Appendix A: Lessons from winter 2023 and the preliminary outlook for winter 2024 and winter 2025

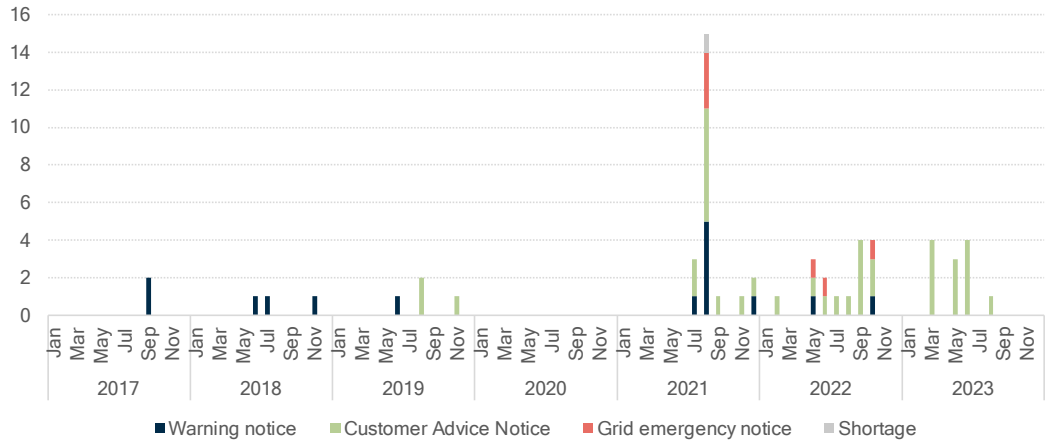
1. The following assessment of winter 2023 and the outlook for winter 2024 and winter 2025 have been used to inform this paper.

Winter 2023 passed with no loss of supply incidents due to peak coordination issues

2. During winter 2023, consumers did not experience forced outages due to coordination issues despite a number of significant plant failures and high peak demand periods. The Authority will be releasing an analysis of the notified low residual periods and the industry response later in 2023.

3. The system operator issued 12 Customer Advice Notices (CANs) to advise of a low-residual situation[1] between March and August 2023 (Figure 1).

Figure 1: Number of low residual and insufficient generation notices by month, January 2017 to August 2023.



4. A ‘low-residual situation’ is when the projected headroom in the supply stack (after taking into account energy, reserve and frequency keeping requirements) is less than 200MW. Once residuals are below 200MW, there is little room to manage any large unforeseen changes in generation or demand whilst maintaining standard reserve levels.

5. If there is insufficient generation to cover demand, the system operator can release Warning Notices (WRNs), or Grid Emergency Notices (GENs). Notably, the system operator did not issue any WRNs or GENs this winter. Participants responded to the CANs, and demand control was not required.

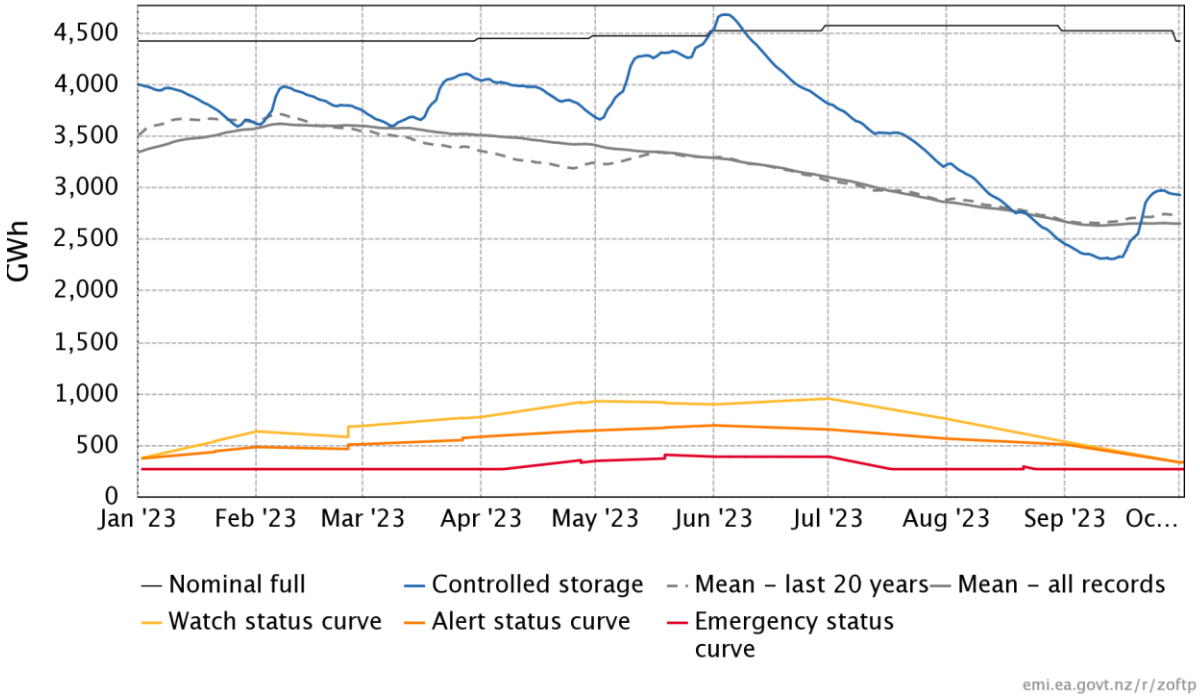
[1] Low Residual Situation CANs were introduced in May 2019. See: Transpower. *Costumer Advice Notice.* May 3, 2019. Available at: CAN Industry Update Introduction of Low Residual Situation 3098623458.pdf (amazonaws.com)

High hydro storage increased the challenge of meeting peak demand

6. For the past three years, New Zealand has experienced La Niña weather patterns. This contributed to dry weather in the South Island, and wet conditions across the upper half of the North Island.

7. Overall, hydro storage has been high for the first half of the year as illustrated by Figure 2 below.

Figure 2: Historical electricity risk curves (ERCs) against controlled storage



8. Although high hydro storage assists with meeting New Zealand's energy needs over winter, high hydrology can increase the challenge of meeting peak demand. This is because – when hydro storage and generation is high – the average electricity price tends to be lower. Lower prices reduce the commercial incentives for thermal generators to offer into the market. Consequently, there is less spare capacity on the system to maintain supply when there are unexpected changes (eg, such as a sudden increase in demand or a sudden drop in wind generation).

9. Low thermal-unit commitment and below-average wind generation led to the system operator issuing seven low residual CANs between May and June,[2] even though demand was not exceptionally high.

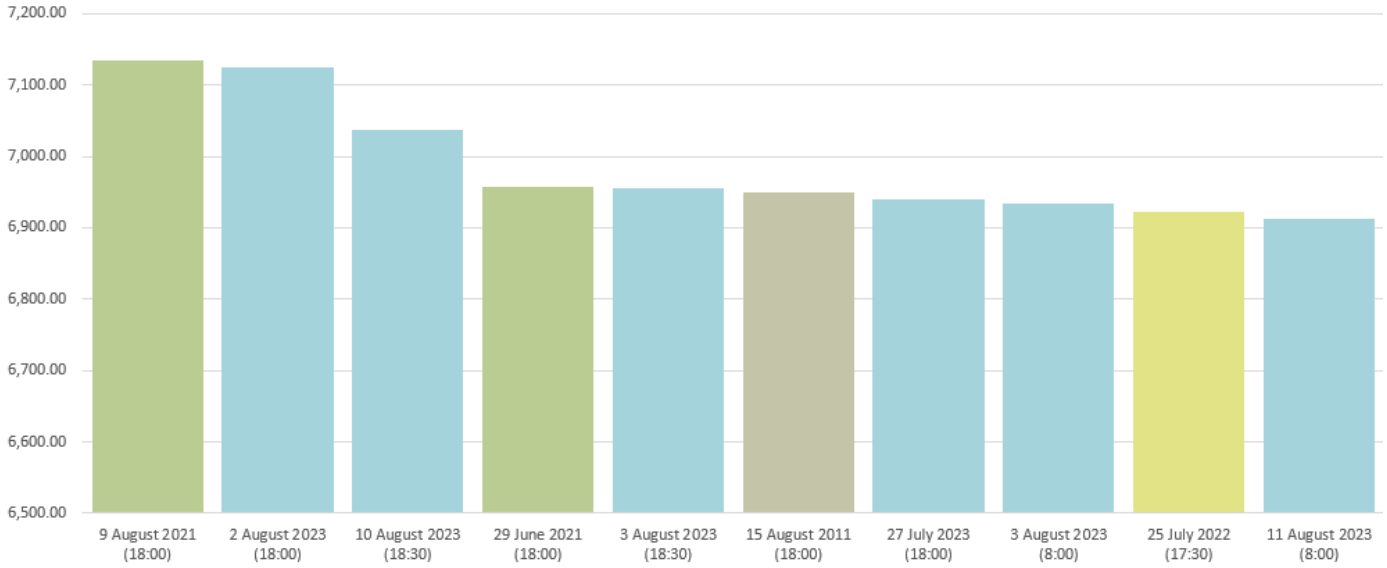
10. The situation started to reverse in June with hydro storage declining sharply. Higher prices along with the unplanned outage of Huntly unit 5 at the end of June resulted in greater thermal commitment over the remainder of winter.

[2] The system operator also issued 4 low residual CANs in March. These CANs coincided with an HVDC outage.

The system experienced six record demand peaks this winter

11. Average temperatures for August were the coldest experienced in seven years.[3] Six of the top 10 record demand peaks occurred this winter, with five of these occurring in August (Figure 3). Despite these high peaks, high thermal commitment meant that the system operator only issued one low residual situation CAN for the 11 August 2023 morning peak. All other demand peaks passed with residuals of between 322MW and 547MW. There were no periods of insufficient generation, and the system operator did not have to instruct any participants to reduce discretionary demand.

Figure 3: Top MW demand peaks (trading period average)



High thermal fuel availability provided resilience against asset failures

12. A significant amount of generation capacity was on unplanned outage this winter. Most notable was the tripping of Huntly unit 5 on 30 June 2023 followed by an extended outage.[4] This removed 403MW of capacity from the system. Genesis responded by committing its three Rankine units.

13. The three-month planned outage by Methanex during winter meant that approximately 90TJ of gas was available to other users, such as the Rankine units, allowing for thermal plant to run relatively unconstrained. It is also worth noting that while extra gas was available, the coal stockpile was also high heading into winter and sufficient to run a single Rankine unit at full capacity for a 12-month period.[5]

14. Additionally, the Stratford peaker GT22 (thermal), Manapouri (hydro) and Kawerau (geothermal) plants experienced unplanned outages. While the units at Manapouri

[3] NIWA. *Climate Summary for August 2023.* September 2023, 4. Available at: https://niwa.co.nz/climate/monthly/climate-summary-for-august-2023

[4] Huntly unit 5 is expected to return to service in late January 2024.

[5] Transpower. *Winter 2023 review.* October 2023. Available at: https://static.transpower.co.nz/public/bulk-upload/documents/Transpower%20Winter%202023%20Review.pdf?VersionId=IxfXgTAuXrk7rjbDNoyy_YFg.bWND481

and Kawerau have returned to service, Contact Energy has advised its Stratford peaker GT22 will not be returned to service until February or March 2025. The Ahuroa gas storage facility also downgraded its storage capability.

15. These unplanned outages highlight that some of Aotearoa New Zealand's generation fleet is ageing, impacting its reliability. This increases the risk of meeting the system's energy and capacity needs in winter 2024 and beyond.

16. High thermal commitment over July and August resulted in fewer low-residual situations and enabled continued supply during periods of high peak demand. However, the reduction in capacity meant that the power system was vulnerable to any further asset failure, or a severe cold weather event.

The industry has worked together to meet the challenges of winter 2023

17. The pan-industry grid emergency exercises in May 2023 provided an opportunity for the system operator and participants to practise and refine their operational and communication processes during potential tight supply situations.

18. In its review of winter 2023, the system operator has noted that this year more planned outages were scheduled to avoid peak demand periods than previous years.[6] This increased capacity and flexibility to meet peak demand periods.

19. The system operator also noted that market participants responded to low residual situation CANs by committing more generation and cancelling outages: 'the response from participants avoided four potential grid emergencies, which would have either seen the power system operating with less reserve than required or managing controllable load down' (p. 20).[7]

20. Anecdotal evidence from engagement with industry stakeholders suggests that the options implemented for winter 2023 have been helpful with managing the risks for winter 2023. Improved information around the residual, wind generation, price sensitivities and the level of available discretionary demand along with cooperation by industry and improved communications from the system operator have resulted in good outcomes for this winter.

21. Following the five low residual CANs published between June and August, distributors indicated that an average of 167MW was available as discretionary demand.

We expect the coordination challenges for winter 2024 and 2025 to be similar to this winter

22. The system operator has previously expressed concerns about the outlook for winter 2024. Referring to its Security of Supply Assessment published in June 2022,

[6] Transpower. *Winter 2023 review.* October 2023. Available at: https://static.transpower.co.nz/public/bulk-upload/documents/Transpower%20Winter%202023%20Review.pdf?VersionId=IxfXgTAuXrk7rjbDNoyy_YFg.bWND481

[7] *Ibidem*

[8] the system operator suggested that that under certain scenarios the winter capacity margin could fall under the security standard in the Code as early as 2024.

23. In December 2023, the system operator will publish a detailed analysis of the peak and energy demand challenges that they foresee for winter 2024 and beyond. However, in their review of winter 2023, the system operator notes that 'the sustained growth in demand and intermittent generation informs our view that the challenges in winter 2024 will be similar to this winter and demonstrates the need for investment in flexible resources to balance demand' (p. 6).[9]

24. The following sections outline the differences we expect to see between this winter and the next two winters.

El Niño conditions may or may not increase coordination challenges

25. The National Institute of Water and Atmospheric Research (NIWA) confirmed the change to El Niño conditions was declared at the end of September 2023. El Niño brings stronger or more frequent winds from the west in the summer, which can lead to wet conditions in the west and drier conditions in east of the country. El Niño winters tend to bring more southerly winds which bring colder weather.

26. NIWA is predicting normal to above normal rainfall over summer in the west and south of New Zealand, where some hydro catchments are located.

27. It is too early to predict the likely impact on hydro storage. As at the end of October, national storage is currently slightly above average for this time of year.[10] The expected rainfall over summer could reduce the likelihood of an energy shortage during 2024. However, as discussed earlier, high amounts of hydro generation could also reduce the amount of slow start thermal generation available to start up quickly.

28. If hydro storage gets low, hydro generators will start conserving water instead of generating. This will be signalled through an increase in the offer price for generating with stored water resulting in an increase in average wholesale prices. Slow start generators, such as Huntly units 1, 2 and 4 and the Stratford combined cycle unit, would be more likely to run and may reduce the likelihood of peak capacity coordination issues.

Increased investment is starting to impact installed capacity

29. The capacity of installed resource is expected to change over the near term. New generation is due to be commissioned, battery energy storage systems are planned or under construction and efficiency improvements to existing hydro generators are being made. This increase is against a backdrop of expected thermal generation retirement.

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[8] Transpower. *Security of Supply Assessment 2023.* June 2023, 26. Available at: https://www.transpower.co.nz/system-operator/planning-future/security-supply-annual-assessment

[9] Transpower. *Winter 2023 review.* October 2023. Available at: https://static.transpower.co.nz/public/uncontrolled_docs/Winter%202023%20Review.pdf?VersionId=Zxdbk14diwGA43UuzjYGV8IhGj44cbji

[10] EMI. *Historical electricity risk curve.* Available at: https://www.emi.ea.govt.nz/Environment/Reports/3UN1KD?_si=v%7C3

30. New intermittent generation sources will help with energy security of supply, but they do not contribute equally to addressing capacity concerns. The winter capacity margin calculation performed by the system operator typically only includes 20% of the installed capacity of intermittent generation. It should be noted that total wind generation can reduce to almost zero during particularly still periods.

31. New sources of firming capacity such as hydro, geothermal and Battery Energy Storage Systems (BESS) will contribute to alleviating capacity concerns (Table 5). Emerging demand-response solutions are also an important area of flexibility to assist with managing demand peaks.

Table 5: An overview of the announced investment in firming generation (including BESS) for winter 2024 and winter 2025

For winter 2024			For winter 2025		
Plant	Type	MW	Plant	Type	MW
Tuai and Karapiro	Hydro (upgrades)	23	Tuai	Hydro (upgrade)	6
Rotohiko	BESS	35	Tauhara	Geothermal	174
			Te Huka	Geothermal	51
			Ruakākā	BESS	100
Total		58	**Total**		331
Large known outages or retirements (firming generation)					
Stratford peaker GT22	Gas	-100	TCC	Gas	-360

32. Genesis has also completed engineering reviews for large grid-scale batteries at Huntly.[11] Its scale and timeframe, however, have yet to be announced.

33. A recent Transpower report[12] has highlighted the growing investment in BESS. Transpower advises that it 'currently has 410MW of dedicated BESS in its connection queue, and a further 3,035MW of solar with BESS firming (330MW of which is consented and 230MW of this is currently in delivery). An additional 500MW is now under investigation and expected to be completed within 12 months' (p. 14).

[11] Genesis. *FY23 Results presentation.* August 2023, 24. Available at: https://media.genesisenergy.co.nz/genesis/investor/2023/genesis_fy23_results_presentation.pdf

[12] Transpower. *Whakamana i Te Mauri Hiko.* October 2023. Available at: https://static.transpower.co.nz/public/uncontrolled_docs/Monitoring%20Report%20-%20October%202023%20-%20Final.pdf?VersionId=EsTmICODtCwlKdlj97z.R83sqdbET7jN

Summary of challenges for winter 2024 and winter 2025

34. We expect the challenges for winter 2024 to be similar to the challenges experienced this winter.

35. Underlying demand growth has remained flat due to a decrease in industrial load, although there is strong evidence of growing demand peaks.

36. Although the Stratford peaker GT22 is expected to be unavailable for winter 2024, Contact has recently announced that it has sufficient gas contracted and available operating hours to operate its Taranaki Combined Cycle Power Station (TCC) across winter 2024.[13]

37. Huntly unit 5 is expected to return to service in late January 2024.

38. While Genesis will no longer be able to rely on its arrangement for supplying gas to Methanex in the summer in exchange for gas in the winter, Genesis expects its new well in the Kupe gas operation (KS-9) to provide additional gas in early 2024.[14]

39. Overall, the availability of thermal generation for winter 2024 (including sufficient gas and coal storage), combined with the expected commissioning of an additional 58MW of firming generation and the expected availability of (an average of) 167MW of discretionary demand indicate that residuals may continue to be tight but manageable for winter 2024.

40. Winter 2025 may be more challenging due to the planned retirement of TCC. However, an additional 225MW of geothermal generation is expected to be commissioned by winter 2025 and there is evidence of significant quantities of BESS in the investment pipeline.

41. This analysis highlights the importance of accelerating the uptake of demand response and BESS solutions for winter 2024 and winter 2025.

[13] Energy News. *Contact shelves TCC overhaul.* May 2023,19. Available at: Contact shelves TCC overhaul | Energy News

[14] Genesis. *Constant change.* 2023. Available at: https://media.genesisenergy.co.nz/genesis/investor/2023/genesis_fy23_integrated_report.pdf?_ga=2.154961723.2042881402.1696287647-1858662414.1696287647