Electricity spot prices above $5000/MWh

South Australia, 1 December 2016, (12.16 am event)

2 February 2017

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: 61334-D16/163748

Amendment Record

Version	Date	Pages
1 version for publication	02/02/2017	30

Contents

1 Introduction....4
2 Summary....5
3 Analysis....6
3.1. Network Availability....6
3.2. Under frequency load shedding and demand....9
3.3. Generator availability and rebidding....9
3.3.1 Offers and rebidding....9
3.3.2 Availability....10
Appendix A: Rebids....12
Appendix B: Price setter....19
Appendix C: Closing bids....22
Appendix D: Relevant Market Notices....24
Appendix E: Directions....30

1 Introduction

The AER is required to publish a report whenever the electricity spot price exceeds $5000/MWh.[1] The report must:

- describe the significant factors contributing to the spot price exceeding $5000/MWh, including the withdrawal of generation capacity and network availability;
- assess whether rebidding contributed to the spot price exceeding $5000/MWh;
- identify the marginal generating units; and
- identify all generating 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.

On 1 December the spot price for electricity in South Australia reached $13 767/MWh at 2 am, $5066/MWh at 3 am and $6674/MWh at 3.30 am, thereby exceeding the reporting threshold. This report examines the circumstances behind the spot price exceeding $5000/MWh on these occasions.

[1] This requirement is set out in clause 3.13.7 (d) of the National Electricity Rules.

2 Summary

On 1 December the spot price for electricity in South Australia reached $13 767/MWh at 2 am, $5066/MWh at 3 am and $6674/MWh at 3.30 am.

These high priced events were a result of South Australia being separated from the NEM.

Planned network outages in the south west of Victoria resulted in only one line connecting South Australia to Victoria via the Heywood Interconnector. At 12.16 am a fault occurred on this line, tripping the interconnector and separating South Australia from the NEM.[2] Supply to Alcoa's Aluminium Smelter at Portland was also interrupted.

In order to restore the frequency of the power system in South Australia following the separation, Under Frequency Load Shedding (UFLS), designed to manage such occurrences, was initiated with around 190 MW of load shed. A further 40 MW of load, not associated with the UFLS scheme, was also interrupted. Load was restored by 1.45 am.

Soon after the separation, AEMO invoked constraints to manage the power system, resulting in the dispatch price rising sharply. There were 16 dispatch intervals where the price was above $5000/MWh. With only 90 MW of generation capacity in South Australia priced between $0/MWh and $10 000/MWh, the sudden loss of up to 250 MW of imports from Victoria across Heywood meant high priced generation was dispatched to meet demand.

The planned network outage was recalled and returned to service at around 4 am, South Australia was reconnected to the rest of the NEM by 4.46 am.

During the separation event, in order to maintain the power system, AEMO issued three directions affecting two generators and South Australia's largest load: BHP Billiton's mine at Olympic Dam.

Rebidding of capacity from low to high prices did not contribute to the high prices in this event.

[2] Murraylink continued to operate at around 100 MW for a majority of the incident but it does not provide a synchronous connection to the rest of the NEM.

3 Analysis

Table 1 shows the actual and forecast spot price and demand for the trading intervals during which the spot price exceeded $5000/MWh (in bold) and other relevant high-price trading intervals following the separation event at 12.16 am.

Table 1: Actual and forecast spot prices

Trading interval	Spot Price ($/MWh)		
	Actual	0.5 hr forecast	4 hr forecast
12.30 am	2507	125	80
1 am	1963	125	80
1.30 am	2373	13 999	80
2 am	**13 767**	**14 000**	**62**
2.30 am	377	1498	60
3 am	**5066**	**1499**	**63**
3.30 am	**6674**	**14 000**	**80**
4 am	2191	13 300	80
4.30 am	53	13 300	80
5 am	2084	13 999	80

Considering that in this case the high prices were caused by an unplanned outage of the Heywood interconnector, it is not surprising that the high spot prices were not forecast four hours ahead. The majority of prices were lower than forecast 30 minutes ahead.

3.1 Network Availability

This section examines the change in network capability approaching the event and its contribution to price outcomes.

Immediately prior to the incident there were two planned network outages underway:

- Heywood No.2 500kV busbar, first notified to the market through the Network Outage Schedule (NOS) on 22 August and commenced 30 November 2016.[3]
- Heywood – APD No.2 500kV line, first notified to the market through the NOS on 7 November and commenced 28 November 2016.

Both outages were due to be completed by 4 pm on 1 December 2016.

[3] There was also notification to the market through market notice 55515 on 31 October 2016.

These planned outages placed South Australia on a single contingency as there was only one 500kV line connecting South Australia and Victoria. When these conditions occur, AEMO set a 35 MW requirement for local regulation services in South Australia. This would normally result in high FCAS prices, however an event several days earlier had resulted in sufficiently high FCAS prices to exceed the cumulative price threshold and FCAS prices were capped to $300/MW.

On 30 November, after both planned outages had commenced, AEMO issued market notice 55904 declaring a Lack of Reserve Condition 2 in South Australia which stated:

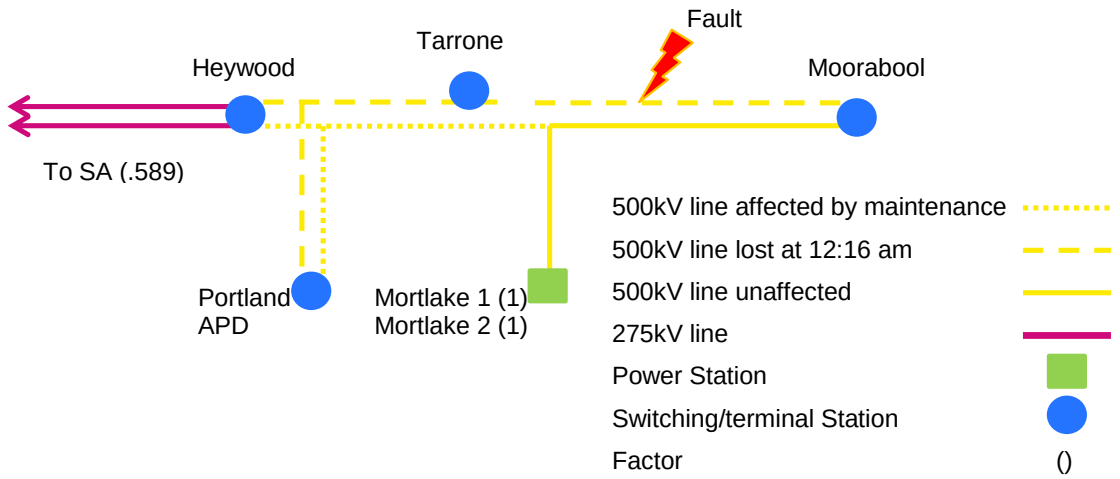
"South Australia region could separate from the rest of the NEM and is likely to result in interruptions to power supplies in South Australia.

There are sufficient capacity reserves in the South Australia region to meet electricity demand but following the next credible contingency it may not be possible to bring the required additional capacity into service in time to avoid automatic under-frequency load shedding causing interruptions to power supplies in South Australia."

As a result of the two planned outages, two other lines in the vicinity were affected: the Mortlake to Heywood 500kV line and the Moorabool to Mortlake to Heywood 500kV line.

Figure 1 shows the area of the network affected before and after the fault occurred. The blue dots are the high voltage switching (or terminal) stations and the green square is the Mortlake power station, which is comprised of two units. The planned outages are represented by the short dashed lines while the longer dashed lines represent the network affected by the fault.

Figure 1: Network diagram

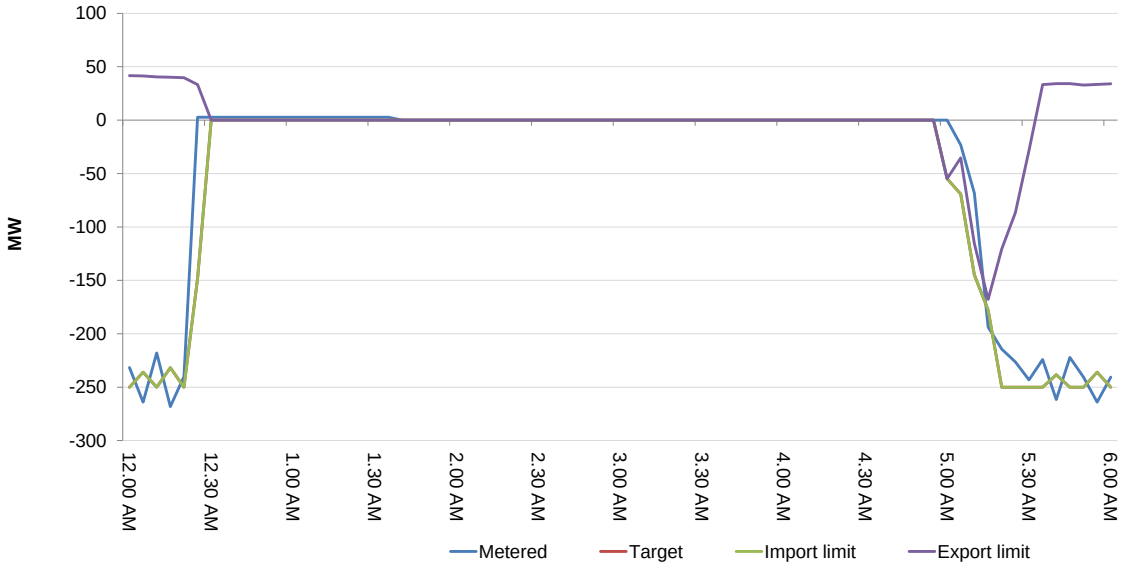


At 12.16 am the Heywood interconnector tripped when the remaining Moorabool to Tarrone 500kV line failed and South Australia separated from Victoria, as highlighted by the fault symbol in Figure 1.[4] Immediately prior to the separation, South Australia

[4] AEMO has published a preliminary report into events on the day http://www.aemo.com.au/-/media/Files/Media_Centre/2016/1-December-SA-separation-report---081216_AEMO.pdf, the final report is due 28 February 2017

was importing 250 MW from Victoria across the Heywood interconnector. Once physically separated, it takes up to two dispatch intervals for the market dispatch engine to reflect this in targets. Hence, in Figure 2 the target flow (green line) hit 0 MW by 12.30 am.

Figure 2: Heywood Interconnector import limits, target and metered flows



Prior to 12.16 am, Murraylink, the DC interconnector between Victoria and South Australia, was importing at its nominal limit of 220 MW. Once the separation event occurred, Murraylink's import limit reduced to a maximum of 100 MW, except for four dispatch interval from around 12.45 am where flow was forced into Victoria.[5] Figure 3 shows the target (blue line) tracking the import limit (red line) meaning Murraylink's target followed its import limit.

Figure 3: Murraylink interconnector import limits and target flows

5 Murraylink is a DC interconnector and cannot transfer FCAS from the rest of the NEM into South Australia as it is not a synchronous link.

3.2 Under frequency load shedding and demand

The loss of the Heywood interconnector when power is flowing into South Australia results in an undersupply of generation and consequently the frequency in South Australia will fall. Under Frequency Load Shedding (UFLS) is triggered once the frequency drops below 49 Hz and is designed to reduce demand, in blocks, to arrest the falling frequency until supply matches demand and the frequency is restored.

At 12.16 am the UFLS scheme shed around 190 MW of load in South Australia. A decrease in load is reflected as a decrease in demand in market systems. Another 40 MW reduction also occurred, not associated with the UFLS scheme.

Figure 4 shows demand in South Australia and the effect on demand of UFLS compared to a recent similar day.

Figure 4: Demand and UFLS

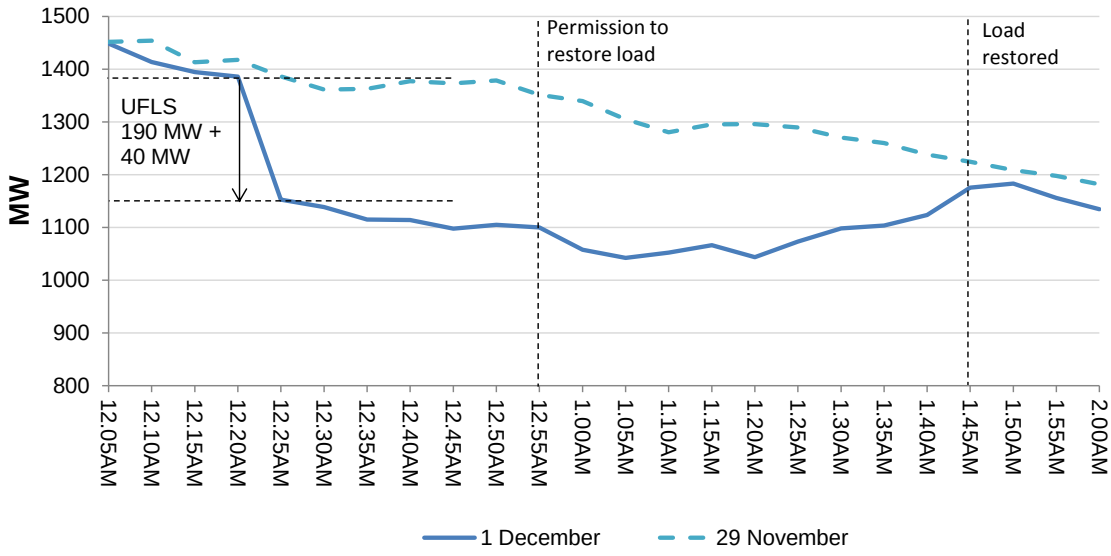


Figure 4 highlights the effect that the load shedding had on demand in South Australia with demand falling around 230 MW at 12.25 am. Under normal conditions, demand during this time slowly decreases as shown by the blue dotted line. Permission to restore load was given at around 12.55 am and all load interrupted by UFLS was restored by 1.45 am.

3.3 Generator availability and rebidding

This section discusses changes to the price and capacity offered by generators, and demand conditions relevant to the pricing event.

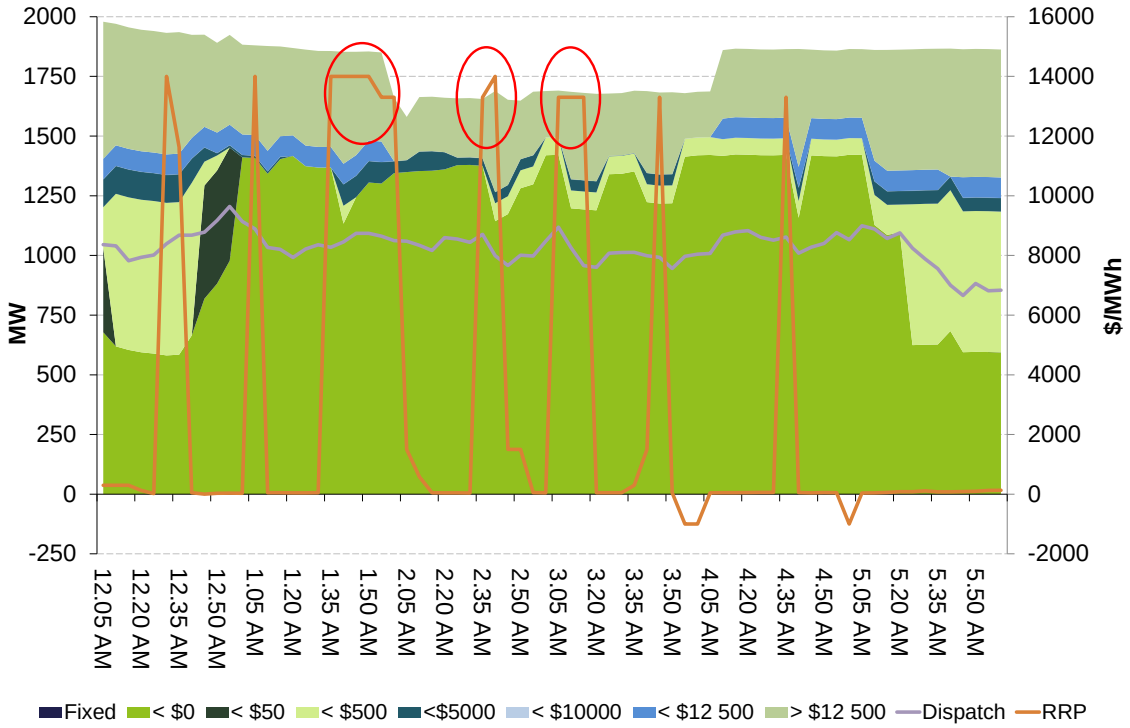
3.3.1 Offers and rebidding

While South Australia was separated from the NEM, prices were forecast in the short-term to be high. However this was not as a result of significant rebidding of capacity from low to high prices. Significant rebidding occurred from high to low prices. Following high price dispatch intervals at the start of the trading interval, participants

rebid capacity from high to low prices, making spot prices lower than what was forecast half an hour ahead for most trading intervals during the period (see Table 1). A summary of the rebids in response to the high prices can be found in Appendix A.

Figure 5 shows the dispatch price (orange line), level of local generation dispatched (grey line) and closing offers in South Australia. The red ellipses encircle the periods where spot prices exceeded $5000/MWh. This shows that following high dispatch prices at the start of a trading interval, participants in South Australia rebid capacity from high to low prices on most occasions (increase in bottom green section after a price spike), resulting in lower dispatch prices for the remainder of the trading interval.

Figure 5: Initial bids of South Australia generators and dispatch price



It is not unusual, for participants to rebid capacity following a high price event to increase their volume and hence revenue in the trading interval. Consequently, participants waited until prices actually went high before rebidding capacity to low prices in order to increase their dispatch.

Appendix B details the generators involved in setting the price during the high-price periods, and how that price was determined by the market systems.

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 C.

3.3.2 Availability

As a result of being separated from the rest of the NEM, AEMO invoked a series of FCAS constraints to ensure frequency stability within South Australia. As a result of these constraints being invoked, energy output of AGL's Torrens Island B power

station was constrained down to provide FCAS, for the majority of the time, by around 150 MW despite this capacity being priced at the price floor.

AEMO directed Engie's Pelican Point power station to reduce its output by around 60 MW which was priced at $300/MWh. Two other directions were also issued:

- to Torrens Island A – to rebid provide up to 10 MW of Raise 6 Second FCAS, and
- to Olympic Dam – to reduce their demand.

Appendix E provides more detail on these directions.

Australian Energy Regulator

February 2017

Appendix A: Rebids

The below tables show significant rebids by participants with generation in South Australia. 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 being offered and the rebid reason.

Rebids for 1 am

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
12.28 am	12.35 am	Engie	Dry Creek	92	>13 300	-1000	0028A response to SA MPC
12.31 am	12.40 am	AGL Energy	Torrens Island	474	>60	0	0030~A~040 chg in AEMO disp~ic flow decrease vs PD SA 0mw v $299.69 0035
12.32 am	12.40 am	Engie	Dry Creek	46	13 300	-1000	0031A response to SA MPC
12.32 am	12.40 am	Engie	Pelican Point	65	>80	-1000	0031A response to SA MPC
12.32 am	12.40 am	Engie	Snuggery	42	1499	-1000	0031A response to SA MPC
12.34 am	12.45 am	Energy Australia	Hallett	60	>579	-1000	0030~A~band ADJ due to mat change in SA price SL~

Rebids for 1.30 am

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
12.55 am	1.05 am	AGL	Torrens A	-10 (R6 second)	>0	N/A	0045~A~060 unfcast network constraint~61 constr on/off out of merit order. FCAS
1.08 am	1.15 am	Energy Australia	Hallett	20	>579	-1000	0055~A~band adj due to mat change in sa price SL~
12.44 am	12.50 am	Engie	Dry Creek	123	>13 300	-1000	0044A response to SA MPC in 5MPD

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
12.53 am	1.05 am	Snowy Hydro	Pt Stanvac	42	-1004	14 056	00:51:00 A SA 5min PD price $13,928.78 lower than 30min PD 01:05@00:32 ($70.21)
1.02 am	1.10 am	Snowy Hydro	Lonsdale	21	14 126	-1009	00:56:00 A SA 5min PD price $13,928.78 higher than 5min PD 01:05@00:51 ($13,998.99)
1.02 am	1.10 am	Snowy Hydro	Pt Stanvac	42	14 056	-1004	00:56:00 A SA 5min PD price $13,928.78 higher than 5min PD 01:05@00:51 ($13,998.99)
1.25 am	1.17 am	AGL	Torrens A	10 (R6 second)	N/A	13 800	0045~A~010 AEMO direction~directed to provide r6sec services by AEMO

Rebids for 2 am

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
1.13 am	1.20 am	Engie	Dry Creek	10	13 300	-1000	0112P unit not responding to target change
1.18 am	2.05 am	AGL Energy	Torrens Island	274	485	-1000	0031~A~050 chg in AEMO PD~55 PD price increase SA +$13192
1.32 am	1.40 am	Engie	Dry Creek	-36	13 300	N/A	0131P unit failing to respond to set point changes: maintain current load
1.33 am	1.40 am	Snowy Hydro	Angaston	37	N/A	-997	01:11:00 A SA 5min PD price $11,801.40 higher than 5min PD 01:35@01:06 ($13,300.20)

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
1.34 am	1.45 am	Energy Australia	Hallett	60	13 999	-1000	0125~A~band adj due to mat change in SA 5PD demand SL~
1.45 am	1.55 am	Energy Australia	Hallett	30	579	13 999	0140~A~band adj due to mat change in SA price SL~

Rebids for 2.30 am

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
1.13 am	1.20 am	Engie	Dry Creek	10	13 300	-1000	0112P unit not responding to target change
1.13 am	2.05 am	Snowy Hydro	Lonsdale	21	14 126	-1009	00:32:00 A SA 30min PD price $13,920.00 higher than 30min PD 02:05@00:02 ($13,999.99)
1.13 am	2.05 am	Snowy Hydro	Pt Stanvac	42	14 056	-1004	00:32:00 A SA 30min PD price $13,920.00 higher than 30min PD 02:05@00:02 ($13,999.99)
1.18 am	2.05 am	AGL Energy	Torrens Island	274	485	-1000	0031~A~050 chg in AEMO PD~55 PD price increase SA +$13192
1.36 am	2.05 am	Snowy Hydro	Angaston	37	13 958	-997	00:32:00 A SA 30min PD price $13,920.01 higher than 30min PD 03:00@00:02 ($14,000.00)
1.49 am	2.00 am	Engie	Port Lincoln	42	14 000	-1000	0148A response to SA MPC
1.58 am	2.05 am	Engie	Dry Creek	77	>13 300	-1000	0158A response to SA MPC IN 5MPD
1.58 am	2.05 am	Engie	Dry Creek	15	1498	-1000	0158A response to SA MPC in 5MPD

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
2.08 am	2.15 am	Engie	Snuggery	10	1499	-1000	0208A response to SA MPC in 5MPD
2.12 am	2.20 am	Energy Australia	Hallett	20	579	-1000	0145~A~band adj due to mat change in SA price SL~

Rebids for 3 am

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
12.34 am	12.45 am	Energy Australia	Hallett	10	13 999	-1000	0030~A~band adj due to mat change in SA price SL~
1.08 am	1.35 am	Energy Australia	Hallett	20	13 999	-1000	0055~A~band adj due to mat change in SA price SL~
1.09 am	1.35 am	Energy Australia	Hallett	20	-1000	13 999	0105~A~band adj due to mat change in SA 5PD prices SL~
1.25 am	1.35 am	Energy Australia	Hallett	40	13 999	579	0120~E~correcting trader error in previous bid SL~
1.36 am	2.05 am	Snowy Hydro	Angaston	37	13958	-997	00:32:00 A SA 30min PD price $13,920.01 higher than 30min PD 03:00@00:02 ($14,000.00)
1.36 am	2.05 am	Snowy Hydro	Lonsdale	20	14126	-1009	00:32:00 A SA 30min PD price $13,920.01 higher than 30min PD 03:00@00:02 ($14,000.00)
1.36 am	2.05 am	Snowy Hydro	Pt Stanvac	34	14 056	-1004	00:32:00 A SA 30min PD price $13,920.01 higher than 30min PD 03:00@00:02 ($14,000.00)

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
2.22 am	3.05 am	Energy Australia	Hallett	40	579	13 999	0215~A~band adj for mat change in sa 5PD prices SL~
2.31 am	2.40 am	Engie	Dry Creek	-36	13 300	N/A	0231P unit still not responding to load changes. maintain current load.
2.34 am	2.45 am	Engie	Port Lincoln	42	14 000	-1000	0234A respond to SA MPC
2.34 am	2.45 am	Energy Australia	Hallett	70	13 999	-1000	0220~a~band adj due to mat change in SA price SL~
2.46 am	2.55 am	Engie	Dry Creek	87	>1498	-1000	0245A response to SA MPC in 5MPD
2.46 am	2.55 am	Engie	Snuggery	32	1499	-1000	0245A response to SA MPC in 5MPD

Rebids for 3.30 am

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
2.32 am	2.40 am	Engie	Mintaro	30	14 000	-1000	0232A respond to SA MPC and extended heywood outage
2.34 am	2.45 am	Engie	Port Lincoln	12	14 000	-1000	0234A respond to SA MPC
2.40 am	3.05 am	Snowy Hydro	Angaston	37	13 958	-997	02:32:00 A SA 30min PD price $12,501.20 higher than 30min PD 03:00@02:02 ($14,000.00)
2.40 am	3.05 am	Snowy Hydro	Lonsdale	20	14 126	-1009	02:32:00 A SA 30min PD price $12,501.20 higher than 30min PD 03:00@02:02 ($14,000.00)

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
2.40 am	3.05 am	Snowy Hydro	Pt Stanvac	42	14 056	-1004	02:32:00 A SA 30min PD price $12,501.20 higher than 30min PD 03:00@02:02 ($14,000.00)
2.40 am	2.50 am	Engie	Dry Creek	15	N/A	-1000	0239P unit in local control: site manned
2.46 am	2.55 am	Engie	Dry Creek	10	>13 300	-1000	0245A response to SA MPC in 5MPD
3.09 am	3.20 am	Energy Australia	Hallett	35	13 999	-1000	0240~A~band adj due to mat chagne in SA 30PD prices SL~
3.12 am	3.20 am	Engie	Dry Creek	83	>1498	-1000	0311A response to SA MPC
3.12 am	3.20 am	Engie	Snuggery	32	1499	-1000	0311A response to SA MPC

Rebids for 4 am

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
2.32 am	2.40 am	Engie	Mintaro	30	14 000	-1000	0232A respond to SA MPC and extended heywood outage
2.40 am	3.05 am	Snowy Hydro	Angaston	37	13 958	-997	02:32:00 A SA 30min PD price $12,501.20 higher than 30min PD 03:00@02:02 ($14,000.00)
2.40 am	3.05 am	Snowy Hydro	Lonsdale	20	14 126	-1009	02:32:00 A SA 30min PD price $12,501.20 higher than 30min PD 03:00@02:02 ($14,000.00)

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
2.40 am	3.05 am	Snowy Hydro	Pt Stanvac	42	14 056	-1004	02:32:00 A SA 30min PD price $12,501.20 higher than 30min PD 03:00@02:02 ($14,000.00)
2.46 am	2.55 am	Engie	Dry Creek	25	>13 300	-1000	0245A response to SA MPC in 5MPD
3.09 am	3.20 am	Energy Australia	Hallett	15	13 999	-1000	0240~A~band adj due to mat chagne in SA 30PD prices SL~

Rebids for 5 am

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
2.42 am	4.05 am	Snowy Hydro	Angaston	37	13 958	-997	02:32:00 A SA 30min PD price $13,920.01 higher than 30min PD 04:30@02:02 ($14,000.00)
2.42 am	4.05 am	Snowy Hydro	Lonsdale	20	14 126	-1009	02:32:00 A SA 30min PD price $13,920.01 higher than 30min PD 04:30@02:02 ($14,000.00)
2.42 am	4.05 am	Snowy Hydro	Pt Stanvac	42	14 056	-1004	02:32:00 A SA 30min PD price $13,920.01 higher than 30min PD 04:30@02:02 ($14,000.00)
3.13 am	4.05 am	Energy Australia	Hallett	15	13 999	-1000	0310~A~band adj for mat change in SA 30PD prices SL~
4.32 am	4.40 am	Engie	Dry Creek	138	>1498	-1000	0432A response to SA MPC
4.32 am	4.40 am	Engie	Mintaro	84	14 000	-1000	0432A response to SA MPC
4.32 am	4.40 am	Engie	Snuggery	42	1499	-1000	0432A response to SA MPC

Appendix B: Price setter

The following table identifies for the trading intervals 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.[6] The 30-minute spot price is the average of the six dispatch interval prices. Prices in italics are capped at the Market Price Cap of $14 000/MWh.

Table 2: price setter for the 2 am trading interval

DI	Dispatch Price	Participant	Unit	Service	Offer price	Marginal change	Contribution
01:35	$13 300.40	Engie	DRYCGT1	Energy	$13 300.40	1.00	$13 300.40
01:40	$13 300.30	Engie	DRYCGT2	Energy	$13 300.30	1.00	$13 300.30
01:45	$153 260.27	Generation deficit constraint			$16 800.00	0.79	$132 720.00
		Origin Energy	QPS5	Energy	$14 000.00	0.57	$7980.00
		EnergyAustralia	AGLHAL	Energy	$578.81	0.57	$329.92
		Snowy Hydro	UPPTUMUT	Energy	$49.51	0.55	$27.23
		Engie	LOYYB1	Energy	$10.50	0.05	$0.53
		Engie	LOYYB2	Energy	$10.50	0.05	$0.53
		Origin Energy	QPS5	Lower reg	$14 000.00	0.57	$7980.00
		Engie	PPCCGT	Lower reg	$14 000.00	-0.57	-$7980.00
		EnergyAustralia	YWPS1	Lower 60 sec	$0.08	-0.09	-$0.01
		Engie	LOYYB1	Lower 60 sec	$0.02	0.05	$0.00
		Engie	LOYYB2	Lower 60 sec	$0.02	0.05	$0.00
		EnergyAustralia	MP2	Lower 6 sec	$0.03	-0.09	$0.00
		Engie	LOYYB1	Lower 6 sec	$0.02	0.05	$0.00
		Engie	LOYYB2	Lower 6 sec	$0.02	0.05	$0.00
		Origin Energy	QPS5	Raise reg	$14 000.00	-0.57	-$7980.00
		AGL (SA)	TORRB2	Raise reg	$14 000.00	-0.57	-$7980.00
		AGL (SA)	TORRB3	Raise reg	$14 000.00	-0.57	-$7980.00
		AGL (SA)	TORRB4	Raise reg	$14 000.00	1.71	$23 940.00
		AGL (SA)	TORRA1	Raise 6 sec	$13 799.99	0.79	$10 901.99
		AGL (SA)	TORRA1	Energy	-$1000.00	-2.38	$2380.00
		AGL (SA)	TORRB2	Energy	-$1000.00	0.57	-$570.00
		AGL (SA)	TORRB3	Energy	-$1000.00	0.57	-$570.00
		AGL (SA)	TORRB4	Energy	-$1000.00	0.57	-$570.00
01:50	$14 000.00	Origin Energy	LADBROK1	Energy	$14 000.00	0.50	$7000.00
		Origin Energy	LADBROK2	Energy	$14 000.00	0.50	$7000.00
01:55	$13 300.30	Engie	DRYCGT2	Energy	$13 300.30	1.00	$13 300.30
02:00	$13 300.20	Engie	DRYCGT3	Energy	$13 300.20	1.00	$13 300.20
Spot Price		**$13 767/MWh**					

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

Table 3: price setter for the 3 am trading interval

DI	Dispatch Price	Participant	Unit	Service	Offer price	Marginal change	Contribution
02:35	$13 300.40	Engie	DRYCGT1	Energy	$13 300.40	1.00	$13 300.40
02:40	$13 998.99	EnergyAustralia	AGLHAL	Energy	$13 998.99	1.00	$13 998.99
02:45	$1498.80	Engie	SNUG1	Energy	$1498.80	1.00	$1498.80
02:50	$1498.80	Engie	SNUG1	Energy	$1498.80	1.00	$1498.80
02:55	$53.97	AGL Energy	BW02	Energy	$55.96	0.47	$26.30
		AGL Energy	BW03	Energy	$55.96	0.16	$8.95
		AGL Energy	BW04	Energy	$55.96	0.31	$17.35
		Engie	LOYYB1	Energy	$10.50	0.09	$0.95
		Engie	LOYYB2	Energy	$10.50	0.09	$0.95
		Hydro	TUNGATIN	Lower 5 min	$0.39	-0.17	-$0.07
		EnergyAustralia	MP2	Lower 60 sec	$0.15	-0.17	-$0.03
		Hydro	GORDON	Lower 6 sec	$0.12	-0.17	-$0.02
		Engie	LOYYB1	Lower 5 min	$0.02	0.09	$0.00
		Engie	LOYYB2	Lower 5 min	$0.02	0.09	$0.00
		Engie	LOYYB1	Lower 60 sec	$0.02	0.09	$0.00
		Engie	LOYYB2	Lower 60 sec	$0.02	0.09	$0.00
		Engie	LOYYB1	Lower 6 sec	$0.02	0.09	$0.00
		Engie	LOYYB2	Lower 6 sec	$0.02	0.09	$0.00
03:00	$44.50	Delta Electricity	VP5	Energy	$49.00	0.29	$14.21
		Delta Electricity	VP6	Energy	$49.00	0.59	$28.91
		EnergyAustralia	YWPS2	Energy	$16.15	0.07	$1.13
		EnergyAustralia	YWPS3	Energy	$16.15	0.06	$0.97
		Engie	LOYYB1	Energy	$10.50	-0.03	-$0.32
		Engie	LOYYB2	Energy	$10.50	-0.03	-$0.32
		Hydro	JBUTTERS	Lower 5 min	$0.39	0.07	$0.03
		EnergyAustralia	MP2	Lower 60 sec	$0.15	0.07	$0.01
		Hydro	POAT110	Lower 6 sec	$0.12	0.07	$0.01
		Engie	LOYYB1	Lower 5 min	$0.02	-0.03	$0.00
		Engie	LOYYB2	Lower 5 min	$0.02	-0.03	$0.00
		Engie	LOYYB1	Lower 60 sec	$0.02	-0.03	$0.00
		Engie	LOYYB2	Lower 60 sec	$0.02	-0.03	$0.00
		Engie	LOYYB1	Lower 6 sec	$0.02	-0.03	$0.00
		Engie	LOYYB2	Lower 6 sec	$0.02	-0.03	$0.00
Spot Price		**$5066/MWh**					

Table 4: price setter for the 3.30 am trading interval

DI	Dispatch Price	Participant	Unit	Service	Offer price	Marginal change	Contribution
03:05	$13 300.20	Engie	DRYCGT3	Energy	$13 300.20	1.00	$13 300.20
03:10	$13 300.10	Engie	MINTARO	Energy	$13 300.10	1.00	$13 300.10
03:15	$13 300.10	Engie	MINTARO	Energy	$13 300.10	1.00	$13 300.10
03:20	$48.77	Snowy Hydro	UPPTUMUT	Energy	$49.51	0.97	$48.02
		Engie	LOYYB1	Energy	$10.50	0.03	$0.32
		Engie	LOYYB2	Energy	$10.50	0.03	$0.32
		Hydro	TUNGATIN	Lower 5 min	$0.39	-0.05	-$0.02
		Engie	LOYYB1	Lower 5 min	$0.19	0.03	$0.01
		Engie	LOYYB2	Lower 5 min	$0.19	0.03	$0.01
		EnergyAustralia	YWPS3	Lower 60 sec	$0.08	-0.05	$0.00
		EnergyAustralia	YWPS1	Lower 6 sec	$0.03	-0.05	$0.00
		Engie	LOYYB1	Lower 60 sec	$0.02	0.03	$0.00
		Engie	LOYYB2	Lower 60 sec	$0.02	0.03	$0.00
		Engie	LOYYB1	Lower 6 sec	$0.02	0.03	$0.00
		Engie	LOYYB2	Lower 6 sec	$0.02	0.03	$0.00
03:25	$48.89	Delta Electricity	VP5	Energy	$49.00	0.33	$16.17
		Delta Electricity	VP6	Energy	$49.00	0.65	$31.85
		Engie	LOYYB1	Energy	$10.50	0.04	$0.42
		Engie	LOYYB2	Energy	$10.50	0.04	$0.42
		Hydro	TUNGATIN	Lower 5 min	$0.39	-0.07	-$0.03
		Engie	LOYYB1	Lower 5 min	$0.19	0.04	$0.01
		Engie	LOYYB2	Lower 5 min	$0.19	0.04	$0.01
		EnergyAustralia	YWPS3	Lower 60 sec	$0.08	-0.07	-$0.01
		EnergyAustralia	YWPS3	Lower 6 sec	$0.03	-0.07	$0.00
		Engie	LOYYB1	Lower 60 sec	$0.02	0.04	$0.00
		Engie	LOYYB2	Lower 60 sec	$0.02	0.04	$0.00
		Engie	LOYYB1	Lower 6 sec	$0.02	0.04	$0.00
		Engie	LOYYB2	Lower 6 sec	$0.02	0.04	$0.00
03:30	$47.88	Delta Electricity	VP5	Energy	$49.00	0.32	$15.68
		Delta Electricity	VP6	Energy	$49.00	0.65	$31.85
		Engie	LOYYB1	Energy	$10.50	0.02	$0.21
		Engie	LOYYB2	Energy	$10.50	0.02	$0.21
		AGL Energy	LYA1	Lower 5 min	$0.50	-0.03	-$0.02
		EnergyAustralia	YWPS2	Lower 60 sec	$0.17	-0.03	-$0.01
		EnergyAustralia	MP2	Lower 6 sec	$0.14	-0.03	$0.00
		Engie	LOYYB1	Lower 60 sec	$0.02	0.02	$0.00
		Engie	LOYYB2	Lower 60 sec	$0.02	0.02	$0.00
		Engie	LOYYB1	Lower 6 sec	$0.02	0.02	$0.00
		Engie	LOYYB2	Lower 6 sec	$0.02	0.02	$0.00
Spot Price		**$6674/MWh**					

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 – Origin Energy (Ladbroke, Quarantine and Osborne) closing bid prices, dispatch and spot price

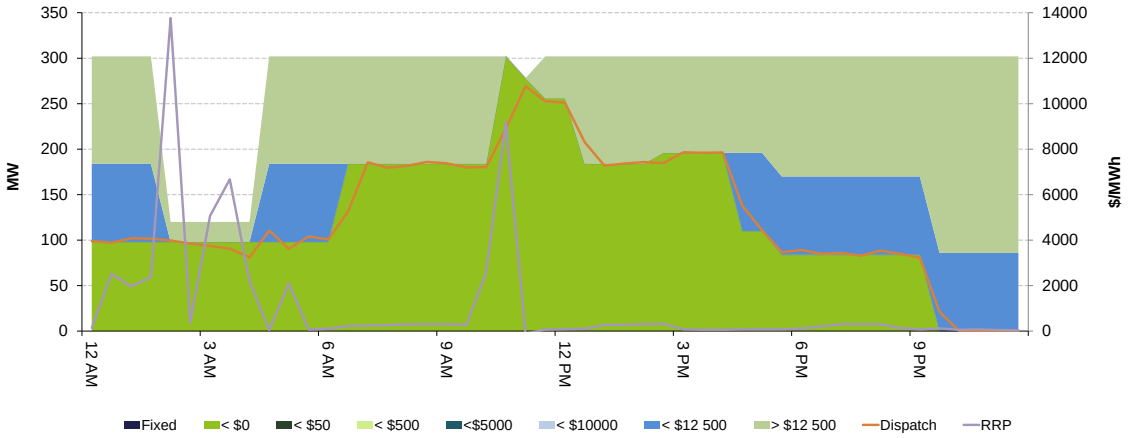


Figure C2 - EnergyAustralia (Hallett, Waterloo) closing bid prices, dispatch and spot price

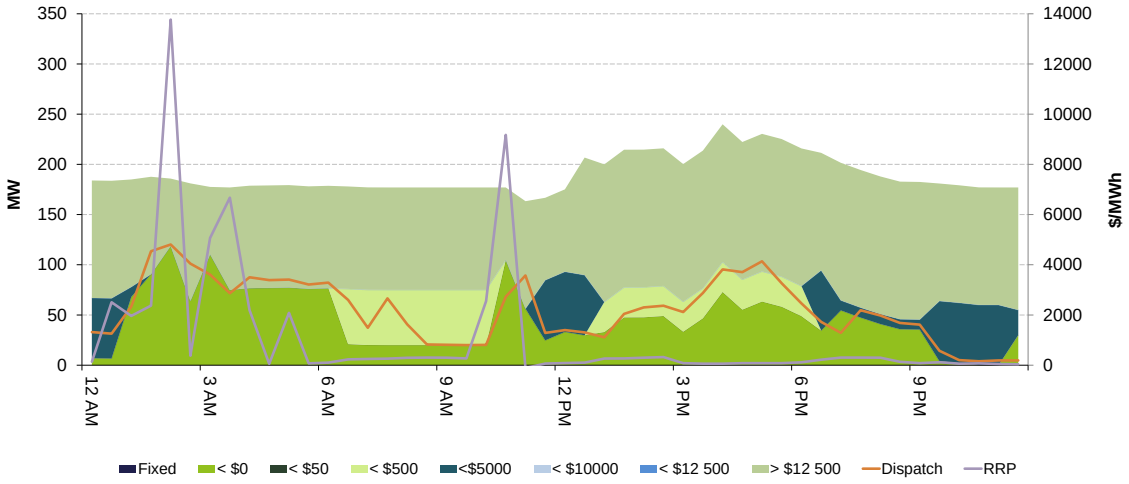


Figure C3 - Engie (Dry Creek, Mintaro, Port Lincoln, Snuggery) closing bid prices, dispatch and spot price

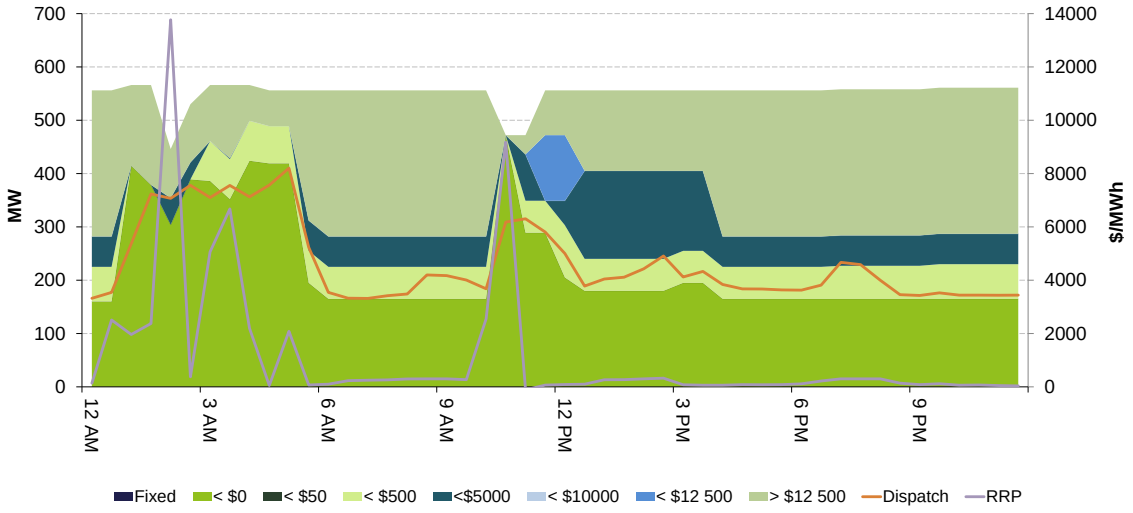
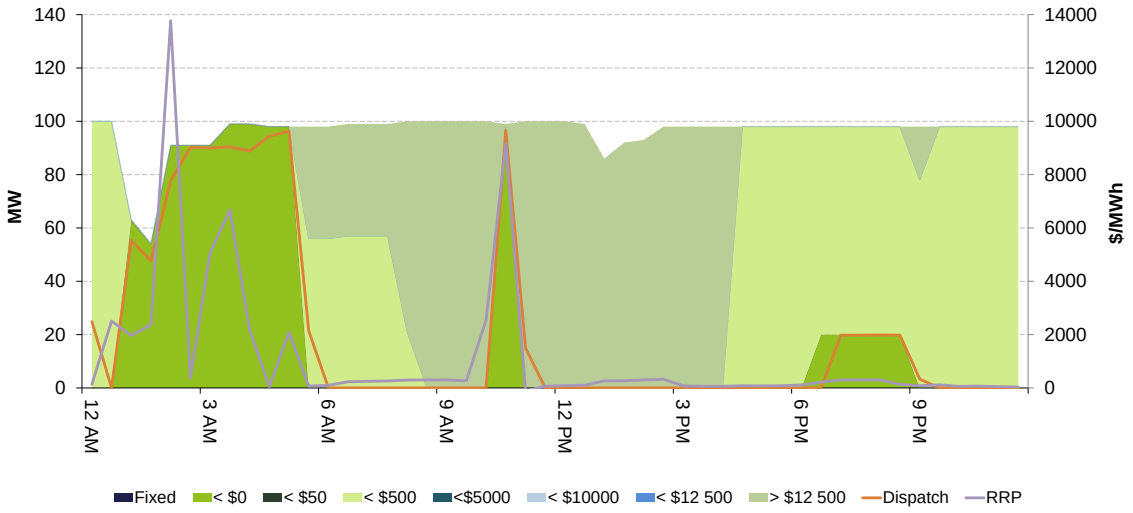


Figure C4 – Snowy Hydro (Lonsdale, Pt Stanvac and Angaston) closing bid prices, dispatch and spot price



Appendix D: Relevant Market Notices

The following market notices either were notifying the market of the network issues in South Australia.

Market Notice	Type	Date of issue	Last Changed
55515	GENERAL NOTICE	31/10/2016 09:42:56	31/10/2016 09:42:56

External Reference

Planned outage of Heywood No.2 500kV Bus in Victoria region from 30/11/2016 0600 hrs to 01/12/2016 1600 hrs

Reason

AEMO ELECTRICITY MARKET NOTICE.

This market notice is FOR INFORMATION ONLY.

The Heywood No.2 500 kV busbar in Victoria Region is planned out of service from 0600 hrs on 30 November 2016 to 1600 hrs on 1 December 2016. During this outage, Heywood 500/275 kV M2 transformer will be off-loaded and Heywood - Mortlake - Alcoa Portland No.2 500 kV line will be opened at Heywood.

During this outage, a credible contingency can separate South Australia region from the rest of the NEM.

Under these circumstances, 35 MW of Raise and Lower regulation FCAS will be sourced from South Australia for the duration of this outage. In addition, consistent with AEMO existing procedures, adequate contingency FCAS lower requirements will also be sourced from South Australia at times when power transfer is from South Australia to Victoria.

The following constraint sets have been invoked for this outage:

F-I_HYSE (includes F-S_LREG_0035 and F-S_RREG_0035)

S-X_BC_CP

V-HYTX_M12

V-HY_500BUS

Refer AEMO Network Outage Schedule (NOS) for further details.

AEMO will continue monitoring this proposed outage and will update the Market accordingly.

Edmund Hon

AEMO Operations

Market Notice	Type	Date of issue	Last Changed
55867	RESERVE NOTICE	28/11/2016 13:43:08	28/11/2016 13:43:08

External Reference

Forecast Lack Of Reserve Level 2 (LOR2) in South Australia Region - 30 Nov to 01 Dec 2016

Reason

AEMO ELECTRICITY MARKET NOTICE

Refer to AEMO Market Notice 55515

Forecast Lack Of Reserve Level 2 (LOR2) in South Australia Region - from 0600 hrs on 30/11/2016 to 1600 hrs on 01/12/2016.

AEMO declares Forecast LOR2 conditions for the South Australia region during the planned outage of Heywood No.2 500 kV busbar from 0600 hrs on 30/11/2016 to 1600 hrs on 01/12/2016.

On the occurrence of a credible contingency during these planned outage, South Australia region could separate from the rest of the NEM and is likely to result in interruptions to power supplies in South Australia.

There are sufficient capacity reserves in the South Australia region to meet electricity demand but following the next credible contingency it may not be possible to bring the required additional capacity into service in time to avoid automatic under-frequency load shedding causing interruptions to power supplies in South Australia.

Operations Planning

Bhishma Chhetri

Market Notice	Type	Date of issue	Last Changed
55904	RESERVE NOTICE	30/11/2016 07:48:43	30/11/2016 07:48:43

External Reference

Actual LOR2 South Australia Region - 30/11/16

Reason

AEMO ELECTRICITY MARKET NOTICE

Actual LOR2 South Australia Region - 30/11/16

Refer AEMO Electricity Market Notice 55867

An actual LOR2 condition has been declared for the South Australia region from 0700 hrs and is forecast to continue until 1600 hrs 01/12/16 during a planned outage of the Heywood No2 500 kV bus in Victoria.

If a credible contingency event occurs in this period the South Australia region would separate from the rest of the NEM and is likely to result in interruptions to power supplies.

There are sufficient capacity reserves in the South Australia region to meet electricity demand but it may not be possible to bring the required additional capacity into service in time to avoid automatic under-frequency load shedding causing power interruptions.

Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
55958	POWER SYSTEM EVENTS	1/12/2016 12:31:57 AM	1/12/2016 12:31:57 AM

External Reference

AEMO advises that South Australia has seperated from the NEM

Reason

AEMO ELECTRICITY MARKET NOTICE

POWER SYSTEM EVENT

At 0016 hrs 1st December 2016 the SA power system seperated from the NEM but remains operating as a separate entity. AEMO are investigating the cause and will develop and implement a reconnection plan as soon as practical.

Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
55973	MARKET INTERVENTION	1/12/2016 2:34:54 AM	1/12/2016 2:34:54 AM

External Reference

Direction - South Australia region 01/12/2016

Reason

AEMO ELECTRICITY MARKET NOTICE.

Direction - South Australia region 01/12/2016

In accordance with clause 4.8.9 of the National Electricity Rules AEMO has issued directions to participants in the South Australia region.

The directions were necessary to maintain the power system in a secure operating state.

The directions was issued from 0130 hrs 01/12/2016 and will remain in place until further notice.

Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
55972	MARKET INTERVENTION	1/12/2016 2:37:42 AM	1/12/2016 2:37:42 AM

External Reference

Direction - Torrens Island A1 01/12/16

Reason

AEMO ELECTRICITY PARTICIPANT NOTICE.

Direction - Torrens Island A1 01/12/16

In accordance with clause 4.8.9 of the National Electricity Rules AEMO is issuing a direction to Torrens Island A1 to take the following action.

Provide up to 10 MW of Raise FCAS. The following constraints were invoked:

#TORRA1_OF

#TORRA1_PF

The direction is issued subject to the Registered Participant's best endeavours to comply with it unless compliance would be a hazard to public safety or materially risk damaging equipment or contravene any other law.

The direction is issued at 0130 hrs 01/12/16 and will remain in place until further notice

Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
56015	MARKET INTERVENTION	1/12/2016 5:02:31 AM	1/12/2016 5:02:31 AM

External Reference

Cancellation of Directions - South Australia region 01/12/2016

Reason

AEMO ELECTRICITY MARKET NOTICE.

Cancellation of Directions - South Australia region 01/12/2016

In accordance with clause 4.8.9 of the National Electricity Rules AEMO had issued directions to participants in the South Australia region.

The directions were necessary to maintain the power system in a secure operating state.

The directions are no longer required and have been cancelled from 0500 hrs 01/12/2016

Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
56016	MARKET INTERVENTION	1/12/2016 5:08:19 AM	1/12/2016 5:08:19 AM

External Reference

Cancellation of Direction - Torrens Island A1 01/12/16

Reason

AEMO ELECTRICITY PARTICIPANT NOTICE.

Cancellation of Direction - Torrens Island A1 01/12/16

AEMO has cancelled the direction to Torrens Island A1 at 0500 hrs 01 Dec 2016

The following constraints were revoked:

#TORRA1_OF

#TORRA1_PF

Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
56021	MARKET INTERVENTION	1/12/2016 6:09:57 AM	1/12/2016 6:09:57 AM

External Reference

Direction - Pelican Point Power Ltd 01/12/16

Reason

AEMO ELECTRICITY PARTICIPANT NOTICE.

Direction - Pelican Point 01/12/16

In accordance with clause 4.8.9 of the National Electricity Rules AEMO is issuing a direction to Pelican Point to take the following action.

Reduce to 165 MW to reduce risk (reduce Raise FCAS requirement). The following constraint was invoked:

#PPCCGT_OE

The direction is issued subject to the Registered Participant's best endeavours to comply with it unless compliance would be a hazard to public safety or materially risk damaging equipment or contravene any other law.

The direction is issued at 0230 hrs 01/12/16 and was cancelled at 0500 hrs

Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
56025	RESERVE NOTICE	1/12/2016 9:06:57 AM	1/12/2016 9:06:57 AM

External Reference

Update - Actual LOR2 South Australia Region - 1/12/16

Reason

AEMO ELECTRICITY MARKET NOTICE

Actual LOR2 South Australia Region - 1/12/16

Refer AEMO Electricity Market Notice 55867 and 55904

An actual LOR2 condition has been declared for the South Australia region from 0700 hrs 30/11/16 and is forecast to continue until further notice following the unplanned outage of the Moorabool Tarone 500 kV line in Victoria.

If a credible contingency event occurs in this period the South Australia region would separate from the rest of the NEM and is likely to result in interruptions to power supplies.

There are sufficient capacity reserves in the South Australia region to meet electricity demand but it may not be possible to bring the required additional capacity into service in time to avoid automatic under-frequency load shedding causing power interruptions.

See Network Outage Schedule (NOS) for further details

Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
56079	RESERVE NOTICE	1/12/2016 9:50:14 PM	1/12/2016 9:50:14 PM

External Reference

Cancellation - Actual LOR2 South Australia Region - 01 Dec 2016

Reason

AEMO ELECTRICITY MARKET NOTICE

Cancellation - Actual LOR2 South Australia Region - 01 Dec 2016

Refer AEMO Electricity Market Notices 55867, 55904 and 56025.

The Actual LOR2 condition in the South Australia Region is cancelled at 2145 hrs 01 Dec 2016

Manager NEM Real Time Operations

Appendix E: Directions

Once South Australia separated from the NEM, the power system was in an insecure state due a shortage of FCAS. Raise and Lower constraints violated. In response, AEMO directed two generators and load to maintain the power system in a secure operating state.

At around 1.15 am AEMO directed Torrens Island A1 to provide up to 10 MW of raise FCAS[7]. This was as a result of AGL withdrawing all of its FCAS availability at Torrens A unit one through a rebid. The rebid was effective from 1.05 am and the reason given was "0045~A~060 unfcast network constraint~61 constr on/off out of merit order. FCAS". Effective 1.25 am, AGL reversed this rebid for Raise 6 services and the reason given was "0045~A~010 AEMO direction~directed to provide r6sec services by AEMO". Other FCAS services were rebid available effective 2 am.

At around 2 am AEMO directed Electranet to reduce the demand at BHP's Olympic Dam's South Australian facility by approximately 70 MW down to 100 MW to maintain system security. At the time, Olympic Dam was the biggest single load in South Australia and was therefore the greatest contributor to the requirement of FCAS lower services. If Olympic Dam was to trip unexpectedly, there would be an increase in the requirement for lower services as the frequency of the South Australian system would increase and risk system security.

At 2.30 am AEMO directed Pelican Point to reduce its output to 165 MW, from around 215 MW[8]. As Pelican Point was the biggest single generator in the South Australian region at the time, they were also the greatest contributor to the requirement of FCAS raise services. If Pelican Point was to trip unexpectedly, there would be an increase in the requirement for raise services as the frequency of the South Australian system would decrease.

All directions were revoked at around 5 am, when the South Australian region was no longer separated from the NEM.

AEMO has published a preliminary operating incident report into this event and will publish their final report by February 28 2017 detailing these directions.

7 See market notices 55972 and 56016 in Appendix D

8 See market notice 56021 in Appendix D