Meeting Date: 22 June 2018

THE ELECTRICITY AUTHORITY'S REVIEW OF WINTER 2017

SECURITY AND RELIABILITY COUNCIL

The Electricity Authority completed a comprehensive review of winter 2017. Aspects of the review relate to electricity security and reliability. In particular, the review found that hydro storage was managed more conservatively than in the past. This indicates that market and regulatory arrangements since 2010 have had the desired effect. In particular, the certainty created by an objective, independently administered threshold for calling for public conservations was very beneficial.

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

The Electricity Authority's review of winter 2017

The Electricity Authority's (Authority) Market Monitoring team completed a review of winter 2017. That review was completed some weeks ago and is due for publication on 19 June 2018.

The scope of that review was designed to align with the Authority's statutory objective. As such, it was not focussed solely on matters pertaining to reliability or security of supply (such as consumer switching between retailers). Nonetheless, there were matters of interest to the SRC:

- the review found that hydro storage was managed more conservatively than in the past
- market and regulatory arrangements since 2010 appear to have had the desired effect
- the certainty created by an objective, independently administered threshold (the 10 per cent hydro risk curve) for calling for public conservations was very beneficial.

The Authority considered whether the review needed SRC input at any early stage, but decided against it. As such, any SRC advice arising from this paper is unlikely to lead to amendment and republication of the review, unless it identifies a material error. Nonetheless, the Authority has other work underway that could benefit from SRC advice on the security of supply arrangements and would appreciate any such advice.

Material for the SRC to consider

The *2017 Winter Review is a*ppended to this cover paper. Of the two appendices to be published with the review, only one (*Insights Dashboard: Dry Winters 2008-2017*) is appended here. The other appendix was excluded from this SRC paper because it was inappropriate for the SRC. It is too technical and out of scope of security, reliability or the system operator's performance.

The secretariat requests that all SRC members read at least the Executive Summary of the review. The secretariat considers that members need not to read sections four or five of the review, as the linkage to the SRC's scope is tenuous.

Questions for the SRC to consider

The SRC may wish to consider the following questions.

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

Q2. What advice, if any, does the SRC wish to provide to the Authority?

2017 Winter review

Final report

22 March 2018

Market Performance

Executive summary

The winter of 2017 was characterised by an extended period of low hydro inflows in the South Island. The Electricity Authority (the Authority) has, since its inception, implemented a wide range of measures aimed at encouraging effective management of low inflow events. The winter of 2017 provided an excellent opportunity to assess the performance of these measures.

Many of the regulatory and market mechanisms that have been introduced since 2010 to improve security of supply are working well. Together these mechanisms meant that despite historically bad hydro inflows, there was no suggestion of non-supply.

Key lessons from the winter of 2017

The indications are that a raft of measures introduced by the Authority—the objective trigger to commence an official conservation campaign, customer compensation scheme, stress testing—have had the desired effect on hydro storage management.

The broader security of supply arrangements put in place by the Authority after the 2009 Ministerial review worked well.

We were concerned about the widening of bid-ask spreads for exchange traded futures. Market making arrangements should be reviewed to ensure that problems do not eventuate in more severe circumstances.

Around 10 per cent of residential consumers on spot contracts switched to fixed price variable volume contracts—the most common sort of retail contract—during the winter. This didn't seem to cause disruption but, nevertheless, the Authority will continue its work to ensure spot price retailers ensure that their customers are well informed about risk.

An important lesson is the power of using the 10 per cent hydro risk curve as a threshold in differentiating between a dry year that the market can manage without the need for public conservation, and a dry year that is unusually severe.

Electricity purchasers were hedged well in advance of the winter of 2017. This includes the swaption between Meridian and Genesis. This meant that purchasers were not adversely affected when the spreads for exchange traded futures widened during the winter. However, the widening of spreads signalled that the market making arrangements are more fragile than anticipated and these should be reviewed to ensure that problems do not eventuate in more severe circumstances.

Something that hasn't been a feature during past dry seasons is residential consumers exposed to spot prices. This is a recent trend in the retail market enabled by the arrival of smart meters and entry of innovative retailers. Around 10 per cent of these consumers switched to fixed price variable volume contracts—the most common sort of retail contract—during the winter. This didn't seem to cause disruption but, nevertheless, the Authority will continue its work to ensure spot price retailers ensure that their customers are well informed about risk.

There is statistical evidence that storage was managed more conservatively than in the past. This indicates that a raft of measures—the official conservation campaign, customer compensation scheme, stress testing—have had the desired effect.

Various security of supply measures had the desired effect. Market mechanisms worked well, and Transpower provided regular updates to customers. In addition, hedging—which was done in advance of the winter—is consistent with the sort of behaviour we would expect to result from the stress test. The stress test is aimed at ensuring that purchasers are informed about the spot price risk they face.

While we can identify some demand response from non-conforming nodes, the situation for spot exposed consumers is more difficult to discern.

Media comment in 2017 compared to corresponding comment in 2008 contained more favourable comment, focused more on prices than storage, contained far fewer references to crises, and there were no widespread calls for government intervention. A large part of the reason for this is the use of the 10 per cent hydro risk curve as a threshold and the fact that, at any point prior to this, there is no need for intervention. An important lesson is the power of this fixed threshold in differentiating between a dry year that the market can handle without any help and one where a conservation campaign is required to reduce the risk of a crisis developing.

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1 Introduction

1.1. In 2017 South Island hydro inflows were very low causing storage to fall to its lowest level since 2008. The market broadly performed as expected, with prices rising to signal increasing risk and participants making decisions to mitigate spot price risk exposures. The system operator provided timely information on the unfolding situation. Media comment did not contain widespread calls for government intervention as it did in 2008.

1.2. Bid-ask spreads on the ASX futures market widened to levels that meant very high price volatility and a consequent high cost to trading in and out of positions. While this had only small practical implications for participants looking for cover during the winter, it was worrying because, while dry, the winter was relatively benign.

1.3. Market Performance routinely undertakes reviews of events in the market to try to understand them, capture any lessons, and to recommend improvements to the Electricity Industry Participation Code.

2 Scope of this review

2.1. A dry winter is essentially a fuel shortage. When fuel—or anything traded in a market—is in short supply, price increase to reflect relative scarcity. So the overall question for this review is: Were there any inefficient barriers to wholesale electricity prices reflecting the scarce fuel situation in the winter of 2017? We have broken this question up into five questions amenable to quantitative analysis:

(a) How did the hedge market perform?

(b) How did spot priced residential consumers react?

(c) Has there been any change to the relationship between spot price and storage?

(d) What was the demand response to high spot prices?

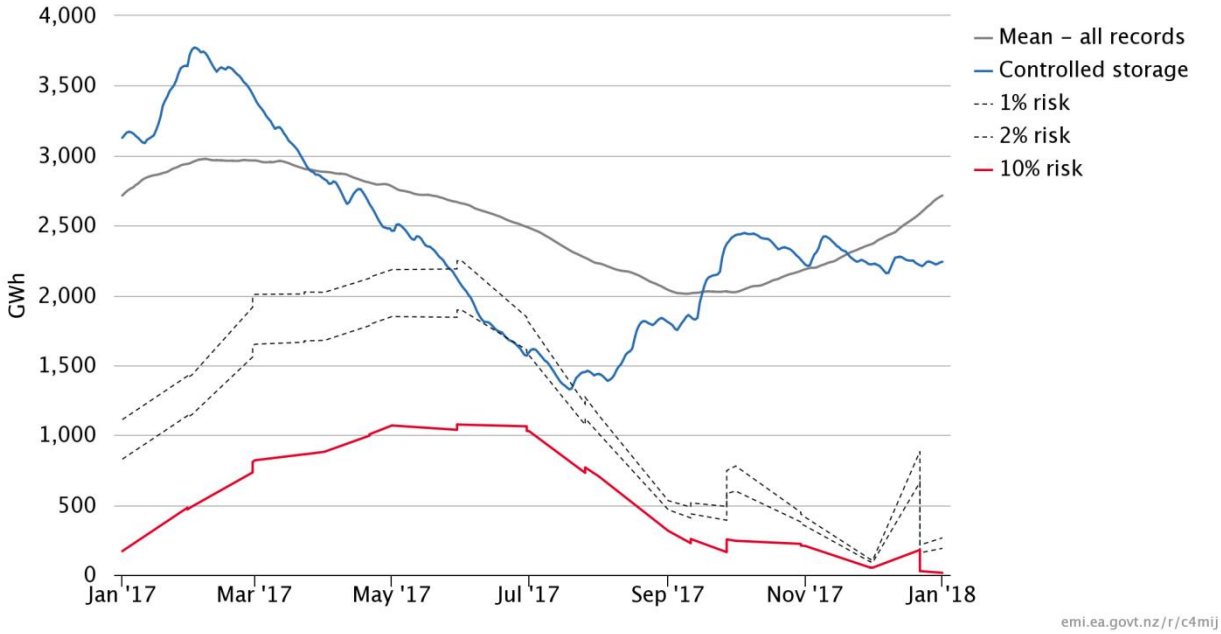
(e) How did the security of supply arrangements perform?

2.2. The rest of this paper provides some context and then answers each of these questions in turn.

3 Context: Very low inflows lead to very low storage, high prices and high levels of thermal generation

3.1. Low inflows in the first 7 months of the year meant low storage over the autumn and winter. This led to low hydro generation, increased prices and increased thermal generation as gas and coal fired generation responded to prices and helped firm renewable generation. As a result, the HVDC began to flow southwards, and the hedge price increased. The charts in this section show these changes and how the system responded to low storage.

Figure 1: New Zealand controlled storage and hydro risk curves in 2017



3.2. Figure 1 shows how storage fell from early February until late July. Storage crossed the 2 per cent hydro risk curve on 10 June and skirted along it for about 10 days before lifting slightly. At an X per cent hydro risk curve, there is an X per cent chance of lake storage falling to the zero line later in the season, based on the historical record of lake inflows. Storage recovered through August and September and remained relatively flat for the rest of the year. Figure 1 also shows that storage going into 2018 is below average. Figure 2 shows the corresponding chart for the South Island.

Figure 2: South Island storage

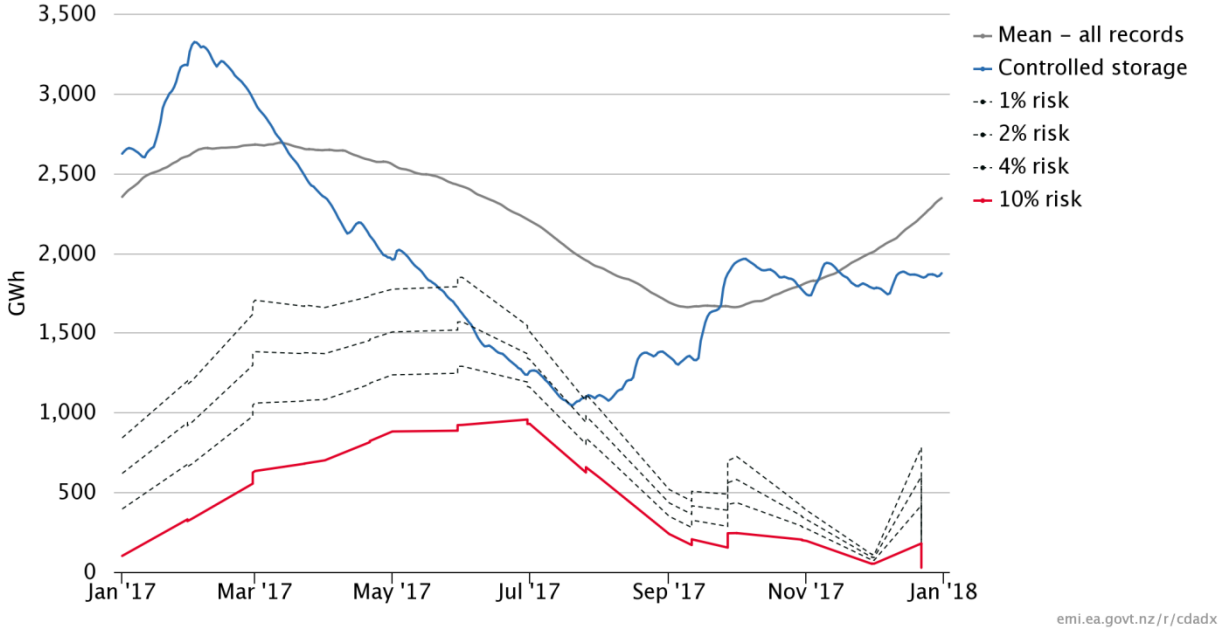
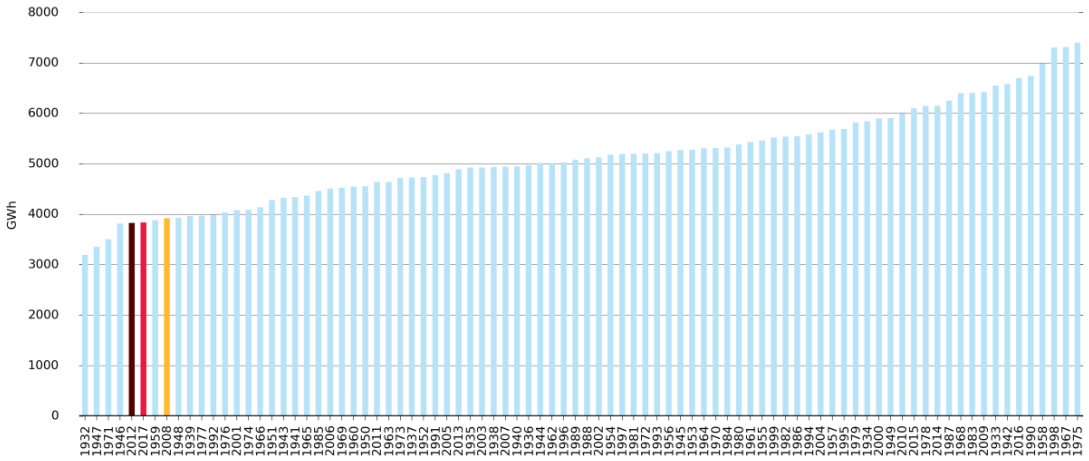
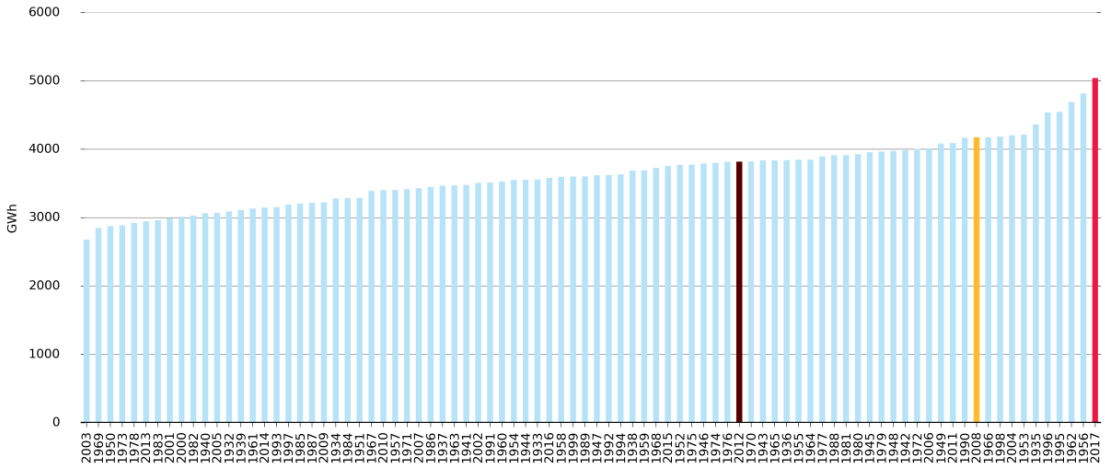


Figure 3: South Island inflows March to August in 2012 and 2017



3.3. Figure 3 shows South Island controlled inflows for March to August inclusive for all years for which we have data: 2017 is shown in red, 2012 is shown in brown and 2008 is shown in yellow. Figure 3 shows the inflows were amongst the worst ever over these 6 months.

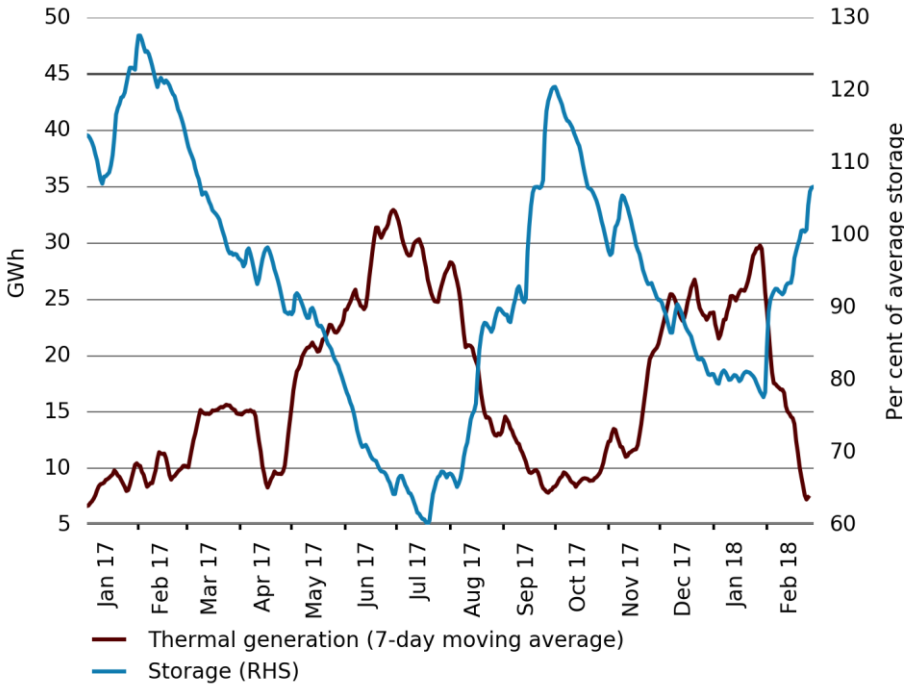
Figure 4: North Island inflows March to August in 2012 and 2017



3.4. Figure 4 shows that, in contrast, North Island inflows were the highest on record for March to August of 2017. The other two years are coloured as in Figure 3.

3.5. Low South Island inflows were accompanied by low levels of wind generation in the first 6 months of 2017. The average capacity figure for the first half of 2017 was 33 per cent compared to 38 per cent in the previous 2 years. There is around 640 MW of wind capacity, so the 5 per cent difference over the year means generation is down about 280 GWh.

Figure 5: Daily thermal generation and New Zealand storage

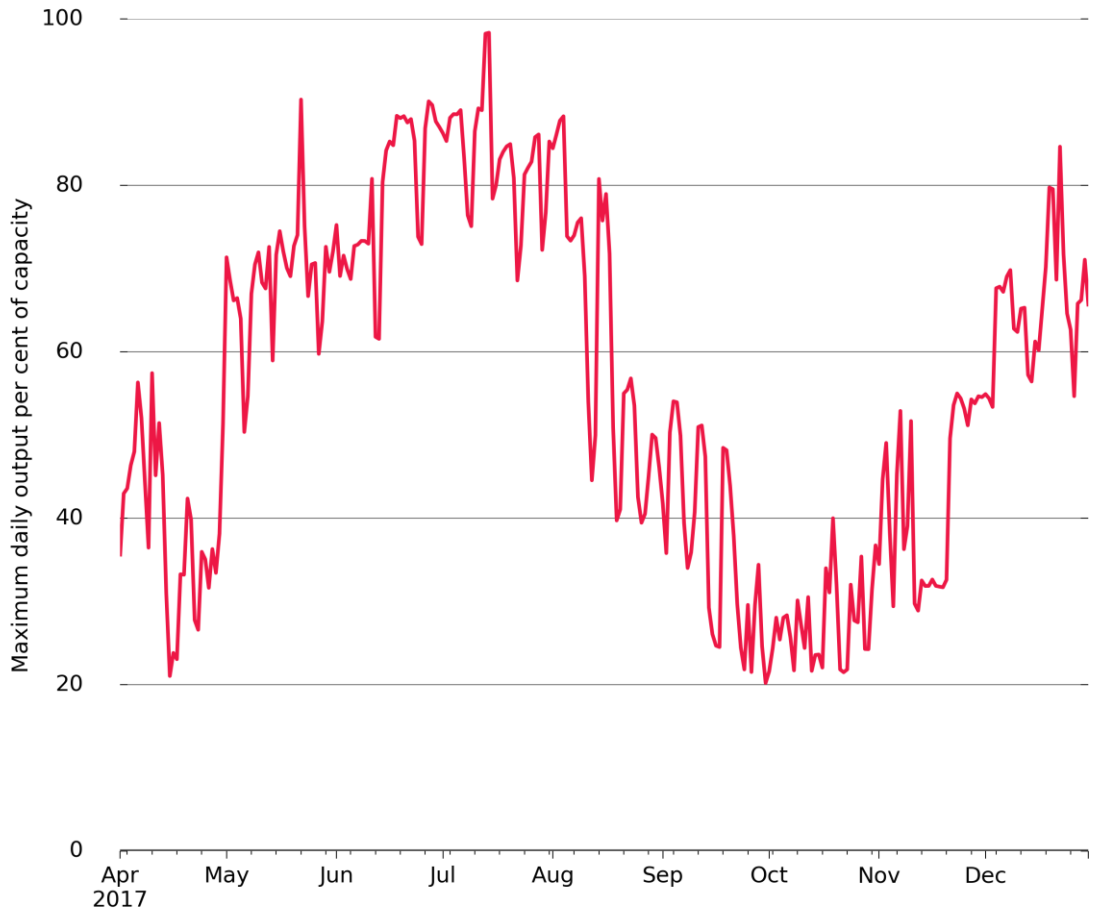


3.6. Figure 5 shows total New Zealand storage as a percentage of mean storage, and a 7-day moving average of thermal generation. It shows that once storage fell below 90 per cent of mean storage in April, thermal generation increased rapidly. Thermal generation peaked in late June before falling away as the winter ended and storage recovered.

Figure 6: Daily thermal output as a percentage of potential output

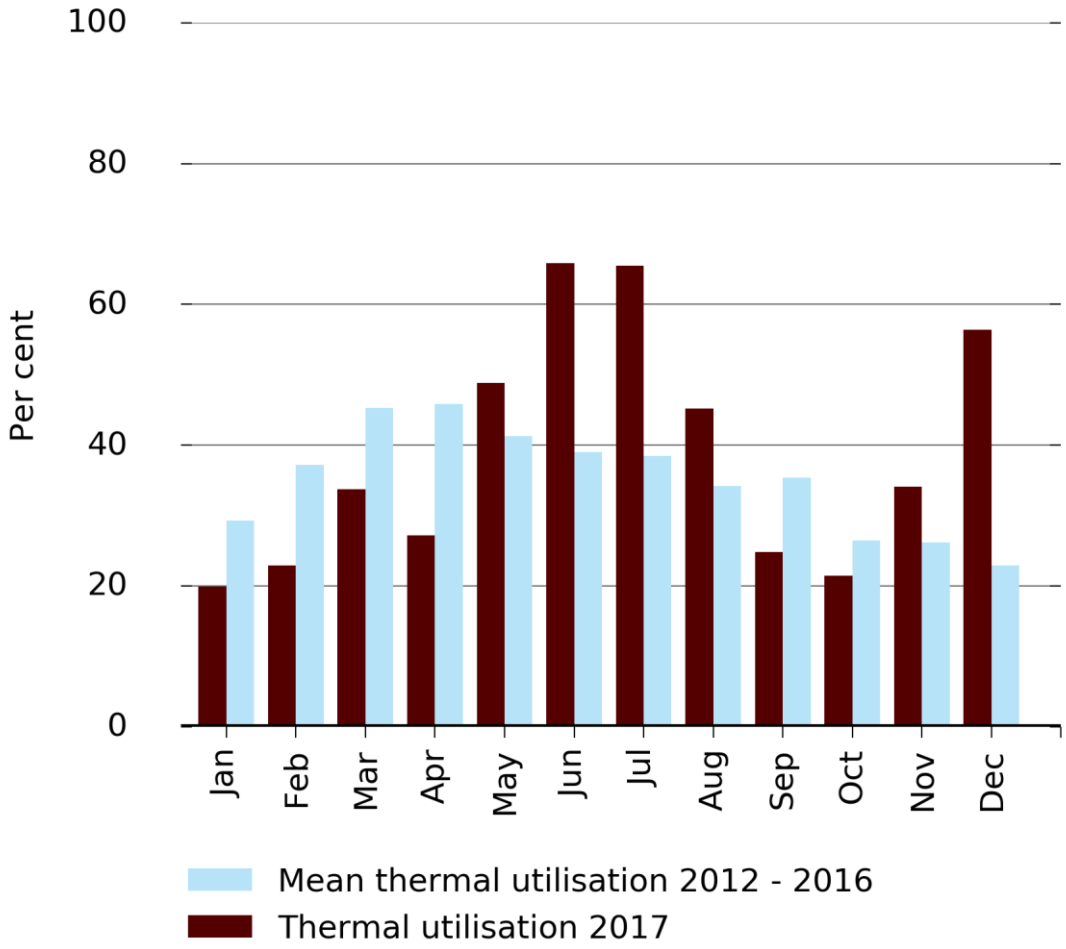
3.7. Figure 6 shows daily thermal output as a percentage of potential output, ignoring outages and fuel constraints. It shows that, even when thermal output was highest, there was potential for thermal generators to generate more energy over a day.

Figure 7: Maximum daily thermal output as a percentage of potential maximum output



3.8. Figure 7 shows maximum daily thermal energy output and reserves as a percentage of potential, ignoring outages and fuel constraints. It shows that at times there was very little spare thermal capacity available. So while Figure 6 shows that, over a day, thermal generators could have generated more output, this is not true for every half hour trading period. Note that, while thermal was running at near its capacity, hydro was not running anywhere near its capacity so there was no risk of the system being unable to supply demand.

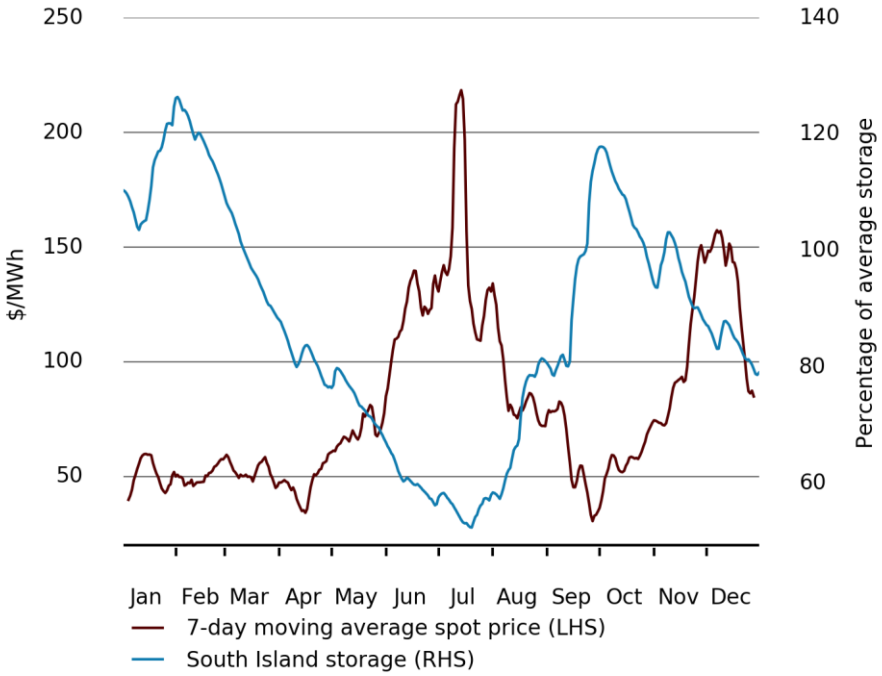
Figure 8: Monthly thermal output for 2017 compared to the previous 5 years



3.9. Figure 8 shows monthly thermal utilisation for 2017 compared to the previous 5 years. It shows that thermal output was comparatively low in the first 4 months of the year. This is likely due to abundant hydro storage at the time. In May, thermal utilisation was just above average utilisation, and then in June and July it exceeded the average by around 25 per cent each month.

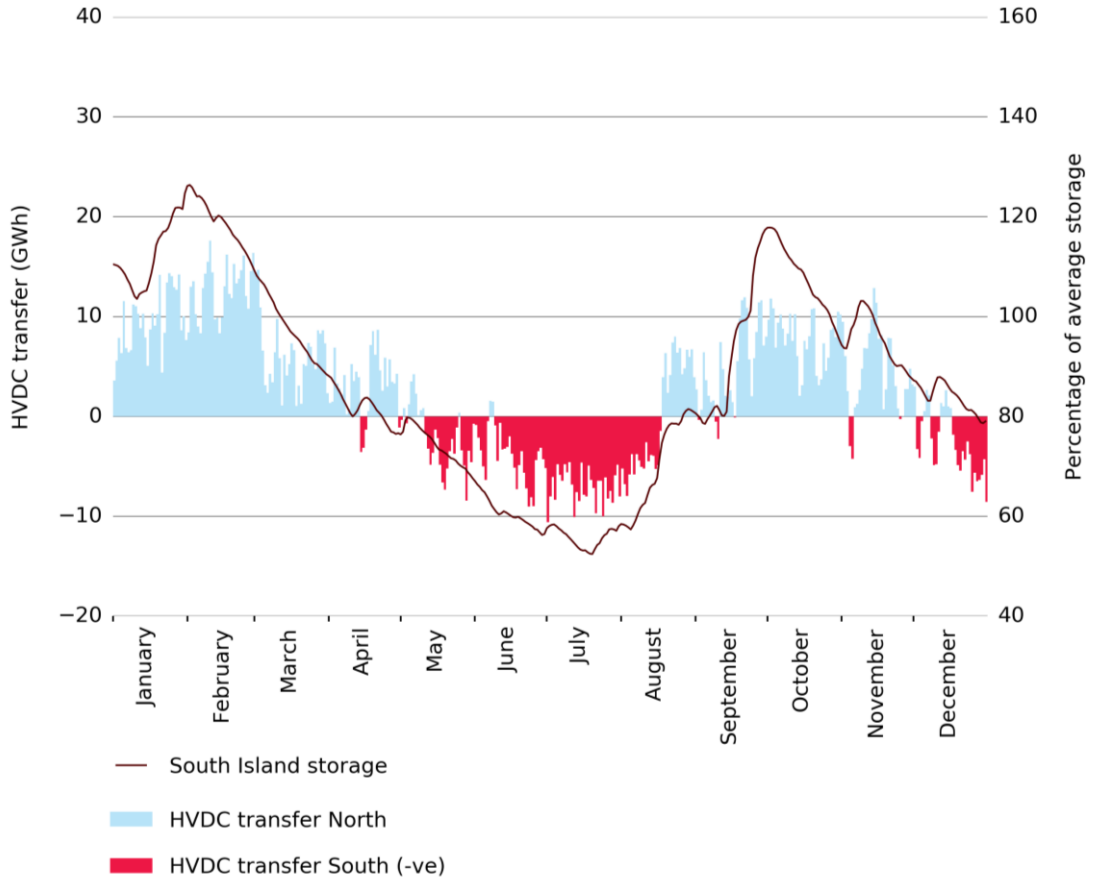
3.10. Figure 8 also shows that in December 2017 thermal output increased again to be above average for the month. Similar to the winter, this was due to high prices caused by low lake levels.

Figure 9: Daily spot price and storage



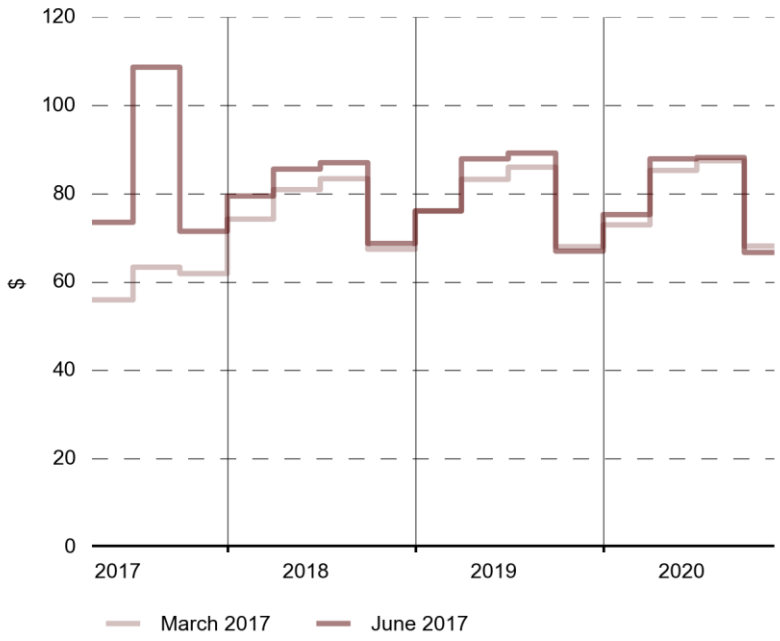
3.11. Figure 9 shows the daily demand-weighted average spot price for New Zealand, and South Island controlled storage as a percentage of average storage. It shows how the spot price responded to the low storage and provided thermal generators with the incentive to run.

Figure 10: HVDC transfer and South Island controlled storage in 2017



3.12. Figure 10 shows high voltage direct current (HVDC) transfer, and South Island controlled storage as a percentage of mean. It shows the effect of storage on the transfer between the islands—lower South Island storage is accompanied by south flow on the HVDC. This in turn reflects relatively better North Island hydro storage and increased thermal generation, the latter reflecting higher spot prices.

Figure 11: Forward curves as at March and June for ASX quarterly contracts



3.13. Figure 11 shows the forward curves as at March and June 2017 for Australian securities exchange (ASX) quarterly contracts. The large increase in prices for the September quarter contracts was partly due to higher than expected spot prices, but also possibly due to ASX market makers pulling out of their market making obligations due to portfolio stress. This meant at times the market was thin which in turn could have led to higher prices.

4 How did the hedge market perform?

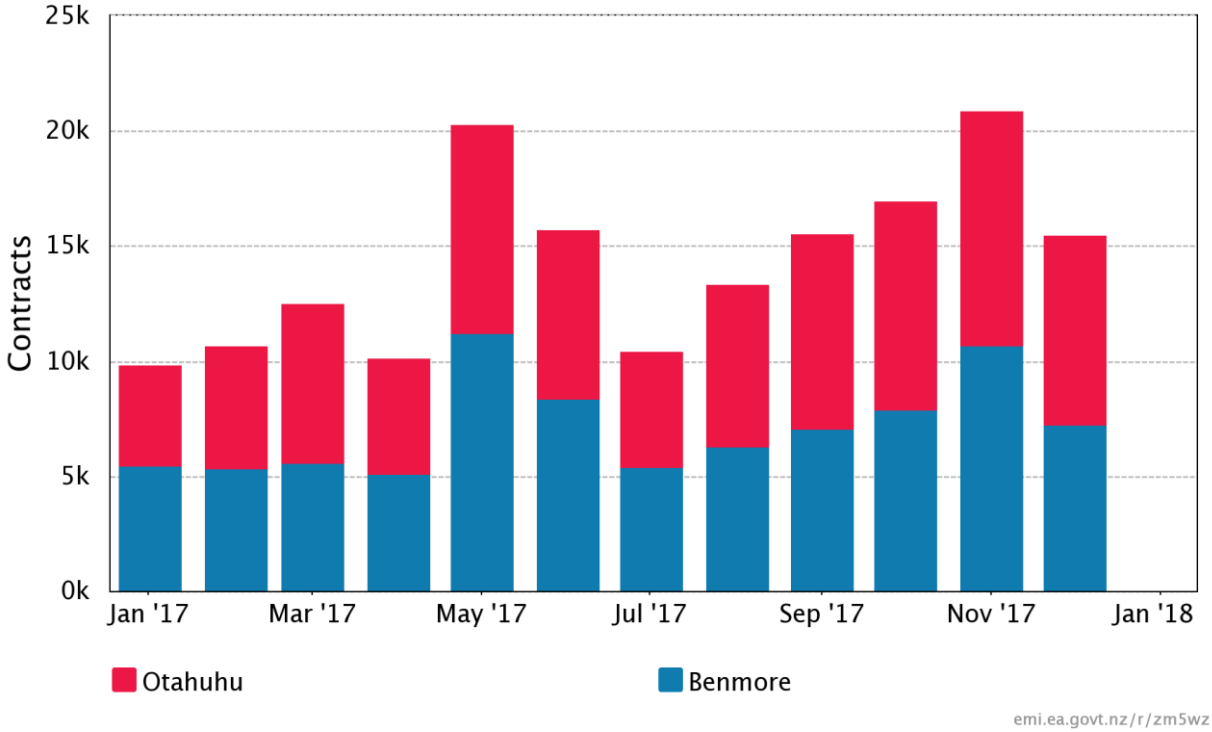
4.1. During the winter of 2017 the hedge market had high trading volumes, high levels of uncovered open interest (UOI) and the ASX exchange traded futures had wide bid-ask spreads for a few months as market makers suffered portfolio stress and began to offer wider bid-ask spreads.

4.2. Over-the-counter forward contracts were similar with high volumes traded, particularly in May and July. The Meridian swaption with Genesis also contributed significantly to system security, firstly by giving Genesis an income stream that justified making thermal units available at Huntly and then, once exercised, adding thermal generation to the mix to ensure that water lasted longer. In effect this arrangement—with vertical integration, and the hedge market more broadly—forms part of a market for firm energy.

4.3. The rest of this section looks more closely at the ASX futures and the spreads that were experienced during the winter of 2017. The market spreads widened as market makers started offering wider bid-ask spreads because of portfolio stress. There is no fixed definition for portfolio stress, but the essence is that it means that market makers found it financially distressing to continue to market make, either because of the cost of doing so, or because risk limits were constraining their ability to do so.

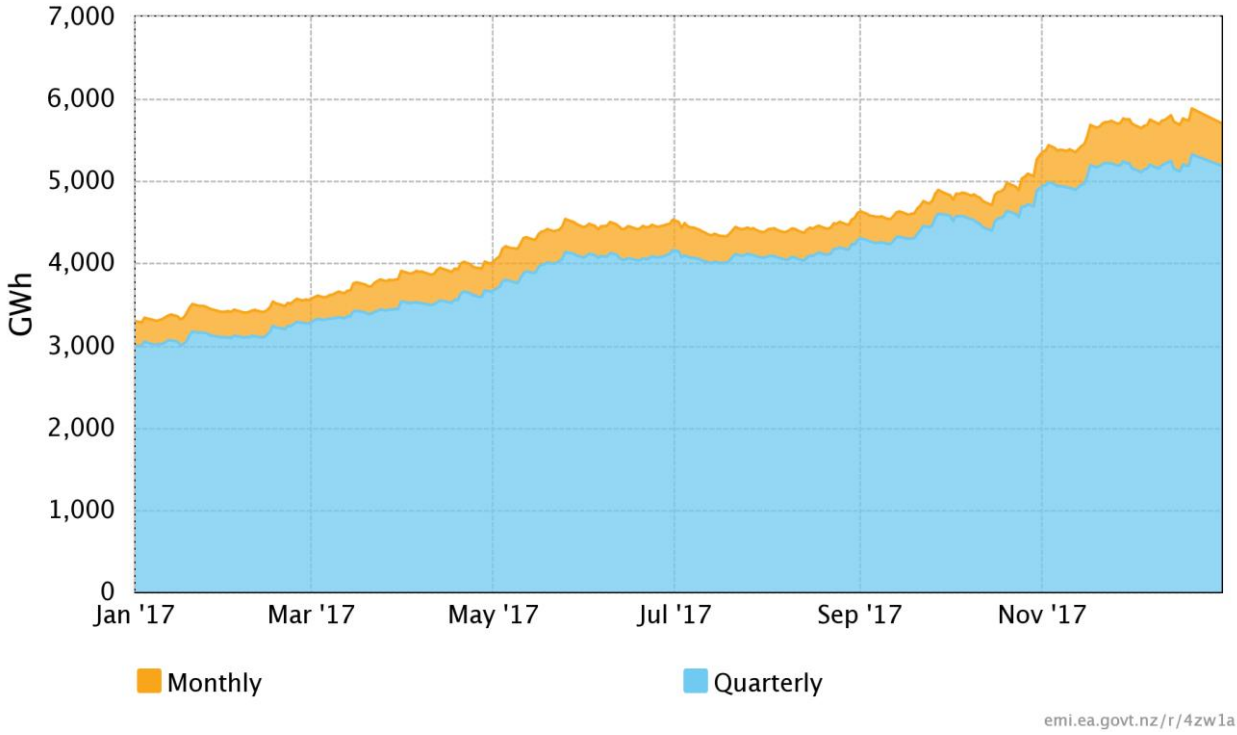
4.4. Figure 12 shows monthly trading volumes on the ASX. It shows that in May—as storage continued to fall—there were strong volumes on the ASX. Volumes fell in June and July coinciding with the increased bid-ask spreads shown in Figure 14 and Figure 15 below. Volumes then recovered to high levels in November as the summer progressed.

Figure 12: Monthly ASX trading volumes 2017



4.5. Figure 13 shows UOI on the ASX. UOI increased in May and again in November, consistent with trading volume.

Figure 13: Uncovered open interest 2017



4.6. Figure 14 shows the bid-ask spreads for Benmore during 2017 for contracts that expired during 2017. Figure 14 clearly shows the increased bid-ask spreads during the winter for July, August and September monthly contracts. Longer dated contracts and quarterly

contracts were not affected to anywhere near the same extent. Figure 15 shows the same data for Otahuhu.

Figure 14: Bid-ask spreads at Benmore 2017

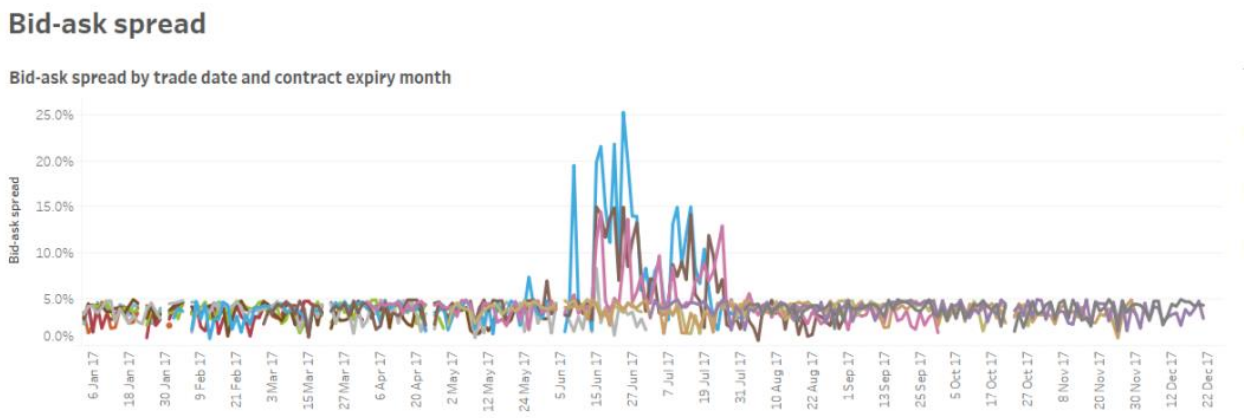


Figure 15: Bid-ask spreads at Otahuhu 2017

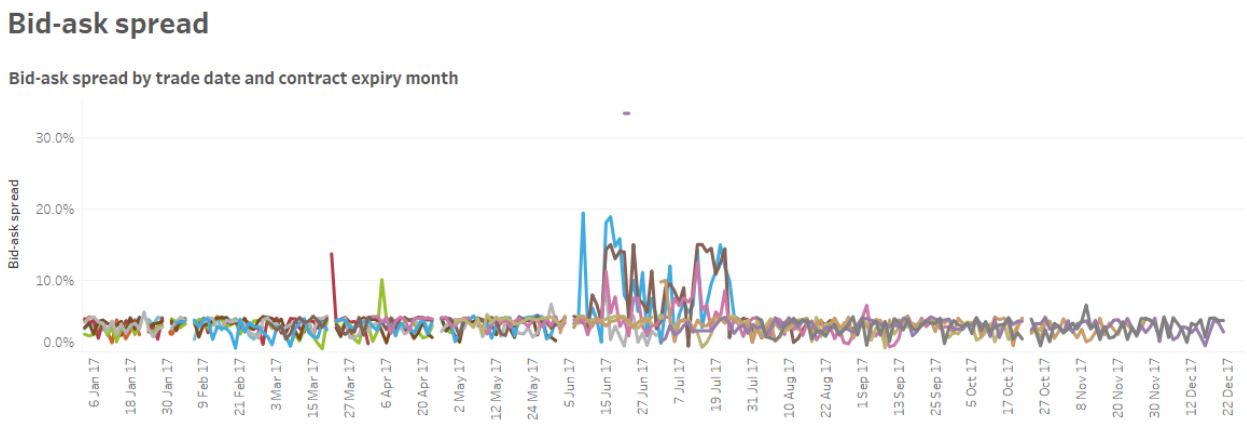
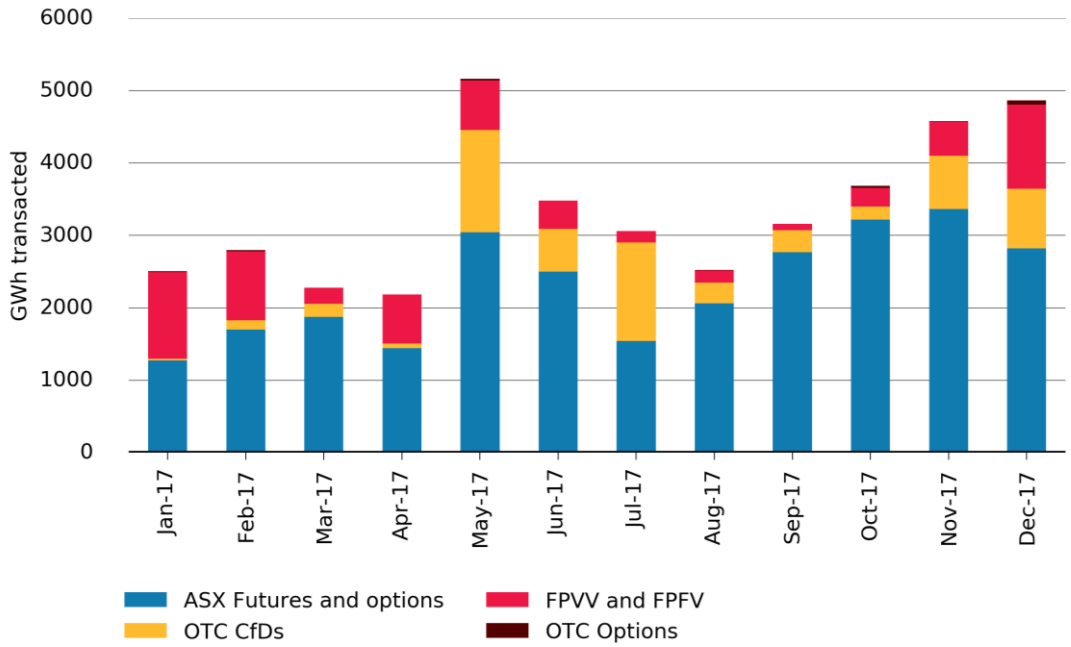


Figure 16: All forward market transactions 2017



4.7. Figure 16 shows all forward market transactions in 2017 that were lodged under the hedge disclosure regime. It shows ASX activity falling from a high in May to a low in July. Over-the-counter (OTC) transactions are high in May, June and July, but tail off as ASX transactions increase through the latter part of the year. Note that the FPVV contracts are for commercial and industrial users, not residential users.

4.8. The Authority asked Concept Consulting to survey hedge market users to discover their experiences during the winter. In summary, the survey finds that:

(a) Although most hedging was done well in advance of the periods with wide spreads, there were some examples of particular participants having problems obtaining cover. However, judging by trading volumes during the winter, these were isolated examples.

(b) Hedge prices are used in a variety of ways by different businesses. Physical market participants use the long-term prices as guides for decision-making rather than the short-term prices. This is because the important decisions they make are long-term decisions like investment choices. This meant that the short-term price volatility caused by wide bid ask spreads didn't necessarily undermine the value of the forward price curve.

4.9. Participants raised the following issues in our hedge survey:

(a) There is no definition of portfolio stress.

(b) Diminished liquidity came as a surprise.

(c) Market-making agreements are voluntary, so the outcomes in winter 2017 are to be expected.

(d) The marginal value of a market maker is large—once one starts offering wider spreads or pulls out of the market entirely, the pressure on those remaining is such that they almost have no choice but to follow suit.

(e) Winter 2017 was testing without being severe—much worse outcomes could happen in worse situations.

(f) Regulators cannot see the fragility of the arrangements.

(g) There is some doubt as to the sustainability of the arrangements.

(h) Risk limits of market makers seem to be small.

(i) The hedge market underpins business, in particular retail competition.

4.10. Findings from the survey have been passed onto the Authority's market design team for consideration as part of its ongoing programme of hedge market development.

The hedge market was stretched, but the winter was not severe

4.11. Overall, we consider that the immediate effect of the widening spreads was not severe because volume was available. However, it is concerning that the commitment to maintaining normal bid-ask spreads seemed fragile, especially when the dry winter was not severe when compared to 2008 for example (see Figure 29). The widening spreads could lead to actual, or effective, withdrawal of the market makers under more severe circumstances. In addition, there may be long-term adverse impacts associated with not being able to rely on (or the perception of not being able to rely on) hedge prices when the physical market becomes tight and/or one of the four market makers drops out.

4.12. The Authority should consider the durability of market-making arrangements in light of the 2017s experience to ensure outcomes from this market facilitation are still consistent with the original policy intent.

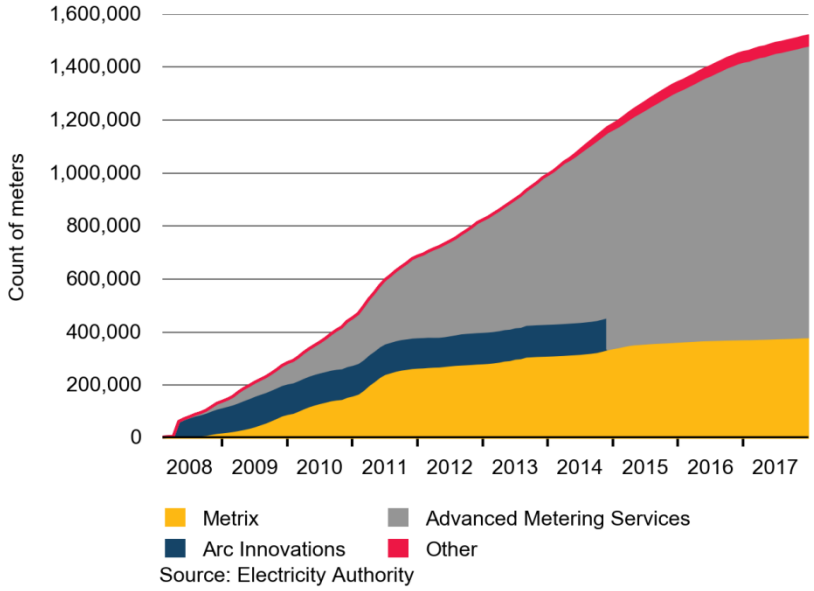
5 About 10 per cent of spot-exposed residential consumers switched retailers

5.1. A change in the New Zealand electricity retail market since the last dry season in 2012 has been retailers offering spot priced contracts to residential consumers have entered the market and built market share. Before 2014, all residential consumers were on contracts that stipulated a price for electricity that didn't vary with the spot price. Most consumers are still on these kinds of contracts.

Smart meters enabled the entry of spot priced retailers

5.2. The Code requires that meters be certified to specific levels of accuracy, and this requirement—work on which dates back to 2000—came into force on 1 April 2015. The effect of this change was that the least expensive way to comply was to replace legacy meters with smart meters. Figure 17 below shows the effect of this change, with about 1.5 million smart meters deployed by the end of 2017.

Figure 17: Smart meter deployment



5.3. About 78 per cent of total meters in New Zealand are smart meters. Compared to other countries that have not simply mandated smart meters, New Zealand's is easily the most successful roll out. New Zealand is well ahead of the US (60 per cent) and the UK (31 per cent). Victoria, Australia has 99 per cent smart meters. For the rest of Australia, a rule change that came into force on 1 December 2017 means all new and replacement meters need to be smart meters.

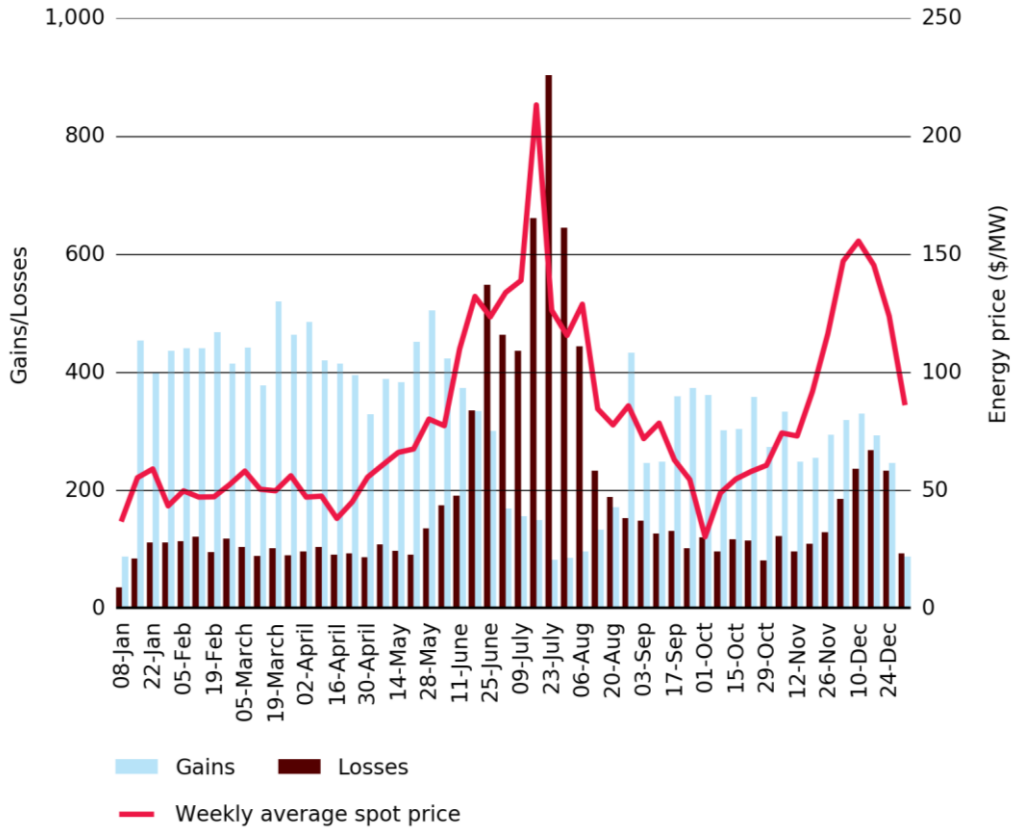
5.4. Smart meters allow retailers to get data on consumption for each ICP (customer) every half hour to coincide with each spot market trading period. These meters are read remotely, so the consumption data can be accessed by the retailer quickly—in most cases these meters are read every day. This enables retailers to match consumption with price every half hour, and therefore pass spot market costs directly on to retail customers. It also allows retailers to bill over different time periods. Flick was the first retailer to innovate in this way using the functionality of smart meters. Low barriers to entry into the retail electricity market mean that several spot priced retailers have entered since Flick started offering spot prices contracts to consumers.

5.5. The Authority has an ongoing work programme to reduce barriers to entry to the retail market. Current projects include the default distribution agreement aimed at standardising the agreements between retailers and lines companies aimed at reducing the negotiation costs for retailers wanting to expand into other regions.

Some residential consumers on spot priced contracts responded to high spot prices by switching away from spot retailers

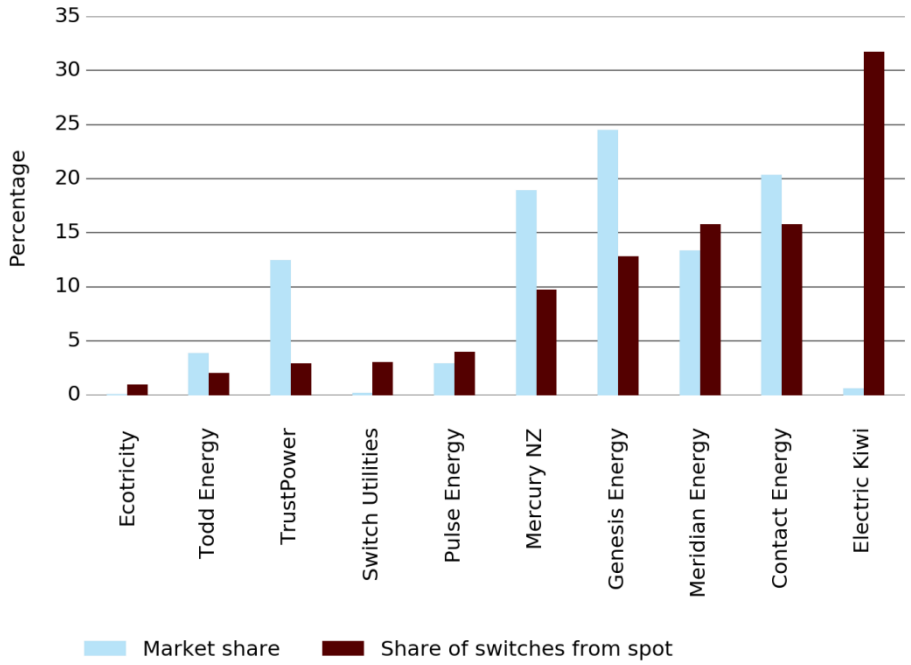
5.6. Figure 19 shows how the customers of these retailers responded to spot prices that were higher than normal.

Figure 18: Gains and losses of customers of retailers offering for spot priced contracts to residential consumers



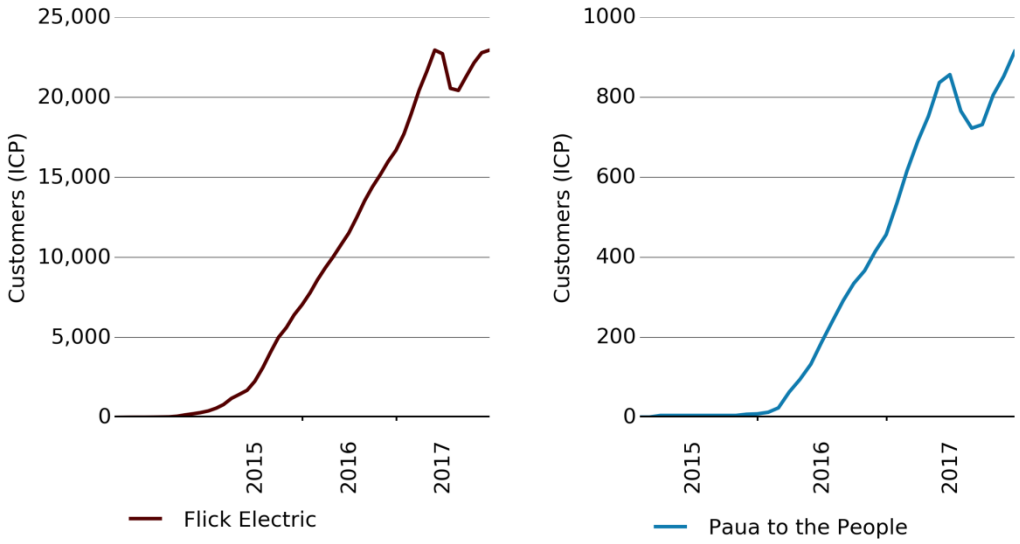
5.7. Figure 18 shows weekly gains and losses of customers for retailers offering spot priced contracts to residential consumers over 2017 and the weekly average spot price. It shows these retailers were making net gains until the second week of June, and then losing customers until the last week of August. As prices increased at the end of 2017, spot retailers' losses increased again.

Figure 19: The retailers that were winning customers leaving retailers that offer spot priced contracts to residential customers



5.8. Figure 19 shows the retailers that gained consumers who switched away from retailers offering spot priced contracts to residential consumers during July, and the market shares of the gaining retailers. It shows that Electric Kiwi gained about a third of these customers in July, while the large gentailers gained about half that amount despite much larger market shares. This probably reflects the deal that Electric Kiwi offers with low prices and no contract.

Figure 20: Two spot priced retailers—Flick and Paua to the People



5.9. Figure 20 shows the market sizes for two retailers that offer spot priced contracts to residential consumers. The charts show the effect of the high winter prices on these

retailers, with Flick losing about 2,500 customers. Both charts show the recovery from these prices. We are not able to tell whether the increase in market sizes in late 2017 is customers returning to spot priced retailers after temporarily switching to avoid high prices, or new customers.

5.10. We contacted a selection of large retailers in early July to ask if they were offering any special conditions to those switching from spot priced retailers. At that point retailers informed the Authority that there were no special conditions offered to these customers and it was business as usual. This implies that retailers were confident enough of being able to cover extra load to take on new customers—this is indicative of mature risk markets.

5.11. With the recent growth of residential consumers choosing spot price products, the Authority undertook a project in 2016/17 entitled 'Spot prices and risk for consumers'. The aim was to consider arrangements for explaining spot price risk to mass-market consumers, especially to residential consumers exposed to the spot market.

5.12. As a result of this project, the Authority introduced a market facilitation measure outlining its expectations of retailers offering spot price products to residential consumers. Those expectations are to:

(a) appropriately inform potential customers of the risks, as well as the benefits, of spot price products

(b) at appropriate intervals, inform their existing customers of the risks and benefits of spot price products

(c) at appropriate intervals, offer their customers options to manage spot price volatility

(d) keep data on new customers' accumulated savings to demonstrate the extent to which its customers have benefited from the spot priced product over time.

5.13. The Authority will continue to monitor how effectively spot retailers meet the expectations listed above. This means spot retailers can expect requests for information from the Authority's market monitoring team.

5.14. This information will help inform the Authority about the practices being used by spot retailers. In the event of a dry year or during shorter-term price spikes, having access to such information will allow the Authority to respond to any concerns raised by these consumers or by other stakeholders regarding these consumers.

5.15. If the Authority believes insufficient action has been taken by retailers offering spot price products, we may consider Code amendments to introduce mandatory requirements.

6 Storage has been managed more conservatively since 2009, and the relationship between spot price and storage has changed

6.1. In 2013 the Authority commissioned Statistics Research Associates Limited (SRA) to explore the relationship between spot price and hydro storage. The paper: *An exploratory analysis of the relationship between electricity spot price and hydro storage in New Zealand*, is a result of this work. This paper is attached as Appendix A to this report.

6.2. The purpose of the paper was to find the appropriate transformations for price and storage data so that it could be more readily modelled. The raw data are daily prices at Benmore in the South Island and South Island storage. The paper focuses on the South Island because this is where the majority of hydro storage is located. The paper develops a model of transformed price as a function of transformed storage.

6.3. For this review we asked SRA to update the model and to investigate whether there has been a structural change in the relationship between storage and prices since the 2009 ministerial review. The data consist of 18 complete years starting each September which are split into two groups before and after September 2009.[1] The paper:

(a) transforms the data into a form that is amenable to later analysis

(b) estimates a relationship between spot price and storage

(c) uses the storage data only to estimate four regimes—high and low storage combined with normal and extreme storage

(d) analyses the timing of the onset and duration of the different regimes.

6.4. The paper finds that:

(a) Real spot prices—deflated using the producer price index (PPI)—have declined over the period of the study (1999–2017).

(b) There has been a significant decline in the volatility of spot prices since September 2009.

(c) There has been a significant reduction in the volatility of hydro storage since September 2009 and storage has not fallen as low since 2009.

(d) When the data are split into seasons, and price and storage are combined into a regression model, since September 2009:

(i) prices change more in response to changes in storage in the spring (Sept–Oct–Nov)

(ii) prices change less in response to changes in storage in the autumn (Mar–Apr–May).

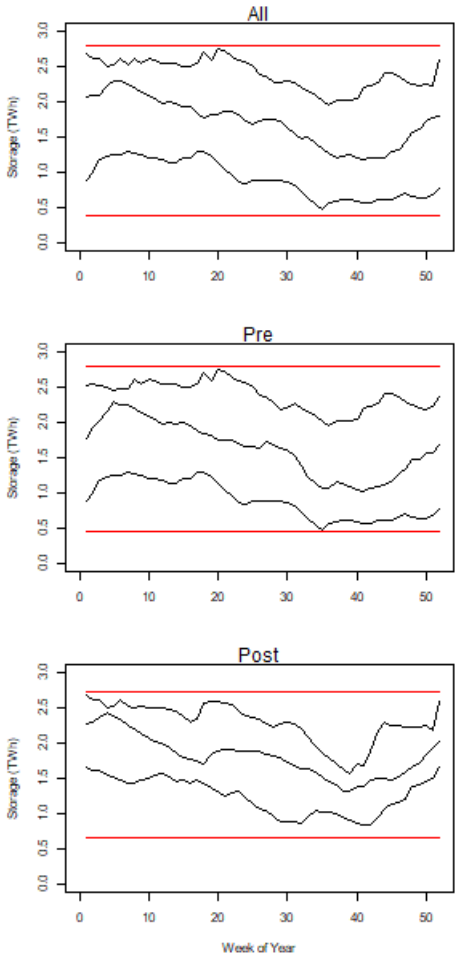
(e) Dry regimes have not been as dry since 2009, have started later, ended earlier and have been shorter.

Transforming the data

6.5. The first step in the analysis is transforming the price and storage data to be more amenable for later analysis. Transforming the storage data involves using upper and lower storage thresholds to create a ratio of storage available to storage used. How these thresholds evolve through time suggests that storage is being managed more conservatively than in the past.

[1] This date is suggested by the data and is roughly aligned with the regulatory changes that resulted from the 2009 ministerial review.

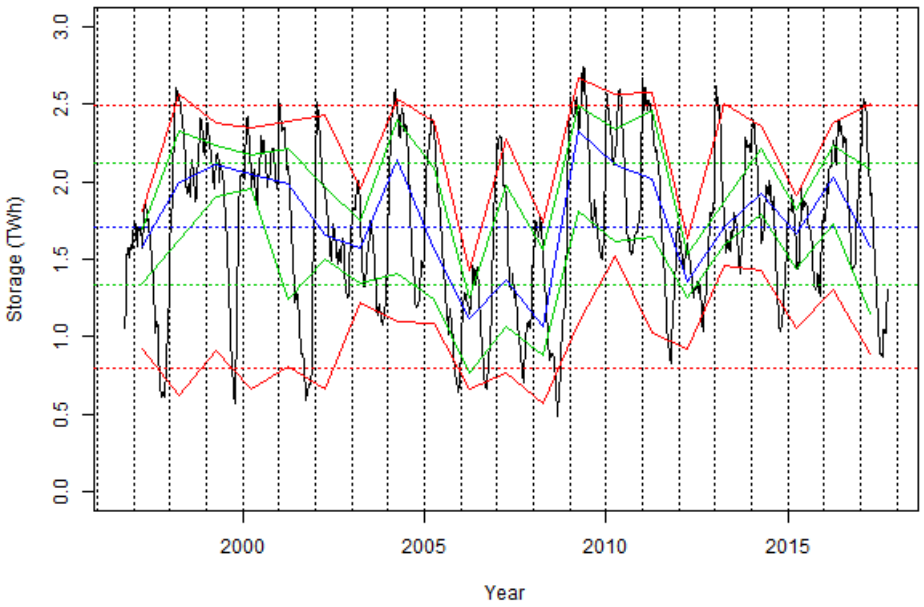
Figure 21: Storage since 1996—estimated parameters for pre-2009, post-2009 and overall



6.6. The thresholds are estimated for each week of the year, or for the year as a whole. Figure 21 shows the constant estimates for two parameters in the model (the red lines) and the week-of-year median, minimum and maximum storage (the black lines).

6.7. The threshold parameters represent the minimum and maximum storage as estimated from the data. What is interesting for this study is that post-2009 (the bottom panel), the minimum storage level has increased. This means the data imply that storage has not fallen as low since 2009.

Figure 22: Storage since 1996—annual quantiles and mean



6.8. Figure 22 shows annual average storage and 5 per cent and 95 per cent quantiles (red), 25 per cent and 75 per cent quantiles (green), and 50 per cent quantile (blue—the median). The quantiles for the whole sample are also superimposed in the same colours with dashed lines. When the annual 5 per cent quantile is compared to the overall 5 per cent quantile (comparing the lower dotted red line and the lower solid red line) we can see that post-2009, the annual quantile does not fall below the overall quantile. Again, this implies that storage has not fallen as low since 2009.

Estimating the relationship between price and storage

6.9. Once the data are transformed, the analysis then estimates a relationship between price and storage—the idea is to measure how sensitive price is to changes in storage. How this relationship evolves through time is interesting.

6.10. One change to the relationship between price and storage is that storage has a reduced effect on price in the autumn (March, April, May) post-2009. One explanation is that hydro generators are ensuring that they come into the autumn with plenty of storage. At times, inflows will mean that there is enough storage to ensure that price is determined by other factors and this is revealed by the model's parameter being smaller—in other words, storage having a reduced effect on price.

6.11. Another change post-2009 is that storage has an increased effect on price in the spring (September, October, November). This could be caused by hydro generators starting to build up storage in reservoirs sooner. The obvious way to do this is to raise the value of water which leads to the spot price being more responsive to storage.

Looking at storage data to examine onset and duration of dry seasons

6.12. The last part of the analysis uses the storage data to estimate regimes. While the earlier analysis divided the year into four seasons of summer, autumn etc, this analysis uses the data to estimate the four regimes set out in Table 1 below.

Table 1: Four states or seasons

	Wet	Dry
Normal		
Extreme		

6.13. The analysis uses a different mean and variance for each regime. In other words, the analysis splits the data up into the four sets of data where each set has a similar mean and variance.

6.14. The method used to estimate these parameters yields two sets of solutions: one that is more influenced by recent years (New), and one more influenced by earlier years (Old). The estimates of the means produced by the New solution are higher for all regimes, and especially high for the two dry regimes. As with the evidence presented above, this implies that storage has not fallen as low since 2009.

6.15. This analysis is extended to analyse both the timing of low and high storage regimes and the duration of low storage regimes. This analysis shows later low storage regime onsets, earlier high storage regime onsets and shorter low regime durations.

6.16. Taken together, this analysis implies that, since 2009:

(a) Storage has not been going as low.

(b) Low regimes have started later, ended earlier and have been shorter.

(c) Hydro generators have started to build up storage in reservoirs sooner.

A number of changes could have affected the relationship between storage and spot prices

6.17. Storage is affected by the level of inflows and how these inflows are managed. Both the pre-2009 period and the post-2009 period have some very low inflow sequences. What we observe is that these are managed better post-2009. This section explores regulatory changes that have changed the incentives to manage low inflow sequences better.

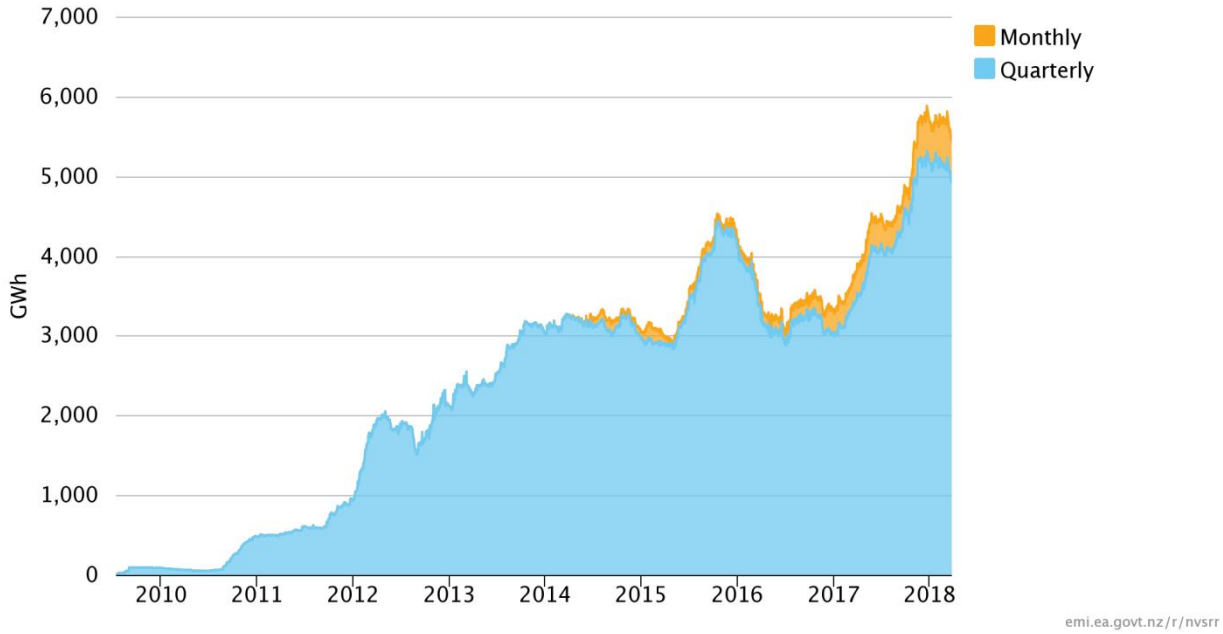
6.18. Since 1 April 2011 the point at which an official conservation campaign needs to start has been defined by the 10 per cent hydro risk curve. At this point, a customer compensation scheme starts which requires retailers to compensate customers for the savings they make. The amount is $10.50 per week which, over 1.8 million residential ICPs and—for example—a 6-week campaign, adds to over $100 million. This means that there is a cost to running storage to low levels and is likely to have affected the behaviour of vertically integrated hydro generators.

6.19. The Authority introduced a stress test on 1 December 2011. The idea of the stress test is to get boards of large load customers to certify that they understand the spot price risk that they face. The stress test requires large load customers to reveal the financial implications of two scenarios—one short-term capacity test and one that mimics a dry winter. Boards certify to the Authority that they have seen the results of the stress tests. The results are sent to an independent party to be anonymised and then they are published by the Authority.

6.20. The idea behind the stress test is that it encourages customers to seek a financial hedge against high spot prices because the “hedge” of claiming surprise at high spot prices and the need for government intervention is not available. Regardless of the mechanism

used to do this—a forward contract or a fixed-price-variable-volume contract for example—it should result in a generator facing increased incentives to be able to deliver energy at a reasonable cost, and therefore incentives to ensure that they have enough fuel to do this. Again, in the case of a hydro generator, this means ensuring that it has enough water.

Figure 23: Uncovered open interest



6.21. Figure 23 shows uncovered open interest for forward contracts traded on the ASX. UOI is the total number of outstanding contracts that are held by traders at the end of each trading day. In other words, it represents the number of contracts that have not yet been exercised (in the case of options), offset (by holding a contract with a counterbalancing obligation) or expired. Open interest is a measure of 'skin in the game' and is an important indicator of liquidity. Greater liquidity generally results in more efficient pricing.

6.22. When a generator has sold a forward contract, it has an incentive to supply the energy if the spot price is greater than its short run marginal cost—this is almost certainly true for the majority of generators during a dry season. This means that hydro generators that sell hedges face an incentive to ensure that they have sufficient water to supply their hedged customers, and this incentive has increased as UOI has increased since 2011.

6.23. Market factors could also have affected the way hydro generators manage storage. Fewer take-or-pay gas contracts in the market means thermal generators face a marginal cost that reflects the price of gas. This could change how hydro generators manage storage. Likewise, increased geothermal generation means that hydro operators are shifting their role towards peaking generation, possibly leading to different approaches to managing storage. Lastly flat demand over the last decade could also have affected how storage is managed.

7 Demand response

7.1. Demand response—demand reducing in response to high spot prices—can happen because of prices, or a public conservation campaign or because of rolling outages. Obviously, different levels of coercion are involved for each of these. In 2017, all demand response happened because of price. To measure this price response, we

looked at consumers that pay the spot price to their retailer and non-conforming load grid exit points (GXP). The latter generally have large industrial consumers that may have varying degrees of exposure to the spot price.

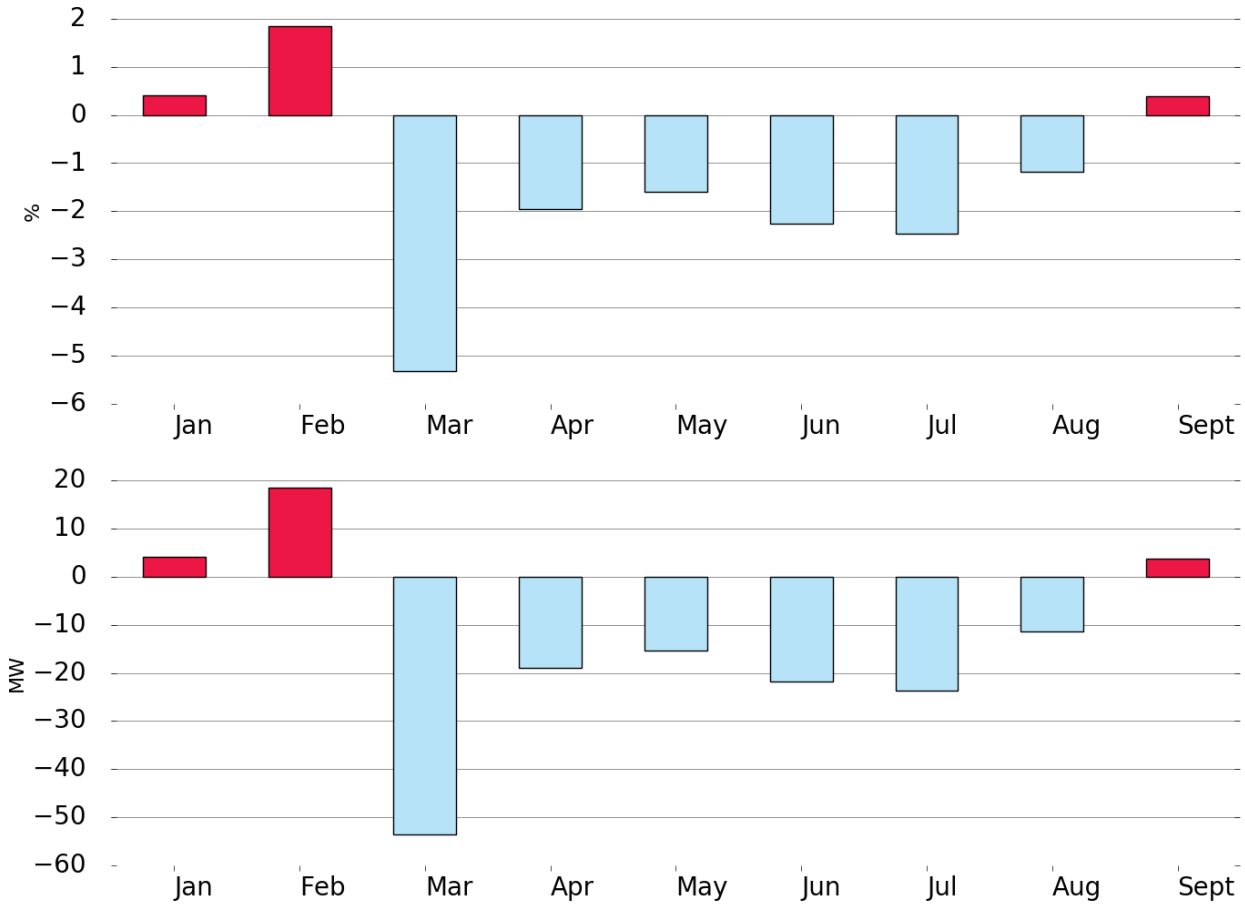
Non-conforming nodes

7.2. Non-conforming nodes are those parts of the transmission network where a small number of consumers—usually large industrial consumers—purchase load. This means forecasting load at these nodes is difficult without input from these customers. As a consequence, purchasers at these nodes are required to estimate their consumption and this estimate contributes to the load forecast and to pre-dispatch forecast prices. Purchasers at these nodes tend to be large industrial purchasers, so could be exposed to some degree to spot prices.

7.3. Figure 24 shows the difference in consumption between 2016 and 2017 at non-conforming nodes. On average between March and August 2017, non-conforming nodes consumed about 2.5 per cent less than 2016, or about 25 MW. This compares with Transpower's security of supply annual assessment which uses an assumption of 2 per cent voluntary demand reduction over all consumption which seems optimistic based on this analysis. The demand reduction was spread over about half the non-conforming nodes. The remaining nodes consumed broadly the same as in 2016 except for one node that is associated with South Island irrigation which consumed a lot more than 2016—probably due to the dry weather.

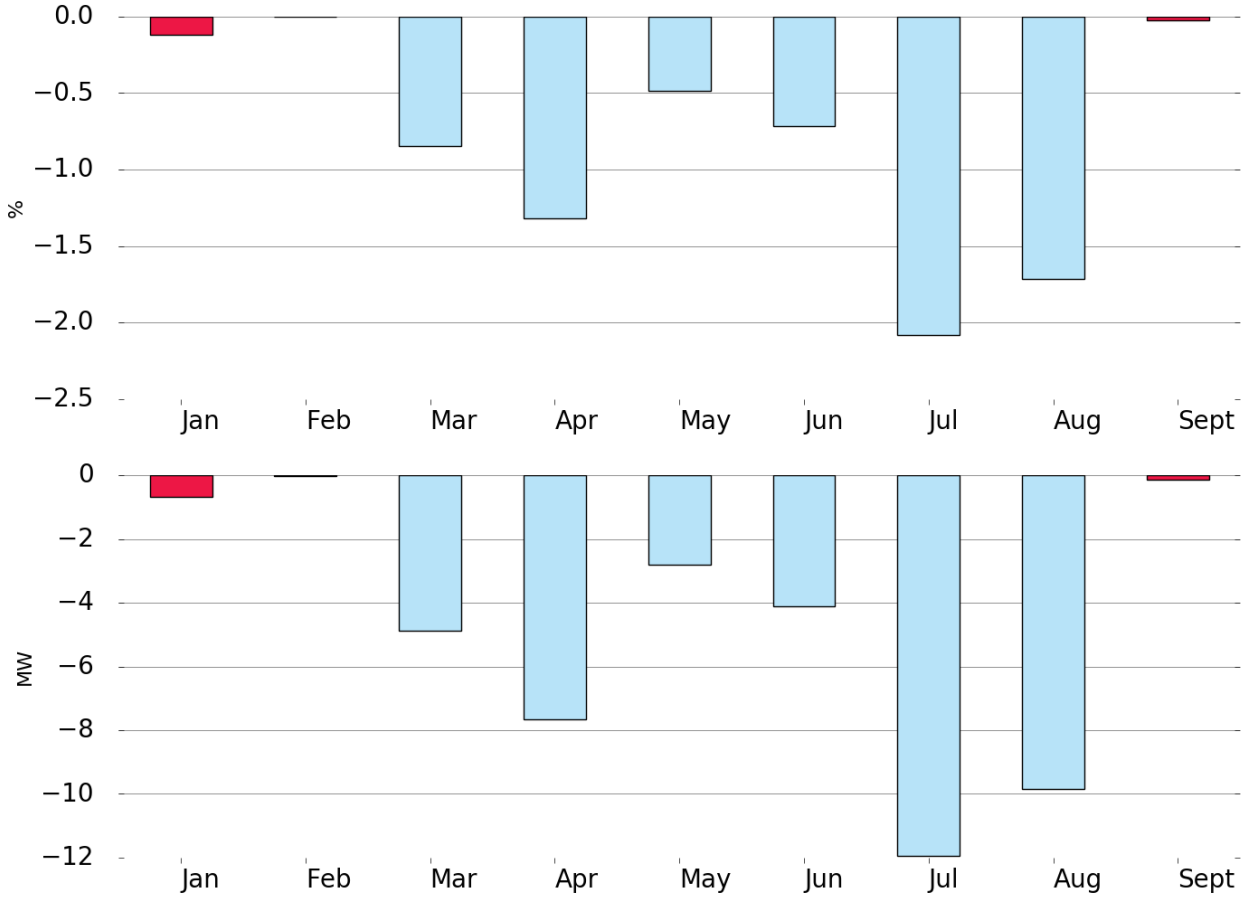
7.4. It seems that from this evidence there was some demand response, but it seems small compared with how high spot prices got. Large consumers at non-conforming nodes should be able to access risk management instruments such as forward contracts or commercial fixed price variable volume contracts. These could have one of two effects. A fixed price variable volume (FPVV) contract could mean a large consumer would be less exposed to spot prices and therefore less likely to cut consumption when prices increase. However, large consumers that have forward contracts would be able to choose between consuming and using the hedge to keep their costs down, or not consuming and profiting from the hedge payments. This range of possibilities probably accounts for the fact that demand reduction varied across the non-conforming nodes.

Figure 24: Difference in consumption between 2016 and 2017 at non-conforming nodes



7.5. As Tiwai consumes about 13 per cent of New Zealand's electricity consumption we have split it out from Figure 24 and presented it in Figure 25. It shows that Tiwai accounted for around half of demand response in April and July, and almost all of it in August. Tiwai accounted for less in other months.

Figure 25: Difference in consumption between 2016 and 2017 at Tiwai



Spot exposed residential consumers' response was less clear

7.6. Residential consumers on contracts that expose them directly to the spot price are unlikely to be able to access risk management instruments like hedges or caps.

7.7. Figure 26 shows demand response for Flick and Giving Energy's customers exposed to spot price risk and, for comparison, Pulse's customers' demand response—Pulse's customers are primarily residential consumers on FPVV contracts—typical residential retail contracts. Figure 26 measures the month-on-month change in consumption per consumer—so February is the change from January to February, March is the change from February to March etc. We would expect to see larger negative changes for spot exposed customers in the highest price months of June and July.

7.8. The chart shows that spot exposed consumers were increasing consumption faster than FPVV consumers up until July when the three lines converge. From then on consumption by spot priced consumers' falls either at about the same rate or more quickly for the remaining months shown.

Figure 26: Demand response for Flick, Pulse and Giving Energy

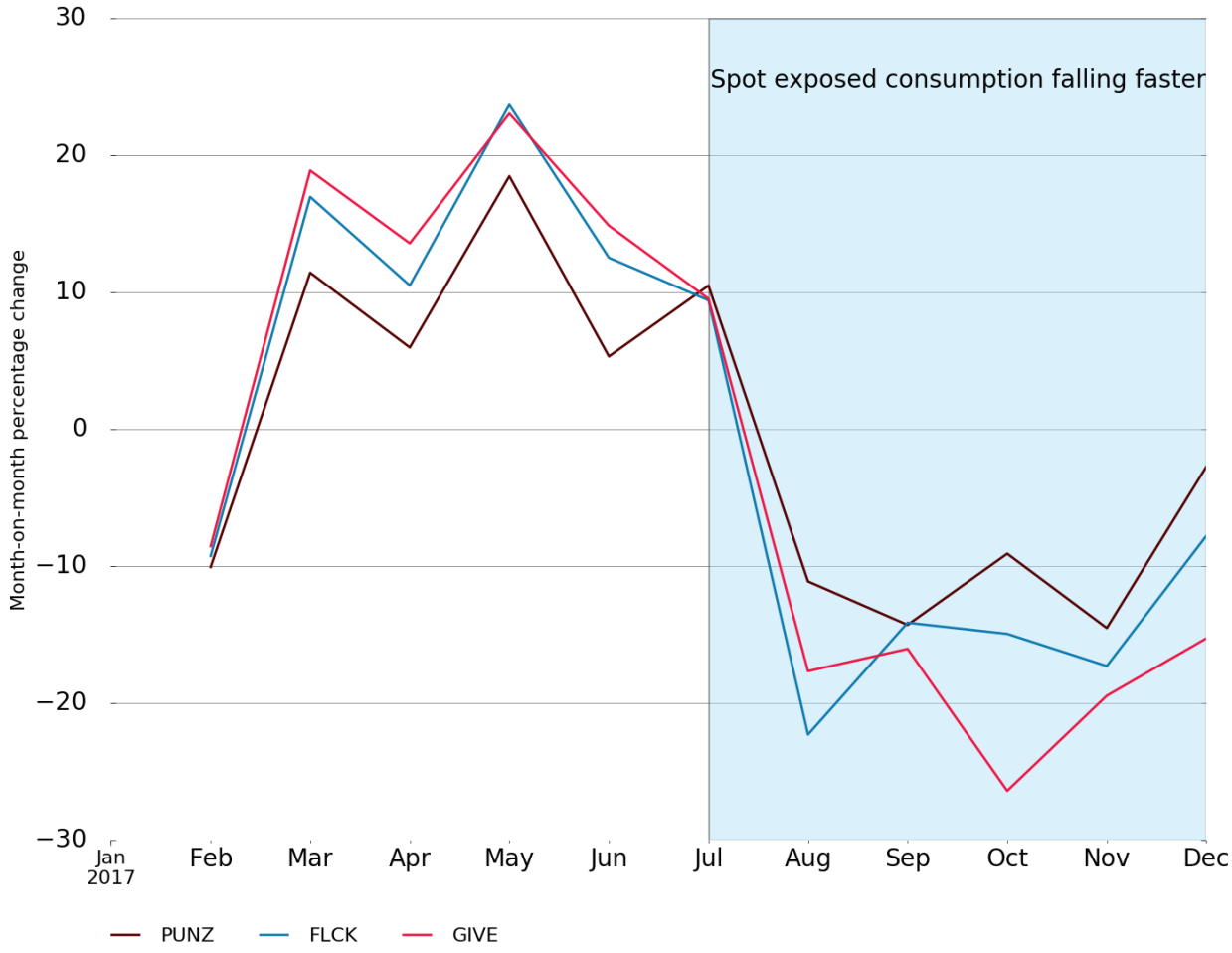
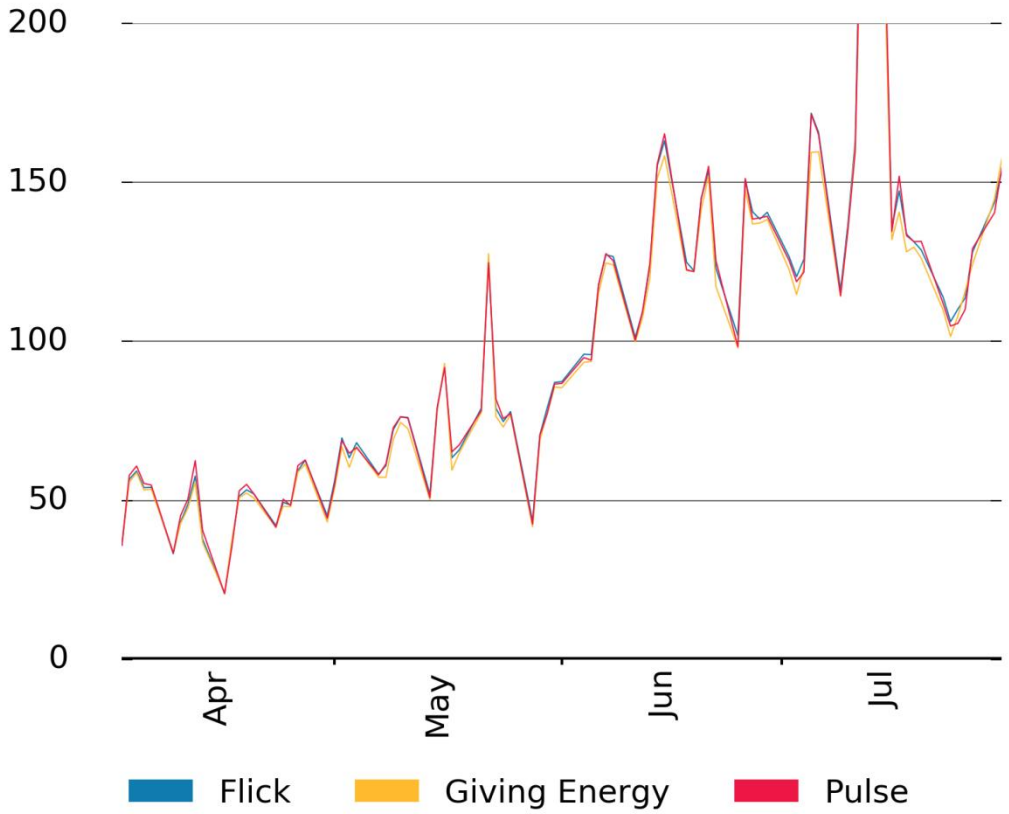


Figure 27: Daily load weighted average prices for three retailers



7.9. Not only do spot exposed consumers face incentives to consume less, but they also face incentives to shift their load to off-peak times when the spot price is lower. To test this idea we looked at the load profiles of Flick, Giving Energy and Pulse from April to July 2017. We have chosen Pulse to compare with Flick and Giving Energy—two retailers that offer spot priced contracts—because, like Flick and Giving, Pulse's customers are mostly residential.

7.10. Figure 27 shows the daily load weighted average prices for three retailers over the winter. These prices will reflect any load shifting that spot exposed consumers do relative to those consumers that are not spot exposed. The vertical axis is truncated to make the differences clearer, however the lines in Figure 27 are very close together indicating that load shifting is not particularly significant. In fact, on average, spot exposed consumers paid about 1.25 cents per kWh less than Pulse consumers.

7.11. Another view of these data is shown in Figure 28. It shows total weekday purchases for each retailer indexed on the first trading period of the day. The lightest colour in each chart is April, and the darkest is July—so the lines fade as time passes.

7.12. This sort of index is useful for showing changes. Note that Figure 28 normalises for the volume of consumption so a falling peak does not mean consumption is falling, but consumption relative to the rest of the day is falling. Demand response in this chart should be seen by lower relative consumption during peak times. The chart shows this as both more consumption overnight and lower consumption over the peaks will be seen in reduced relative consumption at peak times.

7.13. Figure 28 shows that all three retailers' customers' morning peaks fell from May through to July. Giving Energy's customers' morning peak fell more than Flick's and Pulse's customers' peak.

7.14. The evening peak fell from April through to July for all three retailers—with Flick's and Giving Energy's customers' evening peak falling further.

7.15. Figure 28 also shows that Pulse customers have a later morning peak and an earlier evening peak than Giving Energy's and Flick's customers. This could be due to spot customers shifting their load to earlier in the morning and later in the evening when prices are lower.

7.16. Overall, this effect is small, however it does confirm that consumers are able to respond to price signals effectively, albeit with the caveat that choosing to be on a spot price plan effectively selects consumers that are engaged with the spot price and probably have a propensity to respond to it.

Demand side bidding and forecasting introduced more accurate price forecasts

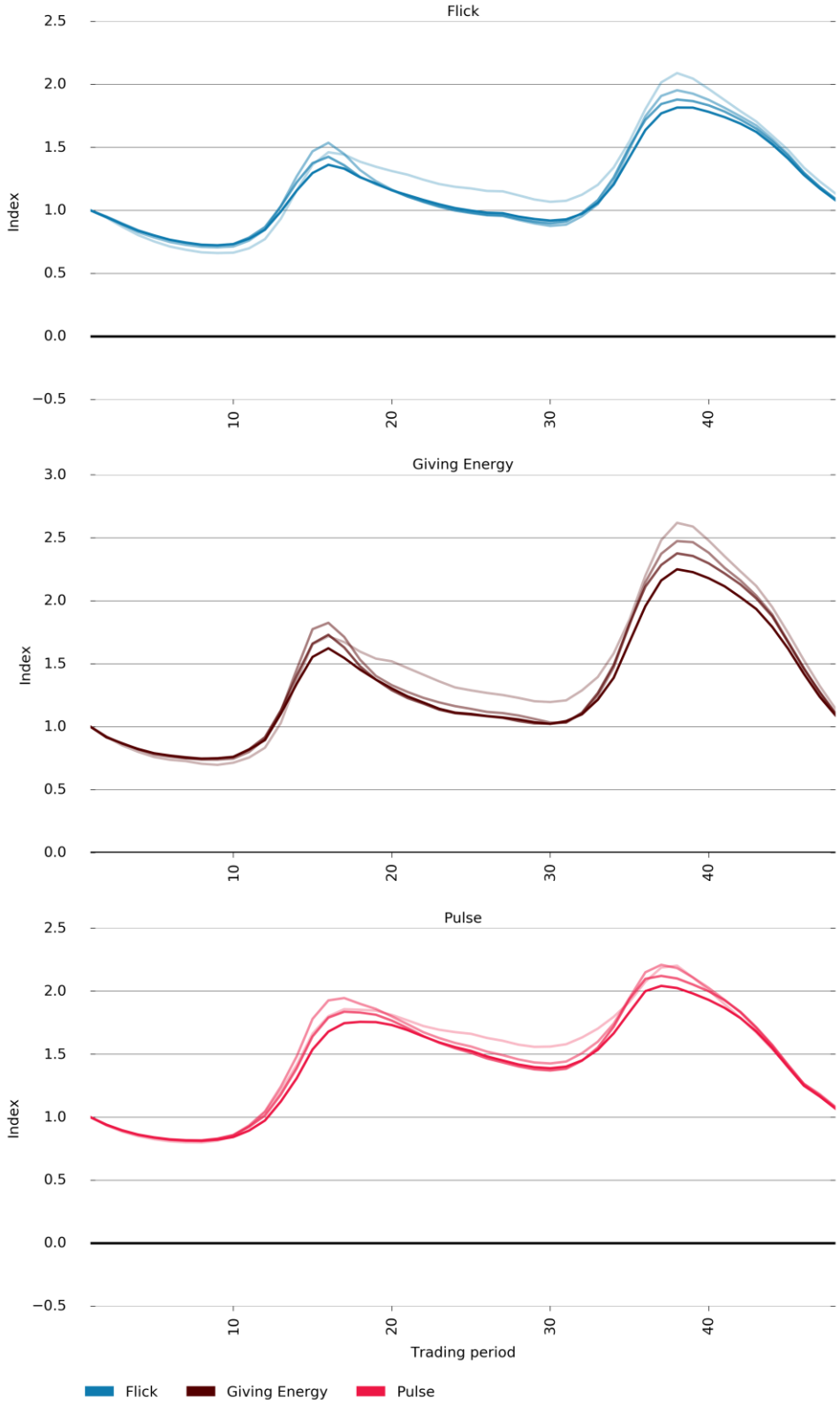
7.17. More accurate price forecasts should have helped those managing load to make better consumption decisions.

7.18. The Authority introduced demand side bidding and forecasting (DSBF) on 28 June 2012 to improve the accuracy of forecast load and prices and facilitate better coordination of demand side and supply side resources. Before the Authority implemented DSBF, there was no way for participants to know what effect demand response might have on spot prices. Prior to this it was possible for a high price in pre-dispatch to cause demand response that in turn lowered the final price to a level where demand regretted turning off.

7.19. The major change that DSBF had on forecast prices was to include additional information, in the form of bids for incremental demand changes (nominated bids). Nominated bids indicate willingness for demand to adjust depending on forecast prices (this is comparable to generators submitting offers into the spot market). Nominated bids are present in the price response schedule (PRS) but are excluded from the non-response schedule (NRS).

7.20. Real time pricing could remove the existing uncertainty that exists for load customers that cut load based on forecast prices. These customers face price uncertainty inherent in any forecast, but as the price is determined by the load, the act of cutting load can also move the price away from the forecast. The dispatchable demand regime introduced by the Authority is one approach to dealing with this problem, but uptake to date has been limited to one load customer.

Figure 28: Week day load profiles for Flick, Pulse and Giving Energy—April to July 2017



8 The security arrangements that were used worked well

8.1. Many security of supply arrangements are meant for circumstances that are materially more severe than those that occurred in the winter of 2017. These include the emergency management policy that sets out what the system operator must do in an extended security of supply emergency, and the rolling outage plan, which is a plan for compulsory electricity outages in order to prevent a complete system failure. Likewise, there was no need for an official conservation campaign or for the associated customer compensation scheme.

8.2. What did occur was daily reporting from Transpower, some grid reconfiguration to support southward flow of energy, and funding was approved for an official conservation campaign (OCC).

8.3. One of the successes of winter 2017 was something that didn't happen—there was no uncertainty about when a public conservation campaign would start and consequently the public discourse was far more positive and contained more discussion on price and less on physical shortage than occurred in 2008.

Daily reporting

8.4. The daily reporting/updates began on 18 May 2017 and continued until 4 August 2017. The content evolved over time based on what Transpower identified as being most useful. Initially, information on hydro and thermal generation (including short-term trends), major south flow constraints and hydro inflows was included. Over the period, wind generation (including short-term trends), changes to hydro generation and demand (including similar information on short-term trends) were also included.

South flow and grid changes

8.5. Transpower generally updated information on investigation into potential operational or grid changes as and when the information became available. This was checked on a weekly basis (ie, the Engineering group within System Operations and Grid divisions was asked if they had any new information/updates) and updates were published in the weekly update cycle.

8.6. In late May Transpower investigated limitations on the HVDC caused by insufficient Over Frequency Arming. Following this investigation, Transpower tuned its real-time operational tools to increase the south flow limit by approximately 60 MW and therefore facilitate greater south transfer. This change was implemented on 31 May 2017.

8.7. Work on investigating further operational or grid changes to facilitate higher transfers (both DC and AC) and relieve potential (or existing) constraints due to the dry conditions began on 8 June 2017. This work included investigating a variety of possible solutions, including grid reconfigurations, variable line ratings (VLR) and special protection schemes.

8.8. The VLR changes (NSY_ROX_1 and LIV_NSY_1), which coincided with turning off the Roxburgh Export Overload Protection Scheme, were implemented on 12 July 2017. A Special Protection Scheme that would free up capacity into Southland was also looked at as part of the investigation, but it was decided on 24 July 2017 not to progress this as it was unlikely to be able to be implemented in time to help with the shortage situation.

8.9. It is worth noting that the HVDC itself was not a significant constraint—the main south flow constraint was predominantly energy surplus available for export from the North Island.

Other planning and communications

8.10. Transpower began informal communications with major stakeholders (including the Authority, Contact, Genesis, Meridian and the Minister of Energy/Ministry of Business, Innovation and Employment (MBIE)) in early May. Following these initial informal engagements, dialog with the industry continued to grow. This included:

(a) Customer advice notices (CANs) advising the industry of information relevant to the dry winter were published (18/05, 22/05, 28/05, 31/05, 07/06, 09/06, 21/06, 23/06, 28/06, 06/07 and 22/08).

(b) A special Dry Winter webpage was established on 18 May 2017 in conjunction with daily reporting beginning.

(c) A Dry Winter Planning webpage was established on 21 June 2017, with weekly updates from this point forward. Note: not all weeks resulted in changes to content (if there were no significant updates that week).

(d) Industry teleconferences were held (two teleconferences were held on 14 June 2017 and 6 July 2017).

(e) Fortnightly hydrology briefings with Meridian were held (moved from monthly hydrology briefings to fortnightly on 30 May 2017).

8.11. Industry communications tapered off once storage returned to above the 1 per cent risk curve. Daily reporting stopped at approximately the same time.

8.12. Transpower held a teleconference on 14 June 2017 to discuss the treatment of contingent storage in calculating the hydro risk curves shown in Figure 1. This was triggered by an industry participant requesting a change that the system operator is obligated to consider. In retrospect, given the importance of the hydro risk curves for determining when a public conservation campaign starts, and the fact that most participants hedge their risk a long way ahead, this was an unnecessary distraction and led to some ill-informed media reporting.

8.13. Transpower, as system operator, had an obligation to review the treatment of contingent hydro storage in the hydro risk curves by 13 March 2017. This obligation was under the Statutory Objective Work Plan 2016–17 as agreed by the Authority and the system operator under the system operator service provider agreement (SOSPA). That review was not completed and the system operator had a new obligation to produce a review by 31 March 2018 which was completed.

Funding for OCC was approved

8.14. During June, the system operator sought and received approval for funding for an OCC. It became clear during this work that the Code's provisions regarding a national campaign and a South Island-only campaign had the potential to create outcomes that would be confusing for consumers, and were too inflexible to address the many different supply scenarios that might eventuate. As a consequence, the Authority is reviewing these provisions and expects to release a discussion document about the middle of 2018.

Analysis of media comment

8.15. One of the main changes in security of supply arrangements since 2008 has been the introduction of a fixed point at which an official conservation campaign starts. An official conservation campaign elicits savings that sit between:

(a) the voluntary savings made when spot exposed consumers respond to high spot prices

(b) the coerced savings of rolling outages.

8.16. Conservation campaigns therefore represent a form of voluntary savings that people make for altruistic reasons when prompted rather than because they are avoiding high spot prices or are being coerced into saving through outages. There is a clear hierarchy of efficiency in these three sources of saving with voluntary savings by spot exposed consumers the most efficient, and coerced savings through outages the least efficient.

8.17. In 2001, 2003 and 2008, the point at which a conservation campaign started was a matter of judgement. Since April 2011, the point where a campaign starts has been set at the point where storage cuts the 10 per cent hydro risk curve. Figure 1 shows that storage ran along the 2 per cent curve for several weeks in the winter of 2017, so was a long way from the point where an official conservation campaign would have started.

8.18. One of the effects of not having a fixed point to start an official conservation campaign in 2008 was that there was uncertainty over exactly how bad the storage situation was. This was exacerbated in the 2000s by the fact that those with the most information—hydro generators—also had a vested interest in a campaign that is effectively a free hedge against running out of water.

8.19. To address this uncertainty, the Authority:

(a) required the system operator to develop a security of supply forecasting and information policy (SOSFIP) which resulted in new hydro risk curves

(b) set the 10 per cent hydro risk curve threshold for an official conservation campaign

(c) created a customer compensation scheme that requires retailers to pay customers $10.50 per week for the period of an official conservation campaign.

8.20. To assess the effectiveness of these measures we commissioned Isentia to look at how the 2008 and 2017 dry winters were reported in the media. The results are attached in Appendix B.

8.21. The report shows that, compared to 2008, comment in the media in 2017:

(a) contained more favourable comments

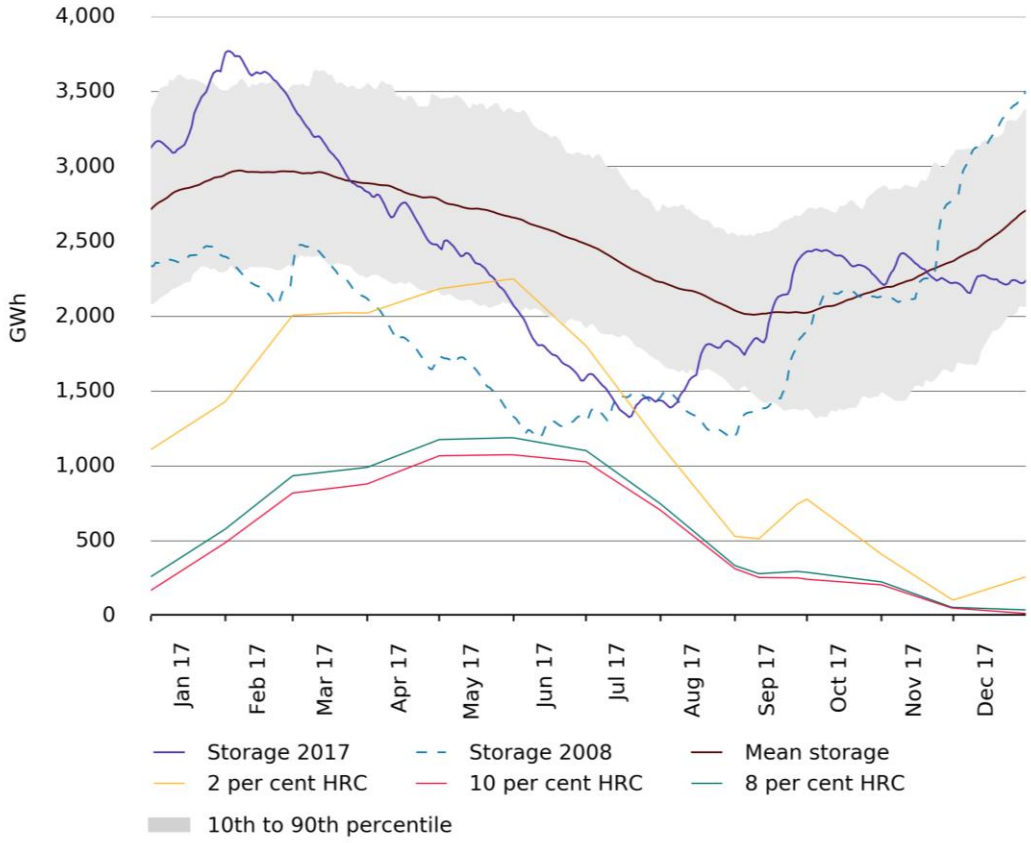
(b) focused more on pricing

(c) contained little reference to the subjects of blackouts and crises—the two dominant subjects in 2008

(d) attributed the blame to the weather rather than to government regulation

(e) Ministers dominated the discourse in 2008 and industry spokespeople dominated it in 2017.

Figure 29: Comparing storage in 2008 and 2017



8.22. Figure 29 shows storage in 2008 and 2017 along with 2017's 2 per cent, 8 per cent and 10 per cent hydro risk curves and mean storage. Note that the first hydro risk curves were calculated starting in February 2010 so there were no hydro risk curves for 2008. If we did have hydro risk curves for 2008, they might be quite different from the 2017 curves, so this chart is indicative only. It demonstrates what would have happened if we had 2008's storage in 2017. The chart shows that, while storage fell to similar levels in 2008 and 2017, levels were low earlier in 2008 and stayed low for longer. Storage in 2008 would have almost cut 2017's 8 per cent hydro risk curve. The chart also suggests that a conservation campaign will not occur in the future if storage were to follow the 2008 pattern (assuming the hydro risk curves are in a similar place) as storage in 2008 didn't cut 2017's 10 per cent hydro risk curve.

8.23. We speculate that there are a number of reasons why the media coverage was more favourable and balanced in 2017 than in 2008. Firstly, as Figure 29 shows, the storage situation was not as bad. But we also speculate that the certainty of having a fixed point for a conservation campaign also contributed to the more favourable coverage. This meant that spokespeople were able to be clear that, while the situation was bad, it was being effectively managed.

8.24. The discourse in the media in 2017 was dominated by comments from participants in contrast to 2008 when it was dominated by politicians. This is partly due to Flick's presence in the market. Because the spot price had a direct impact on Flick's customers, Flick tended to be in the media often. But it also reflects a change in the sense that in 2008 the opposition was criticising the Government's handling of the situation. In 2017 the opposition was unable to do this because the management of the situation was

largely out of the Government's hands. This is because the Authority is independent, and the Code assigns responsibility for security of supply forecasting and communications to Transpower. We speculate that separate management of the situation helped create more constructive media commentary.

8.25. In 2016/17 the Authority completed a review of the stress test regime and a review of the customer compensation scheme. The decision paper, *Review of the customer compensation scheme*, released on 13 June 2017, outlines the decision that the customer compensation scheme remained fit for purpose. However, it was decided to review how often the customer compensation scheme is reviewed, and how it is applied to switching customers. A consultation document was released on 20 February 2018 to canvass views on these issues. Further issues were identified in the 2017 decision paper which will be considered in the future.

8.26. The stress test regime was reviewed and a decision paper released on 13 June 2017. The paper made small technical changes to the stress test regime as, overall, the regime was found to be fit for purpose.

9 Attachments

9.1. The following items are attached to this paper:

Appendix A: Updates of a regression model relating electricity spot price and hydro storage (PH Model) and a seasonal switching model for hydro storage (SH Model) using South Island data

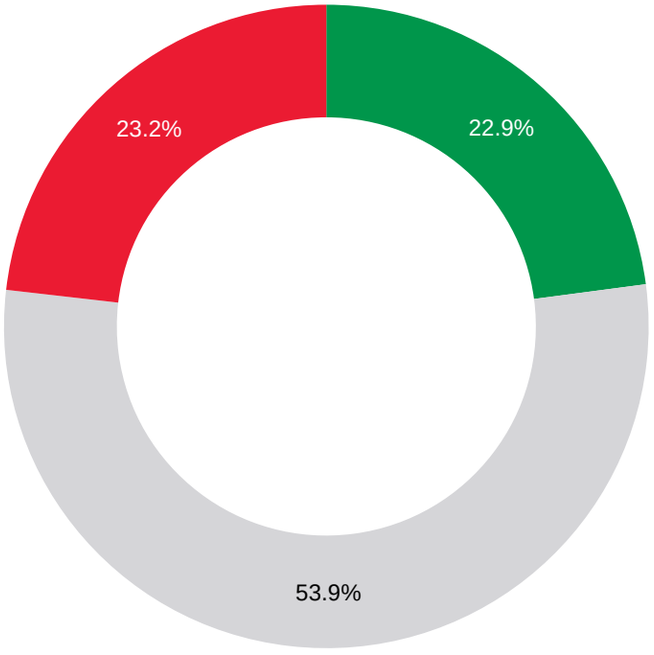
Appendix B: Insights dashboard: dry winters 2008-2017

Appendix A Updates of a regression model relating electricity spot price and hydro storage (PH Model) and a seasonal switching model for hydro storage (SH Model) using South Island data

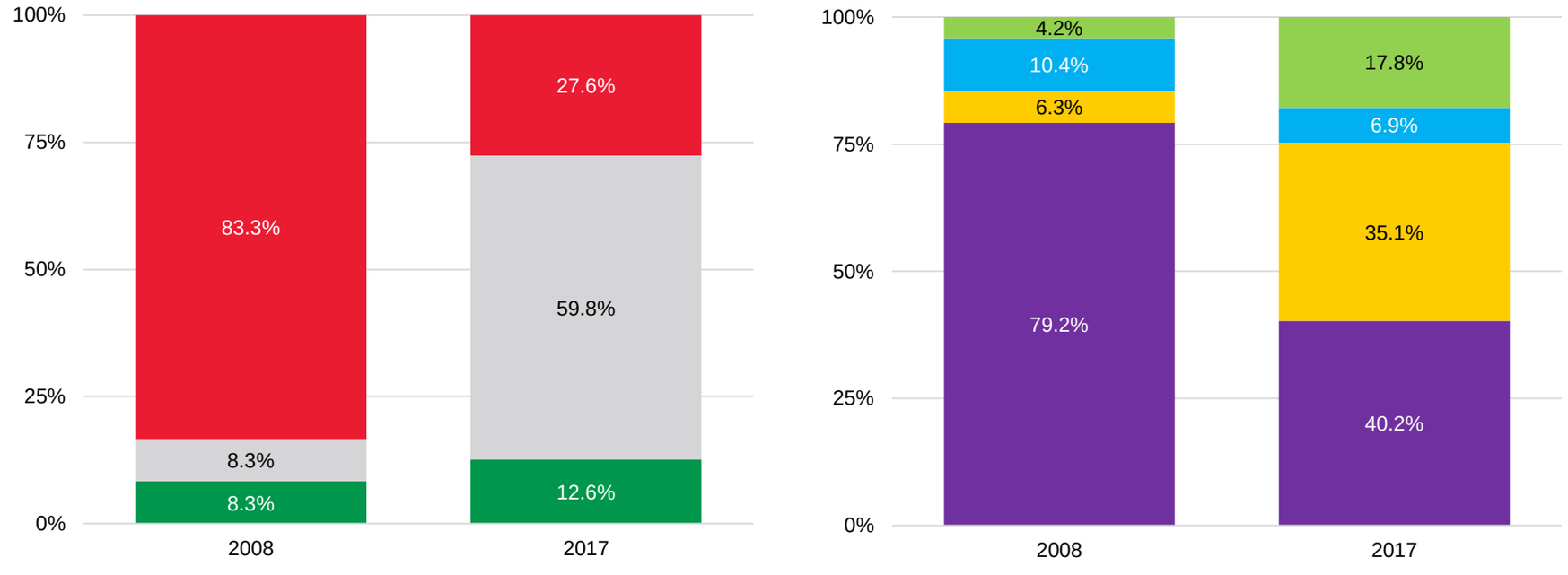
Appendix B Insights dashboard: dry winters 2008-2017

INSIGHTS DASHBOARD: DRY WINTERS 2008–2017

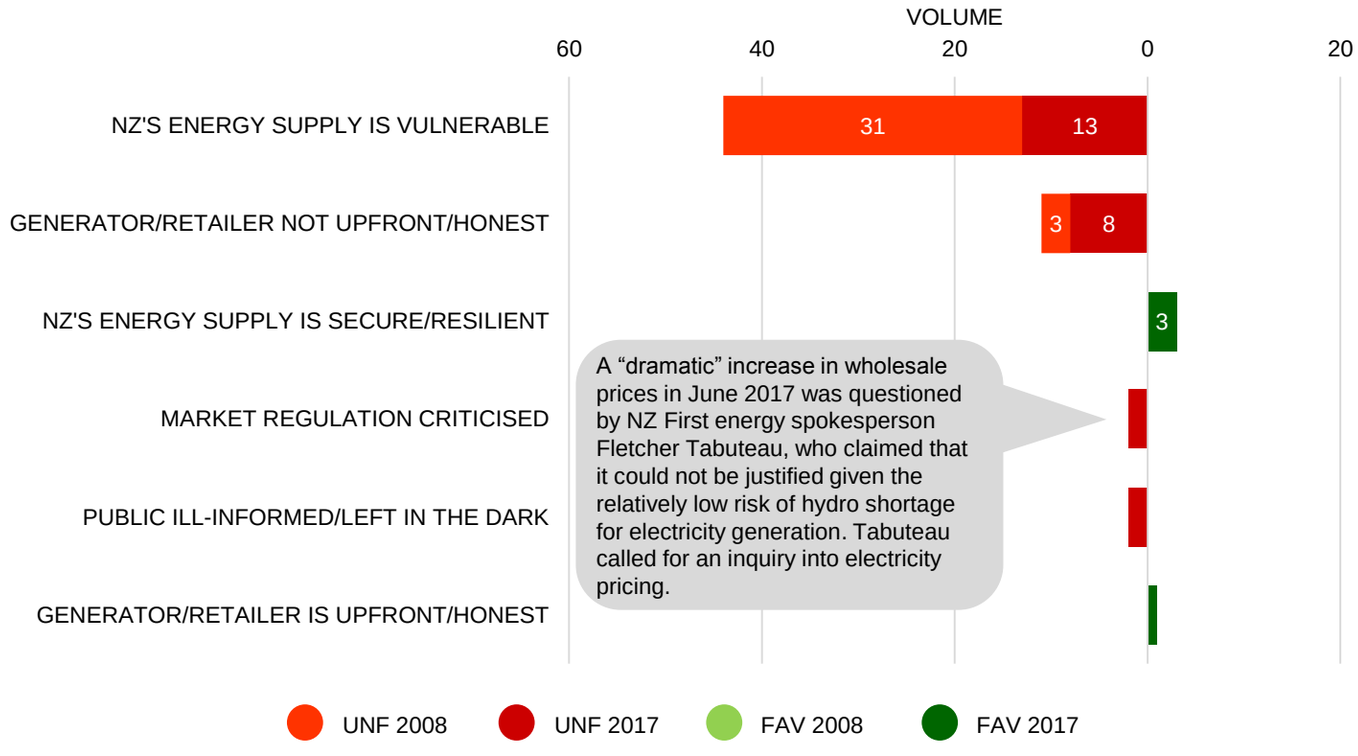
FAVOURABILITY BREAKDOWN (OVERALL)



2008 AND 2017 COMPARISON (BY FAVOURABILITY AND STORY FOCUS)



LEADING MESSAGES (2008 and 2017)

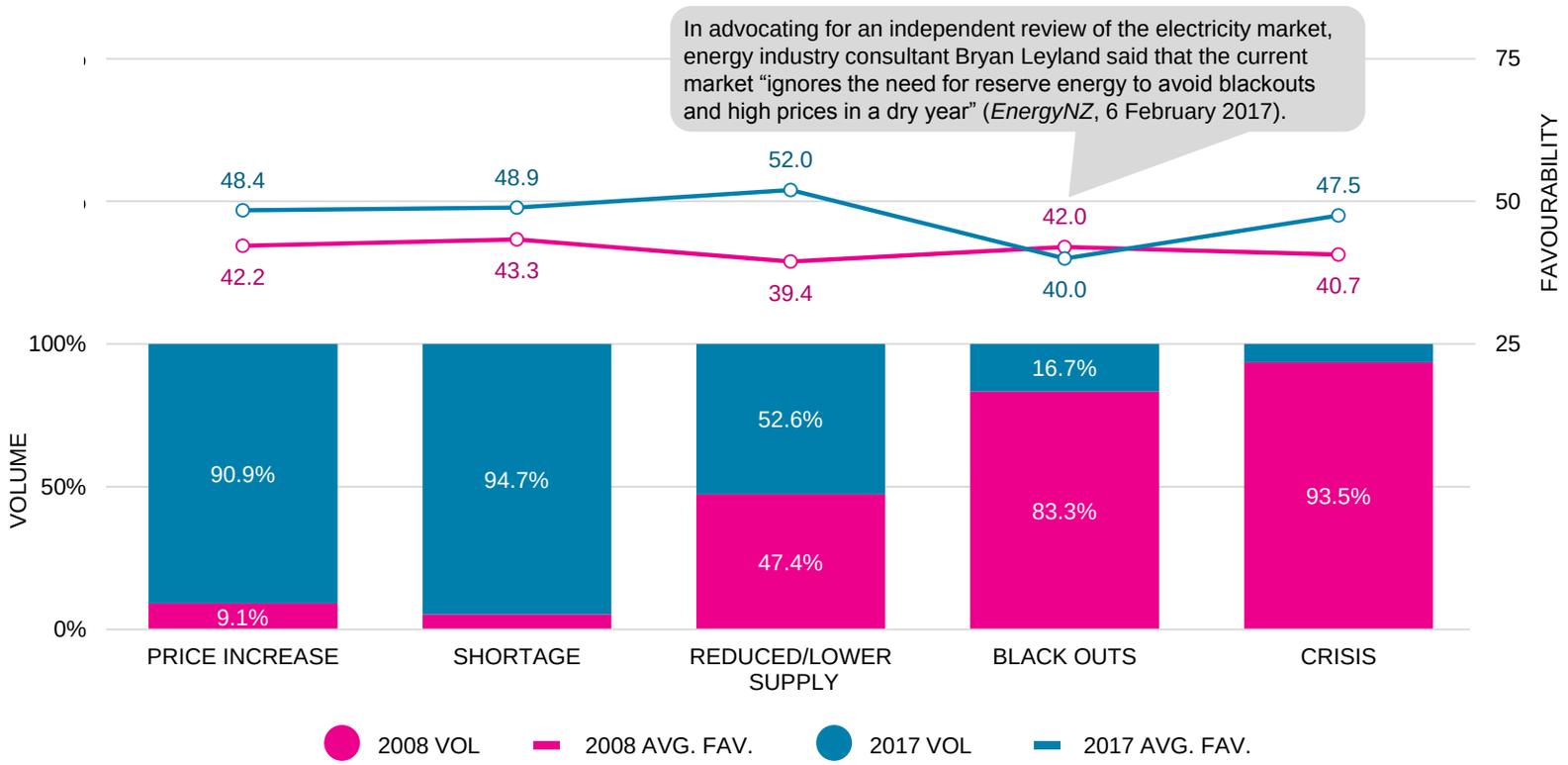


KEY FINDINGS

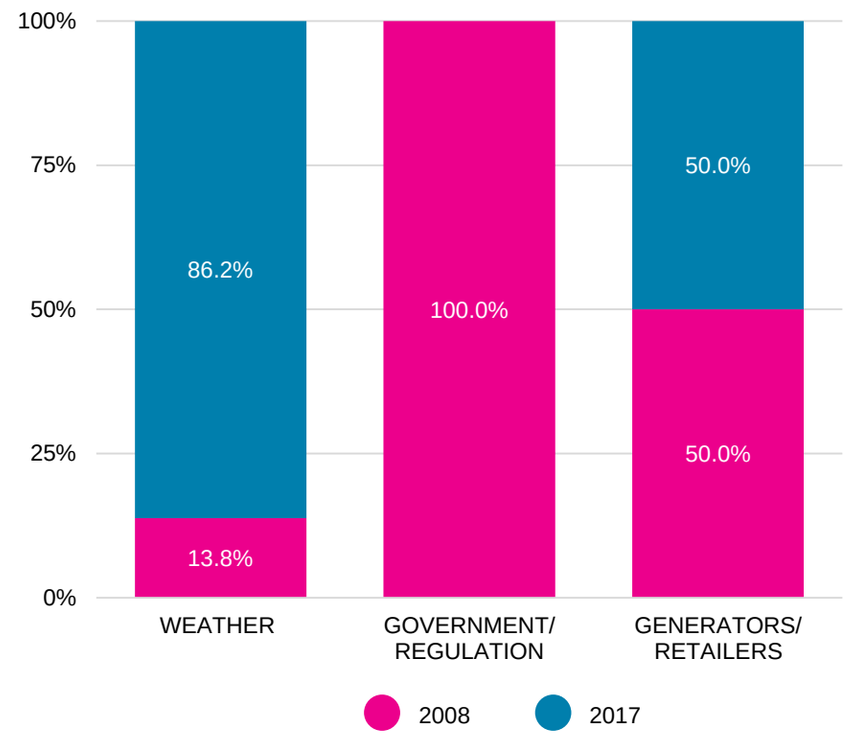
- A total of 716 reports mentioning the topic of dry winters and their impact on electricity supply between 1 January 2008 and 31 August 2017 was analysed. A large proportion of this coverage was neutral or balanced in tone, as the majority of reporting remained factual and focused on communicating weather-related information and hydro lake levels.
- However, reporting during the dry winter of 2008 was overwhelmingly unfavourable (83.3%). Speculation on the security and resilience of the country’s energy supply was widespread (the focus of 79.2% of the coverage), with many expressing concerns that it *is vulnerable* (31 mentions).
- While a sizeable proportion of coverage during the 2017 winter period also focused on energy supply (40.2%), criticism of the security of supply was less prevalent, with only 13 mentions of the message that it *is vulnerable*.
- Instead, pricing emerged as a key issue in 2017, as low hydro lake levels drove an increase in spot prices. This was of particular concern to customers of wholesale power companies such as Flick Electric and Paua to the People, with the former at times accused of *not being upfront or honest* (eight mentions).
- Despite the price spikes, the *resilience of NZ’s energy supply* was also praised in a small number of reports, as some commentators acknowledged the industry’s capacity to deal with cold, dry winters and the contingency plans it has in place.

INSIGHTS DASHBOARD: DRY WINTERS 2008–2017

IMPACT OF DRY WINTER



BLAME/RESPONSIBILITY



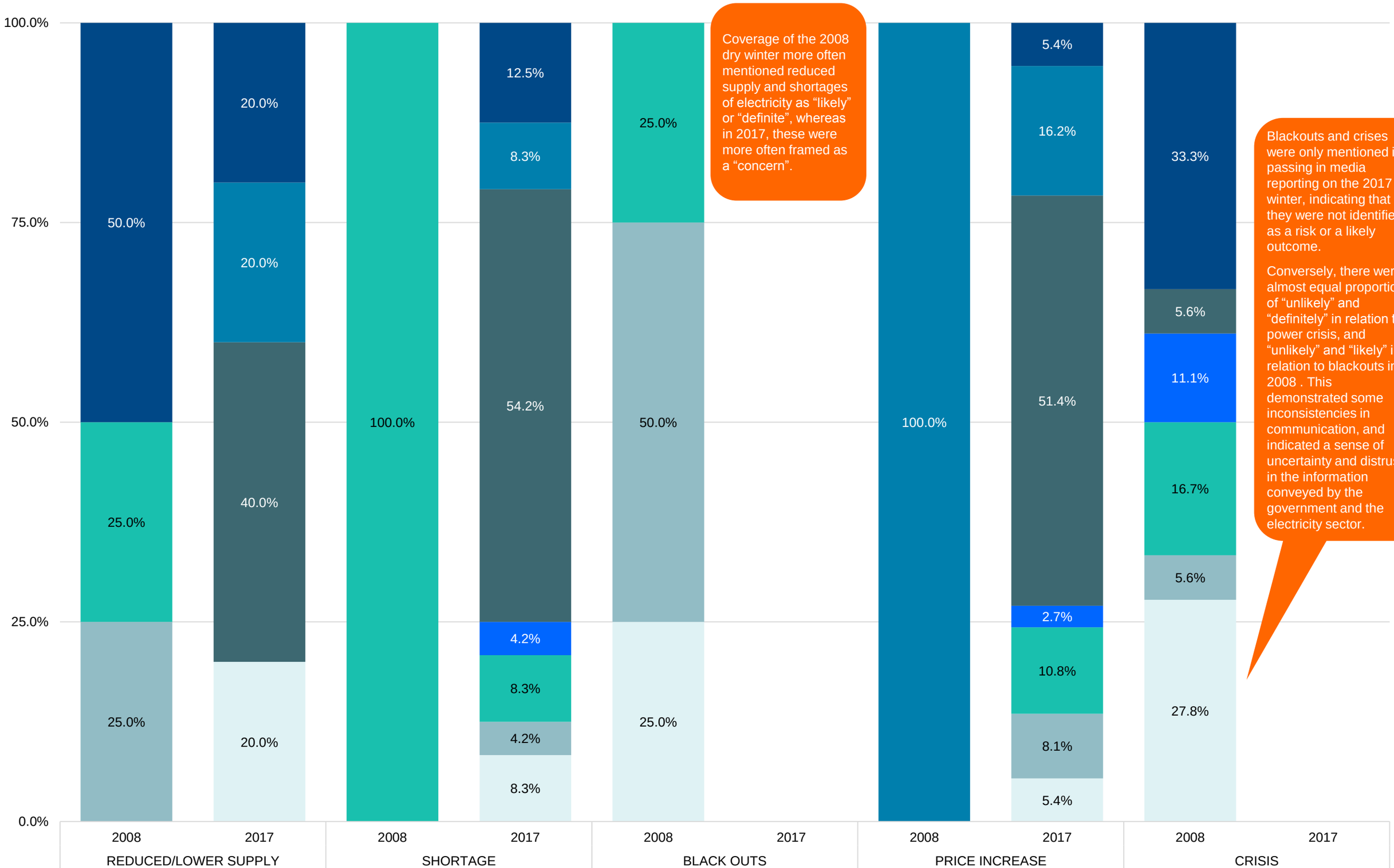
RESPONSE & RELATED TOPICS

KEY FINDINGS

- Reporting on the 2008 dry winter was often framed by the likelihood of an electricity crisis (93.5%) and concerns of black outs (83.3%), which were mentioned only in passing in 2017. On the other hand, price increases and concerns about electricity shortages were key topics of discussion in reporting on the 2017 dry winter, and were seldom mentioned in 2008.
- Reporting on the 2008 dry winter and its impact on the electricity market frequently associated it with regulatory failings and political discourse, particularly by then-National energy spokesperson Gerry Brownlee. Brownlee was a prominent critic, as he called for a conservation campaign to be launched and accused the government of being reluctant to declare a crisis in an election year.
- Conversely, these topics were notably absent in 2017, when discussion about the impact of the dry winter was often closely associated with weather events and the performance of electricity companies (in relation to customer relationship and profitability).
- As a result, media reporting on the 2017 dry winter and its impact on the electricity market was less unfavourable overall compared to 2008.

INSIGHTS DASHBOARD: DRY WINTERS 2008–2017

LIKELIHOOD OF EVENTS – 2008 vs. 2017



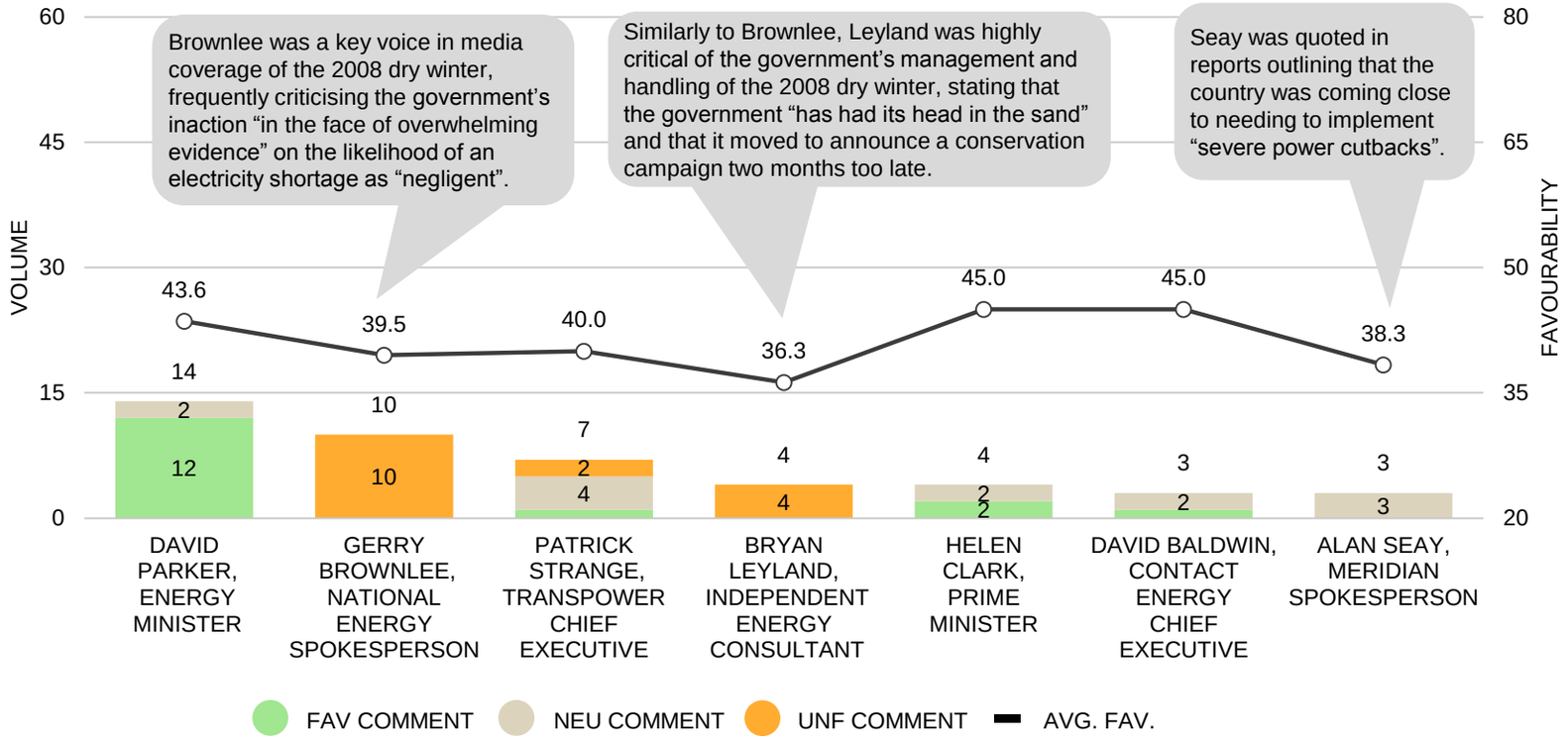
Coverage of the 2008 dry winter more often mentioned reduced supply and shortages of electricity as "likely" or "definite", whereas in 2017, these were more often framed as a "concern".

Blackouts and crises were only mentioned in passing in media reporting on the 2017 dry winter, indicating that they were not identified as a risk or a likely outcome.

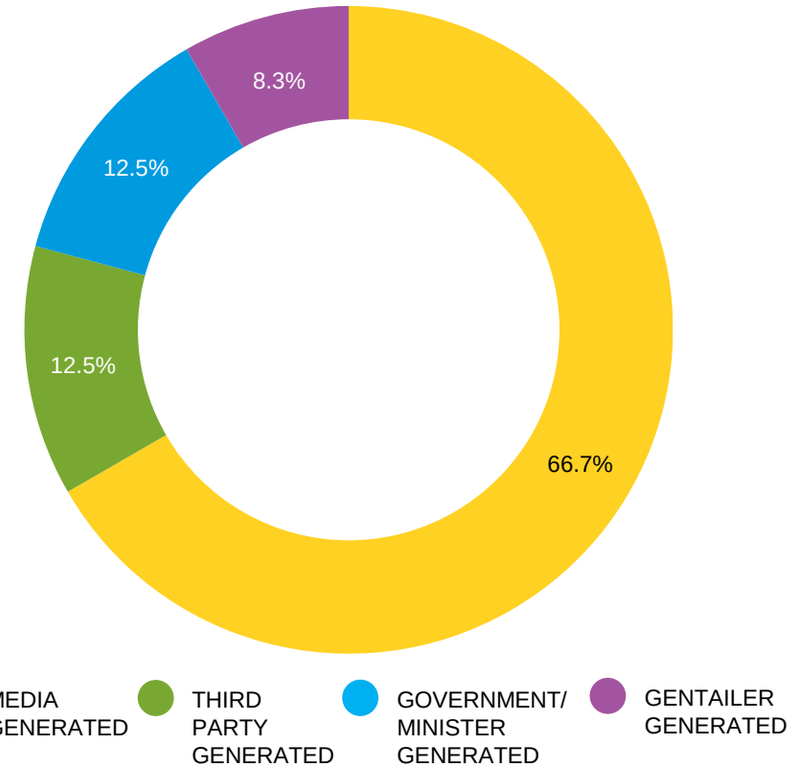
Conversely, there were almost equal proportions of "unlikely" and "definitely" in relation to a power crisis, and "unlikely" and "likely" in relation to blackouts in 2008 . This demonstrated some inconsistencies in communication, and indicated a sense of uncertainty and distrust in the information conveyed by the government and the electricity sector.

INSIGHTS DASHBOARD: DRY WINTERS 2008–2017

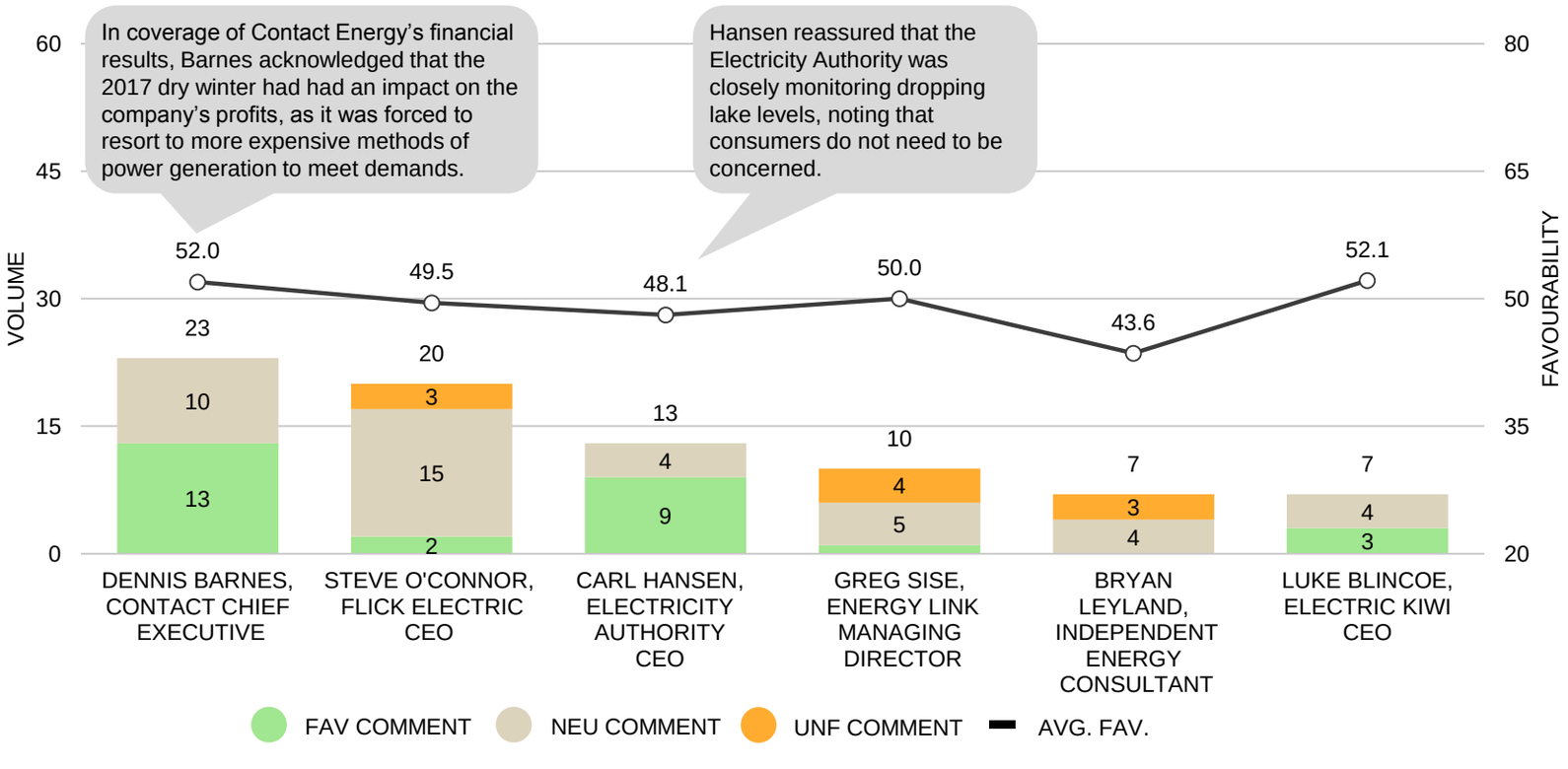
LEADING SPOKESPEOPLE – 2008



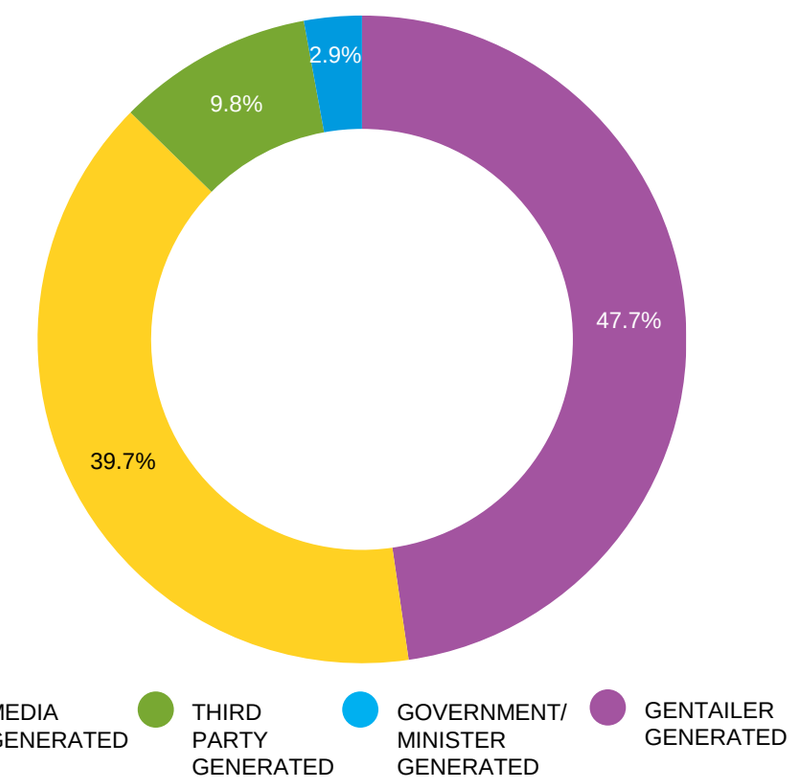
COVERAGE BY ORIGIN – 2008



LEADING SPOKESPEOPLE – 2017

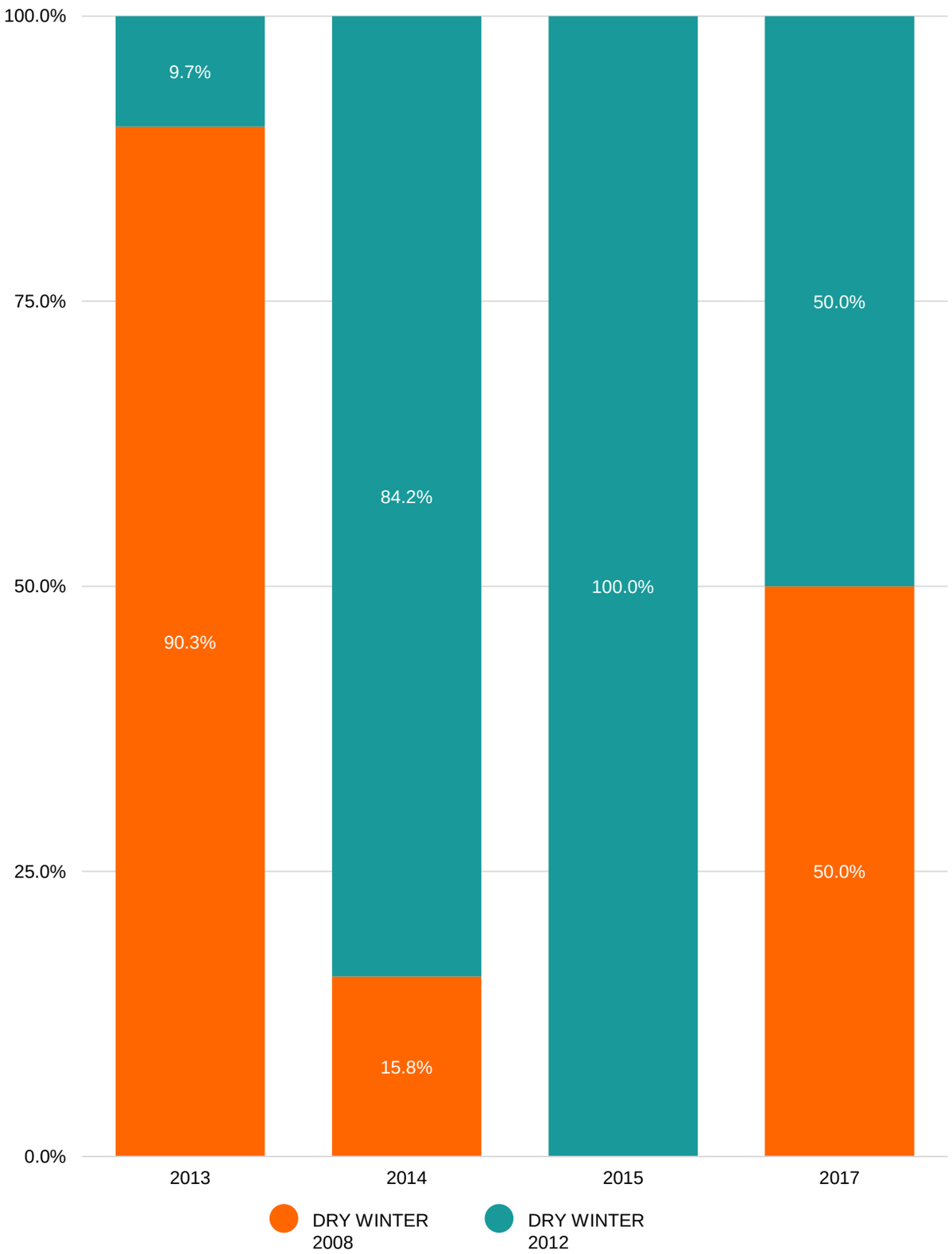


COVERAGE BY ORIGIN – 2017

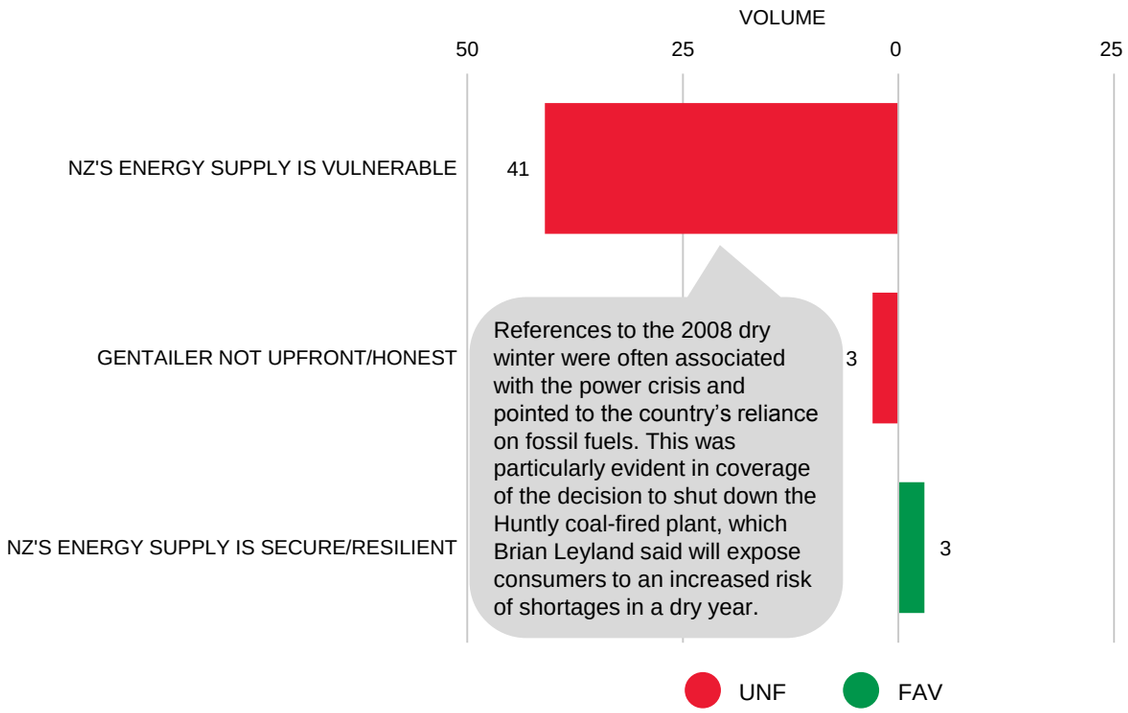


INSIGHTS DASHBOARD: DRY WINTERS 2008–2017

REFERENCES TO DRY WINTER 2008 & 2012



MESSAGES – REFERENCES TO DRY WINTER 2008



MESSAGES – REFERENCES TO DRY WINTER 2012