Electricity spot prices above $5000/MWh

South Australia, 9 July 2018

7 September 2018

AUSTRALIAN ENERGY REGULATOR

Inquiries about this publication should be addressed to:

Australian Energy Regulator
GPO Box 520
MELBOURNE VIC 3001

Tel: (03) 9290 1444
Fax: (03) 9290 1457

Email: AERInquiry@aer.gov.au
AER Reference: 64263-D18/118391

Amendment Record

Version	Date	Pages
1 version for publication	7/09/2016	19

Contents

1 Introduction

The Australian Energy Regulator 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 energy markets, including the annual State of the energy market report, to assist participants and the wider community.

The AER is required to publish a report whenever the electricity spot price exceeds $5000/MWh in accordance with clause 3.13.7 (d) 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 enforcement action.

2 Summary

On 9 July 2018, the maximum spot price for electricity in South Australia reached $8824/MWh for the 12.30 pm trading interval. In essence, the high price occurred because there was not sufficient low-priced electricity available to meet demand in South Australia. The combination of the following factors saw the dispatch (or 5-minute) price exceed $10 000/MWh from 12.05 pm to 12.20 pm inclusive.

- Network outages in South Australia and Victoria, advised to the market over a week in advance, reduced the ability for low-priced electricity to flow into South Australia from Victoria.
- At the start of the 12.30 pm trading interval, around 43 per cent of all capacity offered by generators in South Australia was priced above $5000/MWh.
- (Low-priced) wind generation in South Australia was relatively low, as forecast.

The market operator's (AEMO) initial forecast for the spot price of electricity for 9 July (published at 12.30 pm on 8 July) predicted the spot price would exceed $5000/MWh for most of the day. Given that the high prices were forecast well in advance, participants had sufficient opportunity to react and shift capacity into lower price bands to mitigate the forecast prices.

Participants waited until high 5-minute (dispatch) prices had occurred early in a trading interval and in response shifted their offers to supply electricity from high to low prices, seeking to increase their output during the high priced trading interval. They did this because they hoped to increase their supply of electricity during the remainder of the trading interval to increase their earnings. The Increase in low priced supply from participants acting this way, lowered prices towards the end of trading intervals, resulting in volatile and lower than expected prices.

Compared to other high-price trading intervals, at the start of the 12.30 pm trading interval, there was less capacity priced below $5000/MWh and after the initial price spike participants shifted less capacity to lower prices and consequently the trading interval price exceeded $5000/MWh.

Rebidding of capacity from low to high prices did not contribute to the price exceeding $5000/MWh.

3 Analysis

On 9 July 2018 the spot price in South Australia exceeded $600/MWh from 9 am to 3.30 pm inclusive. The maximum spot price for the day was $8824/MWh for the 12.30 pm trading interval, triggering the requirement to write this report. In short, the high price was the result of limited ability for electricity to be imported into South Australia from Victoria because of planned network outages, combined with insufficient local low-priced electricity to meet demand.

The following sections examine the actual and expected demand and supply conditions in South Australia on 9 July.

AEMO's 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 at a range of prices 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 form the basis for AEMO's assessments of interconnector capacity, transfers between regions, reserves and conditions that relate to power system security.

3.1 Overview of actual and expected conditions

In accordance with the Electricity Rules, the purpose of this report is to explain why the spot price exceeded $5000/MWh on 9 July. In our weekly electricity reports we report on spot prices greater than three times the weekly average for that region and above $250/MWh. As shown in Table 1, spot prices exceeded these thresholds from 9 am to 3.30 pm inclusive. Because the reasons for these high prices are related to the spot price above $5000/MWh, we include the analysis of these prices in this report rather than the Electricity Weekly for the period 8 to 14 July 2018.

Table 1 shows actual and forecast spot prices, demand and availability for the 9 am to 3.30 pm trading intervals in South Australia. This illustrates the changes in the demand for, and supply of, electricity in South Australia (i.e. provided by generators in South Australia – not including electricity over the interconnectors connected to Victoria) at the time of, and leading up to, the high price events.

Looking more closely, Table 1 shows:

Spot prices

- Based on available information at the time, twelve hours before the high prices occurred, the market operator, AEMO, expected spot prices from 9.30 am to

3.30 pm to reach around $14 000/MWh or above.[1] Four hours before the high prices, AEMO expected fewer extreme prices to occur.

- For the majority of trading intervals in Table 1, actual prices were lower than expected four and twelve hours in advance.
- For the 12.30 pm trading interval, both four and twelve hours ahead, AEMO expected the spot price to be around $14 000/MWh - the actual price was $8824/MWh.

Demand for electricity

- Demand for electricity was higher than expected for most high priced trading intervals. For the 12.30 pm trading interval, demand for electricity was 1599 MW[2], around 160 MW higher than forecast four hours prior.

Local supply (availability) of electricity

- In general, local supply in South Australia was close to expected for the high-priced trading intervals.
- For all trading intervals there was sufficient local supply available to meet local demand for electricity.

Table 1: Actual and forecast spot price, demand for and local supply of electricity in 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
9 am	614	1200	13 999	1735	1748	1769	2606	2609	2442
9.30 am	1253	1200	13 999	1739	1731	1753	2614	2600	2497
10 am	1200	14 500	14 500	1714	1699	1711	2644	2593	2547
10.30 am	2424	14 000	14 500	1657	1614	1653	2655	2595	2603
11 am	2558	14 000	14 500	1611	1559	1576	2655	2596	2606
11.30 am	1949	13 999	14 000	1599	1505	1521	2633	2599	2606
12 pm	4064	14 000	14 000	1595	1488	1493	2597	2608	2610
12.30 pm	**8824**	**13 999**	**14 000**	**1599**	**1441**	**1472**	**2613**	**2621**	**2621**
1 pm	920	1196	14 000	1544	1427	1473	2615	2622	2622
1.30 pm	1750	1196	14 000	1546	1430	1475	2636	2595	2644
2 pm	945	1023	14 000	1546	1433	1489	2647	2693	2687

1 Although not shown in Table 1, 12 hours ahead extreme prices were forecast to occur from 9 am to 9 pm.

2 Demand for electricity for the 12.30 pm trading interval was significantly lower than the winter 2018 year to date peak demand level of 2380 MW. See our Wholesale statistics webpage for peak demand levels for all NEM regions as well as other electricity market data.

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
2.30 pm	889	10 670	14 000	1538	1458	1498	2592	2706	2684
3 pm	1276	1750	14 000	1561	1484	1513	2586	2713	2682
3.30 pm	661	13 999	14 000	1565	1531	1536	2637	2714	2682

3.2 Supply conditions

This section examines the supply side factors that contributed to the high price outcomes.

3.2.1 Network availability

Electricity is transferred between National Electricity Market (NEM) regions via high voltage interconnectors. South Australia is connected to Victoria by the Heywood and MurrayLink interconnectors. Under ideal conditions the Heywood interconnector can deliver up to 600 MW of electricity from Victoria into South Australia, while MurrayLink can transfer up to 220 MW.

Import and export limits control the maximum amount of electricity that can flow between regions across interconnectors. The market operator, AEMO, manages network outages 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. AEMO does this by using generator offers to supply electricity to determine optimal generator output to flow across these lines.

On 9 July, network outages in South Australia and Victoria (advised to the market over a week in advance) reduced the ability for electricity to flow into South Australia from Victoria from around 7 am to 5 pm. To maintain system security, AEMO, implemented constraints to manage planned outages on the Tailem Bend to Tungkillo line in South Australia[3] from 9.30 am to 5 pm and the Ararat to Horsham line in Victoria from 7 am to 5 pm.

The constraints to manage the outage on the Tailem Bend to Tungkillo line limited the flow of electricity across the Heywood interconnector while the constraints managing the Ararat to Horsham line outage limited flows across the MurrayLink interconnector, from Victoria into South Australia. As a result, access to electricity from the rest of the national electricity market was materially reduced.

Table 2 shows actual and forecast net flows of electricity and net import limits into South Australia across the MurrayLink and Heywood interconnectors for the high priced trading intervals (9 am to 3.30 pm).

[3] Appendix A provides an explanation of the network constraint managing the Tailem Bend to Tungkillo line outage.

Table 2: Actual and forecast net network capability

Trading interval	Net flows into South Australia (MW)			Net Import limit (MW)		
	Actual	4 hr forecast	12 hr forecast	Actual	4 hr forecast	12 hr forecast
9 00 am	133	589	503	133	589	503
9.30 am	34	619	491	34	619	491
10 00 am	3	168	74	3	168	74
10.30 am	-8	195	73	-7	195	73
11.00 am	6	208	114	24	208	114
11.30 am	4	208	162	31	208	162
12.00 pm	33	124	183	44	124	183
12.30 pm	**26**	**87**	**185**	**26**	**87**	**185**
1.00 pm	-16	71	182	-14	71	182
1.30 pm	-41	37	180	-36	37	180
2.00 pm	-65	34	181	-26	34	181
2.30 pm	-17	68	186	-17	68	186
3.00 pm	-7	64	187	-7	64	187
3.30 pm	-8	60	185	-8	60	185

*Minus signs in front of numbers in Table 2 indicate flows of electricity from South Australia into Victoria.

Table 2 shows that actual net flows into South Australia were lower than forecast.[4] For the 12.30 pm trading interval only (net) 26 MW flowed into South Australia, significantly lower than the combined nominal limits of both interconnectors (820 MW).

Net flows from 1 pm to 3.30 pm were negative which meant electricity flowed from South Australia in to Victoria counter price (as the wholesale spot price was lower in Victoria then South Australia). This was caused by the constraints managing the outages mentioned above.

3.2.2 Generator availability and offers

This section discusses the amount and price of electricity available on the day. The majority of generation in the South Australian region comes from three main fuel sources; gas, wind and diesel. There is approximately 2500 MW of gas-powered generation, 1750 MW of wind generation and 500 MW of diesel generation installed. There is also approximately 800 MW of rooftop PV installed.[5]

4 We calculate net flows by combining flows across the two interconnectors, some of which are positive and some are negative (hence 'net').

5 AEMO: South Australian Electricity Report November 2017

AEMO dispatch of participant offers

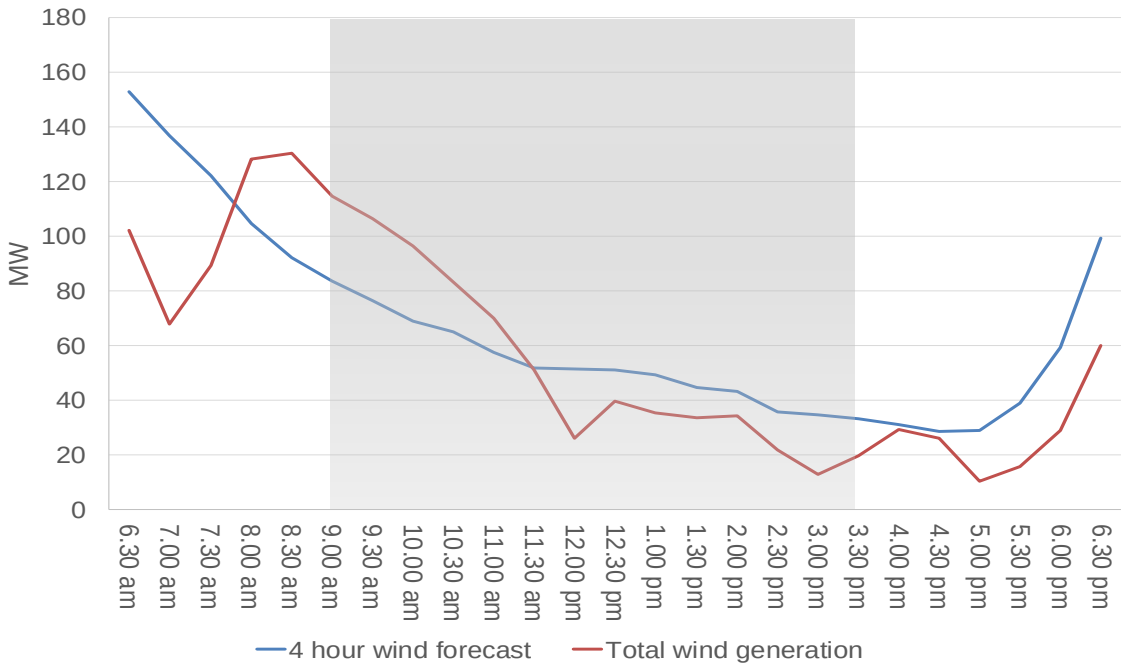
Participants in the National Electricity Market (NEM) choose the amount of electricity or capacity (MW) they offer for each of their generators for dispatch into the market and the price they are prepared to accept ($/MWh) for the energy produced. Participant offers comprise 10 price and quantity (MW) pairs. AEMO aggregates all generator offers from lowest price to highest price and dispatches that generation in ascending order to meet its own forecast of the regional demand for electricity every 5 minutes of the day taking into account the transfer capability of the network.

3.2.2.1 Intermittent Generation

South Australia has around 1770 MW of installed intermittent generation capacity, the vast majority of which is wind (1750 MW), with the remaining 20 MW from solar. At times, a significant proportion of South Australia's energy needs are met by intermittent renewable generation. For example, in 2016, South Australia generated 50 per cent of its electricity from wind and solar.[6] Wind and solar generation is generally priced below $0/MWh.

Figure 1 shows actual (red line) and forecast (blue line) wind output in South Australia on 9 July. The figure shows that, as forecast 4 hours ahead, wind generation dropped to low levels during the high price period (grey shaded area).

Figure 1 Forecast and actual wind generation in South Australia, 9 July 2018



6 See 2017 State of the energy market, p 11.

3.2.2.2 Generator initial offers

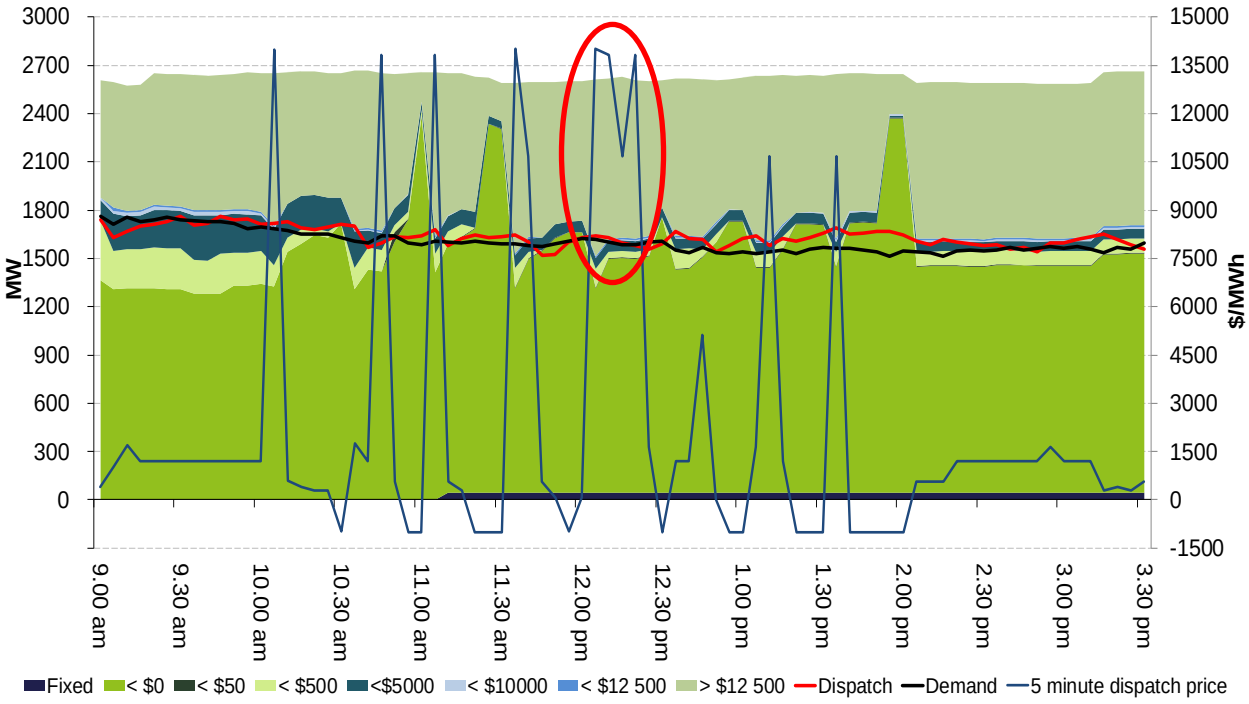
Through initial offers (made the day prior), participants offered, on average, a combined total of around 1439 MW (or 55 per cent) of capacity priced below $5000/MWh over the high price period.

AEMO's forecasts the day before showed that on average, demand for electricity in South Australia was expected to be around 1570 MW. This forecast combined with participant's initial offers resulted in high forecast prices for the majority of the day.

3.2.2.3 Generator closing offers

Figure 2 shows the cumulative offers for generators in South Australia. Also known as closing bids, the figure shows the actual capacity offered at the time of dispatch by generators in South Australia, including amendments to their offers, throughout the day to match changes to their economic and/or physical positions (known as "rebidding"). The figure also shows actual local generation dispatch (red line), actual demand (black line) and the 5-minute dispatch price in South Australia (blue line).

Figure 2: Closing bids, dispatch and dispatch price in South Australia



As shown in Figure 2, the 5-minute dispatch price exceeded $10 000/MWh early in the trading intervals from 10.30 am to 2 pm. On most occasions, in response to these high prices, participants in South Australia shifted capacity from high prices to low prices (demonstrated by the increase in the bottom dark green shaded section), seeking to be dispatched to maximise revenue. As a result, 5-minute dispatch prices were very low for the remainder of these trading intervals, and in turn the 30-minute trading interval 'spot' price remained below $5000/MWh.

The focus of this report is the explanation of the reason for the spot price reaching $8824/MWh for the 12.30 pm trading interval. Compared to other high-price trading intervals, there was less capacity priced below $5000/MWh for the early dispatch

intervals of this trading interval, and participants rebid less capacity to lower prices after the initial price spike. This is reflected in the red ellipse in Figure 2, which shows a reduction in the dark green shaded area (negative priced capacity), giving rise to 5-minute dispatch prices above $10 000/MWh from 12.05 pm to 12.20 pm inclusive.

Figure 2 shows that, on several occasions, although the red line representing generator dispatch crossed through price bands below $5000/MWh, the 5–minute dispatch price exceeded $10 000/MWh. This happened because network or plant constraints limited the ability for cheaper priced generators to be dispatched, requiring higher priced generation to be dispatched to meet demand for electricity.

Appendix B details the generators involved in setting the price during the 12.30 pm trading interval.

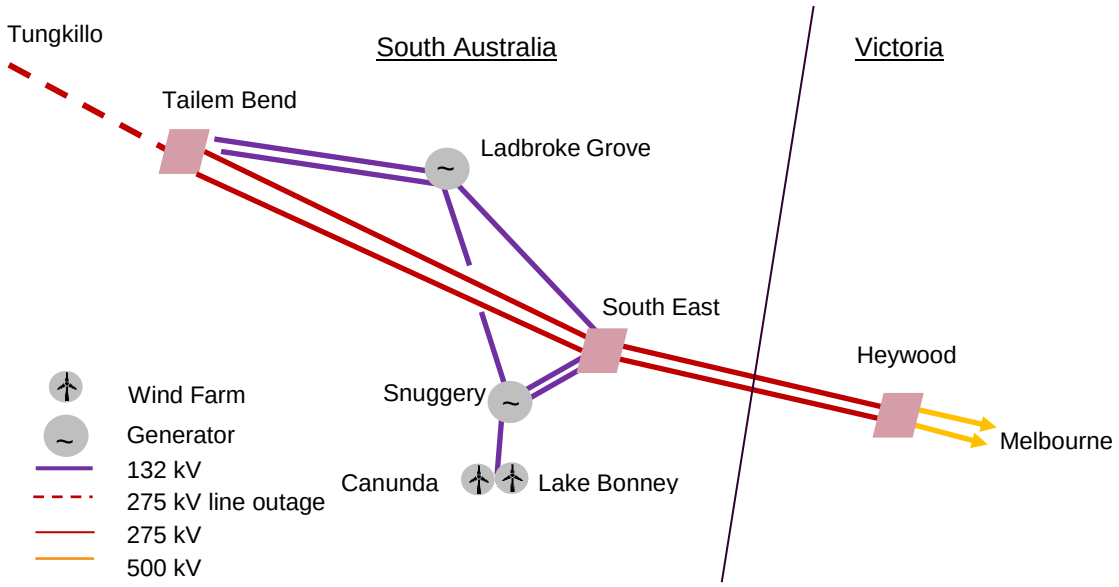
The closing bids for all participants in South Australia with capacity priced at or above $5000/MWh for the 12.30 pm trading interval are set out in Appendix C.

A summary of the significant rebids for the 12.30 pm trading interval are in Appendix E.

Australian Energy Regulator

September 2018

Appendix A: Network Diagram



AEMO invoked the V::S_SETB_TBSE_2 constraint to manage the outage of the Tailem Bend to Tungkillo 275 kV line. The constraint contains six variables, all of which have factors ranging from 0.73 to 1.66:

- generation from Ladbroke units 1 and 2
- generation from Lake Bonney units 2 and 3
- generation from Snuggery unit 1 and
- flow from Vic to SA on the Heywood interconnector.

This means that an increase in generation from these units or an increase in flow into South Australia across Heywood will reduce the headroom of the constraint, until it binds. Conversely, reduced generation from the units or flows into Victoria increases the headroom. If the constraint is binding, flows on Heywood are optimised with local generation in the South East. For example, a MW increase in generation in the South East must be balanced against either a MW reduction in flow into South Australia or a MW increase in flow into Victoria across Heywood.

A similar constraint was also invoked to manage the Ararat to Horsham line outage, however this effected the MurrayLink interconnector and generators in Victoria.

Appendix B: Price setter

The following table identifies 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.[7] The 30-minute spot price is the average of the six dispatch interval prices.

Table 3: price setter for the 12.30 pm trading interval

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
12:05	$14 000.00	Snowy Hydro	ANGAST1	Energy	$14 000.00	0.43	$6020.00
		Snowy Hydro	PTSTAN1	Energy	$14 000.00	0.57	$7980.00
12:10	$13 816.40	Hornsdale Power	HPRG1	Energy	$13 816.40	1.00	$13 816.40
12:15	$10 669.98	Snowy Hydro	LONSDALE	Energy	$10 669.98	1.00	$10 669.98
12:20	$13 816.40	Hornsdale Power	HPRG1	Energy	$13 816.40	1.00	$13 816.40
12:25	$1640.05	Hydro Tasmania	REECE1	Energy	$55.45	2.56	$141.95
		Basslink	T-V-	Energy	$0.01	2.49	$0.02
		Engie	SNUG1	Energy	-$1000.00	-1.50	$1500.00
		EnergyAustralia	MP1	Lower 5 min	$0.15	-2.49	-$0.37
		Hydro Tasmania	CETHANA	Lower 5 min	$0.04	2.49	$0.10
		Engie	LOYYB2	Lower 60 sec	$0.06	-2.49	-$0.15
		Hydro Tasmania	CETHANA	Lower 60 sec	$0.03	2.49	$0.07
12:30	-$1000.00	Origin Energy	OSB-AG	Energy	-$1000.00	0.23	-$230.00
		Origin Energy	QPS5	Energy	-$1000.00	0.15	-$150.00
		EnergyAustralia	AGLHAL	Energy	-$1000.00	0.13	-$130.00
		Engie	DRYCGT1	Energy	-$1000.00	0.05	-$50.00
		Engie	DRYCGT2	Energy	-$1000.00	0.05	-$50.00
		Engie	DRYCGT3	Energy	-$1000.00	0.06	-$60.00
		Engie	MINTARO	Energy	-$1000.00	0.10	-$100.00
		Snowy Hydro	LONSDALE	Energy	-$1000.00	0.02	-$20.00
		Snowy Hydro	PTSTAN1	Energy	-$1000.00	0.08	-$80.00
		AGL (SA)	TORRA1	Energy	-$1000.00	0.06	-$60.00
		AGL (SA)	TORRA3	Energy	-$1000.00	0.06	-$60.00
Spot Price		**$8824/MWh**					

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

Appendix C: Closing bids

Figures C1 to C4 highlight the half hour closing bids for participants in South Australia with significant 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 C1 - AGL (Torrens Island, The Bluff, Hallett Wind Farm, North Brown Hill Wind Farm) closing bid prices, dispatch and spot price

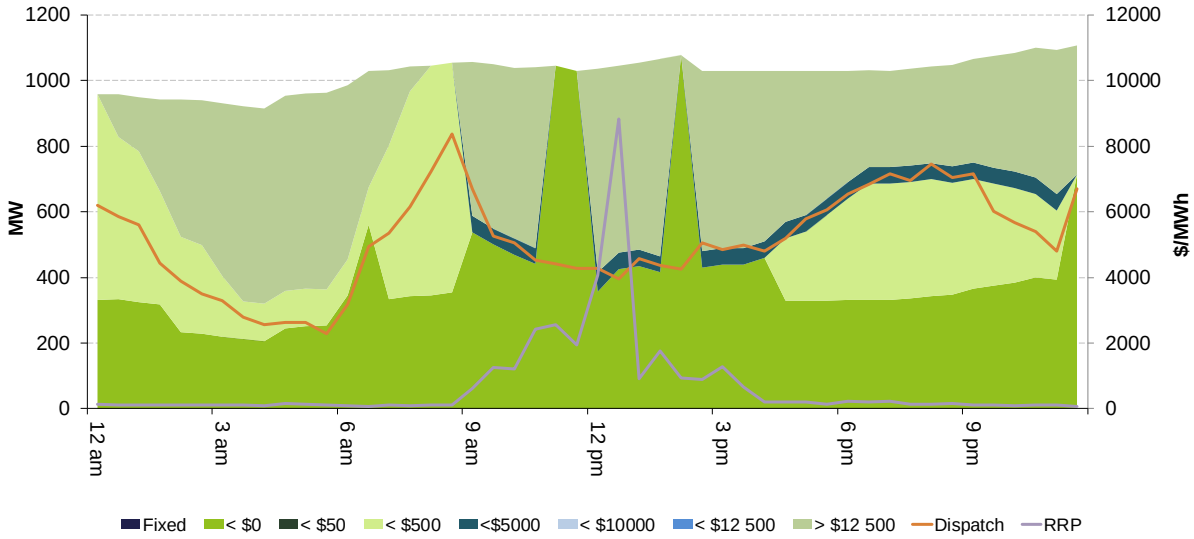


Figure C2 - EnergyAustralia (Hallett Wind Farm, Waterloo) closing bid prices, dispatch and spot price

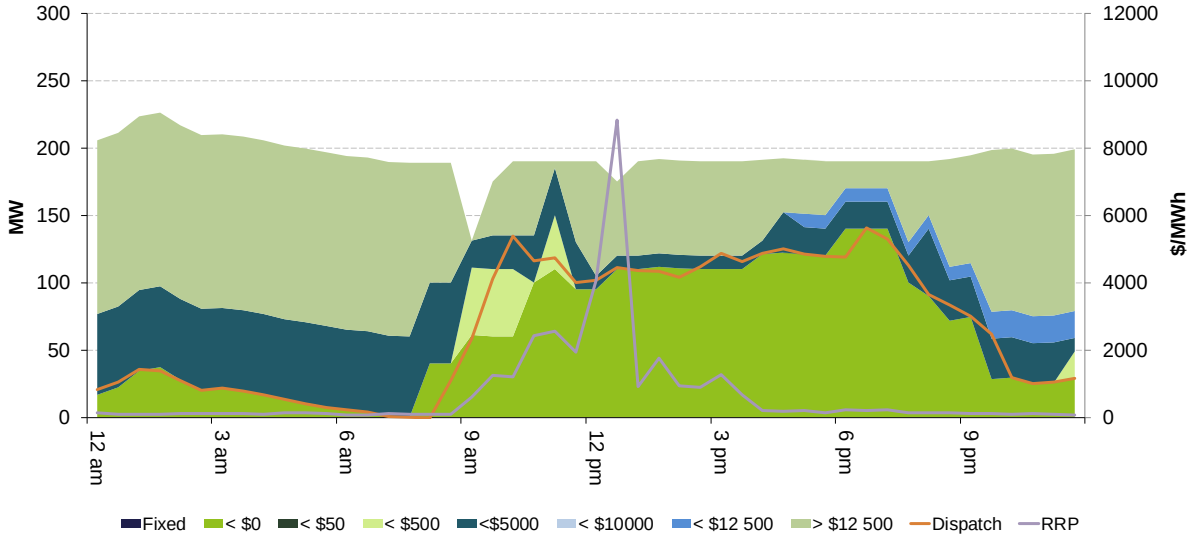


Figure C3 – Origin (Ladbroke Grove, Osborne, Quarantine) closing bid prices, dispatch and spot price

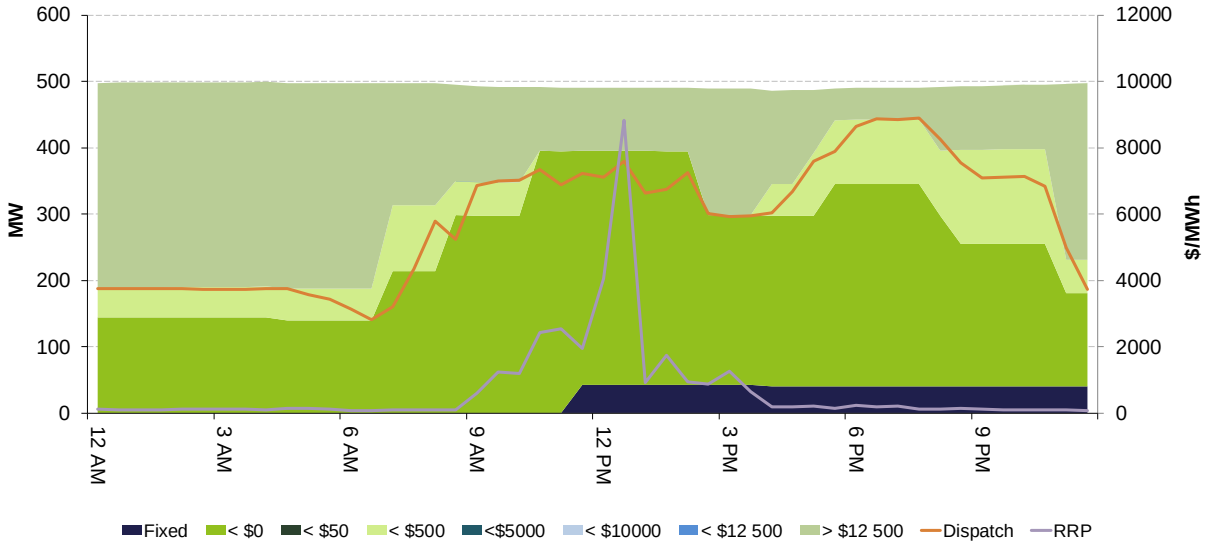
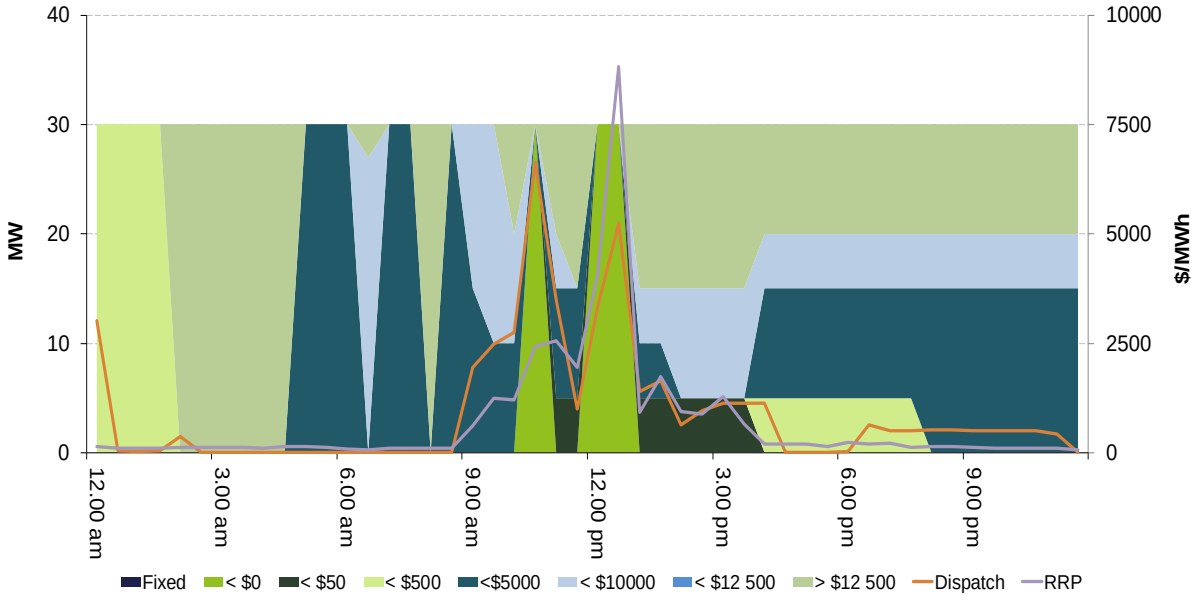


Figure C4 – Hornsdale Power Reserve closing bid prices, dispatch and spot price



Appendix D: Market Notices

The following market notice notified the market of the network issues in South Australia.

Market Notice	Type	Date of issue	Last Changed
63182	General Notice	12/06/2018 09:26:12	12/06/2018 09:26:12

External Reference

Planned outage of Tungkillo - Tailem Bend 275kV line in the SA region previously scheduled for 31/05/2018 has now been scheduled to 9/07/2018

Reason

AEMO ELECTRICITY MARKET NOTICE

The Tungkillo - Tailem Bend 275kV line in South Australia (SA) region which was previously planned to be out of service from 1/05/2018 0830hrs to 01/06/2018 1730 hrs (refer to market notice 62629) has now been rescheduled to the outage period 09/07/2018 0830 hrs - 10/07/2018 1730hrs.

During this outage, SA will remain connected to the rest of the NEM via the Tailem Bend - Cherry Garden 275kV line and the 132kV network.

A credible contingency event on the Tailem Bend - Cherry Garden 275 kV line during this planned outage will sever the 275kV connections between the NEM and SA. If SA remains connected to the NEM via the 132kV network, this will pose a system security issue.

If the above credible contingency occurs, 35 MW of raise and lower regulation FCAS will be sourced from within SA.

If this occurs, AEMO will take all necessary steps as outlined in Section 6.1 of SO-OP-3715 Power System Security Guideline to separate the 132kV network and therefore manage an orderly separation of SA from the NEM.

Diyoni Hoole

AEMO Operations

Appendix E: 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 capacity involved, the change in the price of the capacity was being offered and the rebid reason.

Table 4: Significant rebids for 12.30 pm trading interval

Submit time	Time effective	Participant (region)	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
8.33 am		EnergyAustralia	Hallett	30	13 999	279	0820~A~Band adj due to change in sa p5 price below fcst @0905 578.81<13100 sl~
8.49 am		Engie	Snuggery	40	14 500	<1750	0845~A~Repsonse to unforecast dispatch price~
9.26 am		Snowy Hydro	Lonsdale	10	10 766	302	09:16:00 A SA 5Min pd price $608.98 higher than 5min pd 10:05@09:11 ($1,200.00)
10.10 am		Engie	Pelican Point	10	N/A	-1000	0925~P~Update avail: match current load~
10.39 am		EnergyAustralia	Hallett	35	<579	13 999	1020~P~Adj bands due to fuel and constraint mgmt ref: v::s_setb_tbse_2 sl~
10.53 am		Origin Energy	Quarantine	74	14 500	-1000	1052A Constraint management - v::s_setb_tbse_2 sl
11.13 am		AGL Energy	Torrens Island	-30	-1000	N/A	1112~P~020 Reduction in avail cap~208 rts later than exp
12.01 pm	12.10 pm	Origin Energy	Osborne	48	14 500	-1000	1201A Unforecast dispatch volatility sl
12.01 pm	12.10 pm	Origin Energy	Quarantine	49	14 500	-1000	1201A Unforecast dispatch volatility sl

Submit time	Time effective	Participant (region)	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
12.15 pm	12.25 pm	EnergyAustralia	Hallett	20	13 999	-1000	1210~A~Band adj due to material change in sa p5 price below fcst @ 1220 10669.98<14000 & constraint mgmt ref:v::s_setb_tbse_2 sl~
12.21 pm	12.30 pm	Snowy Hydro	Lonsdale	21	>302	-1009	12:20:05 A SA 5Min actual price $12,176.35 lower than 5min pd 12:25@12:16 ($1,640.05)
12.21 pm	12.30 pm	Snowy Hydro	Pt Stanvac	65	>300	-1004	12:20:05 A SA 5Min actual price $12,176.35 lower than 5min pd 12:25@12:16 ($1,640.05)
12.23 pm	12.30 pm	AGL Energy	Torrens Island	80	14 500	-1000	1201~A~050 Chg in aemo pd~51 average cumulative pd demand increase sa 39mw