Confluence of factors threatening electricity reliability

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Contents

Appendices

Tables

Figures

Executive summary

New Zealand households and businesses were asked to reduce electricity use on a chilly morning in May 2024, as Transpower warned of a potential shortfall of electricity supply. The events of 10 May were not an isolated event. Peak supply capacity relative to peak demand had been tightening for nearly a decade, surfacing as a major concern during the load shedding events of 9 August 2021 as well as becoming increasingly urgent last year, and will be a concern for years to come.

This paper considers how the Electricity Authority (the Authority) came to misjudge the market.

We discuss five interweaved factors:

1. The Authority appeared to **lose focus on reliability** (security standards have not been updated for 12 years) as it prioritised a transition to a low-emissions sector and affordability.
2. **How the Authority weighs 'reliable supply' in its statutory objective is now unclear**, though the importance of reliability to consumers continues to increase. The Authority's statutory interpretation document, written in 2011, is stamped advising it has not been updated for legislative change or guidance provided by court decisions.
3. **Threats to electricity security from outside the electricity sector**, notably the troubled gas supply sector, seem to fall within a regulatory governance gap as the Authority remained largely on the sideline while gas supply for peak electricity generation dwindled.
4. The Authority has **muted its independent voice**. If an 'independent' regulator is not steadfast in pursuing its long-term objectives even when in conflict with short-term political aspirations, capital investment will be undermined.
5. **Prices** in the wholesale market have been **constrained by the Electricity Industry Participation Code (the Code) and its application below efficient levels when supply is scarce** relative to demand, damaging incentives to invest for reliable supply.

A legacy of significant hydro generation capacity and past investment in thermal generation plant allowed the electricity sector, including its regulator, to defer a stark choice between market design features to deliver reliable electricity (noting this choice is explicitly faced in other jurisdictions). This choice recognises that the electricity sector will always be the subject of intense political interest as its services are vital to households and businesses.

With the ever-pending threat of government intervention, an independent regulator focused on the long-term benefit to consumers faces a choice between two market design paths. It can govern and defend a market that:

Explicitly allows prices to clear the market at all times

This design involves:

- accepting spot prices will at times be higher than politically palatable
- fostering competitive entry to discipline price discovery rather than regulatory rules
- promoting contracts between consumers (and their retailer agents) for capacity/firm energy to protect consumers and investors against price volatility, and to pay for peak capacity.

OR

Explicitly constrains peak prices

This design involves:

- unambiguous constraints on peak prices
- consumers accepting a levy to pay for peak capacity which is not commercially viable due to the explicit price constraints
- defining credible criteria for the regulator to identify and compensate capacity made unviable by the price constraints, but needed to meet peak demand.

Mixing these two paradigms, by constraining prices (including non-explicit interventions) from clearing the market without a substitute mechanism to fund the missing capacity, is a recipe for electricity shortfalls and panicked and costly government intervention. We are currently on this path.

1. Introduction

We were asked to examine security of electricity supply in New Zealand, and whether current arrangements are delivering the level of security that consumers, in aggregate, expect. The question was triggered by the recommendations from the Market Development Advisory Group (MDAG) report '*Price discovery in a renewables-based electricity system*' (Market Development Advisory Group, 2023). Although the MDAG recommendations were well considered, we were asked if the report 'papered over the cracks' regarding whether current arrangements would deliver security of supply.

Context

A recent event put that question into sharp relief. On 9 May 2024, Transpower advised there was a risk that the wholesale electricity market could fail the next day to fulfil its primary purpose of reliably matching supply to demand, and requested consumers to conserve electricity the next morning.[1]

Demand reduced by about 260MW in response to Transpower's request, through a combination of contracted arrangements (for example, Meridian contracting with the New Zealand Aluminium Smelter for a 20MW reduction) and voluntary reductions in electricity use.[2] Additional generation was made available as maintenance was cut short and Transpower 'constrained-on' plant at a wholesale price below its offer price.[3] Wholesale electricity prices over the relevant part of the morning peaked well below scarcity levels ($459/MWh at Otahuhu at 0730 compared to $4,933/MWh at the same time two days earlier when there was no warning notice or associated public communications).

The events of 10 May are clearly not consistent with a market operating in the long-term interest of consumers. It is likely some consumers curbed their use of electricity (acting in the public interest) when the benefit to them from using that electricity would have exceeded its cost of supply. It is also the case that some generation plant ran when its operating costs exceeded the market price. These immediate outcomes are in themselves welfare-reducing. Long-term costs to consumers will be much larger if incentives and confidence to invest in electrification, generation, and demand reduction were compromised.

Approach taken

We began our inquiry by considering whether the potential electricity shortfall on 10 May was an isolated event. We find it was not, and that the event is symptomatic of a fundamental problem which has been building for nearly a decade. Growth in peak demand has outstripped growth in firm supply capacity since 2015. As a result, there will be more occasions in which a shortfall of generation is predicted and a much higher risk of outages. The market cannot therefore be said to be delivering

[1] Transpower warning notice of 9 May 2024 at 10:51, warning that there may not be sufficient generation and reserve offers to meet demand and N-1 security.

[2] https://www.energynews.co.nz/news/demand-response/158765/industry-households-deliver-260-mw-demand-reduction

[3] Contact Energy, 23 May 2024, letter to Transpower and Electricity Authority regarding response to forecast tight supply on 10 May.

reliable supply for the long-term benefit of consumers, a core element of the Authority's statutory objective.

We discuss five interweaving factors which we consider led the Authority to misjudge the market. We describe the fundamental and stark choice which is now faced by the Authority and the electricity sector if it is to promote reliable supply for the long-term benefit of consumers.

2. Peak capacity is now a problem for reliable supply

2.1 Peak capacity was not a concern for the first 15 years of New Zealand's electricity market

Generating capacity available to meet peak demand is referred to as 'firm capacity,' as it is capacity that must be available during periods of low wind, solar and/or hydro generation. Maintaining sufficient firm capacity to balance supply and demand under peak demand conditions is a central focus of electricity market design globally. Because electricity cannot be stored economically at scale,[4] and electricity demand varies widely over the hours of the year, sufficient generation capacity must be built to balance supply and demand reliably under peak demand conditions.

Transpower's request to reduce electricity use on a chilly May morning may have been an unpleasant surprise to many consumers, but it should not have been a surprise to those monitoring the electricity sector. Peak capacity relative to peak demand had been tightening for nearly a decade, surfacing as a major concern during the load shedding events of 9 August 2021, and becoming increasingly urgent last year. As discussed below, it will be a concern for years to come.

Peak capacity was not a concern two decades ago

Designers of the New Zealand electricity market did not need to be concerned about peak demand for the first decade and a half of the New Zealand wholesale electricity market, from 1996 to about 2015. Peak demand was not a concern because we had 3,000MW of highly flexible hydro generation capacity (able to supply nearly half the system peak demand in the late 2000's), plus a decent amount of gas and coal-fired generation. These legacy assets meant that when the task of scheduling generation plant to meet demand shifted to the market[5] in 1996, there was sufficient generation capacity within the system to meet peak demand. The market design effort could concentrate on how to achieve the most efficient use of that existing capacity.[6]

The focus of reliability concerns over the first decade of the market was solving the 'dry year' problem—that is, the reliability concerns that arise when inflows into the hydro storage lakes are lower than expected. New Zealand's electricity reliability concerns then centred on whether the

[4] BESS (battery electric storage systems) are becoming increasingly economic but are only now being introduced to New Zealand's firm demand stack. The investment case for BESS relies on efficient peak prices, which we discuss further below.

[5] From being an internal management decision by the former monopoly ECNZ, to 'least cost' dispatch based on competing offers to supply.

[6] The New Zealand wholesale market was the first electricity market globally to dispatch generation based on price offers and to solve simultaneously for both energy and short-term reserves. In testimony to the New Zealand Commerce Commission in 2002, Professor Bill Hogan of Kennedy School of Government at Harvard University described the rules of the market at that time as "at the forefront of best practice" (Kieran Murray et al., 2009, p. 12).

available generating capacity could produce sufficient energy over time to meet demand; we were *energy constrained*.

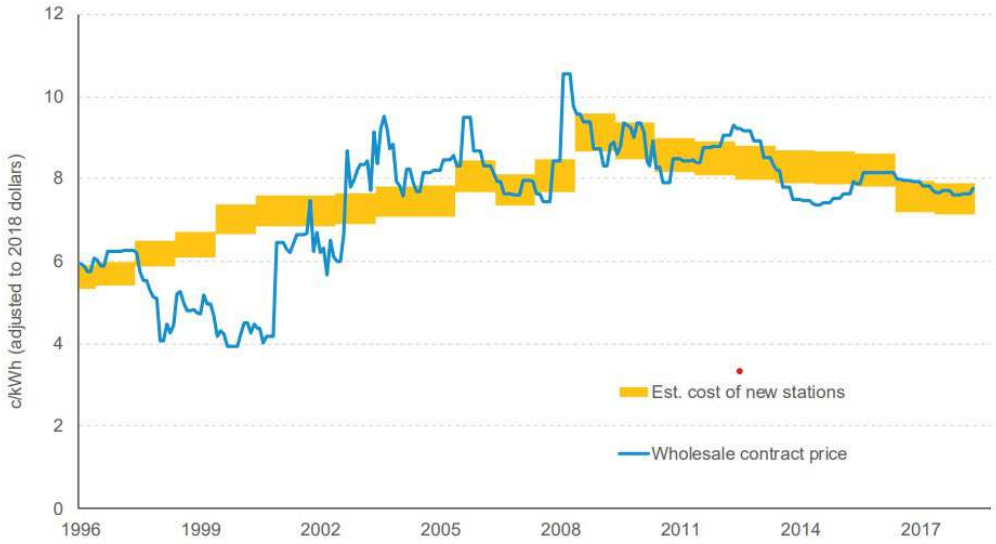
By contrast, designers of electricity markets in the United States, Europe, and Australia were concerned with whether sufficient generating capacity would be in the market at the instant the system reached its peak demand. These markets are *capacity constrained*. In these markets, some generating capacity, invariably thermal generation, is maintained to be used for only a small fraction of the hours during a typical year.

Observed market conditions created no imperative to monitor how investments in peak capacity were rewarded

Little to no growth in peak demand in New Zealand between 2006 and 2015 meant that questions, as to whether the market would provide commercial incentives to maintain capacity to meet peak demand, remained unaddressed for a further decade. Official investigations focused on measures of average price levels, comparing wholesale price levels with the lowest cost source of new generation capacity regardless of whether it could provide firm capacity to meet peak demand.

Figure 1 reproduces a familiar chart from the 2019 Electricity Price Review. As the authors noted, the comparative framework is similar to that adopted in earlier reviews, in particular the 2009 Ministerial Review of Electricity Market Performance, and the 2007 market design review by the Electricity Commission (Electricity Price Review Panel, 2018b, p. 4).

Figure 1: Wholesale contract prices versus cost of building new power stations



Source: Electricity Price Review Panel, 2018b, p. 4

The type of analysis presented in Figure 1 allows broad conclusions that competition is effective in restraining wholesale prices in line with the cost of adding more electricity supply, which has been the finding of each review of wholesale prices (Electricity Price Review Panel, 2018a). However, the analysis provides no insight into whether the market provides sufficient commercial returns to maintain firm capacity, and hence reliable supply.

Meanwhile, the general perception within the industry until about 2015 was that low demand growth was temporary, and demand growth would return. Investment continued in geothermal and wind. Up until 2014, the net increase in firm capacity generally kept pace with or exceeded the growth in peak demand (see Figure 3). To some extent, investment in new capacity 'overshot,' supressing wholesale prices.

By 2015, this 'oversupply' situation challenged the economics of Contact's gas-fired power station, Otahuhu B, and Mercury's gas-fired Southdown plant. The fixed costs of maintaining these power stations were not being recouped by the relatively low wholesale prices, and the plant were decommissioned. The market appeared to be doing what it was designed to do—prices were driving both investment and disinvestment.

The decisions to decommission Otahuhu B and Southdown not only removed energy from the system, but also removed reliable firm capacity. Possibly, these events were the first hint that the remuneration for low-utilisation plant during system peaks (that is, high spot prices for short periods of time) was insufficient for investors. We discuss pricing and the supply of peak capacity in section 6 below.

2.2 Government interventions undermined the business case for investing in firm capacity

Soon after these plant closures, in 2017, the then government announced its intention to remove fossil fuels from the electricity system and to ban offshore oil and gas exploration.

The business case for new firm capacity was undermined by the Lake Onslow proposal…

The Minister of Energy indicated that the government would consider entering the electricity market as a generator. Officially referred to as the New Zealand Battery Project, the investigation focused on a proposed pumped hydro scheme at Lake Onslow. Although the Onslow scheme was initially pitched to resolve dry-year concerns while removing coal generation, it became clear the plant would be used whenever it was 'economic' to operate. Minister Woods described the intent of the scheme would be to draw electricity from the grid when wholesale prices were low to pump water to be stored for generation when prices were high.[7]

Since Onslow would have had an instantaneous capacity of approximately 1,200MW, it would have been the biggest peaker in New Zealand's history. With the prospect of the government entering the market to provide firm capacity on a massive scale, the business case for commercial investment in peak-supporting plant became very difficult, at best.

…and by uncertainty around the future of gas in a low-carbon economy

In 2018, the government moved to ban offshore exploration and in 2022 paused issuing permits for onshore exploration in Taranaki (Wannan, 2024). These interventions, combined with concerns about how the government might view the role of gas as the New Zealand economy decarbonises, and with

[7] Papers showing the evolution of the NZ Battery project are available at: https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/low-emissions-economy/nz-battery

investors increasingly less willing to allocate capital to the greenhouse gas-emitting industry, significantly reduced incentives to invest in maintaining New Zealand gas production. At the same time, major gas fields (Pohokura, Maui, and Kupe) had production problems and declining production rates.

The resulting disruption to the gas market made it progressively more difficult to obtain a fuel contract for a gas-fired generator to meet peak demand.[8]

2.3 Peak pricing signal removed from transmission pricing

During the same period as incentives to invest in peaking plant were supressed by government interventions, the Authority removed the regional coincident peak demand (RCPD) price signal. Under former RCPD pricing, the cost of transmission was allocated based on demand during peak periods in each region. This meant regions with higher demand during peak times paid more for transmission services. The methodology encouraged large consumers to shift or reduce their electricity usage during these peak periods to lower their transmission charges. The RCPD was removed by the Authority in September 2021 when amending the transmission pricing methodology.

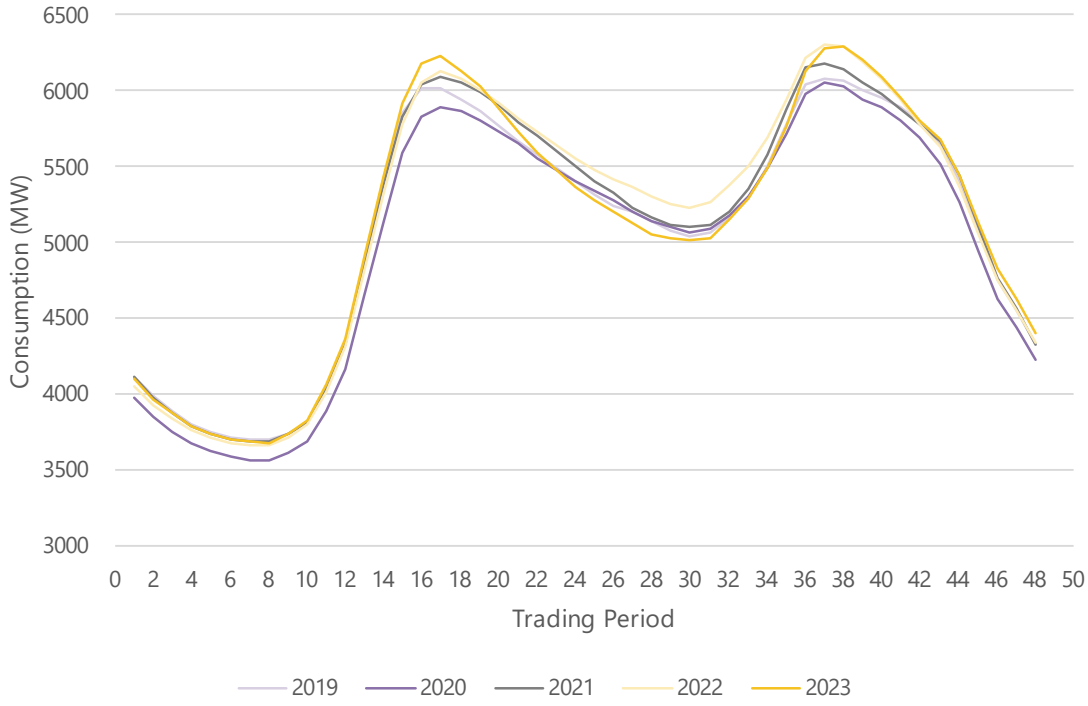
There is evidence that peak consumption has increased since the removal of the peak pricing signal

In Appendix A, we present a comparative analysis of national trading period peak consumption during the winters of 2019 to 2021 (RCPD winters), and the winters of 2022 and 2023 (post-RCPD winters). This analysis reveals an average increase of 157MW (or 2.6 per cent) of daily peak consumption in 2022 and 2023 compared to 2020 and 2021. This analysis confirms the findings from the Authority's 2023 report that peak consumption increased after the RCPD was removed (Electricity Authority, 2023e).

Figure 2 shows the top 20 daily maximum consumption trading periods nationally each year between 2019 and 2023, normalised to daily total consumption in 2023. The evening peak for 2022 and 2023 is higher than in 2019, 2020, and 2021. The morning peak in 2023 is also higher than in previous years.

[8] During the same period, Rio Tinto's threat to close the Tiwai aluminium smelter raised the prospect of a significant reduction in demand that would have reduced wholesale prices, further undermining the business case for new firm capacity.

Figure 2: Annual top 20 daily max national consumption trading periods between 2019 and 2023 normalised to 2023



The Authority removed the RCPD charge after concluding the charge was higher than the economic cost of congestion in peak periods. The Authority reasoned the charge was distortionary and discouraged consumers from using the grid at times they value it the most. The charge created incentives for parties to invest in batteries or generation simply to avoid transmission charges. These charges would then be reallocated to other transmission customers as the cost of transmission was unchanged. The Authority recently summarised its thinking (Electricity Authority, 2023e, para. 1.7):

> A key part of the reasoning for removing the RCPD charge is that wholesale electricity market nodal prices already provide a market-based signal of the cost of using the grid, so there is no requirement for a transmission peak charge to signal the same thing.

The Authority's reasoning rests heavily on wholesale peak prices not being constrained from rising as high as they need to—as we discuss below, this is not a reasonable assumption. As wholesale peak prices are being constrained, removing the distortion to transmission pricing may not improve outcomes for consumers once the impact on electricity reliability is considered. The economic theory of second best demonstrates that if one set of prices are constrained (in this case, wholesale peak prices), it is possible that the next-best solution involves setting other variables (in this case, transmission prices) with values different from those that would otherwise be optimal to partially counteract the price constraints (Lipsey & Lancaster, 1956).

The Authority has since introduced another second-best intervention by requiring uncontracted water-heater control to offer difference bids.

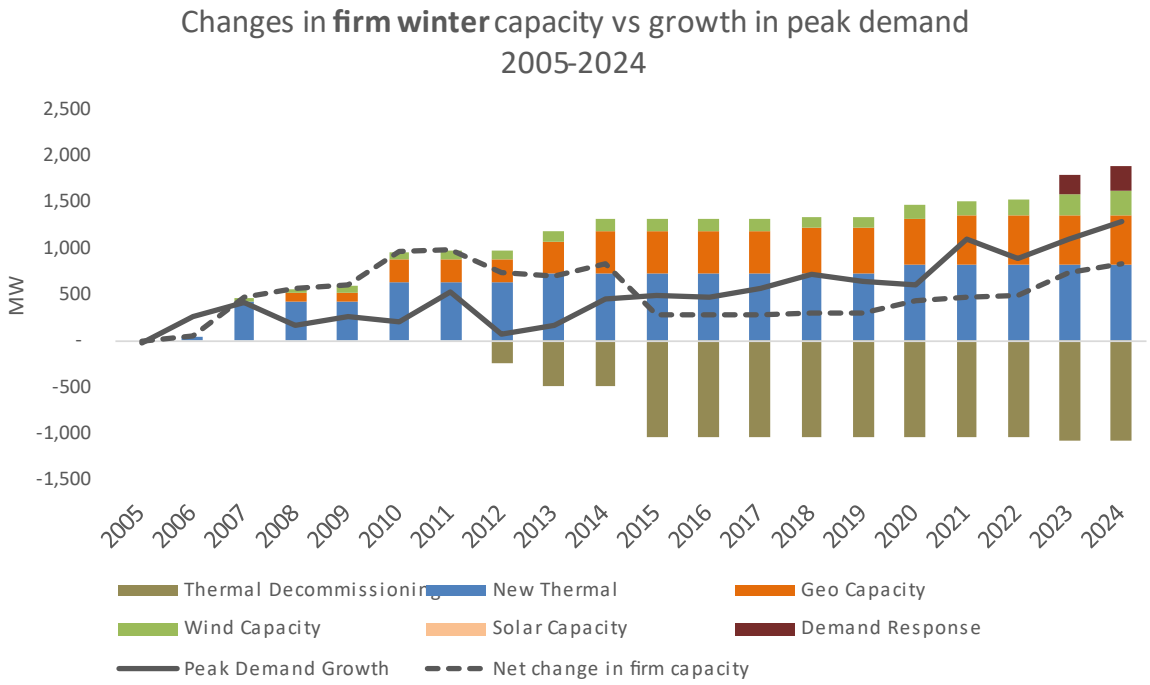
Removing the RCPD likely involved a trade-off between efficient transmission pricing and promoting reliable supply. As discussed below, it is no longer clear how the Authority weighs reliability when evaluating trade-offs between the limbs of its statutory objective.

2.4 Peak demand has been growing faster than firm capacity for nearly a decade

The net outcome of the events described above (and no doubt other factors) is that growth in peak electricity demand exceeded growth in firm capacity for the past decade.

Figure 3 reproduces a chart prepared by Whiteboard Energy. It shows the changes in firm winter capacity compared to the growth in peak demand.

Figure 3: Changes in firm winter capacity vs growth in peak demand 2003-2024



Source: Analysis provided by Whiteboard Energy

The chart uses similar assumptions to the Authority's Security Standards Assumptions Document (SSAD), in particular that 25 per cent of wind generation is deemed likely to be available at the peak. Whiteboard's assessment makes Huntly unit five available but only two Rankine, whereas the SSAD derates all thermal by an average outage factor.

Although firm capacity has grown over the period since 2015, the balance of firm capacity to peak demand only improved in 2023 with the Authority's rule that requires non-contracted water heating control to be offered in as difference bids. The improvement in 2024 was due to the demand response arrangements in the New Zealand Aluminium Smelter (Tiwai) agreements. The assessments do not allow for any derating of thermal generation due to gas supply shortages, but the third Rankine unit can offset some of this. Both the Whiteboard assessment and the SSAD approach rely on 300MW of

wind generation during the worst peak (with this generation assumed to be produced by new and existing windfarms).

New capacity is expected for 2025 (Tauhara No.2, Te Huka expansion, and the Ruakawa BESS). However, once the Taranaki Combined Cycle exits, 57MW of firm capacity will be removed from the market. Despite some increase in firm capacity, the cumulative shortfall of firm capacity from 2003 to 2024 is 427MW (analysis provided by Whiteboard Energy).[9]

With peak demand growing at a faster rate than firm capacity on average, a shortage of supply during winter peak demand (as occurred on 10 May) becomes inevitable. The worsening outlook for electricity reliability did not go unnoticed in the sector.

2.5 Peak capacity shortfall evident in security of supply assessment

In November 2022, Transpower warned:

> The increased number of low-residual CANs and corresponding GENs issued in 2021 and 2022 demonstrate peak demand growth that is not sufficiently balanced by existing generation availability. There is an important distinction between generation capacity and availability.

Source: (Transpower, 2022)

Looking forward, the peak capacity shortfall is evident in Transpower's Security of Supply Annual Assessment. A key aspect of the existing security of supply framework is the medium-term energy and capacity security of supply standards (Transpower, 2023, p. 3). The capacity security standards are defined in relation to winter peak demand, as this is when demand is typically highest and when generation and transmission capacity is under the most stress. The standard is referred to as the winter capacity margin (we discuss the derivation of the existing standard in the following chapter).

In its Security of Supply Annual Assessment, Transpower assesses security of supply scenarios. It establishes a reference case and explores sensitivities around that reference case. For each case, Transpower assesses different potential supply contexts:

- Stage one – considers only existing and committed generation
- Stage two – adds projects that are not yet committed or are on hold, but have consents
- Stage three – adds projects that are on hold but where the consents have lapsed
- Stage four – adds projects that are expected to apply for consent within the next two years.

Transpower's 2024 stage one assessment has the winter capacity margin falling below the existing standard by 2026. The existing standard would not be met under the stage two assessment by 2028, and under the stage three assessment would not be met by 2029. Stage four is the only new supply scenario which shows the existing winter capacity margin being sustained.

[9] www.whiteboardenergy.co.nz

Transpower undertakes sensitivity cases, one of these includes low gas supply. The low gas supply scenario—which should probably now be considered the reference scenario—shows all stages falling below the winter capacity margin by 2029, even under stage four which assumes substantial investment in new generation. Although the winter capacity margin does not drop much earlier under the low gas sensitivity scenario, it drops far further with stages one, two, and three all falling below expected peak demand by 2028 (if not earlier). The Security of Supply Assessment anticipates demand curtailment even at N security[10] if the difficulties of the gas market are recognised.

For its low gas supply scenario, Transpower uses a gas forecast that would have been considered conservative even a year ago. However, it now looks like it might overstate gas supply as major fields are in decline and recent well drilling and refurbishments have failed (Electricity Authority, n.d.). As the state of the gas market has been a concern since 2018, it is deeply concerning that the standard assumptions for the winter capacity margin yield a reference scenario that assumes stronger gas supply than is the case. These assumptions should have been reviewed by now.

At the very least the Authority's conclusions related to the gas market in its Market Competition Review issues paper of November 2022 should have prompted a review of how the "uncertain and dwindling supply" of gas would impact on electricity reliability. In its Market Competition Review the Authority concluded that fossil fuel generation was being displaced, and that this would affect flexible generation:

> B4. Three factors are causing displacement of fossil-fuelled generation by renewables:
>
> - falling investment costs of wind and solar to the point that the LRMC of both wind and solar PV are now well below gas and coal
> - increasing fuel costs for gas and coal – for domestic gas **due to uncertain and dwindling supply**, while for coal it is mainly reflective of international markets [emphasis added]
> - increasing carbon costs through the NZ ETS (Electricity Authority, 2022b B4).

And

> Some portion of flexible generation: renewables are starting to displace some flexible fossil-fuelled generation. Rising carbon prices are making renewables increasingly economic even if some output is spilled. Diversity (technology, location) of the new renewable generation helps with the loss of fossil-fuelled generation (Electricity Authority, 2022b B5, point 2).

2.6 Increasing industry and consumer concern

Surveys indicate that our communities are becoming increasingly concerned about reliability. In the Authority's latest **industry perceptions** survey, 10 per cent fewer respondents agreed that there is a reliable supply of electricity each day (75 per cent compared with 85 per cent last year) (Electricity

[10] A power system is described as being N-1 secure when it is capable of maintaining normal operations in the event of a single contingency event, such as the unplanned loss of a transmission line, generator or transformer. A power system operating at N security is not capable of maintaining normal operations after a single contingency event.

Authority, 2023b). Only 45 per cent (down 13 per cent) agreed that there will be enough electricity to meet ongoing needs. The Authority's **consumer perceptions** survey also indicated that 49 per cent (down 1 per cent) agreed that there is enough electricity to keep New Zealand powered in the future. The results of these surveys are shown in Appendix B.

Moore et al. (2023) noted these survey results were consistent with concerns about the future reliability and security of electricity raised in interviews as part of the recent strategic baseline review of the Authority. This is also consistent with surveys undertaken by the Consumer Advocacy Council which show resilience as a key and growing concern for consumers and small businesses (shown in Appendix B).

These concerns are important as they will impact decisions by consumers to invest in electrification (we discuss investment incentives further below).

2.7 The Authority has been slow to respond

Agitation from the Chief Executives Forum (including an attempt to develop a temporary ancillary service to meet peak demand concerns for 2023) prompted the Authority to adopt some urgent measures for 2023. However, no comprehensive programme emerged from the Authority to understand and address the growing concerns about peak capacity, despite this also being an urgent recommendation by the Market Development Advisory Group (MDAG) high-renewables project.

In July of this year, "based on submissions and lessons learned from the recent low residual situation on 10 May 2024," the Authority decided to:

- accelerate demand response participation in the market by exploring a full range of regulatory levers
- update and consult on the Security Standards Assumptions Document
- start developing a standby ancillary service to cover a sudden reduction from intermittent generation
- undertake work to enhance battery energy storage systems and dispatchable demand participation and remove barriers to entry (Electricity Authority, 2024b).

In the following sections, we consider how the Authority came to misjudge the market and seemingly be surprised by impending shortfalls of electricity supply during periods of peak demand.

3. Reliability standards not updated for 12 years

3.1 Capacity standards were meant to minimise shortfall and additional capacity costs

In July, in response to the low residual supply events of 10 May, the Authority announced it would review the Security Standards Assumptions Document (Electricity Authority, 2024b). This document informs the medium-term energy and capacity security of supply standards which form "a key aspect of the existing security of supply framework" (Transpower, 2023, p. 3). Startlingly, the Authority has not updated the document since 2012. It reviewed the standard in 2017 and decided that, while changes to the 2012 standard may be warranted, the benefits of changing the standard at that time would be minor (Transpower, 2023, p. 3). That conclusion is highly unlikely to hold in 2024.

3.1.1 Method applied by the Authority in 2012

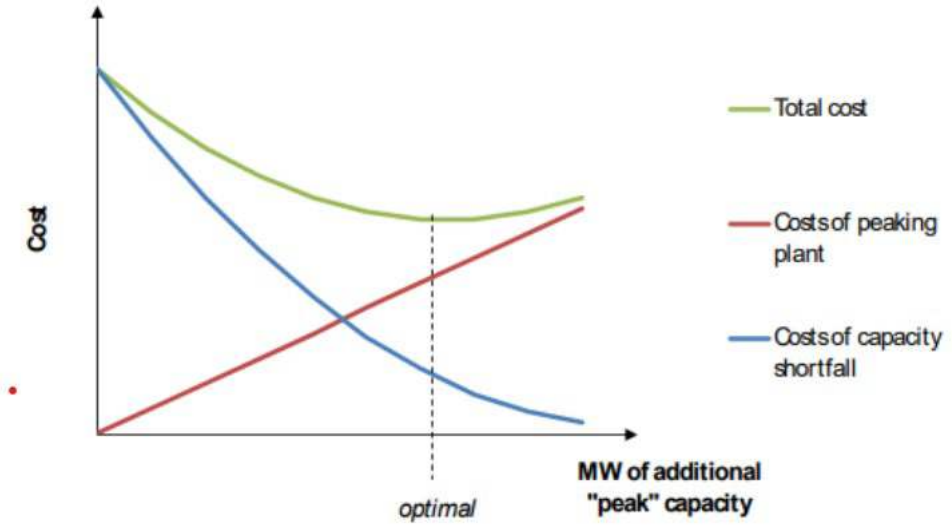
The North Island winter capacity margin (NI-WCM) is New Zealand's relevant resource adequacy standard for capacity—the South Island generally has ample generation capacity to meet demand.

The NI-WCM is a winter peak demand-oriented standard, as this is when demand is typically highest and when generation and transmission capacity is under the most stress. The standard is defined in the Electricity Industry Participation Code (the Code) as "the difference between a measure of the expected capacity and expected demand from 1 April to 31 October between 7am and 10pm." Part 7 of the Code specifies that capacity is expected to exceed demand by 630MW to 780 MW.[11]

The Electricity Authority determined this capacity adequacy standard in 2012 by considering the costs of new firm capacity (to address capacity shortfalls) and the costs of capacity shortfalls (Electricity Authority, 2012a). As illustrated in Figure 4, the 'efficient' capacity margin is where the total cost (cost of firm capacity and cost of capacity shortfall) is minimised.

[11] The Authority calculated an optimal level at approximately 690MW; the range recognises the uncertainty in input assumptions in deriving the standards.

Figure 4: Illustration of NI-WCM cost minimisation approach



Source: (Transpower, 2023)

While the modelling done at the time (2012) was robust, for a topic as important as security of supply we would expect, over time, alternative modelling and analytical methods to be used to assist decision-making and corroborate results. For example, some analysis into the customer damage functions for loss of supply now add a fixed cost component, to recognise there is an underlying level of damage that occurs simply because there is an outage, with the damage building over the duration of the outage.

This way of costing customer shortages would lend itself to the screening curve approach for the optimal mix of meeting demand. We make this point because, if it was determined that the fixed costs of customer outages were higher than the fixed costs of firm capacity, then the screening curve approach would yield an optimal winter capacity margin far higher than the current level. Although, the 2012 modelling could well yield a similarly higher capacity margin if its inputs were simply updated.

3.2 Today's market does not match 2012 input assumptions

To highlight the extent to which the input assumptions that underpin the current winter capacity margin (WCM) are out of date, the generation assumptions include Southdown and Otahuhu B. These two power stations were decommissioned in 2015. It is particularly concerning that these two stations remain in the generation assumptions as much of the generation capacity added since then has been intermittent generation. The 2012 modelling treated discrete and intermittent generation differently, and we would expect the significant change which has occurred in the ratio of discrete to intermittent generation would yield quite different outputs.

The 2012 consultation paper also offers many reasons why it should have been reviewed (Electricity Authority, 2012b). The paper asserts there was no reason to update the previous work on customer

losses, which was undertaken in 2008. Therefore, one of the fundamental input assumptions for the winter capacity margin has not been reviewed since 2008.[12]

The paper also noted, of the shortage cost curve, that:

> This curve is a key input and has a strong influence on the optimal level of the WCM. Even the early part of the curve is influential (with a WCM of 700 MW- 900 MW, the model finds that about 35 per cent to 40 per cent of shortage costs arise from the first 200 MW of Instantaneous Reserve shortfall, which is priced at just $2,420-4,840/MWh).

Given how sensitive the optimal level of winter capacity margin is to the input costs, we would expect reviews every year.

3.3 Importance attached to reliability increasing

The importance that New Zealander's attach to reliable supply will have increased materially since the Authority calculated its 'optimal' capacity margin 12 years ago (let alone since it last estimated the losses to consumers from outages in 2008).

The value of economic activity supported by each unit of electricity has increased significantly. Nominal GDP has increased 83 per cent, from $213 billion to $389 billion (Stats NZ Infoshare) since 2012 while over much of this period, growth in electricity demand was relatively flat. As a result, the economic value supported by electricity will likewise have increased—that is, the slope of the blue curve in Figure 4 (the economic costs of a capacity shortfall) would have increased, raising the 'optimal' capacity margin.

Furthermore, the history of the New Zealand electricity sector demonstrates the increasing importance of security of supply to consumers over time. New Zealand had electricity shortages consistently from 1939 to 1958 with significant rationing. Significant shortages, and rationing, occurred again in the 1970s. These periods of shortage were generally accepted as part of the consequence of a country rapidly electrifying.

A severe drought in 1992 led to some electricity rationing—not as severe as that incurred previously, but the result was a ministerial inquiry. The inquiry was partly due to concerns the newly corporatised Electricity Corporation of New Zealand (ECNZ) was deliberately lifting prices by causing shortages, but it was also clear the appetite for rationing in the power system was far lower now that the country had been fully electrified. ECNZ demonstrated in the inquiry that it had maintained the same security standard as the former New Zealand Electricity Department—a risk of shortage of one in 20 years on average. The inquiry identified that the appetite for security had increased and ECNZ should review the standard. In the meantime, ECNZ should operate and plan for a risk of shortage of one in 60 years on average (this was chosen because ECNZ had 60 years of inflow data).[13]

ECNZ confirmed a standard in which they would manage to the worst inflow sequence available. This was the standard applied by the successors to ECNZ (that is, Contact, Meridian, Genesis, and Mercury)

[12] Though the 2012 work applied a 10 per cent uplift in the cost functions for inflation.
[13] Inquiry by former Chief Justice, Sir Ronald Davison into the 1992 Electricity Shortage.

when energy shortages occurred in 2001, 2003, and 2008. There was some incredulity at the time, and since, that there were three one in 100-year droughts in a row. However, the periods of 2001 and 2008 did set new boundaries for dry conditions, as have years since (2012, 2019, and 2022).[14] This history highlights that even 90 years of inflow data is a small sample and, of course, doesn't capture climate change.

In 2003, the Government's response to an obviously higher appetite for security of supply was to establish the Whirinaki reserve energy scheme and then, in 2009 (as recommended by a 2008 review), establish the Electricity Authority with a mandate to implement a hard trigger for energy conservation campaigns and the customer compensation scheme. The customer compensation scheme is a blunt instrument, applied across all retailers, but it created strong incentives for hydro operators to operate to the worst inflow sequences they could anticipate rather than the sequences they had recorded—a significantly higher security of supply standard. An explicit winter energy margin was established in 2012 in parallel to the customer compensation scheme.

The discussion above relates more to the *winter energy margin* rather than the *winter capacity margin*, as the focus of reliability concerns at the time was solving the 'dry year' problem (as discussed in section 2.1 above). However, the point is that the appetite for security is increasing over time, and governments have a keen interest in ensuring this appetite for security is reflected in industry standards and focus.

The importance consumers attach to reliable electricity will continue to escalate as electricity becomes a key element in decarbonising our energy supply. Electrification of transportation, industrial processes,[15] and new loads to support an ever-increasing digital future,[16] means electricity not only plays a more crucial role in our economy than it did 12 years ago, but its importance will continue to increase.

Finally, the relative per customer cost of achieving reliable electricity supply gets smaller as power systems get larger. The incremental costs of supply do not tend to get relatively larger, but those costs are borne over a larger base. This means that, even if consumers do not value reliability more than in the past (which they clearly do), the optimal capacity margins will still increase over time as the per-unit cost decreases.

3.4 The Authority and Transpower appear not to believe the security standards they set and apply

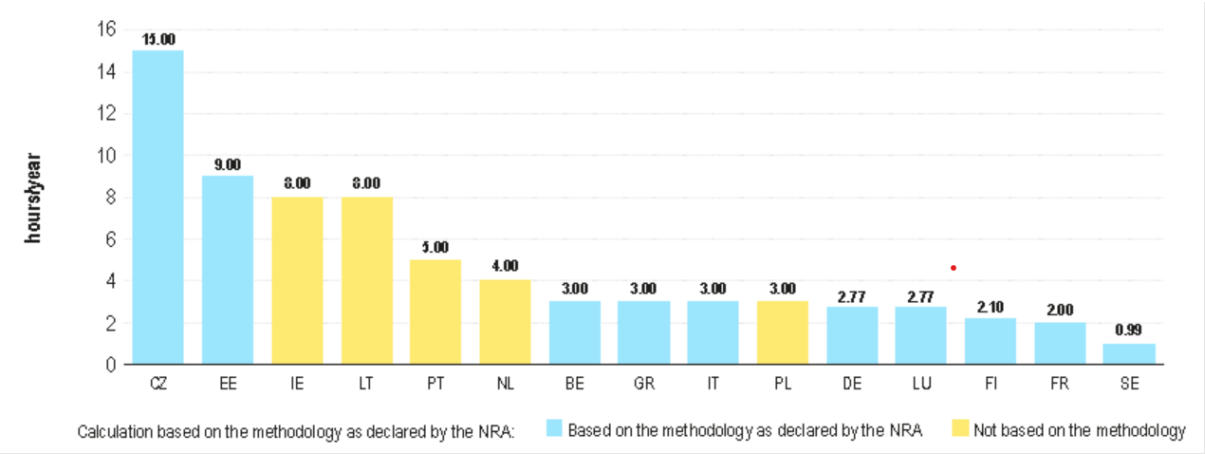
When the Authority calculated the existing standard in 2012, its cost-benefit analysis concluded that up to 22 hours per annum of energy or reserve shortfall (as a result of a capacity shortage) is

[14] 2003 was mis-specified. It wasn't particularly dry but was an overall energy shortage with low inflows, low coal stockpile and Maui nearing redetermination.
[15] See for example NZ-Steel-Media-Release_Electric-Arc-Furnace_21-May-web.pdf (nzsteel.co.nz)
[16] See for example Auckland data centres Contact gets Microsoft backing for Te Huka 3 | Energy News

economic before additional investment in peaking generation is warranted (Transpower, 2023).[17] Such a conclusion is unlikely to be politically credible today—New Zealand political leaders, representing consumers, are more likely to echo former Australian Prime Minister Malcolm Turnbull who reportedly stated that the political tolerance for blackouts is zero (Aurora Energy Research, 2022).

By way of comparison, fifteen countries in the European Union provide an equivalent estimate (referred to in Europe as a 'loss of load expectation'). Only the Czech Republic arrives at a similar order of magnitude estimate to New Zealand, though materially lower at 15 hours compared to New Zealand's 22 hours.[18] Countries we more typically use as comparators, such as France, Italy or Netherlands, set loss of load expectations at two to four hours. Although it may cost less to achieve a given standard in Europe (depending on the scale and costs of interconnectors), this seems unlikely to explain why Europeans are estimated to value secure supply at a standard up to 11 times higher than the Authority's capacity adequacy standard assumes New Zealanders value reliable electricity (22/2 = 11).

Figure 5: European loss of load expectation in hours per year (NZ Electricity Authority assumed 22 hours)



Source: (ACER, 2022)

In practice, both Transpower and the Authority act as if they consider the current winter capacity margin as inadequate. On 9 May, Transpower made a public call for savings with the apparent approval of the Authority. This call was primarily concerned with not meeting the low residual supply, rather than not meeting peak capacity (energy plus reserve). Taking precautions to maintain a buffer over the peak is not consistent with allowing 22 hours of reserve relaxation every year. It seems that while neither Transpower nor the Authority considered the winter capacity margin as adequate, it took the events of 10 May to trigger the Authority into reviewing the capacity margin (Electricity Authority, 2024b).

[17] Usually, some reserves would be forgone before curtailing load. Procuring less reserves means the system is more exposed to a contingent event risk and the consequential triggering of automatic underfrequency load shedding.

[18] The standards are not directly comparable as New Zealand's standard assessment is inconsistent with international norms.

Transpower has brought in the low residual supply measure to allow for variance in increasing intermittent generation, which might otherwise undercut N-1 peak capacity. This measure reinforces the need to review the winter capacity margin. As noted above, recognising the changing ratio of intermittency to discretionary generation in an update of the 2012 modelling would result in an increase in the winter capacity margin, and consequently highlight the poorer performance in the security of supply forecast. In short, treating an increasing proportion of intermittent generation as an operating issue has potentially masked worsening peak security.

3.5 Dynamic management of security and reliability is required

3.5.1 Little attention to resource adequacy in New Zealand relative to other electricity markets

As discussed above, the North Island winter capacity margin is New Zealand's sole resource adequacy standard for capacity. This emphasis on a single static measure (not updated for over a decade) compares unfavourably with electricity markets elsewhere, which take a much more dynamic approach to assessing and managing reliability.

Electricity markets in North America are arguably quite similar to New Zealand. For the Northeastern Power Coordination Council (NPCC), the resource adequacy standard is an average of 0.1 days (2.4 hours) of lost load per year, and Reliability First (RF) has a resource adequacy target of one day of lost load in 10 years (again 2.4 hours on average per year).[19]

Like New Zealand's winter capacity margin and winter energy margin these are described as standards, but unlike New Zealand, they must be achieved. From NPCC's Regional Reliability Reference Directory number one:

> R6 Each Reliability Coordinator shall coordinate outages and deratings of resources to verify adequate resources **will** be available to meet the forecasted demand and reserve requirements [emphasis added].

The Pennsylvania Jersey Maryland (PJM) regional transmission area relies heavily on their capacity market, but the reliability requirement influences the capacity market design, with firm capacity obligations to be met out to three years. The New York Independent System Operator (NYISO) goes further and includes mechanisms such as designating that generators which are planned to be deactivated be retained to meet their short-term assessment of reliability (STAR).

[19] NPCC and RF are regional entities with an agreement with the North American Energy Reliability Council (NERC) to oversee the management of reliability in their areas. NPCC covers the northeastern United States and southeastern Canada including New York state. RF covers the Pennsylvania Jersey Maryland (PJM) regional transmission area and market.

Both system and market operators assess the security standards regularly, as does Transpower, but in the United States action is taken when resource adequacy is a problem.[20]

PJM and NYISO also do deeper analysis of security and reliability, often required by the North American Energy Reliability Council (NERC)[21] and/or NPCC/RF. For example, in response to a changing mix of generation supply, NYISO now undertakes fuel and energy security assessments which are comprehensive assessments of fuel supply risks during winter. The first was done in 2019 and a follow up report was completed in 2023. Interestingly, NYISO's concerns about the changing mix of generation were not just because of increasing renewables but also due to increasing reliance on pipeline natural gas (from increasingly cheap shale gas resources). The previous fuel mix was both more diverse and had onsite storage.

The focus on resource adequacy by PJM and NYISO could be ascribed to their need to establish the settings for their capacity markets. However, the requirements are set by NERC and the regional entities.[22] Also, although it seems obvious that an electricity market operator with a two-part market (energy and capacity) would seek to ensure its market is delivering security and reliability, it seems no less obvious that an electricity market operator with a one-part market (energy) as in New Zealand would seek to promote reliable supply.

It is useful to also compare the Electric Reliability Council of Texas (ERCOT).[23] The ERCOT market is more similar to the New Zealand market—both operate one-part (energy) markets, and both have high intermittent renewable penetration and reliance on pipeline gas supplies. We have not undertaken a detailed comparison between the North American jurisdictions, but a summary assessment seems to show less detail and analysis on security of supply for both ERCOT and the Texas Regional Entity compared to PJM, NYISO and their regional entity.

Nevertheless, since the major power outage of February 2021, ERCOT has completed further analysis and made modifications to the market.[24] In 2023, a new ancillary service was introduced for reserve plant that can provide two hours of supply when called. In addition, there have been two tranches of the Firm Fuel Supply Service where ERCOT contracts directly for firm energy supply. A key requirement

[20] An Independent System Operator (ISO) or Regional Transmission Operator (RTO) under the Federal Energy Regulatory Commission (FERC) standard model has responsibilities for both system and market operation. Under the American model an ISO/RTO makes the market rules and operates the system, aspects that fall across the Authority and Transpower in New Zealand. However, the standards themselves are set by NERC and NPCC/RF.

[21] NERC is a regulatory authority charged with assuring the effective and efficient reduction of risks to the reliability and security of the grid. It develops and enforces reliability standards; annually assesses seasonal and long-term reliability; monitors the bulk power system through system awareness; and educates, trains, and certifies industry personnel. NERC's area of responsibility spans the continental United States, Canada, and the northern portion of Baja California, Mexico. It is subject to oversight by the FERC and governmental authorities in Canada.

[22] Regional entities are contracted to NERC to discharge the regional responsibilities for reliability.

[23] While ERCOT is described as a reliability coordinator, it is the ISO for the Texas electricity market. The regional entity for Texas (under NERC) is the Texas Regional Entity.

[24] A major power outage in Texas during significant winter storms in February 2021 left at least 246 people dead. While the weather was extreme the key problem was not the grid but the failure of generation resources—some wind generation that wasn't suitably winter-proofed, but mainly gas-powered generation that wasn't 'winterised' and froze up.

for firm energy supply is that there must be local fuel storage. In November of last year, Texas voters authorised a $5 billion fund to provide low-interest loans to finance new construction or upgrades to existing dispatchable electric generating facilities within the ERCOT region (Proctor, 2024).

In Texas, between the ISO (ERCOT) and the regional entity there is constant review of resource adequacy, transmission adequacy, operating management and coordination, and system planning covering the setting of standards, implementation, monitoring, and audit. The other North American ISO/RTOs, regional entities, and NERC are even more active.

3.5.2 New Zealand's static standards that have not been updated

While aspects of the above are done in New Zealand, predominantly by Transpower, the list of security and reliability standards and guidelines that have not been substantially reviewed or audited since the establishment of the Authority includes:

- winter energy margin
- winter capacity margin
- grid reliability standards
- core grid determination
- technical codes
- security policy
- dispatch objective
- ancillary service settings.

Some of the activities performed by North American operators have never been done in New Zealand. For example, there is no published, independent audit of Transpower or the Authority for security and supply. This lack of an independent audit is despite previous reviews suggesting greater accountability for security and supply (Electricity Price Review Panel, 2019a).[25]

Looking at the Authority's project plans it seems evident that it is far more comfortable being a market regulator than a regulator for security and reliability. Part of the problem is, of course, the Authority has responsibilities for security and reliability while also being the regulator. However, unless an organisation is tasked with maintaining the expertise for security and reliability from grassroots to management, which is highly technical, then it will always struggle.

Although we would not want to replicate the size of the North American reliability system (as in addition to being substantially larger than New Zealand, it has the complexity of federal and state levels), it seems advantageous to have an independent entity responsible for the oversight of security and reliability (bearing in mind that we consider that the Authority cannot be that entity as it has direct responsibilities for security and reliability).

[25] Recommendation G3, and Investigation into electricity supply interruptions of 9 August 2021- recommendation 2.

In our view, the Security and Reliability Council was supposed to play some of this role, but the arrangements for establishing the council never allowed the level of independence and resources necessary to perform the role (see section 5.1 below).

4. How the Authority weighs its reliability objective is now unclear

4.1 Reliability is one of three limbs

The Authority's main objective is to "promote competition in, reliable supply by, and the efficient operation of, the electricity industry for the long-term benefit of consumers" (Electricity Industry Act 2010).[26]

From recent High Court and Court of Appeal decisions, we understand that if the Authority considers that a particular measure, consistent with one of the three limbs of section 15(1) of the Act, would achieve the long-term benefit of consumers, it is entitled to pursue that measure—there is no requirement for the Authority to promote all three limbs equally (Manawa Energy Ltd v Electricity Authority, NZHC 1444 (2022), para 71).

The Act presumes all three limbs serve the long-term benefit of consumers. Any given decision by the Authority may therefore engage more than one limb and may involve trade-offs among them. In such a case, we understand the Authority must consider the impact on one limb of a decision to promote another (Nova Energy v Electricity Authority & Meridian Energy, NZCA 275 (2023), para. 35).

In 2011, the Authority published how it interpreted its statutory objective at that time. The Authority explained that it viewed "the interpretation of its statutory objective as a key strategic statement." By clarifying how it interpreted its statutory objective, the Authority expected to "assist the Authority Board to make consistent decisions, and [to] assist staff and advisory groups to develop Code amendment and market facilitation proposals" (Electricity Authority, 2011).

How the Authority weighs 'reliable supply' when considering trade-offs among the limbs of its statutory objective is now unclear. The importance of reliability to the long-term benefit of consumers will have increased since 2011 (as discussed in section 3.3 above). But the Authority has not explained how it factors into its decision-making the changing importance of each limb in serving the long-term benefit of consumers.

Presumably an interpretation of its objective is still needed to "assist the Authority Board to make consistent decisions." The Authority announced several years ago that it intended to review its interpretation, but that work seems not to have progressed.[27] Rather than update its interpretation document, the Authority recently added a warning in bold red ink to the front page of its

[26] The Authority has an additional objective to protect the interests of domestic consumers and small business consumers in relation to the supply of electricity to those consumers. This additional objective applies only to the Authority's activities in relation to the dealings of industry participants with domestic consumers and small business consumers, and hence does not appear relevant to achieving reliability.

[27] The Authority advised in its Strategy Development paper in 2020 that "there is clear support from stakeholders for us to review our interpretation of our statutory objective, especially given the length of time that has elapsed since the original interpretation was released. We intend to commence this review in the 2020-21 Financial Year." From https://eacorpsitelegacy.z8.web.core.windows.net/assets/dms-assets/27/27030Strategy-development-Final-strategy-discussion-paper.pdf

interpretation document. This notice warns readers that the Authority has not updated how it interprets its statutory objective following Parliament amending its objective with effect from December 2022, nor has the Authority reviewed the document to ensure it is consistent with the guidance provided by the Courts.

4.2 Focus seems to have shifted from the Authority's statutory objective

Until 2020, the Authority's corporate documents centred its strategy and operations on its statutory objective. For example, the Authority's Statement of Intent 2014-2018 begins:

> The Electricity Authority was formed on 1 November 2010 to promote competition in, reliable supply by, and the efficient operation of, the electricity industry for the long-term benefit of consumers.

The Authority's Chair in its Statement of Performance Expectations 2017/18 says:

> We are driven by section 15 of the Electricity Industry Act, which requires the Authority to promote competition in, reliable supply by, and the efficient operation of the electricity industry for the long-term benefit of consumers.

However, by 2020 the Authority had undertaken a 'strategic reset.' The Authority advised that it was now focused on five key sector ambitions, supported by five key strategic capabilities 'in which we will invest for success.' These five key sector ambitions on which it would focus, and the key strategic capabilities it would develop are as follows:

Table 1: Authority's key sector ambitions and strategic capabilities

Sector ambitions	Strategic capabilities
• We want *consumer centricity* to guide regulation and the industry • We want *low-emission energy* to electrify the economy • We want to build *trust and confidence* in the industry for all stakeholders • We want to see *thriving competition* delivering better outcomes for New Zealanders • We want to see *innovation flourishing*	• Listening and empathy • Purposeful connection • Inspired culture • Transformative mindset • Impactful delivery

Source: (Electricity Authority, 2020a, p. 2) emphasis in original.

Notably, the reliability and efficient operation limbs of its statutory objective are not mentioned within its key sector ambitions, and its strategic capabilities do not include developing the expertise and experience required to monitor and assess the reliability of the electric power system.

The Authority announced that now:

> We are the kaitiaki of electricity. Our purpose is to enhance New Zealanders' lives, prosperity and environment through electricity (Electricity Authority, 2020).

The foreword by the Chair to the Authority's Statement of Intent 2021-2025 does not lead or conclude with its statutory objective. In fact, the foreword does not mention its statutory objective at all. The Authority's documents now give prominence to being the kaitiaki of electricity with a purpose to enhance lives, prosperity and the environment.

It is not clear how the Authority derived this purpose from its statutory objective, which does not mention enhancing the environment but does require it to promote reliable supply. Facilitating the transition to a low-emissions economy, which the Authority now maintains is a key strategic objective, is not one of the three limbs of the Authority's statutory objective (though an efficient transition may contribute indirectly to one or more of the limbs).

The Electricity Price Review considered whether the Authority's objectives should be extended to include environmental goals. It concluded that adding to the Authority's:

> …existing objectives could pull them in too many directions, require difficult trade-offs between competing objectives and blur their accountability. This is the very reason the Authority's statutory objectives were narrowed as a result of the 2009 review (Electricity Price Review Panel, 2019b).

How the Authority might trade off advancing its key strategic ambition against its statutory requirement to promote reliable supply is not explained in any document we could locate.

Similarly, the Authority added in its current statement of intent that "we see our role as broader than electricity—we are part of the wider energy discussion" (Electricity Authority, 2021b). It is not clear what the Authority means by seeing its role as being broader than electricity and how that broader role ties to its statutory objective. This broader role the Authority envisions for itself did not seem to include taking an active stance in relation to the factors impacting the gas market and its implications for reliable electricity supply, which we discuss below.

5. Independent voice lost from the market

5.1 The Authority may have compromised its independence

There are two main reasons for delegating regulatory or quasi-regulatory powers from Parliament to government agencies such as the Authority (Majone, 2005). These two reasons are to:

- reduce decision-making costs, for example by taking advantage of agency expertise
- enhance the credibility of long-term policy commitments.

Each of these motivations for delegating decisions share a number of common features. In both cases, Parliament remains interested in the competence of the entity making the decision and in the costs of the decision process. However, the two motivations require quite different governance structures.

Where the purpose of the delegation is to reduce decision-making costs, the key problem addressed in the governance design is ensuring that the agent makes decisions that represent the preferences of the delegating principal. Hence the governance arrangement contains various controls that *align* as much as possible the preferences of the agent with the principal. For example, a core government department such as MBIE is expected to implement and support government policy decisions.

The situation is very different if the main reason for delegating the decisions is to enhance credibility of long-term policy commitments, which is necessary to support investment decisions in long-lived assets such as electricity generation and electrification. Where this is the objective, the policy preferences of the party to which decisions are delegated, with its focus on the long-term objectives, differ from the short-run preferences of the delegating principal. This is why, for example, central bankers are independent from ministers, because otherwise the long-term policy commitment to maintaining low inflation would be overruled for short-term political imperatives (Rogoff, 1985).

Independence of a regulator is therefore a means for achieving higher-level objectives, which in the case of the Authority are specified in its statutory objectives to promote competition in, reliable supply by, and the efficient operation of the electricity industry for the long-term benefit of consumers. These policy objectives are at risk in circumstances where a government's short-run objectives may conflict with its long-term commitments. Without a binding commitment to the long-term policy, the government may use its discretion to switch to what appears a better policy politically (in the short-term). Scarcity pricing provides a strong example of the conflict between short-term political objectives (keeping prices as low as possible) and the long-run objective of ensuring security of supply.

To avoid these long-run costs, decisions by an electricity regulator that impact on pricing and investment must be free from direction or influence of political interests. This is why the former Electricity Commission (which was subject to government direction via frequently amended government policy statements) was abolished and replaced by an independent Electricity Authority. In recent years, the intent of Parliament in establishing the Authority as independent of government appears to have been forgotten by the Authority.

In its response to a letter of expectations from Minister Woods in 2022, for example, the Authority repeated its view that its purpose is to enhance New Zealanders' lives, prosperity and environment through electricity and that the breadth of its purpose reflects the broader social and economic framework within which it operates. It then advised the minister:

> We note the government's focus, to be reflected in the forthcoming energy strategy, is a just transition to net zero carbon emissions by 2050, while building a more productive, sustainable and inclusive economy…
>
> The Authority is well-placed to align with the government's priorities… (Electricity Authority, 2022).

The Authority is not a core government department—its job is not to align with the government's priorities. Parliament stipulated that the Authority's main objective is to promote competition in, reliable supply by, and the efficient operation of, the electricity industry for the long-term benefit of consumers. It must pursue those objectives even if they do not align with the government's priorities— that is why it is independent, so that it can promote these long-term benefits to consumers even if that conflicts with the government's short-term priorities.

Where the Authority refers to its statutory objective, it is now often somewhat perfunctory rather than a test of its intervention. For example, in its consultation paper on distribution pricing the Authority refers to its statutory objective, however the focus of the paper is stated as follows:

> "This paper discusses the regulatory settings for distribution pricing and how to ensure they support the shift to a low emissions future at the least cost to consumers" (Electricity Authority, 2023d).

The only reference to reliable supply, in a document that affects the pricing incentives for those that would directly interact with the power system, was to acknowledge in two places that reliable supply is part of its statutory objective. It is for Parliament to direct the Authority, by amending its statutory objective, to include an emissions reduction or environmental element directly into its objective if the government wants the Authority to pursue these objectives in addition to, or instead of, its current objectives.

5.2 Blinkered view of impending failure of gas market

On 8 May 2024, the day prior to Transpower requesting consumers reduce electricity demand, the Gas Industry Company released figures showing a 12.5 per cent reduction in gas production during 2023, and a 27.8 per cent reduction in gas production in the first three months of this year beyond what was projected (Gas Industry Co., 2024). The Gas Industry Company advised that insufficient gas was available to meet contracted demand, and it expected gas supplies to be constrained throughout the decade.

The Authority was warned in 2021, 2022, 2023, and 2024 that the government's interventions were damaging the gas market with severe implications for security of supply in electricity (Contact Energy, 2021; Electricity Authority, 2021a; Energy Link, 2021; Energy News, 2022a, 2022b; Gas Industry Co., 2021, 2023; Mercury Energy, 2022; Meridian Energy, 2021; Stephens, 2021). In the final conclusions of the Market Competition Review 2022, the Authority accepted that gas market uncertainty was

affecting the electricity market. It made recommendations to MBIE that the gas strategy be prioritised. There was no mention of the council of regulators being the solution, which was MBIE's response to the Electricity Price Review recommendation in relation to the potential impact on electricity reliability of disruptions in the gas market.

There seems to be two possible explanations for the Authority's seemingly inactive response to the developing risks of gas supply when the consensus among industry commentators was increasing concern:

- The Authority gives little weight to the link between poorly conceived regulatory interventions and investment incentives.
- The Authority felt obligated to support the policies of the government rather than express an independent view.

We consider each of these possibilities in turn.

Achieving clarity of the policy objectives and stability in the instruments used to achieve those goals has long been accepted in the economics literature as critical for performance in capital intensive sectors such as gas and electricity (see for example, Spiller & Vogelsang, 1997; Levy & Spiller, 1994; Spiller, 1993). Assets deployed in these sectors embody the economic and regulatory conditions at the time of construction, hence inappropriate investment decisions due to poor regulatory policy settings or signals may go on influencing the efficiency and effectiveness of the sector for long periods after initial construction. If construction is delayed or abandoned, because of regulatory uncertainty, the costs are greater still because consumers may be denied services for which they would have been willing to pay. In short, behaviour and incentives will not be modified in ways that improve welfare unless policies are credible and predictable.

The electricity and gas sectors are particularly vulnerable to behavioural uncertainty by regulators because of three particular factors:

- Technology is characterised by large specific, fixed investment, providing regulators and political stakeholders considerable leeway to act opportunistically.
- The entire population consumes electricity services and hence politicians and interest groups are sensitive to price and service levels.
- The services are a focal point for individuals and groups concerned with climate change and emissions.

These characteristics mean governments face strong incentives to adopt short-run policies that may harm its long-run policy. In the absence of a safeguard against regulatory actions that undermine investment, businesses subject to intervention will protect themselves from this risk by under-investing. Investment that does occur will require higher rates-of-return, or will be undertaken from entities well connected politically. Sustained underinvestment will imply higher costs in the future and/or potentially capacity constraints and other symptoms of deterioration in service levels.

These effects are so well established in the literature, and were so evidently occurring in the gas sector, in significant part due to government interventions (for example, its ban on off-shore exploration), it is difficult to conceive that the Authority is unfamiliar with the research. Such a conclusion would be alarming in relation to a regulator responsible for the electricity market.

A more plausible explanation is that the Authority thought it should support government policy or at least not be vocal in pointing out the implications of that policy for promoting its statutory objectives in the electricity sector. That is, the Authority lost its independent voice.

5.3 Muting the Security and Reliability Council

The Electricity Industry Act 2010 (sec 20) requires there to be a Security and Reliability Council (SRC). The Act specifies the function of the SRC is to provide independent advice to the Authority on:

- the performance of the electricity system and the system operator
- reliability of supply issues.

The Act provides for the SRC to determine its own procedure, subject to the Act and the advisory group charter established by the Authority. The Authority's Working Group Charter, updated in December 2023, outlines the basis of how the SRC should work and interact with the Authority. Appropriately, the Charter recognises that the SRC will provide advice on any matters it considers relevant and necessary to fulfil its statutory function. The Charter provides for the Authority to require the SRC to examine certain issues (Electricity Authority, 2023a).

However, the Authority has also issued a terms of reference for the SRC (Electricity Authority, n.d.), which subordinates the SRC to the Authority. The terms set out to do the following:

- Define the matters on which the SRC is to provide advice (paragraph 10.2) culminating in "any other matters that the Authority considers to be within the function of the SRC as set out in the Act;" whereas the Act defines the function of the SRC, not the Authority.
- Make the SRC's procedures subject to "these terms of reference," whereas the Act stipulates the SRC is to determine its procedures subject only to the Act and the Charter.
- The terms of reference expand the role of the Authority as secretariat to include scheduling meetings and proposing the agenda for each meeting; via the Charter, the Authority appoints itself as the secretariat and appoints a staff member as the Authority's 'representative' to attend SRC meetings.

There is also an implicit problem in the Act and the Charter where the role of the SRC is only to provide advice to the Authority. An improvement would be for the SRC to be required to publicly publish any concerns it has with power system and system operator performance, and supply reliability. Neither the Act nor the Charter prohibit this, but we are not aware of any public commentary by the SRC on recent supply issues.[28]

The material that is published by the SRC seems remarkably sedate. For example, SRC periodically updates a risk register and this is included in the meeting paper zip file. The latest version available when writing this paper was October 2023 and simply listed a "persistent risk" being "P2: Gas supply running down (in part due to exploration uncertainty) reduces generation adequacy and availability." This risk was blandly noted amongst a host of other issues, such as the Tree Regulations.[29]

[28] Minutes of SRC meetings are published but the SRC seems to be rarely referenced in any other reports.
[29] SRC meeting papers - 26 October 2023.zip

In subordinating the SRC to the Authority, the Authority has muzzled the only check on accountability of the Authority and the system operator. This accountability was determined to be a problem in the review of the 9 August 2021 load shedding and that review's recommendations do not appear to have been adequately addressed by the Authority (MBIE, 2021).

5.4 Reluctant to hold system operator to account

The Authority's lack of emphasis on security of supply seems evident in its tacit acceptance of a prima facie rule breach by the system operator concerning residual supply.

Clause 8.11(3) of the Code outlines what the policy statement must include:

> "A policy statement must include—
>
> (a) the policies and means that the system operator considers appropriate for the system operator to observe in complying with its principal performance obligations; and
>
> (e) the policies and means by which scheduling and dispatch are adjusted to meet the dispatch objective, and must include the provision of a dispatch process statement. The dispatch process statement must contain the details of the processes that enable the system operator to meet the dispatch objective, including the methodologies to be used by the system operator for planning to meet the dispatch objective during the period leading up to real time and meeting the dispatch objective in real time…"

The system operator uses a low residual band to influence scheduling and dispatch. It clearly believes that the low residual band is a necessary means to meet its principle performance obligations (Transpower, 2023b). However, the low residual band is not in the policy statement. The policy thereby escapes the rigour of oversight that changes to the policy statement should be subject to. This seems to be a worrying lax in both the management of security and reliability, and accountability that the Authority appears to be taking less seriously than it should.

After the load shedding of 21 August 2021, the Hodgson review recommended that system operator accountability be reviewed. Nothing meaningful was implemented.

5.5 Recommendations from the Electricity Price Review on security not followed through

Recommendation G2 from the Electricity Price Review was to examine the security and resilience of the electricity system:

> "The Electricity Authority should commission the Security and Reliability Council to examine the potential impact of technological advances and other changes on the long-term security and resilience of the country's electricity supply. The Council should interpret resilience and reliability broadly, taking into account developments throughout the electricity supply chain. It should draw on relevant reports written here and overseas to avoid duplication of effort… The Council should complete its work within 12 months,

having been given sufficient resources, including access to specialist advice and analysis, to carry out the task."

Source: (Electricity Price Review Panel, 2019a)

It appears the Security and Reliability Council (SRC) gave some consideration to the possible scope of such a review, with one paper identifying potential issues (Electricity Authority, 2019; Security and Reliability Council, 2019, 2020). However, the Authority did not ask the SRC for advice and the SRC did not continue with its initiative. MBIE decided that all that was needed was more coordination through a council of energy regulators and marked that action as completed.[30]

The Authority did eventually initiate the Future Security and Reliability project but gave that project to Transpower for transmission—the Authority is supposedly looking at distribution itself, however its scope does not comprehensively consider externalities.

In summary, the Authority was established by Parliament as an independent regulator so that it would promote competition, reliability, and efficient operation of the electricity sector, even when doing so conflicts with short-term political objectives. The Act assumes that promoting these objectives will be in the long-term interest of consumers.

The Authority appears to have lost sight of the reason for its independence and has sought to align its priorities with the government of the day's priorities. It has constrained and muted the Security and Reliability Council.

[30] Implementing the Electricity Price Review: Dashboard (MBIE, 2024), recommendation: Explore new institutional arrangements for policy and regulation.

6. Wholesale prices do not signal scarcity

6.1 Prices should clear the market in periods of scarcity

A defining feature of the New Zealand wholesale electricity market is that the market pays for energy and ancillary services supplied; there is no additional payment for keeping capacity available as occurs in some other electricity market designs. Conceptually, how such an 'energy only' market should work—when demand is at or near its peak level and generating capacity is highly utilised in supplying energy or ancillary services consistent with reliability standards—is well understood and described in the relevant economics literature.

Under these 'scarcity' conditions, prices for energy and ancillary services should rise to clear the market consistent with maintaining reliability. Specifically, wholesale prices should rise to reflect opportunity cost—that is, the value of lost load (VOLL) (see for example Stoft (2002); Joskow & Tirole (2007).

As the events of 10 May 2024 demonstrate, New Zealand wholesale prices for energy do not rise fast enough or high enough to clear the market and maintain reliability in periods of scarcity.

The actions of Transpower on 9 and 10 May illustrate that as long as the system operator uses reasonably sensible non-price rationing schemes, and gives advanced notice of impeding shortages, the short-run costs of the market failing to clear on price are relatively small, unless there is a wide scale system collapse.

However, the long-run inefficiencies are much larger. If wholesale market prices for energy and ancillary services do not rise high enough to clear the market when capacity is fully utilised, the market will not induce efficient levels of investment in new generating capacity and demand reduction consistent with the costs of different types of generating capacity and consumer valuations for reliability.

As electricity demand varies widely over the hours of the year, sufficient capacity must be built to balance supply and demand reliably under peak demand conditions.[31] In an efficient system, some generating capacity or demand reduction will be used for only a small fraction of the hours during a typical year, and in some years may not operate at all (if needed to meet low-probability high-demand/low generation contingencies).

In an 'energy only' market, such as in New Zealand, generators providing cover for this peak demand must earn all of the net revenue (revenue net of fuel and other operating costs) required to cover their investment costs during these few critical hours. Inframarginal generators in an efficient generation portfolio may earn a significant fraction of their net revenue during these hours as well. In a well-functioning market, generators with firm capacity would have parties willing to contract with them as entities seek to offset the risk of scarcity prices when pricing to their own customers.

[31] BESS (battery electric storage systems) are becoming increasingly economic but are only now being introduced to New Zealand's firm demand stack. Even so, the investment case for BESS also relies on efficient peak prices.

If prices during these few critical hours are too low, or if industry participants believe regulatory interventions (broadly defined to include actions by the system operator sanctioned by the regulator) will prevent prices from rising to scarcity levels, then the net revenue of generators will be inadequate to support an efficient quantity and mix of generating capacity and demand response. That is, there will be underinvestment in generating capacity and demand response, too many hours when capacity is fully utilised, too much reliance on non-price rationing, and too high a probability of a network collapse (in instances where non-price rationing does not deliver the required reduction in demand). Cramton & Stoft, (2006) refer to these distorted incentives as the "missing money" problem.

As noted above, these concerns are well established and uncontroversial in the relevant literature. The Authority understands the problem conceptually (Electricity Authority, 2024a). However, the Authority has proved unable to allow wholesale prices to rise fast enough or high enough to clear the market in periods of scarcity. It has introduced, or permitted, arrangements which have the effect of constraining wholesale prices during periods of scarcity.

In parallel, large consumers and retailers have not been collectively persuaded to contract against high peak prices. Many retailers seem to view high peak prices as a market failure that they should not have to pay, although the issue is also caught up in generally high prices in the market currently. There is also concern that suitable peak price insurance products are not liquidly available, as identified by MDAG. Nevertheless, some retailers appear to have more faith in regulatory and political pressure on prices than the contract market (see also section 6.4).

6.2 Effective price caps introduced with real time pricing

In 2022, when implementing real time pricing (RTP), the Authority introduced administered prices for energy and reserve that would bind before generator offers, unless there were higher bids from purchasers. Part 13.58AA of the Code requires the system operator to assign the following price and quantity values to demand that is not subject to a bid or is not available or capable of being dispatched:

- $10,000 per MWh for the first 5 per cent of the relevant demand
- $15,000 per MWh for the next 15 per cent of the relevant demand
- $20,000 per MWh for the remaining 80 per cent of the relevant demand.

As dispatchable demand is in its infancy,[32] there have been no bids from purchasers that exceed these values (to the best of our knowledge). As a result, these prices are likely to be binding in an event where there is insufficient generation capacity to meet demand, in effect providing a cap on wholesale prices. How these values are calculated and how frequently they are updated therefore becomes critical to whether the market will clear in the long-term interest of consumers.

The scarcity prices above were based on the values assessed in 2011 but were reviewed in the consultation on RTP (Electricity Authority, 2017 Appendix D). The $10,000/MWh value was deemed to

[32] A sample of bid files from emi.ea.govt.nz over the last six months showed the only regular dispatchable demand bids are from the Rotohiko BESS, and at prices well below scarcity.

be sufficient to enable a "last-resort diesel-fired peaking plant to breakeven at a given level of security."

In Europe, electricity regulators must update their estimates of VOLL every five years and may not set a price cap that is below VOLL—for the obvious reason that a price cap below VOLL harms consumers as it means there will be periods when electricity is not supplied though the benefit to consumers would exceed the cost of supply (ACER, 2022).

Troublingly, although demand reductions were requested by Transpower on 10 May, wholesale prices remained well below scarcity levels. As the demand reductions were requested rather than imposed, the scarcity pricing mechanism did not apply, though electricity supply was 'scarce' relative to demand, otherwise the request for demand reductions would not have been necessary.

6.3 Dispatch practices for RTP appear to be suppressing prices

With the introduction of RTP then, as described in section 6.2 above, prices become effectively capped by scarcity prices. This raises the question of what happens if energy resources (energy or reserve offers) are offered into the market at prices higher than the administrated scarcity levels presented above. Our understanding is that such resources are formally constrained-on to ensure security of supply, but this prevents them from actually setting the market price at their offer price, and in fact seems to have a supressing effect on prices, further weakening peak price signals.

We investigated this potential issue by analysing the evening of 10 May 2024. On 10 May, the system operator constrained-on Contact Energy's diesel plant at Whirinaki. Figure 6 shows a snapshot of relevant trading periods.

The blue bars (nominal cleared) are the cleared generation based on the WHI2201 price and Contact's offers. The combined blue and orange bars are actual dispatch and, therefore, the orange bars are constrained-on.

Figure 7 shows prices lifted in period 36 and the SIR scarcity price was struck in a couple of RTP solves despite some constrained-on. A substantial amount of Whirinaki is constrained-on in period 37 and prices are around $250 to $300/MWh. A manual check confirms that no Whirinaki generation was offered at less than $1,000/MWh in period 37. It is reasonable to assume that without the Whirinaki generation in period 37, some of the prices are likely to have been substantially higher.

Interestingly, the blue line is the cleared offer stack, presumably from the RTP solve. If this is the case, then Whirinaki generation has clearly been constrained-on by altering the offered prices in RTP.

Figure 6: Snapshot of Whirinaki constrained on 10 May 2024

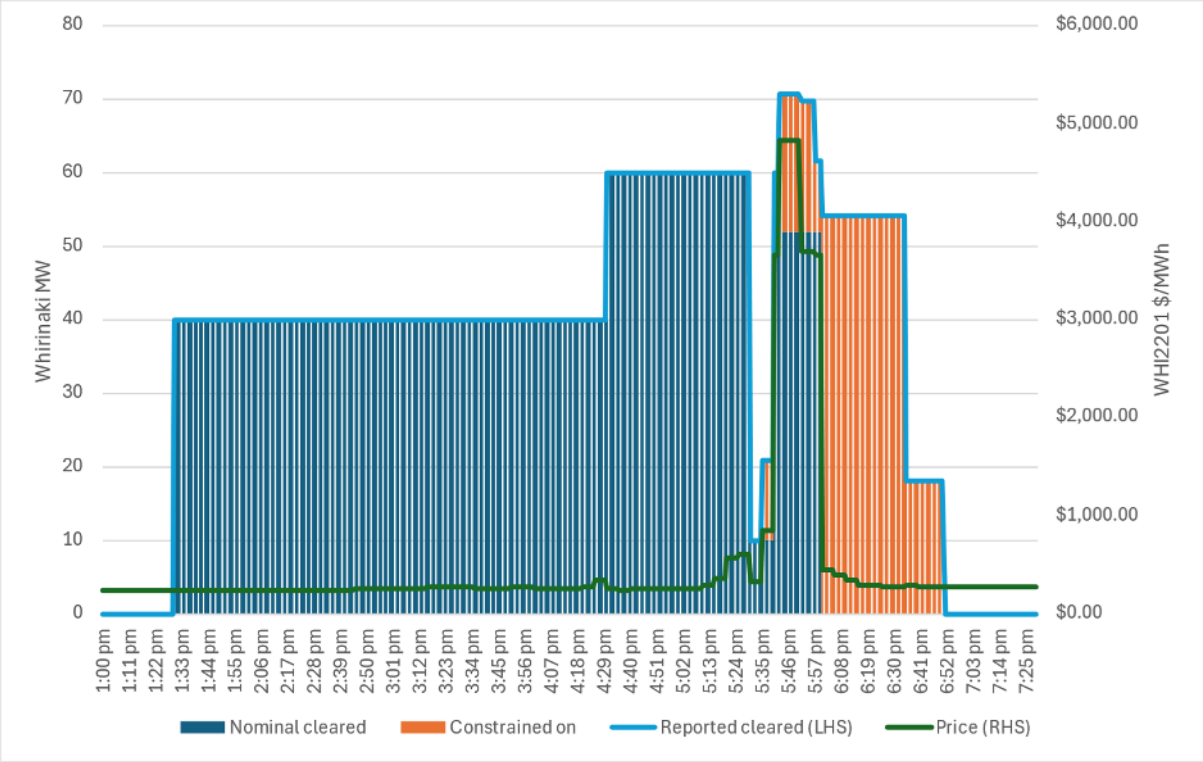


Figure 7: Supply, demand, and prices over evening peak 10 May 2024

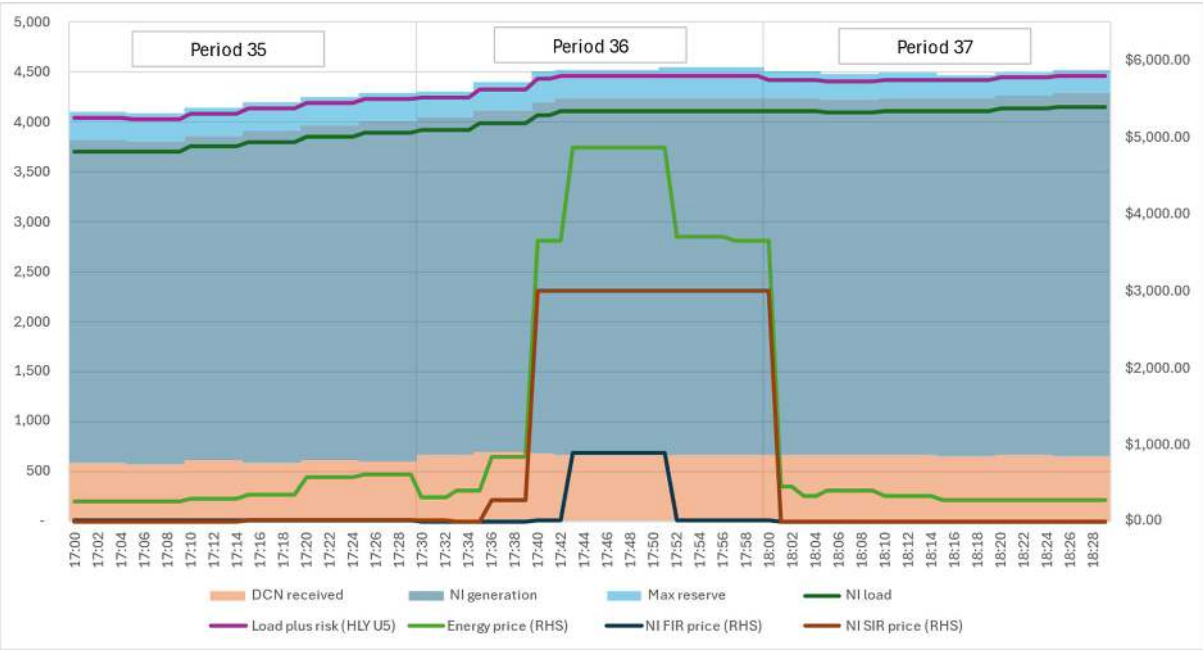


Figure 7 shows that system conditions (supply and demand) were similar in period 37 to period 36. As Whirinaki was constrained-on, the loading on Huntly unit five would also likely have been similar. Therefore, it seems likely that the system operator's actions suppressed prices by thousands of dollars for at least part of period 37.

Our explanation of this data is that reserve cleared at the scarcity constraint for multiple periods in pre-dispatch. Whirinaki offered reserve cheaply but had a gradient on PLSR offers (that is, the turbines had to be running at a minimum load to offer reserve). Therefore, reserve would have cost the cheap reserve price plus the cost of running Whirinaki units (up to $6,400/MWh). The unaltered RTP solution would have been to relax N-1 security even though there was spare generation capacity at Whirinaki.

We understand that this situation is subject to an arrangement between the Authority and the system operator to constrain-on spare generation to manage security. We understand that this is done by moving the constrained-on offers to the bottom of the stack, but this is not clarified in any Authority or Transpower material we could find.

The logic for the approach is as follows. The system operator cannot just constrain-on Whirinaki reserve; it has to constrain-on Whirinaki generation to constrain-on reserve. It cannot constrain-on generation, in this case Whirinaki, without constraining-off something else. Adding the constrained-on generation to the bottom of the stack achieves this, and results in efficient dispatch (i.e. the right combination of plant being used). However, three serious problems are evident:

- While the dispatch is efficient, the arrangement results in inefficient prices and substantially reduces peak energy and reserve prices, undermining incentives to invest and hence threatening reliability.
- We do not believe this is permitted under the Code, nor is it contained in the security policy or dispatch policy; non-transparent agreements between the Authority and system operator that constrain market prices during periods of scarcity will further undermine investor confidence.
- the Authority went through an extensive design period for RTP and yet these problems have still been encountered; this suggests a problem with the Authority's rule design process.

6.4 Focus on pursuing market power not reliability

Unfortunately, the supply and demand conditions which should lead to high spot market prices in a well-functioning competitive wholesale market (that is, when there is competitive 'scarcity') are also extremely difficult to distinguish from the conditions when market power problems are likely to be most severe. The limited amount of real time demand response in the wholesale market leads to wholesale spot market demand that is price inelastic. i.e. demand is not that sensitive to price in real time. During high demand periods, as capacity constraints are approached, this inelastic demand presents opportunities for suppliers facing unilateral incentives an ability to increase prices above competitive levels.

Accordingly, price caps (such as those introduced with RTP) will almost inevitably 'clip' some high prices that truly reflect competitive supply scarcity and consumer valuations for energy and reliability as the regulator endeavours to constrain high prices that reflect market power.[33]

There is therefore an inevitable trade-off between (i) promoting the long-term benefit of consumers in allowing wholesale prices for energy to rise fast and high enough to clear the market and maintain reliability in periods of scarcity, and (ii) the short-term political imperatives to curbing prices. From a consumer welfare perspective, the trade-off is conceptually simple. The long-term benefit to consumers from maintaining security vastly exceed the short-term allocative loss to consumers from overpricing, and any overpricing is likely to be self-correcting as alternative suppliers and demand response enters the market (as long as the regulator is committed to identifying and removing barriers to entry). As we outline below, we acknowledge this is often a challenging argument for a regulator to support, but it is critical to the long-term benefit of consumers.

The statutory objective charges the Authority to "promote competition;" it does not require it to regulate prices consistent with outcomes from any particular state of competition (workable or otherwise). The Authority is to promote competition—rivalry—for the long-term benefit of consumers and it should continue to seek ways of improving the competitive process regardless of its view as to the state of competition in the market. It is the role of the Commerce Commission, under Part 4 of the Commerce Act, to price-regulate firms consistent with outcomes produced in workably competitive markets.

6.5 Facing a fork in the road

While we have stressed the importance of the independence of the Authority, we recognise that the 'political economy' dynamics for regulators are extraordinarily difficult to manage as politicians and interest groups are highly sensitive to prices.

These pressures played out as the Authority implemented its new trading conduct rule in 2021. The Authority stressed that efficient prices included dynamic efficiency, however the perception among many parties was that the rule was about limiting prices. This is difficult to verify, but checking a sample of trading conduct monitoring reports reveals a constant focus on high prices and price spikes. Reports over a low-price period May/June 2023 did not appear to contain any commentary on whether prices might be too low. However, the highest prices and price separation events were identified and commented on even though the average price in the week of the report dated 6 June 2023 was only $6/MWh. We are not suggesting that the trading conduct monitoring reports are inconsistent with dynamic efficiency, but that they might create that impression.

The fragile balance for one-part (energy) markets was raised by Grant Read and CRA in a report on "the impact of risk on capacity investment in electricity markets" (condensed presentation reference). They make the point that one-part (energy) markets can theoretically meet security of supply, but this

[33] The reason for introducing the scarcity prices in RTP was more about ensuring there is always a feasible solution for RTP. However, having decided to introduce these scarcity prices the Authority must now decide what scarcity prices are efficient. We note that this potentially also creates confusion with the application of clause 13.5A of the code – the 'trading conduct' rule.

will only work if prices can be relied on to rise high enough to make returns on all plant, including low utilisation peaking solutions. The expectation of these higher prices should be enough for consumers to contract for 'insurance' products, which would then guarantee peaking investments.

This requires faith that new entrant generation will temper electricity prices over time. Even if this is true there can be periods of short-term volatility before there is investment that can test the resolve of regulators and the government. Even when prices are not volatile, consumers may not contract for 'insurance' because:

- they do not understand the issues, or believe the numbers
- they don't think they personally will benefit
- they expect Government to guarantee supplies and/or cap prices.

Read et al consider that, in the above context, "The existence of government makes the threat/promise of intervention unavoidable" and that some level of market failure is inevitable. This threat is very real as there has been the Electricity Price Review of 2017 and the Authority's Market Competition Review of 2021, and the recent change in the Commerce Act has been used to assert anti-competitive behaviour in electricity, which the Commerce Commission has asked the Authority to investigate.

According to Read et al, "under such threat the regulator **must either**:

- allow market prices to clear, explicitly acknowledging risk of short-run price "gaming"
- rely on competitive entry to discipline price discovery in the long run
- convince consumers that they must contract for capacity/firm energy

or:

- credibly and robustly define criteria for intervention
- compensate value removed from the market across all plant types, by a capacity market mechanism.

Mixing these two paradigms may spell disaster" [emphasis added].

The Authority's response may be that it remains convinced that the price interventions applied, trading conduct rule, RTP price caps etc., are set to make security of supply investments economic. Even if this is true, the message to investors is that the regulators will tend to focus on market power above security of supply (until security of supply becomes a problem) and will respond to political and popular pressure.

This is not a criticism of the Authority. Regulators can only exist as a product of legislation unless set up to be robustly independent with the appropriate governance. Even then all independent institutions come under some threat of intervention, such as the perennial debate on the wording of objectives of the Reserve Bank (The Treasury, 2024).

What is needed is the honest conversation. If the electricity regulator cannot realistically resist these government threats, or New Zealand cannot accept a market that requires faith in long-term competition above short-term volatility, then there is only one conclusion that can be reached about the one-part (energy only) market.

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Appendix A Analysis of peak consumption trends following RCPD removal

Since the removal of the Regional Coincident Peak Demand (RCPD) price signal in September 2021, there has been a rise in consumption during peak periods.

The purpose of the RCPD was to incentivise consumers to reduce demand during peak periods to reduce the need for additional transmission capacity. Under RCPD pricing, the cost of transmission was allocated based on the demand during the peak periods in each region. This meant that regions with higher demand during peak times would pay more for transmission services. The methodology encouraged large consumers to shift or reduce their electricity usage during these peak periods to lower their transmission charges.

A comparative analysis of national trading period peak consumption during the winters of 2019 to 2021 (RCPD winters) and the winters of 2022 and 2023 (post-RCPD winters) reveals a statistically significant increase in peak consumption of 15.1 per cent following the policy change. By removing the RCPD, the Electricity Authority has sent a signal to the market that consumption doesn't need to decrease during peak times.

We analysed wholesale market demand data between 2019 and 2023[34] to determine if peak consumption increased following the removal of the RCPD. The following sections provide a summary of our analysis.

Peak consumption increased following the removal of RCPD

Comparing the 300 peak consumption trading periods each year from 2019 and 2023 shows a significant increase in national peak consumption in the two years following the removal of the RCPD (Figure 8).

The trend in the graph indicates that the highest electricity consumption periods have generally increased over the years, with 2023 having the highest consumption levels, followed by 2022, 2021, 2020, and then 2019. This suggests a trend of increasing peak electricity consumption over the observed period.

[34] Wholesale metered data was downloaded from the Electricity Authority's Electricity Market Information website (https://www.emi.ea.govt.nz/Wholesale/Datasets/Metered_data/Grid_export).

Figure 8: Top 300 national consumption trading periods each year between 2019 and 2023.

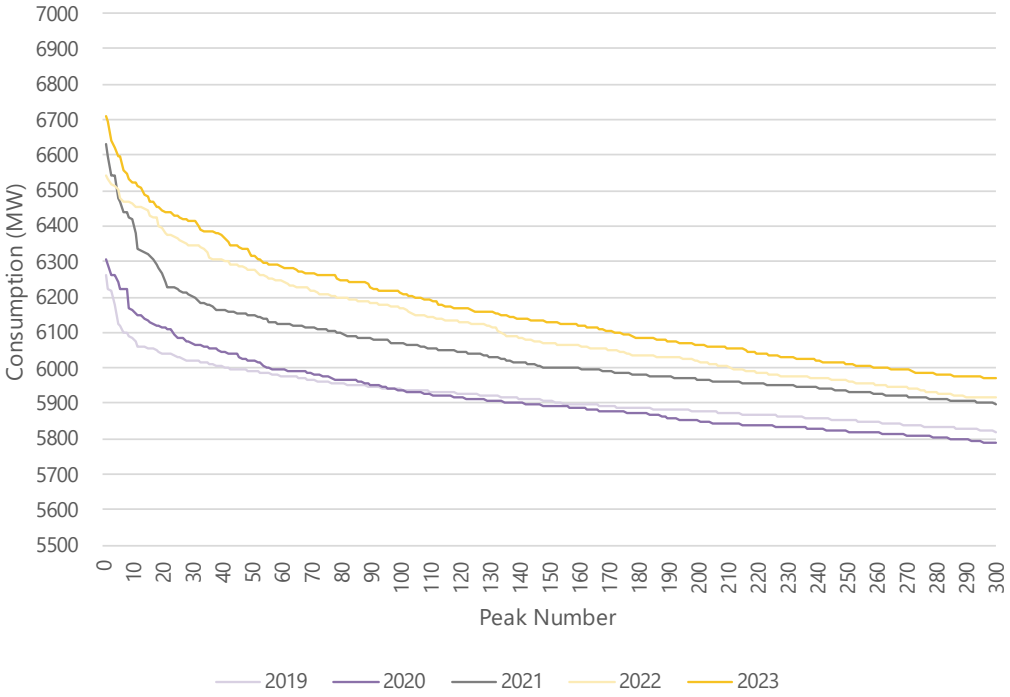


Figure 9 shows the same 300 peak consumption trading periods each year as a box plot. The horizontal line within each box indicates the median and the 'x' marks the average of the 300 trading periods.

Over the five-year period, the data highlights a general increase in both the average and median peak consumption (see Table 2), with a noticeable widening of the interquartile range (the shaded box in the plot) and an increase in the upper whisker boundary (the largest data value that is within 1.5 IQR above the third quartile), in the post-RCPD years.

This growing variability in demand indicates a shift in consumer behaviour following the removal of the RCPD towards higher demand during peak consumption trading periods, which is likely to increase the occurrence of low residual situations.

Figure 9: Box plot illustrating the distribution of the top 300 national consumption trading periods annually from 2019 to 2023

Note: The cross on each box is the average of the top 300 trading periods each year

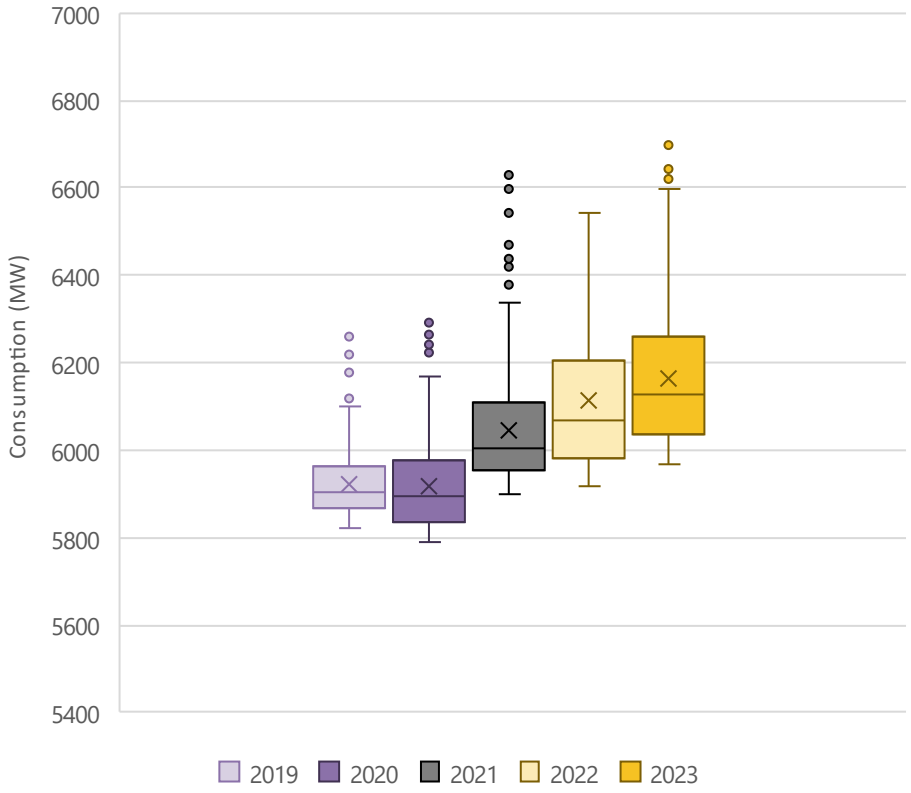


Table 2: Average and median consumption for the top 300 trading periods each year between 2019 and 2023.

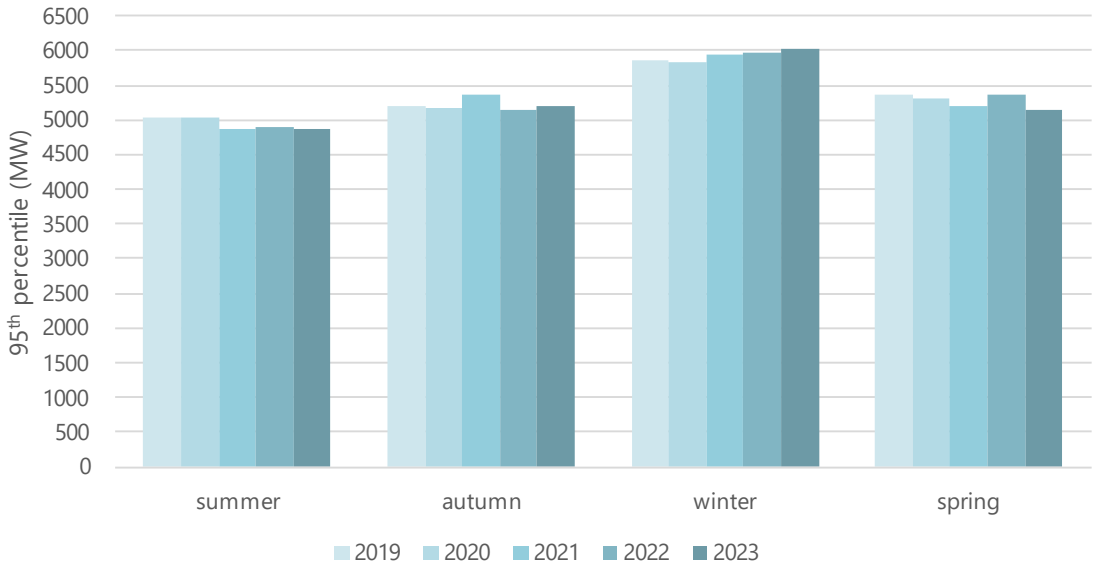
Year	Average (MW)	Median (MW)
2019	5921.0	5905.6
2020	5918.9	5893.2
2021	6044.6	6002.3
2022	6112.6	6068.0
2023	6165.2	6128.6

Peak consumption is most common during winter

Unsurprisingly, peak consumption occurred during the winter months. On average, 92 per cent of the top 300 peaks each year occurred during winter. Figure 10 below shows the 95th percentile of trading period peaks during each season over the five years.

Looking specifically at peak trading periods during winter (6am to 9am and 5pm to 8pm) we found that trading period peak consumption during the post-RCPD winters surpassed the 95th percentile of RCPD winter consumption 15.1% of the time. This signifies a substantial increase in peak consumption when the RCPD was removed. Performing a proportion test confirms that this is a statistically significant increase. On average, the 95th percentile of peak consumption during peak trading periods in winter post-RCPD is 121 MW higher than during the RCPD winters.

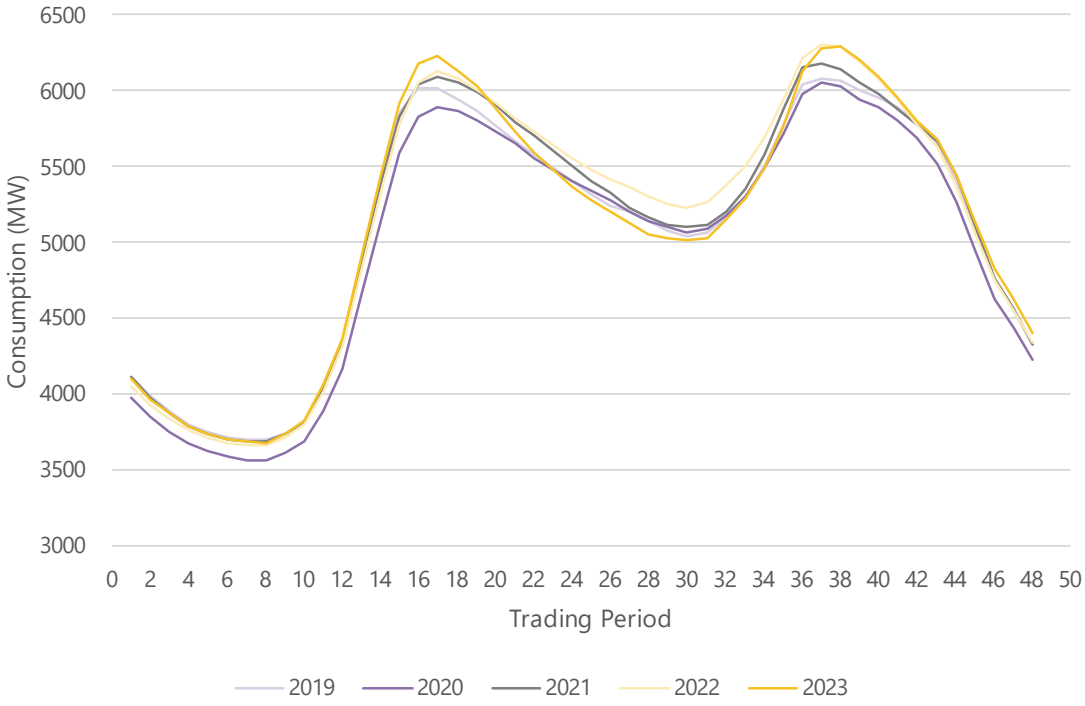
Figure 10: Column graph showing the seasonal 95th percentile of national trading period consumption from 2019 to 2023



Daily consumption peaks are also higher

Figure 2 shows the top 20 daily max consumption trading periods nationally each year between 2019 and 2023, normalised to daily total consumption in 2023. The figure confirms the findings from the Electricity Authority's 2023 report (Electricity Authority, 2023f) that peak consumption was higher after the RCPD was removed. The evening peak for 2022 and 2023 is higher than in 2019, 2020, and 2021. The morning peak in 2023 is also higher than previous years.

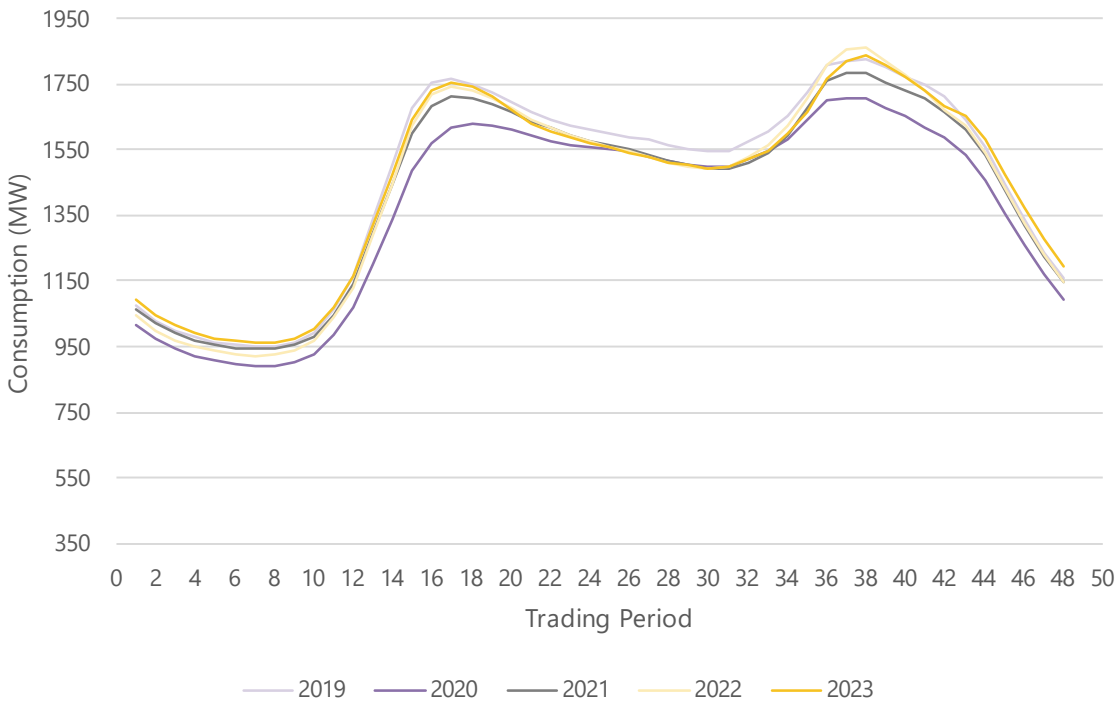
Figure 11: Annual top 20 daily max national consumption trading periods between 2019 and 2023 normalised to 2023



The graphs below show the top 20 daily consumption trading periods by region. All regions, apart from the Central North Island region show a similar trend to the national daily consumption, indicating that these regions are all contributing the national peaks. The Central North Island region showed higher peaks in 2022 but daily consumption in 2023 appears to much lower compared earlier years.

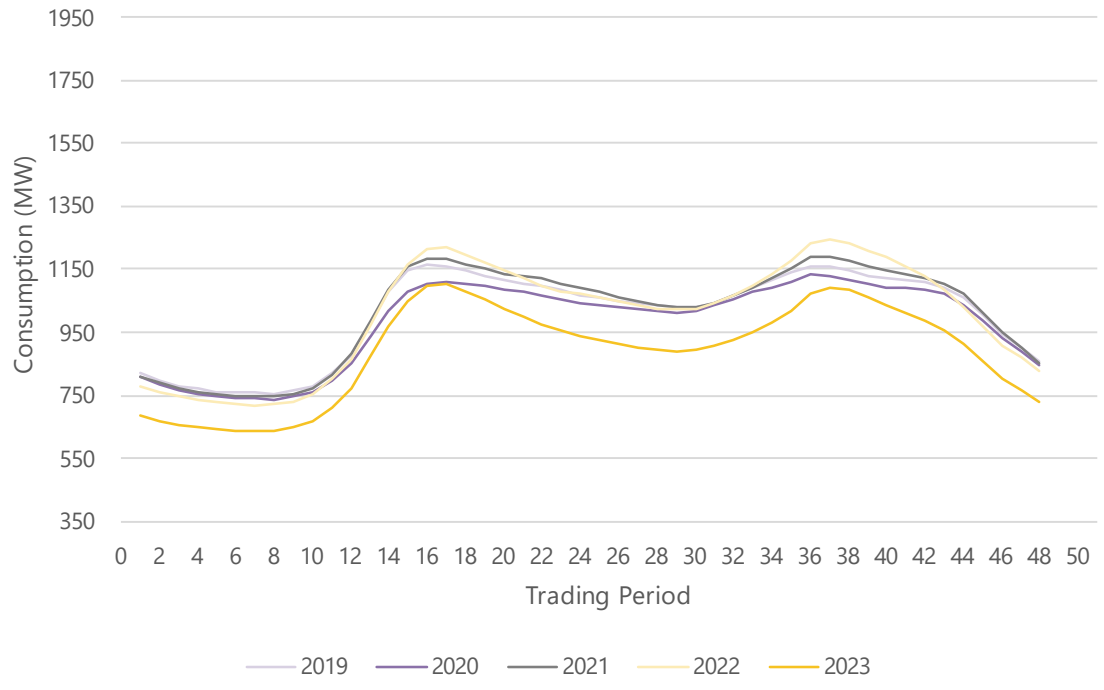
Upper North Island

Figure 12: Upper North Island annual top 20 daily max consumption trading periods between 2019 and 2023 normalised to 2023



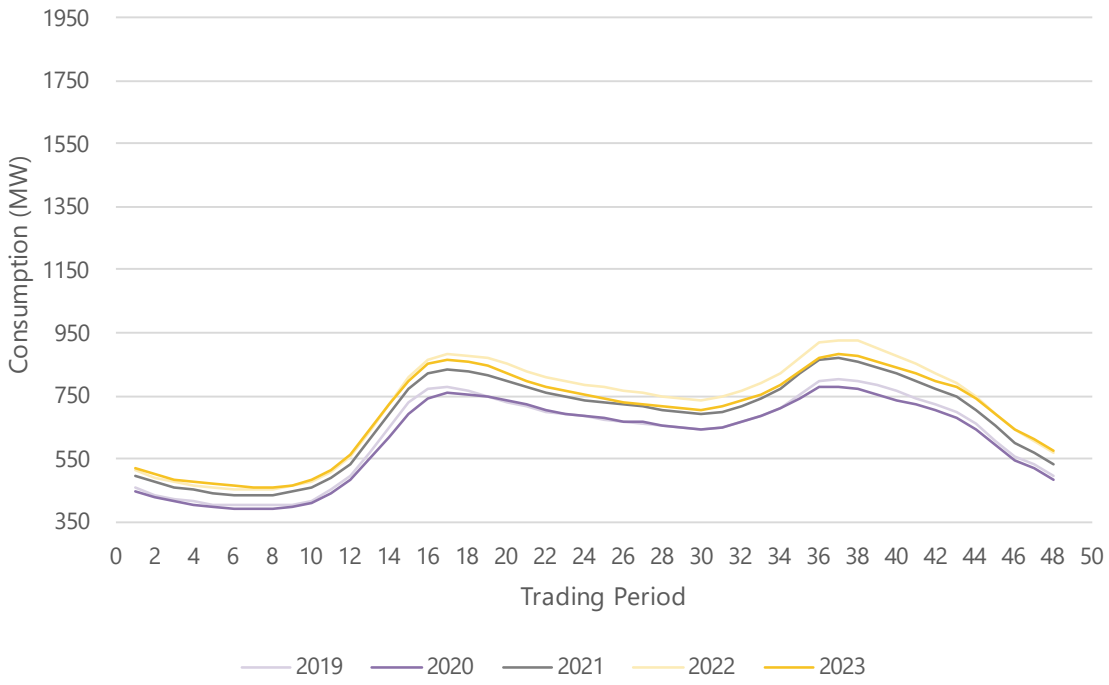
Central North Island

Figure 13: Central North Island annual top 20 daily max consumption trading periods between 2019 and 2023 normalised to 2023



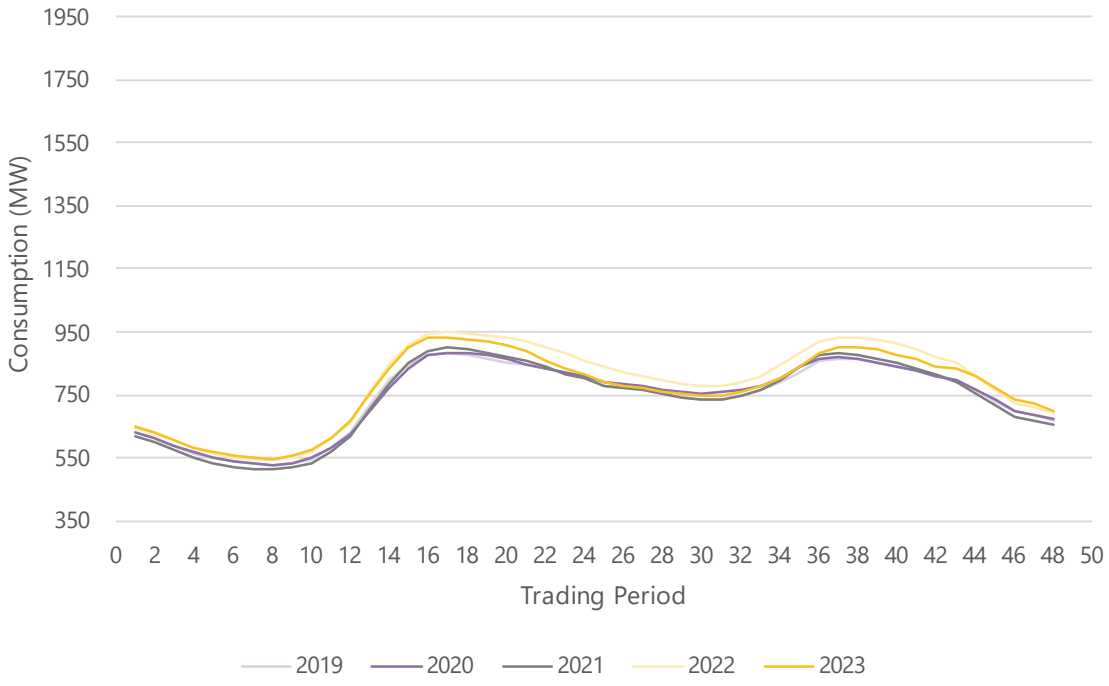
Lower North Island

Figure 14: Lower North Island annual top 20 daily max consumption trading periods between 2019 and 2023 normalised to 2023



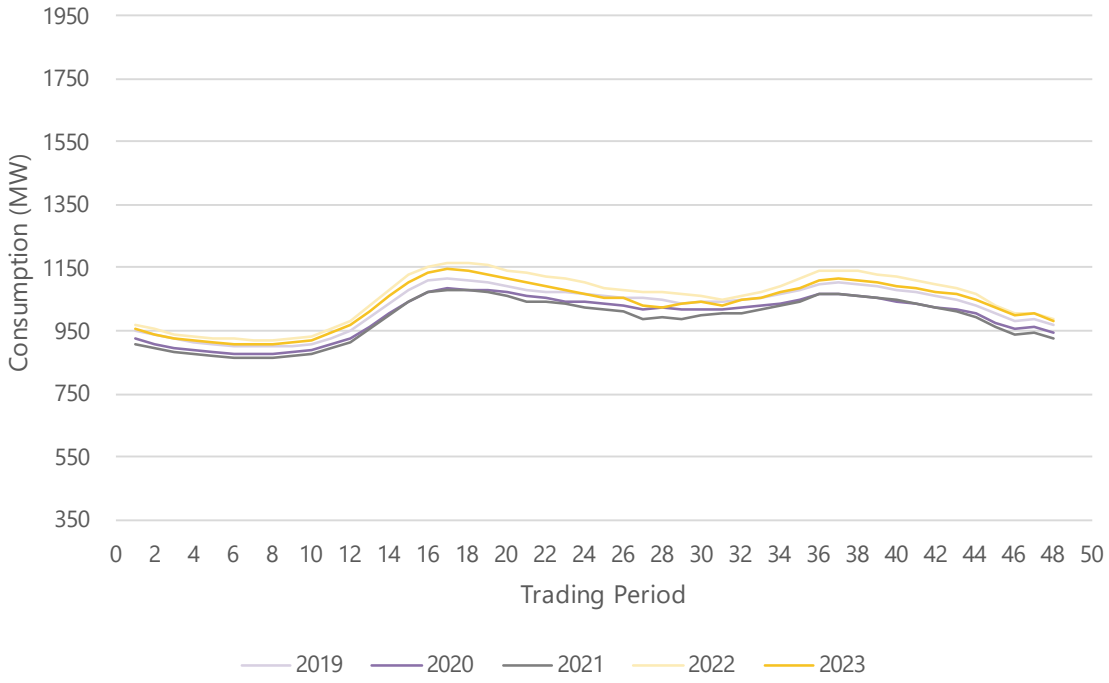
Upper South Island

Figure 15: Upper South Island annual top 20 daily max consumption trading periods between 2019 and 2023 normalised to 2023



Lower South Island

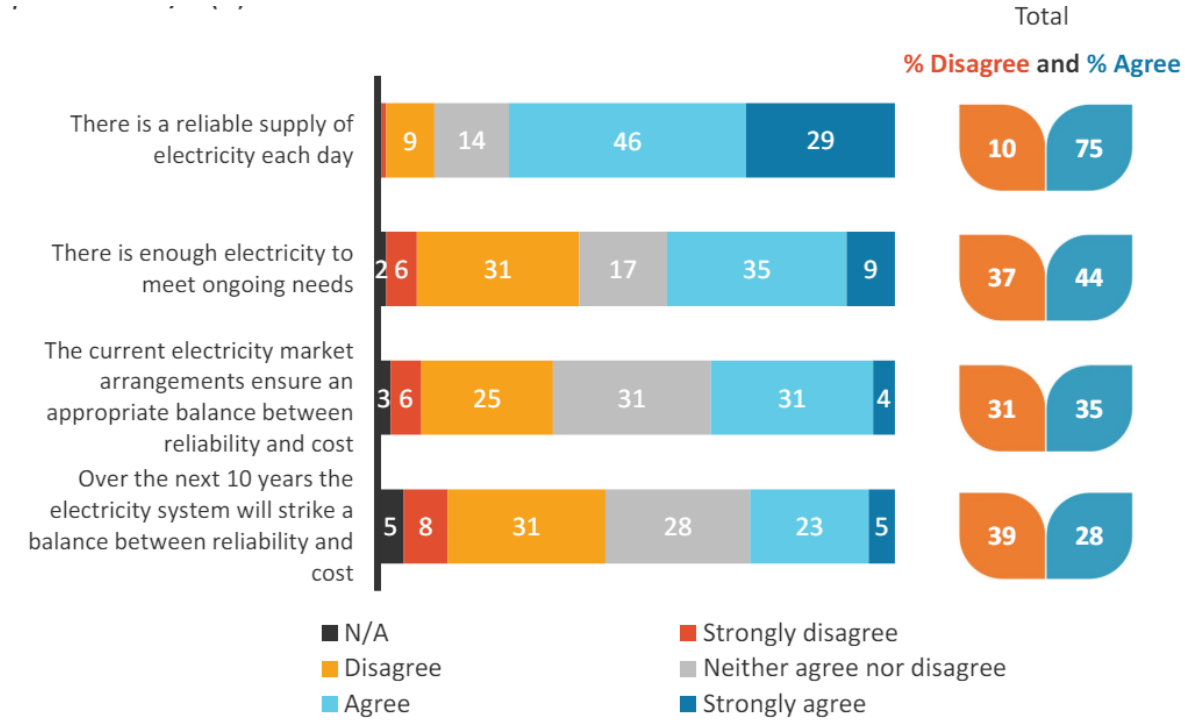
Figure 16: Lower South Island annual top 20 daily max consumption trading periods between 2019 and 2023 normalised to 2023



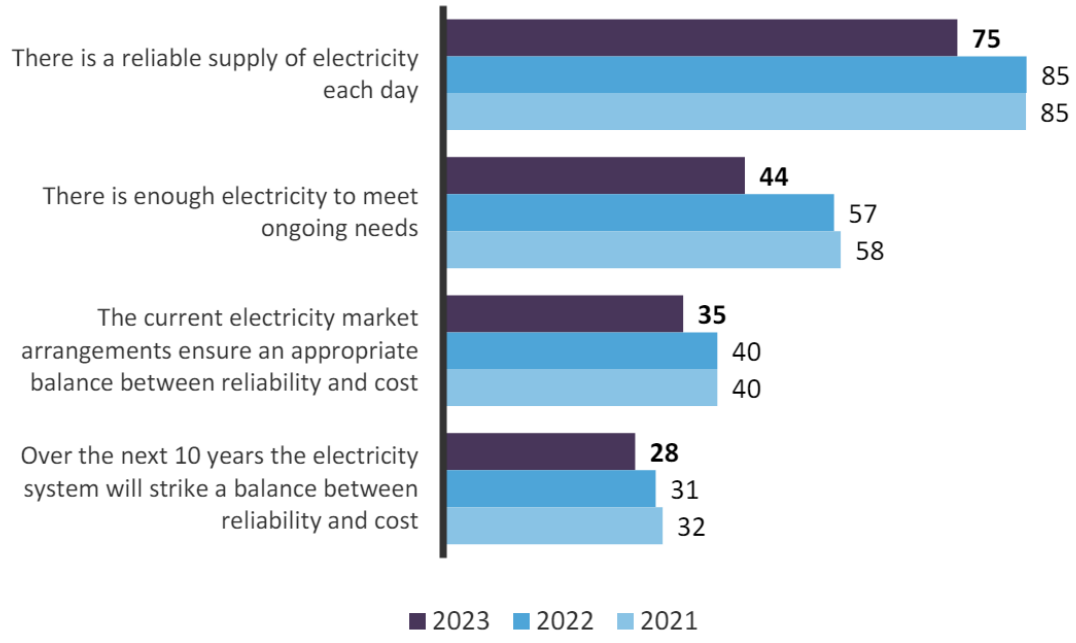
Appendix B Customer surveys of reliability

Figure 17: Electricity Authority's Industry and Consumer Survey results in relation to reliability, 2023

Industry survey results

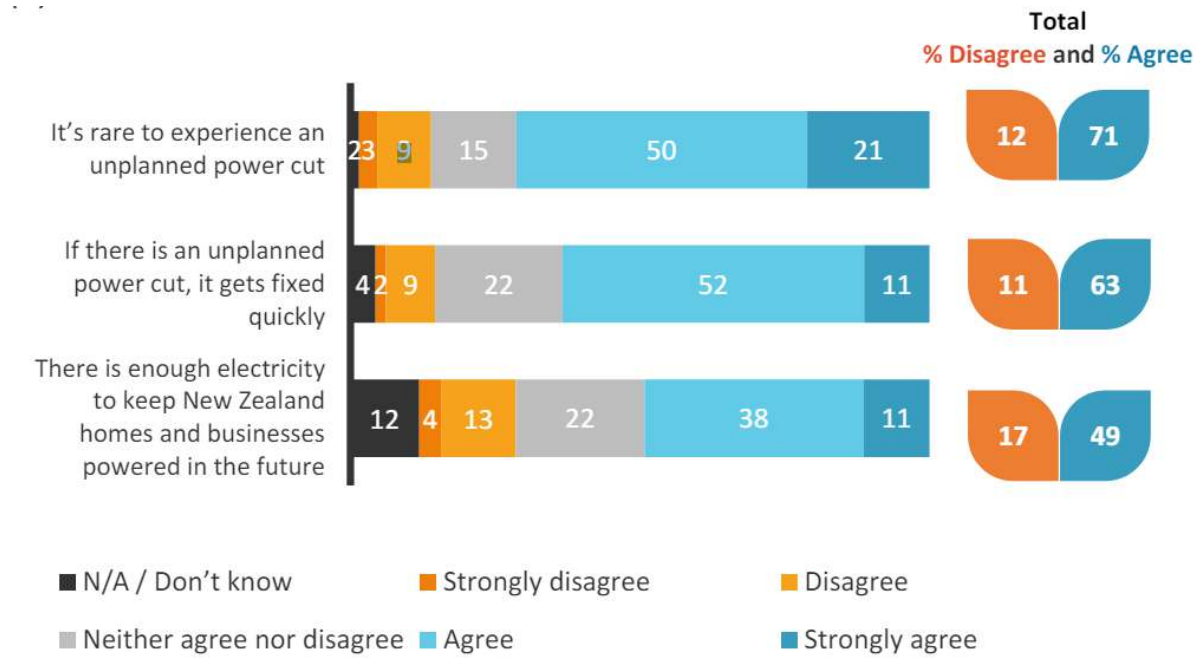


Base: All Respondents (n=118).

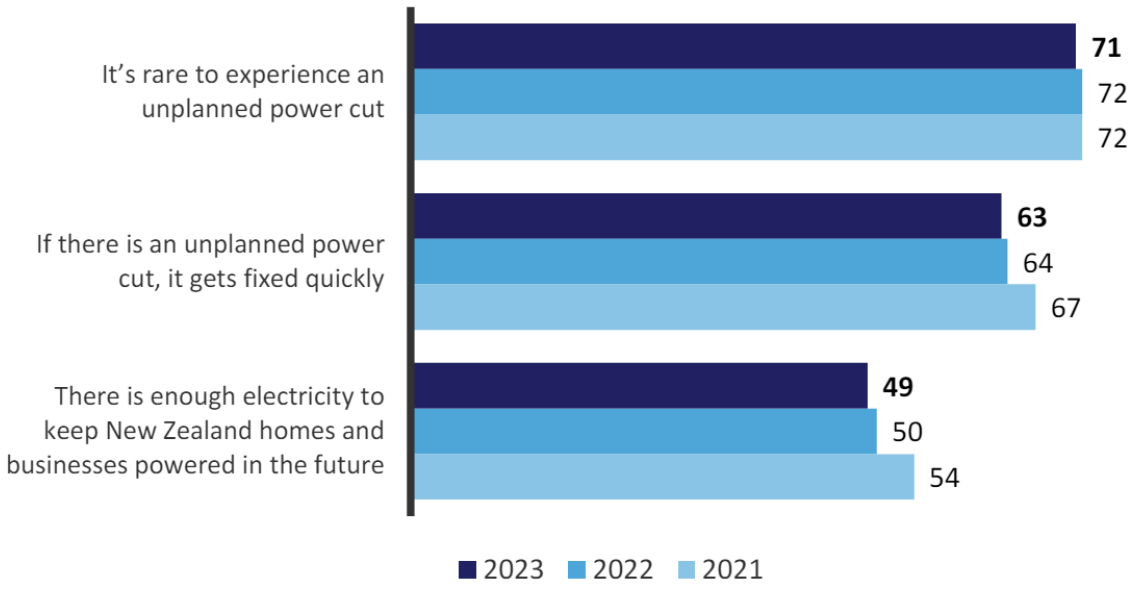


Base: All Respondents (approx n=100 per survey).

Consumer survey results



Base: All respondents (n=1006).



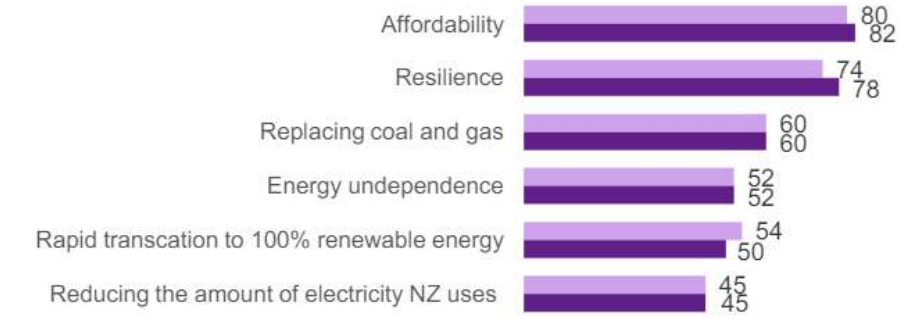
Base: All respondents (approx. n=1000 per survey).

Source: (Electricity Authority, 2023b, 2023c)

Figure 18: Consumer Advocacy Council's Consumer and Small business survey results in relation to issues/concerns, 2023

Consumer survey results

Affordability and a resilient system remain the two most important issues for New Zealanders.

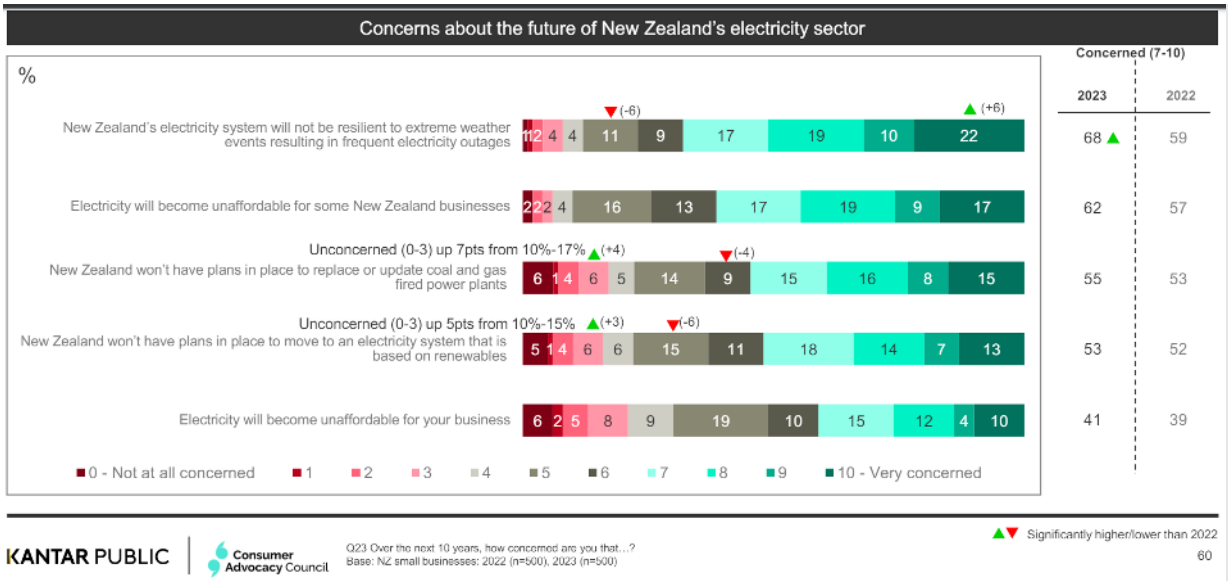


And in 2023, more New Zealanders are concerned the system will not be resilient to extreme weather over the next ten years.

% concerned about the future of New Zealand's electricity sector…	2022	2023
Electricity will become unaffordable for some New Zealanders	69	72
New Zealand's electricity system will not be resilient to extreme weather events resulting in frequent electricity outages	57	65 ▲
Electricity will become unaffordable for you	52	53
New Zealand won't have plans in place to replace or update coal and gas fired power plants	51	50
New Zealand won't have plans in place to move to an electricity system that is based on renewables	51	49

▲▼ Significantly higher/lower than 2022

Small business survey results



Source: (Consumer Advocacy Council, 2023)

About Sapere

Sapere is one of the largest expert consulting firms in Australasia, and a leader in the provision of independent economic, forensic accounting and public policy services. We provide independent expert testimony, strategic advisory services, data analytics and other advice to Australasia's private sector corporate clients, major law firms, government agencies, and regulatory bodies.

'Sapere' comes from Latin (to be wise) and the phrase 'sapere aude' (dare to be wise). The phrase is associated with German philosopher Immanuel Kant, who promoted the use of reason as a tool of thought; an approach that underpins all Sapere's practice groups.

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