Date: 29 May 2023

TRADING CONDUCT REPORT

Market Monitoring Weekly Report

TRADING CONDUCT REPORT

1. Overview for week of 21 – 27 May 2023

1.1. Price volatility remained high this week, with low off-peak prices due to increased hydro storage and generation, but significant price spikes occurred during peak times when additional thermal generation was necessary to meet demand. On Monday and Thursday, prices exceeded the 90th percentile, primarily driven by high peak demand and a reserve deficit. Prices were also higher on Tuesday, likely due to low temperatures and low wind generation.

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. Prices above the historic 90th percentile are highlighted with a black line. Other notable prices, but which did not breach the 90th percentile, are marked in black dashed lines (if any).

2.2. Between 21 – 27 May 2023:

(a) The average wholesale spot price across all nodes was $29/MWh.

(b) 95 percent of prices fell between $0/MWh and $209/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. Prices continue to be volatile, similar to the past two weeks with prices both below the 10th percentile and above the 90th percentile. Most prices fell below the historic average (around $50/MWh), with the average spot price decreasing by $26/MWh compared to the previous week. However, there were significant price spikes.

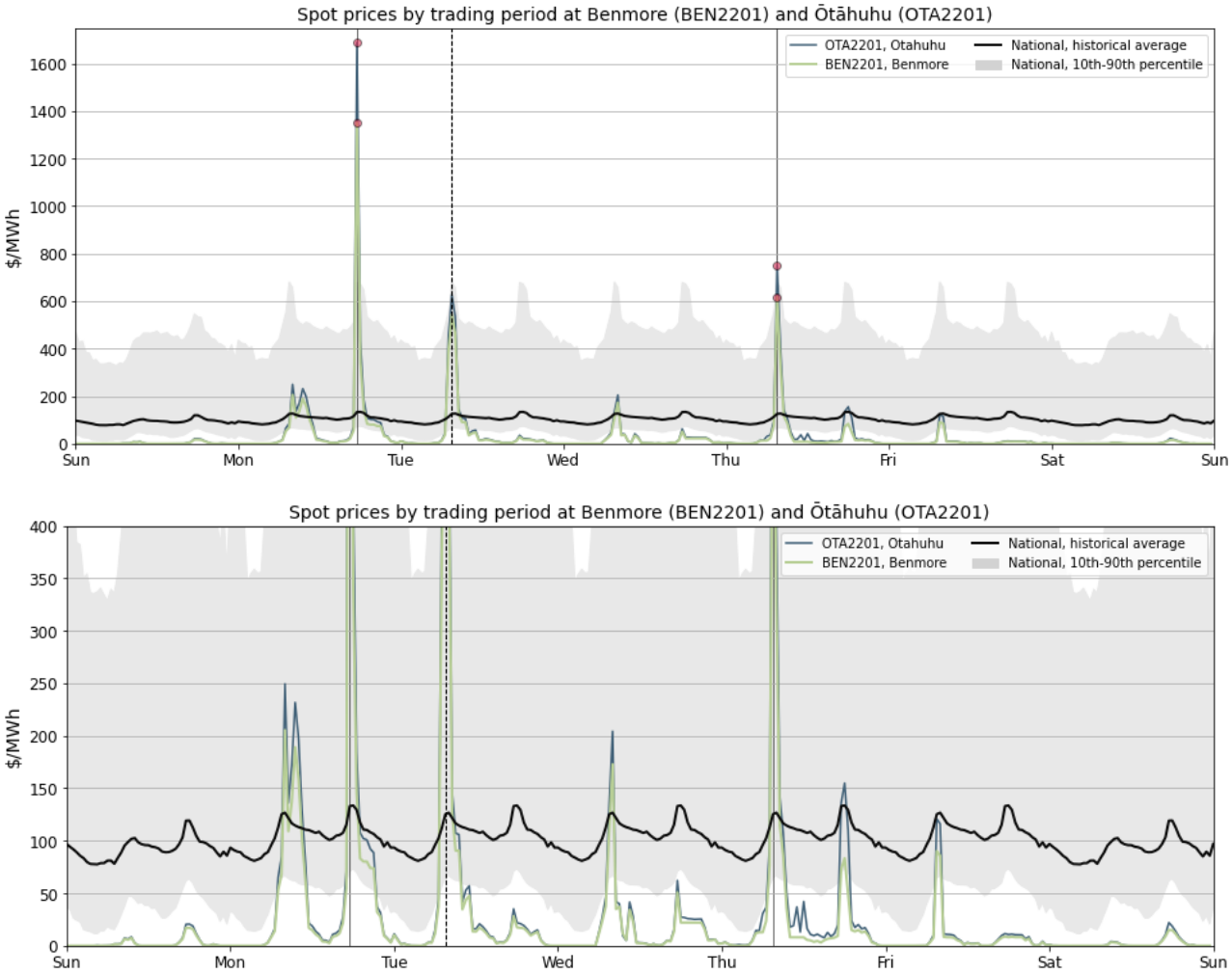
2.5. On Monday, 22 May 2023 at 5:30 pm a price spike above the historic 90th percentile was observed due to a shortfall which resulted in reserve scarcity pricing, with a 5-min Sustained instantaneous reserve (SIR) price reaching $3000/MWh. This gave prices of $1,694/MWh at Ōtāhuhu and $1,351/MWh at Benmore with SIR prices of $373/MWh for the North Island and $341/MWh for the South Island. The actual wind generation fell short of the forecasted values and remained below 200 MW.

2.6. Other price spikes below the 90th percentile on Tuesday, 23 May 2023 during the morning peak time between 7:00 am and 8:00 am with maximum prices of $627/MWh at Ōtāhuhu and $544/MWh at Benmore with Fast instantaneous reserve (FIR) prices of $394/MWh for the North Island and $297/MWh for the South Island. On Tuesday morning the demand was high due to low temperatures (Christchurch was around zero degrees) and wind generation was around 200 MW.

2.7. On Thursday, 25 May a price spike above the 90th percentile occurred during the morning peak at 7:30 am with prices of $752/MWh at Ōtāhuhu and $618/MWh at Benmore. The prices this day were likely due to lower wind generation (below 100 MW) with more peakers running to cover the morning peak demand.

2.8. During Sunday, Wednesday, Friday and Saturday, prices were mostly below the 10th percentile for most of the day due to high hydro storage, with spilling at lakes Pūkaki, and Manapōuri. Additionally, wind generation was also significant during these specific days.

Figure 1: Wholesale Spot Prices between 21 May (Sunday) – 27 May (Saturday) 2023.



2.9. Figure 2a 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. Figure 2b shows this week's volatility.

2.10. This week, the median was lower when compared to the week before with more outliers due to price spikes. The price decrease was driven by relatively high hydro generation. Prices were lower than prices in March and April, due to increased hydro generation as lake levels have recovered.

[1] Quartile - Wikipedia

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

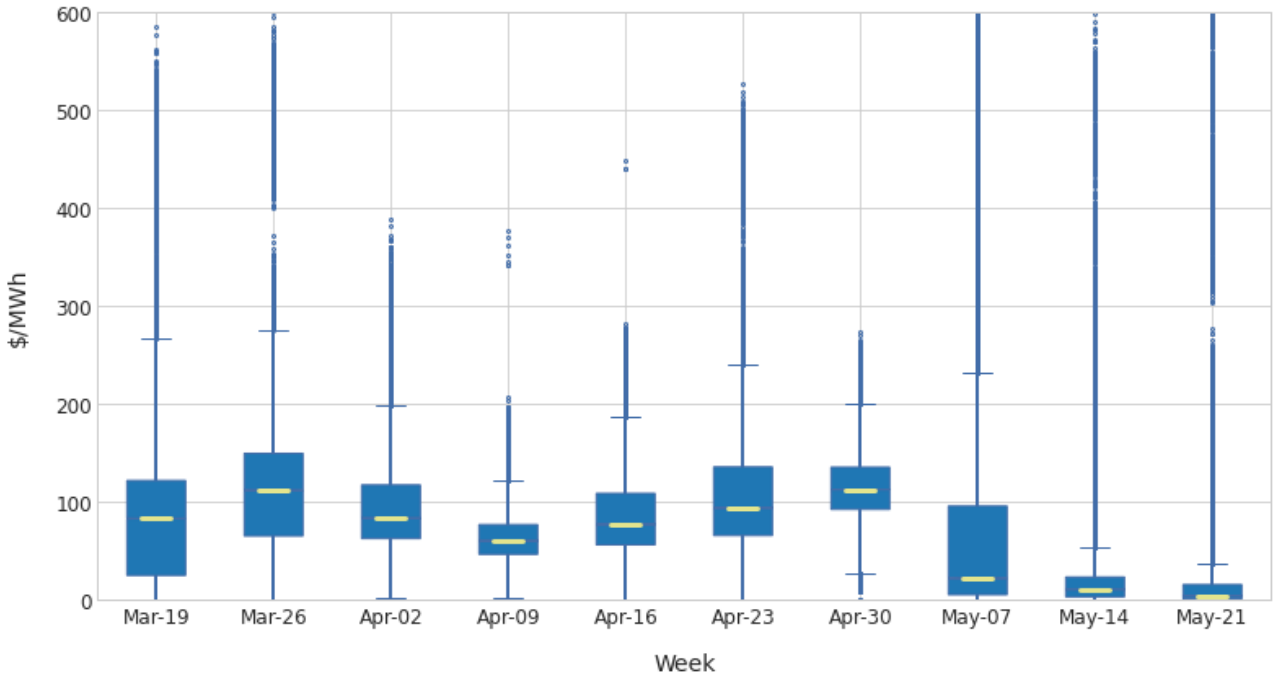
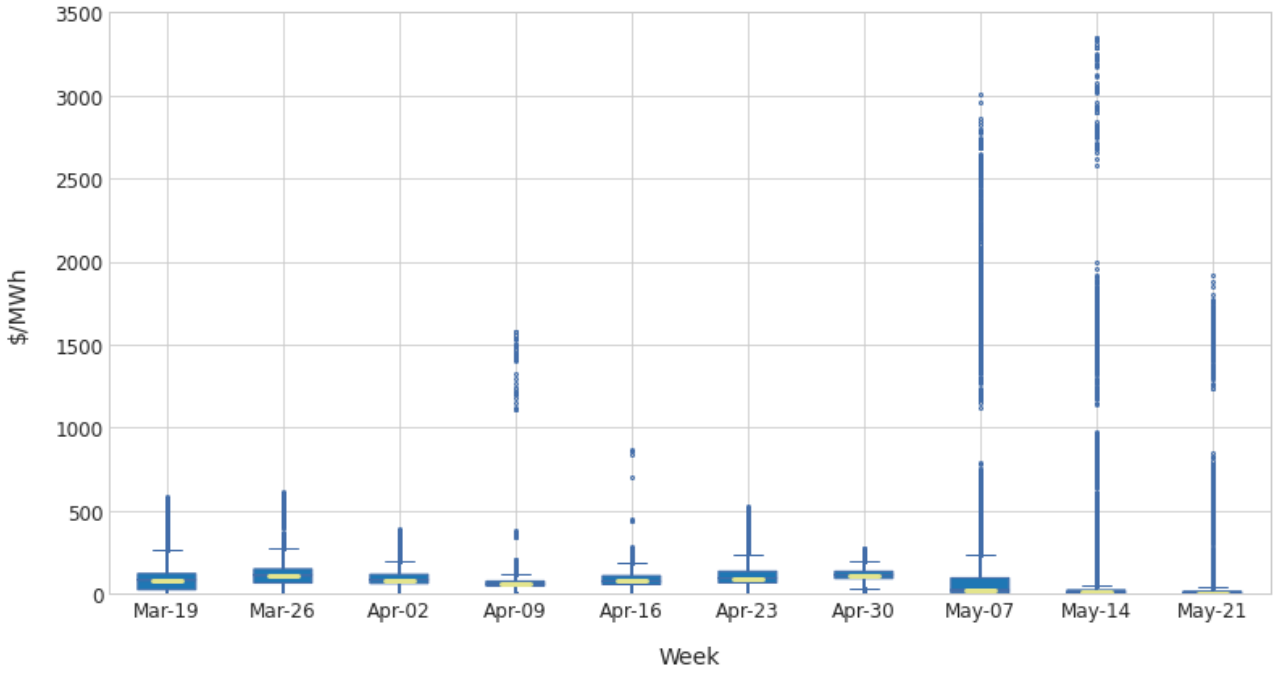


Figure 2b: Boxplots showing the volatility in spot prices this week compared to the previous nine weeks.

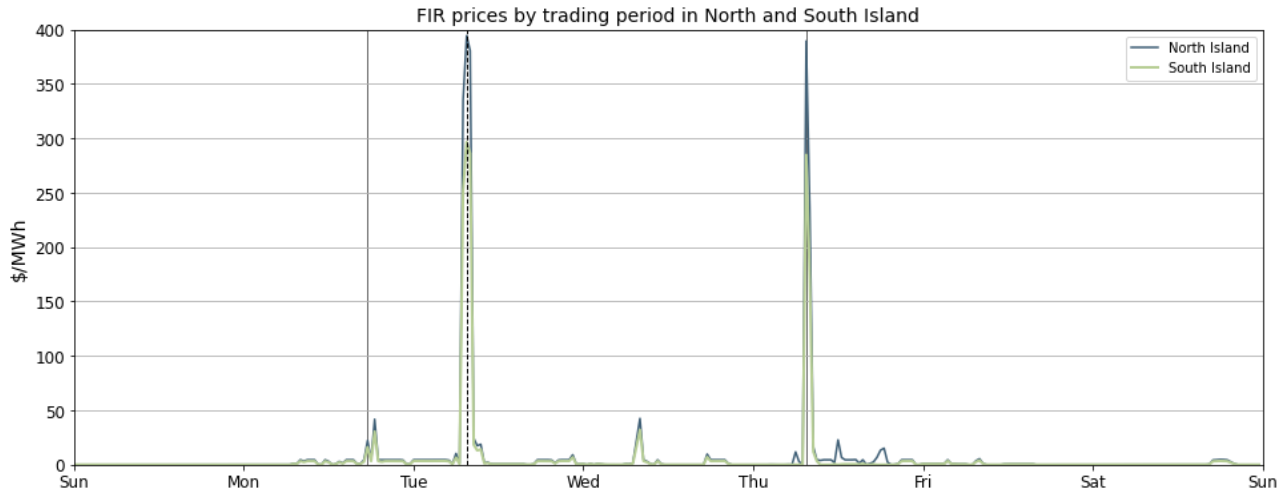


3. Reserve Prices

3.1. FIR prices for the North and South Islands are shown below in Figure 3. This week the FIR prices were mostly below $20/MWh for both islands with a significant price spike on Tuesday 23 May between 7:00 am and 8:00 am, and Thursday 25 May at 7:30 pm during the morning peaks. The high FIR prices were in line with significant spot price spikes caused by a shortage of reserves. These spikes were primarily attributed to a relatively high demand coupled with limited wind generation. During this period, prices in the North Island

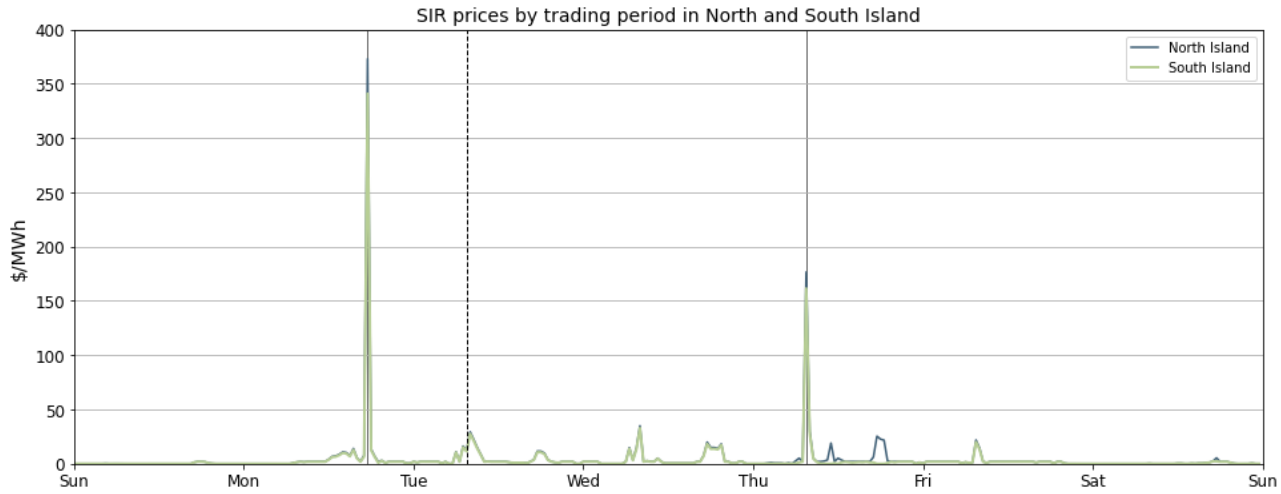
reached to as high as $394/MWh, while the South Island experienced prices of up to $297/MWh.

Figure 3: FIR prices by trading period and Island.



3.2. SIR prices for the North and South Islands are shown in Figure 4. SIR prices were mostly below $10/MWh this week, however, there were two significant price spikes on Monday 22 May, and on Thursday 25 May. All price spikes coincided with high energy prices, indicating reserve shortfall. The highest reserve pricing occurred on Monday, 22 May at 5:30 pm with North Island SIR prices of $373/MWh and South Island SIR prices of $341/MWh.

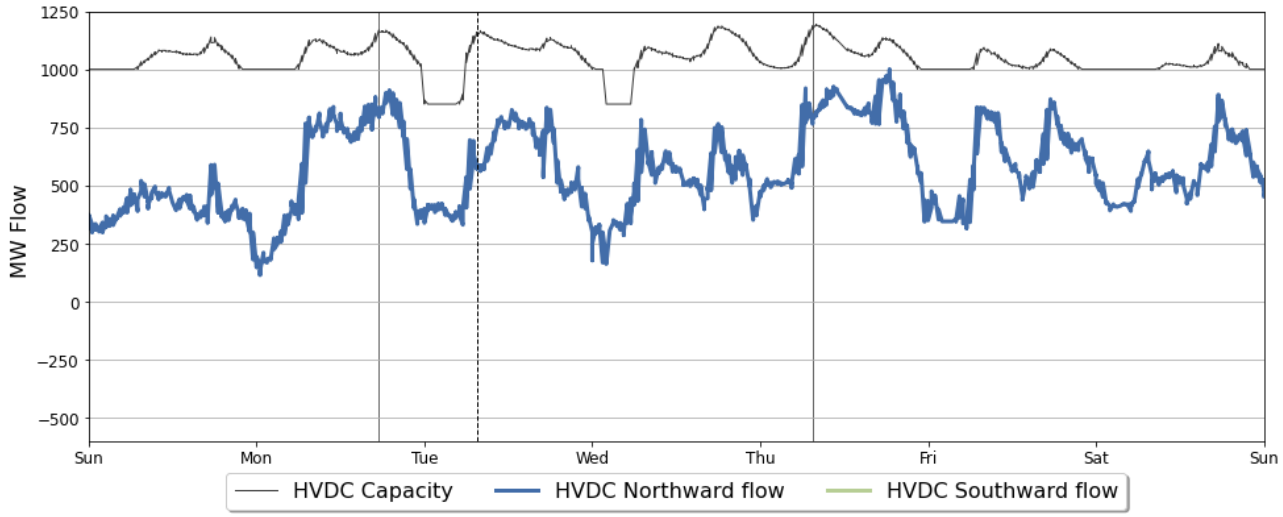
Figure 4: SIR prices by trading period and Island.



4. HVDC

4.1. Figure 5 shows HVDC flow between 21 – 27 May. HVDC flows were northward during both daytime and night-time, reaching up to 1000 MW during the daytime. Northward flows were particularly high on Monday and Thursday when demand was high and wind generation was low. This week, no southward HVDC flow was observed.

Figure 5: HVDC northward flow and capacity.

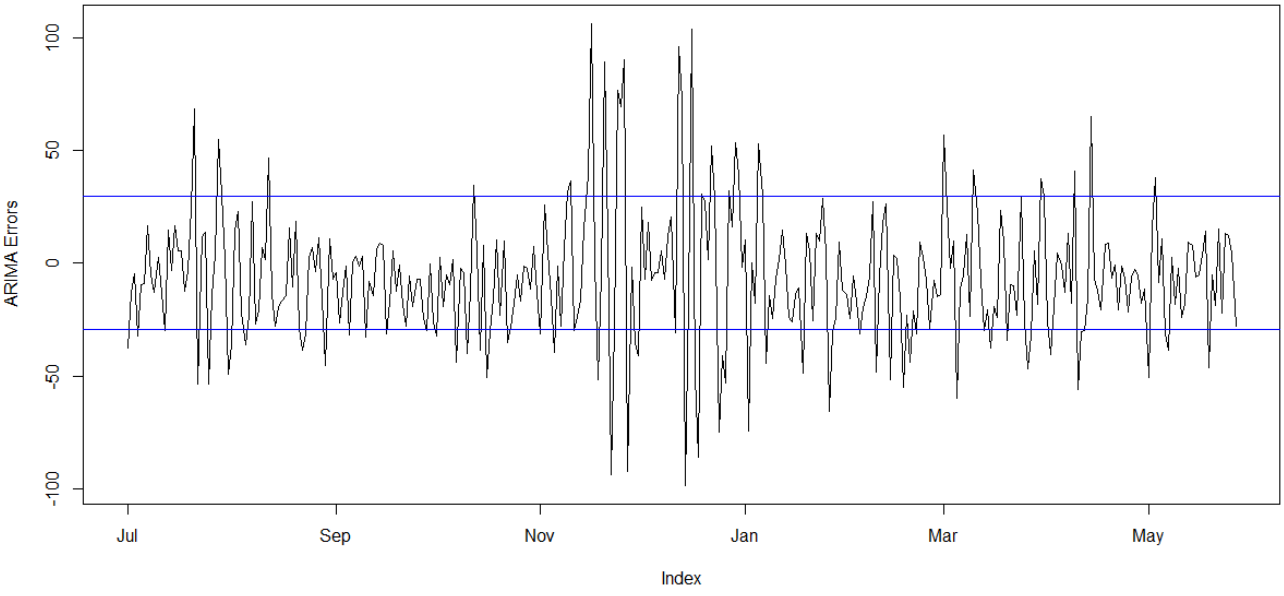


5. Regression Residuals

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 average daily prices on those dates appear to be largely aligned with market conditions. Despite the price spikes this week, there were no residuals above or below the one standard deviation of the data as the daily average prices were relatively low.

Figure 6: Residual plot of estimated daily average spot prices from 1 July 2022 – 27 May 2023. The blue lines show two standard deviations of the ARMA errors.

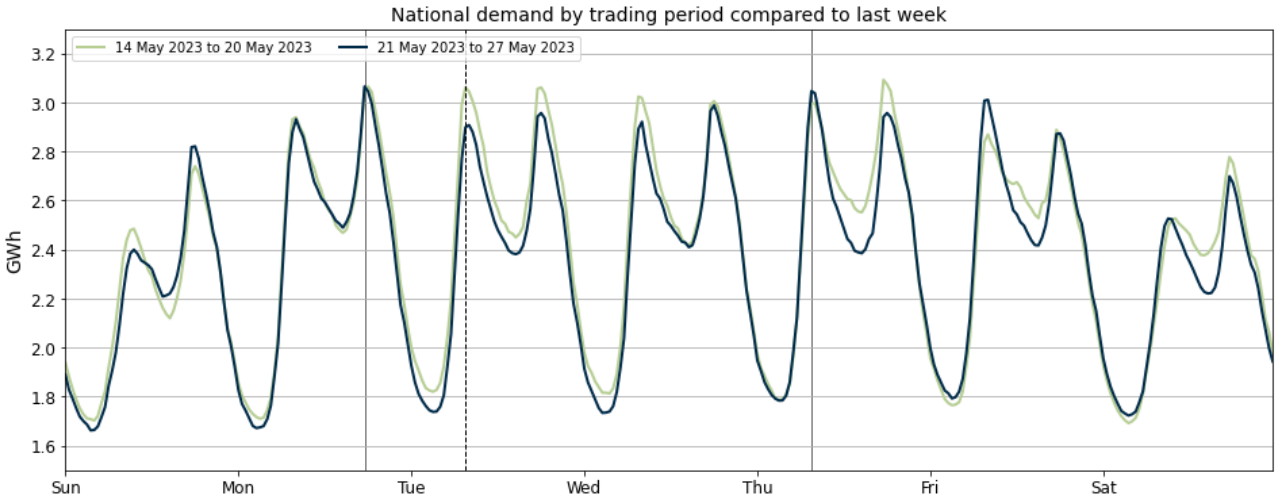


[2] Appendix_A_Regression_analysis_V500y1B.pdf (ea.govt.nz)

6. Demand

6.1. Figure 7 shows national grid demand between 21 – 27 May, compared to the previous week. Overall, demand was similar this week compared to the previous week, with relatively lower peak demand between Tuesday and Thursday.

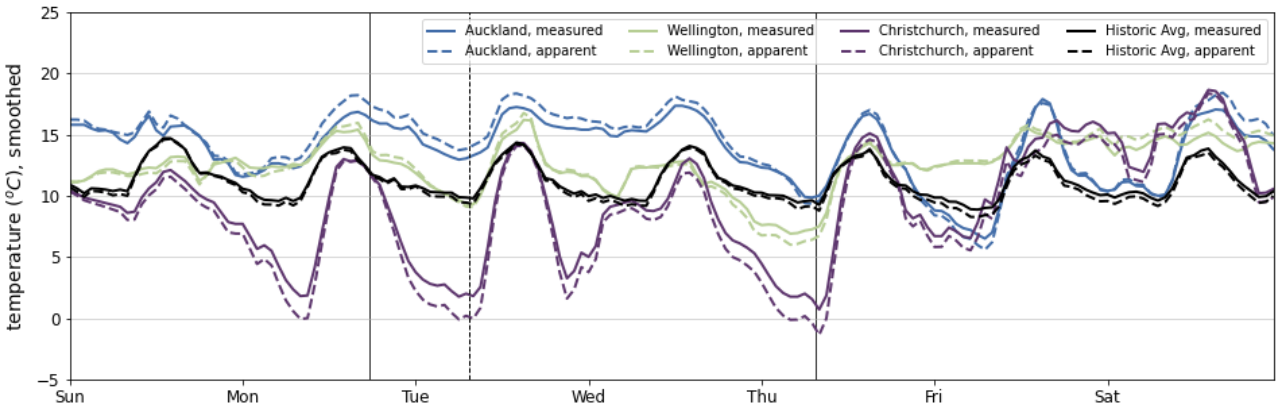
Figure 7: National demand by trading period compared to the previous week.



6.2. Figure 8 shows hourly temperatures at the three main population centres between 21 – 27 May. 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. At the beginning of the week, temperatures in Auckland, and Wellington were above or close to the historic average, ranging from 10 to 20 degrees. Auckland temperatures were above average except on Friday. However, Christchurch experienced the greatest variation, with apparent temperatures dropping to around zero degrees from Monday to Thursday, however, at the end of the week hovering around the historic mean.

Figure 8: Temperatures across main centres.



7. Outages

7.1. Figure 9 shows generation capacity on outage. Total capacity on outage between 21 – 27 May ranged between ~1,100 – 1,400 MW.

7.2. Notable outages include:

(a) Huntly 1 is on outage until 31 May.

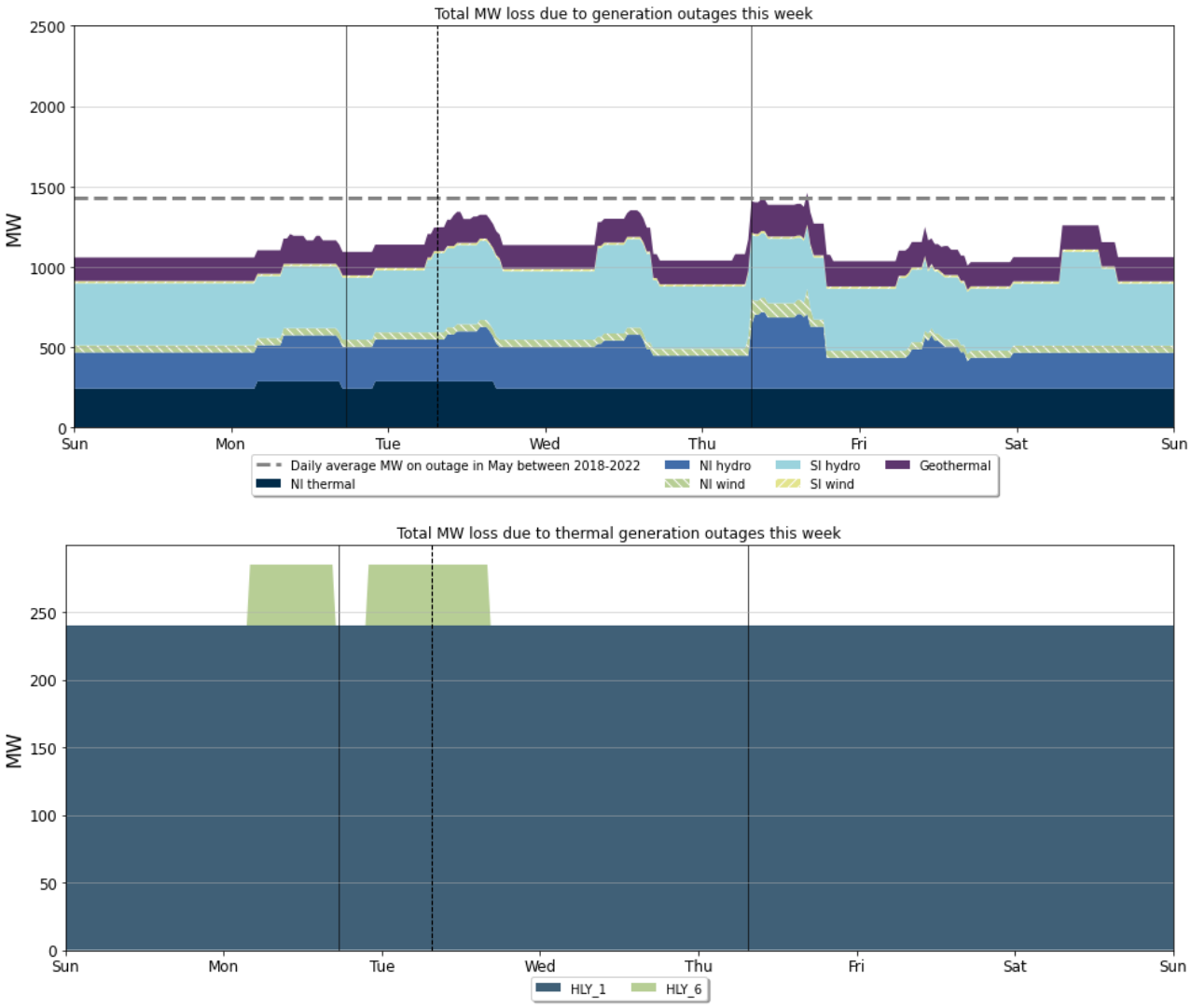
(b) Huntly 6 was on short outage on Monday and Tuesday.

(c) The Geothermal plant Kawerau extend outage until 8 June.

(d) West wind partly on outage until 30 May 2023 (changed from 24 November).

(e) Various North and South Island hydro units were on outage this week.

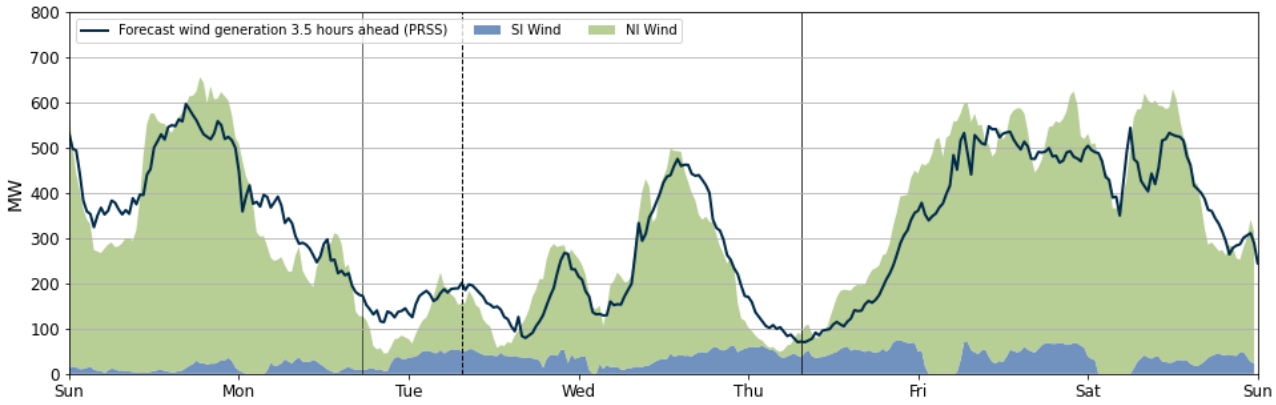
Figure 9: Total MW loss due to generation outages.



8. Generation

8.1. Wind generation, between 21 – 27 May, varied between 45-650 MW (Figure 10). Wind generation was around 630 MW at the start of the week and dropped to around 50 MW between Monday and Tuesday, West Wind farm was also partly on outage which also contributed to low generation. Subsequently, wind increased steadily, peaking at 500 MW on Wednesday. Wind peaked on Saturday and reached up to 600 MW.

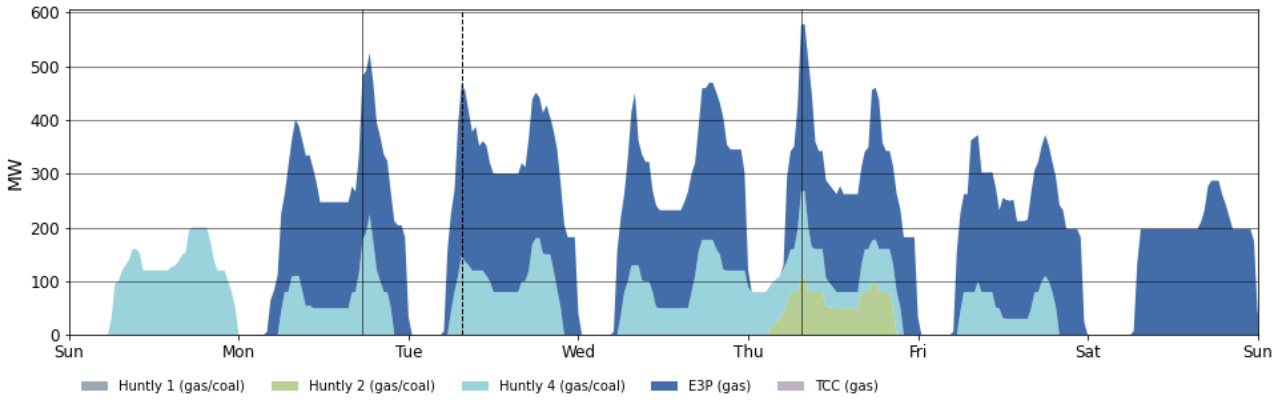
Figure 10: Wind Generation and forecast.

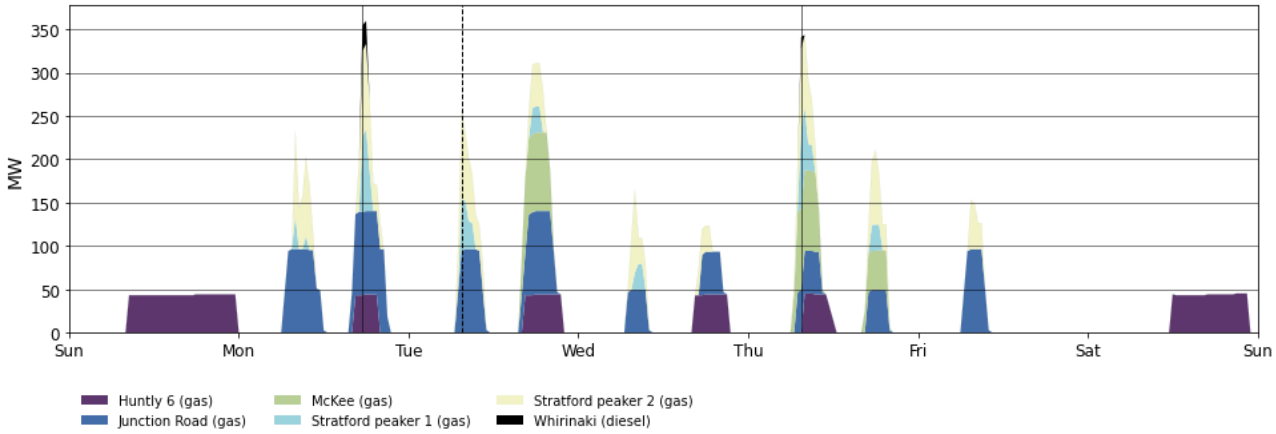


8.2. Figure 11 shows generation of thermal baseload and thermal peaker plants between 21 – 27 May. E3P (Huntly 5) ran from Monday through to Saturday as baseload but did not run continuously through the night. Huntly 4 mainly ran in support over Sunday to Friday, with Huntly 2 running during the peak and shoulder period of Thursday only.

8.3. Huntly 6 ran most days, covering the evening peak on Monday, Tuesday and Wednesday and the morning peak on Thursday. Junction Road and both Stratford peakers ran during both morning and evening peaks from Monday to Thursday. McKee only ran during the Tuesday evening peak and during Thursday's peak periods. Whirinaki was also dispatched during both Tuesday and Thursday peak times that saw the price spikes occurring.

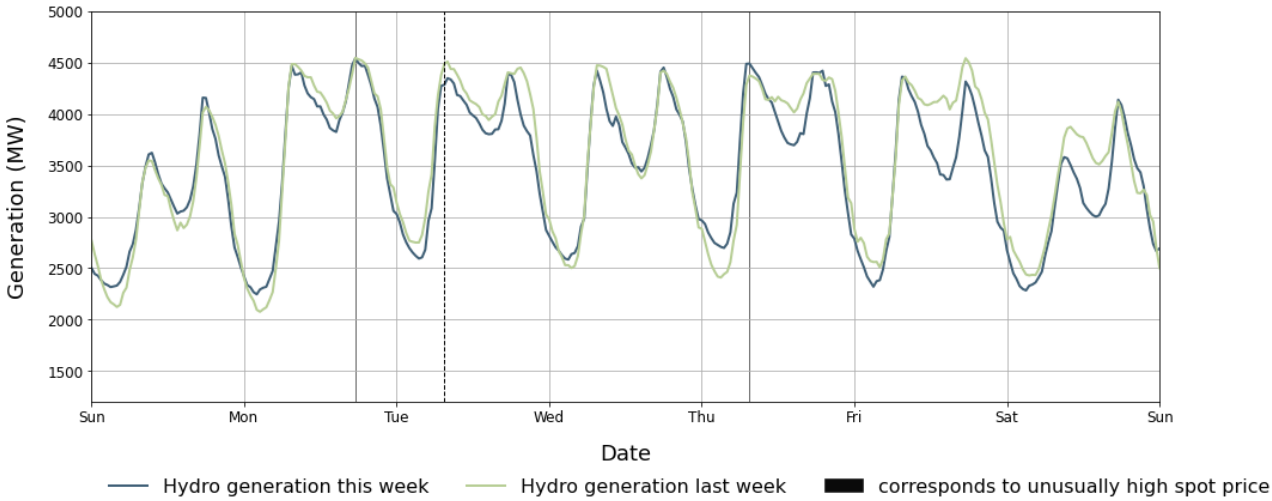
Figure 11: Thermal Generation.





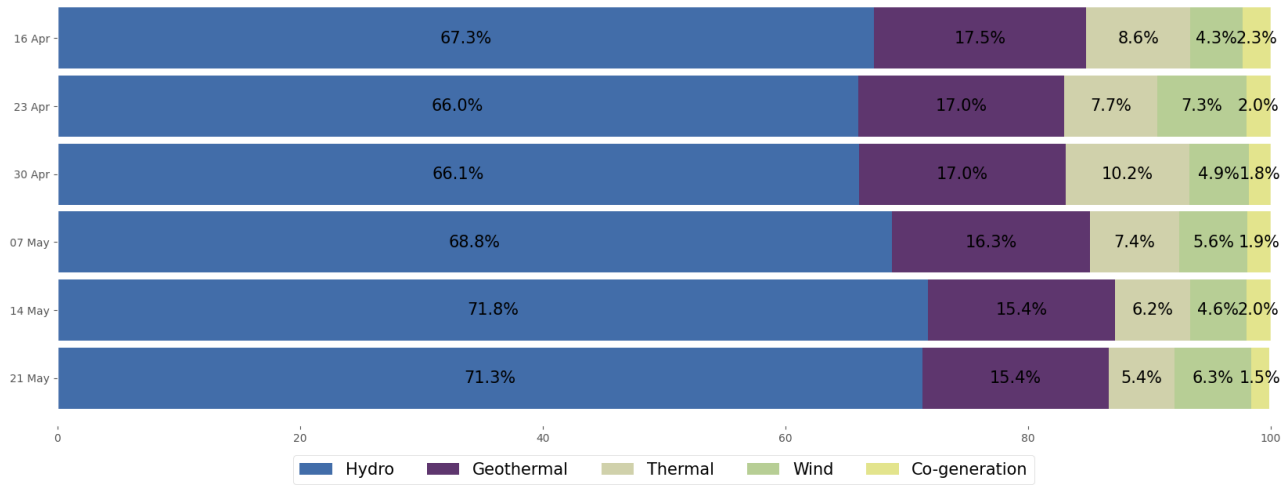
8.4. Figure 12 shows total hydro generation in MW produced each trading period, compared to the same time in the previous week. Hydro generation was similar compared to the previous week, primarily driven by high demand and high lake levels.

Figure 12: Hydro generation between 21 – 27 May compared to the previous week.



8.5. As a percentage of total generation, between 21 – 27 May, total weekly hydro generation totalled 71.3 percent, geothermal 15.4 percent, thermal 5.4 percent, wind 6.3 percent, and co-generation 1.5 percent.

Figure 13: Total generation as a percentage each week between 16 April and 27 May 2023.



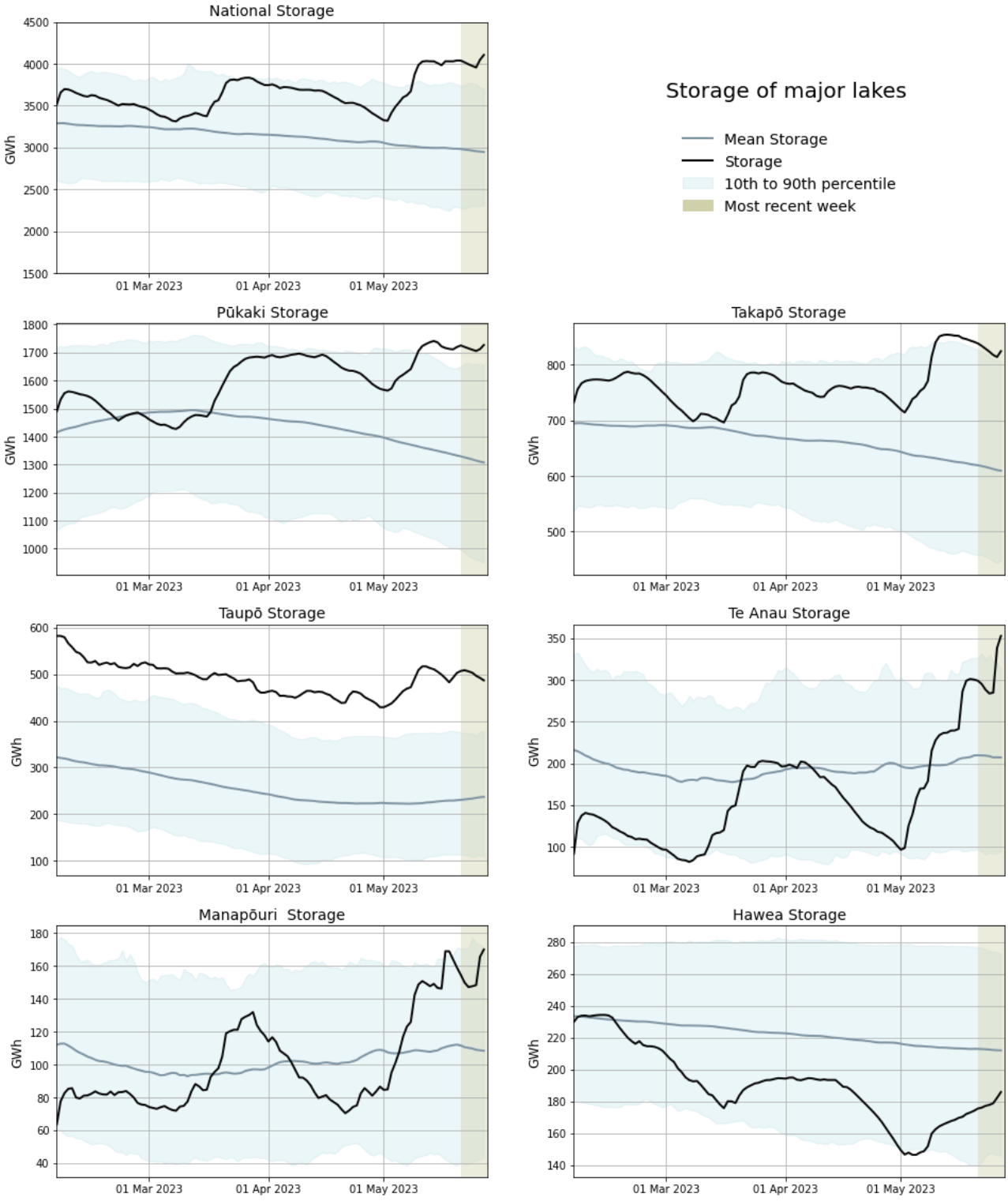
9. Storage/Fuel Supply

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 increased over the week and is well above its historic 90th percentile. Total national storage is around 96.2 percent of nominal full as of 27 May.

9.3. All lakes are showing a significant increase in storage levels. Storage at lakes Pūkaki, Takapō and Taupō are above their respective historic 90th percentile. Lakes Te Anau and Manapōuri storage significantly increased with Lake Manapōuri touching its historic 90th percentile, and Lake Te Anau above its historic 90th percentile. High lake levels resulted in spill at both Lake Pūkaki and Lake Manapōuri. Hawea storage also increased although still below its historic mean.

Figure 14: Hydro Storage.

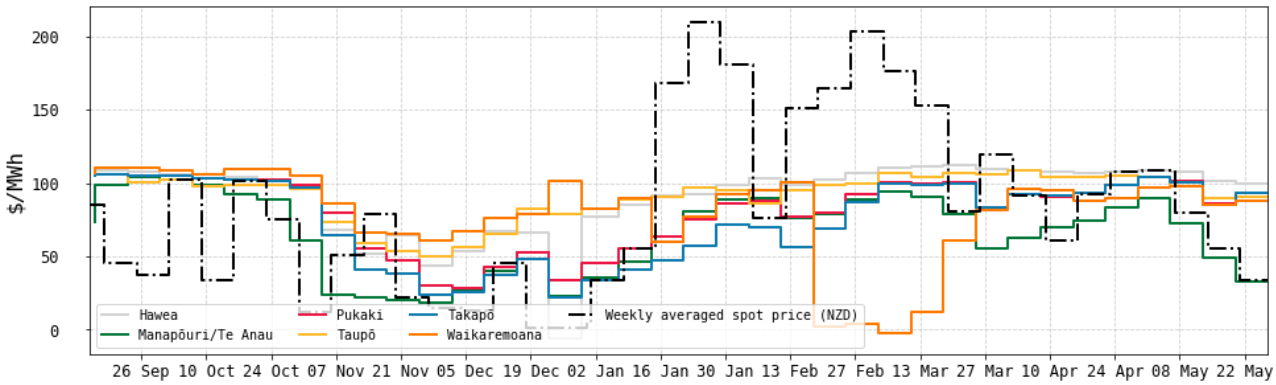


10. JADE Water Values

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 27 May 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. Last week, once again there was a decrease in water values across all lakes, primarily attributed to a significant rise in storage levels. Specifically, the water values at Te Anau and Manapōuri experienced a drastic drop following the recent increase in storage (above the 90th percentile). 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 27 May 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 May 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 ~$542/MWh.

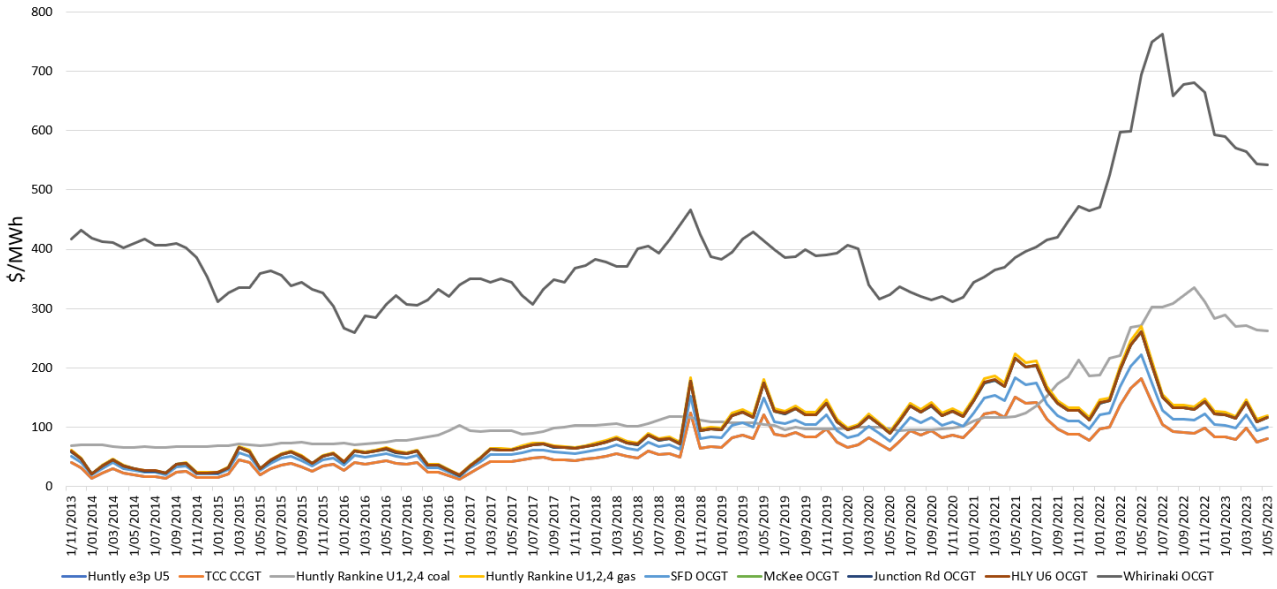
[3] JADE (Just Another DOASA Environment) is an implementation of the Stochastic Dual Dynamic Programming (SDDP) algorithm of Pereira and Pinto. JADE was developed by researchers at the Electric Power Optimisation Centre (EPOC) for the New Zealand electricity market.

[4] Appendix_B_JADE_water_value_model.pdf (ea.govt.nz)

11.6. The SRMC of gas run thermal plants decreased and is between $80/MWh and $120/MWh, likely due to a decrease in gas demand.

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

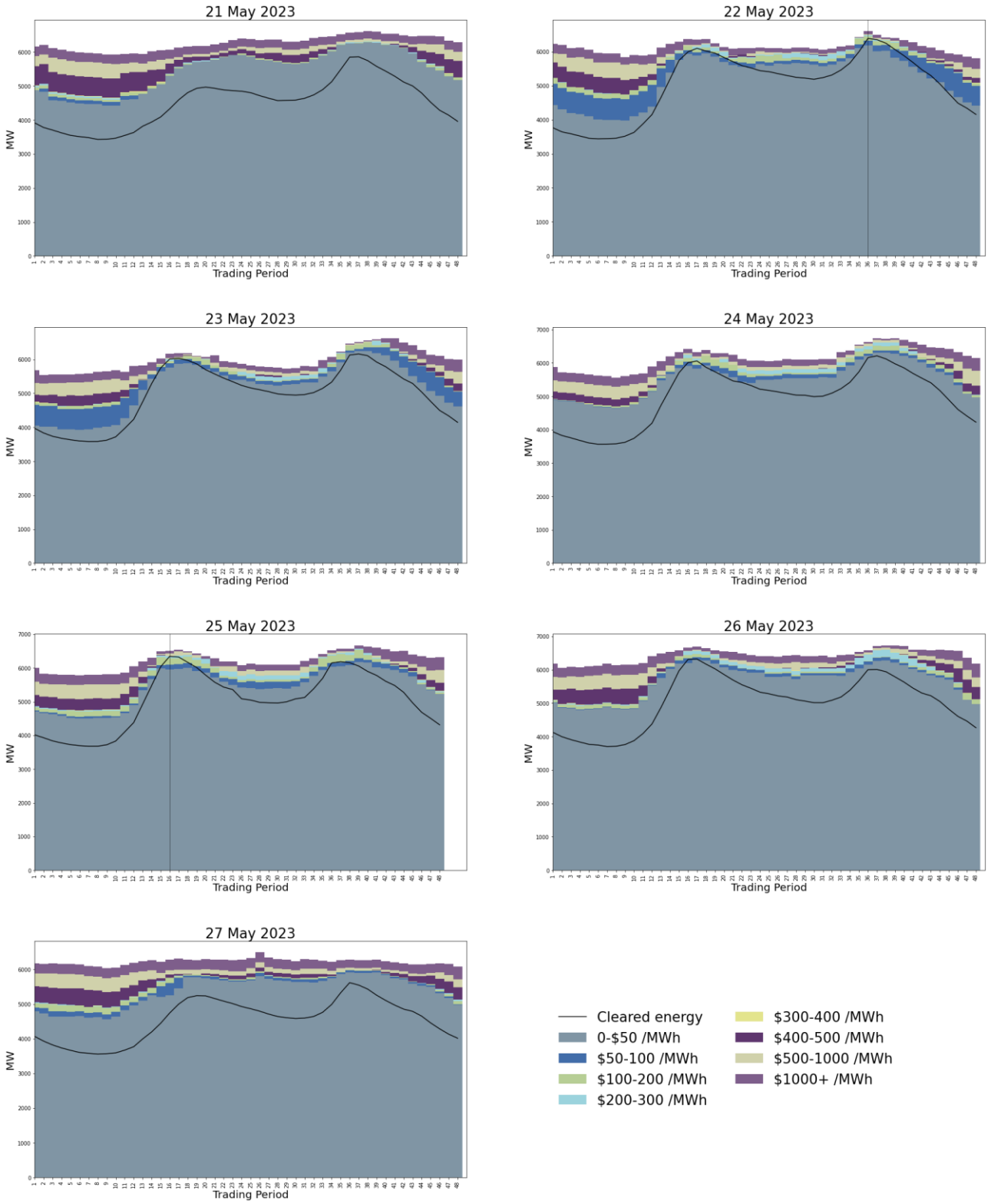
12.1. Figure 17 shows this week's national daily offer stacks. The black line shows cleared energy, indicating the range of the average final price.

12.2. Similar to last week, there was a high quantity of generation offered between $0 and $50/MWh. As a result, the majority of cleared energy fell in this band. There was an increase in offers between $50-100/MWh on Monday and Tuesday, but this thinned as hydro inflows increased from Wednesday.

12.3. The stack remained thin above $100/MWh and as a result when energy cleared was higher than the quantity offered between $0-50/MWh, there were large price spikes. This occurred when demand was high and wind generation was low, such as during Monday, Tuesday and Thursday peaks.

[5] Appendix_C_Calculating_thermal_SRMC_o2b3l0j.pdf (ea.govt.nz)

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. However, there appear to be offer changes/market conditions which may have resulted in instances of higher prices. These are being further looked into.

13.2. 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	Participant	Location	Enquiry Topic
07/10/2022	15-16	Further analysis	Genesis	Huntly 5	Prices change for final energy tranche.
15/1/2023 4/2/2023	Several	Further analysis	N.A	Multiple	High energy prices associated with high hydro offers.
17/4/2023	48	Further analysis	Contact	Clyde and Roxburgh.	Offer changes.
19/4/2023	27	Further analysis	Contact	Clyde and Roxburgh.	Offer changes.
11/5/2023	37-40	Further analysis	Genesis	Huntly 4	Offer changes.
15/5/2023	36-37	Further Analysis	Genesis	Huntly 2,4,5	Offer changes.
18/05/2023	Several	Further Analysis	N.A	Multiple	Market conditions which led to higher off-peak prices
22/05/2023	36	Further Analysis	System Operator	McKee	Grid configuration which resulted in McKee not being dispatched