Date: 11 April 2023

TRADING CONDUCT REPORT

Market Monitoring Weekly Report

TRADING CONDUCT REPORT

1. Overview for week of 2 – 8 April 2023

1.1. High hydro storage in the South Island resulted in a decrease in average spot prices. However, a combination of low wind, generation outages, and high peak demand caused a few price spikes in both the energy and reserve markets. There was sufficient generation available, with price spikes likely related to low wind generation at peak demand times, especially on Thursday when wind generation dropped dramatically. Note that Friday was a public holiday so demand was much lower than last Friday, but similar to Saturday.

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 2 – 8 April 2023:

(a) The average wholesale spot price across all nodes was $97/MWh.

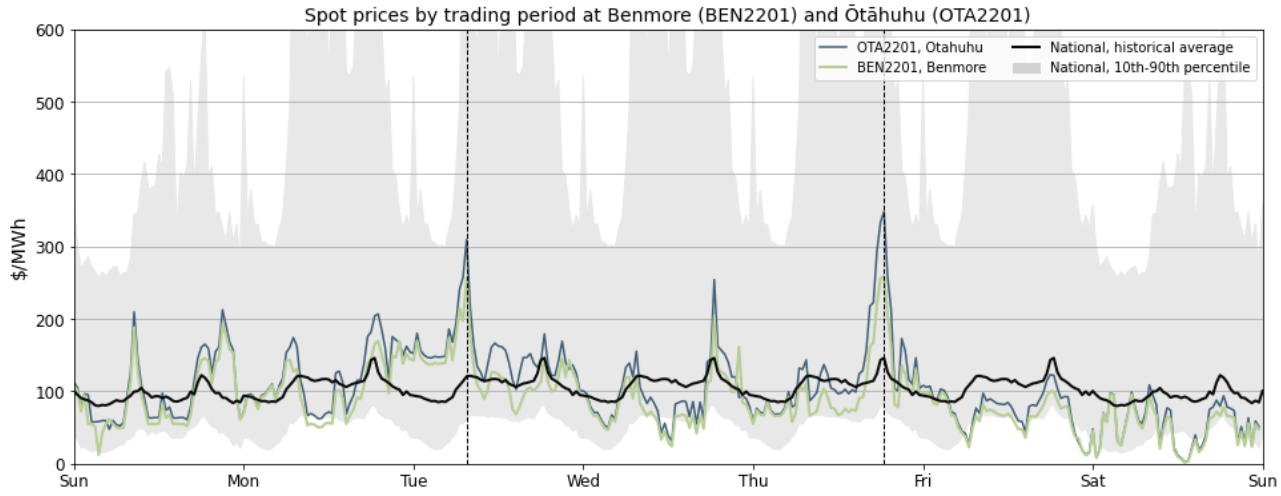
(b) 95 percent of prices fell between $19/MWh and $213/MWh.

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, prices were generally below $200/MWh during the week, with some prices later in the week dropping below the historic 10th percentile in line with lower demand likely due to Easter weekend.

2.5. There were two price spikes with prices going above $300/MWh at Ōtāhuhu but remaining below the historic 90th percentile (shown by a vertical black dashed line on the graph). The first was during the morning peak demand at 7.30 am where the price at Ōtāhuhu was around $309/MWh and at the same time the price at Benmore was around $256/MWh. The second was during the evening peak at 6.30 pm where the price at Ōtāhuhu was around $348/MWh and the price at Benmore was $259/MWh.

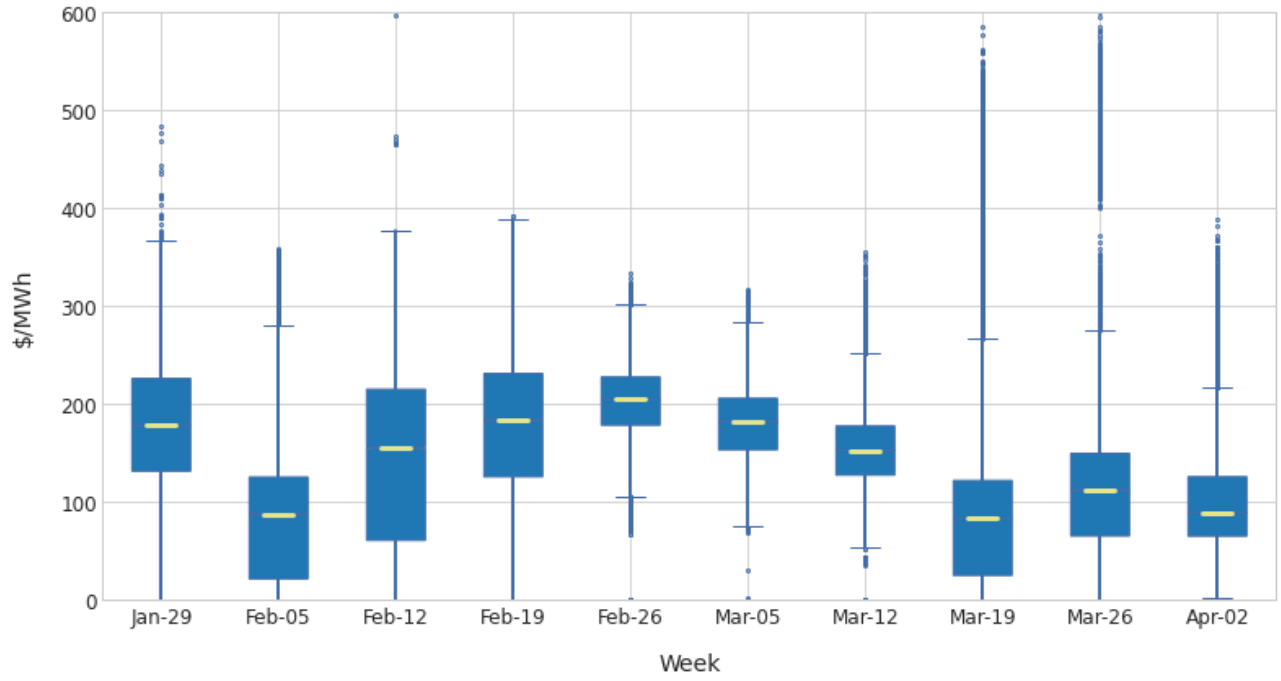
Figure 1: Wholesale Spot Prices between 2 April (Sunday) – 8 April (Saturday) 2023.



2.6. 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.

2.7. This week, the median was slightly lower when compared to the week before. The price decrease was largely driven by the low prices during Easter weekend. 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.

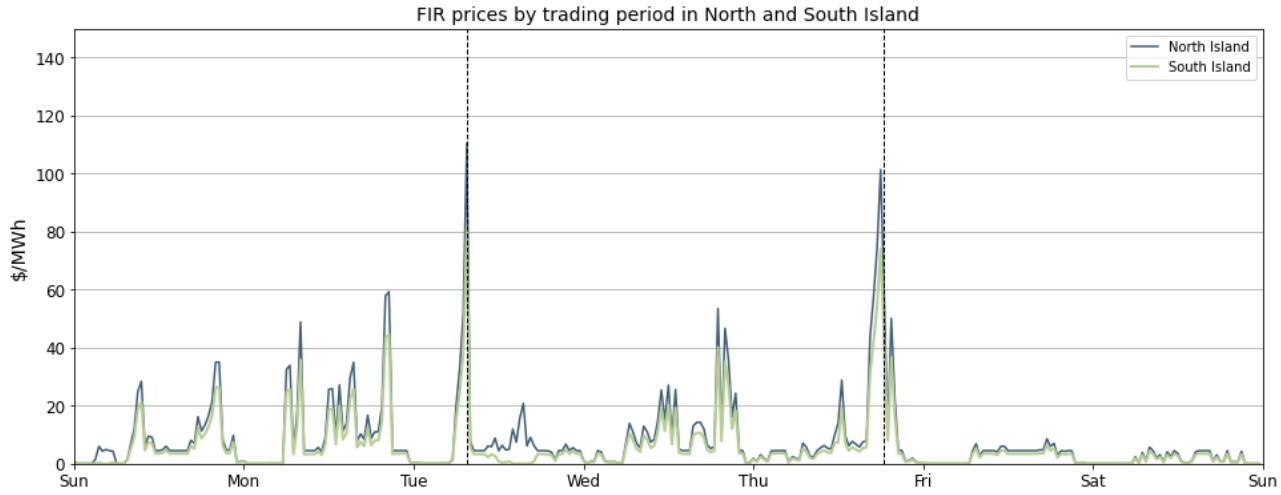


[1] Quartile - Wikipedia

3. Reserve Prices

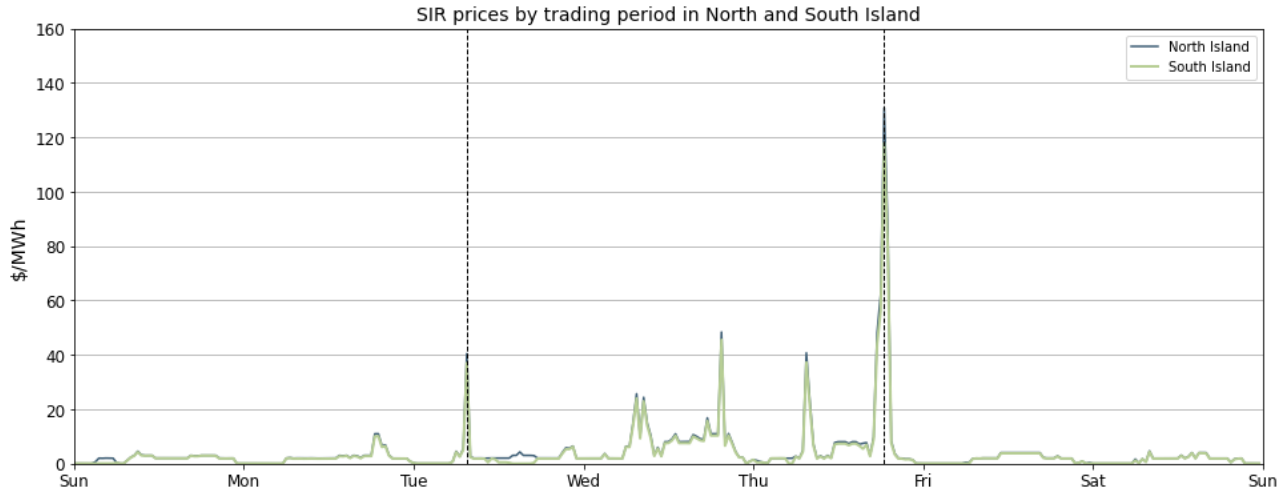
3.1. Fast instantaneous reserve (FIR) prices for the North and South Islands are shown below in Figure 3. This week there were several instances between Sunday and Thursday where the FIR prices were high for both Islands. The highest FIR price occurred on Tuesday at 7:30 am of $110/MWh in the North Island, and $81/MWh in the South Island, the highest of this week. The other significant high FIR prices occurred at 6:00 pm on Thursday 6 April. The North and South Island FIR price spikes, coinciding with the relatively high prices for energy, and appear to be due to tight supply as capacity was dispatched as energy and therefore unavailable to the reserve market.

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. Similar to FIR the high North and South Island SIR price on Thursday evening coincided with the high energy prices and reflect tight supply.

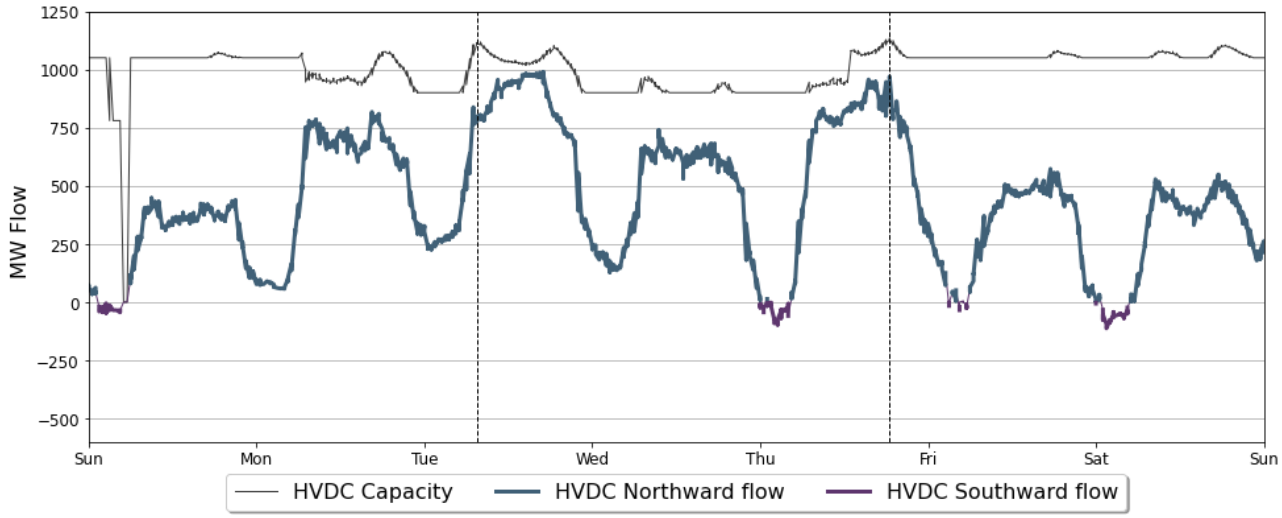
Figure 4: SIR prices by trading period and Island.



4. HVDC

4.1. Figure 5 shows HVDC flow between 2 – 8 April. HVDC flows were mostly northward up to 1,000 MW during the day, and very low flows southward during the night. Between Monday and Wednesday, flows were entirely Northward due to low wind. Northward flows were particularly high on Tuesday and Thursday evening, when wind generation was low. There was some HVDC flow southward overnight between Thursday and Saturday.

Figure 5: HVDC northward flow and capacity.



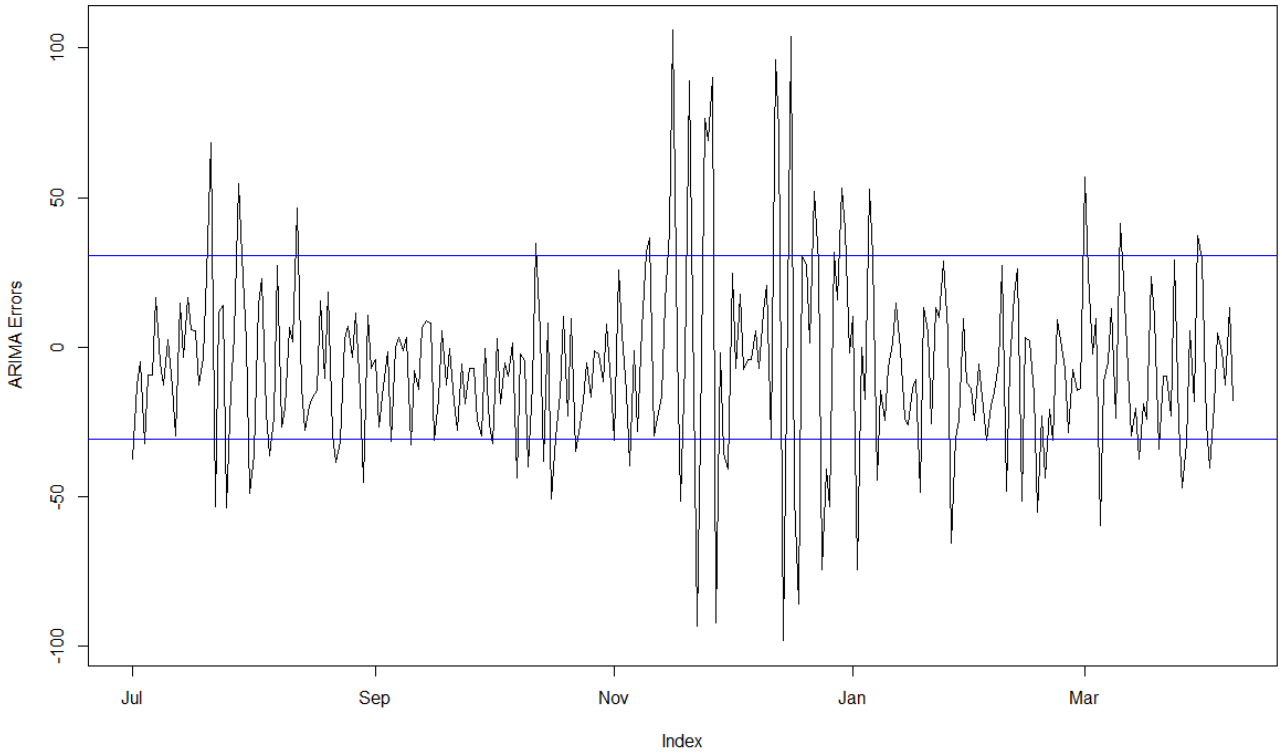
5. Regression Residuals

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 was a residual above one standard deviation of the data, which occurred on Thursday. Here the residual was positive, indicating that the modelled price was lower than the actual prices.

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

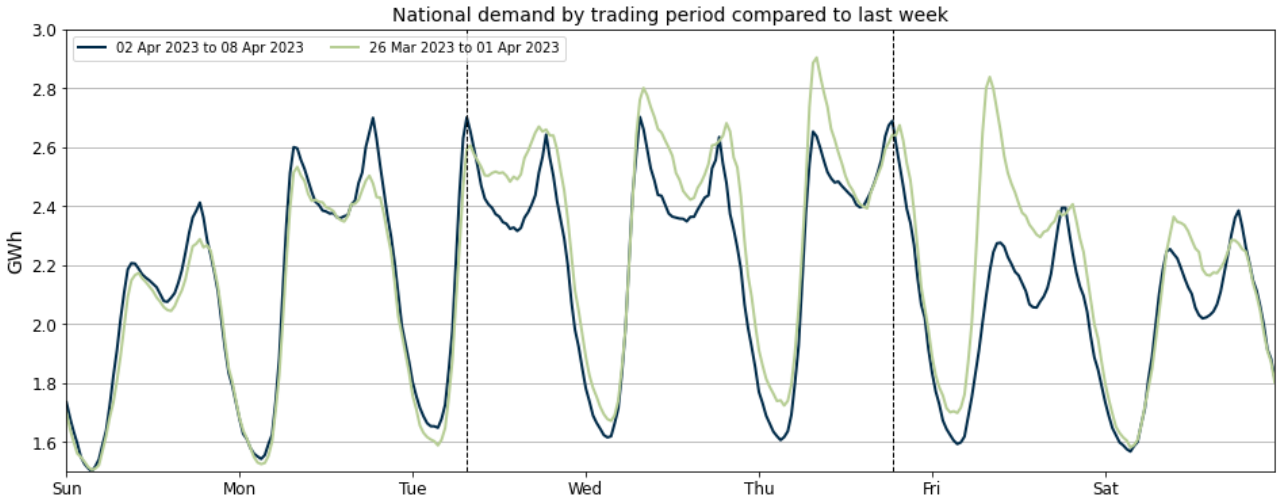
Figure 6: Residual plot of estimated daily average spot prices from 1 July 2022 – 8 April 2023. The blue lines show two standard deviations of the ARMA errors.



6. Demand

6.1. Figure 7 shows national grid demand between 2 – 8 April, compared to the previous week. Daily demand was slightly higher on Sunday and Monday compared to last week, especially during the evening peak. After the high morning peak on Tuesday, related to low temperatures, demand was generally lower for the remainder of the week than the previous week. On Friday the demand was low due to public holiday.

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

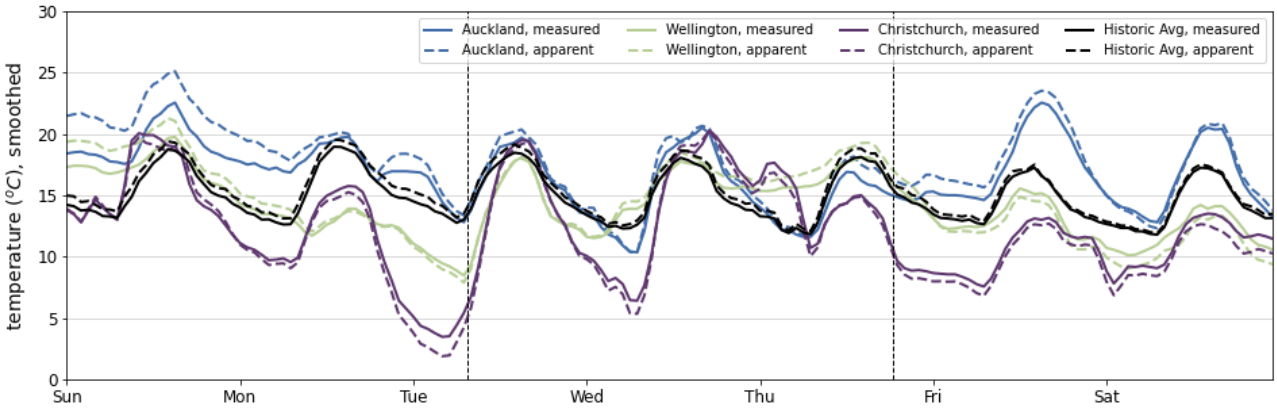


6.2. Figure 8 shows hourly temperatures at the three main population centres. The measured temperature is the recorded temperature, while the apparent temperature adjusts for factors like wind speed and humidity to estimate how cold it feels. Also included for reference is the

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

6.3. Apparent temperatures in Christchurch fell below the historic average for most of the week, ranging between 2 and 20 degrees. On Tuesday morning temperatures were lowest for both Christchurch and Wellington. Temperatures in Wellington fluctuated across the week, dipping below historic average from Monday to Tuesday and then again over Friday and Saturday. Auckland temperatures generally stayed slightly 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 2 – 8 April ranged between ~1,200 – 1,700 MW. Outages were high on Tuesday and Wednesday.

7.2. Notable outages include:

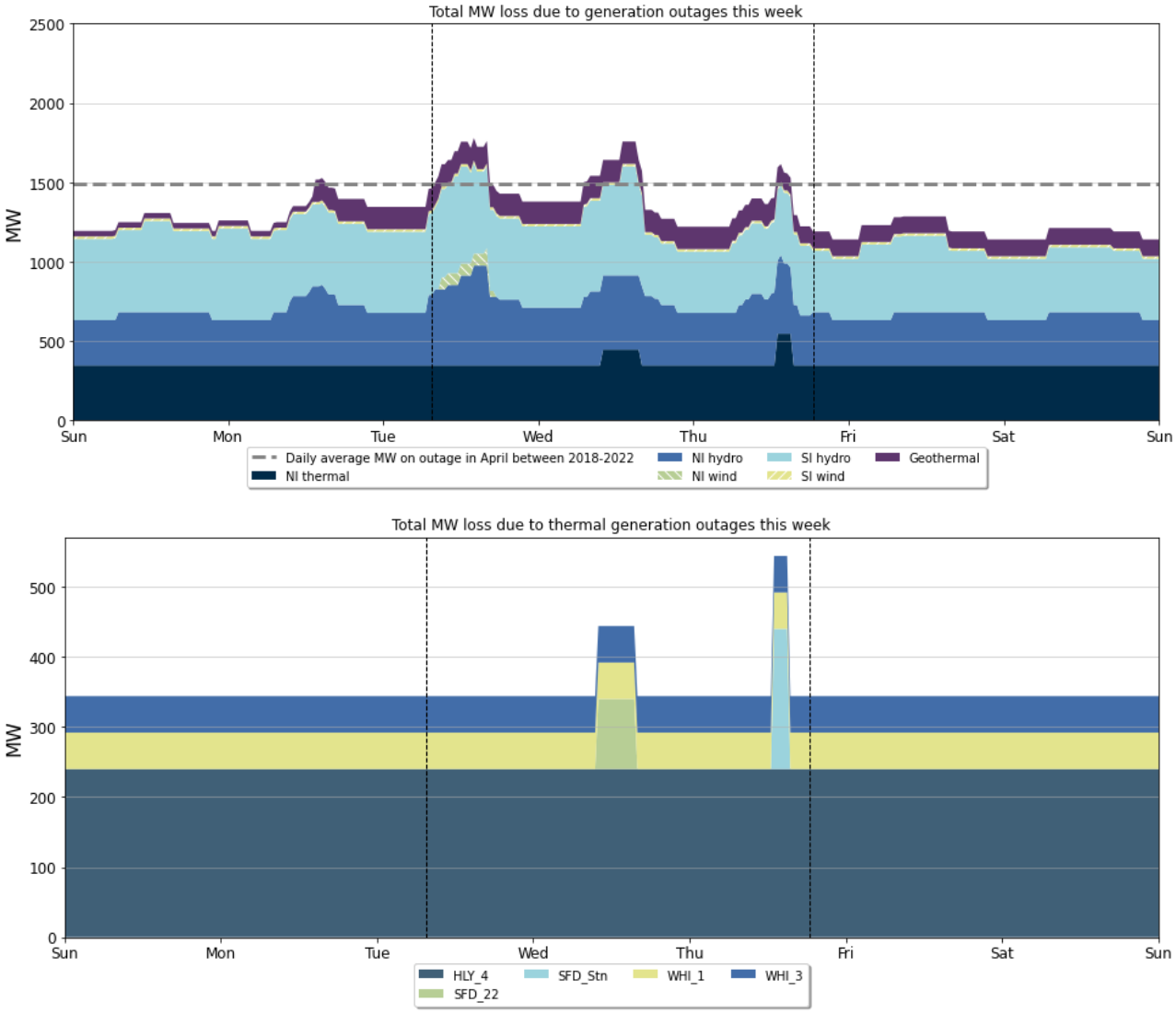
(a) Huntly 4 remains on outage until 28 April 2023.

(b) Two Whirinaki units extend outage until 12 May 2023.

(c) The Geothermal plant Kawerau was on outage.

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

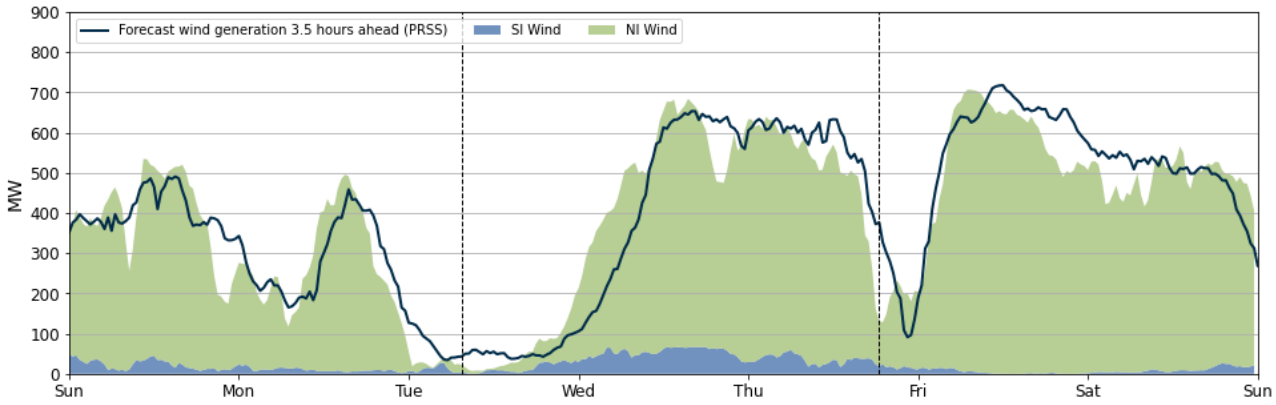
Figure 9: Total MW loss due to generation outages.



8. Generation

8.1. Wind generation, between 2 – 8 April, varied between ~7-700 MW (Figure 10) across the week. Tuesday saw a large drop in wind generation to below 10MW for most of the day. From Wednesday to Saturday wind generation was mostly above 500MW apart from a sharp drop off to between 150 – 200 MW on Thursday evening.

Figure 10: Wind Generation and forecast.

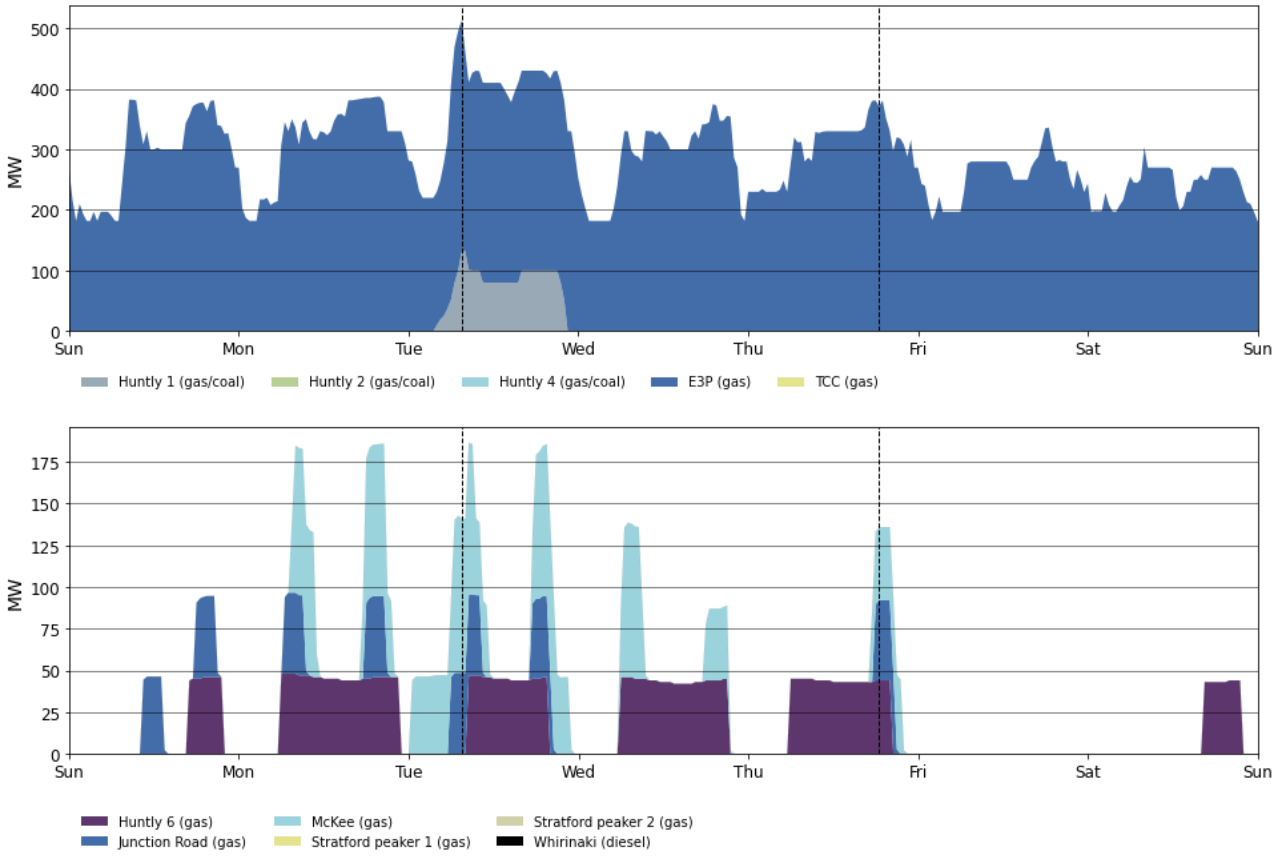


8.2.

8.3. Figure 11 shows generation of thermal baseload and thermal peaker plants between 2 – 8 April. E3P (Huntly 5) ran all week as baseload. Huntly 1 ran on Tuesday helping make up for low wind generation, but did not run for the rest of the week.

8.4. Huntly 6 ran during the day from Monday to Thursday and also on Sunday and Saturday evening peak times. Junction Road and McKee ran on Monday and Tuesday covering peak demand, with McKee also covering peaks on Wednesday and Thursday. Peakers were ramped up during the low wind generation times.

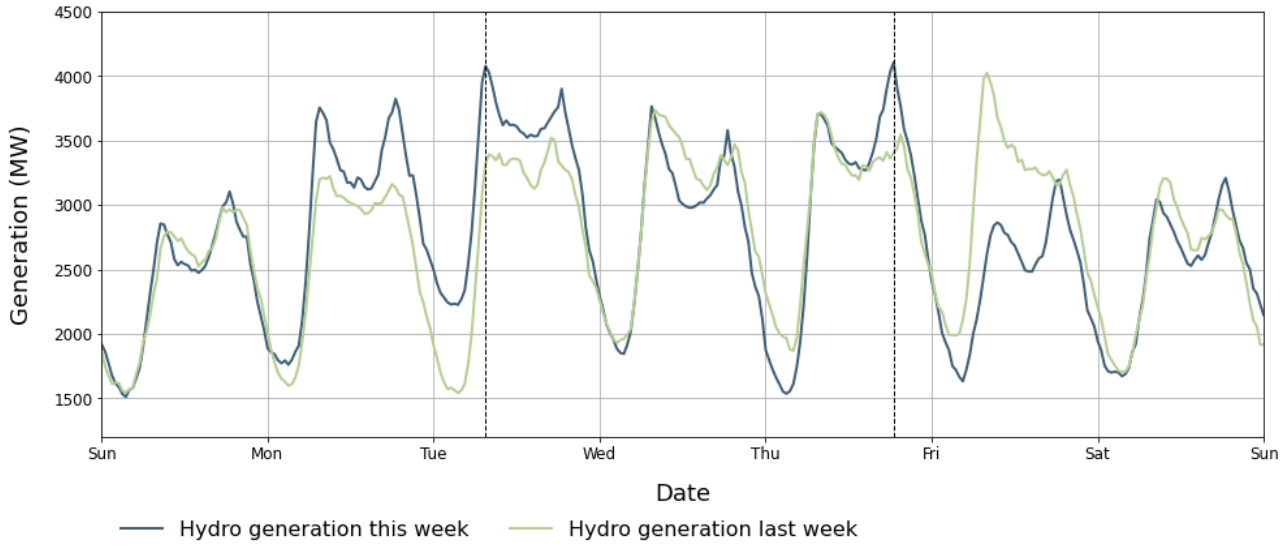
Figure 11: Thermal Generation.



8.5. 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 Monday onwards, especially on Tuesday when wind generation was low. Hydro

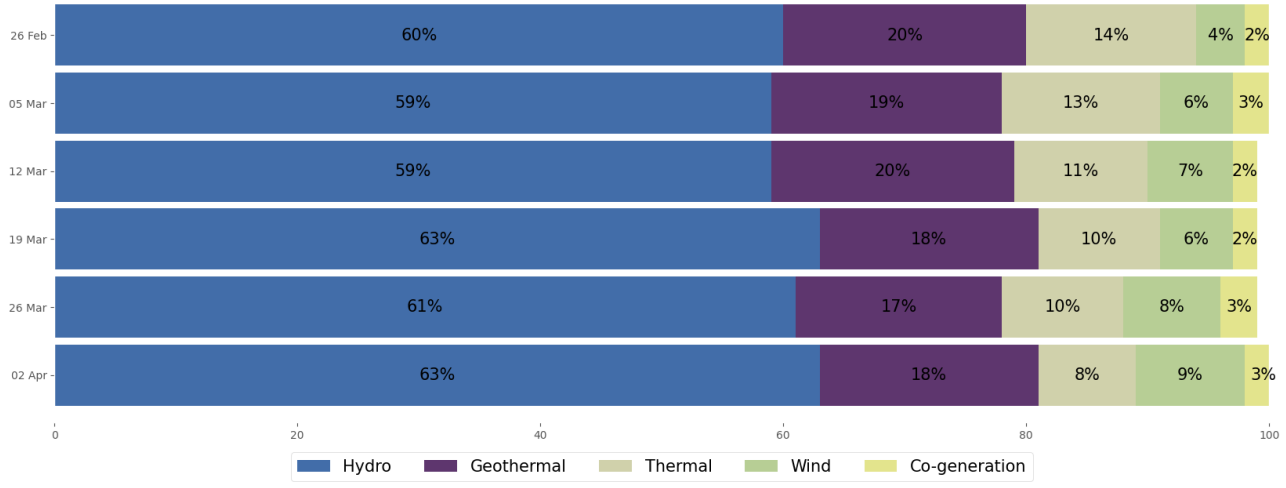
generation was also high on Thursday evening as there was low wind, high peak demand, and no Rankine units running. Hydro generation fell on Friday due to low demand.

Figure 12: Hydro generation between 2 – 8 April compared to the previous week.



8.6. As a percentage of total generation, between 2 – 8 April, total weekly hydro generation totalled 63 percent, geothermal 18 percent, thermal 8 percent, wind 9 percent, and co-generation 3 percent.

Figure 13: Total generation as a percentage each week between 26 Feb and 8 April 2023.



9. Storage/Fuel Supply

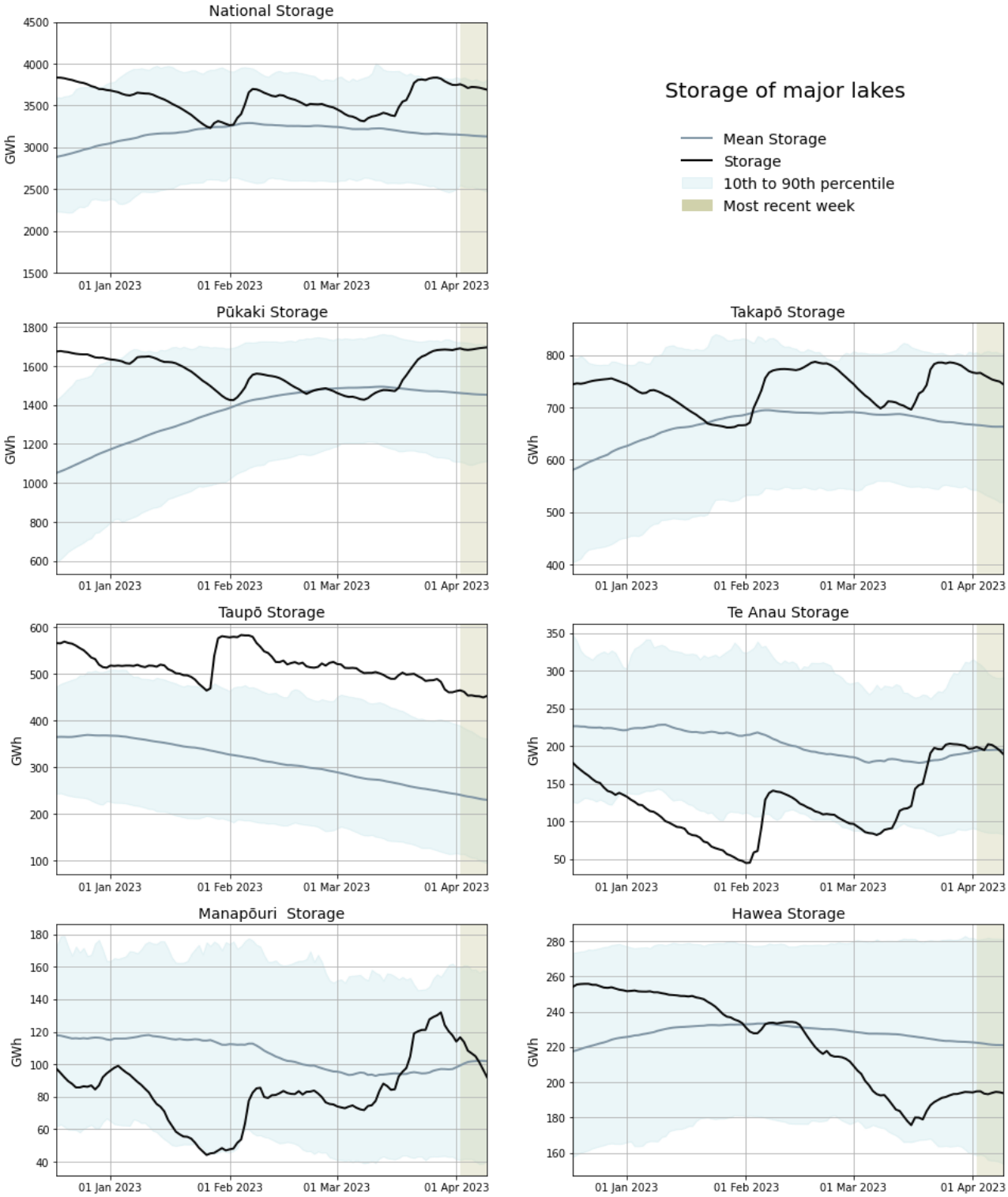
9.1. Figure 14 shows total controlled national hydro storage as well as the storage of major catchment lakes including their historical mean and 10th to 90th percentiles.

9.2. Overall, national hydro storage slightly decreased and by the end of the week touched its 90th percentile. Total national storage is around 90 percent of nominal full as of 9 April.

9.3. Most lakes showed a drop in storage levels except Pūkaki which remains around its historic 90th percentile and Hawea which remained at a steady level below its historic mean.

Taupō's storage has dropped slightly, though it remains above its historic 90th percentile. Manapōuri's storage fell below the historic mean.

Figure 14: Hydro Storage.

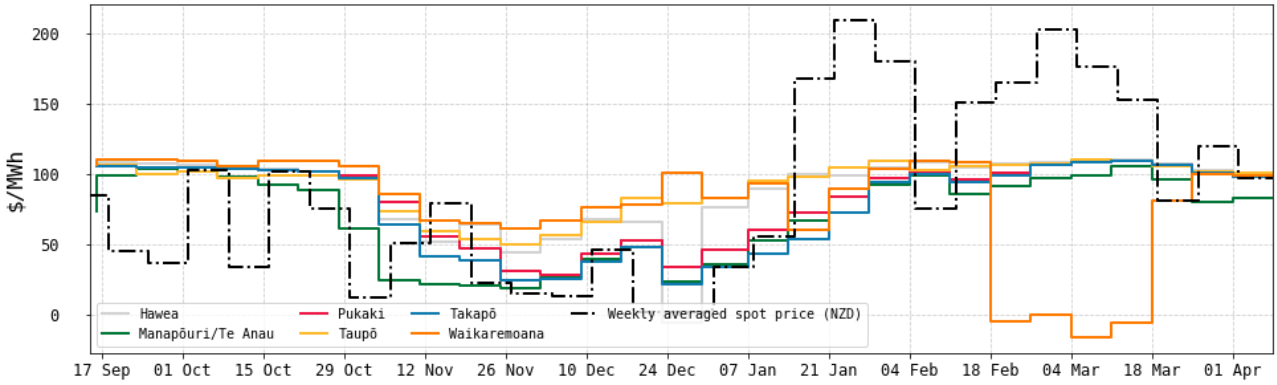


10. JADE Water Values

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 8 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 remain 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 8 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. The decline in prices might be due to the reduction in Carbon prices.

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.

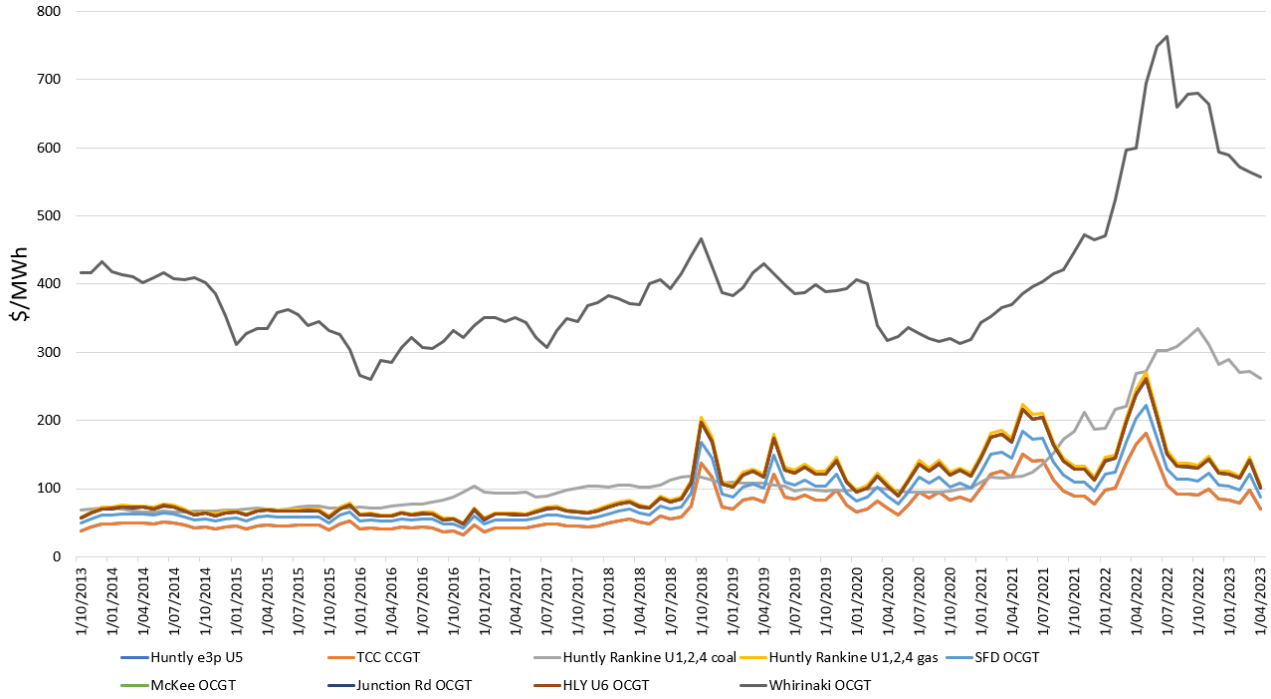
11.6. The SRMC of gas run thermal plants decreased to between $70/MWh and $105/MWh, likely due to a decrease in gas demand.

[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.



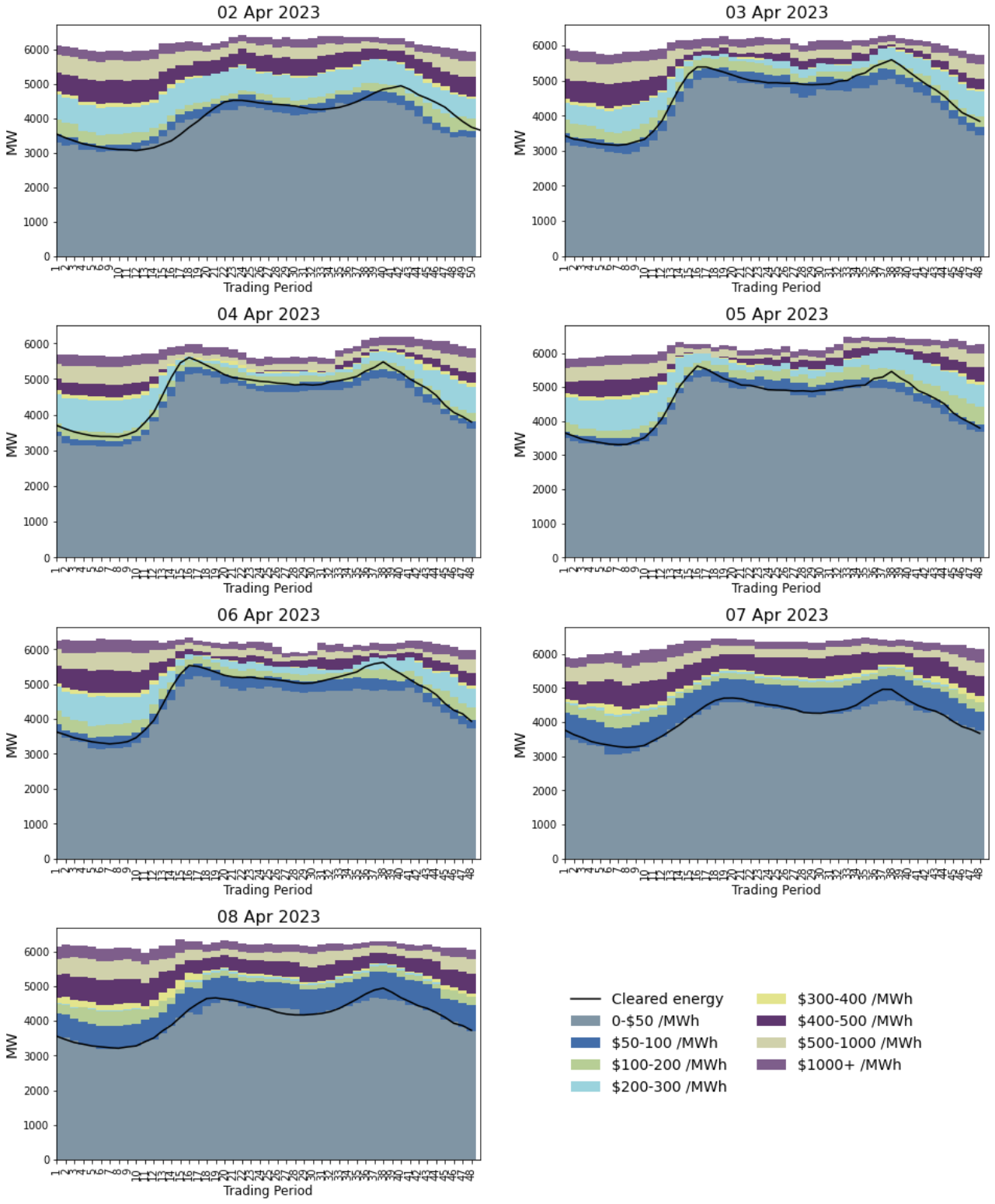
12. Offer Behaviour

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 $50 and $300/MWh. However, on Tuesday morning, there was a less generation offered in these price bands, mostly due to an increase in generation offered below $50/MWh. However, high peak demand say generation clear above $300/MWh.

12.2. On Friday and Saturday due to the Easter holidays, more energy was offered at $50-$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.
21/3/2023	33	Further analysis	The Authority will continue analysis into the high energy and reserve prices.
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.
31/3/2023	17,18	Further analysis	The Authority will continue analysis into the high energy and reserve prices.