has determined that it will prioritise the establishment and market-making of standardised cap products. An associated project has been added to the Authority's pending projects work programme to consider factors that may be undermining demand for caps.

b) A review of spot market arrangements, in particular whether half-hourly optimisation is leading to inefficient outcomes over the long-term.

c) Reviews of the stress testing, scarcity pricing and customer compensation schemes to ensure they are appropriately calibrated to provide efficient risk management incentives.

The Authority also liaises closely with the system operator to ensure that we remain well informed on supply risks, and can identify any issues with related policy settings.

The SRC is being asked to consider what advice it would like to give to the Authority

The purpose of this paper is to inform the SRC about recent announcements and seek the SRC's advice (if any, at this stage) to the Authority Board.

The SRC may wish to consider the following questions.

Q1.	What further information, if any, does the SRC wish to have provided to it by the secretariat?
Q2.	What advice, if any, does the SRC wish to provide to the Authority?

Security and Reliability Council discussion paper – Impact of Thermal De-commissioning

TRANSPOWER

Version	Date	Change
1.0	8th October 2015	Initial version

IMPORTANT

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1. INTRODUCTION AND APPROACH

Transpower is analysing what impacts de-commissioning the Otahuhu and Southdown power stations and the expected de-commisioning of the remaining Huntly Rankine generating units will have on power system operation and security of supply.

This paper provides a summary of the work Transpower has carried out to date and outlines future work.

Transpower is obliged, in its capacity as the system operator, to understand what impacts these de-commissionings may have on the power system. Understanding these impacts enables Transpower to deliver on two objectives:

- determine the actions that Transpower, and other industry participants, need to take in order to meet their performance obligations in the future
- provide clear and timely information to industry enabling participants to make well informed decisions regarding the future of the power system.

Transpower is taking a staged and collaborative approach to meeting these objectives to ensure the system operator, the transmission owner and industry work together to understand the impacts of the de-commissioning decisions. To date Transpower has carried out two analyses in response to the announcements[1]:

- Upper North Island (UNI) Supply Study: A technical engineering analysis assessing management of peak load in the UNI during Summer 2015/16 and Winter 2016, following the closure of Otahuhu B and Southdown generators
- Update of the Security of Supply Annual Assessment: A high level security of supply analysis assessing the supply and demand balance out to 2020.

This paper provides summaries of the two analyses described above. The technical engineering study is discussed in Section 2. The security of supply analysis is discussed in section 3. Ongoing and future work is outlined in section 4.

[1] The 2016 Hydro Risk Curves have also been updated. Information on latest Hydro Risk Curves can be found here: *http://www.systemoperator.co.nz/security-supply/sos-weekly-reporting/hydro-risk-curves*

2. UPPER NORTH ISLAND SUPPLY STUDY

A report of this study outlines the System Operator's view of the power system's ability to supply Zone 1 during peak loading times without Otahuhu and Southdown generation, taking into account thermal and voltage stability issues. Zone 1 essentially covers the Northland and Auckland regions. The report is on the System Operator website[2].

Three periods were assessed:

1. summer 2015/2016 peak
2. winter 2016 peak
3. November 2015, when major scheduled transmission outages coincide with a planned outage of Huntly unit 5.

Studies indicate thermal and voltage issues can be managed with the currently commissioned transmission and remaining generation assets available to the market.

2.1 SUMMER 2015/16 PEAK

For summer 2015/2016 the forecast peak load in Zone 1 is 1711 MW.

Under N-1 conditions[3] peak loads are manageable with Huntly unit 5 available. During an outage of one of the main 220kV circuits into the Auckland region (for example Pakuranga-Whakamaru-1), additional units at Huntly may be required if central North Island generation is not high enough.

Table 1 shows the limits obtained in the summer peak studies and relevant thermal constraint equations.

Table 1: Summer peak load limit summary

Scenario	Zone 1 Maximum MW	Limiting Issue	Limiting Contingency	Thermal Constraint Equation
Huntly unit 5 in service	1825 MW	Thermal violation on Bunnythorpe-Mataroa-1	Hamilton-Whakamaru-1	1.085 * BPE_MTR1.1 - 0.03 * HAM_WKM.1 <= 62
Huntly unit 5 and unit 1 in service	2095 MW	Voltage stability	Huntly unit 5	
Pakuranga-Whakamaru-1 outage Huntly unit 5 and unit 1 in service	1935 MW	Thermal violation on Bunnythorpe-Mataroa-1	Hamilton-Whakamaru-1	1.085 * BPE_MTR1.1 - 0.03 * HAM_WKM.1 <= 62

[2] *http://www.systemoperator.co.nz/activites/current-projects/impact-thermal-generator-decommissioning*

[3] The System Operator is obliged to avoid cascade failure; in practice this is achieved by operating to N-1 conditions ensuring the largest contingent event is covered.

2.2 WINTER 2016 PEAK

For winter 2016 the forecast peak load in Zone 1 is 2170 MW.

Under N-1 conditions the peaks are manageable with two units at Huntly generating; either unit 5 and unit 1 or unit 1 and unit 2. The amount of generation required from Huntly will vary depending on central North Island generation. During an outage of one of the main 220 kV circuits into the Auckland region (for example Pakuranga-Whakamaru-1), the peaks are also manageable with Huntly unit 5 and Huntly unit 1 or 2 available.

Table 2 shows the limits obtained in the winter peak studies and thermal constraint equations.

Table 2: Winter peak load limit summary

Scenario	Zone 1 Maximum MW	Limiting Issue	Limiting Contingency	Thermal Constraint Equation
Huntly unit 5 in service	2150 MW	Thermal violation on Bunnythorpe-Mataroa-1	Huntly-Stratford-1	1.081 * BPE_MTR1.1 - 0.05 * HLY_SFD.1 <= 75
Huntly unit 5 and unit 1 in service	2350 MW	Thermal violation on Bunnythorpe-Mataroa-1	Huntly-Stratford-1	1.081 * BPE_MTR1.1 - 0.05 * HLY_SFD.1 <= 75
Pakuranga-Whakamaru-1 outage Huntly unit 5 and unit 1 in service	2250 MW	Voltage Stability	HLY unit 5	

2.3 CONCURRENT OUTAGES IN NOVEMBER 2015

During the scheduled transmission outages in November concurrent with Huntly unit 5 also on outage, the forecast peak load in Zone 1 of 1760 MW is manageable with generation at Huntly from Huntly units 1 or 2. Thermal issues which may be arise can be mitigated by increased Huntly or central North Island generation.

Thermal constraint equations were developed for scenarios limited by thermal overloading issues. The contingent circuit which overloads Bunnythorpe-Mataroa-1 110 kV circuit may vary depending on generation and load profiles. It is expected the constraint limiting transfer through this region will vary based on different operating conditions[4].

2.4 PROPOSED MITIGATION FOR IDENTIFIED ISSUES

As thermal and voltage issues can be managed with currently commissioned and available assets, investigation of options for mitigating the identified issues has been

[4] For example, different generation configurations or load levels.

limited to reviewing the current mechanisms and market options[5]. The current upper North Island voltage stability constraint has been reviewed and a new constraint is proposed to be introduced. This new constraint will monitor circuits south of Huntly, therefore placing Huntly generation in the region of the constraint; this allows Huntly generation to be dispatched to alleviate voltage stability violations.

Industry feedback on the proposed equation constraint has been sought. Pending the resolution of a number of actions following the industry teleconference the reviewed equation constraint will be implemented prior to the Huntly unit 5 outage in November.

[5] Mitigation mechanisms considered but not investigated in detail (the need was not justified based on the results of the study) were grid reconfiguration, demand response, and contracting for voltage support.

3. THERMAL DECOMMISSIONING IMPACT ASSESSMENT USING SECURITY OF SUPPLY ANNUAL ASSESSMENT MODELLING

3.1 SUMMARY

Assessment of the security of supply implications of thermal decommissioning used the same model used within the Security of Supply Annual Assessment[6].

The analysis shows there is significant risk to the New Zealand power system if thermal decommissioning proceeds as announced in the absence of little or no new generation build and demand growth proceeds as forecast[7] (Figure 1 and Figure 2). In this scenario there is a risk New Zealand could face an elevated risk of capacity and energy shortages and sustained high wholesale market prices. However, this scenario is deemed unlikely as sufficient new generation, or other market based solutions, are likely to be made available in the next three years to ensure capacity and energy margins remain at efficient levels.

It is expected the power system will require ~2200 GWh of new winter energy supply[8] and ~350 MW of new winter capacity supply in order for energy and capacity margins to remain at optimal levels.

Under a low demand growth scenario[9] the winter capacity and energy margins will still drop below efficient levels in 2019 (Figure 3 and Figure 4). This implies that even with a pessimistic view of growth investment in generation will still be required.

Continuation of Tiwai aluminium smelter operations presents a significant uncertainty to the power system. NZAS has the option to exit its electricity supply contract from January 2018 at the earliest (by giving 12 months' notice in January 2017). Figure 5 and 6 show the impact of a Tiwai closure, noting that a Tiwai closure has quite different impacts on the energy and capacity margins. While the energy margin in 2020 is above the standard, the capacity margin continues to remain below the standard. This is caused by the generation in the South Island becoming stranded; the HVDC link would be unable to transfer all the excess capacity north should the smelter close. This implies investment into flexible peaking generation will be prioritised over inflexible baseload generation. This assertion is supported by numerous industry commentators.

[6] *http://www.systemoperator.co.nz/security-supply/security-supply-annual-assessment*

[7] Assumed growth rate is 1.45% per annum

[8] This is the additional energy requirements expected for between April and September 2019.

[9] Assumed growth rate is 0.45% per annum

3.2 RESULTS

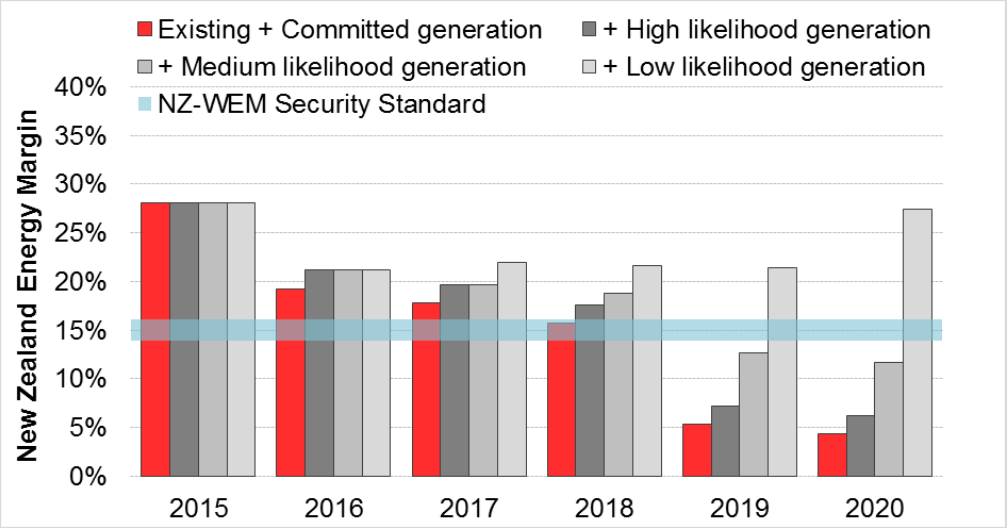

Figure 1: Winter Energy Margins - Thermal Decommissioning as announced

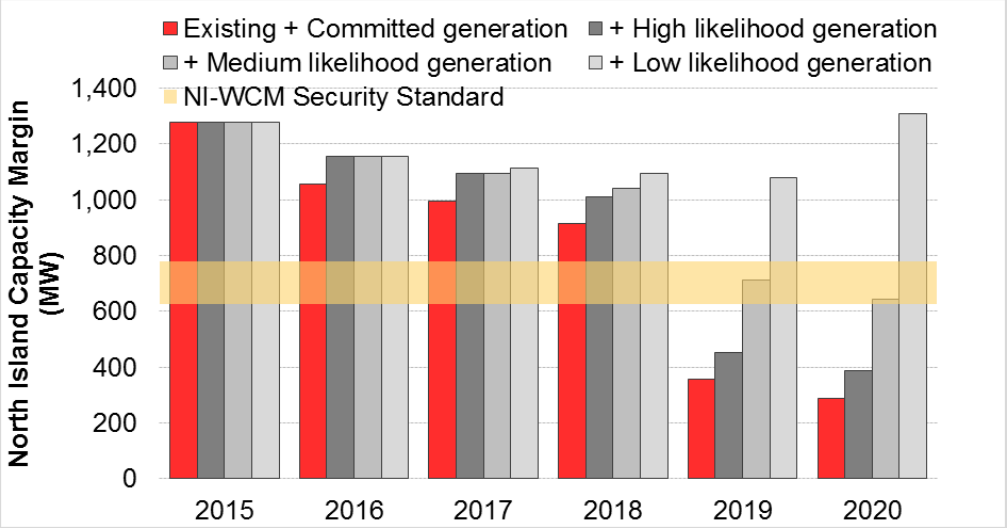

Figure 2: Winter Capacity Margins - Thermal Decommissioning as announced

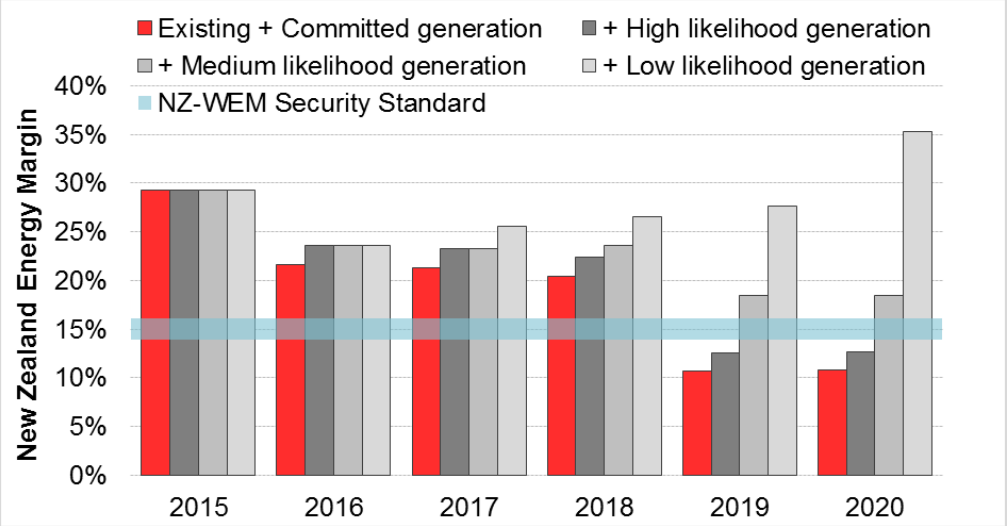

Figure 3: Winter Energy Margins - Thermal Decommissioning as announced and low demand

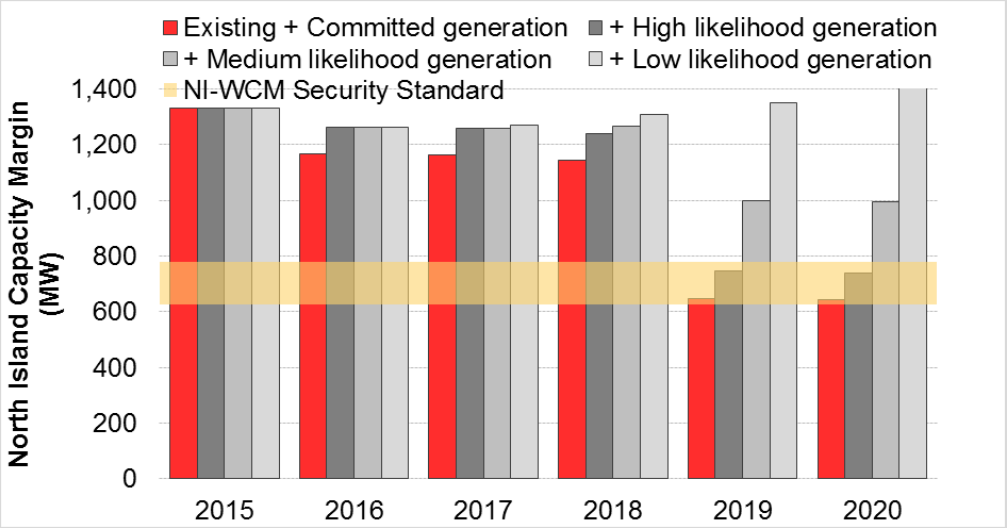

Figure 4: Winter Capacity Margins - Thermal Decommissioning as announced and low demand

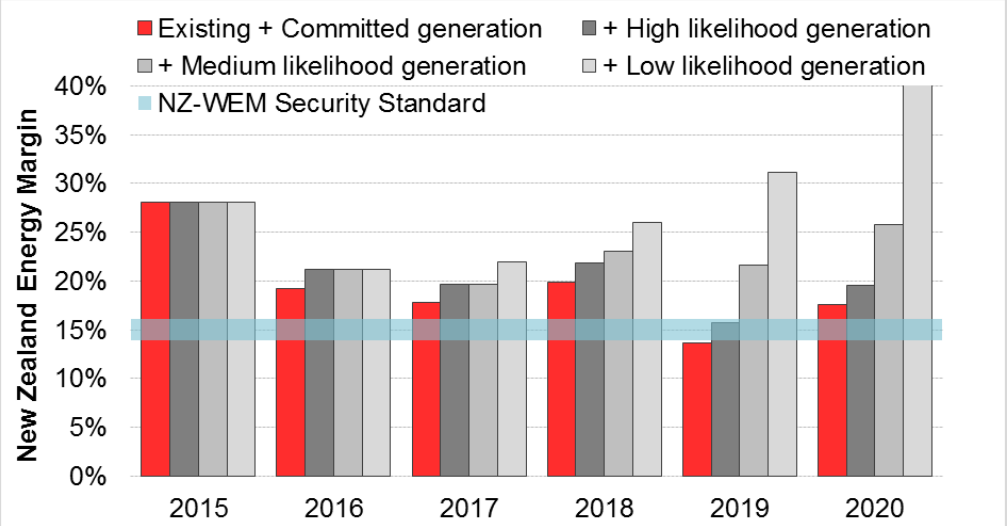

Figure 5: Winter Energy Margins - Thermal Decommissioning as announced and Tiwai exits from 2018

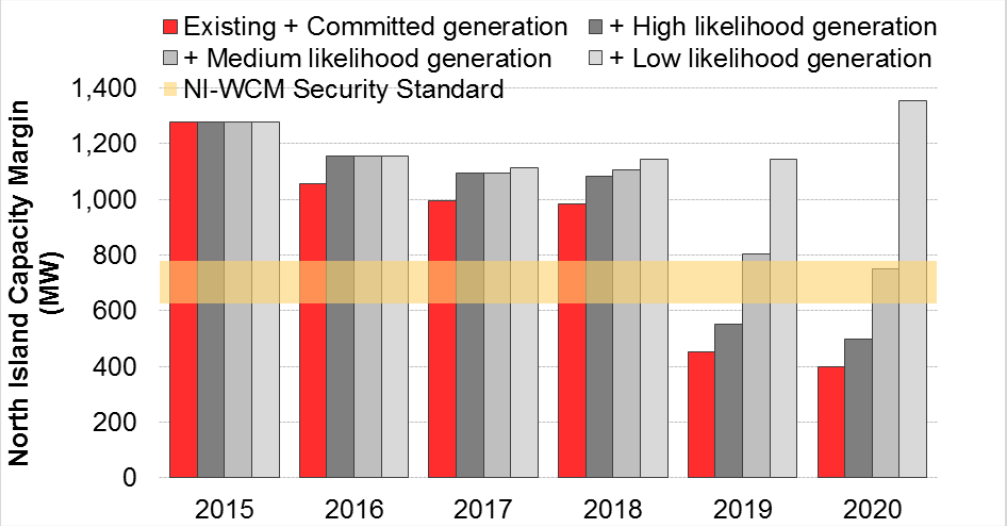

Figure 6: Winter Capacity Margins - Thermal Decommissioning as announced and Tiwai exits from 2018

4. FUTURE WORK

Update of the System Security Forecast

The 2015 System Security Forecast (SSF) update will be published in November. The SSF provides detailed information on the capability of the power system and where constraints and limits[10] may arise out to the end of 2017.

Power System Analysis of Huntly Rankine units in 2019

An assessment focused on understanding the limits of the power system in response to the removal of the Huntly Rankine units is currently being prepared. This analysis will be similar in form to the analysis summarised in section 2. The analysis is expected to be complete in early 2016.

Comprehensive Security of Supply analysis

An assessment focused on understanding the security of supply implications out to 2019 will be published in November. The goal of this analysis is to quantify the level of energy shortage risk the power system may face, and identify what may be required in order for the power system to avoid energy shortage[11]. This assessment will take into account the decommissioning of Otahuhu B, Southdown and Huntly. This work will be carried out using two complex market models: SDDP (PSR Inc.) and Emarket (Energy Link).

Grid Development

The Grid Development division within Transpower is assessing what grid investment may be required in light of the proposed changes to the power system. This work is being carried out collaboratively with the System Operator and other industry stakeholders. This work is currently at the scoping stage.

[10] Including, but not limited to, thermal and voltage stability limitations on the AC and DC power systems.

[11] For example how much new generation investment may be required, how much fuel (natural gas) is expected to be consumed and how much spilling of hydro energy is likely to occur.