Date: 17 April 2023

TRADING CONDUCT REPORT

Market Monitoring Weekly Report

TRADING CONDUCT REPORT

1. Overview for week of 9 – 15 April 2023

1.1. High hydro storage in the South Island and low demand due to school holidays resulted in a decrease in average spot prices. However, price separation in the energy market between Tuesday and Thursday was likely related to low wind generation in the North Island at peak demand times, and high northward HVDC transfer, which require greater quantities of North Island reserves to cover its risk. However, there was sufficient generation available. Note that Monday was a public holiday, so demand was much lower than the previous Monday, but similar to Saturday/Sunday.

2. Spot Prices

2.1. This report monitors underlying wholesale price drivers to assess whether there are trading periods that require further analysis for the purpose of identifying potential non-compliance with the trading conduct rule. In addition to general monitoring, we also single out unusually high-priced individual trading periods for further analysis by identifying when wholesale electricity spot prices at any node exceed its historical 90th percentiles. Note that this week, prices above the historic 90th percentile are highlighted with a translucent green line. Other notable prices, but which did not breach the 90th percentile, are marked in black dashed lines (if any).

2.2. Between 9 – 15 April 2023:

(a) The average wholesale spot price across all nodes was $62/MWh.

(b) 95 percent of prices fell between $6/MWh and $119/MWh.

2.3. Figure 1 shows spot prices at Benmore and Ōtāhuhu alongside their historic median and historic 10th - 90th percentiles adjusted for inflation.

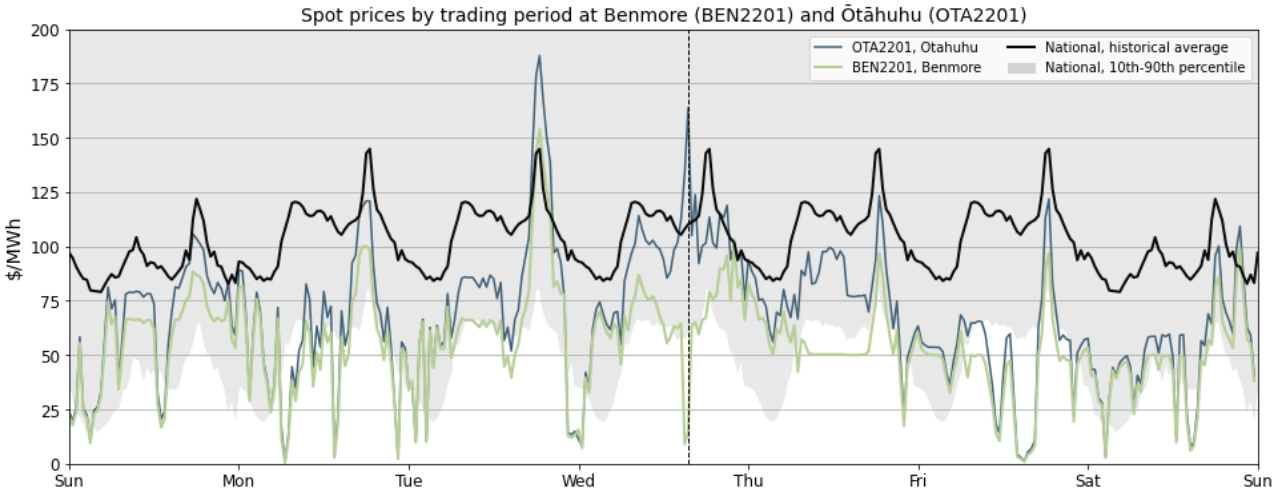
2.4. Overall, the prices were below the historic average and mostly fell below $100/MWh. Prices remained well below the historic 90th percentile, with some prices dropping below the historic 10th percentile.

2.5. On Tuesday, 11 April at 6:30 pm the prices at Benmore and Ōtāhuhu were both above the historic average, but well below the historic 90th percentile. The price at Ōtāhuhu was $188/MWh and the price at Benmore was $154/MWh. This was in line with a high evening demand peak and a drop in wind generation.

2.6. Price separation between Benmore and Ōtāhuhu was observed on Wednesday and Thursday. The largest instance of price separation occurred on Wednesday, 12 April at 3:30 pm when the price at Ōtāhuhu was around $164/MWh and the price at Benmore was $15/MWh (shown by a vertical black dashed line on the graph). The extended periods of price separation on these days were driven by high northward HVDC transfers, which require greater quantities of North Island reserves to cover its risk. Hence prices are separated as the effective cost of using cheaper South Island electricity to meet North Island demand increased by the cost of more expensive North Island reserve.

2.7. There was also price separation between Hawkes Bay and the rest of the North Island on Tuesday and Wednesday. This occurred when binding constraints into the Hawkes Bay region resulted in a very high tranche of energy being cleared from Waikaremoana – which the Monitoring team is analysing further.

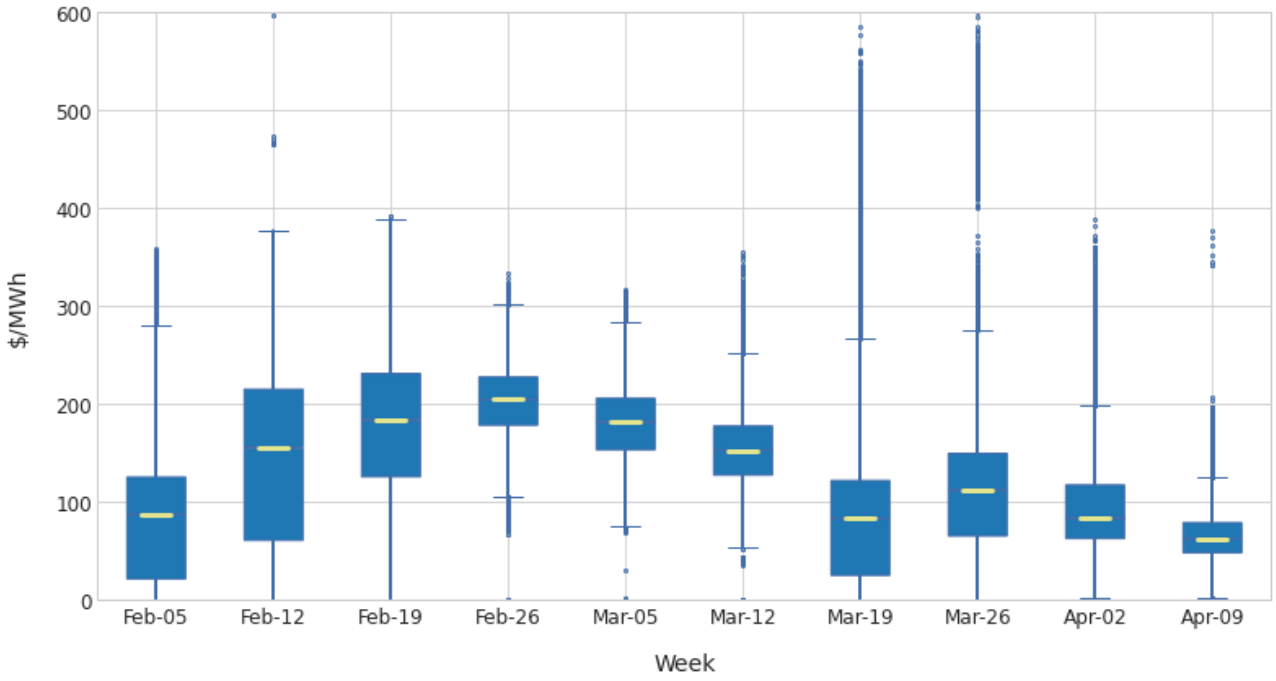
Figure 1: Wholesale Spot Prices between 9 April (Sunday) – 15 April (Saturday) 2023.



2.8. Figure 2 shows a box plot with the distribution of spot prices during this week and the previous nine weeks. The green line shows each week's median price, while the box part shows the lower and upper quartiles (where 50 percent of prices fell). The "whiskers" extend to points that lie within 1.5 times the inter-quartile range (IQR)[1] of the lower and upper quartile, and then observations that fall outside this range are displayed independently.

2.9. This week, the median was slightly lower when compared to the week before. The price decrease was largely driven by the low demand due to school holidays. Prices were lower than prices in late February and early March, due to increased hydro generation as lake levels have recovered.

Figure 2: Boxplots showing the distribution of spot prices this week and the previous nine weeks.

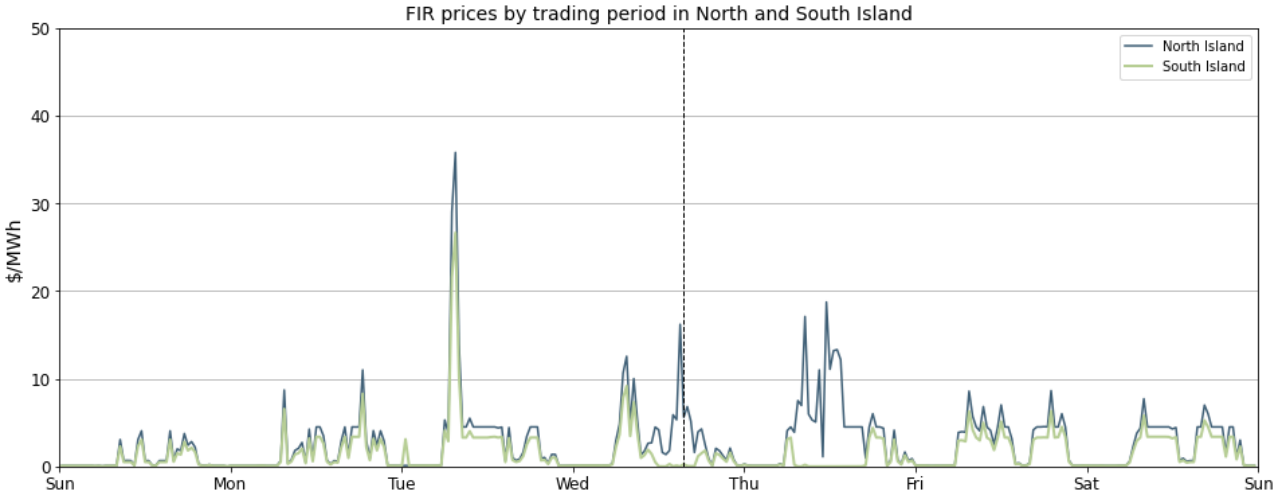


[1] Quartile - Wikipedia

3. Reserve Prices

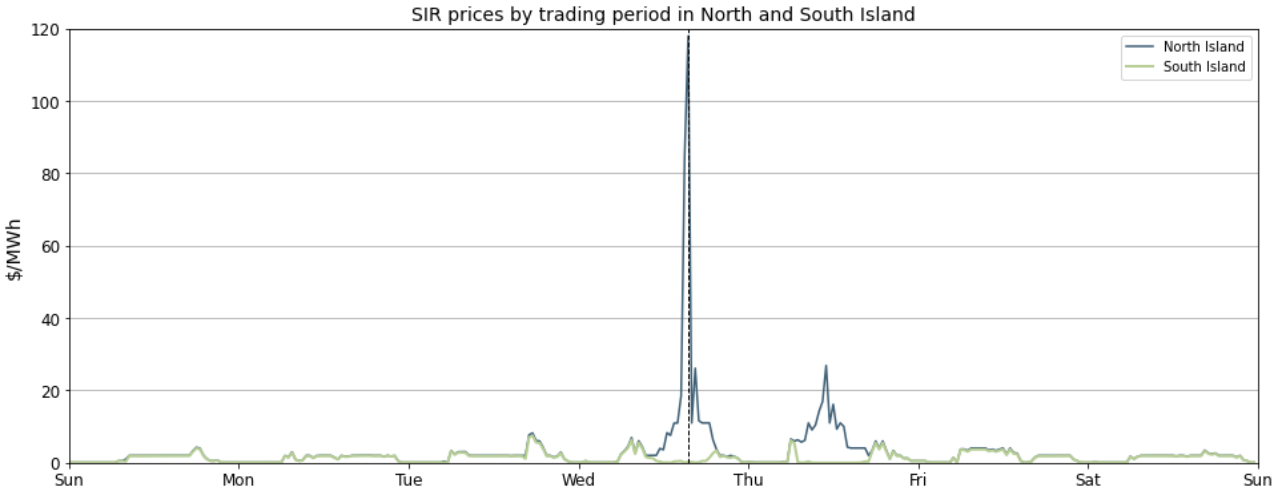
3.1. Fast instantaneous reserve (FIR) prices for the North and South Islands are shown below in Figure 3. This week the FIR prices were below $20/MWh for both Islands, except on Tuesday, 11 April at 7:00 and 7:30 am when they increased slightly to around $30/MWh.

Figure 3: FIR prices by trading period and Island.



3.2. Sustained instantaneous reserve (SIR) prices for the North and South Islands are shown in Figure 4. SIR prices were mostly below $10/MWh with a few price spikes on Wednesday and Thursday in the North Island. These high SIR prices reflect the high requirements of reserve needed to cover the risk of the HVDC in the North Island, as it was running close to capacity at the time. The highest SIR on Wednesday, 12 April at 3:30 am occurred in the same trading period as the spot price separation.

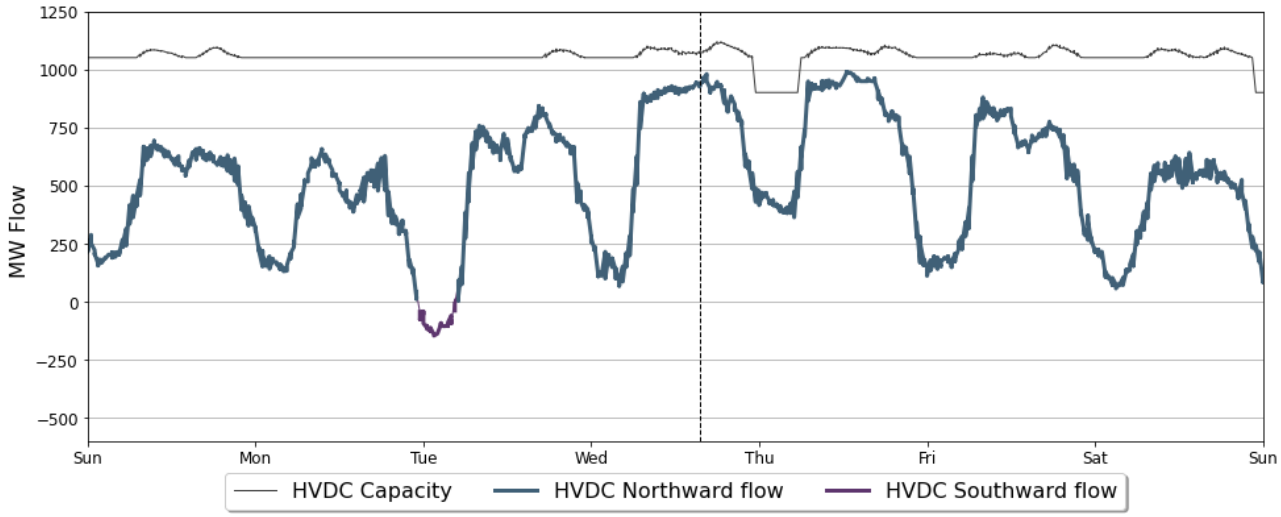
Figure 4: SIR prices by trading period and Island.



4. HVDC

4.1. Figure 5 shows HVDC flow between 9 – 15 April. HVDC flows were mostly northward during both daytime and night-time, reaching up to 1,000 MW during the daytime. Northward flows were particularly high on Wednesday and Thursday, when wind generation was low. There was some small HVDC flow southward overnight on Tuesday.

Figure 5: HVDC northward flow and capacity.



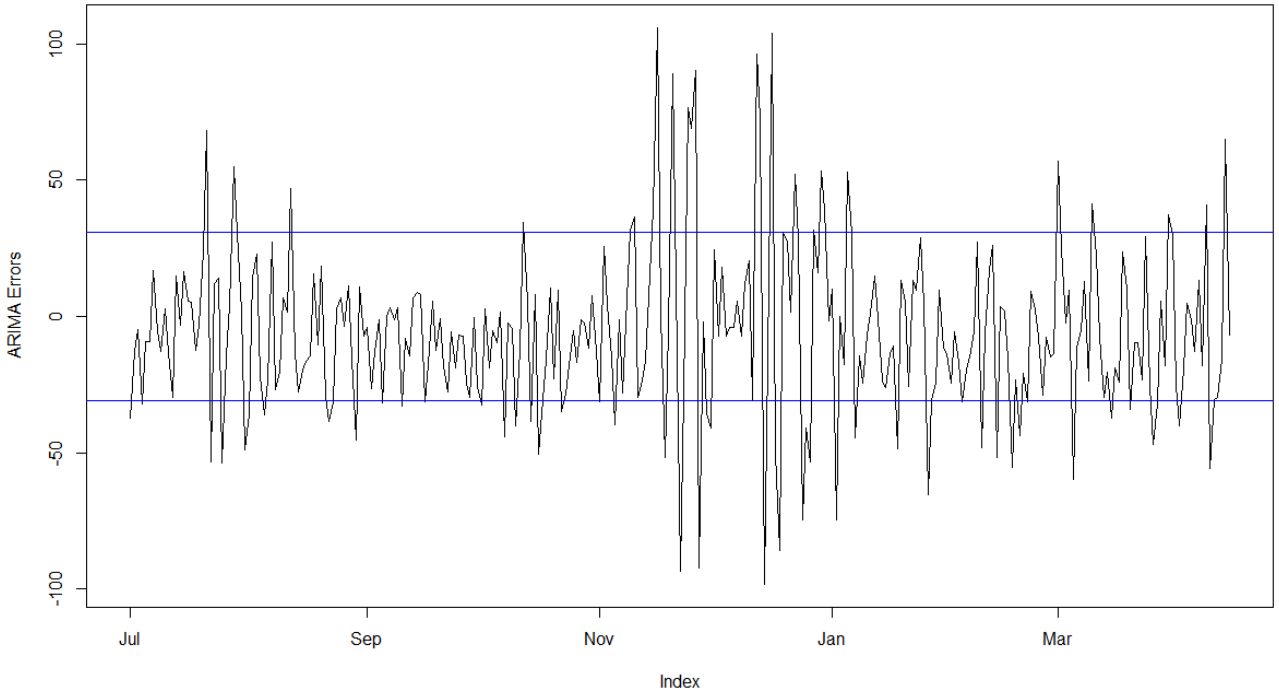
5. Regression Residuals

5.1. The Authority's monitoring team uses a regression model to model spot price. The residuals show how close the predicted prices were to actual prices. Large residuals may indicate that prices do not reflect underlying supply and demand conditions. Details on the regression model and residuals can be found in Appendix A[2] on the trading conduct webpage.

5.2. Figure 6 shows the residuals of autoregressive moving average (ARMA) errors from the daily model. Residuals were mostly relatively small, suggesting that prices on those dates appear to be largely aligned with market conditions. There were two residuals above, and one below the one standard deviation of the data, but all are small. These small deviations reflect market variations that may not be controlled for in the regression analysis. Note that the positive residual indicates that the modelled price was lower than the actual prices and vice versa.

[2] https://www.ea.govt.nz/assets/dms-assets/29/Appendix-A-Regression-Analysis.pdf

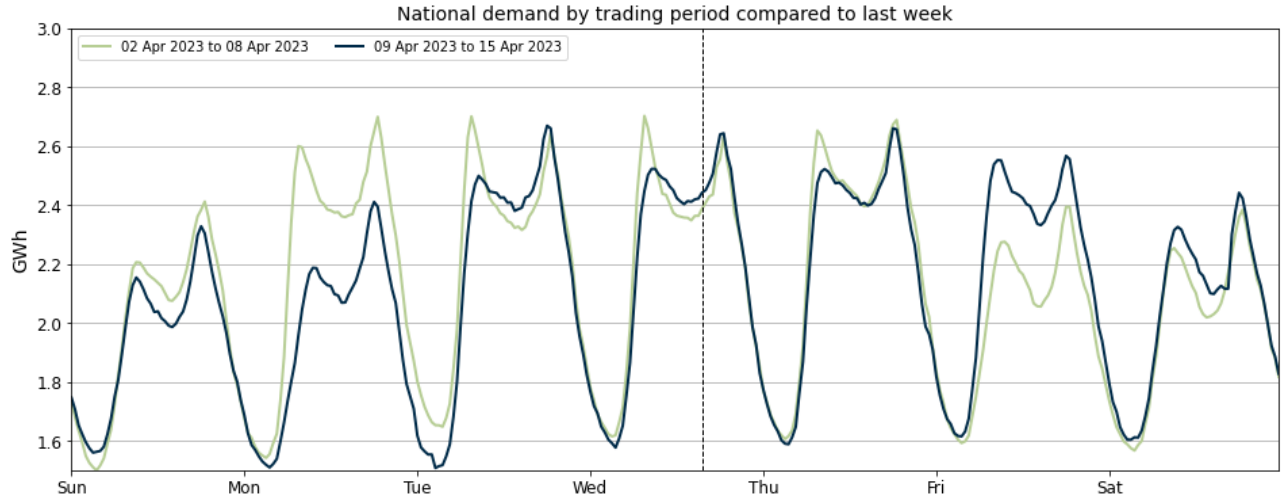
Figure 6: Residual plot of estimated daily average spot prices from 1 July 2022 – 15 April 2023. The blue lines show two standard deviations of the ARMA errors.



6. Demand

6.1. Figure 7 shows national grid demand between 9 – 15 April, compared to the previous week. The morning peak demand decreased due to school holidays, while evening peaks are relatively consistent compared to the previous week. On Monday the demand was low due to the public holiday. The low Friday demand for the previous week was due to the Easter holiday.

Figure 7: National demand by trading period compared to the previous week.

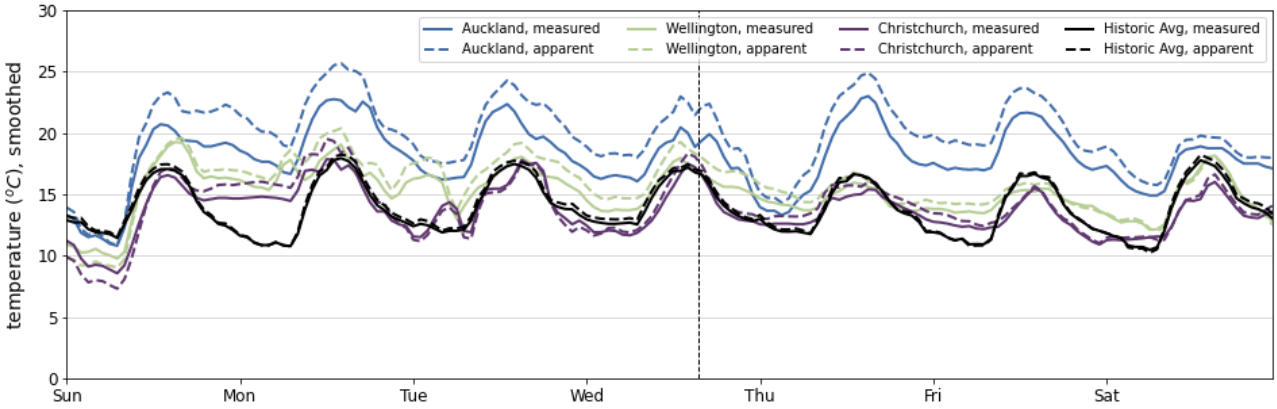


6.2. Figure 8 shows hourly temperatures at the three main population centres. The measured temperature is the recorded temperature, while the apparent temperature adjusts for factors like wind speed and humidity to estimate how cold it feels. Also included for reference is the

mean historical temperature of similar weeks, from previous years, averaged across the three main population centres.

6.3. Between 9 - 15 April, temperatures in all three main centres were mostly above or around the historic average, ranging between 10 and 25 degrees. Lowest temperatures occurred on Sunday morning where apparent temperature in Christchurch was around 7 degrees and 9 degrees in Wellington. Auckland temperatures generally stayed above the historic average across the week.

Figure 8: Temperatures across main centres.



7. Outages

7.1. Figure 9 shows generation capacity on outage. Total capacity on outage between 9 – 15 April ranged between ~1,100 – 1,900 MW. Outages were low on Saturday and Sunday.

7.2. Notable outages include:

(a) Huntly 4 remains on outage until 28 April 2023.

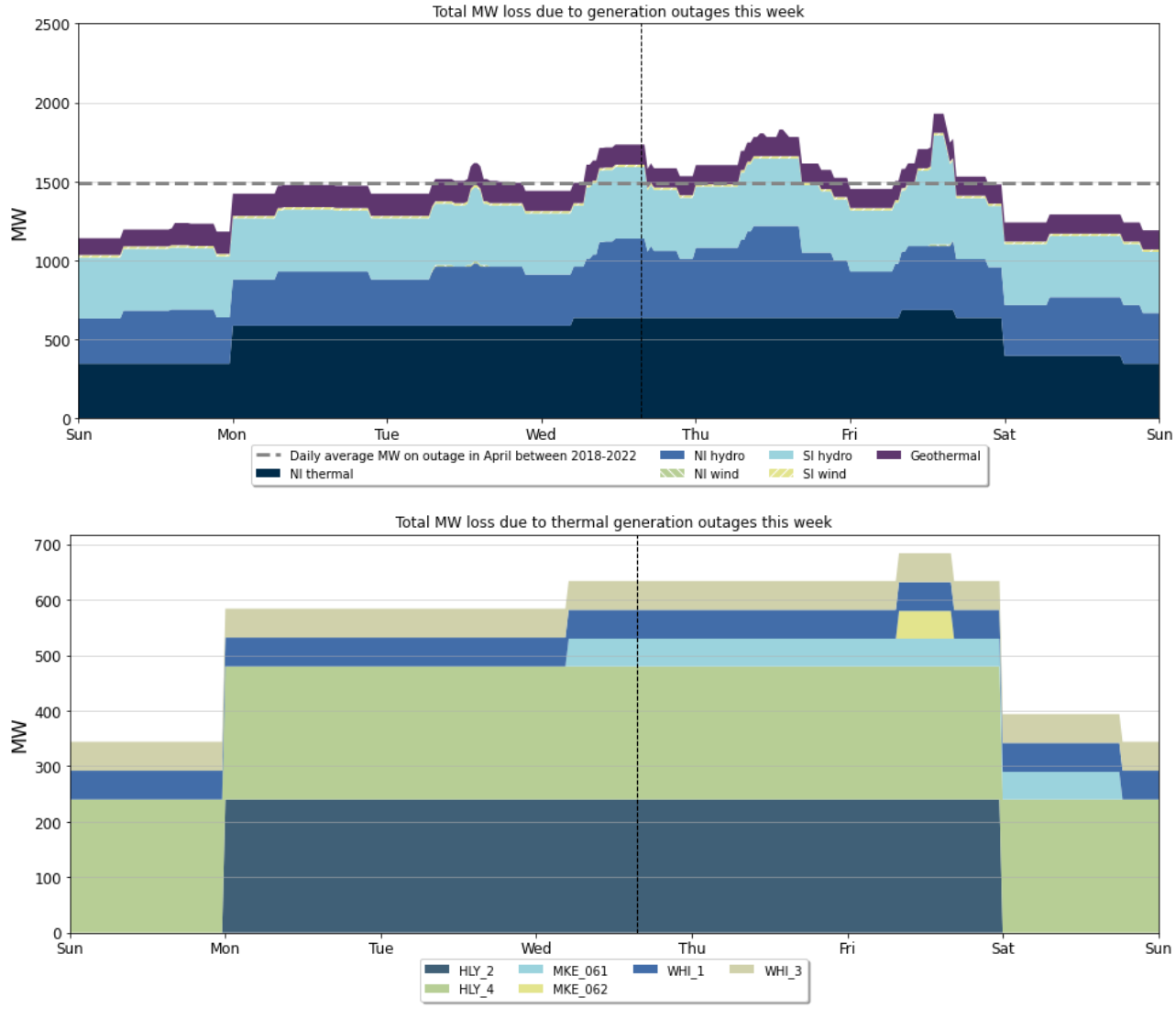
(b) Huntly 2 was on outage between 10-14 April 2023.

(c) Two Whirinaki units have an extended outage until 12 May 2023.

(d) The Geothermal plant Kawerau was on outage all week.

(e) Various North and South Island hydro units continue to be on outage this week.

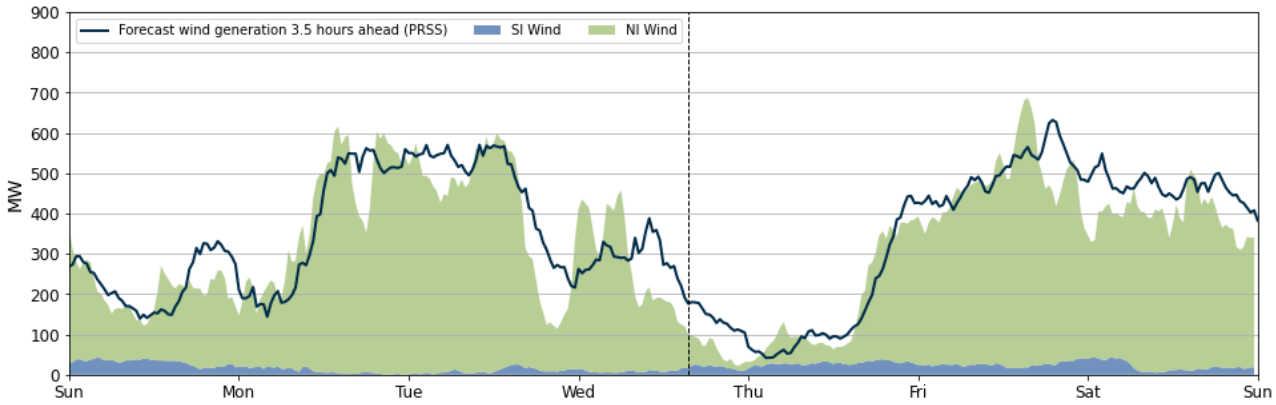
Figure 9: Total MW loss due to generation outages.



8. Generation

8.1. Wind generation, between 9 – 15 April, varied between ~20-650 MW (Figure 10) across the week. Tuesday saw a steep drop in wind generation from 600 MW to around 100 MW, which coincided with a price increase in both islands. On Wednesday wind increased to 400 MW in the morning but again dropped significantly to 20 MW by the end of the day, with low wind generation continuing for most of Thursday as well. During Friday and Saturday, wind generation hovered around 400 MW.

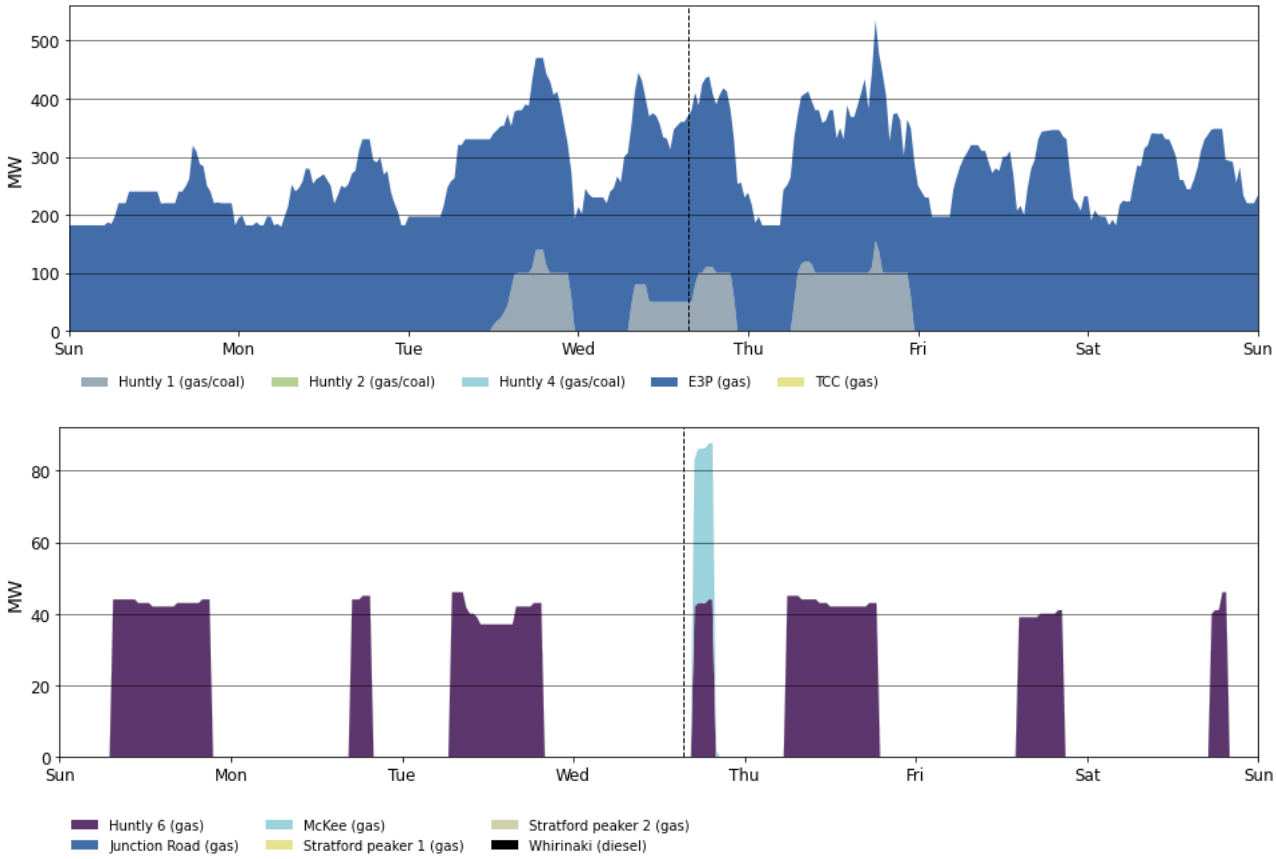
Figure 10: Wind Generation and forecast.



8.2. Figure 11 shows generation of thermal baseload and thermal peaker plants between 9 – 15 April. E3P (Huntly 5) ran all week as baseload. Huntly 1 ran between Tuesday and Thursday, helping make up for low wind generation.

8.3. Huntly 6 ran each day mostly during the evening peak times. McKee also ran to cover the Wednesday evening peak demand. Thermal generations were ramped up during the low wind generation times.

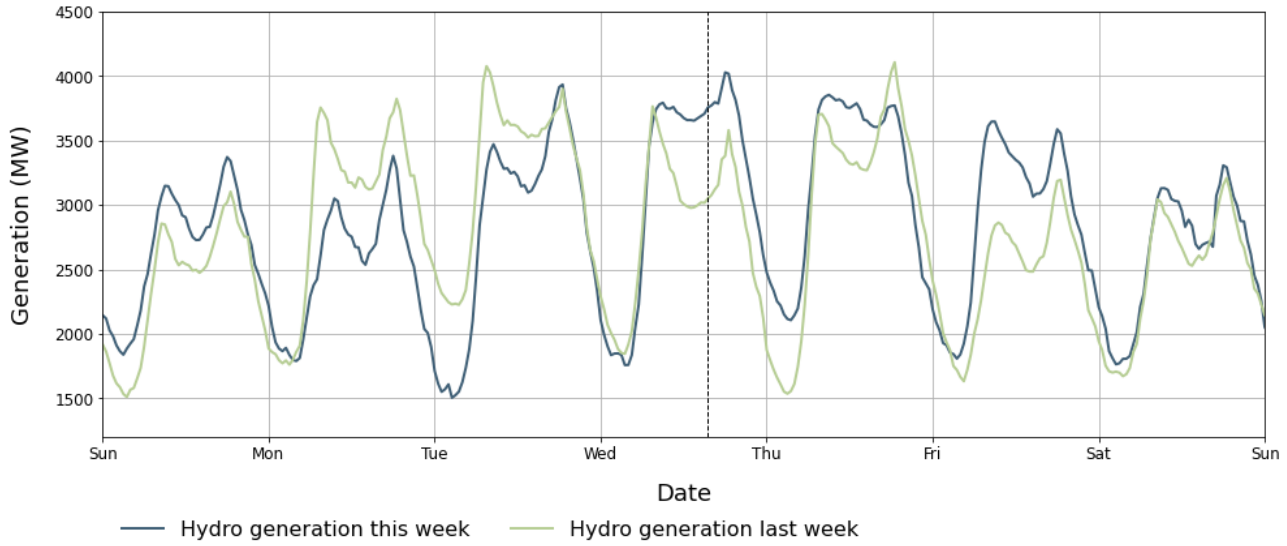
Figure 11: Thermal Generation.



8.4. Figure 12 shows total hydro generation in MW produced each trading period, compared to the same time in the previous week. There was higher hydro generation compared to last week from Tuesday evening onwards, especially on Wednesday and Thursday when wind generation was low. Hydro generation was also high on Tuesday during the evening peak

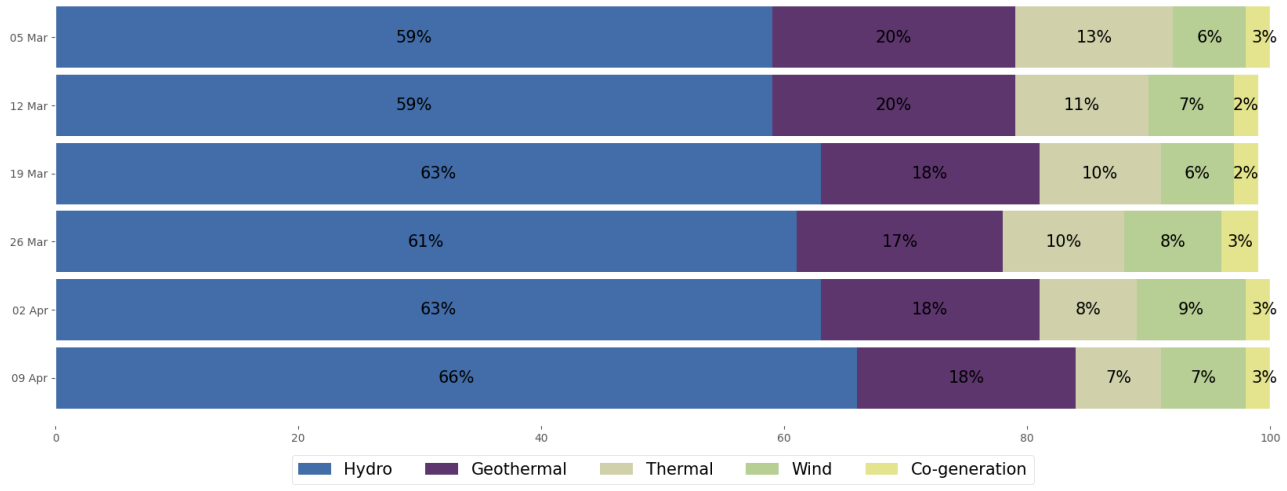
demand with low wind generation. Hydro generation followed the demand trend on Monday due to the public holiday.

Figure 12: Hydro generation between 9 – 15 April compared to the previous week.



8.5. As a percentage of total generation, between 9 – 15 April, total weekly hydro generation totalled 66 percent, geothermal 18 percent, thermal 7 percent, wind 7 percent, and co-generation 3 percent.

Figure 13: Total generation as a percentage each week between 26 Feb and 15 April 2023.



9. Storage/Fuel Supply

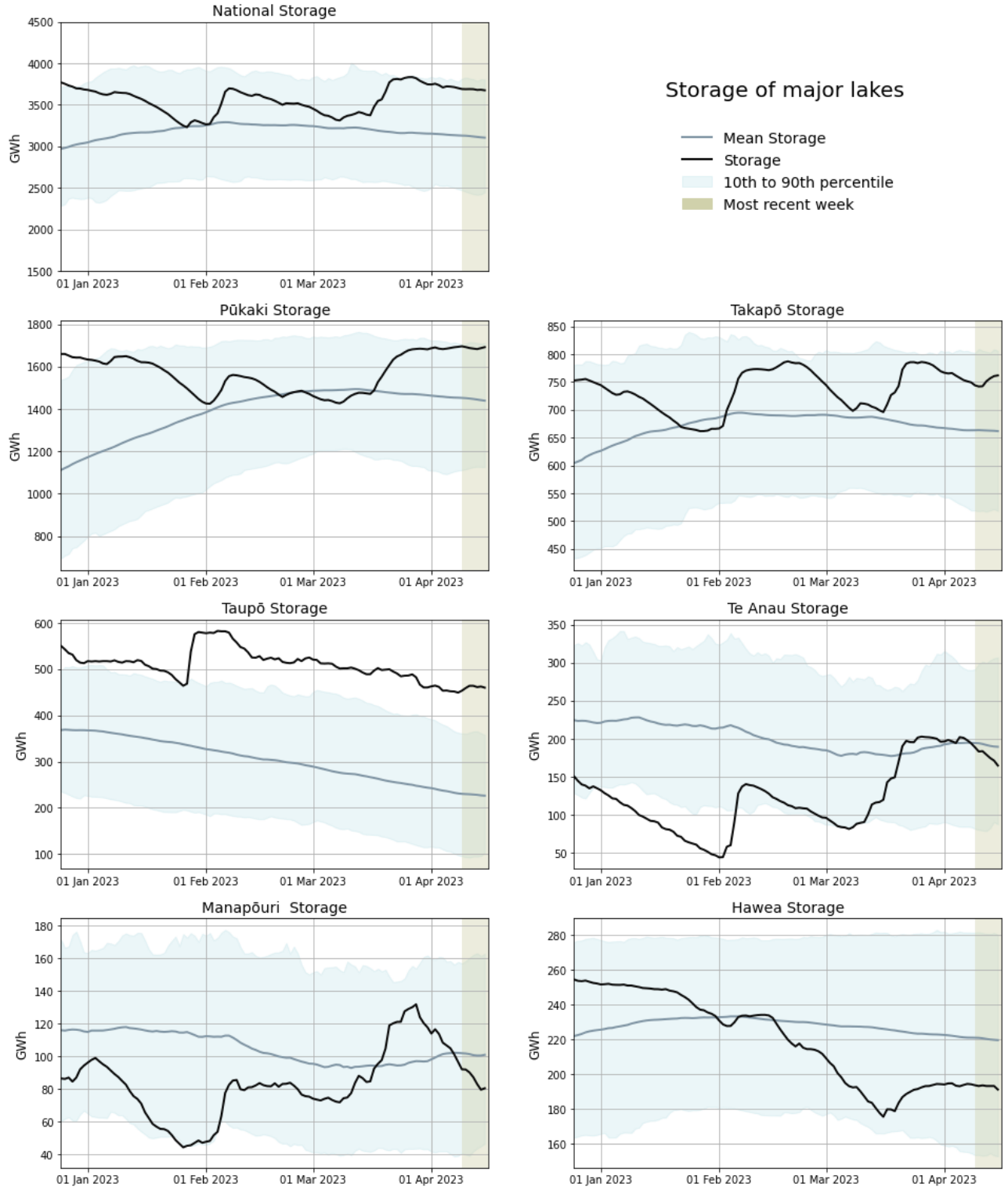
9.1. Figure 14 shows total controlled national hydro storage as well as the storage of major catchment lakes including their historical mean and 10th to 90th percentiles.

9.2. Overall, national hydro storage remained consistent over the week and slightly below its 90th percentile. Total national storage is around 89 percent of nominal full as of 15 April.

9.3. Storage at lake Pūkaki is touching its historic 90th percentile, while Lake Takapō storage slightly increased but is still below its 90th percentile. Hawea remained at a steady level

below its historic mean. Taupō's storage has been consistent, remaining above its historic 90th percentile. Lakes Manapōuri and Te Anau storage fell below their historic means.

Figure 14: Hydro Storage.

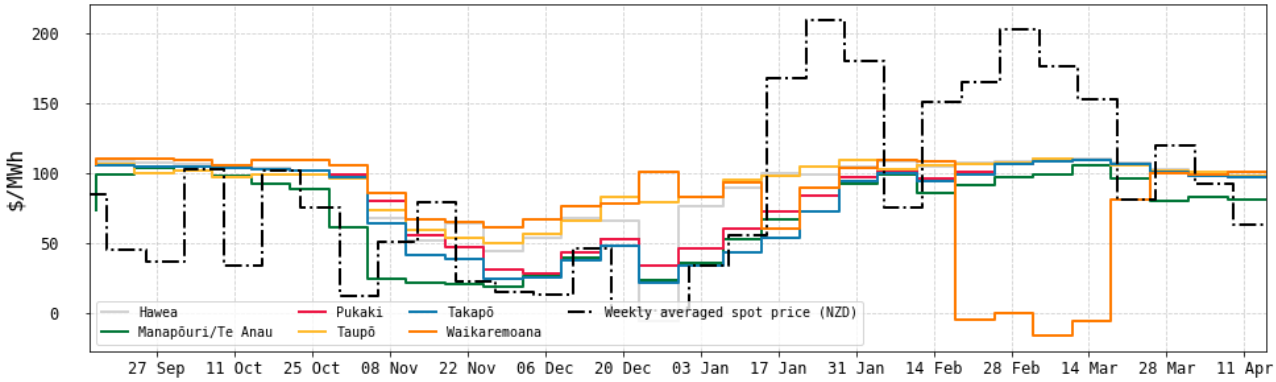


10. JADE Water Values

10.1. The JADE[3] model gives a consistent measure of the opportunity cost of water, by seeking to minimise the expected fuel cost of thermal generation and the value of lost load and provides an estimate of water values at a range of storage levels. Figure 15 shows the national water values between 15 September 2022 and 15 April 2023 using values obtained from JADE. These values are used to estimate the marginal water value at the actual storage level. More details on how water values are calculated can be found in Appendix B[4] on the trading conduct webpage.

10.2. Since the beginning of February, the water values at most lakes have been relatively steady, with a small drop in March as lake levels rose. Water values across all lakes remained steady last week. Note that the water value for Waikaremoana dropped to below zero during February and March when it was full and was only able to supply parts of Hawkes Bay.

Figure 15: JADE water values across various reservoirs between 15 September 2022 and 15 April 2023.



11. Prices versus estimated costs

11.1. In a competitive market, prices should be close to (but not necessarily at) the short run marginal cost (SRMC) of the marginal generator (where SRMC includes opportunity cost).

11.2. The SRMC (excluding opportunity cost of storage) for thermal fuels is estimated using gas and coal prices, and the average heat rates for each thermal unit. Note that the SRMC calculations include the carbon price, an estimate of operational and maintenance costs, and transport for coal.

11.3. Figure 16 shows an estimate of thermal SRMCs as a monthly average up to 1 April 2023. The SRMC of diesel plants has significantly decreased, and the SRMC of gas-fuelled and coal plants has also slightly decreased. A reduction in carbon prices has contributed to the decline in SRMCs.

11.4. In early April Indonesian coal stayed at around ~$450/tonne (NZD) putting the latest SRMC of coal-fuelled Huntly generation at ~$262/MWh.

11.5. The SRMC of Whirinaki has decreased to ~$557/MWh.

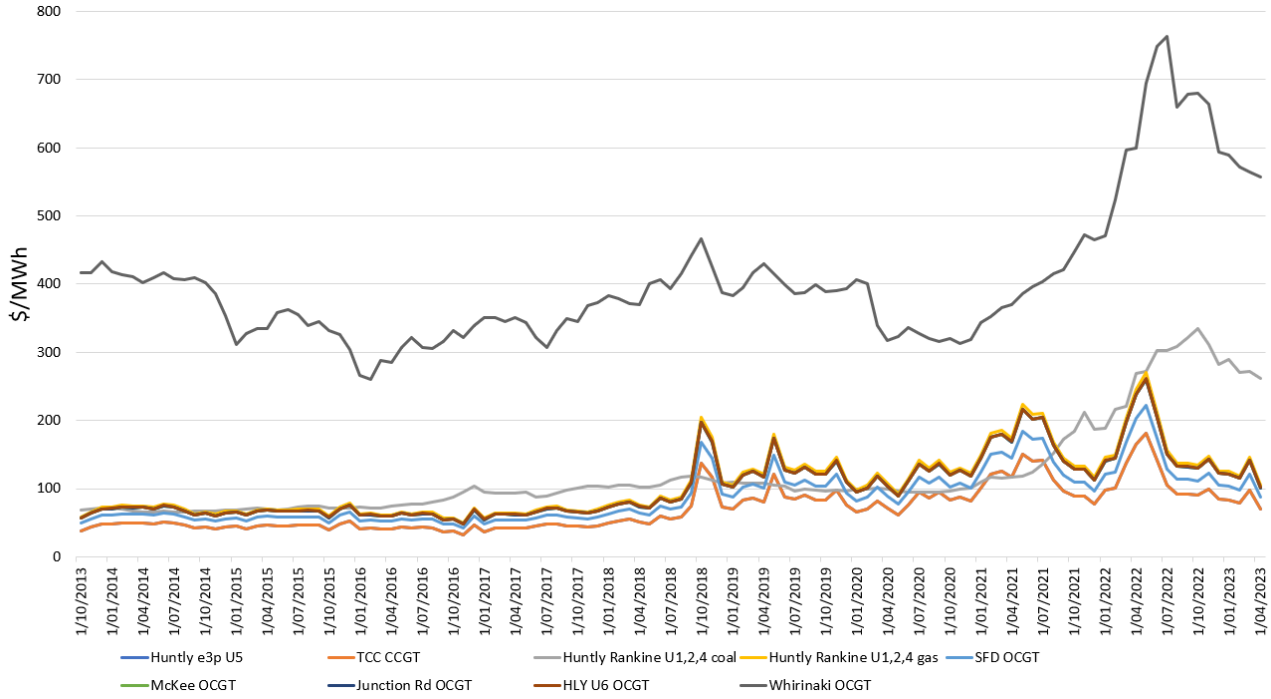
11.6. The SRMC of gas run thermal plants decreased to between $70/MWh and $105/MWh, likely due to a decrease in gas demand.

[3] JADE (Just Another DOASA Environment) is an implementation of the Stochastic Dual Dynamic Programming (SDDP) algorithm of Pereira and Pinto. JADE was developed by researchers at the Electric Power Optimisation Centre (EPOC) for the New Zealand electricity market.

[4] https://www.ea.govt.nz/assets/dms-assets/29/Appendix-B-JADE-water-value-model.pdf

11.7. More information on how the SRMC of thermal plants is calculated can be found in Appendix C[5] on the trading conduct webpage.

Figure 16: Estimated monthly SRMC for thermal fuels.



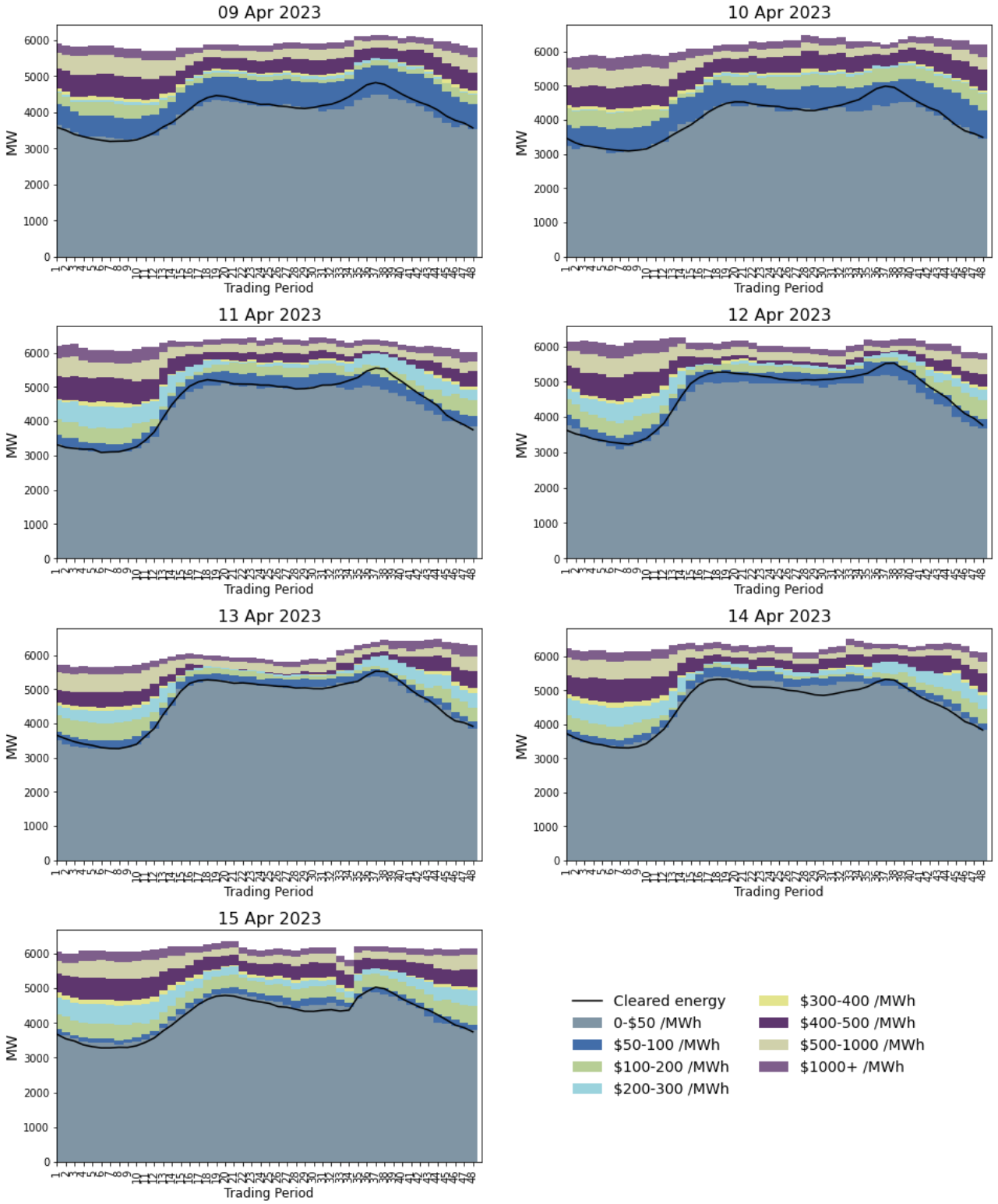
12. Offer Behaviour

12.1. Figure 17 shows this week's national daily offer stacks. The black line shows cleared energy, indicating the range of the average final price. Most of the time energy cleared in between $0 and $100/MWh. However, on Tuesday evening, high peak demand saw generation clear around $300/MWh.

12.2. On Sunday and Monday due to the Easter holidays, more energy was offered at $0-$100/MWh as demand was expected to be lower, with the price clearing in the $0-50/MWh or $50-100/MWh band.

[5] https://www.ea.govt.nz/assets/dms-assets/30/Appendix-C-Calculating-thermal-SRMCs.pdf

Figure 17: Daily offer stacks.



13. Ongoing Work in Trading Conduct

13.1. This week, prices generally appeared to be consistent with supply and demand conditions. Further analysis is being done on the trading periods in Table 1 as indicated.

Table 1: Trading periods identified for further analysis.

Date	TP	Status	Notes
07/10/2022	15-16	Further analysis	The Monitoring team is making enquires with Genesis regarding offer changes to final tranche prices at Huntly 5 for trading period 15-16.
13/12/2022-16/12/2022	Several	Further analysis	The Authority will continue analysis into the high energy prices.
15/1/2023 4/2/2023	Several	Further analysis	The Authority will continue analysis into the high energy prices associated with high hydro offers.
23/3/2023	16-18	Further analysis	The Authority will continue analysis into the energy prices and participant response in relation to the CAN notice.
24/3/2023	17,28	Further analysis	The Authority will continue analysis into the high energy and reserve prices in relation to the CAN notice and for other high price TP.
11/4/2023-12/4/2023	36-39	Further analysis	The Authority will continue analysis into the high energy prices in and around the Hawkes Bay region.