Meeting Date: 21 August 2024

2024 ANNUAL SECURITY OF SUPPLY ASSESSMENT

SECURITY AND RELIABILITY COUNCIL

The 2024 annual Security of Supply Assessment, covering energy and capacity adequacy over a ten-year horizon

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

1. Background

The Security and Reliability Council is asked to consider the 2024 annual Security of Supply Assessment

1.1. The Security and Reliability Council's (SRC) functions include offering advice to the Electricity Authority on the security of the power system. One aspect of security is adequacy of generation investment to provide energy and capacity.

1.2. The system operator's annual Security of Supply Assessment (SOSA) is the primary source of information on adequacy of generation investment to provide energy and capacity over a time horizon of years. The 2024 SOSA provides a medium-term view of the balance between supply and demand in the New Zealand electricity system between 2024-2033.

1.3. The SRC is asked to consider the 2024 SOSA, so it can provide meaningful feedback to the system operator. The final version of the SOSA is attached as Appendix A (SRC summary paper) and Appendix B (full paper)). The system operator can incorporate feedback into:

1.3.1. future editions of the report; and

1.3.2. how the information is summarised and presented to the SRC

1.4. The secretariat notes that SRC members do not need to read the entire SOSA and offers the following guidance:

a) The SRC summary paper provides a short background to the SOSA and what it measures,

b) Section one (the Executive Summary in the full report) is essential reading,

c) Section four is relevant to the SRC, as it looks at a range of thermal generation scenarios, together with the renewable supply pipeline, estimating the required contribution from each to maintain the standards,

d) Section two may be useful for readers unfamiliar with SOSA reports, covering background and a summary of the methodology.

1.5. The system operator will attend the SRC meeting to answer any questions about the 2024 SOSA.

The SOSA framework

1.6. The security standards set by the Authority are:

a) a winter energy margin for New Zealand (NZ-WEM) of 14-16% greater than forecast energy consumption

b) a winter energy margin for the South Island (SI-WEM) of 25.5-30% greater than forecast energy consumption

c) a winter capacity margin for the North Island (WCM) of 630-780 MW greater than forecast peak demand (in MW).

1.7. The margins reflect that if under-supply occurs, there is an 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 surplus generation. While the risks are asymmetric, the margins represent an efficient level of generation oversupply that minimises overall cost to the country.

1.8. The results against the margins help inform stakeholders whether an efficient level of energy or capacity generation supply exists now and in future scenarios. 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.

1.9. There are no legislative consequences for generators not meeting the efficient margins; the margins are intended to be informative. 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.

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

1.11. The Authority provides certain assumptions that the system operator must use when preparing the annual assessment. These assumptions are published in the Security Standards Assumptions Document (SSAD).[1] The purpose of the SSAD is to help ensure that results against the margins are calculated in a way that is consistent with the derivation of the margins. 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.

Approach for 2024 SOSA

1.12. Before 2022, the system operator used four core scenarios for SOSA (low demand, medium demand, high demand, and gas constrained). Under that approach each scenario had a different 'underlying' demand growth rate (for winter only) and a different rate of uptake of electrification and distributed energy resource technologies.

1.13. Since 2022 the system operator has used a single reference scenario (reference case) that represents the resources potentially available to the power system over the 10-year assessment horizon. The assumptions and inputs for the reference case are based upon:

a) a market participant survey;

b) Transpower's demand forecast aligned with transmission and strategic planning

c) The Authority's Security Standards Assumptions Document (SSAD)[2]

d) Industry and MBIE gas information

e) Historical market behaviour and other available market information.

Assumptions

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[1] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.ea.govt.nz/documents/166/Security_standards_assumptions_document.pdf

[2] Security Standards Assumption Document

1.14. Key assumptions in the reference case:

a) Existing generation and industrial demand will not change unless decommissioning is publicly announced, and decommissioning activities are actively being pursued

b) A medium demand forecast

c) Tiwai remains

d) A “significant” amount of thermal generation is not decommissioned in the near term

e) Investment in upstream gas sector continues

f) The HVDC interconnector is not upgraded

1.15. Generation is divided into the following categories:

- Stage 1 - existing and committed
- Stage 2 – Stage 1 + consented, on hold
- Stage 3 – Stage 2 + consented, on hold, requiring reconsent
- Stage 4 – Stage 3 + consent expected.

Sensitivities

1.16. Sensitivities may also be applied to each scenario to reflect uncertain changes in supply and demand and represent what the system operator considers as plausible variations from the reference case. Examples include delayed build times for new generation (supply side) and demand growth and changes in peak demand (demand side).

1.17. The 2024 SOSA includes a greater level of demand response in the *increased demand response sensitivity* (100MW in both North and South Islands) reflecting the larger role demand response could play in managing the NI-WCM.

1.18. The 2024 SOSA explores the impact of additional long-term demand response on the NZ-WEM and SI-WEM by decreasing the demand by 2.5% and 5% respectively.

1.19. new sensitivity this year – *less operational flexibility* simulating what happens when intermittent wind and solar falls below average capacity factors at the same time as thermal generation becomes unavailable. The system operator notes the coordination challenge this presents.

1.20. Because of the large number of potential combinations of scenarios, the report only considers a subset in detail.

2. The key findings of the 2024 SOSA

2.1. As noted in the report overview (p6), there has been a **minor decrease in the demand forecast**, largely attributed to a lower North Island demand forecast.

2.2. There has been an **increase in the South Island demand forecast**, largely attributed to distributor’s forecasting expected step demand increases on their networks.

2.3. **The *existing supply* pipeline has changed** through an increase of approximately 200MW compared to 2023**,** with newly commissioned generation. The ***committed supply* pipeline** has also increased by approximately 160MW. While these indicate the supply pipeline is being developed, the report cautions uncertainty in the unconsented pipeline could result in project delays

2.4. In the 2023 SOSA **98% of the unconsented pipeline was made up of intermittent generation sources** (wind and solar), which “has a larger impact on increasing the energy margin than the capacity margin”. This measure is reflected as “*over 90%*” in the 2024 SOSA.

2.5. **The reference case for NI-WEM falls below the upper security standard by 2030**, for projects existing and committed, three years later than predicted in the 2023 SOSA. If consented projects are included, the standard is reached for the 10-year assessment horizon.

2.6. **The reference case for SI-WEM falls below the upper security standard by 2028**, for projects existing and committed, a year earlier than predicted in the 2023 SOSA. This is due to a higher demand forecast and no major increase in the South Island committed generation. If consented projects are included, the margin crosses the lower security standard in 2030.

2.7. **The reference case for the NI-WCM falls below the standard by 2027, for projects existing and committed.** This is mainly due to the supply pipeline being made up of intermittent generation, which has a lower contribution to peak capacity than controllable resources.

3. Questions for the SRC to consider

3.1. The SRC may wish to consider the following questions.

Q1. What are the SRC’s views on the 2024 SOSA results?

Q2. What comment or feedback does the SRC have for the system operator on its approach to, or findings of, the 2024 SOSA?

Q3. What further information, if any, does the SRC wish to have provided to it by the secretariat?

Q4. What advice, if any, does the SRC wish to provide to the Authority?

4. Appendices

4.1. Appendix A: System operator’s summary paper for the SRC

4.2. Appendix B: 2024 annual Security of Supply Assessment (SOSA) final version

Appendix A: System operator's summary paper for the SRC

Appendix B: 2024 annual Security of Supply Assessment (Final version)

Security and Reliability Council Paper

Meeting Date: 21 August 2024

Security of Supply Assessment 2024

1 Purpose

Transpower, as the system operator, published the final 2024 annual Security of Supply Assessment (SOSA) on 26 June 2024.[1] This paper summarises the SOSA's purpose, and the process followed for the 2024 SOSA.[2]

To support its function to provide independent advice to the Authority on reliability of supply issues, the SRC considers the SOSA each year. Transpower's Chantelle Bramley (EGM, Operations) and Ramu Naidoo (Market Operations Manager) will join the Council's August 2024 meeting to present and discuss the 2024 SOSA.

2 What we measure in the SOSA and why

The purpose of the SOSA is to inform risk management and investment decisions by market participants, policy makers and other stakeholders. Transpower, as the system operator, is Code-obligated to publish the SOSA annually. Many of the assumptions used are prescribed by the Electricity Authority (Authority) in the Security Standards Assumptions Document (SSAD).[3]

The SOSA provides a ten-year assessment (2024 to 2033) of the balance between supply and demand in the Aotearoa New Zealand electricity system. Generally, an excess of supply (i.e. available generation) is maintained to ensure that demand can always be met. This excess is referred to as the margin (Figure 1).

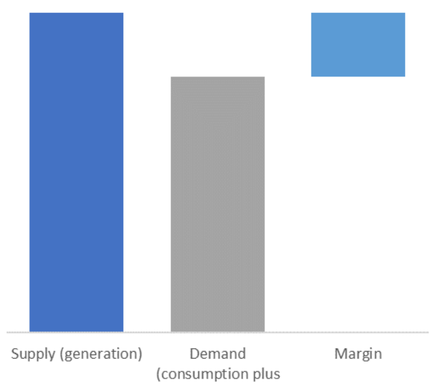

Figure 1: Margin visualisation

The SOSA evaluates three security of supply margins:

- **New Zealand Winter Energy Margin (NZ-WEM):** adequacy of generation to meet expected national electricity demand under extended dry periods across the winter months

[1] [Security of Supply Annual Assessment | Transpower]
[2] [Security of Supply Assessment 2024 (transpower.co.nz)]
[3] [Security Standards Assumptions Document (ea.govt.nz)] The Authority has recently announced it will consult on an update to the SSAD with the intention to have a new SSAD in place before winter 2025. Our work to produce the 2025 SOSA will proceed in parallel.

- **South Island Winter Energy Margin (SI-WEM):** adequacy of generation and north-to-south transmission capacity to meet expected South Island electricity demand under extended dry periods across the winter months, and
- **North Island Winter Capacity Margin (NI-WCM):** adequacy of peaking generation and south-to-north transmission capacity to meet peak winter demand.

The three margins presented in the assessment cover the key areas of risk for the electricity system. The North Island and South Island are treated differently because around two thirds of installed hydro generation capacity and nine tenths of controlled hydro storage are in the South Island.

The margins are then compared against the security of supply standards as specified in the SSAD. The standards represent an efficient level of reliability - that is, where the expected cost of shortage is equal to the expected cost of new generation. As an example, the national cost-benefit analysis conducted by the Authority when producing the current NI-WCM security standards determined that up to 22 hours per annum of shortfall (i.e. insufficient capacity to supply the reserve requirements and sometimes the actual load on the system) is economic before additional investment in peaking generation is warranted.[4]

Falling below the lower security standards does not equate to electricity shortage. Rather, it implies that investment in new generation would result in an efficient increase in reliability. It can also be interpreted as representing the likelihood of electricity shortage—the higher the actual margin observed the less likely electricity shortage will be all things being equal.

The key inputs into security of supply margin assessments are information about generation availability (existing and the new supply pipeline) provided by participants, Transpower forecasts of demand, and assumptions specified by the Authority (SSAD). The margins are assessed under a reference case and plausible variations from the reference case (sensitivities) that could occur over the 10-year assessment horizon to understand:

- when, and under what circumstances, the capacity and energy margins could fall below security standards if no new supply projects are built (other than those already committed); and
- whether the pipeline of new supply projects (consented and unconsented) is adequate to maintain security standards assuming a stable investment environment and adequate market incentives.

[4] Security Standards Assumptions Document, Table 2

3 2024 SOSA consultation

As part of the SOSA process, we complete two rounds of consultation. The first round is to seek feedback on the proposed reference case and sensitivities. We received four submissions. These are published on our webpage along with our response to the feedback. [5]

We completed the second consultation in May 2024 when we published a draft 2024 SOSA for feedback. The two submissions we received are published on our webpage, along with our 2024 SOSA – Summary of Submissions with Responses, which sets out the feedback we received and the changes we have made to finalise the 2024 SOSA.

4 Key findings from the 2024 SOSA

The 2024 SOSA assessment horizon covers the period 2024 to 2033. A summary of the key results from the 2024 SOSA is provided below.

New Zealand Winter Energy Margin (NZ-WEM):

- The reference case crosses the standard in 2030 with existing and committed generation. Development of more consented projects in the pipeline is needed to maintain the margins above the standards over the next 10 years.
- If demand were to grow faster than the reference case, development of the consented pipeline could be needed as early as 2029 (one year earlier than the reference case).
- Early thermal exit or insufficient fuel for dry-year thermal operation could accelerate the margins crossing the standards, requiring more rapid development of consented and unconsented generation resources to maintain the margins above the standard.
- The NZ-WEM could drop below the standards in the near term (2025) unless there is sufficient gas flexibility from industrial gas users to support increased gas-fired electricity generation during dry-years. This aligns with current observations due to gas constrained supply in the market. Reduced gas consumption from industrial gas users is needed to support increased thermal backup generation under the current low hydro inflow conditions.

South Island Winter Energy Margin (SI-WEM):

- The reference case crosses the lower security standard in 2028 with existing and committed generation projects. Development of consented and currently unconsented generation is needed to maintain the margins above the standards over the next 10 years.
- A step increase in demand could require development of the consented pipeline as early as 2026.

[5] Security of Supply Annual Assessment | Transpower

- Lower available gas supply could require development of the consented generation pipeline as early as 2026, or the unconsented pipeline as early as 2029.
- Unlocking greater transfer capability from north-to-south can help North Island resources support the SI-WEM.

North Island Winter Capacity Margin (NI-WCM):

- The 2024 SOSA concludes, as did the 2023 SOSA, that new North Island capacity supply is required more urgently than New Zealand or South Island energy supply.
- The reference case crosses the lower security standard in 2027 with existing and committed generation projects. Development of consented and currently unconsented generation and batteries is needed to maintain the margins above the standards over the next 10 years.
- The "Constrained Operational Capacity" sensitivity indicates a current margin below the standards. This reflects the challenges of integrating increased intermittent generation with slow start thermal plant. The scenario models an unforecast drop in intermittent generation at a peak with insufficient time for slow-start thermal to respond and one large slow-start thermal unit unavailable. Because this sensitivity assumes a low probability event, it illustrates the impact on a single peak (and not the impact across a winter).
- Additional demand response can delay the crossing of the lower security standard. Given demand response does not require consenting and could enter the market within one or two years, this could be an effective means of contributing to the NI-WCM in the near term.
- A key reason for the capacity margin falling below the lower security standard earlier than the energy margins is because the supply pipeline is primarily made up of intermittent generation, which has a lower contribution to peak capacity than controllable resources. This highlights an increased need for flexible resources in the supply pipeline - beyond dispatchable generation, these can include batteries, demand response, non-generation reserve and upgrades to increase the HVDC northward capacity.

TRANSPOWER

Security of Supply Assessment 2024

System Operator

Version: 2.0

Date: 26 June 2024

Version	Date	Change
1.0	7 May 2024	First release
2.0	26 June 2024	Final release

IMPORTANT

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Contents

1.0 Executive Summary

The purpose of the Security of Supply Assessment (SOSA) is to inform risk management and investment decisions by market participants, policy makers, and other stakeholders.

Transpower, as the system operator, publishes the SOSA annually. It provides a 10-year assessment (2024 to 2033) of the balance between supply and demand in the New Zealand electricity system.

Three security of supply margins are evaluated,[1] the:

1. **New Zealand Winter Energy Margin (NZ-WEM)**; adequacy of generation to meet expected national electricity demand under extended dry periods across the winter months;
2. **South Island Winter Energy Margin (SI-WEM)**; adequacy of generation and north-to-south transmission capacity to meet expected South Island electricity demand under extended dry periods across the winter months; and
3. **North Island Winter Capacity Margin (NI-WCM)**; adequacy of peaking generation and south-to-north transmission capacity to meet peak winter demand.

The SOSA analysis assesses these three security of supply margins against security standards set by the Electricity Authority (the Authority). These security standards are specified in the Code[2] with further details provided in the Security Standards Assumptions Document (SSAD).[3] The current standards are:

1. NZ-WEM: 14-16%
2. SI-WEM: 25.5-30%
3. NI-WCM: 630-780 MW

The standards represent an efficient level of reliability[4]—that is, where the expected cost of shortage is equal to the expected cost of new generation. As an example, the national cost-benefit analysis conducted by the Authority when producing the NI-WCM security standards determined that up to 22 hours per annum of energy or reserve shortfall (as a result of capacity shortage) is economic before additional investment in peaking generation is warranted.

However, falling below the lower[5] security standards does not equate to electricity shortage. Rather, it implies that investment in new generation would result in an efficient increase in reliability. It can also be interpreted as representing the likelihood of electricity shortage—the higher the actual margin observed the less likely electricity shortage will be all things being equal.

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[1] Further information on the margin assessment methodology is provided in Appendix 1.

[2] Part 7, Clause 7.3(2)

[3] Electricity Authority, Security Standards Assumptions Document

[4] The range represents the fact that this efficient level should not be considered as a single number due to uncertainties in key assumptions when determining these standards.

[5] The lower standard being 14% for NZ-WEM, 25.5% for SI-WEM and 630 MW for NI-WCM.

The analysis assesses the energy and capacity margins against the three security standards using the supply pipeline based on information provided by market participants, and does not analyse or consider other aspects of future investment such as:

- the availability of transmission and distribution network capacity;
- the deliverability of planned new-build generation; or
- the commercial viability or market incentives required for resources to be developed.

More detailed security of supply forecasts that highlight shorter term timeframes and operational risk include the Electricity Risk Curves, New Zealand Generation Balance, System Security Forecast, various market insight publications,[6] and the Weekly Summary.[7]

Changes to Key Inputs for the SOSA 2024

After consultation on the Draft 2024 SOSA, we have amended the final 2024 SOSA to include a greater level of demand response in the *increased demand response* sensitivity.

There has been a minor decrease in the national demand forecast compared to that reported in the 2023 SOSA, largely attributed to a lower North Island demand forecast where existing large industrial consumption and the quantity of step demand increases have been revised down[8].

There has been an increase in the South Island demand forecast compared to that reported in the 2023 SOSA. This is largely due to forecasts provided by distributors of expected step demand increases on their networks related to electrification and decarbonisation initiatives.

The supply pipeline has changed compared to that reported in the 2023 SOSA. The existing pipeline has increased by approximately 200 MW with newly commissioned generation. The committed[9], supply pipeline has also increased by approximately 160 MW. The 'consent expected' pipeline (Stage 4) has decreased in the earlier years of the analysis period but increases in later years compared to the 2023 SOSA. These movements indicate the supply pipeline is being developed, and continues to expand, but also that the uncertainty in the unconsented pipeline could result in project delays.

Over 90% of the unconsented supply pipeline is made up of intermittent generation sources (wind and solar). Intermittent generation has a larger impact on increasing the energy margin than the capacity margin. This highlights the need for investment in flexible

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[6] Market insights | Transpower

[7] Table 8 in Appendix 6 provides a breakdown of the purpose of each report.

[8] These step demand loads are largely signalled by distributors although we do have some modelling to estimate these step changes as well.

[9] The committed supply pipeline refers to projects that are consented and committed to being developed (i.e. projects that are consented and underway or proceeding).

peaking capacity such as peaking generation, batteries and demand response to maintain the capacity margins above the standards.

Summary of 2024 Margin Analysis

New Zealand Winter Energy Margin: The reference case[10] (which represents the resources available to the market) falls below the lower security standard by 2030 when considering only those new supply projects that are existing and committed. This is later in the analysis period compared to the 2023 SOSA which suggested the security standard would not be met from 2027 onwards. This change in the 2024 SOSA is due to a reduction in the demand forecast and a developing supply pipeline (i.e. moving from consented to being committed projects).

When including all consented projects, the margin stays above the security standards for the 10-year assessment horizon. This shows that the market has consents to build resources that could maintain the NZ-WEM for the 10-year assessment horizon. This also assumes a rate of build that is significantly higher than seen in recent years.

We explore the impact of several variations to the reference case assumptions through sensitivities. These sensitivities reflect variations in demand, delays to generation project commissioning, increased HVDC capability and reduction in fossil-fuelled generation capability.

The key insights from analysing these sensitivities are:

1. Unless there is sufficient development of the consented and unconsented pipeline to bring more supply to market, we are dependent on thermal generation[11] (including sufficient fuel for its operation during dry years) to maintain the NZ-WEM above the lower security standard over the duration of the assessment horizon. The required contribution from the supply pipeline reflects an increase in the rate of renewable build when compared to the rate of build seen in recent years.

   There are four key sensitivities that reflect a transition away from thermal generation and its fuel supply. These are underpinned by:
   a. intentions signalled by the market to decommission or not develop new thermal generation; and
   b. risks to ongoing thermal fuel development and flexibility highlighted by industry groups.[12]

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[10] Section 2.2 provides a definition of the reference case.
[11] "Thermal generation" in this analysis refers exclusively to fossil-fuelled generation (diesel, natural gas, or coal). Currently our analysis does not explore future supply options that may utilise thermal generation technologies that are carbon zero in some form. In future when considering other thermal sources such as bio-fuelled generation, this will be specified.
[12] Gas Market Settings Investigation and Gas Supply and Demand Study

The reduced gas availability sensitivities highlight that the NZ-WEM could drop below the standards in the near term (2025) unless there is sufficient gas flex from industrial gas users to support increased gas-fired electricity generation during dry-years.[13] New generation investment is needed in the market to alleviate these reduced gas availability risks pulling the NZ-WEM below the standards.

2. Lower than expected growth in demand or large scale dry-year demand response could delay the NZ-WEM crossing the lower security standard to outside of the assessment horizon.
3. If demand were to grow faster than the reference case, development of the consented pipeline could be needed as early as 2029 (one year earlier than the reference case).

South Island Winter Energy Margin: the reference case falls below the lower security standard by 2028 based on the existing and committed generation. This is two years earlier than in the 2023 SOSA, due to a higher demand forecast and no major increase in the South Island committed generation. The ability for the North Island supply to support the South Island is constrained by the north-to-south transfer capability, including the HVDC link.

When including consented projects, the reference case shows the margin crossing the lower security standard in 2030. Substantial development of the unconsented pipeline is needed to maintain security standards for the 10-year assessment horizon.

The key insights from analysing the impacts of the sensitivities on the SI-WEM are:

1. A step increase in demand could require development of the consented pipeline as early as 2026.
2. A lower available gas supply could require development of the consented pipeline as early as 2026, or the unconsented pipeline as early as 2029.
3. In the absence of sufficient South Island supply and demand-side resources to support the SI-WEM, unlocking greater transfer capability from north-to-south can help North Island resources support the SI-WEM. This involves increased offering of South Island reserves and removing transmission constraints restricting north-to-south transmission.

Together these show that if Tiwai remains[14], even with the increased demand response, there is a reliance on thermal back up generation to manage dry year risks, until additional renewable generation and/or South Island long-duration demand response comes to market. Increasing north-south transfer capability can help reduce the amount of generation needed to manage dry-year risk in the South Island. If Tiwai exited no

[13] This gas demand flex has been seen previously (2021) and during H1 2024 with reduced hydro inflows and reduced gas supply.
[14] Tiwai remaining is now looking more likely with the recently announced conditional contract between Tiwai and several generating companies. Given some conditions are still outstanding at the time of this report, we've have maintained "Tiwai exit" as a sensitivity. A "Tiwai exit" sensitivity could also be a proxy for large scale demand response in the South Island.

further investment outside of the existing and committed pipeline would be required to maintain the SI-WEM above the standards over the assessment horizon.

North Island Winter Capacity Margin: The reference case falls below the lower security standard by 2027 when considering only existing and committed generation.

A key reason for the capacity margin falling below the lower security standard earlier than the energy margins is because the supply pipeline is primarily made up of intermittent generation, which has a lower contribution to peak capacity than controllable resources. This highlights an increased need for flexible resources in the supply pipeline.

All committed and consented projects are needed to commission as planned to maintain the NI-WCM above the lower security standard until 2029. Beyond 2029, additional projects which do not currently have consents will be required to maintain the NI-WCM above the lower security standard over the 10-year assessment horizon.

Some of these resources have a greater contribution to the peak capacity margin such as non-intermittent generation, batteries and demand response. Some resources can be developed more quickly than others (e.g. demand response does not need to be consented). The building of new resources that can provide a high contribution to the capacity margin and ideally high levels of flexibility, such as fast start generation, storage, or demand response, is needed more urgently than energy.

We explore the impact of several variations to the reference case through sensitivities. The key insights from these sensitivities are:

1. When there is low thermal unit commitment,[15] combined with materially less wind generation than forecast, the NI-WCM is operating below the security standards today. This is shown by the *constrained operational capacity* sensitivity to demonstrate the operational and market co-ordination challenge of integrating increased intermittent generation with slower start thermal plant. These issues were explored in the System Operator's Winter Review and Outlook papers.[16]
2. The *low demand growth* sensitivity had little impact on the NI-WCM and shows the NI-WCM still crosses the lower security standard in 2027.
3. The *high demand growth* sensitivity caused the NI-WCM to cross the lower security standard in 2026, one year earlier than the reference case.
4. The *increased demand response* sensitivity (starting at 200 MW)[17] delayed the crossing of the lower security standard by one year to 2028. Given demand response does not

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[15] "Unit commitment" refers to the process of deciding when and which generating units at each power station should start-up and shutdown in advance of the anticipated need when taking the technical constraints, potential costs and expected revenue into account.

[16] See System Operator Winter Review and System Operator Winter Outlook

[17] 200 MW was the average demand response provided by distribution companies during low residual conditions in winter 2023.

require consenting and could enter the market within one or two years, this could be an effective means of contributing to the NI-WCM in the near term.

5. Under the existing and committed supply, the sensitivities testing reduced thermal unit availability and gas supply, show that from 2025 we have an increased dependence on thermal generation to maintain the NI-WCM above the lower security standard.
6. Reducing the contribution of thermal generation would require development of resources that contribute significantly to the NI-WCM in the unconsented supply pipeline and beyond.[18]
7. All the sensitivities show there is a lack of renewable, flexible peaking capacity and signal a clear need for new resources that have a significant contribution to the NI-WCM in the near term. Beyond dispatchable generation, these can include batteries, demand response, non-generation reserve or upgrades to increase the HVDC northward capacity.

The NI-WCM analysis highlights the increased capacity risks now with the current plant mix and the need for a step increase in flexible resources to enter the market to manage these risks. These capacity risks will increase with the addition of more intermittent generation which is the major proportion of the supply pipeline. Uncertainties in future thermal availability (including with reduced fuel) can further exacerbate the peak capacity risks and the need for additional flexible resources in the supply pipeline to manage these peak capacity risks over the next decade.

A short summary of the key results from the 2024 SOSA is shown below.

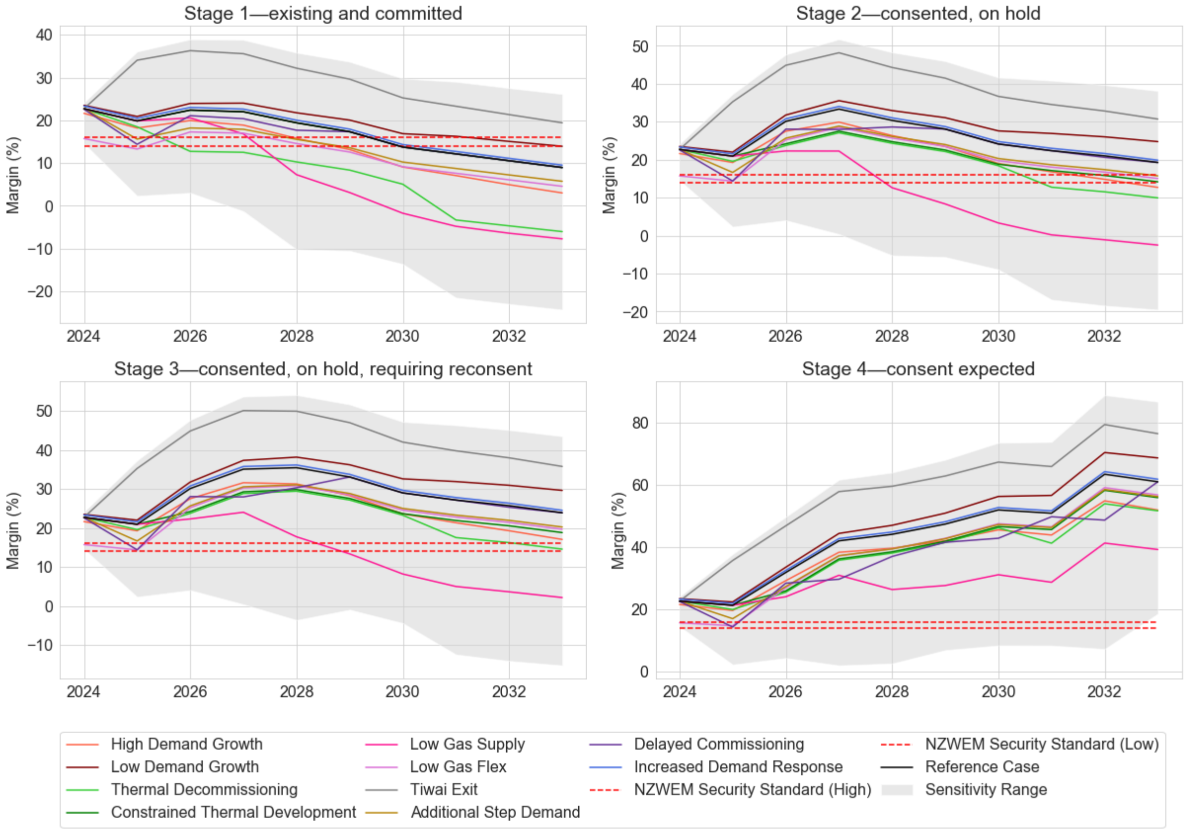
NZ-WEM

- The reference case crosses the standard in 2030 with existing and committed generation. Development of further consented projects are needed to maintain the margins above the standards over the next 10 years.
- Early thermal exit or insufficient fuel for dry-year thermal operation could accelerate the margins crossing the standards, requiring more rapid development of consented and unconsented generation resources to maintain the margins above the standard.
- The NZ-WEM could drop below the standards in the near term (2025) unless there is sufficient gas flex from industrial gas users to support increased gas-fired electricity generation during dry-years.
- If demand were to grow faster than the reference case, development of the consented pipeline could be needed as early as 2029 (one year earlier than the reference case).

[18] While we recognise thermal fuel supply can have an impact on short term capacity, it is less material or quantifiable than its impact on maintaining the NZ-WEM.

- Tiwai exit[19] could delay the NZ-WEM crossing the lower security standard to outside of the assessment horizon.

Figure 1: New Zealand Winter Energy margins for the reference case and all sensitivities



SI-WEM

- The reference case crosses the lower security standard in 2028 with existing and committed generation projects. Development of consented and currently unconsented generation is needed to maintain the margins above the standards over the next 10 years.
- A step increase in demand could require development of the consented pipeline as early as 2026.
- If Tiwai exited, no further investment outside of the existing and committed pipeline would be required to maintain security standards over the assessment horizon.
- Lower available gas supply could require development of the consented pipeline as early as 2026, or the unconsented pipeline as early as 2029.

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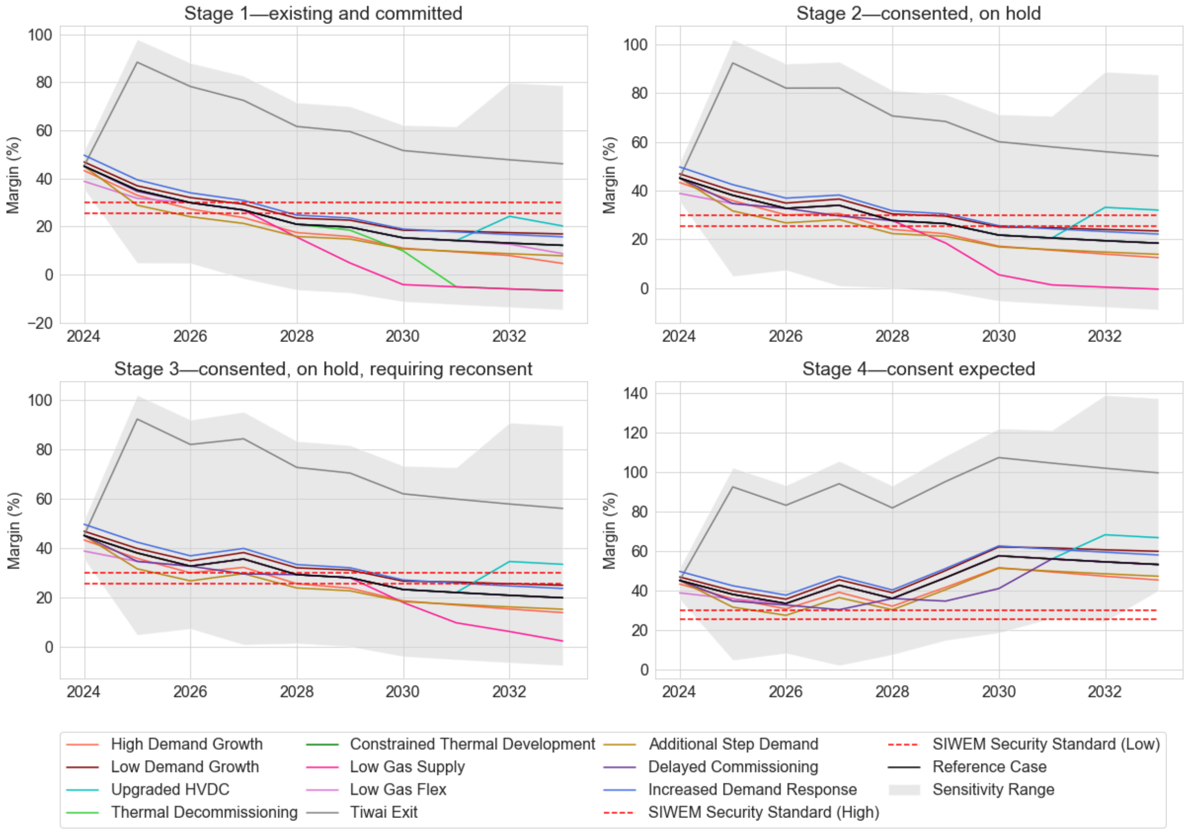
[19] As noted earlier this sensitivity is maintained in the SOSA but is now considered less likely to occur over the assessment horizon given the new conditional contract between Tiwai and several generators. Given this contract is still conditional at the time of writing this report, we have maintained "Tiwai exit" as a sensitivity.

- Unlocking greater transfer capability from north-to-south can help North Island resources support the SI-WEM.

Figure 2: South Island Winter Energy margins for the reference case and all sensitivities



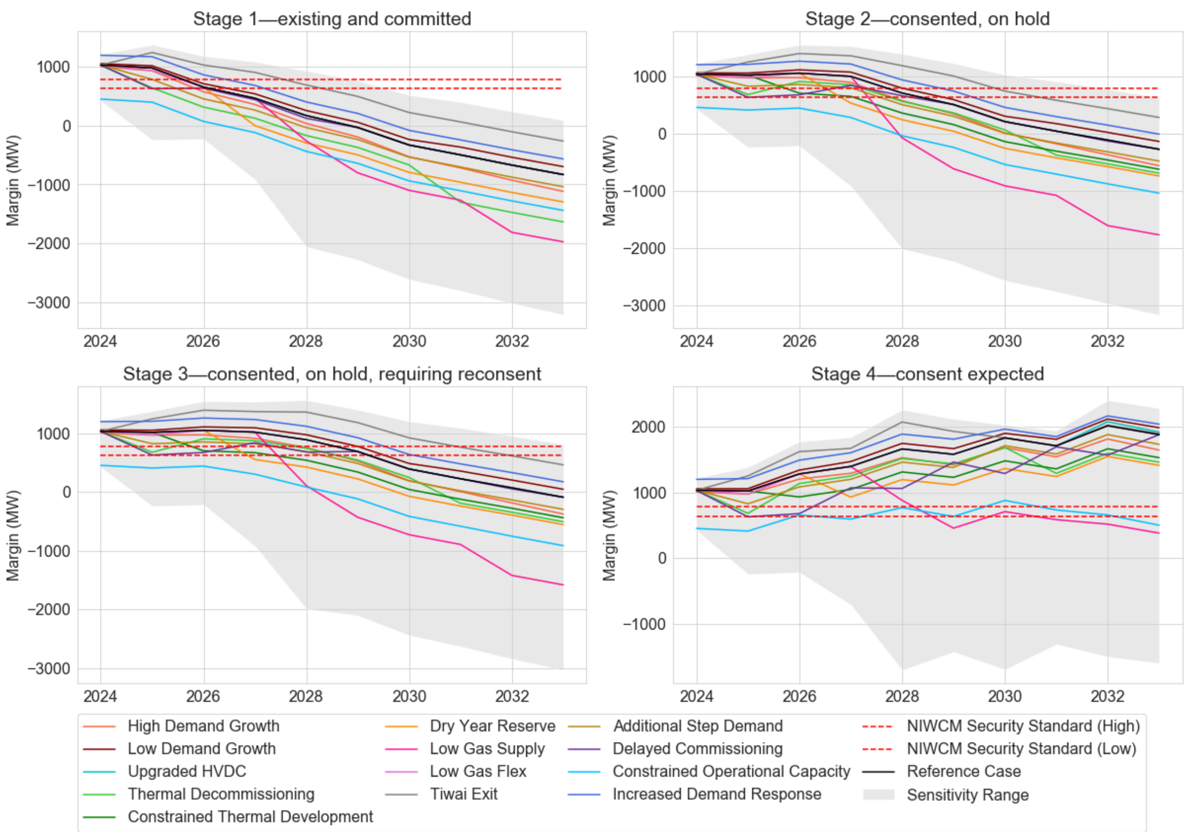
NI-WCM

- The reference case crosses the lower security standard in 2027 with existing and committed generation projects. Development of consented and currently unconsented generation and batteries are needed to maintain the margins above the standards over the next 10 years.
- Additional demand response can delay the crossing of the lower security standard. Given demand response does not require consenting and could enter the market within one or two years, this could be an effective means of contributing to the NI-WCM in the near term.
- Operational co-ordination challenges (i.e. lower levels of unit commitment with lower wind) indicate current margins below the standards[20].

[20] These challenges involve integrating increased intermittent generation with slower start thermal plant. This can lead to scenarios with lower levels of committed slower start thermal plant and intermittent generation over peak load periods.

- The low demand growth sensitivity had little impact on the NI-WCM and shows the NI-WCM still crosses the lower security standard in 2027.
- The high demand growth sensitivity caused the NI-WCM to cross the lower security standard in 2026, one year earlier than the reference case.
- All the sensitivities show there is a lack of renewable, flexible peaking capacity and signal a clear need for new resources that have a significant contribution to the NI-WCM in the near term. Beyond dispatchable generation, these can include batteries, demand response, non-generation reserve and upgrades to increase the HVDC northward capacity.

Figure 3: North Island Winter Capacity margins for the reference case and all sensitivities



2.0 Methodology, Reference Case and Sensitivities

2.1 Methodology

2.1.1 Winter Margins

This assessment provides a 10-year view of the balance between supply and demand in the New Zealand electricity system. It forecasts:

- the Winter Energy Margins for New Zealand (NZ-WEM) and the South Island (SI-WEM). These are winter energy supply, in gigawatt-hours (GWh), divided by winter energy demand, in GWh. The margins are expressed as a percentage of total demand; and
- the North Island Winter Capacity Margin (NI-WCM).[21] This is the sum of North Island supply capacity, less the expected peak demand, plus surplus South Island supply capacity able to be sent via the HVDC link to the North Island. The margin is expressed as a megawatt (MW) value.

Winter is defined as the period from April to October for the NI-WCM, and April to September for the NZ-WEM and SI-WEM.

The NZ-WEM and SI-WEM assess whether it is likely there will be an adequate level of supply and, in the case of the South Island, HVDC south transmission capacity, to meet expected electricity demand during the winter. The NI-WCM assesses whether it is likely there will be adequate supply and HVDC north transmission capacity to meet North Island winter peak demand.

In the context of this assessment the term *supply* includes grid connected generation, embedded generation, hydro storage and batteries.

2.1.2 Security Standards

The Authority defines security standards as part of its responsibility to ensure that the regulatory environment promotes an efficient level of reliability. The standards represent an efficient level of reliability—that is, where the expected cost of shortage is equal to the expected cost of new generation.

The current security standards specified in the Code[22] with further details provided in the Security Standards Assumptions Document (SSAD)[23] are:

- a NZ-WEM of 14–16%;

[21] Note that our analysis does not make allowances for spinning reserve—that is, the peak demand is not increased by the quantity of reserves required. This means the subsequent margin represents excess supply prior to the provisioning of reserves.
[22] Part 7, Clause 7.3(2)
[23] Electricity Authority, Security Standards Assumptions Document

- a SI-WEM of 25.5–30%; and
- a NI-WCM of 630-780 MW.[24]

Falling below the lower[25] security standards does not equate to electricity shortage. Rather, it implies that investment in new generation would result in an efficient increase in reliability. It can also be interpreted as representing the likelihood of electricity shortage—the higher the actual margin observed the less likely electricity shortage will be all things being equal.

2.1.3 Our Assessment

Our assessment evaluates the capacity and energy margins and compares these against the Authority's security standards. We do this for both existing generation and the pipeline of new supply projects that could be potentially built. The objectives of the assessment are to understand:

- when, and under what circumstances, the capacity and energy margins will fall below security standards if no new supply projects are built (other than those already committed); and
- whether the pipeline of new supply projects is adequate to maintain security standards assuming a stable investment environment and adequate market incentives.

While our analysis identifies when a project *could* be developed, we do not attempt to forecast *if* or *when* new supply projects will be developed. Our assessment considers a reference case, valid sensitivities and valid sensitivity combinations.

2.1.4 Consultation Outcomes

As part of the SOSA process, we complete two rounds of consultation. The first round is to seek feedback on the proposed reference case and sensitivities. Published on our webpage are the four submissions we received this year along with our response to the feedback.

We completed the second consultation in May 2024 when we published a draft 2024 SOSA for feedback. The two submissions we received are published on our webpage, along with our 2024 SOSA – Summary of Submissions with Responses, which sets out the feedback we received and the changes we have made to finalise this 2024 SOSA.

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[24] The ranges represent the fact that this efficient level should not be considered as a single number due to uncertainties in key assumptions when determining these standards.
[25] The lower standard being 14% for NZ-WEM, 25.5% for SI-WEM and 630 MW for NI-WCM.

2.2 Reference Case

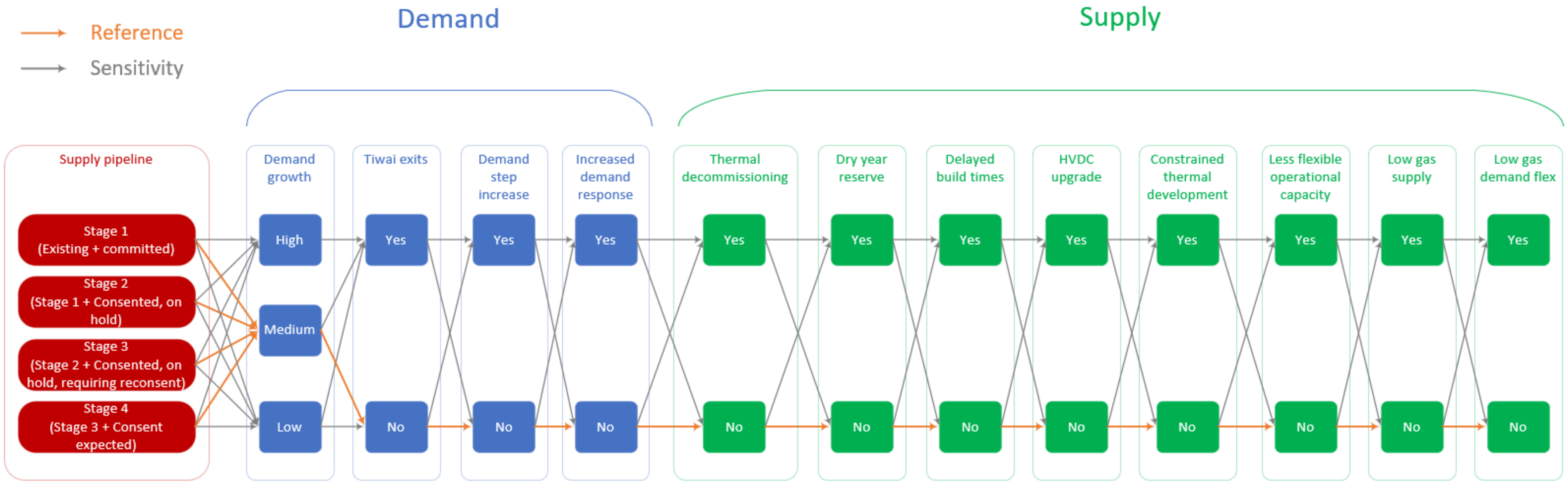
We have used a single reference scenario known as the reference case for the future New Zealand electricity system that represents the resources potentially available to the power system over the 10-year assessment horizon. The reference case represents what the market could develop; not necessarily what it will develop. In making this representation, we used a fixed set of assumptions, and then adjusted these using several key variables, or sensitivities, to test a range of plausible deviations from the reference case and the impact these have on the future capacity and energy margins.

In the reference case we assume existing generation and industrial demand will not change unless decommissioning is publicly announced and decommissioning activities are actively being pursued. The reference case assumes a medium demand forecast and that during the 10-year assessment horizon Tiwai remains, a 'significant' amount of thermal generation is not decommissioned in the near term, investment in the upstream gas sector continues and the HVDC interconnector is not upgraded.

Section 2.3 defines the sensitivities our analysis explores. In addition to applying individual sensitivities, we have applied valid combinations of sensitivities to the reference case for a more comprehensive range of futures. Figure 4 below provides an illustration of the combinations of sensitivities.

Stakeholders are invited, and may be better placed, to make their own decisions as to which sensitivities should have more weighting than others.

Figure 4: Assessed supply pipeline stages and sensitivities



The orange arrows represent the combination of key variables that make up the reference case. The grey arrows represent the potential combinations of sensitivities.

2.2.1 Detailed Reference Case Assumptions

We have used the following key assumptions for the reference case.

Demand Growth

Our reference case focuses on a *medium* rate of acceleration of electrification across the economy and growth of distributed energy resources.[26] To achieve this, transport electrification (electric vehicles), process heat electrification, solar photo voltaic (PV) and small-scale batteries are specifically modelled in this scenario.[27]

An underlying demand growth is expected within the existing sectors of the economy. It includes the impact of expected population and economic growth, ongoing electricity efficiency gains (including from urban densification), and ongoing sectoral changes in energy intensity and demand in line with recent trends.

Figure 5 shows the winter energy and peak demand forecasts. They include the demand forecasts used in the 2023 SOSA to show the relative change in energy and peak demand this year compared to last year. The NI-WCM is measured against the North Island winter peak demand forecast; the South Island winter peak demand forecast is used as part of this calculation as it impacts the HVDC transfer.

The forecast of NZ winter energy demand used in this year's SOSA has decreased compared to last years. A decrease is also observed in the forecast of North Island peak demand. These changes are largely attributed to a decrease in customer notified step loads, expected industrial load reduction and a decrease in the base demand forecast.

Despite the forecast of national energy and North Island peak being lower than last year, the South Island winter energy demand and South Island peak demand forecasts have generally increased from the 2023 SOSA (excluding 2024). These are mainly due to changes in customer notified step demand with increases expected within the Canterbury, Otago and Southland regions as a result of residential and commercial developments, process heat electrification and decarbonisation in the food processing/dairy industries.

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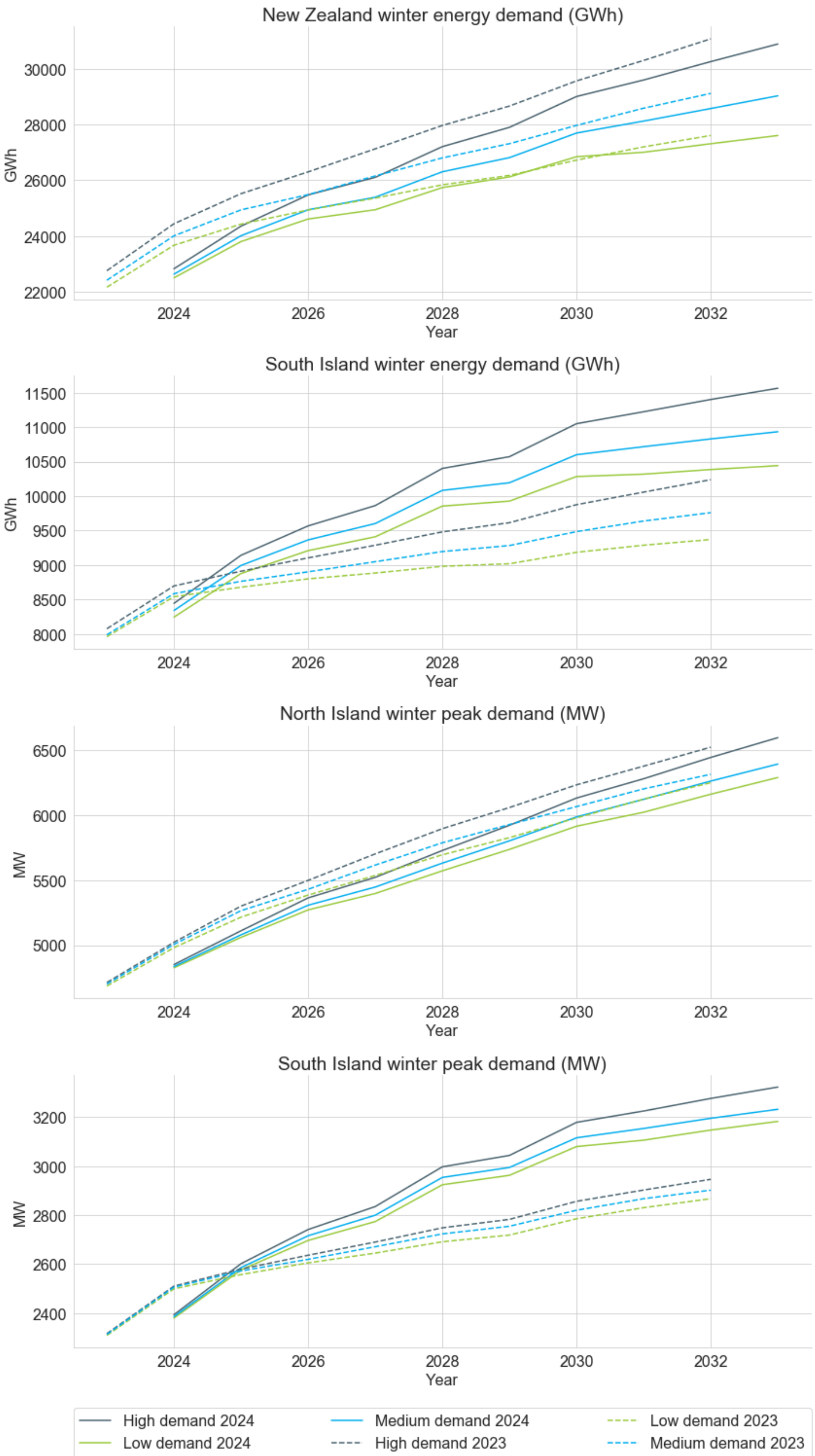
[26] Distributed energy resources provide energy and capacity at a household level, offsetting grid demand. For this reason, the expected rate of uptake is modelled in the demand forecast rather than as a supply sensitivity.
[27] Appendix 2 sets out the demand forecast modelling process.

Figure 5: New Zealand winter energy, North Island winter peak and South Island winter peak demand forecasts compared to the 2023 Security of Supply Assessment



Tiwai Smelter Load

The reference case includes the Tiwai smelter load over the 10-year assessment horizon. The new long-term conditional contracts between Tiwai and several generators increases the likelihood of Tiwai remaining over the 10-year assessment horizon. There are still some outstanding conditions at the time of producing this report hence we maintained Tiwai exit as a sensitivity in this analysis as discussed below.[28]

HVDC Capacity

The reference case assumes the HVDC maximum transfer capacity will not be upgraded in the 10-year assessment horizon. The Authority's SSAD describes the capacity of the HVDC.

Supply Pipeline Stages

As in the 2023 SOSA, the supply pipeline is based on information provided by market participants on a confidential basis. The reference case is analysed across the four supply pipeline stages shown in Table 1.

Table 1: Supply pipeline stages

Stage	Short description	Long description
Stage 1	Existing and committed	Existing, consented and committed to being developed[29]
Stage 2	Stage 1 + consented, on hold	Includes: • existing, consented and committed to being developed • consented and on hold/awaiting market conditions to change
Stage 3	Stage 2 + consented, on hold, requiring reconsent	Includes: • existing, consented and committed to being developed • consented and on hold/awaiting market conditions to change • consented and on hold/awaiting market conditions to change—consent revision or reconsenting will be required
Stage 4	Stage 3 + consent expected	Includes: • existing, consented and committed to being developed • consented and on hold/awaiting market conditions to change • consented and on hold/awaiting market conditions to change—consent revision, or reconsenting will be required • not consented, but likely to seek a consent in the next two years

[28] See Section 2.3.2.
[29] These are projects that are consented and underway or proceeding.

We assume existing generation remains available unless decommissioning is publicly announced, and decommissioning activities are being actively pursued.

Figure 6 shows the contribution of the supply pipeline stages for both energy and capacity. New supply project timings are based on commissioning dates provided by market participants, and if a date has not been provided, we have used an estimated earliest potential build date.[30] Any subplots in Figure 6 should not be interpreted as a forecast of new generation build.

The four subplots in Figure 6 titled *Stage 3 – Consented, on hold, requiring reconsent* show the potential winter energy and capacity capability from existing and committed generation, as well as consented or requiring reconsent supply projects. The existing and committed generation is shown in the grey bars and the pipeline of new supply projects that are consented but on hold (some requiring reconsent) are shown in the other colours. Here we see a range of technologies being considered under Stage 3 including geothermal, thermal, wind and solar with the majority of these expected in the North Island.

The four subplots in Figure 6 titled *Stage 4 – Consent expected* show the potential winter energy and capacity capability from Stage 3 but also including unconsented supply projects (where consent is likely to be sought within the next two years).

The large increase in potential contribution to winter energy and capacity margins in Stage 4 (compared to Stage 3) indicates the significant interest in new supply resources (majority in the North Island) beyond those already consented.[31] The additional unconsented projects under Stage 4 include solar, wind (onshore and offshore) as well as batteries. Given these projects are not yet consented, they entail a higher degree of uncertainty.

The reason for including the supply pipeline of South Island winter capacity in Figure 6, is this capacity less South Island peak demand contributes to the calculation of the NI-WCM but is limited by the HVDC capability.

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[30] Table 6 within Appendix 3 defines earliest build dates.

[31] This observation is supported by Transpower in its role as Grid Owner; the Grid Owner has seen a large increase in customer enquiries from both generation and demand, as highlighted in [Transpower's New Connection Enquiries Dashboard](#).

Figure 6: Contributions of supply pipeline to the New Zealand Winter Energy, South Island Winter Energy and North Island Winter Capacity margins

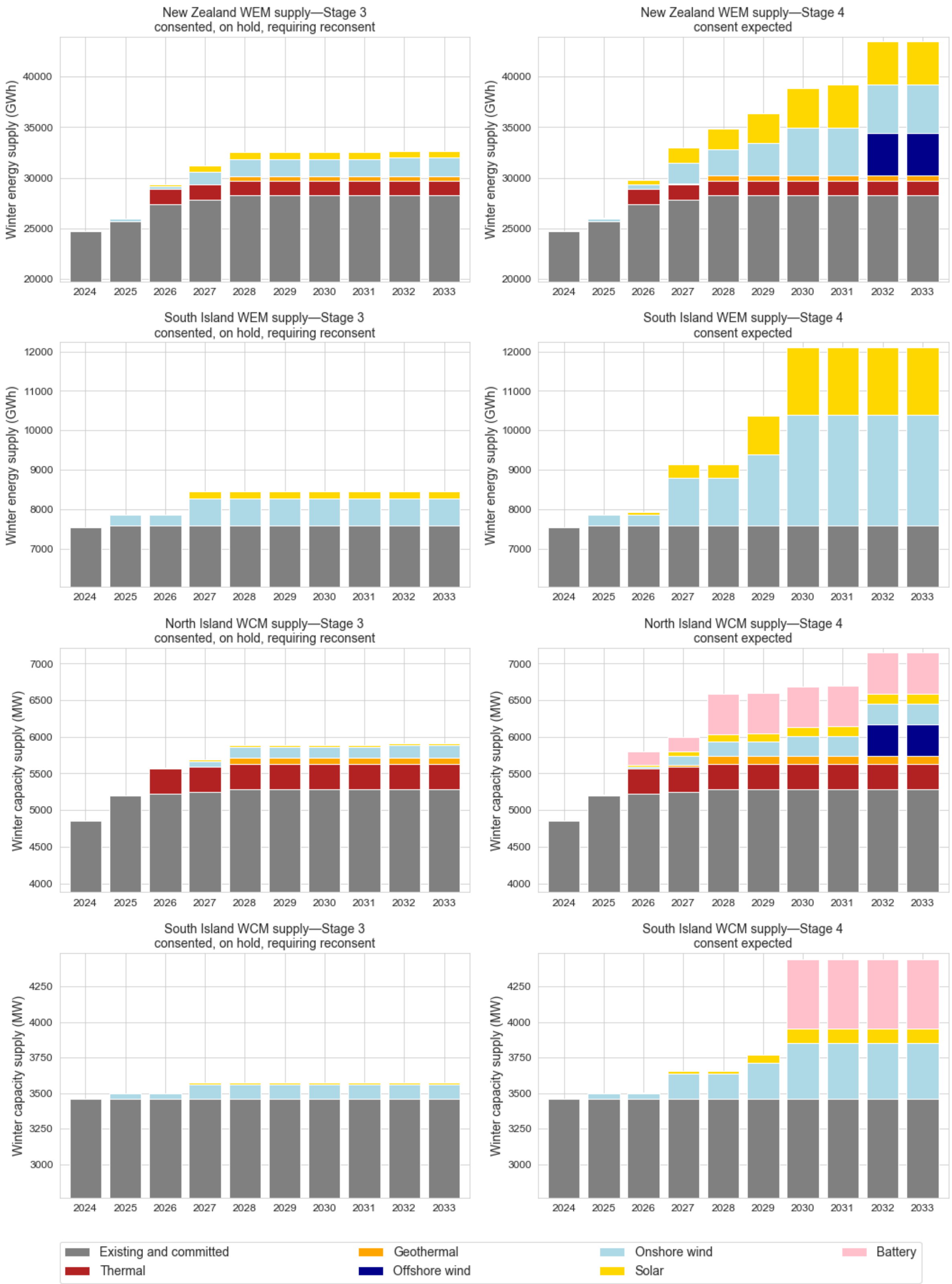


Figure 7 provides a comparison of the supply pipeline used in the 2024 SOSA to that used in the 2023 SOSA. These include the pipelines for the existing and committed as well as new supply projects (Stages 1 to 4).

This shows that the existing and committed supply pipeline is higher in the 2024 SOSA compared with the 2023 SOSA from 2025 for capacity and 2026 for energy. There has been a net 200 MW increase in existing generation since 2023 and a 160 MW increase in the committed pipeline. These are positive changes, as committed supply projects have the highest level of certainty in being delivered, and the movement suggests the supply pipeline is being developed.

The quantity of supply pipeline projects in Stage 4,[32] has decreased in earlier years of the assessment period but increased in later years when compared to the 2023 SOSA. This is due to:

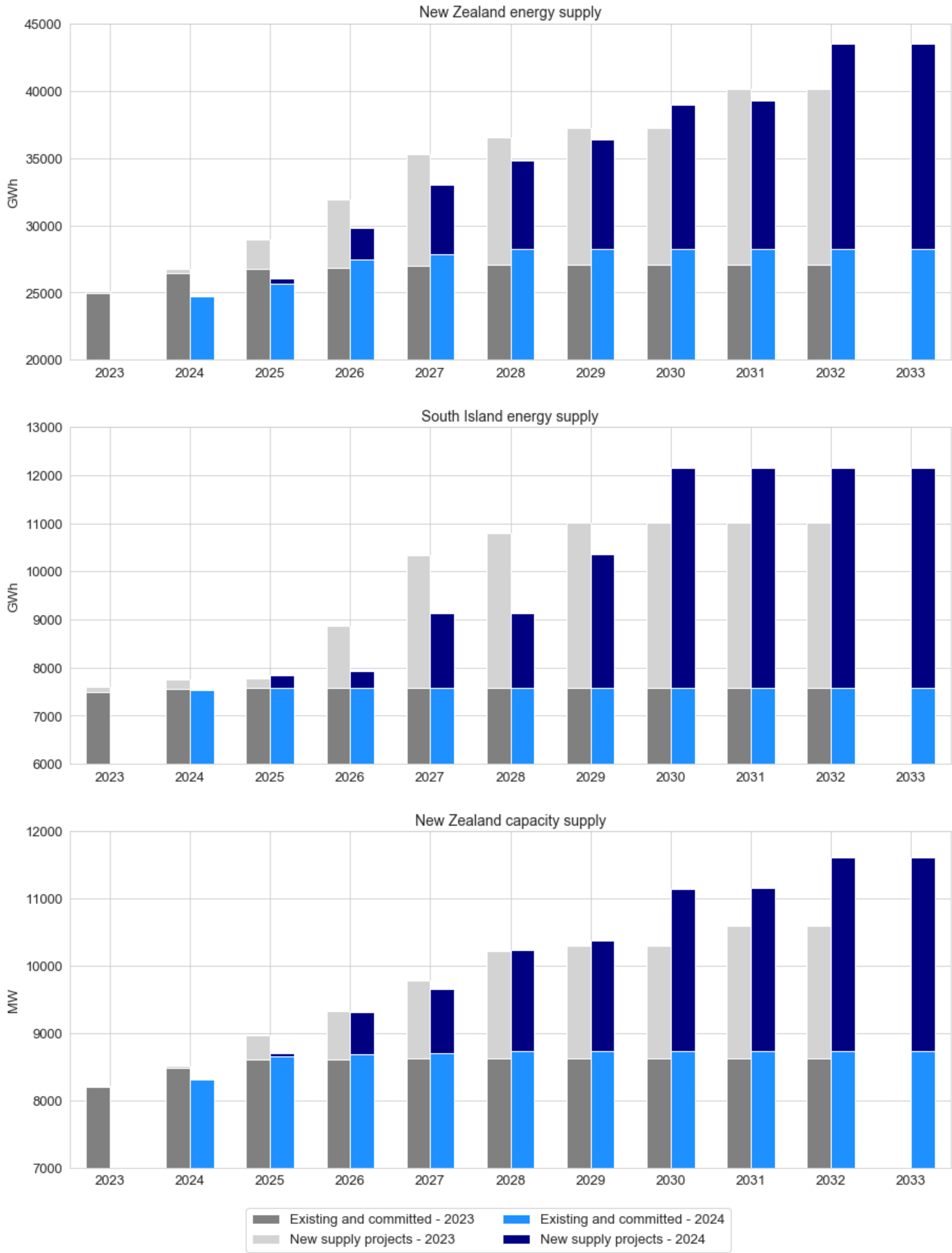
a) new supply projects progressing up the pipeline (e.g. moving to a committed state), as there is an increase in existing and committed generation;

b) new supply projects moving further out due to a higher level of uncertainty around delivery of currently unconsented projects that fall into Stage 4; or

c) new supply projects that were not reported in the 2023 SOSA.

[32] See Table 1 for definition.

Figure 7: Winter energy and capacity supply in 2024 compared to 2023



Gas Supply

For the reference case we have assessed the gas supply availability (for gas generation) by estimating a dry year gas supply margin for the 10-year assessment horizon. Gas supply assumptions use confidential information from gas producers for 2024 to 2025 and Ministry of Business, Innovation and Employment (MBIE) statistics[33] for the later years.

The dry year gas supply margins[34] indicate that we expect gas supply constraints to limit dry year winter energy supply from gas generators in 2024 and 2025.

From 2026 onwards, we model a sufficient gas supply to run gas generators at their maximum available capacity over a dry winter in the reference case. This assumes gas demand flexibility from some industrial gas users if needed for increased electricity generation in a dry winter, substitution of gas demand through industrial process electrification, and ongoing investments in the gas sector to enable additional gas supply, including the development of potentially recoverable contingent resources.

We are aware that the level of future investment in the upstream gas sector is uncertain. As such, we consider the impact of a low gas supply sensitivity, as discussed in the next section. Together these can show the effect of the range of plausible gas supply outcomes.

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[33] MBIE's Petroleum Reserves 2022

[34] Appendix 4 defines the process for determining the dry year gas supply margins.

2.3 Sensitivities

We have identified several key variables that we explore as sensitivities in our analysis. These sensitivities represent plausible variations from the reference case that could occur over the 10-year assessment horizon.

In addition to applying individual sensitivities to the reference case, we consider applying all valid sensitivity combinations to the reference case to form a wider range of plausible futures. We have assessed the reference case and the sensitivities (and their feasible combinations) for different potential future generation[35] scenarios, which we refer to in the SOSA as supply pipeline stages.

Recent SOSAs have considered the aspirational target of 100% renewable energy by 2030 as a separate case study. We have included this assessment in the 2024 SOSA (see Section 4.0) as it is continually relevant to study the impacts a greater proportion of renewable energy generation has on the security margins.

2.3.1 Supply Side Sensitivities

Thermal decommissioning

This sensitivity tests the potential impact of the decommissioning (or mothballing) of significant fossil-fuelled slow start thermal generation assets throughout the assessment horizon.

Dry year reserve

This sensitivity assumes a small number of 'baseload' fossil-fuelled thermal generators change their operation so that they only provide dry year reserve from 2027 onwards. This sensitivity tests the impact on the NI-WCM if these generators were not available to contribute to short-term, unanticipated supply shortages (unrelated to hydrology). Existing fossil-fuelled thermal generation installed capacity will be reduced by 480 MW when calculating the NI-WCM. As this capacity will still be available for dry year reserve, it will still be included when calculating both the NZ-WEM and SI-WEM.

Low gas supply

This sensitivity is intended to show a future of reduced gas supply for electricity generation over the 10-year assessment period. It reflects concerns that future capital investment in the

[35] This also includes batteries.

upstream gas industry may be at risk, given uncertainties in future gas demand (e.g. increased renewable generation replacing gas-fired electricity generation) and supply.[36]

In this sensitivity, we assume that gas supply after 2025 is limited to forecast production from 2P reserves, where these are the known reserves that have a 50% chance of being 'recovered' or produced. We assume that gas supply after 2027 is limited to estimated 1P reserves. 1P reserves are a subset of 2P reserves and have a 90% chance of being produced. We also assume that there is no investment to import natural gas and contingent gas reserves is not brought to market. This is consistent with this sensitivity's underlying assumption of minimal levels of investment in upstream gas sector infrastructure or investments not realising the expected gas production gains. Forecast domestic gas production begins to decline substantially from 2026. This results in a progressive curtailment of existing gas generation, with only gas co-generation plant contributing to security margins from 2033.

Low gas demand flex

This sensitivity is intended to explore the impact of low gas demand flexibility from industrial gas users. In this sensitivity we assume that industrial users provide less gas demand flexibility meaning less gas is available when needed for increased electricity generation during a dry winter.[37]

Delayed build times

This sensitivity explores the impact of delaying the commissioning dates for all new generation by one year. This sensitivity is intended to cover a range of possible eventualities. For example, new generation may be delayed due to transmission constraints, resource consent issues or investment uncertainty.

Upgraded HVDC

The exit of Tiwai and/or new South Island generation capacity and demand response may result in surplus South Island generation capability that could be exported to load centres in the North Island, which could result in the upgrade of the HVDC link, including through the addition of a fourth cable. An upgraded HVDC link would also allow greater southward energy transfer during a dry year, when the output of major South Island hydro generators would be reduced. Increased Southward transfer would also be dependent on the availability of sufficient reserves in the South Island and removal of any AC transmission and voltage stability constraints restricting increased southward flow. In this sensitivity we consider a potential upgrade of the HVDC link with the addition of a fourth cable. If feasible, this is

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[36] As observed recently where gas supply investment has not yielded the expected increases in gas production.

[37] While such gas demand flex has been observed recently (e.g. 2021 and during the first half of 2024) the expectation of this flex (or gas swaps from industrial users to electricity generation) during dry winters going forward is uncertain, hence we consider this as a sensitivity.

assumed to occur with the end-of-life replacement of the existing HVDC subsea cables which is nominally indicated to occur by 2032.[38]

Constrained thermal development

In this sensitivity we consider the impact if no new fossil-fuel generation is developed during the 10-year assessment horizon (2024 to 2033). This could be for a variety of reasons which could make the economic returns on new thermal generation highly uncertain, as we transition towards a lower carbon economy.

Constrained operational capacity

This sensitivity explores the market co-ordination challenge of integrating increased intermittent generation with slower start thermal plant. This challenge can lead to scenarios with lower levels of committed slower start thermal plant and intermittent generation, thus resulting in lower levels of operational capacity available over peak demand periods.[39] While the SOSA does not provide a nuanced analysis of this issue, this sensitivity gives an indication of how this situation can impact the NI-WCM.[40]

2.3.2 Demand Side Sensitivities

Demand growth

The demand growth sensitivities explore higher and lower rates of electricity demand growth compared to the reference case. Each of these will differ by varying the rates of acceleration of electrification across the economy and growth of distributed energy resources. To achieve this, we have specifically modelled transport electrification (electric vehicles) and process heat electrification for each growth rate. We have also modelled different rates of solar PV and small-scale batteries, as they can offset growth in demand from the grid.[41]

Additional step demand

This sensitivity explores the potential impact of new industrial sources of demand, such as data centres, other new industries or electrification of process heat demand. In this sensitivity we consider an additional 100 MW step of load in each island.

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[38] Transpower, Asset Management Plan 2022 (page 122) and Examining the purpose and future role of our HVDC link (page 18).
[39] These challenges are described further in System Operator Winter Review and System Operator Winter Outlook
[40] This sensitivity reduces the contribution of intermittent generation over peak periods, while simultaneously removing the availability of a large slow starting fossil-fuelled generator.
[41] Appendix 2 defines the demand forecast modelling process.

Increased demand response

Demand response could play a larger role in managing peak loads going forward. This sensitivity explores the impact of increased uptake in demand response (100 MW in both the North and South Islands) on the NI-WCM. It also explores the impact of additional long-term demand response on the NZ-WEM and SI-WEM by decreasing the demand by 2.5% and 5% respectively.[42]

Tiwai exits

This sensitivity considers a case where the conditions of the new Tiwai contracts are not met and the smelter exits the New Zealand market at the end of 2024. In this sensitivity, we assume a 'hard' exit, with no ramp-down in demand from the smelter up to and including 2024.

The reduction in demand in the Tiwai exit sensitivity exceeds that in the increased demand response sensitivity described above. While the likelihood of the Tiwai exit sensitivity is now reduced the inclusion of this sensitivity with its large reduction in demand also allows us to consider the impact of very large-scale[43], long-duration winter demand response[44] on the security of supply margins.

[42] We've made updates to this sensitivity based on feedback from the consultation. Appendix 5 defines the demand response sensitivity.
[43] Even greater than that modelled in the increased demand response sensitivity.
[44] This is because in terms of the SOSA modelling, this reduction in demand is equivalent to winter energy and capacity demand response.

3.0 Results

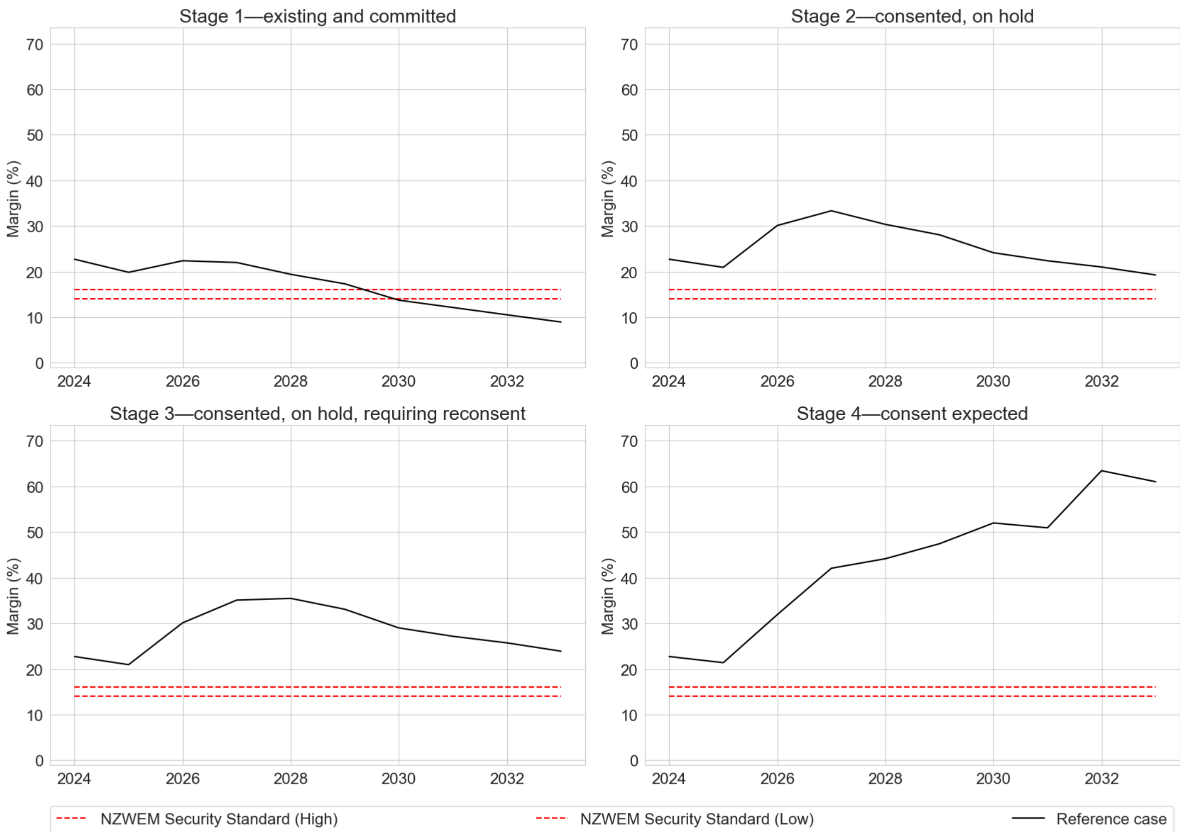
3.1 Winter Energy Margin Results

3.1.1 New Zealand Winter Energy Margin Reference Case Results

Figure 8 shows the NZ-WEM results for the reference case. This illustrates that:

1. with existing and committed generation (Stage 1) the NZ-WEM declines and crosses the lower security standard in 2030;
2. for the reference case to maintain the NZ-WEM above the lower security standard throughout the assessment horizon, in addition to the existing and committed generation, most of the consented and on-hold supply projects would need to be developed (Stage 2); and
3. from 2027, there is a large increase in the amount of unconsented generation in the pipeline (Stage 4) however these projects have a higher degree of uncertainty in coming to market.

Figure 8: New Zealand Winter Energy Margin reference case results

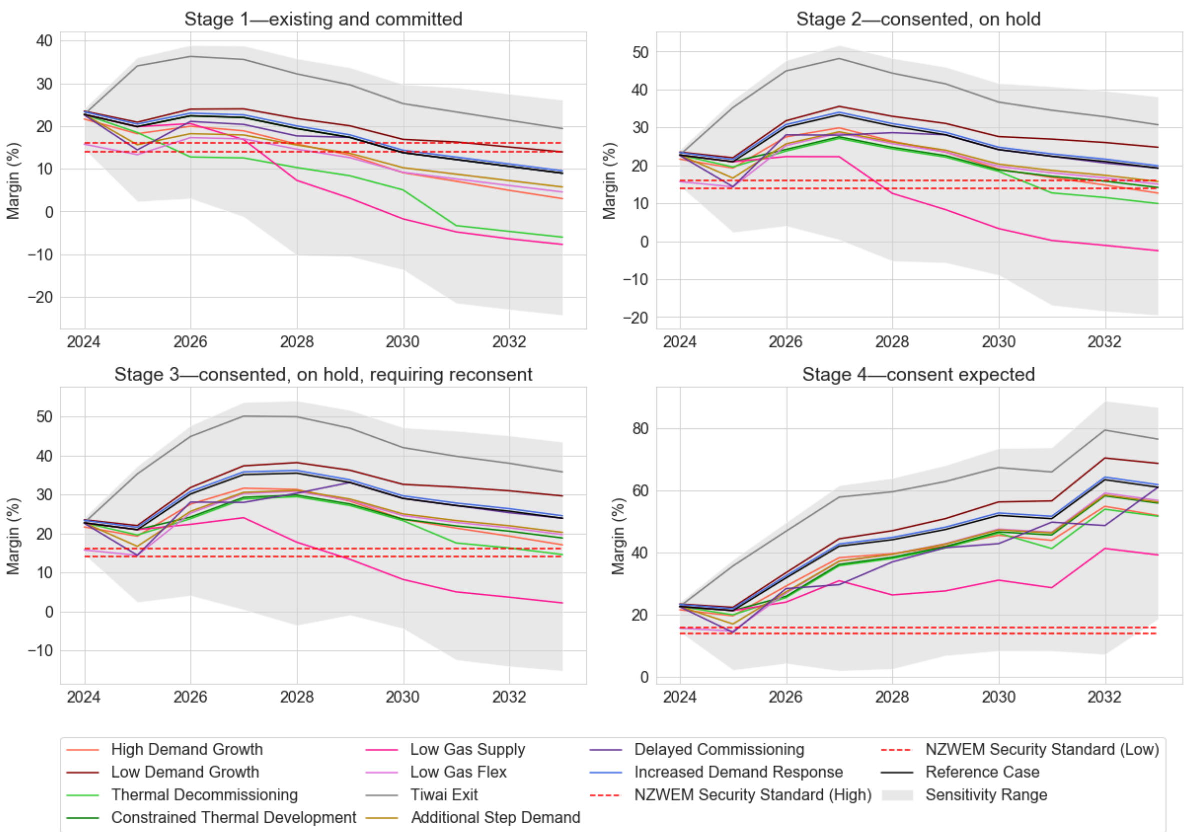


3.1.2 New Zealand Winter Energy Margin Sensitivities

In this section we present the impact the sensitivities have on the reference case and discuss whether these impacts accelerate or delay the NZ-WEM crossing the lower security standard.

Figure 9 shows the impact of each of the sensitivities when applied independently to the reference case for each of the four supply pipeline stages. The grey shaded area defines the boundary for the best and worst case of the plausible sensitivity combinations (shown in Figure 4).[45] Applying each sensitivity independently from one another allows us to observe the magnitude of each sensitivity's impact on the NZ-WEM (relative to the reference case).

Figure 9: New Zealand Winter Energy margins for the reference case and all sensitivities



The *low gas supply* and *thermal decommissioning* sensitivities have the greatest impact on pulling the NZ-WEM down below the lower security standard. The figures above indicate that unless sufficient consented and some unconsented generation (Stage 4) is commissioned,

[45] The boundary of the grey area provides an indication of the range of the potential outcomes where different combinations of sensitivities are assumed to occur. As would be expected, combinations of sensitivities that individually reduce the WEM or WCM would pull the margins even lower if considered together (such as higher demand and thermal decommissioning and low gas supply). We provide the data of all these combinations so readers can explore the different combinations they consider a reasonable expectation of future scenarios.

we are dependent on thermal generation to help maintain margins above the lower security standard over the duration of the assessment horizon.

In contrast, the reduced demand sensitivities (*Tiwai exit*, *low demand growth and increased demand response*) have the greatest impact on increasing the NZ-WEM. Under both these sensitivities if all Stage 2 generation supply was commissioned, we could maintain margins above the lower security standard over the duration of the assessment horizon.

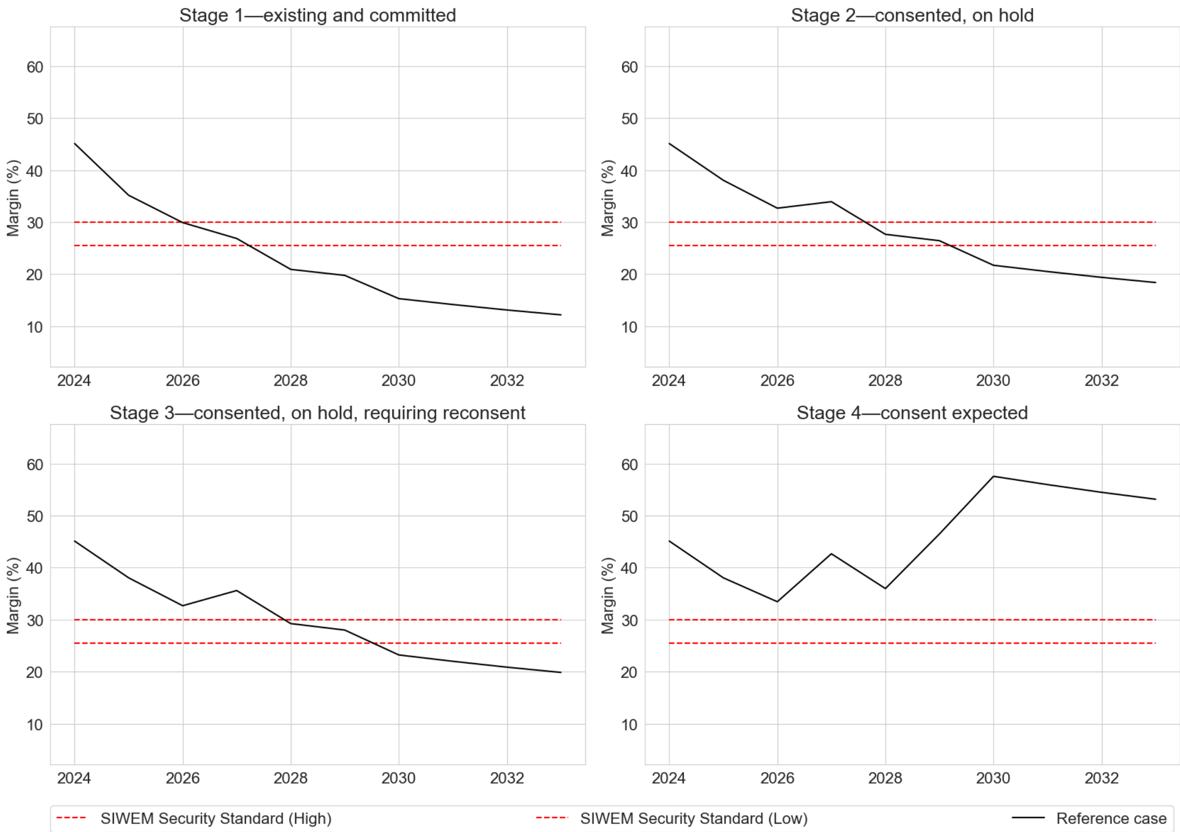
These impacts are discussed further in Section 3.4.

3.1.3 South Island Winter Energy Margin Reference Case Results

The SI-WEM results for the reference case are shown in Figure 10. This illustrates that:

1. the SI-WEM crosses the lower security standard earlier than the NZ-WEM under supply pipeline Stages 1-3;
2. with existing and committed generation (Stage 1) the SI-WEM declines and crosses the lower security standard in 2028; and
3. for the reference case to maintain the SI-WEM above the lower security standard throughout the assessment horizon, in addition to the existing and committed generation, all the consented and some of the unconsented supply projects (Stage 4) need to be developed.

Figure 10: South Island Winter Energy Margin reference case results

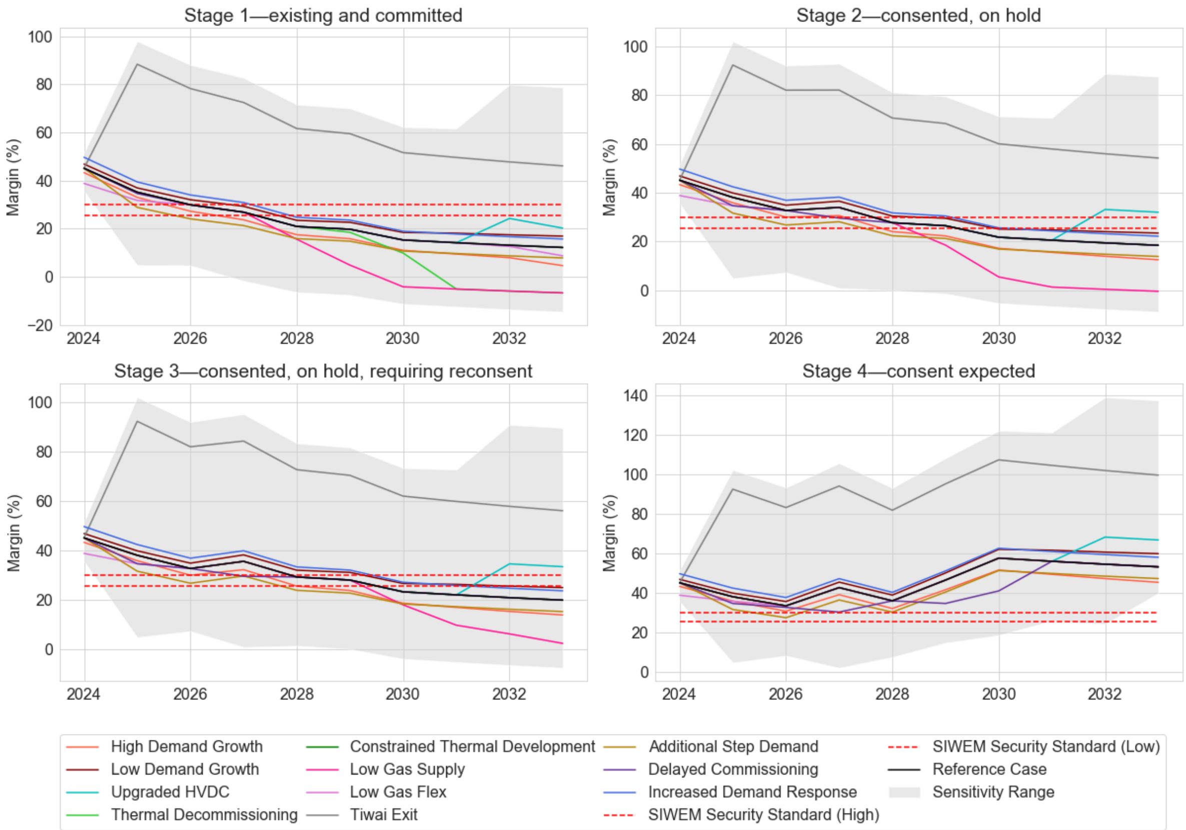


3.1.4 South Island Winter Energy Margin Sensitivities

In this section we present the impact the sensitivities have on the reference case and discuss whether these impacts accelerate or delay the SI-WEM crossing the lower security standard.

Figure 11 shows the impact of each of the sensitivities when applied independently to the reference case for each of the four supply pipeline stages. The grey shaded area defines the boundary for the best and worst case of the plausible sensitivity combinations. Applying each sensitivity independently from one another allows us to observe the magnitude of each sensitivity's impact on the SI-WEM (relative to the reference case).

Figure 11: South Island Winter Energy Margins for the reference case and all sensitivities



The increased South Island demand forecast with most of the new generation expected in the North Island has meant the SI-WEM has an increasing risk of falling below the security standard, as shown in the reference case. Reducing thermal generation capability to provide dry-year back-up has the most substantial impact in accelerating this risk as shown in the *low gas supply* and *thermal decommissioning* sensitivities.

The *high demand* and *additional step demand* sensitivities cause the SI-WEM to cross the lower security standard earlier than the reference case. Consented and some unconsented generation (Stage 4) is needed to come to market in time to maintain the margins above the lower security standard under the reference case. This generation investment needs to be increased and accelerated if these sensitivities materialised. Increasing north-south transfer capability could also help increase the SI-WEM above the lower security standard, as shown in the *upgraded HVDC* sensitivity.

In contrast, the *Tiwai exit, low demand and increased demand response* sensitivities have the greatest impact on increasing the SI-WEM. These could also be proxies for the impact of varying quantities of South Island dry-year winter demand response and/or additional South Island generation on the SI-WEM.

The impacts of the various sensitivities on the SI-WEM show the reliance on thermal back up generation to manage dry year risks, until significant new renewable generation and South Island long-duration demand response comes to market. Increasing north-south transfer capability can help reduce the amount of generation needed to manage dry-year risk in the South Island.

These impacts are discussed further in Section 3.4.

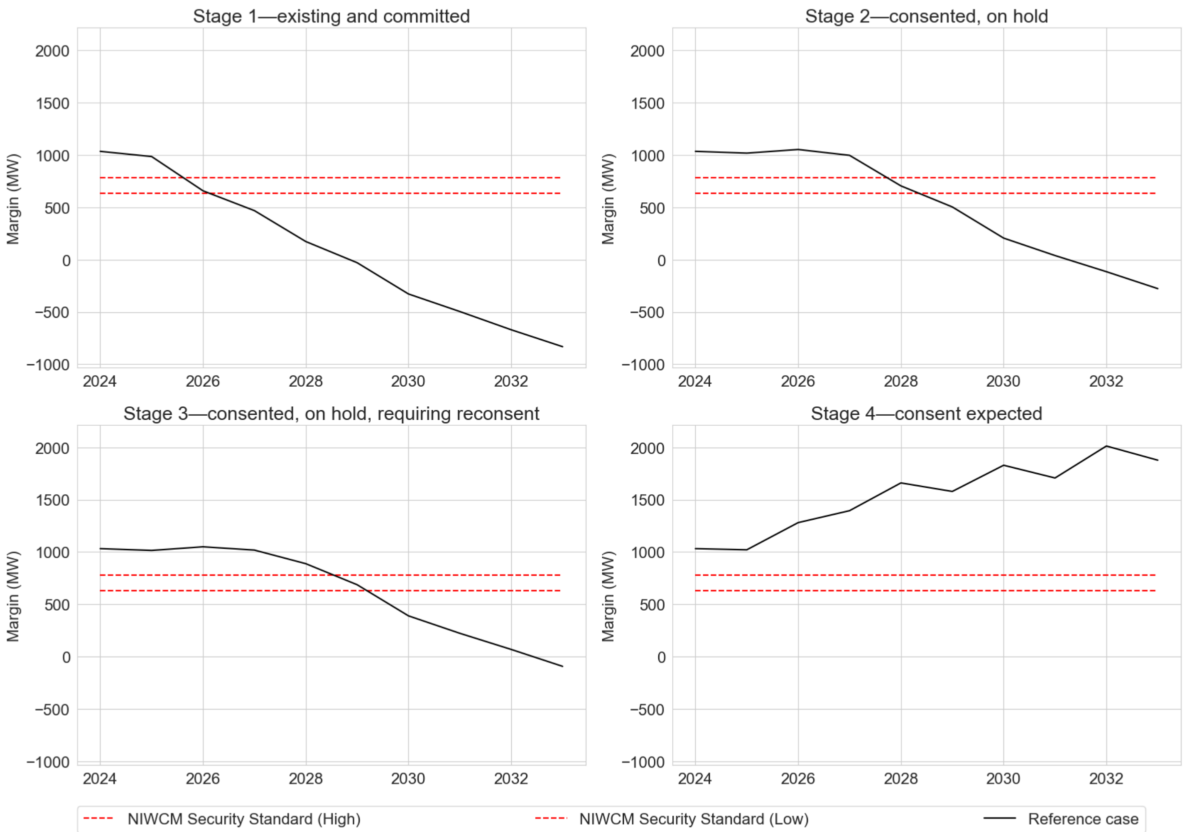
3.2 Winter Capacity Margin Results

3.2.1 North Island Winter Capacity Margin Reference Case Results

Figure 12 shows the NI-WCM results for the reference case. This illustrates that:

1. with existing and committed generation (Stage 1) the NI-WCM declines and crosses the lower security standard in 2027;
2. consented and on hold projects (Stages 2 and 3) help maintain the NI-WCM above the lower security standard through to approximately 2029; and
3. additional unconsented projects (Stage 4) would be needed to maintain the NI-WCM above the lower security standard from 2030 for the remainder of the assessment horizon.

Figure 12: North Island Winter Capacity Margin reference case results

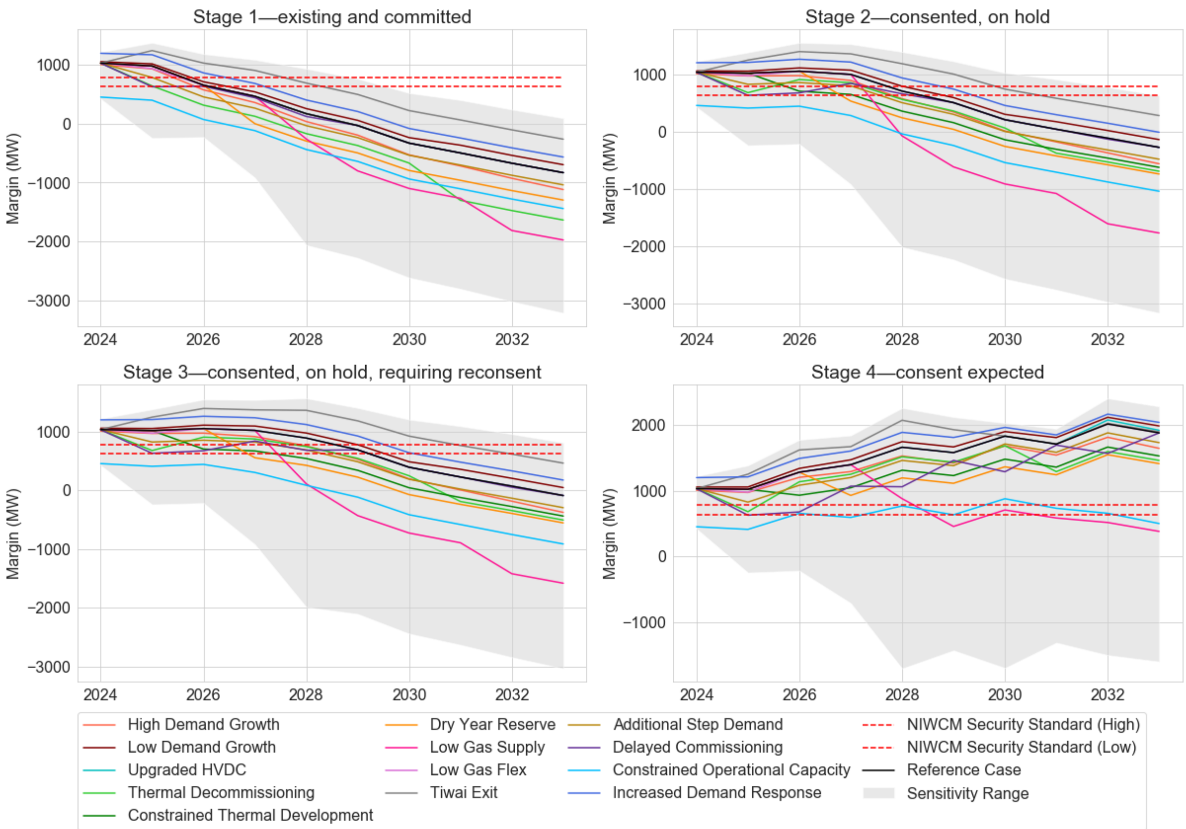


3.2.2 North Island Winter Capacity Margin Sensitivities

In this section we present the impact the sensitivities have on the reference case and whether these accelerate or delay the NI-WCM crossing the lower security standard.

Figure 13 shows the impact of each of the sensitivities when applied independently to the reference case for each of the four supply pipeline stages. The grey shaded area defines the boundary for the best and worst case of the plausible sensitivity combinations. Applying each sensitivity independently from one another allows us to observe the magnitude of each sensitivity's impact on the NI-WCM (relative to the reference case).

Figure 13: North Island Winter Capacity Margins for the reference case and all sensitivities



The *constrained operational capacity* sensitivity has one of the most substantial impacts on decreasing the NI-WCM below the lower security standard. This impact reduces under Stage 4 where more unconsented battery investment is signalled. This highlights the importance of adequate thermal commitment to manage capacity risks in our system with increasing intermittent generation if there is insufficient investment in flexible resources. The *low gas supply* and *thermal decommissioning* sensitivities substantially impact on pulling the NI-WCM down below the security standards. Even if all consented and unconsented (Stage 4) resources are commissioned, sufficient gas supply is still required to ensure availability of enough flexible peaking capacity to maintain the NI-WCM above the lower security standard.

In contrast, the *Tiwai exit* and *increased demand response* sensitivities have the greatest impact on improving the NI-WCM, by reducing demand over peak periods, although this is insufficient to maintain the NI-WCM above the lower security standard for the duration of the assessment horizon. Consented and some unconsented (Stage 4) resources are still required.

These impacts are discussed further in Section 3.4.

3.3 Comparison with the 2023 Security of Supply Assessment

Figure 14 shows the NZ-WEM reference case results cross the lower security standard two years later than in the 2023 SOSA, when considering only the existing and committed supply projects (Stage 1). This is primarily due to a decrease in the NZ-WEM demand forecast (Figure 5) and an increase in the existing and committed supply pipeline (Figure 7).

When considering all the consented supply projects (Stages 2 and 3), we can see that for most of the assessment horizon the NZ-WEM reference case is higher than in the 2023 SOSA. This is again due to a decrease in the NZ-WEM demand forecast, and an increase in consented supply projects from 2026 onwards. A slight decrease in consented projects until 2025 compared to the 2023 SOSA, corresponds to this year's NZ-WEM dropping below last year's margin, however it still remains above the standards over the assessment horizon.

When considering the entire supply projects pipeline (Stage 4), the NZ-WEM reference case is lower than in the 2023 SOSA until 2029. This is the result of a reduction in consent-expected projects from the supply pipeline (Figure 7), exceeding the drop in the demand forecast. This is a good example of the higher level of uncertainty in the unconsented projects pipeline and the corresponding impact on the NZ-WEM.

Figure 14: New Zealand Winter Energy Margin reference case comparison, 2023 and 2024

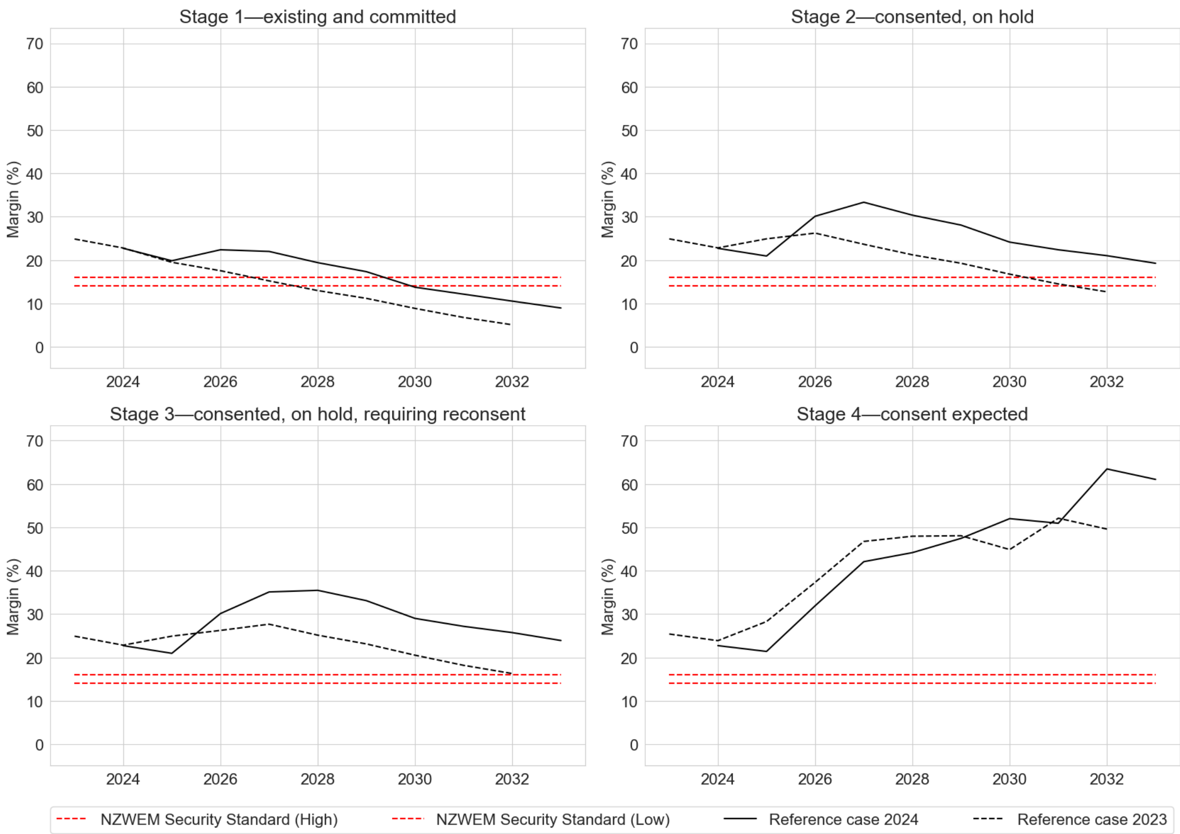


Figure 15 shows the SI-WEM reference case results cross the lower security standard two years earlier than in the 2023 SOSA, when considering only the existing and committed supply projects (Stage 1). This is primarily due to an increase in the SI-WEM demand forecast (Figure 5) and no corresponding increase to the existing and committed South Island supply pipeline, with the ability for the North Island supply to support the South Island constrained by the north-to-south transfer capability.

This shift remains consistent across all project pipeline stages. In the 2023 SOSA, consideration of the consented, on hold projects (Stage 2) was enough to keep the SI-WEM above the lower security standard over the assessment horizon. However, the increase in expected South Island demand in this year's SOSA means some of the unconsented projects (Stage 4) are required to maintain the SI-WEM above lower security standards if there is no increase in the north-to-south transfer capability. In this year's South Island supply pipeline, there has been a decrease in the unconsented projects (Stage 4) up until 2030, which amplifies the drop in SI-WEM for Stage 4.

Figure 15: South Island Winter Energy Margin reference case comparison 2023 and 2024

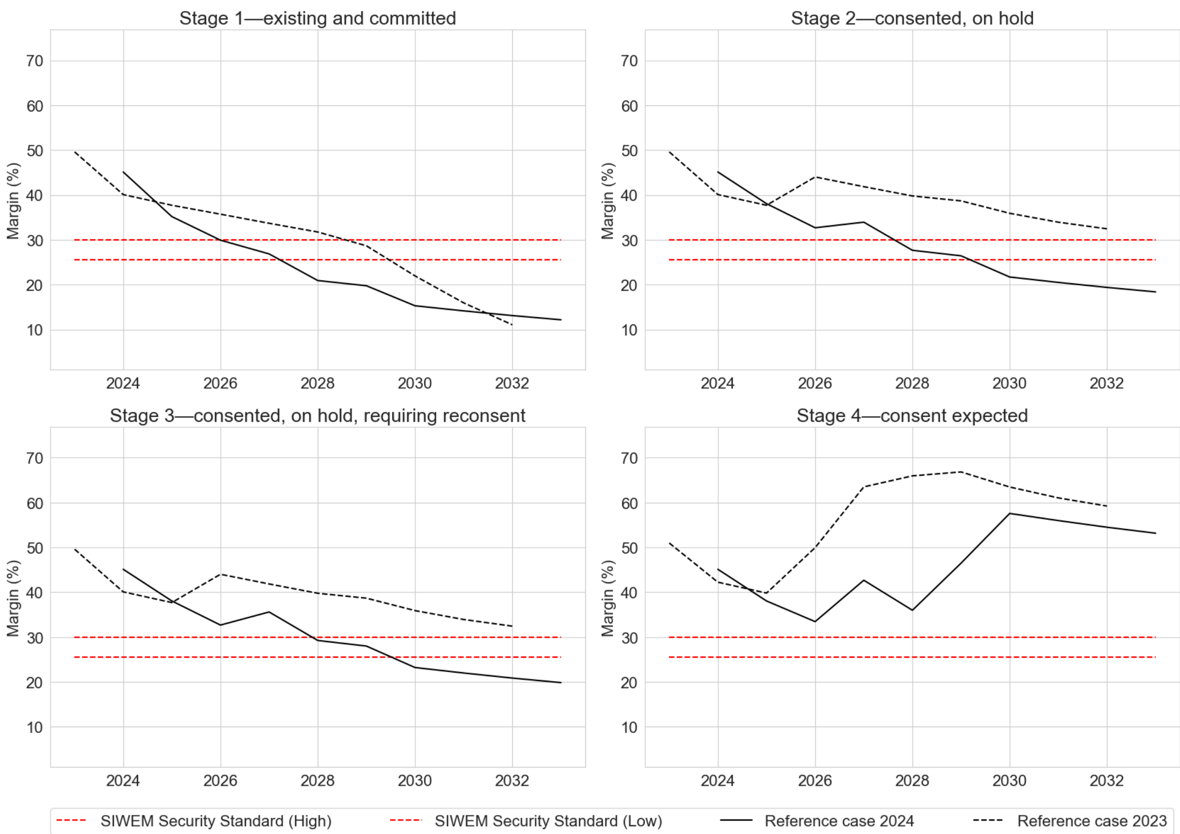
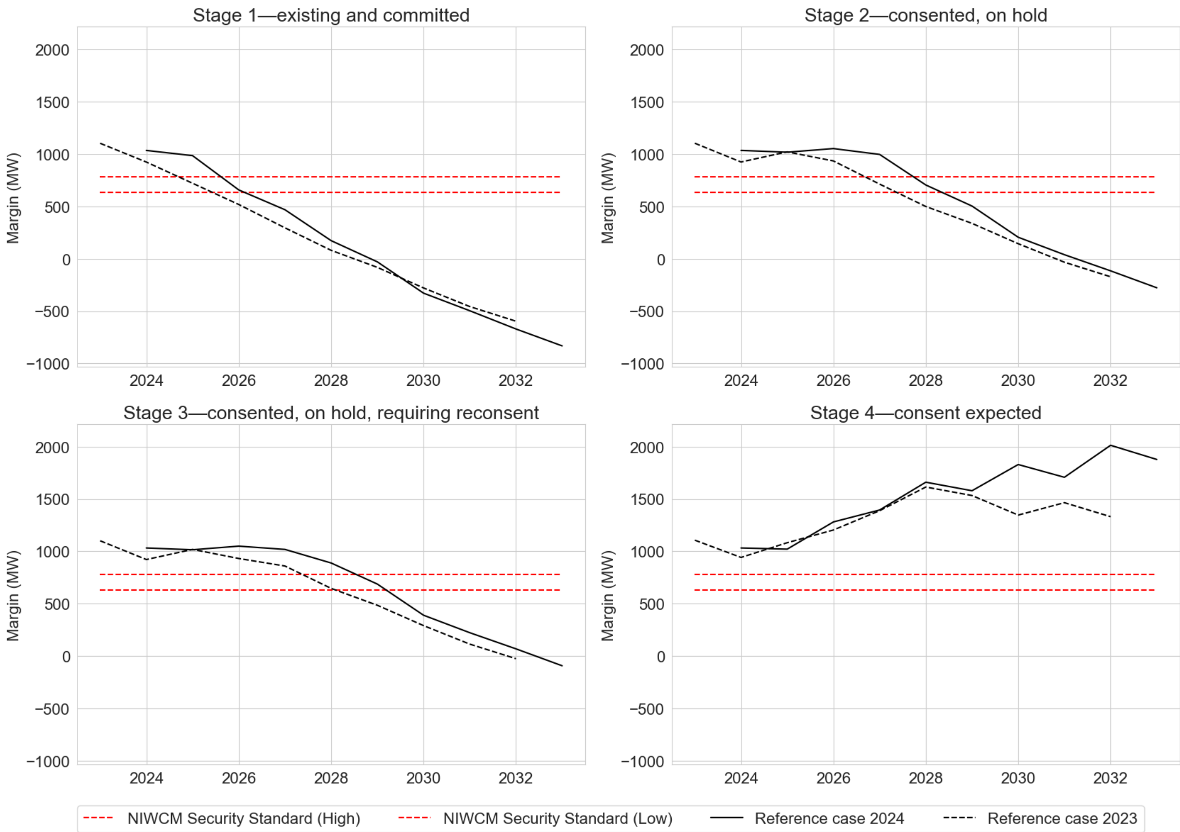


Figure 16 shows the NI-WCM reference case results cross the lower security standard one year later than in the 2023 SOSA, when considering only the existing and committed supply projects (Stage 1). This is primarily due to a decrease in the NI-WCM demand forecast (Figure 5) and an increase in the existing and committed projects from 2025 onwards. This shift remains consistent when considering each stage of the project pipeline, with an increase of new supply projects in all stages from the 2023 SOSA.

Figure 16: North Island Winter Capacity Margin reference case comparison, 2023 and 2024



3.4 Key Insights

3.4.1 Energy

Reduced gas availability requires earlier generation investment

Reduced gas availability adversely impacts the NZ-WEM and SI-WEM, increasing the risk of these margins falling below their respective lower security standards earlier, unless sufficient new generation resources in the supply pipeline come to market in time.

Table 2, Figure 17 and Figure 18 show the impact on the NZ-WEM and SI-WEM of two different sensitivities, and a combination of both, which reduce the availability of gas for electricity generation. These are:

- *low gas supply*, in which gas supply after 2025 is limited to estimated 1P reserves; and
- *low gas demand flex*, in which less gas demand reallocation is assumed to occur from industrial gas users to gas-fired electricity generators.

Reduced gas availability could cause the NZ-WEM to fall below the lower security standard by 2025, when considering only existing and committed generation. Reduced gas availability has less impact on the SI-WEM, but it could still fall below the lower security standard as early as 2027, under the same conditions. Under the reduced gas availability sensitivities, development of unconsented generation is required from 2028 to maintain the NZ-WEM above the lower security standard for the duration of the assessment, and from 2029 for the SI-WEM.

Table 2: NZ-WEM and SI-WEM earliest crossing of the lower security standard for the reference case and reduced gas availability sensitivities

Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
Reference case (NZ-WEM)	**2030**	**>2033**	**>2033**	**>2033**
Low gas	2028	2028	2029	>2033
Low flex	2025	>2033	>2033	>2033
Low gas + low flex	2025	2028	2028	>2033
Reference case (SI-WEM)	**2028**	**2030**	**2030**	**>2033**
Low gas	2028	2029	2030	>2033
Low flex	2028	2030	2030	>2033
Low gas + low flex	2027	2028	2029	>2033

Under the *low gas supply* sensitivity, Figure 17 shows a noticeable decrease in the NZ-WEM, which crosses the lower security standard in 2028 as opposed to 2030 for the reference case, when considering existing and committed generation (Stage 1). To maintain the NZ-WEM above the lower security margin, supply projects from the consent expected pipeline (Stage 4) would need to be developed prior to 2029, at which point the consented projects (Stage 3) of the supply pipeline would no longer be sufficient to maintain the NZ-WEM above the lower security margin.

The *low gas demand flex* sensitivity shown in Figure 17 indicates that without significant gas demand flexibility the NZ-WEM could cross the lower security standard from 2025. This highlights the importance of gas demand flexibility from industrial gas demand users for increased electricity generation, particularly in the near term where options to increase gas supply are limited.[46] Increases in the gas supply will reduce the reliance on gas demand flex to maintain the NZ-WEM above the standards, pushing the crossing of the NZ-WEM lower

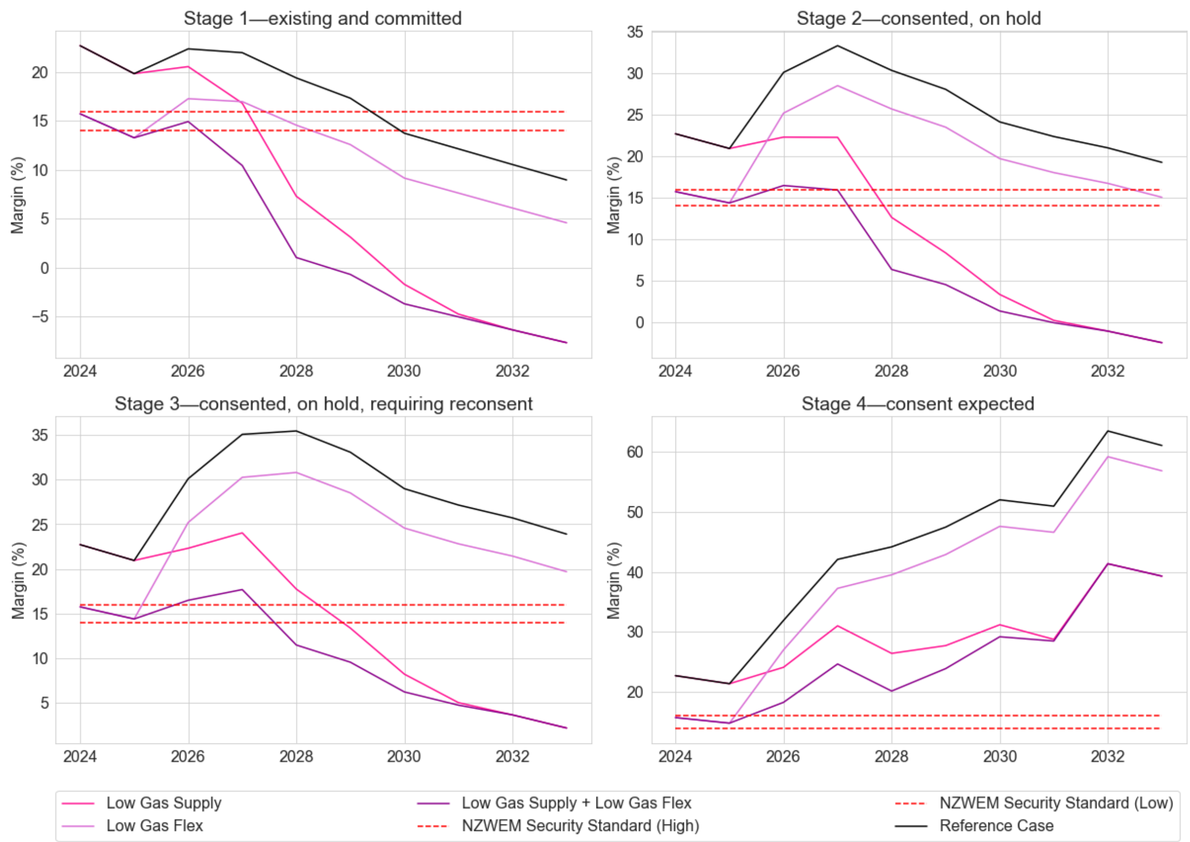
[46] While such gas demand flex has been observed recently (e.g. 2021 and during the first half of 2024) the expectation of this flex (or gas swaps from industrial users to electricity generation) during dry winters going forward is uncertain, hence we consider this as a sensitivity to highlight the impact on the security standards.

standards out to 2029 with existing and committed generation only (Stage 1). To reduce the reliance on gas demand flex to maintain the NZ-WEM above the standards for the remainder of the assessment horizon, sufficient consented generation (Stage 2) needs to be commissioned by 2029.

We have also explored the impact of both sensitivities combined. This results in a further reduction in the NZ-WEM, with gas-fuelled generation fully derated from 2029. The lower security standard is first crossed in 2025, but the NZ-WEM increases and then crosses below again in 2027 when considering existing and committed generation. Again, this would require development of the unconsented pipeline by 2028 to maintain the NZ-WEM above the lower security standard for all sensitivities.

Development of consented generation by 2025 (Stage 2) and some unconsented generation (Stage 4) by 2028 is required to be robust to any of the reduced gas availability sensitivities and maintain the NZ-WEM above the lower security standard.

Figure 17: New Zealand Winter Energy Margins for the reference case and sensitivities that reduce gas availability

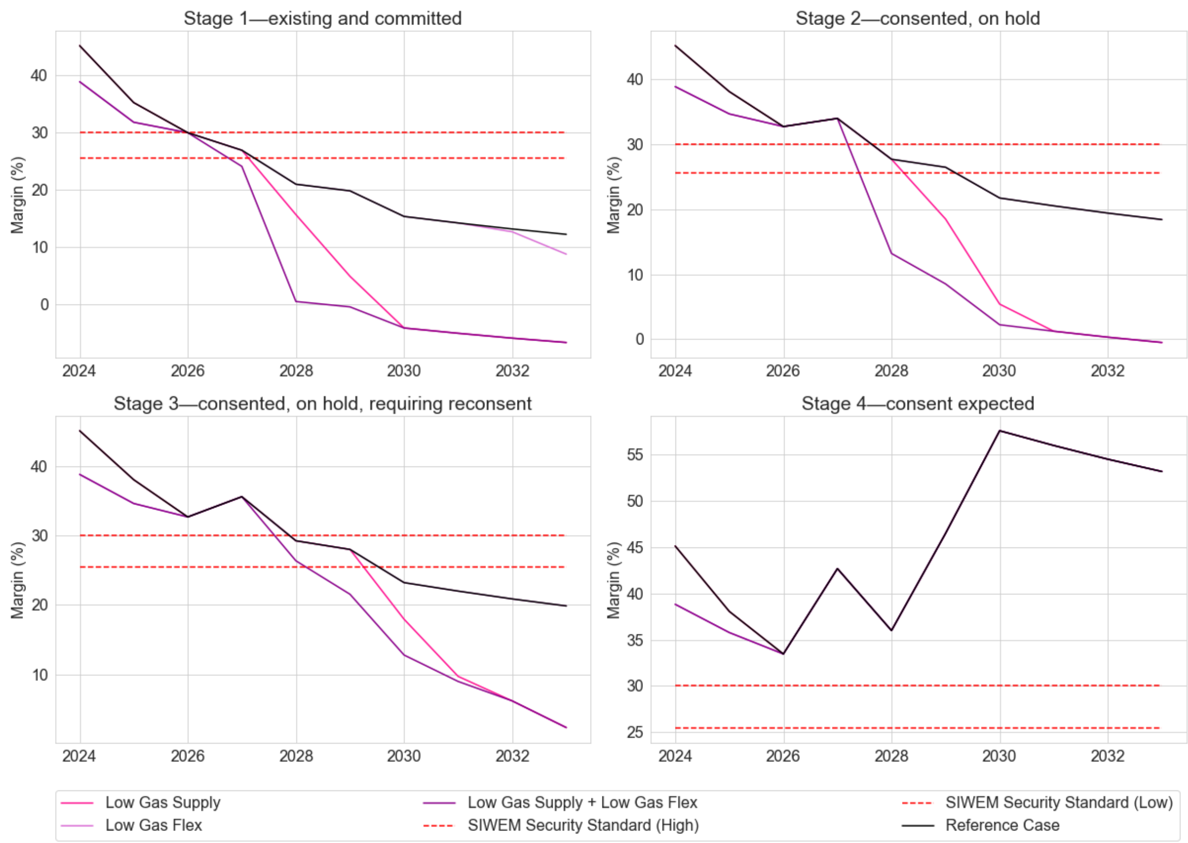


Reduced gas availability impacts the NZ-WEM more substantially than the SI-WEM with limited north-to-south transfer capability. The *low gas flex* and *low gas supply* sensitivities combined could lower the SI-WEM to bring the crossing of the lower security standard forward a year from the reference case, to 2027, for existing and committed generation

(Stage 1). When the sensitivities are applied separately, they do not impact the year the SI-WEM crosses the lower security standard, relative to the reference case.

Consistent with the NZ-WEM, the reduced gas availability sensitivities require development of consented (from 2027) and some unconsented generation (from 2028) to maintain the SI-WEM above the lower security standard for the assessment duration.

Figure 18: South Island Winter Energy Margins for the reference case and sensitivities that reduce gas availability



Sufficient investment in new generation is required to reduce the thermal generation availability risk

Fossil-fuelled thermal generation availability over the next 10 years can be impacted with potential decommissioning of existing thermal generation and/or no new thermal generation capability added to the system. In this section we explore the impacts on the NZ-WEM from these two reduced thermal generation availability sensitivities, and a combination of both, namely:

- *thermal decommissioning*, in which some slow-start thermal generation is decommissioned in steps; and
- *constrained thermal development*, in which no new fossil fuelled generation is developed.

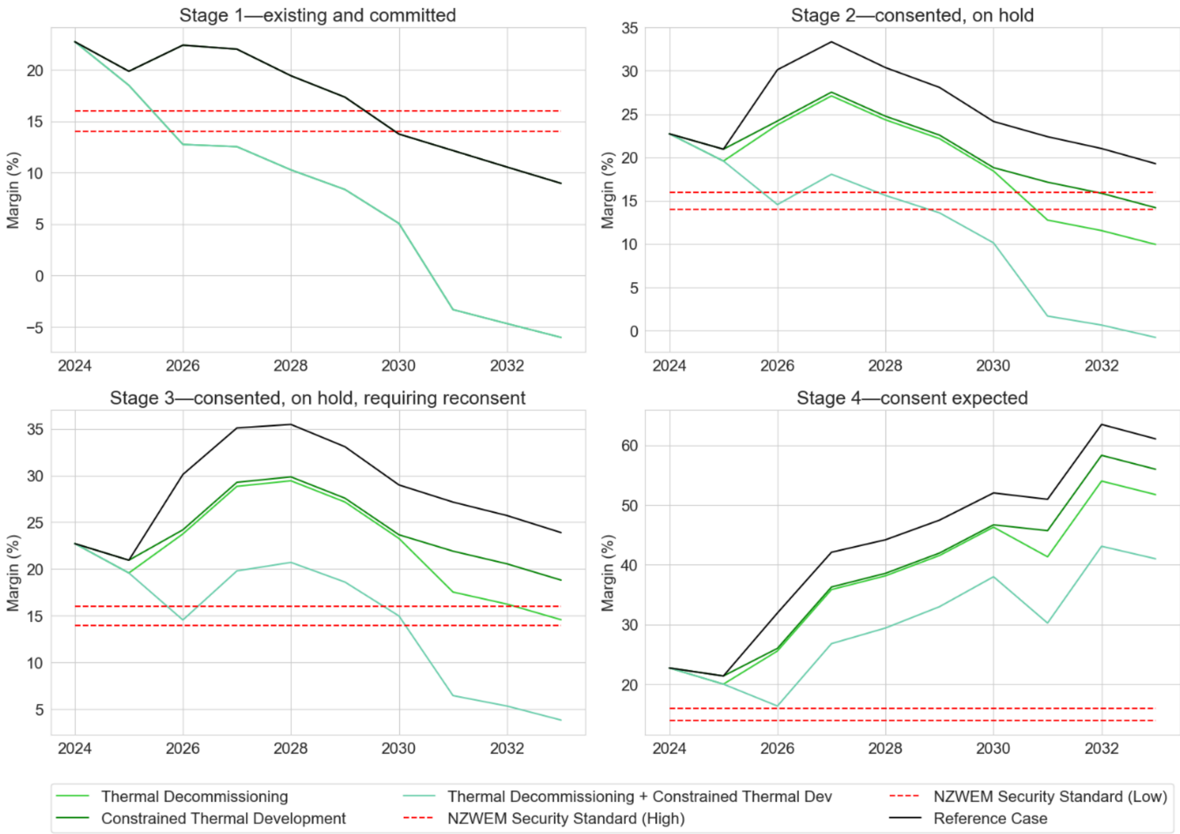
Table 3 and Figure 19 shows the impact of these sensitivities on the NZ-WEM. Stage 1 of the supply pipeline does not contain any thermal generation projects. When considering only the existing and committed generation (Stage 1), the combination of sensitivities has an identical impact on the NZ-WEM as the *thermal decommissioning* sensitivity.

Table 3: NZ-WEM and SI-WEM earliest crossing of the lower security standard for the reference case and thermal unit availability sensitivities

Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
Reference case (NZ-WEM)	**2030**	**>2033**	**>2033**	**>2033**
Thermal decommissioning	2026	2031	>2033	>2033
Constrained thermal development	2030	>2033	>2033	>2033
Decommissioning + constrained development	2026	2029	2031	>2033
Reference case (SI-WEM)	**2028**	**2030**	**2030**	**>2033**
Thermal decommissioning	2028	2030	2030	>2033
Constrained thermal development	2028	2030	2030	>2033
Decommissioning + constrained development	2028	2030	2030	>2033

Under these sensitivities the NZ-WEM falls below the lower security standard unless consented projects (Stage 2 and Stage 3) are delivered by 2026 (four years earlier than the reference case) and currently unconsented projects are developed before 2031 (Stage 4). As would be expected if both existing generation exits and no-new thermal generation is added, additional development of the unconsented (Stage 4) pipeline is needed from 2031 to maintain the NZ-WEM above the standards. This highlights the risk of thermal generation exiting before sufficient new generation comes online. If there is little interest from participants in commissioning new fossil-fuelled generation, then additional unconsented (Stage 4) renewable generation resources would need to come online by 2031 to maintain the NZ-WEM above the standards.

Figure 19: New Zealand Winter Energy Margins for the reference case and sensitivities that reduce thermal availability



The impact of the thermal unit availability sensitivities on the SI-WEM can be seen in Figure 11 and Table 3, where they do not affect the year the SI-WEM crosses the security standards, but do further reduce the SI-WEM below the security standards. Consented and unconsented generation (Stage 4) is required to lift the SI-WEM above the security standards.

South Island demand growth increases the need for investment in additional demand response, generation and transmission capability to reduce South Island dry-year risks

There is a need for investment to reduce the South Island dry-year energy risks. The forecast increase in the South Island energy demand with most of the future generation pipeline located in the North Island and limited north-to-south transfer has meant the SI-WEM crosses the lower security standard sooner (in 2028) in this year's SOSA (Figure 15). Under the demand sensitivities the SI-WEM could cross the lower security standard as early as 2026.

Table 4, Figure 20, and Figure 21 show the impact of the different demand side sensitivities on the NZ-WEM and SI-WEM:

- *demand growth*, a high and low demand growth rate;
- *additional step demand*, a 100 MW step in each island;
- *increased demand response,* a reduction in demand of 2.5% in the NZ-WEM and 5% in the SI-WEM; and

- *Tiwai exit*, a drop in ~400 GWh/month from 2025.

Table 4: NZ-WEM and SI-WEM earliest crossing of the lower security standard for the reference case and demand sensitivities

Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
Reference case (NZ-WEM)	**2030**	**>2033**	**>2033**	**>2033**
Additional Step Demand	2029	>2033	>2033	>2033
High demand	2029	2033	>2033	>2033
Low demand	2033	>2033	>2033	>2033
Increased demand response	2031	>2033	>2033	>2033
Tiwai exit	>2033	>2033	>2033	>2033
Reference case (SI-WEM)	**2028**	**2030**	**2030**	**>2033**
Additional Step Demand	2026	2028	2028	>2033
High demand	2027	2028	2029	>2033
Low demand	2028	2030	2033	>2033
Increased demand response	2028	2031	2032	>2033
Tiwai exit	>2033	>2033	>2033	>2033

Excluding the *Tiwai exit* sensitivity, under all remaining demand side sensitivities, development on top of the existing and committed generation (Stage 1) is needed within the next decade to maintain the SI-WEM and NZ-WEM above the lower security standard.

Figure 20 shows that under the *low demand growth* and *increased demand response* sensitivities the SI-WEM crosses the lower security margin in the same year as the reference case (2028) when considering existing and committed generation. The *additional step demand* sensitivity increasing South Island demand accelerates the need for development of consented generation by two years to 2026, while the *high demand* sensitivity accelerates this need by one year to 2027. Development of the unconsented pipeline (Stage 4) is required to maintain the SI-WEM above the lower security standard for the reference case and all demand sensitivities excluding *Tiwai exit*, over the assessment horizon.

Increasing north-to-south transfer capability could also help increase the SI-WEM above the lower security standard with less generation investment needed, as shown in the *upgraded HVDC* sensitivity in Figure 11.

Figure 20: South Island Winter Energy Margins for the reference case and demand sensitivities

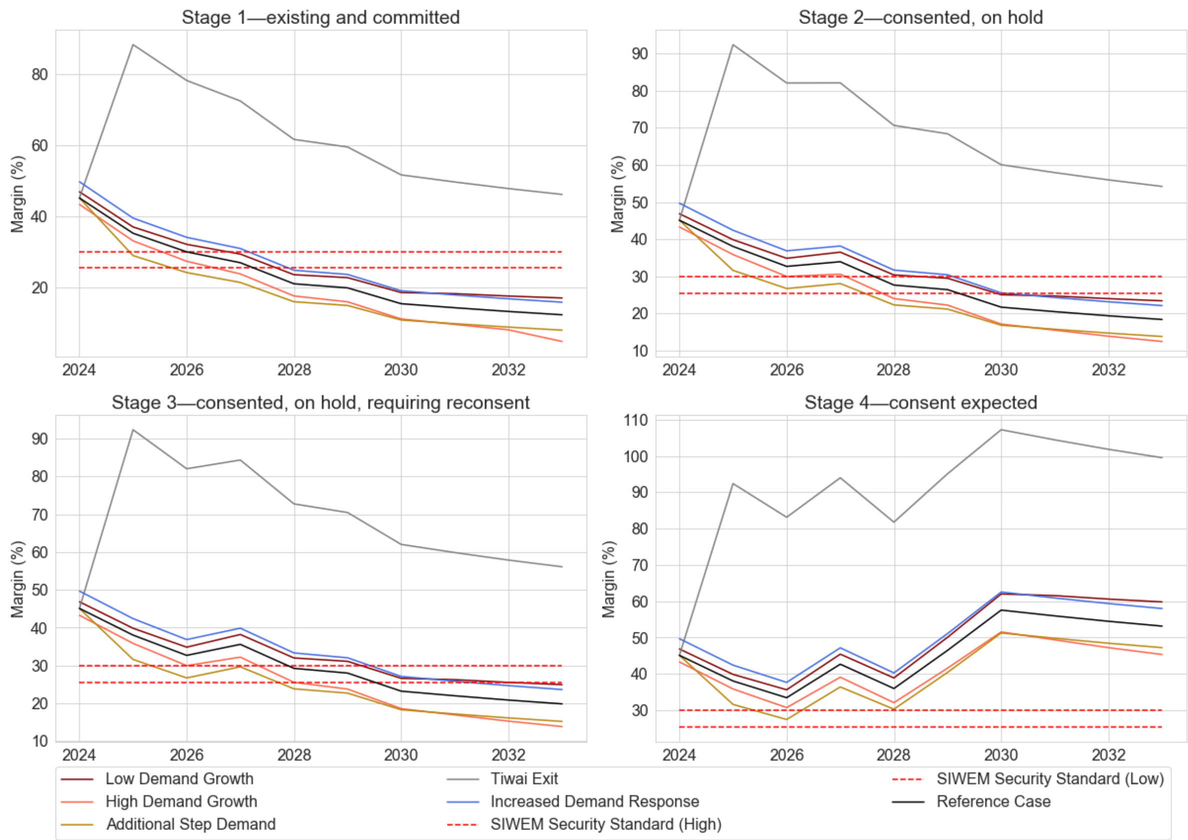
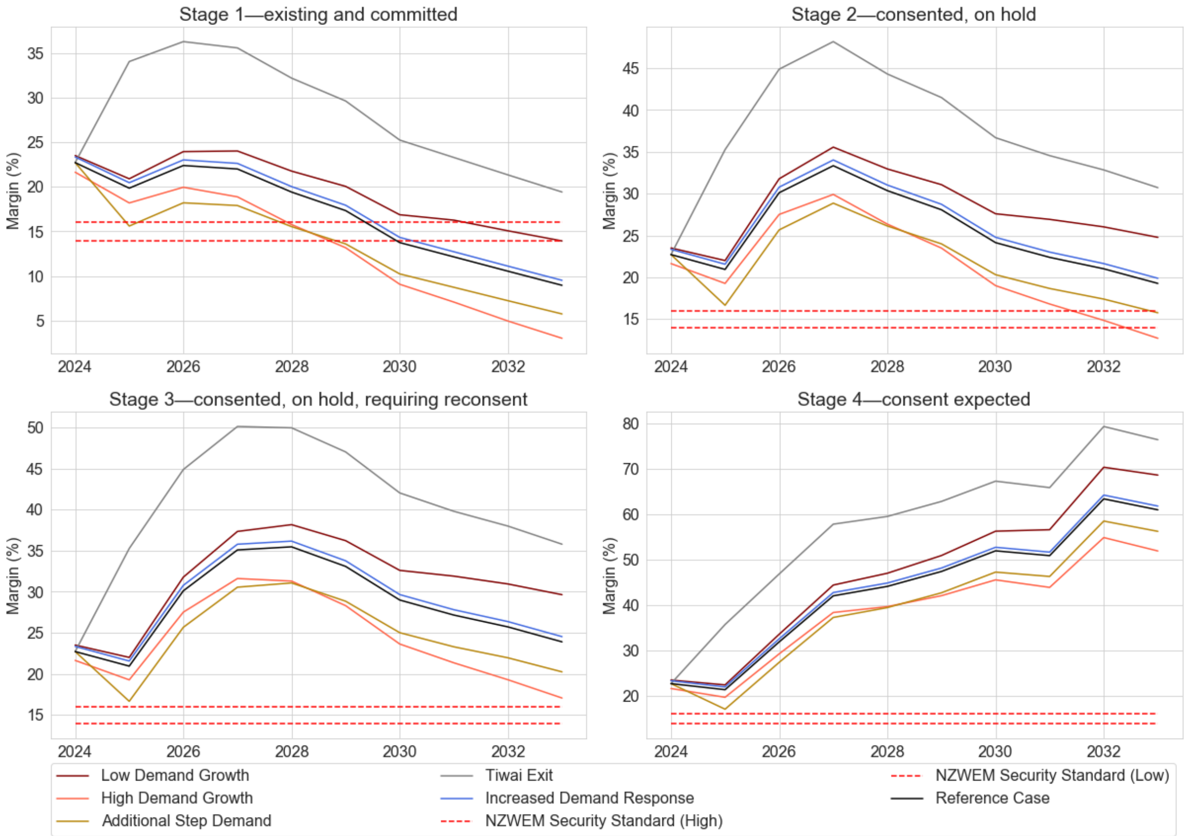


Figure 21 shows there could be a one-year acceleration or up to three-year delay in the need for investment to maintain the NZ-WEM above the lower security margin over the assessment horizon, based on the demand growth sensitivities and existing and committed generation (Stage 1).

When considering only the existing and committed generation (Stage 1), the demand growth sensitivities can cause the NZ-WEM to cross the lower security margin as early as 2029 or delay the crossing to 2033. Development of the Stage 2 pipeline is required to ensure the reference case along with the low demand, increased demand response and the *additional step demand* sensitivities do not cross the lower security standard over the assessment horizon. Development of the Stage 3 pipeline is required to ensure the NZ-WEM does not cross the lower security standard for the reference case or any of the demand related sensitivities.

The *Tiwai exit* sensitivity[47] increases the NZ-WEM and SI-WEM above the security standards over the assessment horizon provided no significant reduction in existing and committed generation capability.

Figure 21: New Zealand Winter Energy Margins for the reference case and demand sensitivities



3.4.2 Capacity

Less capacity contribution from intermittent renewable resources

The intermittency of generation resources in the supply pipeline reduces the pipeline's contribution to capacity margins. However, this could be supplemented by batteries or demand response.

Table 5 compares the years that the reference case crosses the lower security standard for the NZ-WEM and NI-WCM when considering each of the supply pipeline stages.

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[47] In terms of the SOSA modelling the reduction in demand in this sensitivity could be a proxy for large scale, long-duration South Island winter demand response.

- For existing and committed supply projects (Stage 1), the reference case for the NI-WCM crosses the lower security standard three years before the NZ-WEM.
- For the consented projects pipeline (Stage 3), the reference case for the NI-WCM crosses the lower security standard more than three years before the NZ-WEM.
- For the unconsented projects pipeline (Stage 4), the reference case for both margins remain above the lower security standard for the duration of the assessment horizon.

The reason that the NI-WCM crosses the lower security standard reasonably earlier than the NZ-WEM across most pipeline stages is due to the supply pipeline being primarily renewable intermittent generation projects, as shown in Figure 6. There is a lack in flexible peaking capacity in the consented pipeline (Stage 3). While the contribution of intermittent generation assets to energy requirements over the entire winter period is relatively predictable, their contribution to capacity requirements for a specific peak is less certain.

This issue could be addressed with the addition of flexible peaking resources such as batteries, peaking generation, and demand response. Most of the signalled battery capacity is currently not consented (Stage 4). These currently unconsented resources need to come to market to increase the NI-WCM above the security standards.

Table 5: Comparison of years in which the New Zealand Winter Energy Margin and North Island Winter Capacity Margin cross the lower security margins

Reference case margin	Stage 1	Stage 2	Stage 3	Stage 4
New Zealand Winter Energy	2030	>2033	>2033	>2033
North Island Winter Capacity	2027	2029	2030	>2033

Demand response can help mitigate near-term demand uncertainty risks and delay investments in supply

Demand response over peak periods can help delay the need for investment in supply. Some demand response capability can come to market quicker than supply-side options meaning these can be a viable short-term option. Table 6 and Figure 22 show that based on our current assessment, unconsented supply side resources are needed to maintain the NI-WCM above the lower security standard.

Table 6: North Island Winter Capacity Margin earliest crossing of the lower security standard for the reference case and demand side sensitivities

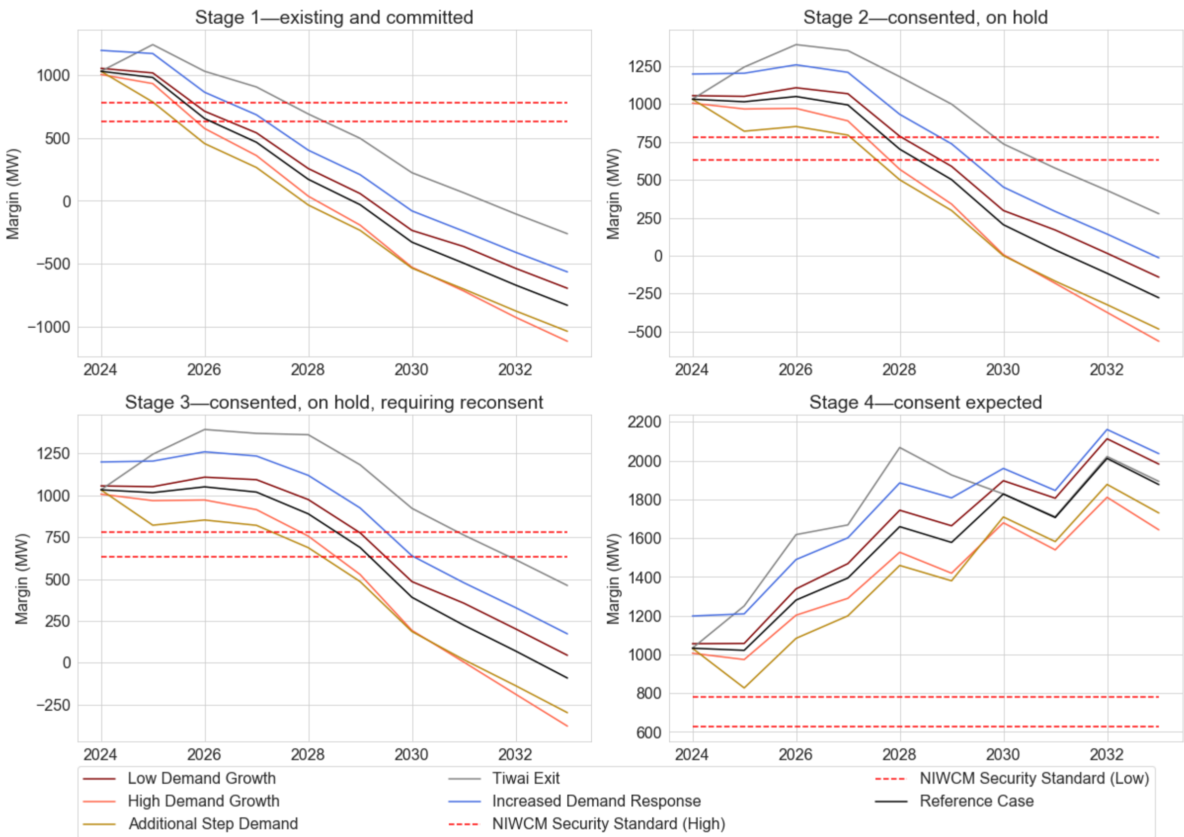
Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
Reference case	**2027**	**2029**	**2030**	**>2033**
Additional step demand	2026	2028	2029	>2033

Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
High demand	2026	2028	2029	>2033
Low demand	2027	2029	2030	>2033
Tiwai exit	2029	2031	2032	>2033
Increased demand response	2028	2030	2030	>2033

Figure 22 shows the *increased demand response* sensitivity delays the crossing of the lower security standard by one year when considering the existing and committed pipeline, and *Tiwai exit* delays the crossing by two years. This provides us a proxy for the impacts of 200-580 MW of demand response over peak periods on the NI-WCM.

Uncertainty in the rate of demand growth (including the *additional step demand* sensitivity) in the short-term can impact the NI-WCM dropping below the standards. As an example, the *additional step demand* sensitivity resulted in the NI-WCM crossing the security standard in 2026. Additional demand response that can come to market quickly can help mitigate these short-term capacity risks.

Figure 22: North Island Winter Capacity Margin crossing of the lower security standard for the reference case and demand sensitivities



Constrained operational capacity risk requires further development of flexible resources

Integrating a mix of slow start thermal generation and intermittent renewable generation will keep the NI-WCM below the security standards during specific operational conditions for the coming decade regardless of whether expected investment is developed. With development of the entire unconsented pipeline (Stage 4), the NI-WCM still drops below the lower security standard at the start and end of the assessment horizon under this sensitivity as shown in Figure 13 and Table 7. Additional flexible resources are required, particularly in the near term to increase the NI-WCM above the security standards. Some of these flexible resources such as demand response or batteries can come to market relatively quickly compared to traditional peaking generation options.

Table 7: North Island Winter Capacity Margin earliest crossing of the lower security standard for the reference case and constrained operational capacity *sensitivity*

Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
Reference case	**2027**	**2029**	**2030**	**>2033**
Constrained operational capacity	2024	2024	2024	2024

Sufficient early investment in flexible resources is needed to manage risks of thermal retirement and reduced thermal investment

If significant thermal generation assets are decommissioned and no new thermal generation is built, the NI-WCM could cross the lower security standards in 2026, even with development of all the consented projects in the supply pipeline (Stage 3). Development of unconsented projects is needed to increase the NI-WCM above the lower standard for most of the remaining assessment horizon.

Table 8 identifies the years in which the NI-WCM crosses the lower security standard for the reference case and reduced thermal unit availability sensitivities, for each supply pipeline stage. In addition to the sensitivities exploring the impacts of thermal unit availability (which were also applied to the WEMs), the impact of a *dry year reserve* sensitivity on the NI-WCM was also assessed. In this sensitivity a small number of 'baseload' fossil-fuelled thermal generators change their operation so that they only provide dry year reserve from 2027 onwards, so are unavailable to respond to peak demand periods.

Table 8: North Island Winter Capacity Margin earliest crossing of the lower security standard for the reference case and reduced thermal unit availability sensitivities

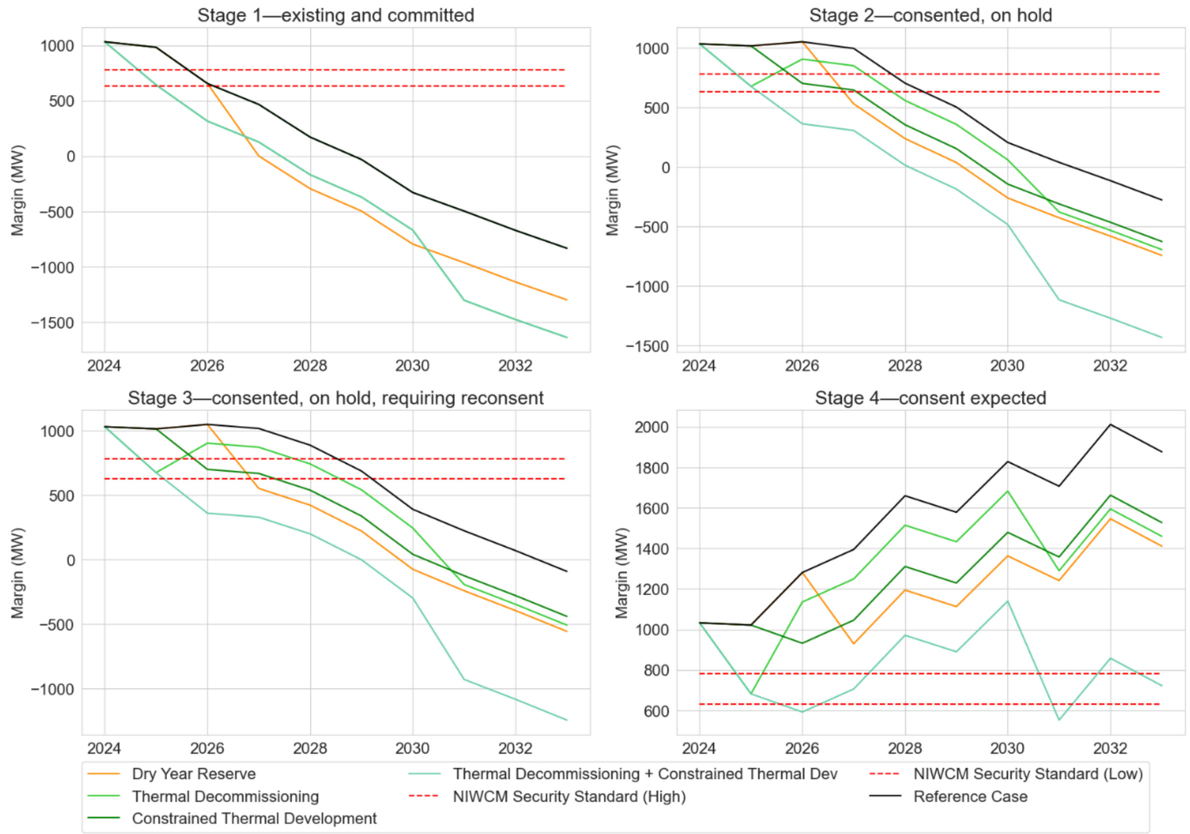
Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
Reference case	**2027**	**2029**	**2030**	**>2033**

Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
Dry Year Reserve	2027	2027	2027	>2033
Thermal Decommissioning	2026	2028	2029	>2033
Constrained Thermal Development	2027	2028	2028	>2033
Thermal Decommissioning and Constrained Thermal Development	2026	2026	2026	2026

Figure 23 shows under the *thermal decommissioning* sensitivity the NI-WCM crosses the lower security standard in 2026, one year earlier than the reference case, for existing and committed generation (Stage 1). At this point the sensitivity assumes ~600 MW of thermal generation has been decommissioned.

Development of consented and unconsented resources (Stage 4) is needed to maintain the NI-WCM above the lower security standard for all thermal availability sensitivities apart from the combined sensitivity where existing thermal generation is progressively decommissioned (*thermal decommissioning*) and no new fossil-fuelled thermal generation commissioned (*constrained thermal development*). To maintain the NI-WCM above the lower security standard for this combined sensitivity, some additional flexible resources (beyond those signalled as Stage 4) are needed. As discussed earlier this could be both additional supply-side resources (such as batteries or peaking generation) or additional demand response.

Figure 23: North Island Winter Capacity Margins for the reference case and sensitivities that reduce thermal unit availability



Gas supply essential to maintain security over peak demand periods unless additional flexible resource capability is developed

Table 9 and Figure 24 show the rapid drop-off in the NI-WCM when there is insufficient gas to operate thermal generation, even for peaking, under the reduced gas availability sensitivities. While development of consented and unconsented resources increase the NI-WCM, there is insufficient resources in the current supply pipeline to replace the reduction in gas-fired generation and maintain the NI-WCM above the lower security standard over the assessment horizon.

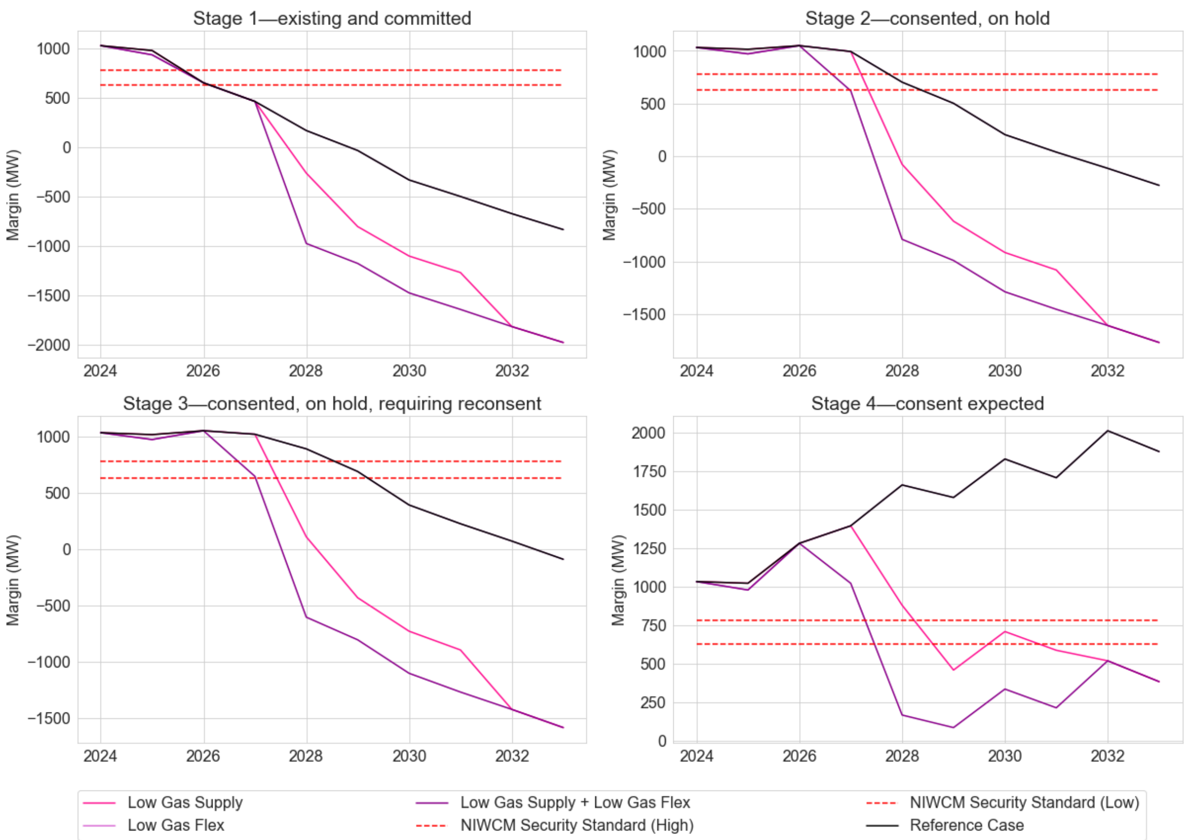
Table 9: North Island Winter Capacity Margin earliest crossing of the lower security standard for the reference case and reduced gas availability sensitivities

Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
Reference case	**2027**	**2029**	**2030**	**>2033**
Low gas	2027	2028	2028	2029
Low flex	2027	2029	2030	>2033

Sensitivity	Stage 1	Stage 2	Stage 3	Stage 4
Low gas + low flex	2027	2027	2028	2028

The reduced gas availability sensitivities show that even with full development of the unconsented pipeline, the NI-WCM could drop below the lower security standard as early as 2028 due to reduced gas supply. Under these scenarios, additional flexible resources need to be developed to sustain the NI-WCM above the lower security standard. In the absence of such investment, sufficient gas supply is needed to ensure adequate gas-fired peaking generation is available to generate over peak load periods.

Figure 24: North Island Winter Capacity Margins for the reference case and sensitivities that reduce gas availability



4.0 Maintaining Security Margins with Greater Proportions of Renewable Generation

4.1 Overview and Summary

Due to the ongoing strong cross-industry drive to de-carbonise electricity generation, in this section we look at a range of thermal generation scenarios together with the 2030 renewable supply pipeline, and the impact this has on the NZ-WEM and NI-WCM. Our approach is to investigate five thermal generation scenarios, which consider progressively smaller amounts of thermal generation. For each of these scenarios we estimate the contribution from renewable generation and other technologies that would be required to maintain the NZ-WEM and NI-WCM above the security standards.

This analysis is exclusively focused on security of supply; we have not investigated economic or technical issues outside of this brief.[48] Consistent with the margin forecasts we present in Section 3.0, we do not attempt to forecast or otherwise determine the likelihood of whether any of these scenarios could occur.

Using the full unconsented (Stage 4) supply pipeline there are indications that:

- there are sufficient potential renewable supply projects to provide the additional energy required to maintain the NZ-WEM at the lower security standard for all five thermal scenarios THM1 – NoTHM (see Table 10);
- there are sufficient potential renewable supply projects to provide the additional capacity required to maintain the NI-WCM at the lower security standard for thermal scenarios THM1 and THM2; and
- there are insufficient potential renewable supply projects to provide the additional capacity required to maintain the NI-WCM at the lower security standard for thermal scenarios THM3 – NoTHM.

The majority of the renewable supply pipeline is intermittent generation (wind and solar). Due to their shorter-term intermittency, these resources have a greater contribution to the winter energy margin compared to the winter capacity margin. This indicates greater capacity risks compared to energy risks under three thermal generation scenarios with the new supply pipeline.

The entire renewable supply pipeline, including existing generation and unconsented generation (i.e. Stage 4) could contribute 33,032 GWh of winter energy and around 5,459 MW of winter capacity by 2030. To bring this renewable supply pipeline to market would require a significant increase in the pace of development, including consenting, construction, and

[48] As an example, with more low short-run marginal cost (SRMC) intermittent renewable generation coming online the market spot prices would reduce and price volatility would increase. This could dampen future revenue expectation of new projects and impact investment decisions. These revenue adequacy effects were not considered in this assessment of the modelled supply pipeline. Technical issues are those related to the impacts on power system voltage, frequency and power quality with the introduction of large amounts of inverter-based intermittent generation. These technical issues are being considered as part of the Authority's Future Security and Resilience project.

regulatory development.[49] Outside of the supply pipeline, development of additional flexible resources such as batteries, demand response, non-generation reserve and upgrades to increase the HVDC northward capacity could contribute to improving the NI-WCM.

4.2 Thermal Generation Scenarios

We have developed five thermal generation scenarios, set out in Table 10 below. These scenarios consider progressively less thermal generation than current levels.

Figure 25 and Figure 26 set out the scenarios' relative contributions to winter energy and capacity margins.

These thermal generation scenarios should not be interpreted as indicating a potential or likely pathway to higher proportions of renewable generation. It is possible that the pathway to higher proportions of renewable generation will involve step changes in thermal generation that vary from the thermal generation scenarios that this analysis considers.

Table 10: Thermal generation scenarios

Scenario	Description
THM1 One Rankine unit (dry year support only), one closed cycle gas turbine (CCGT) remains	One Huntly Rankine unit remains for dry year support, while two are decommissioned. We assume that this Rankine unit will not contribute to winter capacity margins. One CCGT remains at Huntly, which contributes to both energy and capacity margins; the other CCGT at Stratford (TCC) is decommissioned. All other remaining thermal generation is available to contribute to winter energy and capacity security margins.
THM2 No Rankine units, one CCGT remains	All Huntly Rankine units are decommissioned. Note this scenario has the same contribution to the NI-WCM as the THM1 scenario. This is because, even

[49] An example of regulatory development required to support the supply pipeline is the development of regulation for offshore wind generation. Technical considerations also need to be taken into account to ensure reliable operation of the power system with significant amounts of inverter-based intermittent generation.

Scenario	Description
	though THM1 has one Huntly Rankine unit in service, it does not contribute to the NI-WCM. The CCGT at Huntly continues to contribute to winter energy and capacity security margins, the other CCGT at Stratford (TCC) is decommissioned. All other remaining thermal generation is available to contribute to winter energy and capacity security margins.
THM3 No Rankine or CCGT units	The CCGT and all Rankine units at Huntly are decommissioned, the other CCGT at Stratford (TCC) is decommissioned. All other remaining thermal generation is available to contribute to winter energy and capacity security margins.
THM4 Whirinaki and co-generation	Only gas co-generators and the Whirinaki diesel generator remain.
NoTHM No thermal, including Whirinaki and co-generation	There is no gas, coal or diesel thermal generation.

Figure 25: Thermal scenarios' contribution to winter energy margins

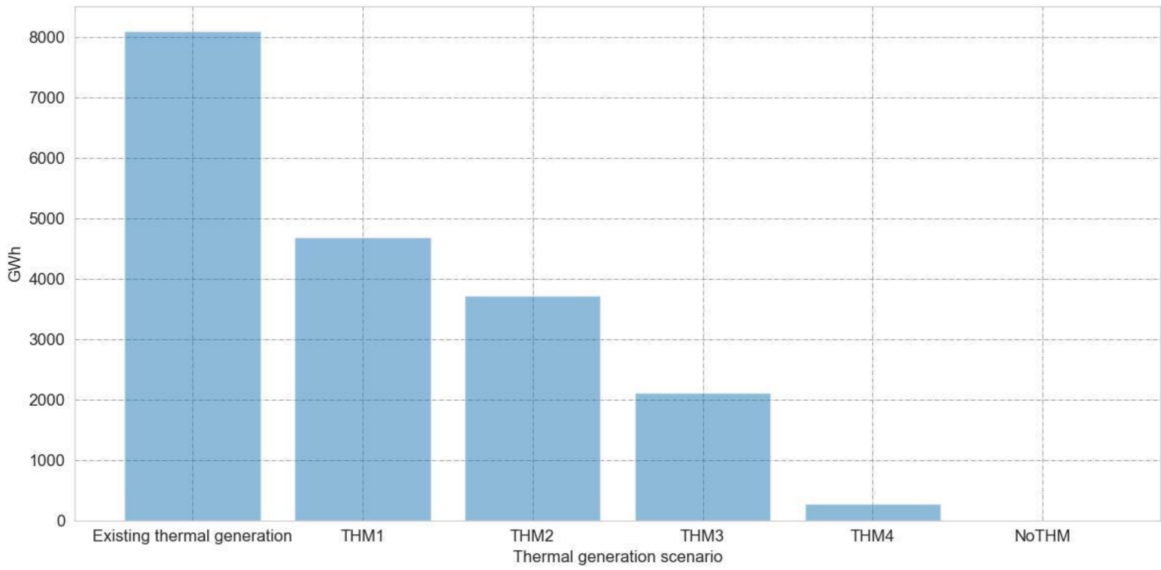
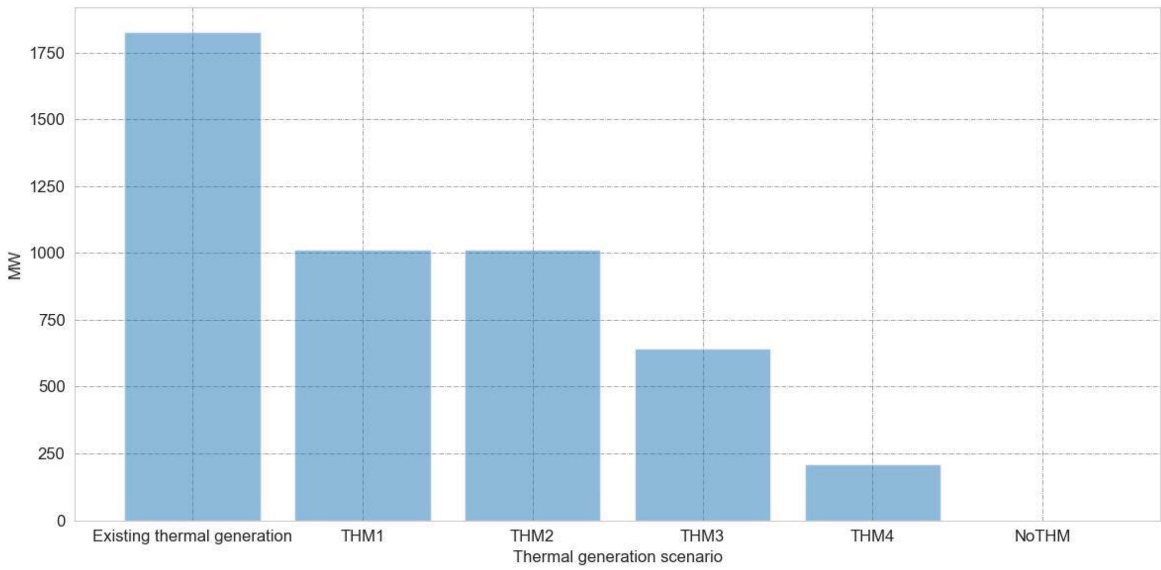


Figure 26: Thermal scenarios' contribution to winter capacity margin



4.3 Security Margin Impacts

4.3.1 Winter Energy Margins

To displace the thermal generation in each of the scenarios, supply the increased level of demand expected by 2030, and maintain the NZ-WEM above the lower security margin, significant contribution is required from projects additional to those in the consented renewable projects pipeline.

Figure 27 compares the energy required to maintain the NZ-WEM at the lower security standard to the energy contribution in each of the thermal generation scenarios and from the renewable supply pipeline in 2030. These contribution calculations use the reference case. The green bars show potential contributions from known consented renewable projects in the supply pipeline (Stages 2 and 3).[50] The blue bars show the potential contributions from known unconsented renewable projects (Stage 4). The grey dotted line shows the amount of energy required to maintain the NZ-WEM above the lower security margin. This indicates that:

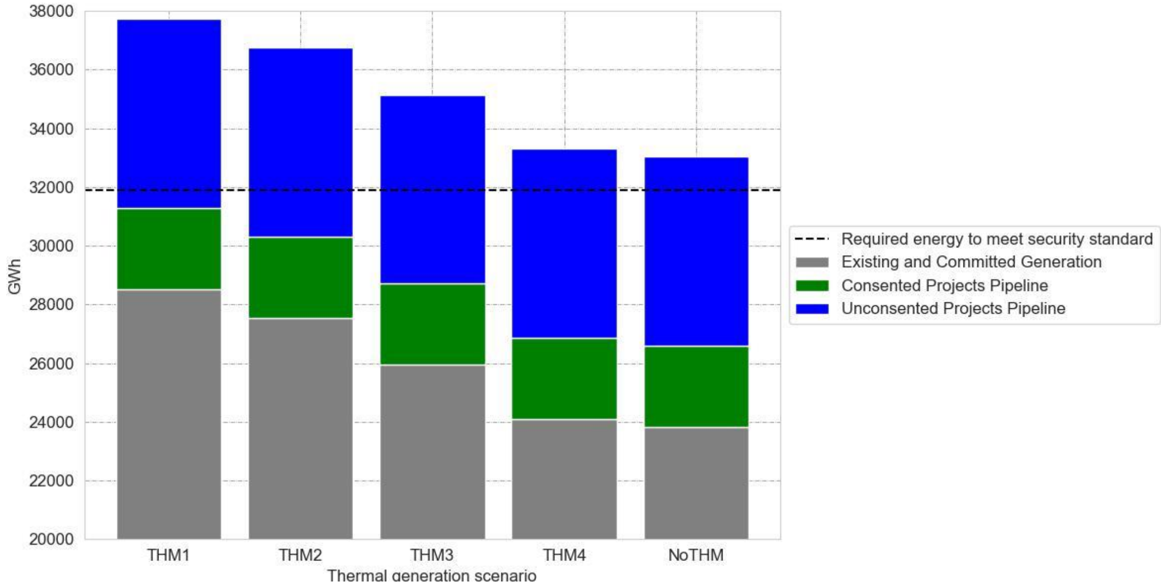
- The consented and unconsented projects pipeline is sufficient to maintain the NZ-WEM at the lower security standard for the five thermal scenarios.
- For the NZ-WEM to be maintained above the lower security standard for any scenario, development of the unconsented renewable projects in the pipeline (Stage 4) are required.[51] The consented projects alone are not sufficient to maintain the NZ-WEM.

The entire renewable supply pipeline (Stage 4) could contribute 33,032 GWh of winter energy.

[50] See Table 1 for a description of the project pipeline stages.

[51] As noted previously, given these projects are currently unconsented, there is a higher level of uncertainty around their delivery.

Figure 27: Energy available to meet NZ-WEM lower security standard in different thermal scenarios



4.3.2 Winter Capacity Margins

Figure 28 compares the capacity required to maintain the NI-WCM at the lower security standard to the capacity contribution in each of the thermal generation scenarios and from the renewable supply pipeline in 2030.[52]

The extent to which South Island generation can contribute to the NI-WCM is limited by the capacity of the HVDC. For our assessment of capacity margins, we assume that the current northward capacity of the HVDC is constrained to ~950MW.[53]

The grey dotted line shows the amount of capacity required to maintain the NI-WCM above the lower security margin. This indicates that:

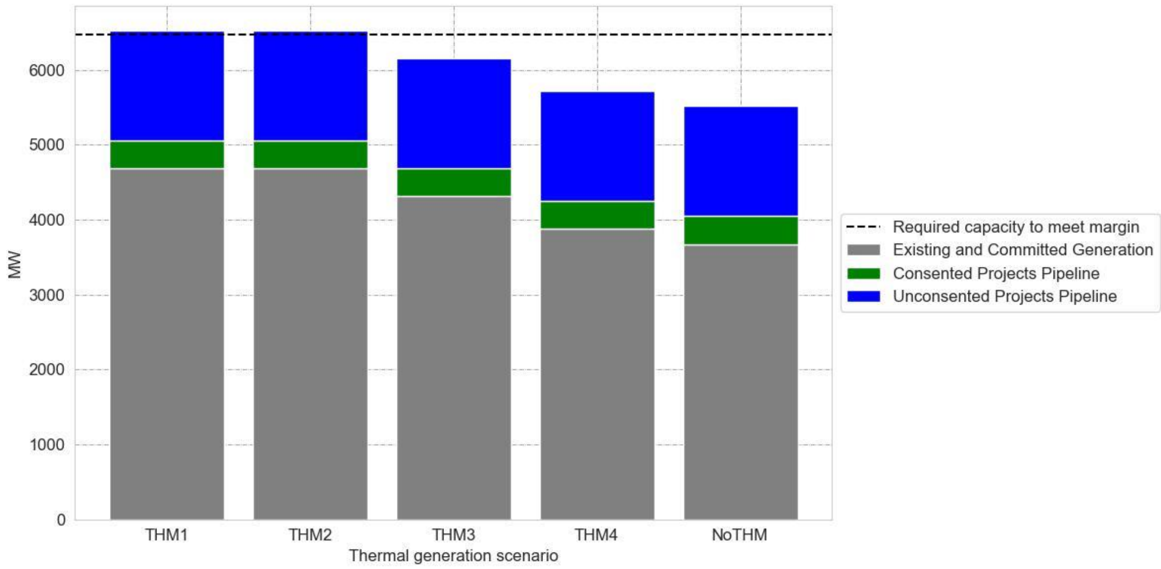
- The consented and unconsented renewable projects pipeline is sufficient to provide the additional capacity required to maintain the NI-WCM at the lower security standard for thermal scenarios THM1 and THM2 (i.e. decommissioning of the Rankines and one CCGT); and
- The consented and unconsented renewable projects pipeline is insufficient to provide the additional capacity required to maintain the NI-WCM at the lower security standard for the thermal scenarios THM3 – NoTHM (i.e. remaining thermal up to 100% renewable supply).

[52] Note the THM1 scenario has the same contribution to the NI-WCM as the THM2 scenario. This is because even through THM1 has one Huntly Rankine unit in service (whereas the THM2 scenario has none), this unit does not contribute to the NI-WCM in the THM1 scenario.
[53] This is without the HVDC fourth cable.

The contribution of unconsented projects to the capacity margin is considerably lower than for the energy margin, given that most projects that are still unconsented are wind and solar, which have a lower contribution to winter peak demand compared with energy over the winter period.

To maintain the NI-WCM above the lower security standard under the different thermal scenarios, up to 1,013 MW of additional winter capacity resources are required. This indicates increased capacity risks under the reduced thermal generation scenarios unless additional peak capacity resources are planned to compensate for the reduced thermal generation capability.

Figure 28: Capacity available to meet NI-WCM lower security standard in different thermal scenarios

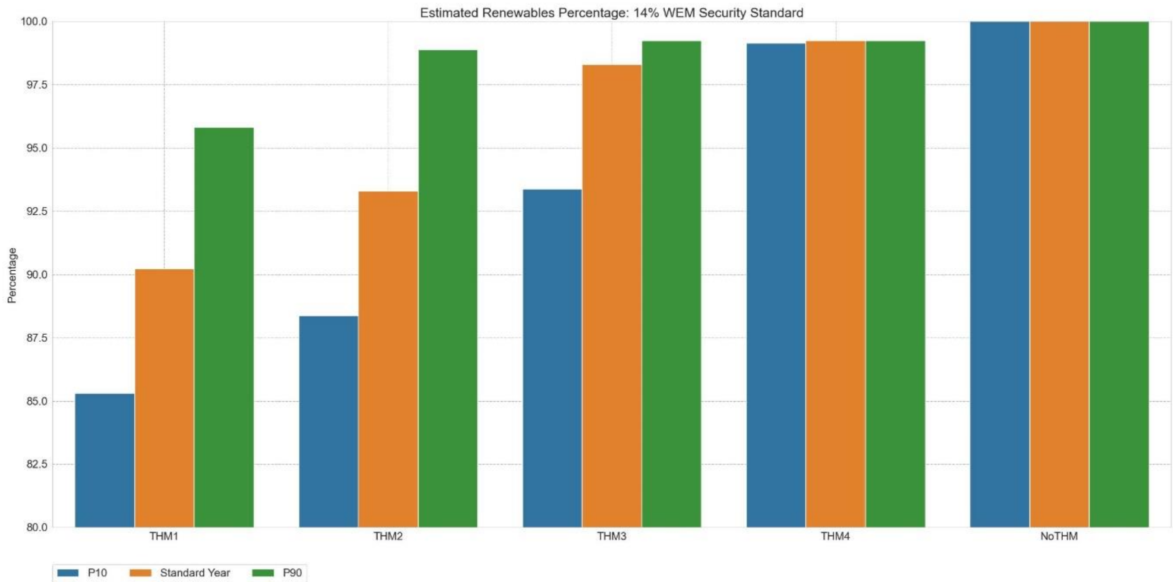


4.4 Renewable Generation Percentage Estimates

Figure 29 shows annual renewable generation as a percentage of forecast demand for each thermal generation scenario. Renewable generation percentages are shown for a standard hydrological year (orange bar), as well as dry (P10, blue bar) and wet (P90, green bar) hydrological years. P10 and P90 refer to the lower and upper percentile range of historical hydro inflows respectively. The amount of generation assumed for each scenario is equal to that required to maintain NZ-WEM at the lower security standard.

For the THM2 scenario and other scenarios with less thermal generation to maintain the NZ-WEM security standards, this implies a level of renewable generation 'over build'. This means that for wet years the amount of renewable generation capacity will be greater than required to meet demand, resulting in spilling of renewable sources due to insufficient storage.

Figure 29: Renewables percentages: medium demand scenario and as required to maintain a 14% security standard



We have not considered the use of alternative technologies, such as pumped storage or large industrial demand response, in our analysis; these would alter our P10 and P90 estimates. These alternative technologies may also reduce the quantity of excess generation developed (and excess energy generated).

The amount of new renewable generation that this analysis assumes to meet energy margin security standards would not be sufficient to maintain the NI-WCM above the lower security standard. While it is uncertain how the NI-WCM would be maintained for each thermal generation scenario; it is likely that a mix of complementary technologies could be used. This could, for example, include a combination of renewable generation over build, demand flexibility, storage or renewable thermal fuels such as hydrogen or biomass.

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