6 May 2024

Trading conduct report

Market monitoring weekly report

Trading conduct report

1. Overview for the week of 28 April-4 May

1.1. Prices were above the historical median this week and were mostly between $200-$300/MWh. Between Monday and Friday, four price spikes occurred during periods of peak demand and low wind generation. The highest demand of the year so far occurred on Friday morning. Huntly 4, Huntly 5 and then Huntly 2 ran to provide baseload generation. Junction Road and Stratford 1 ran to support baseload while McKee ran during times of high demand. Hydro and thermal generation ramped up this week as wind generation was low, and demand increased. Hydro storage decreased slightly this week and is currently at its historical average level, as of 4 May.

2. Spot prices

2.1. This report monitors underlying wholesale price drivers to assess whether trading periods require further analysis to identify 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 are outliers compared to historic prices for the same time of year.

2.2. Between 28 April-4 May:

(a) the average wholesale spot price across all nodes was $241/MWh.

(b) 95% of prices fell between $157/MWh and $302/MWh.

2.3. This week, all spot prices were above the national historical median and were mostly between $200-$300/MWh. The average price increased by $27/MWh compared to the previous week.

2.4. There were four price spikes this week: on Monday at 7:30am, then on Wednesday and Thursday, both at 5:30pm, and on Friday at 7:30am.

2.5. The Ōtāhuhu spot price reached a maximum of $572/MWh on Monday morning when high demand and low wind generation required more expensive hydro and thermal generation to be dispatched.

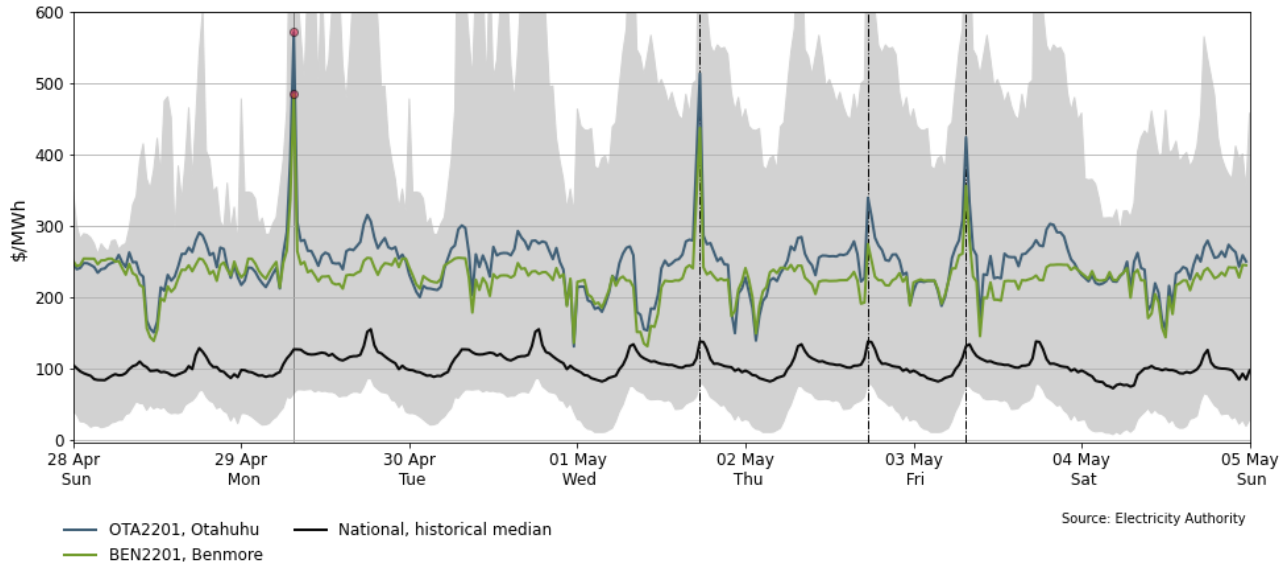
2.6. Prices spiked above $400/MWh again during the Wednesday afternoon and Friday morning peak demand periods. Wind generation was under forecast by more than 100MW at the time of Wednesday's high prices, and the price spike on Friday coincided with the highest demand of the year so far.

2.7. Figure 1 shows the wholesale spot prices at Benmore and Ōtāhuhu alongside the national historic median and historic 10th-90th percentiles adjusted for inflation. Prices greater than quartile 3 (75th percentile) plus 1.5 times the inter-quartile range[1] of historic prices are

[1] We are identifying any significantly high prices by using the historic distribution of prices depending on whether it is a weekday or weekend day and looking for prices that lie 1.5 times the interquartile range above the 75th percentile of the distribution. This is using the outlier calculation Q_3+1.5×IQR, where Q_3 is the 75th percentile (or third quartile value) and IQR is your inter-quartile range.

highlighted with a vertical black line. Other notable prices are marked with black dashed lines.

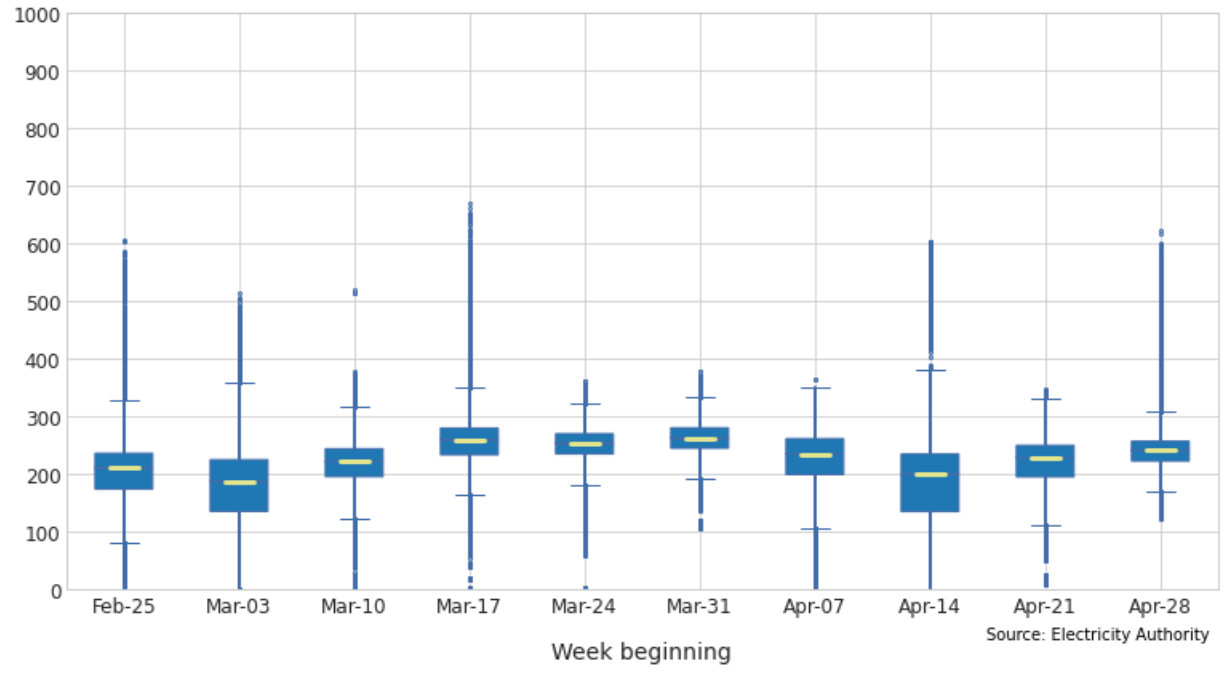
Figure 1: Wholesale spot prices at Benmore and Ōtāhuhu between 28 April-4 May



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

2.9. The spot price distribution was more condensed this week due to a decrease in hydro storage, lower wind generation and higher thermal commitment. This week's median price was $241/MWh, compared to $226/MWh in the previous week, a $15/MWh increase. The middle 50% of the prices were between $222-$257/MWh.

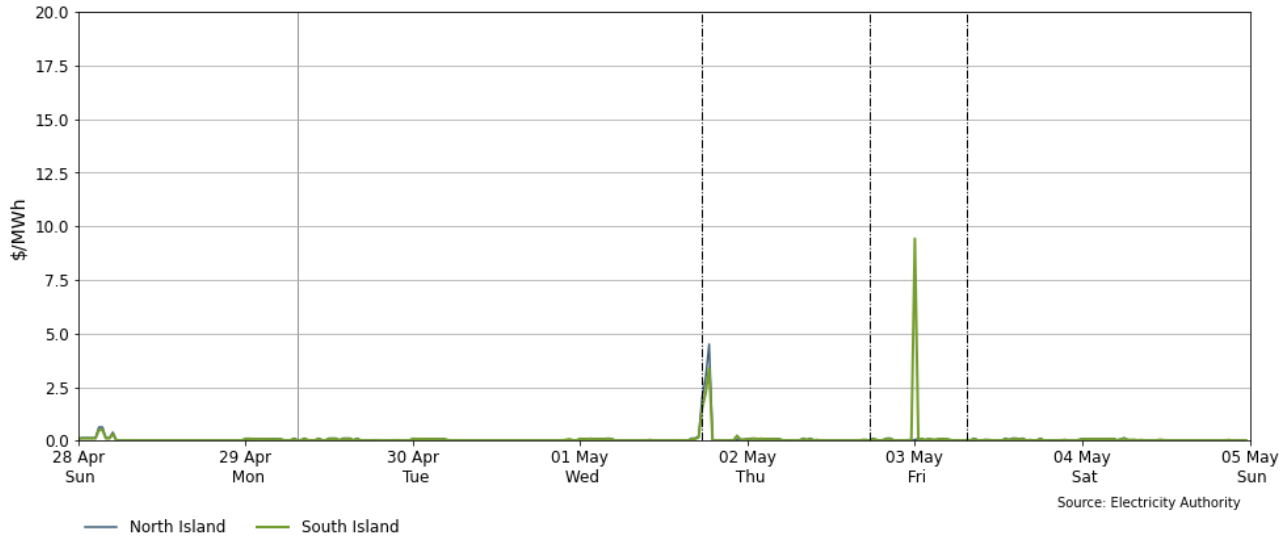
Figure 2: Boxplots showing the distribution of spot prices this week and the previous nine weeks



3. Reserve prices

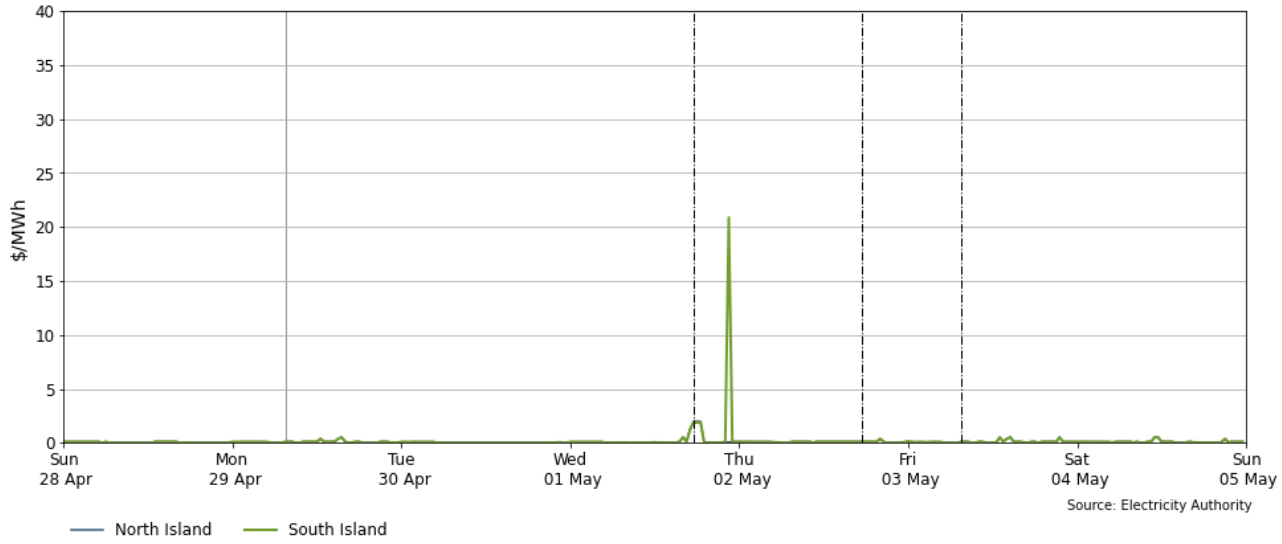
3.1. Fast Instantaneous Reserve (FIR) prices for the North and South Islands are shown below in Figure 3. FIR prices were all below $10/MWh this week. There were only two FIR price spikes this week. The most noticeable one occurred on Friday at midnight, when HVDC was reversing its flow.

Figure 3: Fast Instantaneous Reserve (FIR) price by trading period and island between 28 April-4 May



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 except for one trading period on Wednesday, close to when the HVDC was reversing its flow.

Figure 4: Sustained Instantaneous Reserve (SIR) by trading period and island between 28 April-4 May



4. Regression residuals

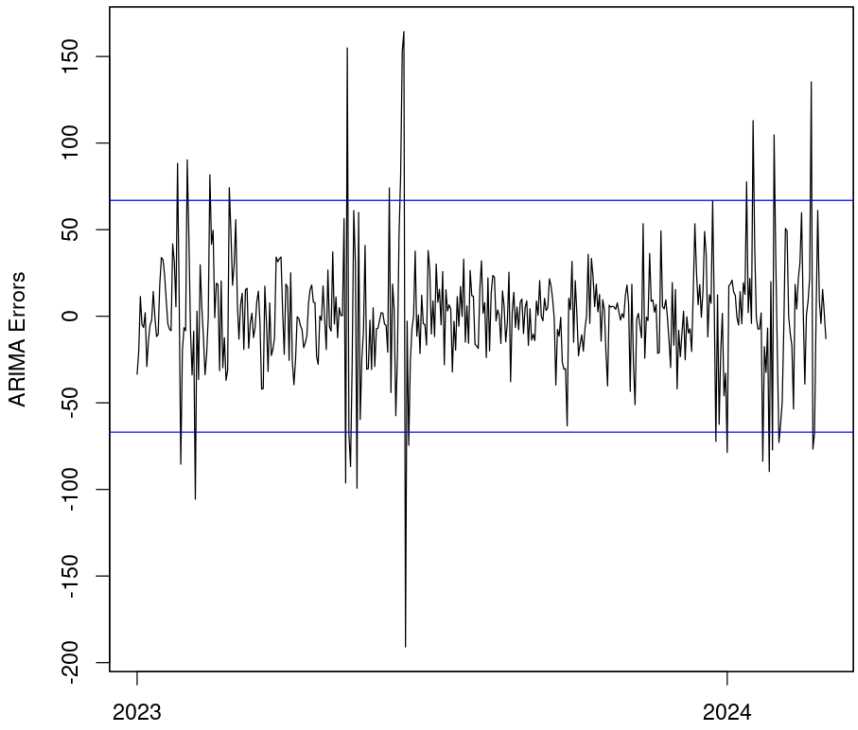
4.1. The Authority's monitoring team uses a regression model to model spot price. The residuals show how close the predicted prices were to actual prices. Large residuals may indicate that prices do not reflect underlying supply and demand conditions. Details on the

regression model and residuals can be found in Appendix A on the trading conduct webpage.

4.2. Figure 5 shows the residuals of autoregressive moving average (ARMA) errors from the daily model. Positive residuals indicate that the modelled daily price is lower than the actual average daily price and vice versa. When residuals are small this indicates that average daily prices are likely largely aligned with market conditions. These small deviations reflect market variations that may not be controlled for in the regression analysis.

4.3. This week, there were no residuals above or below two standard deviations of the data, indicating that the actual and modelled prices were similar.

Figure 5: Residual plot of estimated daily average spit prices from 1 January 2023 to 4 May 2024

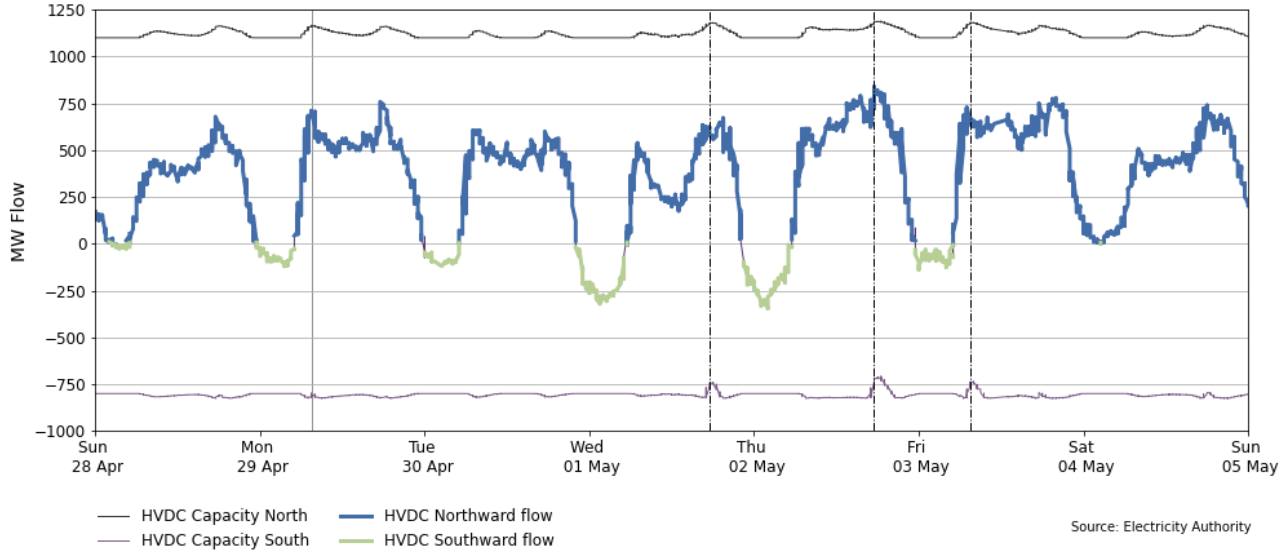


Source: Electricity Authority/see Appendix A

5. HVDC

5.1. Figure 6 shows the HVDC flow between 28 April-4 May. HVDC was mostly flowing northward this week due to relatively low wind generation. Overnight southward flow occurred between Sunday and Friday, with higher southward flows on Wednesday and Thursday due to increased wind generation during those days.

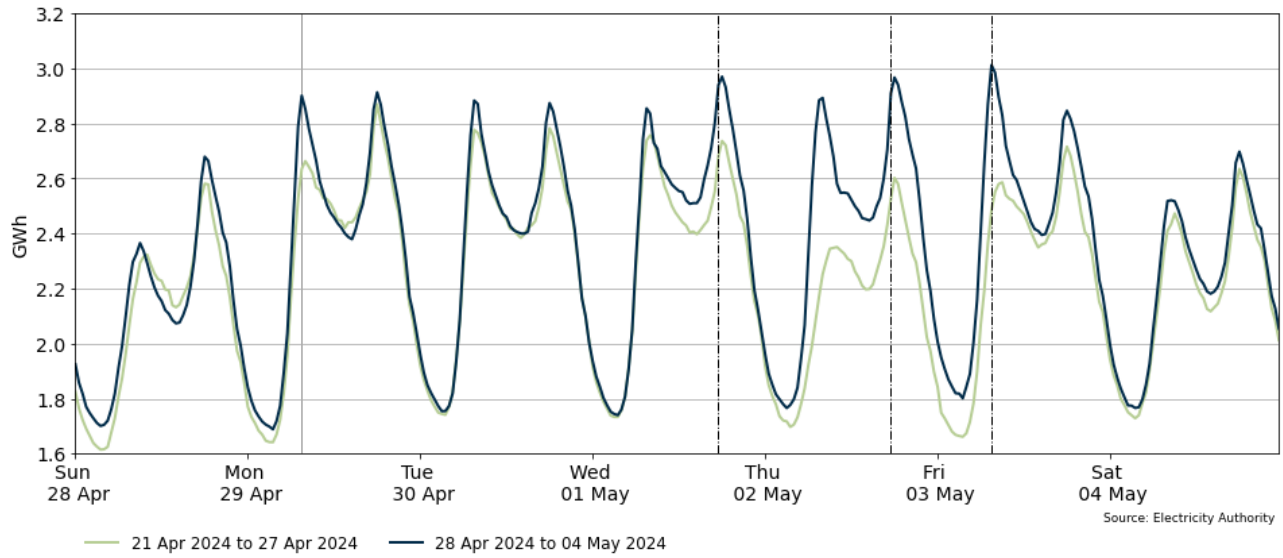
Figure 6: HVDC flow and capacity between 28 April-4 May



6. Demand

6.1. Figure 7 shows national demand between 28 April-4 May compared to the previous week. Demand was higher this week compared to the previous week with this year's highest demand on record, 3.01GWh, occurring Friday. Demand between Wednesday afternoon and Friday morning was considerably higher than the previous week, likely because of the ANZAC Day holiday.

Figure 7: National demand between 28 April-4 May compared to the previous week

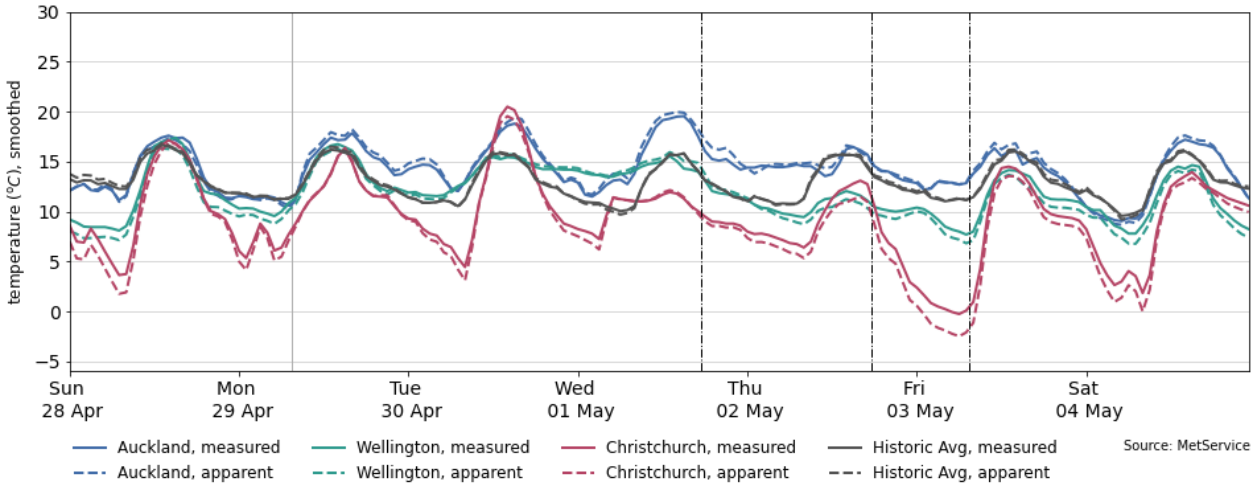


6.2. Figure 8 shows the hourly temperature at main population centres from 28 April-4 May. The measured temperature is the recorded temperature, while the apparent temperature adjusts for factors like wind speed and humidity to estimate how cold it feels. Also included for reference is the mean historical temperature of similar weeks, from previous years, averaged across the three main population centres.

6.3. Apparent temperatures in Auckland were mostly at or above the historical averages this week, with temperatures varying between 9ºC and 20ºC. Temperatures in Wellington were

between 7ºC and 16ºC, with temperature fluctuating around the historical average until Thursday when it dropped slightly. Apparent temperatures in Christchurch were mostly at or below the historical average this week, between -5ºC and 23ºC. Lower temperatures this week likely contributed to increases in peak demand.

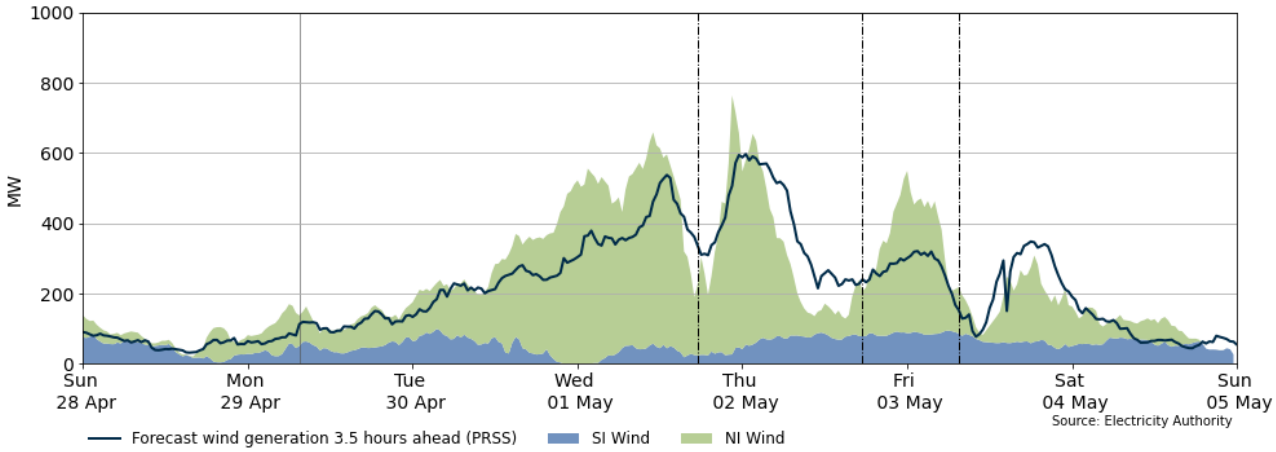
Figure 8: Temperatures across main centres between 28 April-4 May



7. Generation

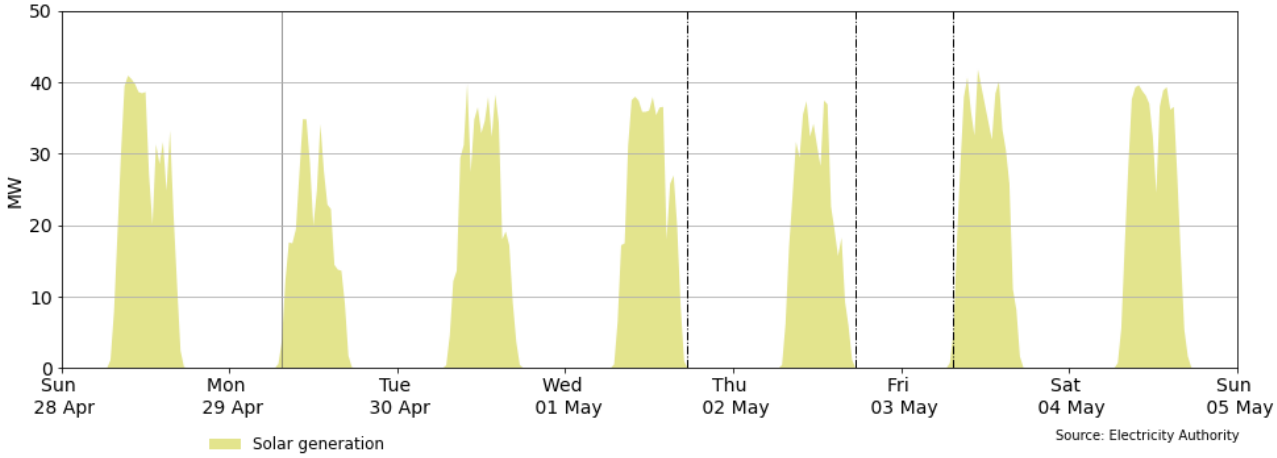
7.1. Figure 9 shows wind generation and forecast from 28 April-4 May. This week wind generation varied between 21MW and 763MW, with an average of 237MW. Wind generation was often below 200MW, except for a few hours between Tuesday and Friday when wind generation was above 400MW. Wind generation was below 300MW during the four highlighted price spikes. On Wednesday wind generation was under forecast by more than 100MW during the price spike.

Figure 9: Wind generation and forecast between 28 April-4 May



7.2. Figure 10 shows solar generation from 28 April-4 May. Solar generation was between 35MW and 42 MW this week. The minimum solar generation occurred on Tuesday due to overcast conditions. Solar generation is expected to decrease due to shorter days and higher declination angles limiting the availability of the resource, as we approach the winter solstice.

Figure 10: Solar generation between 28 April-4 May

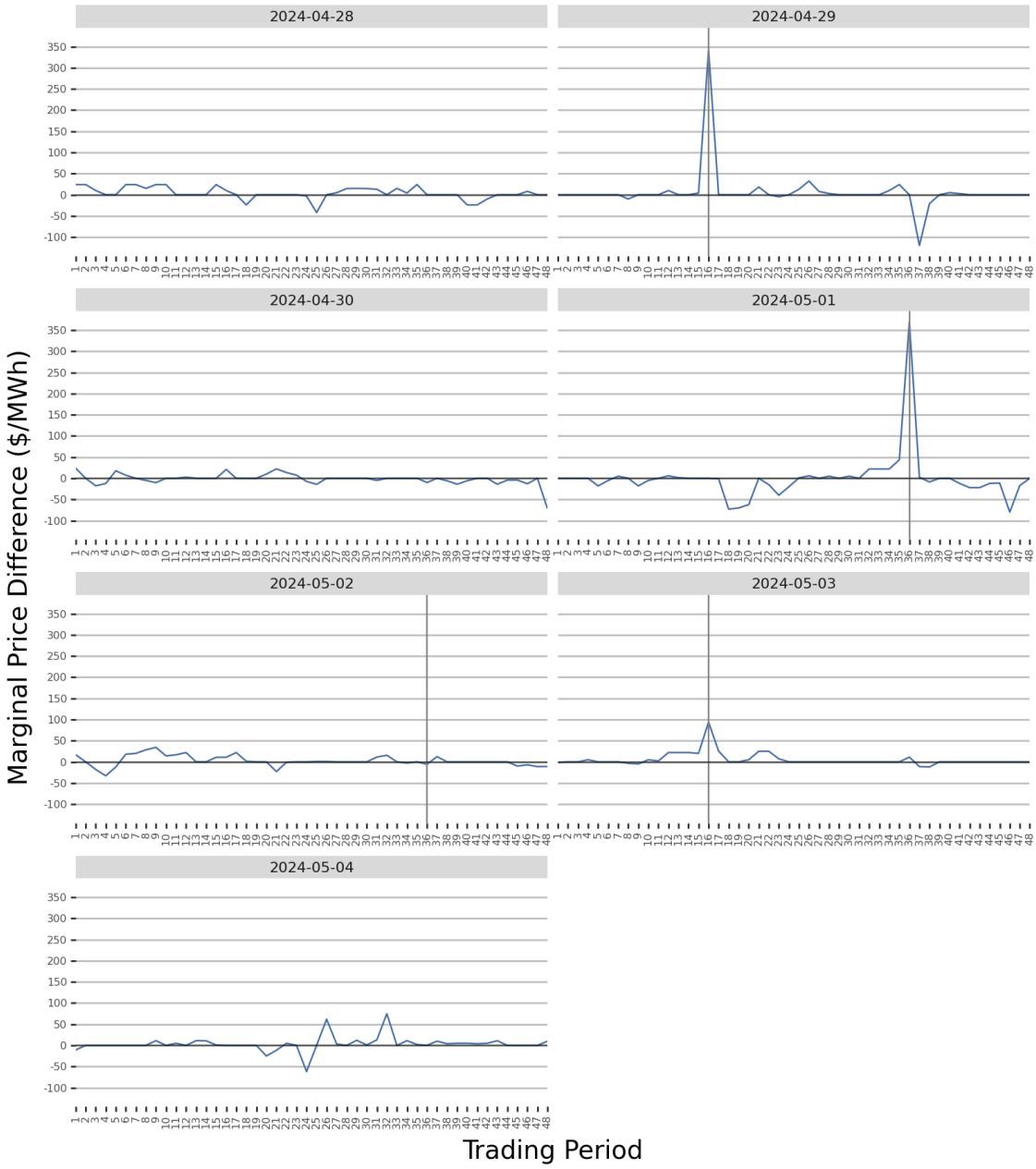


7.3. Figure 11 shows the difference between the national real-time dispatch (RTD) marginal price and a simulated marginal price where the real-time wind and demand matched the 1-hour ahead forecast (PRSS) projections. The figure highlights when forecasting inaccuracies are causing large differences in final prices. When the difference is positive this means that the 1-hour ahead forecasting inaccuracies resulted in the spot price being higher than anticipated - usually here demand is under forecast and/or wind is over forecast. When the difference is negative, the opposite is true. Because of the nature of demand and wind forecasting, the 1-hour ahead and the RTD wind and demand forecasts will rarely be the same, but trading periods where this difference is exceptionally large can signal that forecasting inaccuracies had a large impact on the final price for that trading period.

7.4. This week the most notable positive differences (marginal prices higher than simulation) occurred on Monday and Friday during the trading period 16 (7:30am) and on Wednesday during the trading period 36 (5:30 pm). These differences in marginal prices, which were over $300/MWh, were related to either demand being under-forecast or wind generation being over-forecast, or a combination of both.

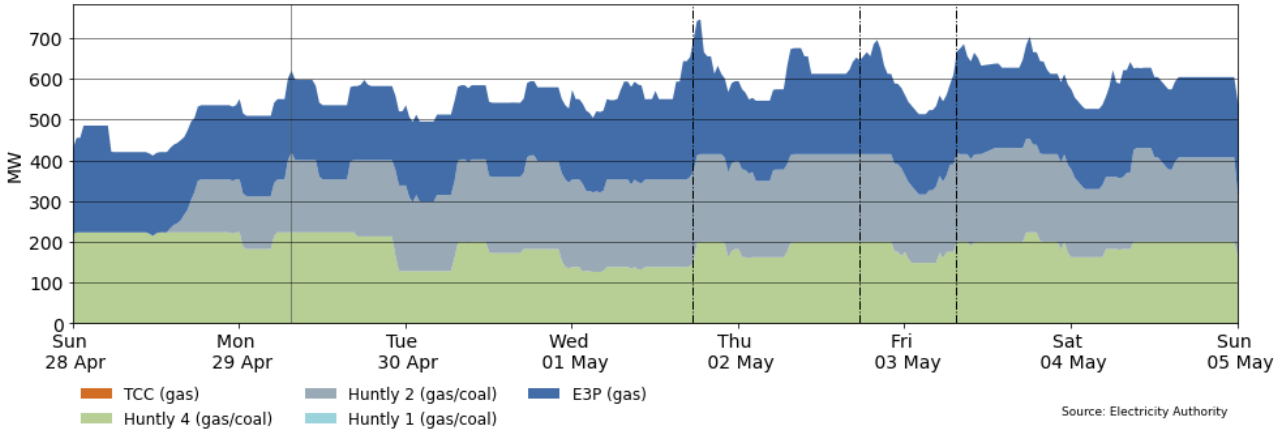
7.5. During most of the time this week, however, differences between actual and simulated RTD marginal prices were mostly between +/-$50/MWh.

Figure 11: Difference between national marginal RTD price and simulated RTD price, with the difference due to one-hour ahead wind and demand forecast inaccuracies between 28 April-4 May



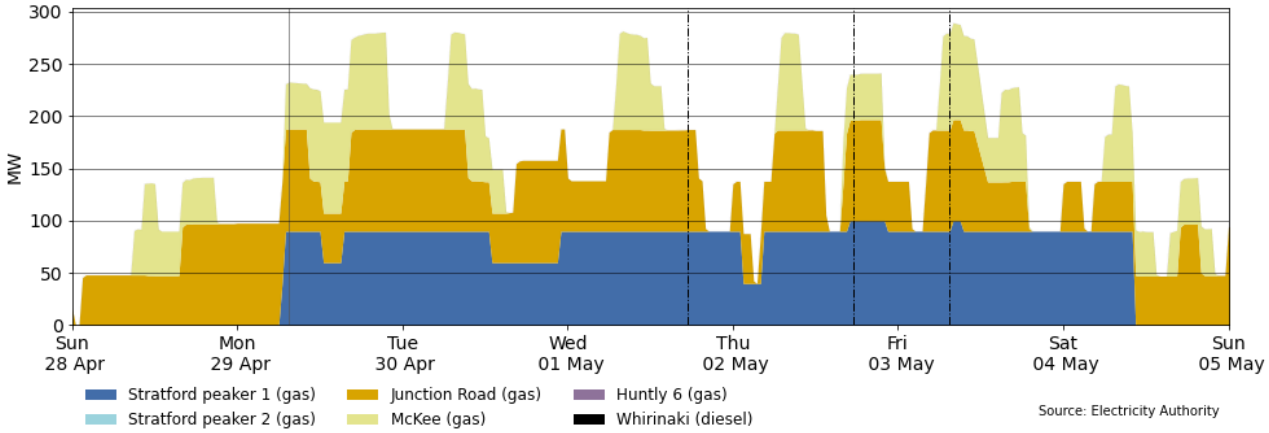
7.6. Figure 12 shows the generation of thermal baseload between 28 April-4 May. Huntly units 4 and 5 (E3P) ran continuously this week to support baseload. From Sunday afternoon onwards Huntly 2 also ran, contributing to the baseload.

Figure 12: Thermal baseload generation between 28 April-4 May



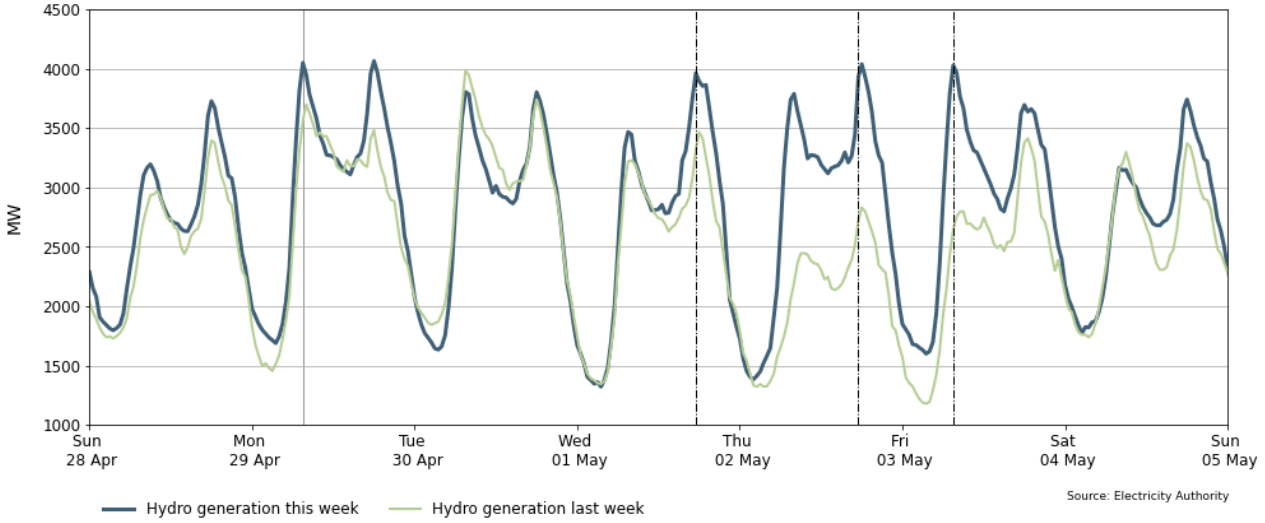
7.7. Figure 13 shows the generation of thermal peaker plants between 28 April-4 May. Junction Road, McKee, and Stratford ran every day this week. Junction Road and Stratford 1 contributed to the baseload by running continuously for days in a row; the first running every day while Stratford 1 ran between Monday and Saturday. McKee ran during times of high demand.

Figure 13: Thermal peaker generation between 28 April-4 May



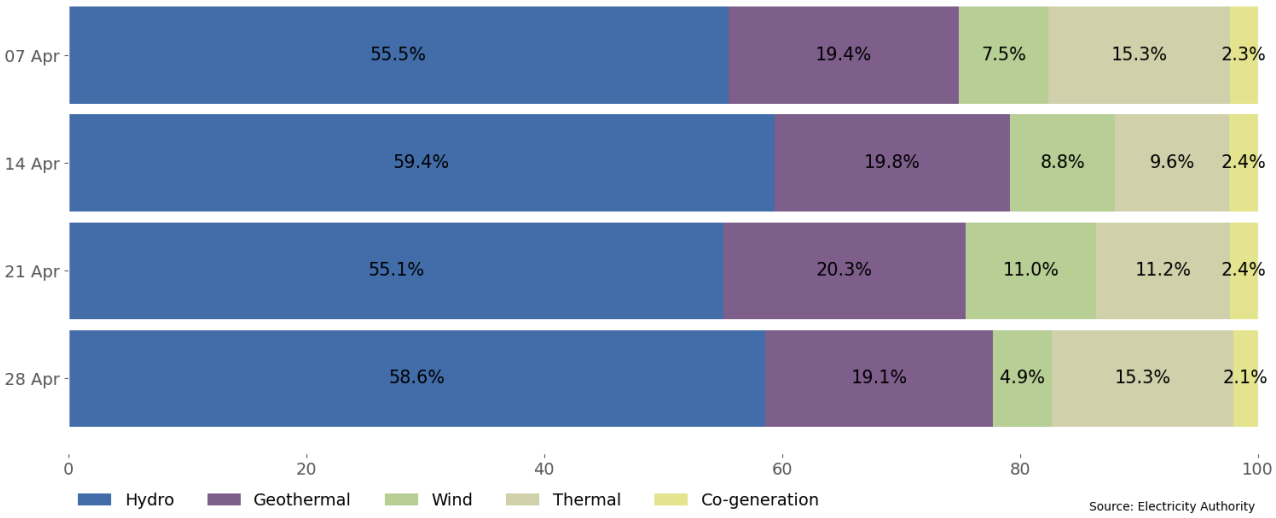
7.8. Figure 14 shows hydro generation between 28 April-4 May. Hydro generation was usually higher than the previous week and mainly followed the demand. Low wind generation this week contributed to the high hydro generation.

Figure 14: Hydro generation between 28 April-4 May



7.9. As a percentage of total generation, between 28 April-4 May, total weekly hydro generation was 58.6%, geothermal 19.1%, wind 4.9%, thermal 15.3%, and co-generation 2.1%, as shown in Figure 15. The relative increase in hydro and thermal generation this week can be attributed to a decrease in wind generation and higher demand.

Figure 15: Total generation by type as a percentage each week between 7 April and 4 May



8. Outages

8.1. Figure 16 shows generation capacity on outage. Total capacity on outage between 28 April-4 May ranged between ~1150MW and ~1880MW. From Friday onwards, over 700MW of combined thermal outages occurred. Figure 17 shows the thermal generation capacity outages.

8.2. Notable outages include:

(a) Huntly 1 is on outage until 8 May 2024

(b) TCC is on outage until 10 May 2024

(c) Huntly 6 is on outage until 10 May 2024

(d) Stratford 2 is on outage until 30 June 2024

(e) Stratford 1 was on outage on 4 May

(f) Kawerau geothermal plant was on outage on 29 April

(g) Several North and South Island hydro units were on outage this week.

Figure 16: Total MW loss due to generation outages between 28 April-4 May

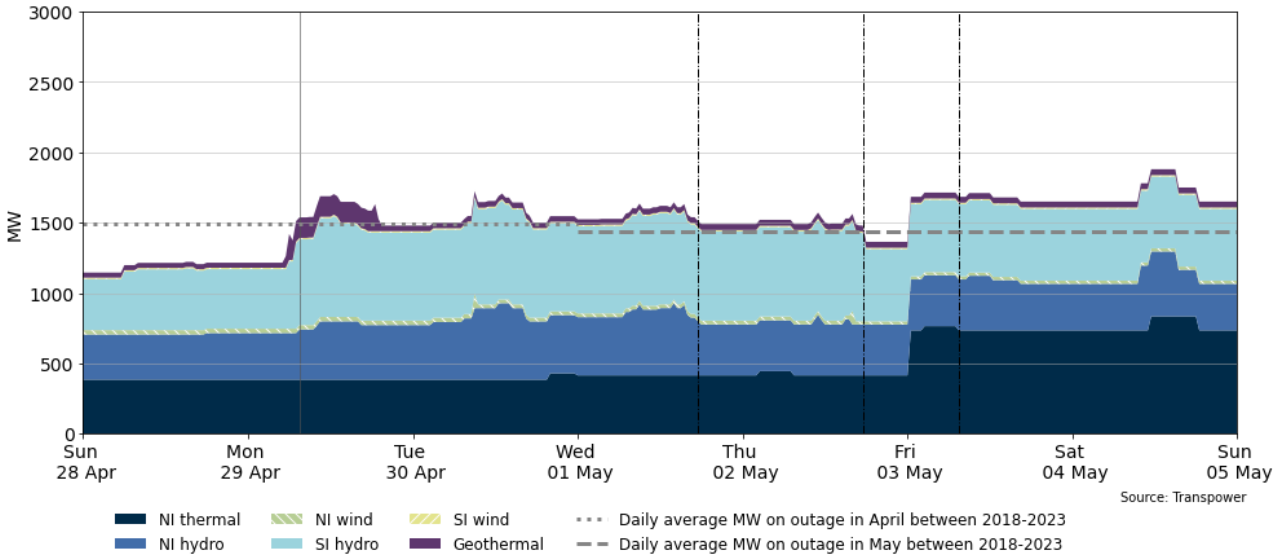
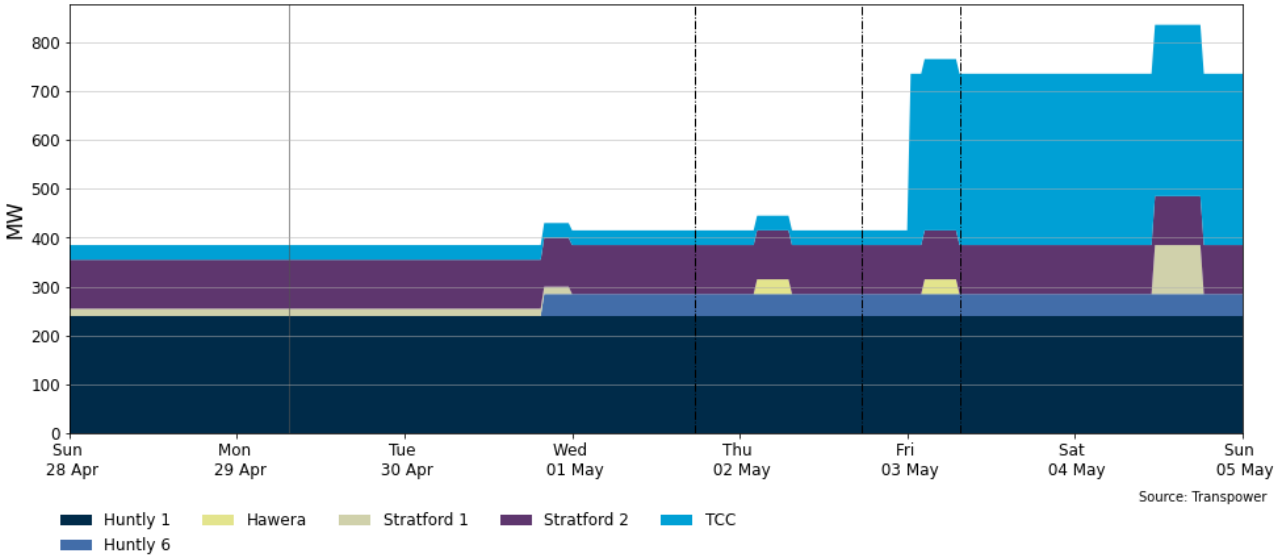


Figure 17: MW loss from thermal outages between 28 April-4 May

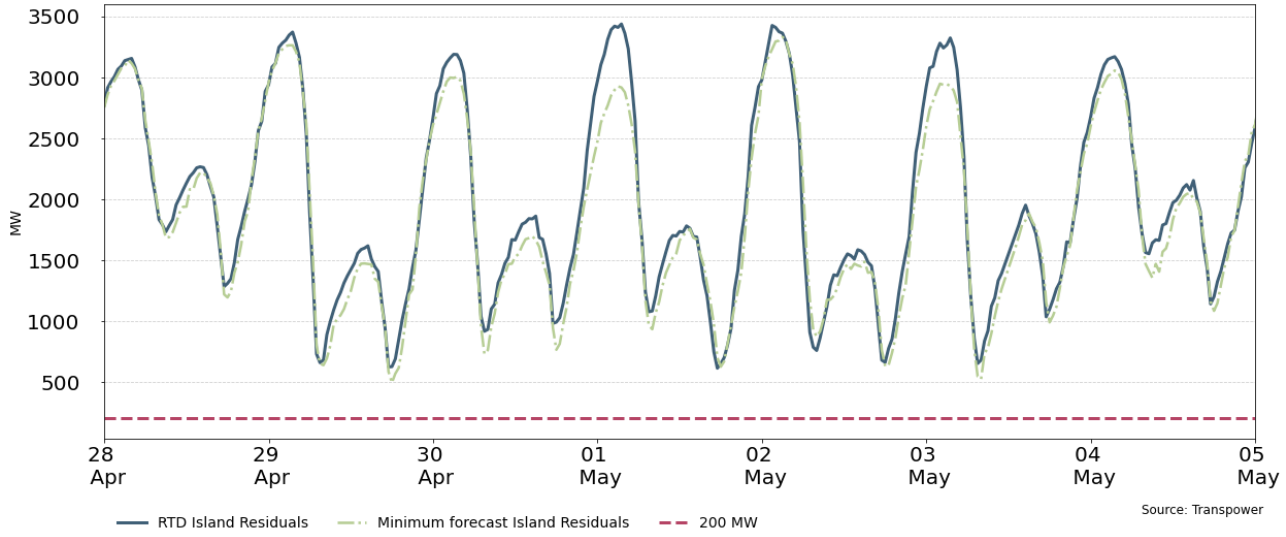


9. Generation balance residuals

9.1. Figure 18 shows the national generation balance residuals between 28 April-4 May. A residual is the difference between total energy supply and total energy demand for each trading period. The red dashed line represents the 200MW residual mark which is the threshold at which Transpower issues a customer advice notice (CAN) for a low residual situation. The green dashed line represents the forecast residuals and the blue line represents the real-time dispatch (RTD) residuals.

9.2. Generation residuals were healthy this week, with the minimum national residual levels occurring on Wednesday afternoon at around 613MW. The minimum North Island residual levels occurred on Friday morning at around 496MW when wind generation was low, and demand was high.

Figure 18: National generation balance residuals 28 April-4 May



10. Storage/fuel supply

10.1. Figure 19 shows the total controlled national hydro storage as well as the storage of major catchment lakes including their historical mean and 10th to 90th percentiles.

10.2. National controlled storage decreased compared to the previous week, now sitting at 76% of nominally full and at the historical average for this time of the year (as of 4 May).

(a) Lake Taupō storage decreased this week and is now approaching its historical average.

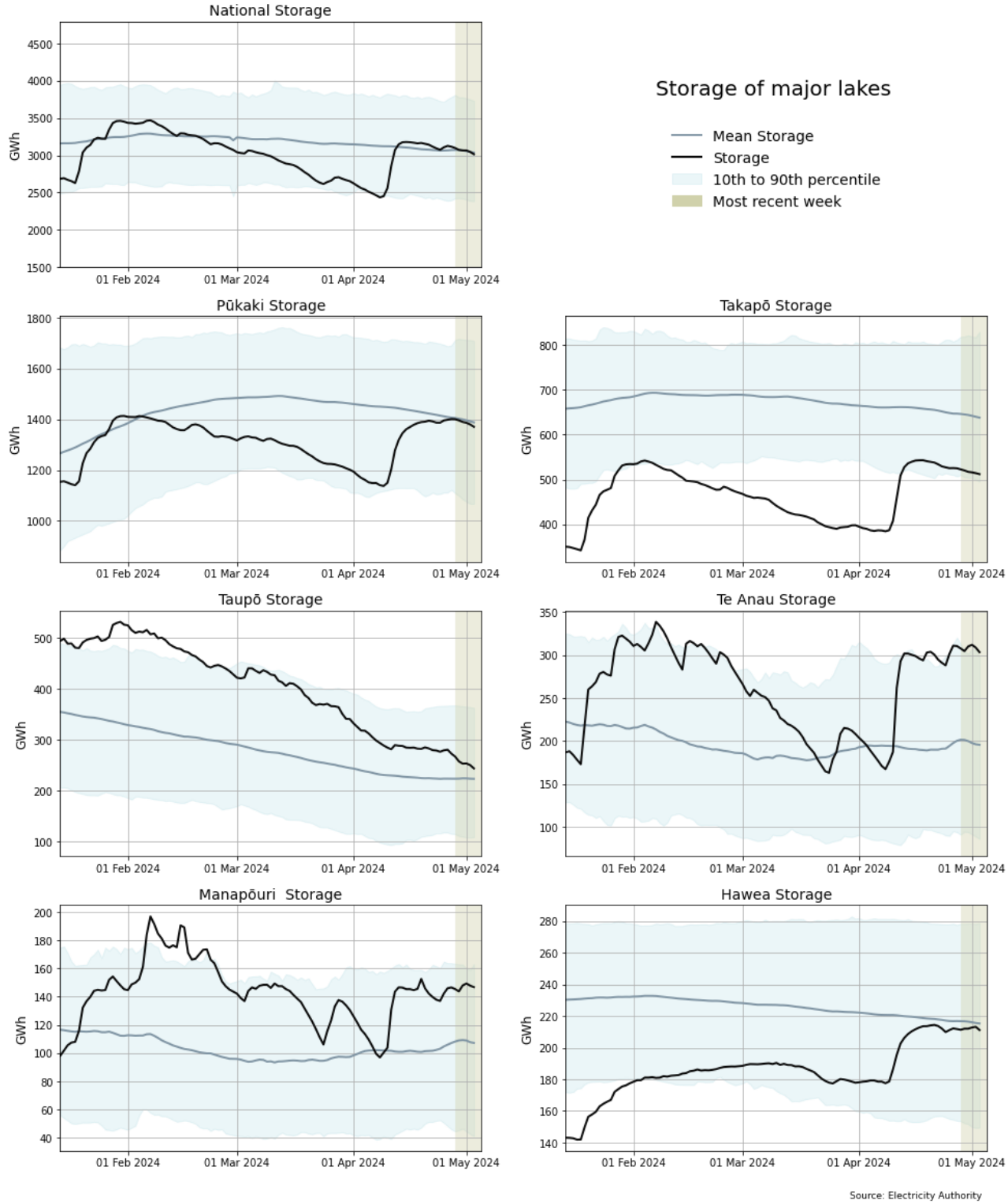
(b) Lake Pūkaki decreased slightly this week, now slightly below its historical average.

(c) Lake Takapō storage decreased a little this week, sitting at its 10th percentile.

(d) Lake Manapōuri and Te Anau saw a decrease in storage. Lake Te Anau is close to its 90th percentile while Manapōuri is slightly below its 90th percentile.

(e) Lake Hawea's storage was relatively stable this week, still sitting close to its historical average.

Figure 19: Hydro storage

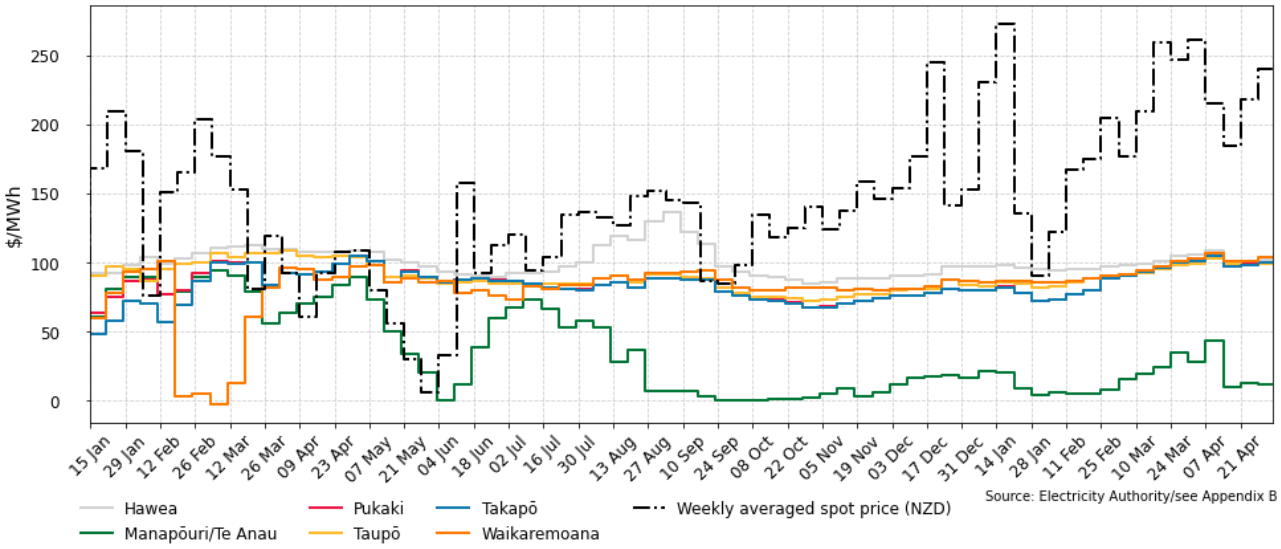


11. JADE water values

11.1. The JADE[2] 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 20 shows the national water values between 8 January 2023 and 4 May 2024 obtained from JADE calculated at the start of the week. 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.

11.2. Compared to the previous week, most lakes saw an increase in their water values between $1/MWh and $3/MWh. The exception was Manapōuri/Te Anau, which saw a decrease of around $1/MWh.

Figure 20: JADE water values across various reservoirs between 8 January 2023 and 4 May 2024



12. Prices versus estimated costs

12.1. 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).

12.2. 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.

12.3. Figure 21 shows an estimate of thermal SRMCs as a monthly average up to 1 April 2024. The SRMCs for coal and diesel have seen small changes from the previous month. The coal SRMC decreased, while the diesel SRMC increased slightly. The gas SRMCs have increased this month, likely due to current gas availability and demand.

12.4. The latest SRMC of coal-fuelled Rankine generation is ~$164/MWh. The cost of running the Rankines on gas remains more expensive at ~$257/MWh.

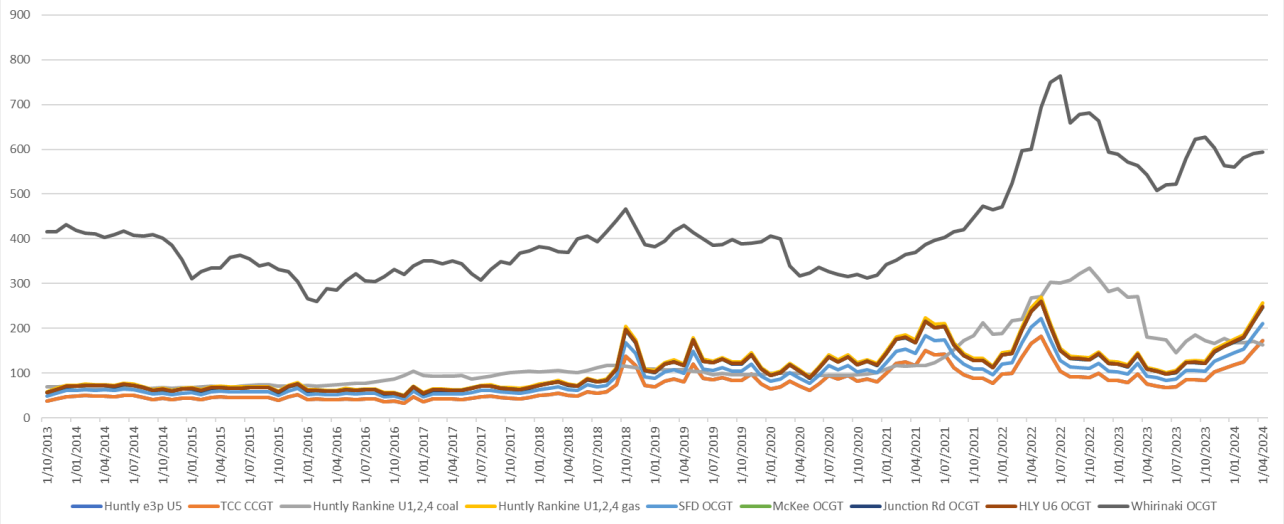
[2] JADE (Just Another DOASA Environment) is an implementation of the Stochastic Dual Dynamic Programming (SDDP) algorithm of Pereira and Pinto. JADE was developed by researchers at the Electric Power Optimisation Centre (EPOC) for the New Zealand electricity market.

12.5. The SRMC of gas-fuelled thermal plants is currently between ~$173/MWh and ~$257/MWh.

12.6. The SRMC of Whirinaki is ~$594/MWh.

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

Figure 21: Estimated monthly SRMC for thermal fuels



Source: Electricity Authority/see Appendix C

13. Offer behaviour

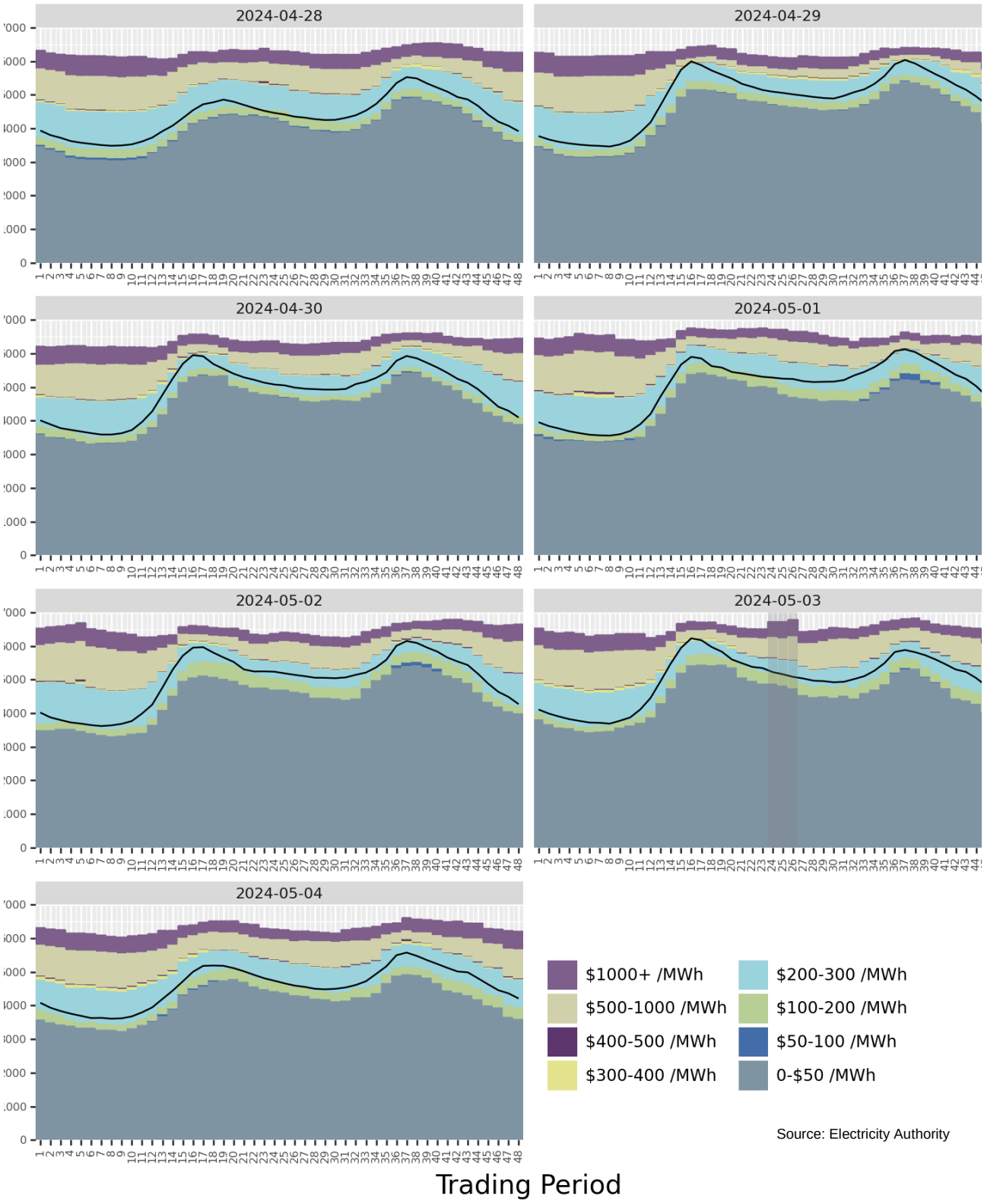
13.1. Figure 22 shows this week's national daily offer stacks. The black line shows cleared energy, indicating the range of the average final price.

13.2. This week, most offers were cleared in the $200-$300/MWh region except for one trading period on Monday, Wednesday, and Friday, when offers were cleared in the more expensive tranches. A slight increment in the position of the offers' clearing curve this week is likely due to the relatively low wind generation.

13.3. The trading periods 24-26 on Friday shown in the chart use data PRSS data as the RTD schedules were not published due to a failure in the System Operator scheduling system[3].

[3] Transpower Customer Advice Notice - 03-may-2024: Failure to publish schedules

Figure 22: Daily offer stacks[4]



[4] PRSS data has been used for trading periods where RTD data was not available. These stacks will be highlighted within the offer stack and may be slightly higher than the adjusted offers.

14. Ongoing work in trading conduct

14.1. This week, prices generally appeared to be consistent with supply and demand conditions.

14.2. 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
14/06/2023-15/06/2023	15-17/ 15-19	Passed to Compliance	Genesis	Multiple	High energy prices associated with high energy offers
22/09/2023-30/09/2023	Several	Further analysis	Contact	Multiple	High hydro offers
21/01/2024-27/01/2024	Several	Further analysis	Mercury	Waikato hydro dams	High offers
15/03/2024-16/03/2024	Several	Further analysis	Mercury	Waikato hydro dams	High offers