Electricity spot prices above $5000/MWh

South Australia, 19 December 2019

19 February 2020

AUSTRALIAN ENERGY REGULATOR

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1 Obligation

The Australian Energy Regulator (AER) regulates energy markets and networks under national legislation and rules in eastern and southern Australia, as well as networks in the Northern Territory. Its functions include:

- monitoring wholesale electricity and gas markets to ensure energy businesses comply with the legislation and rules, and taking enforcement action where necessary;
- setting the amount of revenue that network businesses can recover from customers for using networks (electricity poles and wires and gas pipelines) that transport energy;
- regulating retail energy markets in Queensland, New South Wales, South Australia, Tasmania (electricity only), and the ACT;
- operating the Energy Made Easy website, which provides a retail price comparator and other information for energy consumers;
- publishing information on the performance of energy markets, including the annual State of the energy market report and biennial effective competition report, to assist stakeholders and the wider community.

The AER is required to publish a report whenever the electricity spot price exceeds $5000 per megawatt hour ($/MWh) in accordance with clause 3.13.7 (d) of the National Electricity Rules.

The report:

- describes the significant factors contributing to the spot price exceeding $5000/MWh, including withdrawal of generation capacity and network availability;
- assesses whether rebidding contributed to the spot price exceeding $5000/MWh;
- identifies the marginal scheduled generating units; and
- identifies all units with offers for the trading interval equal to or greater than $5000/MWh and compares these dispatch offers to relevant dispatch offers in previous trading intervals.

These reports are designed to examine market events and circumstances that contributed to wholesale market price outcomes and are not an indicator of potential compliance issues or enforcement action.

2 Summary

On 19 December 2019 the spot price for electricity for the 7 pm and 7.30 pm trading intervals reached the market cap of $14 700/MWh in South Australia. Maximum temperatures in Adelaide exceeded 45°C, leading to close to record demand. With imports from Victoria limited across the Murraylink interconnector and despite 83 per cent of capacity in South Australia being priced below $5000/MWh, capacity priced above $5000/MWh was dispatched to meet demand.

Generator rebidding from low to high prices did not contribute to the price exceeding $5000/MWh. In fact, generators shifted capacity from high to low prices throughout the day, postponing the forecast high prices until later in the day.

Price sensitivity reports published throughout the day by AEMO, the market operator, indicated that less than a one percent error in forecast demand, supply or network capacity from neighbouring regions could lead to significant swings in price outcomes of between $115/MWh and the market cap.

A number of factors varied from those forecast four hours ahead. Imports from Victoria were as much as 210 MW lower than forecast, demand was up to 70 MW greater than forecast and low priced wind generation was at times more than 110 MW lower than forecast. These factors combined resulted in actual prices being higher than those forecast.

Given the extreme conditions on the day it seems the market performed as expected. With high temperatures and calm wind conditions almost all generation that could be available was offered into the market. As a result while wholesale prices rose, there were no supply shortfalls declared by AEMO.

3 Analysis

On 19 December 2019 the spot price in South Australia exceeded $300/MWh from 5.30 pm to 8 pm inclusive during a period of extreme weather conditions. The maximum spot price for the day was set during the 7 pm and 7.30 pm trading intervals at $14 700/MWh, exceeding the AER's reporting threshold.

Prices on the day were forecast to be sensitive to change. Price sensitivity forecasts published by AEMO, suggested that minor variations in demand, local generation or imports from Victoria would lead to spot price volatility.

In short, the 7 pm and 7.30 pm spot prices were as a result of high temperatures, which led to high demand, reduced imports from Victoria and lower than forecast wind generation.

3.1 Overview of actual and expected conditions

AEMO's short-term forecasting role in the NEM

The Australian Energy Market Operator (AEMO) makes regular assessments of expected demand for electricity in each region, based on inputs including forecast temperature, season and the day of the week. AEMO issues "targets" to generators to generate electricity to meet this demand, taking into account network capability and generator offers. Generator offers comprise the mega-watt (MW) capacities a generator is willing to supply across a range of 10 price bands and the total amount they can produce (generator availability).

To inform market participants about market conditions, AEMO publishes price, network capability and demand forecasts in five minute and 30 minute timeframes. These forecasts help inform market participants' commercial decisions and form the basis for AEMO's assessments of interconnector capacity, transfers between regions, reserves and conditions that relate to power system security.

Throughout the day, AEMO also publish price sensitivity reports which provide what-if analysis of each region. These reports explore potential price outcomes considering a range of positive or negative changes in the supply or demand of electricity.

The spot price exceeded $5000/MWh for the 7 pm and 7.30 pm trading intervals. Table 1 shows the actual and forecast spot prices along with demand and local availability for the 5.30 pm to 8 pm trading intervals in South Australia. It reflects how sensitive prices were to forecast conditions.

Table 1: Actual and forecast spot prices, demand and available capacity for South Australia

Trading interval	Price ($/MWh)			Demand (MW)			Availability (MW)		
	Actual	4 hr forecast	12 hr forecast	Actual	4 hr forecast	12 hr forecast	Actual	4 hr forecast	12 hr forecast
5.30 pm	379	13 100	13 100	2913	2968	2938	3110	3113	3084
6 pm	269	13 100	13 100	2999	3025	2998	3057	3139	3066
6.30 pm	3595	12 920	13 100	3089	3059	3055	3039	3090	3038
7 pm	**14 700**	**3577**	**13 100**	**3108**	**3038**	**3036**	**3011**	**3105**	**3016**
7.30 pm	**14 700**	**380**	**13 072**	**3082**	**2985**	**2975**	**2997**	**3115**	**3075**
8 pm	2590	177	380	3001	2882	2898	3077	3152	3125

Table 1 shows:

- Based on information available at the time, four and 12 hour forecasts indicated prices to exceed $13 000/MWh earlier in the day.[1]
- Forecast high prices did not eventuate in the 5.30 pm to 6.30 pm trading intervals. This was mostly due to local gas generation rebidding capacity from high to low price bands, meaning demand was met by lower priced generation.
- For the 7 pm, 7.30 pm and 8 pm intervals, the four hour forecast price was significantly lower than the 12 hour forecast price. This was due to a change in two factors. First, there was rebidding of existing capacity from high to low price bands. Second, more low priced wind generation was expected in the four hour forecast than in the 12 hour forecast, leading to an increase in availability.
- The actual price was higher than both the four and 12 hour forecasts. This was due to actual wind generation being lower than both forecasts, reducing availability, and demand being slightly higher than forecast.

  Imports from Victoria across Murraylink were lower than forecast and also contributed to the price being higher than expected.

3.2 Demand

The temperature in Adelaide on the day exceeded 45°C[2] and it was the third consecutive day in South Australia where the temperature exceeded 40°C. Persistent high temperatures drove demand to reach a maximum of 3108 MW at 7 pm, which was 70 MW greater than forecast. This was only around 280 MW below record levels for South Australia.[3]

[1] Although not shown in Table 1, 4 and 12 hour ahead forecasts indicated the spot price to exceed $10 000/MWh from 4 pm and 3.30 pm onwards respectively

[2] Adelaide, South Australia - Dec 2019 (Bureau of Meteorology)

[3] Record total demand was 3385 MW in South Australia on 31 January 2011

Figure 1: Forecast versus actual demand in South Australia

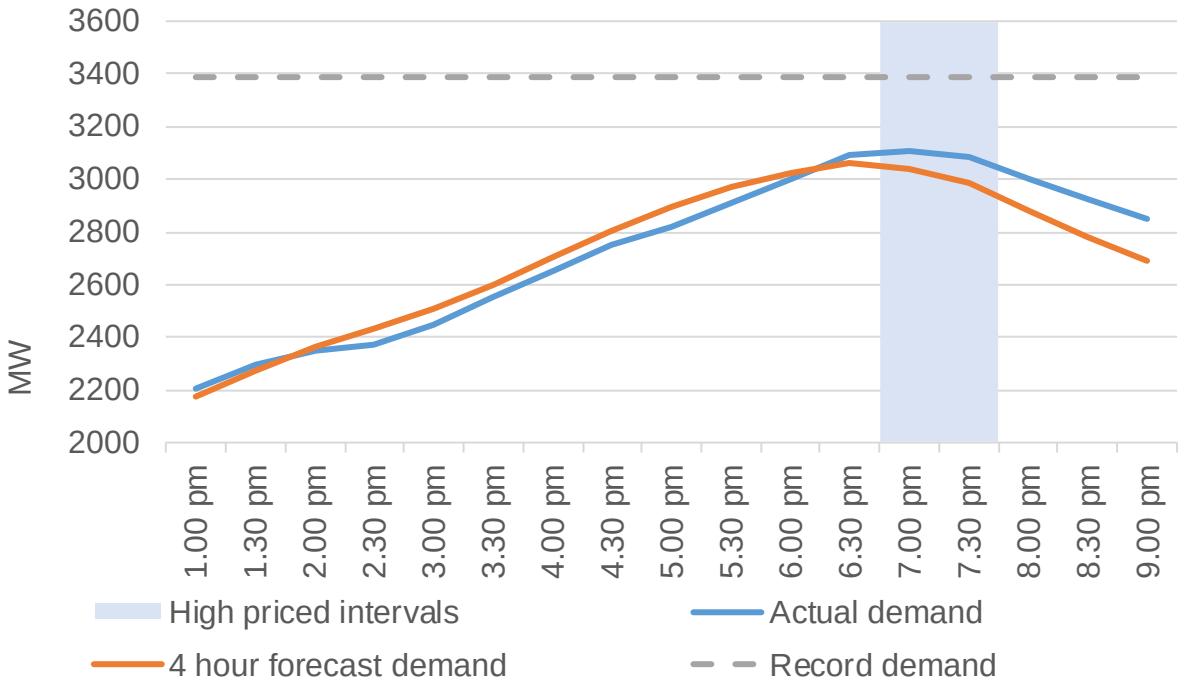


Figure 1 shows how actual demand was slightly above forecast demand during the 7pm and 7.30 pm trading intervals. It also shows how close demand levels were to record demand levels in South Australia, previously set 31 January 2011.

3.3 Supply

This section examines the supply side factors that had an effect on the high price outcomes.

3.3.1 Network availability

The regions of the National Electricity Market are connected via high voltage interconnectors, through which electricity is transferred. South Australia is connected to Victoria via two interconnectors, Heywood and Murraylink. Import and export limits control the maximum amount of electricity that can flow between regions across interconnectors. The market operator, AEMO, manages the flow of electricity across the network using constraints to ensure that system security is maintained. Constraints are mathematical equations that manage or "limit" flows on specific transmission lines (including interconnectors) for each five minute interval.

During the high priced trading intervals both the Heywood and Murraylink interconnectors were importing into South Australia at their limit. The Heywood interconnector operated close to its nominal limit, as forecast, so will be excluded from further analysis. Imports across Murraylink however were close to zero when forecasts had it at or close to its nominal limit.

Table 2: Actual and forecast flows and limits across Murraylink

Trading interval	Import flows (MW)			Import limit (MW)		
	Actual	4 hr forecast	12 hr forecast	Actual	4 hr forecast	12 hr forecast
5.30 pm	37	151	161	37	151	162
6 pm	34	164	162	34	164	177
6.30 pm	22	168	177	22	168	194
7 pm	**5**	**170**	**194**	**5**	**170**	**194**
7.30 pm	**11**	**182**	**220**	**11**	**182**	**220**
8 pm	22	193	220	22	193	220

Table 2 shows actual and forecast flows across Murraylink into South Australia were at the import limit for the 7 pm and 7.30 pm trading intervals. However, actual flows were between 165 MW and 209 MW lower than forecast. This means supply of cheaper generation into South Australia from neighbouring regions was materially reduced.

The nominal import limit from Victoria to South Australia on Murraylink is 220 MW. Although the correct constraint was forecast to set the import limit on Murraylink, the import limit was significantly lower than the nominal limit. Conditions on the day (likely due to temperature) were more restrictive than forecast which reduced the transfer capability from Victoria.

3.3.2 Generation availability

This section discusses the amount and price of available generation on the day. During the time prices were above $5000/MWh, around 3000 MW of generation was offered into the market out of the 4900 MW installed in South Australia. The reduced availability was almost entirely due to low wind conditions. Of the 1800 MW of semi-scheduled wind installed, only as much as 220 MW was available. The only other significant unit not available was AGL's 120 MW Torrens Island A3 unit which was made unavailable two days earlier.

Figure 2: Generation availability South Australia

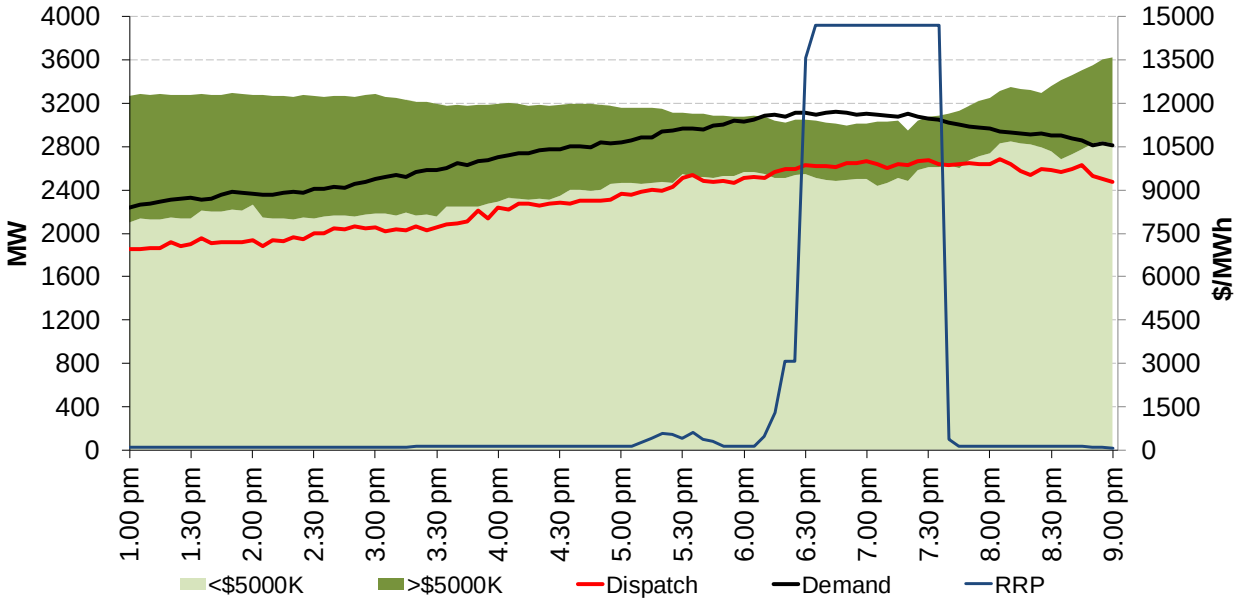


Figure 2 shows the cumulative generator offers for South Australia. Also known as closing bids, the figure shows the actual capacity offered by generators including amendments to their offers to match changes to their own economic and/or physical circumstances. Capacity offered below $5000/MWh is shown in light green and capacity offered above $5000/MWh is in dark green. The red, black and blue lines show the local dispatch (MW), local demand (MW) and spot price ($/MWh) for electricity in South Australia respectively. With demand (black line) higher than local generation (red line), the gap to satisfy demand was met by imports from Victoria. However, it was still necessary to dispatch local generation that lay in the dark green band (above $5000/MWh).

Figure 3: Semi-scheduled wind generation forecast and actual

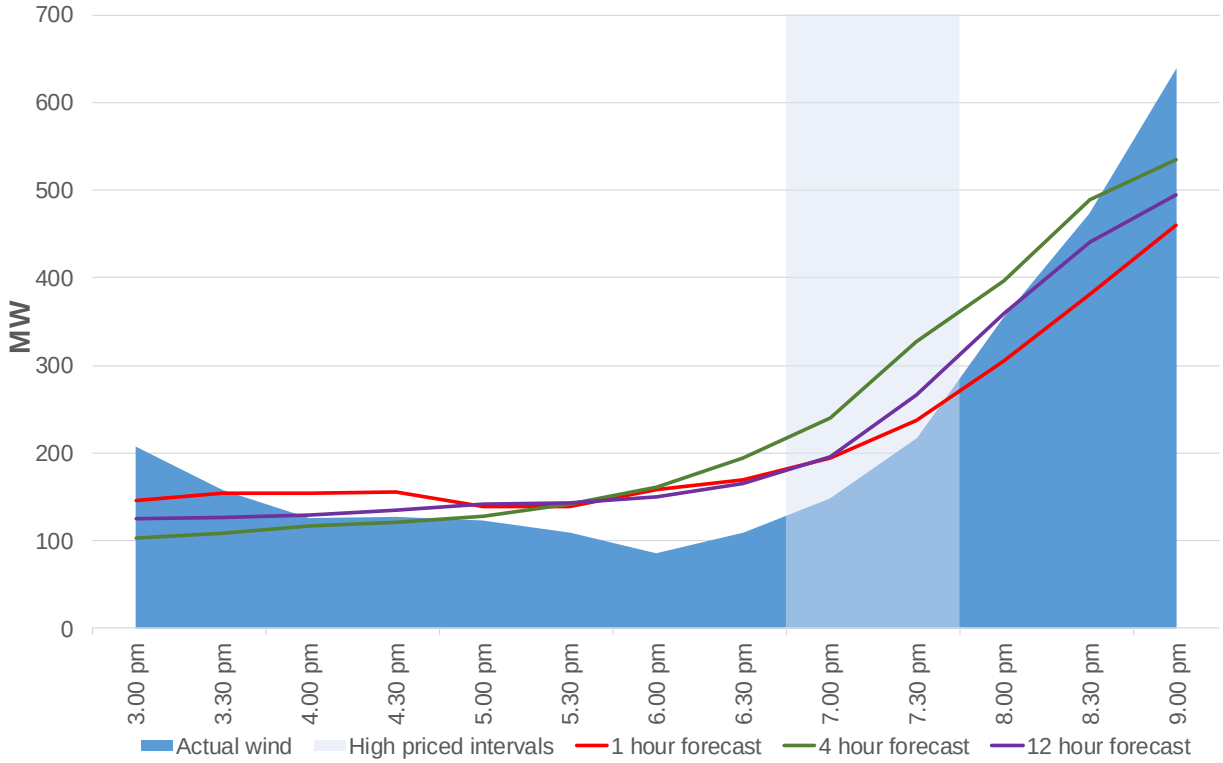


Figure 3 shows actual semi–scheduled wind generation in South Australia and three published forecasts from earlier in the day. Across the forecasts shown above, actual wind generation for the 7 pm and 7.30 pm trading intervals was as much as 115 MW below forecast. This reduced the expected amount of local low-priced available electricity.

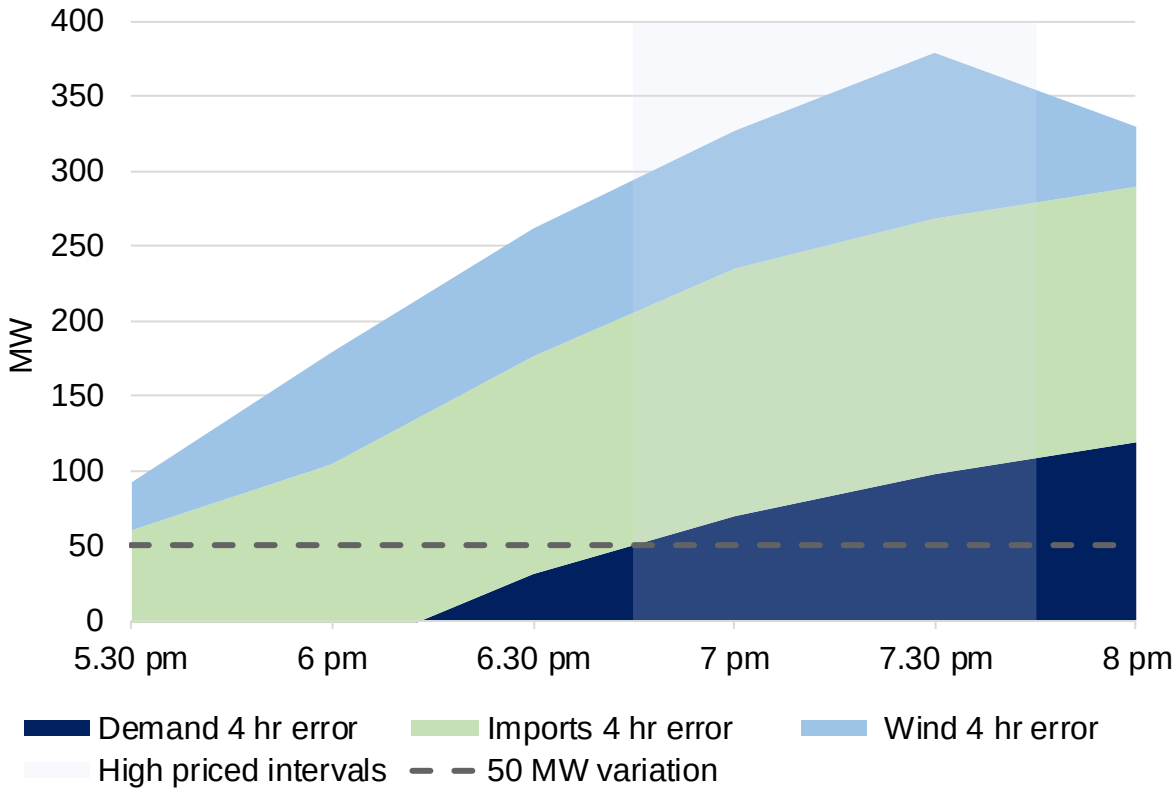
Even though 83 per cent of the available capacity was priced below $5000/MWh (figure 2 above), with reduced imports on Murraylink, high demand and lower than forecast wind generation, electricity generation above $5000/MWh was dispatched to meet demand.

3.4 Sensitivities

Sensitivity reports, published by AEMO throughout the day, indicated that as little as a 50 MW variation of demand or supply would see the spot price spike to $14 700/MWh or fall to $115/MWh.

Figure 4 below shows the combined actual error of demand, wind and imports on Murraylink compared to the four hour forecast which led to higher price outcomes. According to the sensitivity reports, any variation above 50 MW (the grey dashed line) would likely lead to spot prices at the market cap of $14 700/MWh. During the 7 pm and 7.30 pm trading intervals, the variation was around 330 MW above the threshold line, so as expected spot prices reached the price cap. Given such a highly sensitive afternoon, a variation in even one of these inputs would have still led to spot prices above $5000/MWh.

Figure 4: Combination of errors contributing to higher price outcomes



The closing bids for all participants in South Australia with capacity priced at or above $5000/MWh for the high-price periods are set out in *Appendix A: Closing bids*.

Rebidding into high price bands did not contribute to the high prices in South Australia. However any significant rebids are contained in *Appendix B: Significant rebids*.

The generators involved in setting the price during the high-price periods, and how that price was determined by the market systems are detailed in *Appendix C: Price Setter.*

Australian Energy Regulator

February 2020

Appendix A: Closing bids

Figure A1 to A3 highlight the half hour closing bids for participants in South Australia with capacity priced at or above $5000/MWh during the periods in which the spot price exceeded $5000/MWh. They also show generation output and the spot price.

Figure A1: AGL Energy (Barker Inlet, The Bluff, Hallett, North Brown Hill, Torrens Island) closing bids, dispatch and spot price

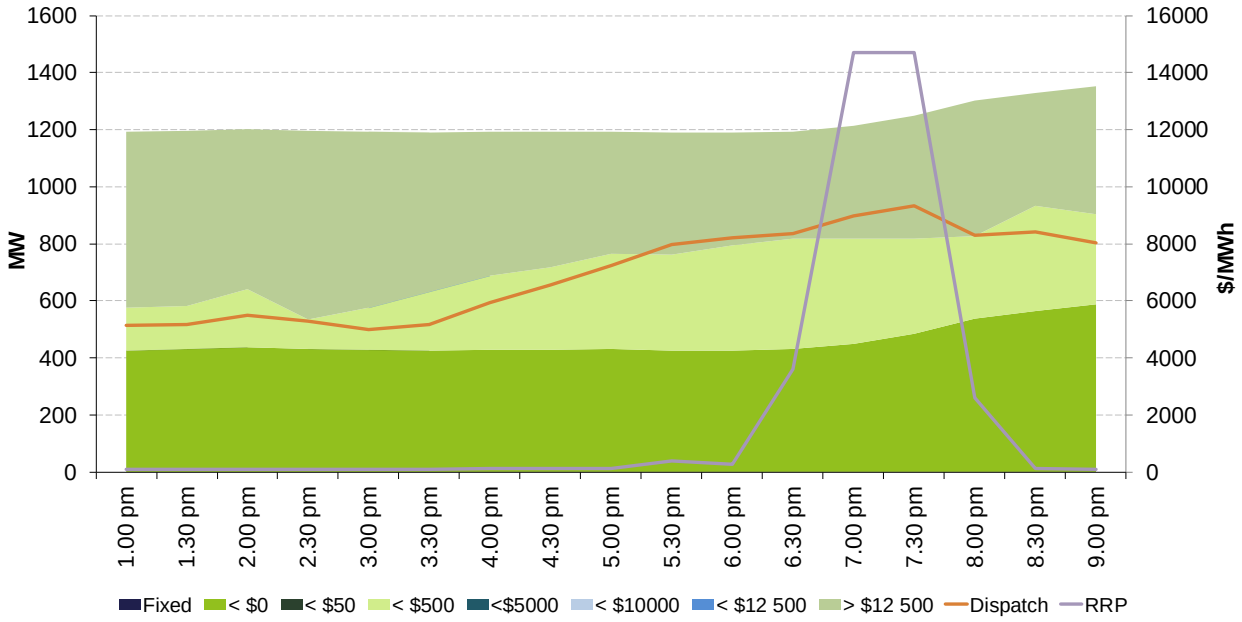


Figure A2: Neoen (Hornsdale Wind Farm, Hornsdale Power Reserve) closing bids, dispatch and spot price

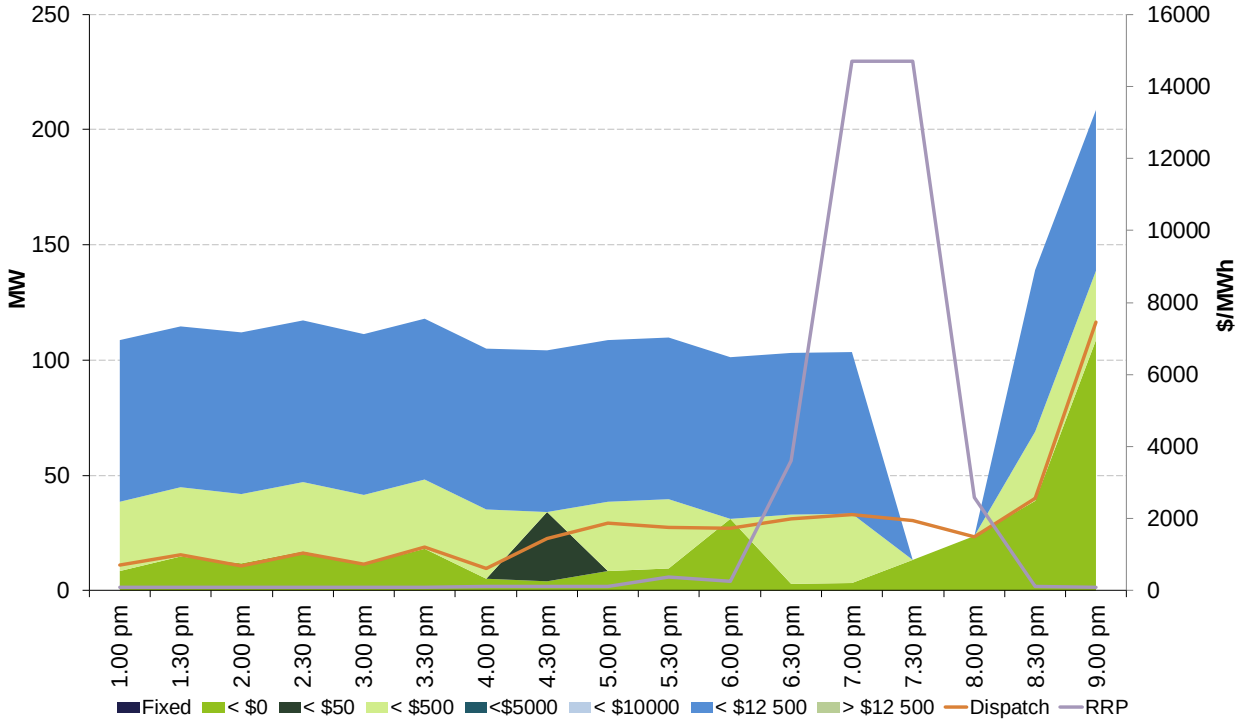
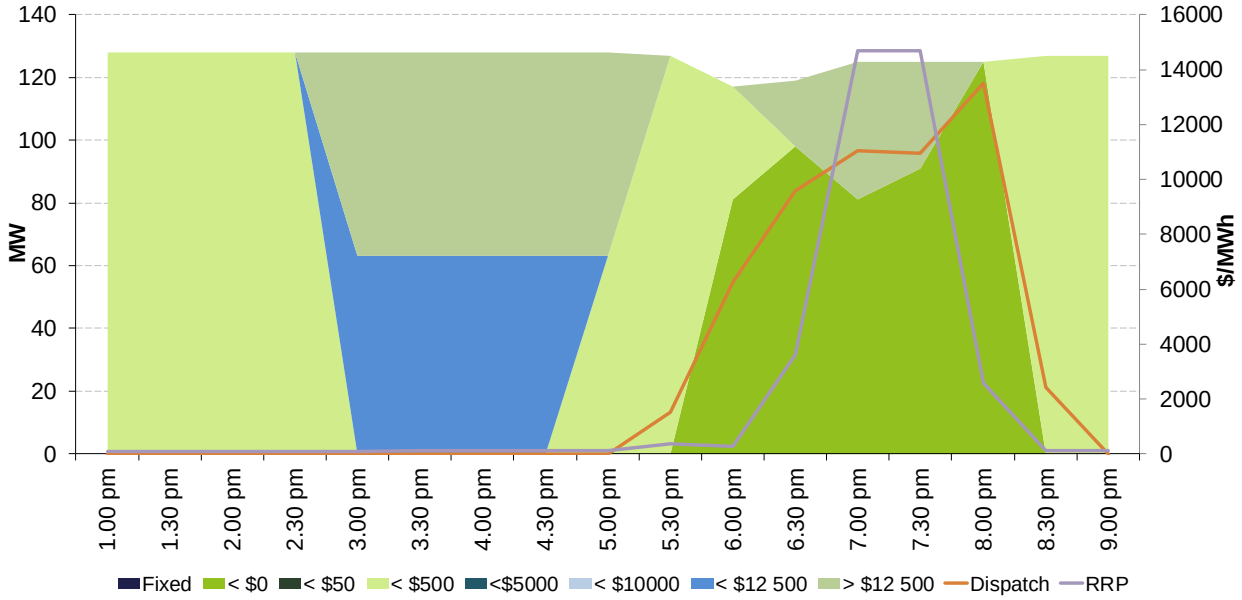


Figure A3: Snowy Hydro (Angaston, Lonsdale, Port Stanvac) closing bids, dispatch and spot price



Appendix B: Significant rebids

The rebidding tables highlight the relevant rebids submitted by generators that impacted on market outcomes during the time of high prices. It details the time the rebid was submitted and used by the dispatch process, the maximum capacity involved, the change in the price of the capacity being offered, and the rebid reason.

Table 3: South Australia significant rebids for 7 pm and 7.30 pm trading intervals

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
1.53 pm		Engie	Mintaro	65	14 700	-1000	1305~A~respond to 5min predispatch $344>$115 in DI 13:55~
3.07 pm		Engie	Dry Creek	40	13 100	-1000	1450~A~respond to 5 min predispatch. Unforecast high prices $1264.18~
3.47 pm		Engie	Dry Creek	35	13 100	-1000	1505~A~respond to 5 min predispatch. High unforecast prices $ 1248.35~
4.41 pm		Engie	Dry Creek	20	13 100	-1000	1545~A~respond to 5 min predispatch. High prices $3257.0~
5.10 pm		Engie	Dry Creek	15	>13 100	-1000	1700~A~respond to 5 min predispatch. High price $1309.76 > $590.~
5.25 pm		Engie	Dry Creek	4	>13 100	-1000	1720~A~respond to 5 min predispatch. $14700> $3174.85~ 3
5.31 pm		Engie	Port Lincoln	110	14 700	-1000	1725~A~respond to 5 min predispatch. $14700> $590~
6.07 pm		Origin	Quarantine	6	-1000	N/A	1800P change in avail - ambient conditions sl
6.46 pm	6.55 pm	Engie	Snuggery	18	N/A	-1000	1840~P~update RTS profile- unit 1 ~

Appendix C: Price setter

The following tables identify for the trading interval in which the spot price exceeded $5000/MWh, each five minute dispatch interval price and the generating units involved in setting the energy price. This information is published by AEMO.[4] The 30-minute spot price is the average of the six dispatch interval prices. The dispatch prices that are in italics are capped at the price cap of $14 700/MWh when published by AEMO.

Table 4: South Australia price setter 7 pm

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
6.35 pm	*$14 700*	AGL (SA)	TORRA1	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRA2	Energy	$14 700	0.09	$1323
		AGL (SA)	TORRA4	Energy	$14 700	0.09	$1323
		AGL (SA)	TORRB1	Energy	$14 700	0.19	$2793
		AGL (SA)	TORRB2	Energy	$14 700	0.19	$2793
		AGL (SA)	TORRB3	Energy	$14 700	0.19	$2793
		AGL (SA)	TORRB4	Energy	$14 700	0.19	$2793
6.40 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	0.10	$1470
		AGL (SA)	TORRA1	Energy	$14 700	0.07	$1029
		AGL (SA)	TORRA2	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRA4	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRB1	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB2	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB3	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB4	Energy	$14 700	0.17	$2499
6.45 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	0.10	$1470
		AGL (SA)	TORRA1	Energy	$14 700	0.07	$1029
		AGL (SA)	TORRA2	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRA4	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRB1	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB2	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB3	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB4	Energy	$14 700	0.17	$2499
6.50 pm	*$14 700*	AGL (SA)	TORRA1	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRA2	Energy	$14 700	0.09	$1323
		AGL (SA)	TORRA4	Energy	$14 700	0.09	$1323
		AGL (SA)	TORRB1	Energy	$14 700	0.19	$2793
		AGL (SA)	TORRB2	Energy	$14 700	0.19	$2793
		AGL (SA)	TORRB3	Energy	$14 700	0.19	$2793
		AGL (SA)	TORRB4	Energy	$14 700	0.19	$2793
6.55 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	0.10	$1470
		AGL (SA)	TORRA1	Energy	$14 700	0.07	$1029
		AGL (SA)	TORRA2	Energy	$14 700	0.08	$1176

[4] Details on how the price is determined can be found at www.aemo.com.au

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
		AGL (SA)	TORRA4	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRB1	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB2	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB3	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB4	Energy	$14 700	0.17	$2499
7 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	0.10	$1470
		AGL (SA)	TORRA1	Energy	$14 700	0.07	$1029
		AGL (SA)	TORRA2	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRA4	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRB1	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB2	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB3	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB4	Energy	$14 700	0.17	$2499
Spot Price		**$14 700/MWh**					

Table 5: South Australia price setter 7:30 pm

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
7.05 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	$0	$1323
		AGL (SA)	TORRA1	Energy	$14 700	$0	$1029
		AGL (SA)	TORRA2	Energy	$14 700	$0	$1176
		AGL (SA)	TORRA4	Energy	$14 700	$0	$1176
		AGL (SA)	TORRB1	Energy	$14 700	$0	$2499
		AGL (SA)	TORRB2	Energy	$14 700	$0	$2499
		AGL (SA)	TORRB3	Energy	$14 700	$0	$2499
		AGL (SA)	TORRB4	Energy	$14 700	$0	$2499
7.10 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	0.09	$1323
		AGL (SA)	TORRA1	Energy	$14 700	0.07	$1029
		AGL (SA)	TORRA2	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRA4	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRB1	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB2	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB3	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB4	Energy	$14 700	0.17	$2499
7.15 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	$0	$1323
		AGL (SA)	TORRA1	Energy	$14 700	$0	$1029
		AGL (SA)	TORRA2	Energy	$14 700	$0	$1176
		AGL (SA)	TORRA4	Energy	$14 700	$0	$1176
		AGL (SA)	TORRB1	Energy	$14 700	$0	$2499
		AGL (SA)	TORRB2	Energy	$14 700	$0	$2499
		AGL (SA)	TORRB3	Energy	$14 700	$0	$2499
		AGL (SA)	TORRB4	Energy	$14 700	$0	$2499
7.20 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	0.09	$1323

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
		AGL (SA)	TORRA1	Energy	$14 700	0.07	$1029
		AGL (SA)	TORRA2	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRA4	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRB1	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB2	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB3	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB4	Energy	$14 700	0.17	$2499
7.25 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	$0	$1323
		AGL (SA)	TORRA1	Energy	$14 700	$0	$1029
		AGL (SA)	TORRA2	Energy	$14 700	$0	$1176
		AGL (SA)	TORRA4	Energy	$14 700	$0	$1176
		AGL (SA)	TORRB1	Energy	$14 700	$0	$2499
		AGL (SA)	TORRB2	Energy	$14 700	$0	$2499
		AGL (SA)	TORRB3	Energy	$14 700	$0	$2499
		AGL (SA)	TORRB4	Energy	$14 700	$0	$2499
7.30 pm	*$14 700*	Snowy Hydro	ANGAST1	Energy	$14 700	0.09	$1323
		AGL (SA)	TORRA1	Energy	$14 700	0.07	$1029
		AGL (SA)	TORRA2	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRA4	Energy	$14 700	0.08	$1176
		AGL (SA)	TORRB1	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB2	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB3	Energy	$14 700	0.17	$2499
		AGL (SA)	TORRB4	Energy	$14 700	0.17	$2499
Spot Price		**$14 700/MWh**					