Electricity spot prices above $5000/MWh

Victoria and South Australia, 25 January 2019

26 March 2019

AUSTRALIAN ENERGY REGULATOR

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AER Reference: 64867-D19/41013

Amendment Record

Version	Date	Pages
Final report	26/3/2019	31

Contents

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 energy markets, including the annual State of the energy market report, to assist stakeholders 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) 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 enforcement action.

2 Summary

On 25 January 2019, the spot prices for electricity exceeded $5000/MWh in Victoria and South Australia, reaching $7433/MWh at 11 am and $14 500/MWh at 11.30 am in Victoria and $11 340/MWh at 11.30 am in South Australia.

Victoria experienced its second day of extreme heat, with temperatures reaching 43ºC in Melbourne. This drove high demand (1100 MW below the 2009 record level) for electricity in Victoria. Meanwhile, the temperature in Adelaide reached 29ºC, significantly lower than the previous day's record setting maximum temperature of 47ºC.

Of around 10 350 MW of maximum possible generation usually available in Victoria during summer, about 8100 MW was offered into the market on the day all of which was priced below $50/MWh at the time of high prices. The difference was due to several generator outages in the region (all of which were incorporated into AEMO's forecasts), high temperatures affecting generation capacity, and low wind output.

In light of the high demand for electricity in Victoria and the generator outages, AEMO activated the Reliability Emergency Reserve Trader (RERT) at around 9 am. As a result, AEMO invoked special intervention pricing arrangements, called 'what-if' pricing across the National Electricity Market (NEM). "What-if" pricing seeks to preserve price signals by setting the price as if the intervention, in this case the activation of the RERT contracts, had not occurred.

Demand for electricity in Victoria was much higher than anticipated for the 11 am trading interval. With all available local supply being used, South Australia exported electricity to Victoria, some of which was offered at high prices, causing an unexpected price above $5000/MWh.

However, even with imports from other regions and despite the activation of the RERT, there was insufficient supply of electricity to meet demand in Victoria. As a result, from around 11.15 am AEMO shed 250 MW of customer load in Victoria. In accordance with the Electricity Rules, customer load shedding caused the spot price in that region to be set at the market price cap for the 11.30 am trading interval.

The spot price for electricity reached $11 340/MWh in South Australia for the same trading interval, as forecast, as high demand for electricity in both regions was met by high priced offers from generators in South Australia.

As a result of the previous day's high prices and the high prices on 25 January, the cumulative price threshold was breached and an administered pricing cap was put in place from 11.30 am. The administered price cap is a price safety net that limits the price to $300/MWh.

Rebidding from low to high prices did not contribute to high price outcomes. In fact, generators rebid capacity from high to low prices throughout the day.

3 Analysis

The following sections examine why the high spot prices occurred. AEMO activated the Reliability Emergency Reserve Trader (RERT) at around 9 am until 4.30 pm and so "what-if" pricing applied for this period. See Box 1 in section 3.4.2.

Despite the activation of the RERT, at 11.14 am there was still insufficient generation from the market to meet the higher than expected demand. As a result AEMO commenced involuntary load shedding in Victoria to reduce demand, causing the spot price in Victoria to reach the price cap at 11.30 am.

3.1 Overview of actual and expected conditions

Spot prices exceeded $5000/MWh for the 11 am and 11.30 am trading intervals in Victoria, and in the 11.30 am trading interval in South Australia. Table 1 and Table 2 show actual and forecast spot prices, demand and local availability (that is, excluding imports from other regions) for the 11 am and 11.30 am trading intervals in Victoria and South Australia respectively.

Victoria

Table 1 shows:

- The spot price reached $7433/MWh at 11 am and the market price cap at 11.30 am.
- Four hours ahead, the spot price in Victoria was expected to reach around $450/MWh for the 11 am trading interval and the market price cap for the 11.30 am trading interval.
- Compared to four and 12 hours ahead, demand in Victoria was higher than forecast (by up to 700 MW for the 11 am trading interval).
- Availability was slightly lower than forecast primarily due to reduced plant capacity because of high ambient temperatures (discussed in Section 3.3.2)
- Even with imports from neighbouring regions, ultimately there was insufficient supply of electricity to meet demand. As a result AEMO engaged several interventions in order to maintain power system security, including emergency reserves and load shedding (see Section 3.4 – Market Intervention).
- Load shedding occurred at 11.14 am, which (according to the National Electricity Rules) caused the spot price for the 11.30 am trading interval to be set at the market price cap.

Table 1: Actual and forecast spot price, demand and available capacity for Victoria

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
11 am	7433	457	450	9076	8382	8366	8166	8218	8181
11.30 am	14 500	14 500	11 499	9075	8872	8619	8018	8232	8186

South Australia

Table 2 shows:

- The spot price for electricity reached $3817/MWh at 11 am and $11 340/MWh at 11.30 am.[1]
- The spot price for the 11 am trading interval was higher than forecast, while the spot price for the 11.30 am trading interval was close to forecast.
- Demand for electricity in South Australia was close to forecast. Demand is discussed further in Section 3.2.
- Availability was slightly lower than forecast, primarily due to reduced plant capacity due to high ambient temperatures (discussed in Section 3.3.2).

Table 2: Actual and forecast spot price, 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
11 am	3817	408	404	1932	1983	1948	3130	3270	3211
11.30 am	11 340	10 248	9155	1995	1987	1947	3146	3298	3251

3.2 Demand

The temperature reached a maximum of 43°C in Melbourne on 25 January, following a maximum of 41°C the previous day.[2] In Adelaide, the temperature reached a maximum of 29°C, following an extended period of extreme temperatures, culminating in a record maximum for Adelaide of 47°C the previous day.[3]

[1] Even though the spot price of $3817/MWh is below $5000/MWh it will be analysed as part of this report instead of the relevant weekly report.
[2] Bureau of Meteorology - Melbourne, Victoria January 2019
[3] Bureau of Meteorology - Adelaide, South Australia January 2019

Victoria

The hot weather in Melbourne drove high demand, reaching a maximum of 9076 MW at 11 am, as shown in Figure 1.

Figure 1: Actual and forecast demand for Victoria

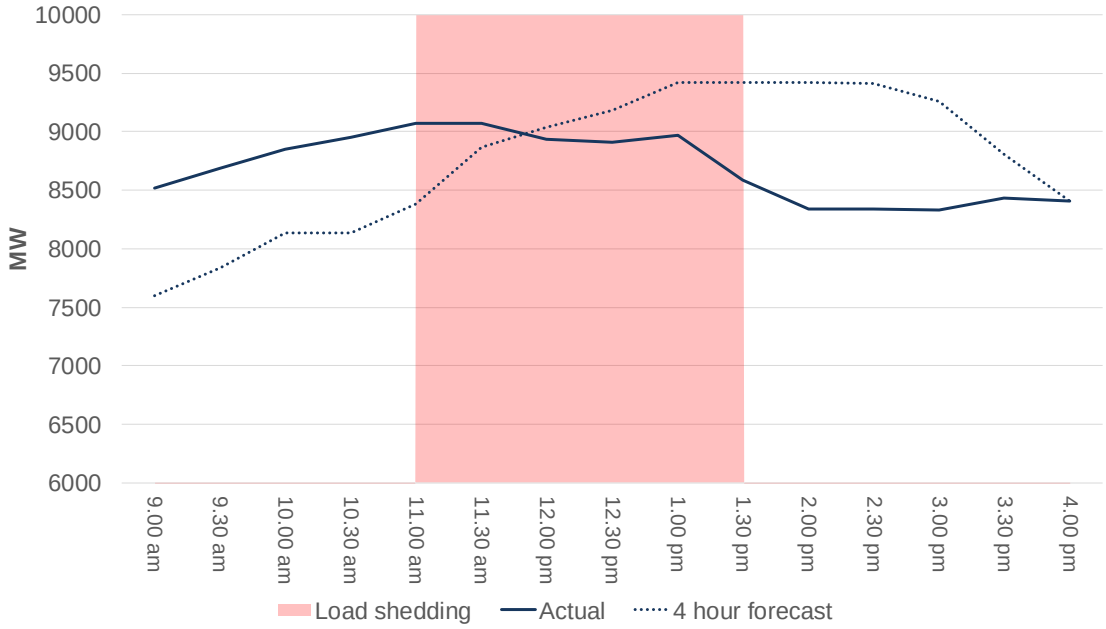


Figure 1 shows actual and forecast demand for Victoria (solid black line and dotted lines, respectively). Figure 1 shows the differences between forecast and actual demand. At 11 am, actual demand for electricity was 694 MW higher than forecast four hours previously. The actual spot price for electricity in Victoria at 11 am was significantly higher than forecast four hours ahead because higher priced generation from South Australia was required to meet higher than expected demand in Victoria for most of the trading interval.

Figure 1 also shows the period of involuntary load shedding which began at 11.14 am and ended at 1.26 pm.

South Australia

During the time of high prices, demand for electricity in South Australia was just over 1900 MW, and close to forecast. Following the extreme heat the previous day, for the most part overnight demand for electricity in South Australia was higher than during the time of high prices.

As shown in Table 2, the spot price for electricity in South Australia at 11 am was significantly higher than forecast. This was because the demand for electricity in Victoria for the same trading interval was much higher than forecast, so South Australia exported electricity to Victoria to meet this unexpected higher level of demand. Combined demand for electricity across both regions could only be met by higher priced generator offers, leading to a higher than expected spot price in South Australia.

3.3 Supply

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

3.3.1 Generator offers and availability

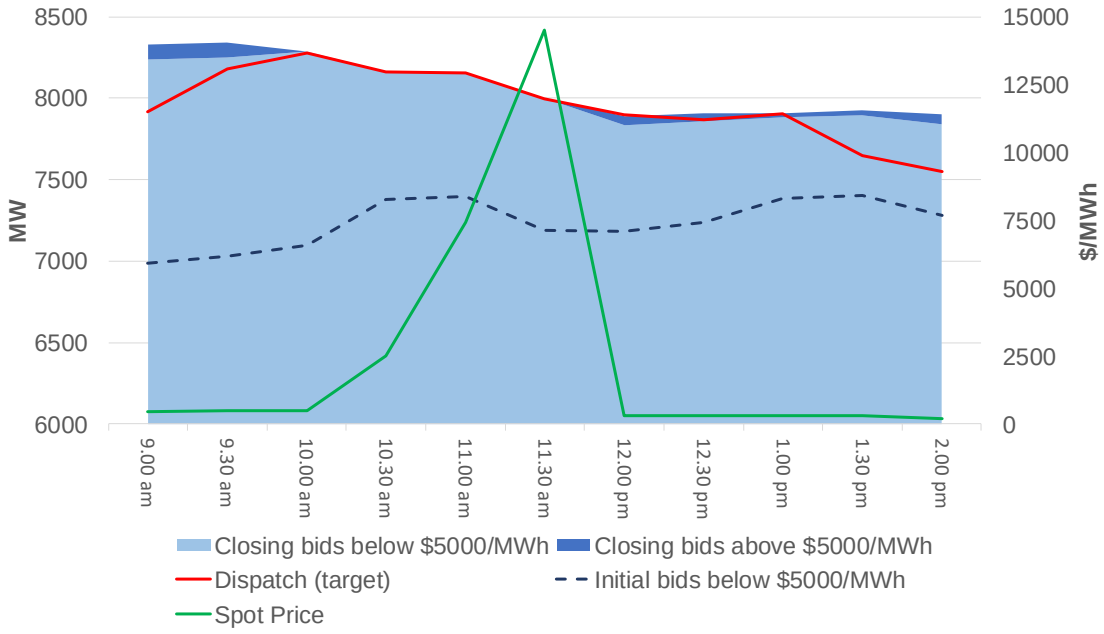
Figure 2 and Figure 3 show the cumulative generator offers for Victoria and South Australia respectively. Also known as closing bids, the figures show the actual capacity offered by generators in each region, including amendments to their offers throughout the day to match changes to their own economic and/or physical positions (known as "rebidding"). Also shown on the figures are the initial bids below $5000/MWh (dotted blue line) and actual local generation output (red line).

Capacity offered below $5000/MWh is shown in light blue and capacity offered above $5000/MWh is in dark blue, and the green line shows the spot price for electricity.

Victoria

In initial forecasts, generators in Victoria were offering up to 92 per cent of their capacity at prices below $5000/MWh (dotted blue line), with the remainder offered above $10 000/MWh.

Figure 2: Generator bids for Victoria



Throughout the day generators rebid further capacity into low price bands such that all capacity was priced below $5000/MWh for the two high priced trading intervals. Of this, 99 per cent was priced below $0/MWh, with the remaining one percent priced below $50/MWh. Thus, rebidding into high price bands did not contribute to the high prices in Victoria.

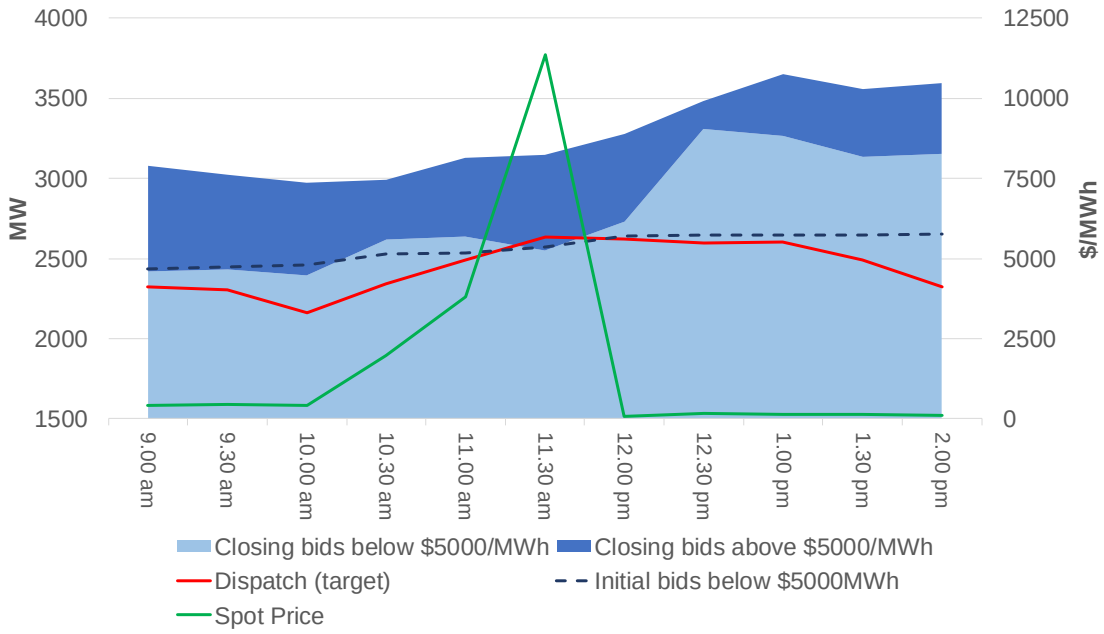
All available generation in Victoria was dispatched at the time of high prices (shown by the red line at the top of the offers). But Table 1 shows there was not enough local generation available to meet local demand for electricity in Victoria. As discussed in section 3.3.3, exports of electricity from South Australia, some of which was offered at high prices, helped to meet the demand for electricity in Victoria.

As discussed in section 3.4.3, with load shed at 11.14 am, the spot price in Victoria was set at the price cap from 11.30 am.

South Australia

In initial forecasts, generators in South Australia were offering 80 per cent of their capacity at prices below $5000/MWh, with most of the remaining capacity offered above $10 000/MWh for the high priced trading intervals.

Figure 3: Generator bids for South Australia



On the day, generators in South Australia rebid higher priced capacity into lower price bands such that for the 11 am trading interval 84 per cent of capacity was priced below $5000/MWh, and for the 11.30 am trading interval 81 per cent of capacity was priced below $5000/MWh.

As discussed in section 3.2, higher than forecast demand in Victoria drove the higher than forecast spot price in South Australia at 11 am. However, as shown in Table 2, the 11.30 am spot price for electricity in South Australia was close to forecast.

Appendix A: Price setter 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 Victoria and South Australia with capacity priced at or above $5000/MWh for the high-price periods are set out in *Appendix B: Closing bids*.

3.3.2 Generator outages and reduced capacity

Summer installed generation capacity in Victoria is approximately 10 350 MW, of which approximately 1050 MW is semi-scheduled wind. On the day, of the 9300 MW of non-wind generation, over 7600 MW (or 80 per cent) was offered in Victoria.

However, installed capacity is not always a true reflection of what may be available at any particular time, particularly during summer, when high ambient temperature conditions can materially affect a generator's ability to generate at its maximum capacity. This was an issue on 25 January, as shown in the 'Reason' column of Table 4.

At the time of high prices three generating units in Victoria were unavailable, all for technical reasons. As a result, a total of 1240 MW of potential capacity was unavailable. All of these outages were factored into AEMO's supply forecasts.

- Energy Australia advised AEMO that it would be taking its 355 MW Yallourn unit 4 out of service for planned maintenance from 19 January for a period of seven days. This maintenance outage lasted longer than anticipated and unit 4 returned to service on 4 February.
- Energy Australia's Yallourn unit 3 experienced a boiler tube leak at about 1.30 am on 25 January and reduced available capacity in Victoria by a further 355 MW.
- AGL's Loy Yang A unit 3 experienced a tube leak removing a further 530 MW of potential available capacity in Victoria from the afternoon of 22 January to 26 January.

These outages are detailed in Table 3.

Table 3: Generation plant outages in Victoria

Station	Unit	Unavailable capacity (MW)	Start	End	Reason	Rebid time
Yallourn	YWPS3	355	25-Jan 1.30 am	6-Feb 3 pm	Boiler tube leak	23-Jan 3.42 pm
Yallourn	YWPS4	355	19-Jan 12.30 am	4-Feb 9 pm	Planned maintenance outage	15-Jan 8.17 am
Loy Yang A	LYA3	530	22-Jan 3.30 pm	26-Jan 6 pm	Plant failure, tube leak	22-Jan 2.30 pm
Total		**1240**				

Also, several units in Victoria and South Australia were operating at reduced capability, all due to technical reasons. Details are provided in Table 4.

Table 4: Generation with reduced capacity due to technical issues

Station	Unit	Unavailable capacity (MW)	Reason	Rebid time
Victoria				
Loy Yang A	LYA2	140	Plant failure; subsequent outage from 25-Jan 6.30 pm	24-Jan 7.29 am

Station	Unit	Unavailable capacity (MW)	Reason	Rebid time
Various	-	102	Revised station capability due to ambient temperatures	25-Jan 7 am onwards
South Australia				
Torrens Island	TORRA1	45	Plant failure - unexpected plant limits during return to service	25-Jan 10.38 am
Total		**460**		

3.3.2.1 Wind availability

During the high priced trading intervals, semi-scheduled wind generation in South Australia was around 300 MW (compared to installed capacity of 1400 MW), while in Victoria semi-scheduled wind generation was between 490 MW to 650 MW (compared to installed capacity of 1050 MW). Wind generation in both regions was below forecast, reducing potential supply of electricity in both regions.

3.3.3 Network Availability

The NEM regions are connected via high voltage interconnectors, through which electricity is transferred between regions. Victoria is connected to South Australia via two interconnectors – Heywood and Murraylink, while Victoria is connected to New South Wales via the Victoria – New South Wales (VIC – NSW) interconnector, and to Tasmania via Basslink.

Table 5 shows the combined net actual and forecast flows into Victoria, as well as the combined net actual and forecast import limits. Table 5 shows Victoria was importing around 1000 MW of electricity to meet demand at the time of high prices which was higher than forecast.

Table 5: Combined net actual and forecast flows and import limits into Victoria

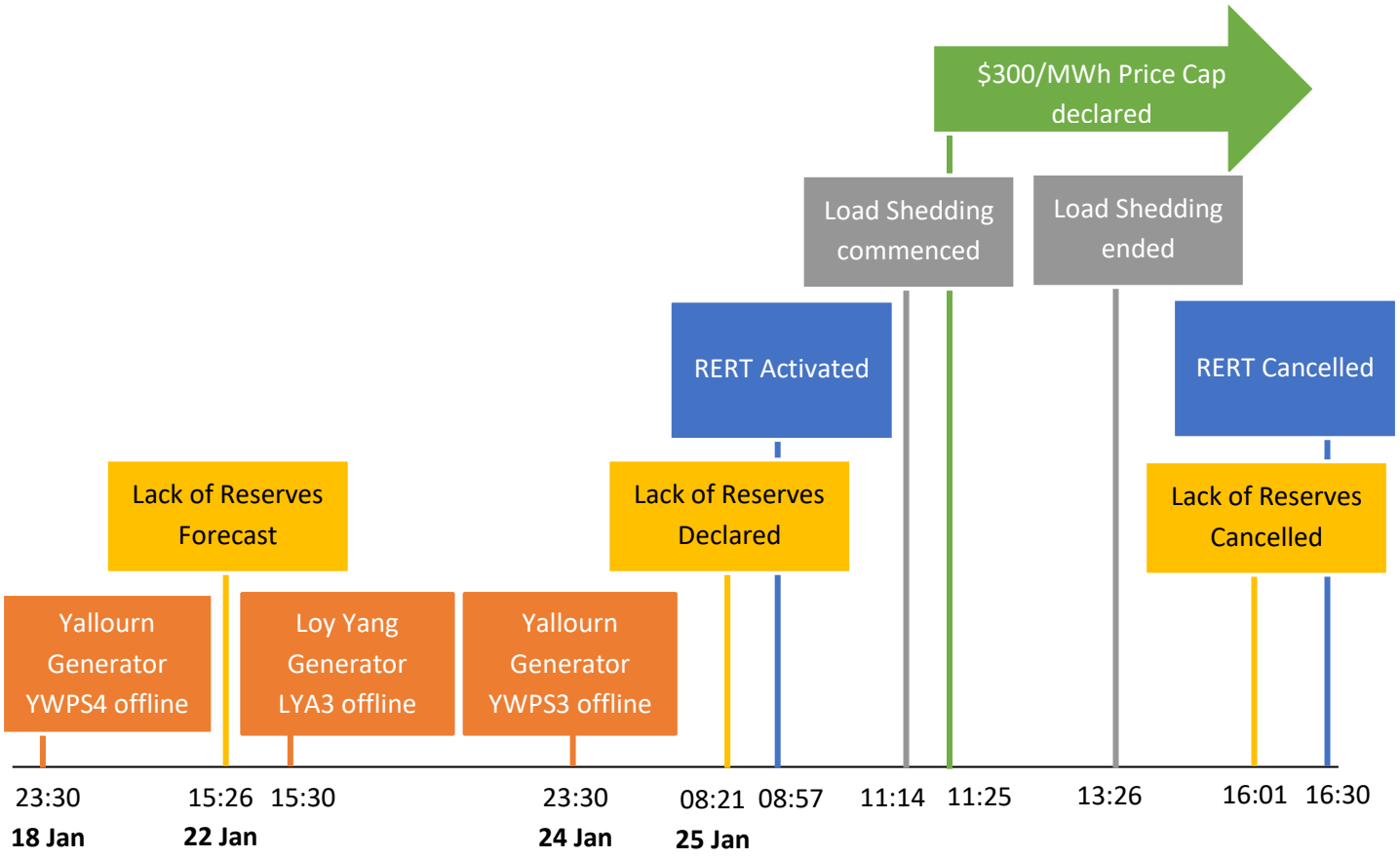
Trading interval	Net Flows (MW)			Net Import limit (MW)		
	Actual	4 hr forecast	12 hr forecast	Actual	4 hr forecast	12 hr forecast
11 am	974	773	907	958	1226	1269
11.30 am	1146	941	968	760	1057	1065

While Victoria was a net importer of electricity for the high price trading intervals, for a short time Victoria exported electricity (counter-price) to New South Wales across the VIC - NSW interconnector. Congestion over the transmission network meant that not all of the low priced generation in the north of Victoria could be sent to the load centre in Melbourne and had to be sent to New South Wales, causing negative settlement residues to accrue for the 11.30 am trading interval.

3.4 Market Intervention

The following sections outline the interventions by AEMO, including the lack of reserves, activation of emergency reserves, and activation of the administered price cap. Figure 4 outlines the timeline of market intervention and events which led up to the high prices across Victoria and South Australia on 25 January.

Figure 4: Timeline of events for 25 January in Victoria



3.4.1 Lack of Reserves

Against the backdrop of anticipated hot weather and the first outages at Yallourn and Loy Yang A, AEMO forecast as early as 22 January that there may be insufficient supply to meet demand in Victoria on 25 January.

Consequently, AEMO issued several lack of reserve (LOR) notices seeking a market response. These reserve notices focus on three thresholds in ascending order of severity: LOR 1, 2 and 3. Each threshold is based on the number of unplanned failures of either transmission or generating equipment (known as credible contingencies) that should they occur, would result in AEMO having to shed load.

Although there was about 150 MW of additional capacity offered into the market as a result of the notices, additional outages and capacity restrictions (outlined in Section

3.3.2) offset the effects, resulting in overall reduction of availability. *Appendix E: Relevant Market Notices* lists all the relevant market notices for 25 January. As Appendix E shows, the LOR notices escalated to Level 3 by the evening of January 24. Ultimately there was insufficient generation and electricity from neighbouring regions to meet demand and actual Lack of Reserves were declared the morning of 25 January.

LOR notices are explained further in *Appendix D: Lack of Reserve*.

3.4.2 Reliability Emergency Reserve Trader Activated

In preparation for the forecast lack of reserves in Victoria at around 9 am AEMO activated the Reliability and Emergency Reserve Trader (RERT) contracts in that region.

Through contracts from providers outside of the market, emergency reserves increase the supply of, or lower the demand for, electricity. The total amount of RERT contracts activated in Victoria on 25 January was 595 MW, effectively reducing the generation required by the market by this amount. [4]

When AEMO activates RERT contracts, prices for all regions across the NEM are determined using "what-if" pricing. "What if" pricing is discussed in more detail in Box 1 and *Appendix F: Pricing during an intervention*.

Box 1: "What-if" pricing

The market operator, AEMO, invokes "what-if" pricing when it intervenes in the market, for example by activating RERT contracts. Normally AEMO sets targets for generation and interconnectors and determines wholesale electricity market prices (energy and FCAS) in a single calculation (or "run") for every five minute dispatch interval. After an intervention these are calculated twice for each dispatch interval, one taking into account the RERT contracts called "Intervention" and one that does not include the direction called "What-if".

"What-if" attempts to calculate what the price would have been had AEMO not intervened in the market. This effectively removes the effects of the RERT contracts thereby preserving the market price signal. To achieve this, the "what-if" run recalculates, amongst other things, the level of demand and the targets for generation and interconnectors.

The RERT contracts were concluded at 4.30 pm on 25 January.[5]

3.4.3 Involuntary Load Shedding

Despite the activation of the RERT, at 11.14 am there was still insufficient generation from the market to meet the higher than expected demand. AEMO commenced involuntary load shedding in Victoria to reduce demand. This consisted of controlled supply interruptions across the state to ensure the power system stayed secure. When involuntary customer load shedding occurs the price is set at the price cap.

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[4] AEMO RERT Contracts for 24 & 25 January 2019

[5] Under the National Electricity Rules, AEMO is required to publish reports detailing the circumstances that gave rise to the need for the activation of RERT contracts, their processes and the costs that occurred (cl. 3.20)

More than 250 MW of load was required to be shed. This equated to short supply interruptions on rotation, with approximately 60 000 to 100 000 consumers affected at any one time.

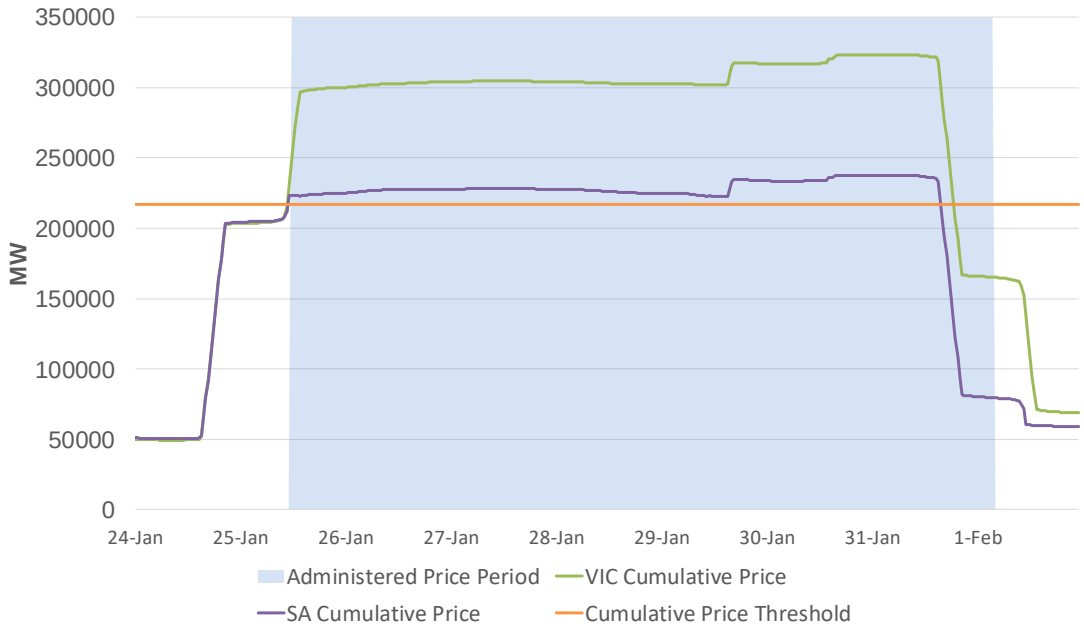
AEMO issued an instruction for networks to begin the restoration of all interrupted load at approximately 2 pm.

3.4.4 Administered Price Cap

In times of sustained periods of high prices, AEMO can apply a cap to the price for a defined period of time in order to protect consumers from excessive costs. This administered price cap is triggered when the sum of all the spot prices for the past seven days exceeds an upper limit, called the Cumulative Price Threshold (CPT, $216 900).[6] When the CPT is breached, a price cap of $300/MWh and price floor of -$300/MWh applies to all trading days until the cumulative price drops below the threshold – the administered pricing period finishes at the end of that trading day.

As Figure 5 shows, high prices in both Victoria and South Australia on 24 January had already pushed the cumulative prices to just below the CPT at around $204 000. Consequently, the high prices on 25 January drove the cumulative prices for both states above the CPT at 12 pm, and the administered price cap applied to all trading intervals. Cumulative prices fell below the threshold on 31 January in South Australia and Victoria at 4.30 pm and 7.30 pm respectively, and the administered price period ended at the end of that trading day (i.e. at 4 am on 1 February).

Figure 5: Cumulative Price Threshold for Victoria and South Australia, 24 January to 1 February



Australian Energy Regulator

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[6] Equivalent to the past 336 trading intervals

Appendix A: 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. The dispatch prices that are in italics are capped at the price cap of $14 500/MWh when published by AEMO.

Victoria

Table 6: Victoria 11 am

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
10:35	$181.14	AGL (SA)	TORRB1	Energy	$148.00	0.61	$90.28
		AGL (SA)	TORRB2	Energy	$148.00	0.61	$90.28
10:40	$938.61	Snowy Hydro	TUMUT3	Energy	$449.59	-2.03	-$912.67
		AGL (SA)	TORRB1	Energy	$148.00	1.40	$207.20
		AGL (SA)	TORRB2	Energy	$148.00	1.40	$207.20
		CS Energy	GSTONE1	Energy	$104.73	0.54	$56.55
		CS Energy	GSTONE3	Energy	$104.73	0.54	$56.55
		CS Energy	GSTONE4	Energy	$104.73	0.54	$56.55
		CS Energy	GSTONE6	Energy	$104.73	0.54	$56.55
		Snowy Hydro	MURRAY	Energy	-$1000.00	-1.21	$1210.00
10:45	$4661.21	Hornsdale Power Reserve	HPRG1	Energy	$1023.44	3.90	$3991.42
		Snowy Hydro	TUMUT3	Energy	$449.59	-2.72	-$1222.88
		AGL Hydro	YABULU	Energy	$92.35	2.33	$215.18
		AGL Hydro	YABULU2	Energy	$92.35	0.60	$55.41
		Snowy Hydro	MURRAY	Energy	-$1000.00	-1.62	$1620.00
10:50	*$14 500.00*	Snowy Hydro	PTSTAN1	Energy	$10 618.48	3.90	$41 412.07
		Snowy Hydro	TUMUT3	Energy	$449.59	-2.72	-$1222.88
		ERMPower and Arrow	BRAEMAR 6	Energy	$144.00	3.03	$436.32
		Snowy Hydro	MURRAY	Energy	-$1000.00	-1.62	$1620.00
10:55	*$14 500.00*	AGL (SA)	TORRA2	Energy	$12 100.00	1.30	$15 730.00
		AGL (SA)	TORRA3	Energy	$12 100.00	1.30	$15 730.00
		AGL (SA)	TORRA4	Energy	$12 100.00	1.30	$15 730.00
		Snowy Hydro	TUMUT3	Energy	$449.59	-2.72	-$1222.88
		Delta Electricity	VP5	Energy	$300.00	-0.35	-$105.00
		Delta Electricity	VP6	Energy	$300.00	-0.35	-$105.00
		Stanwell	TARONG#1	Energy	$105.53	1.95	$205.78

[7] 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
		Stanwell	TARONG#2	Energy	$105.53	1.95	$205.78
		Snowy Hydro	MURRAY	Energy	-$1000.00	-1.62	$1620.00
		CS Energy	W/HOE#2	Raise 5 min	$7.73	-0.69	-$5.33
		Delta Electricity	VP5	Raise 5 min	$1.00	0.35	$0.35
		Delta Electricity	VP6	Raise 5 min	$1.00	0.35	$0.35
		Stanwell	TARONG#1	Raise reg	$34.00	-1.95	-$66.30
		Stanwell	TARONG#2	Raise reg	$34.00	-1.95	-$66.30
		AGL (SA)	TORRA2	Raise reg	$0.00	1.30	$0.00
		AGL (SA)	TORRA3	Raise reg	$0.00	1.30	$0.00
		AGL (SA)	TORRA4	Raise reg	$0.00	1.30	$0.00
		CS Energy	GSTONE6	Raise 60 sec	$2.37	-0.69	-$1.64
		Delta Electricity	VP5	Raise 60 sec	$1.00	0.35	$0.35
		Delta Electricity	VP6	Raise 60 sec	$1.00	0.35	$0.35
		Stanwell	TARONG#1	Raise 6 sec	$3.00	-0.69	-$2.07
		Delta Electricity	VP5	Raise 6 sec	$1.00	0.35	$0.35
		Delta Electricity	VP6	Raise 6 sec	$1.00	0.35	$0.35
11:00	$9815.16	Snowy Hydro	TUMUT3	Energy	$449.59	-22.30	-$10 025.86
		ERMPower and Arrow	BRAEMAR 6	Energy	$144.00	42.80	$6163.20
		Snowy Hydro	GUTHEGA	Energy	-$1000.00	-13.68	$13 680.00
Spot Price		**$7433/MWh**					

Table 7: Victoria 11.30 am

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
11:05	*$14 500.00*	Snowy Hydro	TUMUT3	Energy	$14 198.00	3.25	$46 143.50
		Stanwell	TARONG#1	Energy	$105.53	-0.59	-$62.26
		Stanwell	TARONG#2	Energy	$105.53	-0.59	-$62.26
		Stanwell	TARONG#3	Energy	$105.53	-0.59	-$62.26
		Stanwell	TARONG#4	Energy	$105.53	-0.59	-$62.26
11:10	*$14* 000.00	Generation deficit constraint			$2 175 000.00	1.00	$2 175 000.00
11:15	*$14* 000.00	Generation deficit constraint			$2 175 000.00	1.00	$2 175 000.00
11:20	*$14* 000.00	Generation deficit constraint			$2 175 000.00	1.00	$2 175 000.00
11:25	*$14* 000.00	Generation deficit constraint			$2 175 000.00	1.00	$2 175 000.00
11:30	*$14* 000.00	Generation deficit constraint			$2 175 000.00	1.00	$2 175 000.00
Spot Price		**$14 500/MWh**					

South Australia

Table 8: South Australia 11.30 am

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
11:05	$12 035.30	AGL (SA)	TORRA2	Energy	$12 100.00	0.21	$2541.00
		AGL (SA)	TORRA3	Energy	$12 100.00	0.21	$2541.00
		AGL (SA)	TORRA4	Energy	$12 100.00	0.21	$2541.00
		AGL (SA)	TORRB2	Energy	$12 100.00	0.38	$4598.00
		Stanwell	STAN-3	Raise reg	$64.70	-1.00	-$64.70
		AGL (SA)	TORRA2	Raise reg	$0.00	0.21	$0.00
		AGL (SA)	TORRA3	Raise reg	$0.00	0.21	$0.00
		AGL (SA)	TORRA4	Raise reg	$0.00	0.21	$0.00
		AGL (SA)	TORRB2	Raise reg	$0.00	0.38	$0.00
11:10	$10 618.48	Snowy Hydro	PTSTAN1	Energy	$10 618.48	1.00	$10 618.48
11:15	$10 618.48	Snowy Hydro	PTSTAN1	Energy	$10 618.48	1.00	$10 618.48
11:20	$12 234.56	AGL (SA)	TORRB1	Energy	$12 100.00	0.52	$6292.00
		AGL (SA)	TORRB2	Energy	$12 100.00	0.48	$5808.00
		ERMPower and Arrow	BRAEMAR6	Energy	$144.00	1.00	$144.00
		Millmerran	MPP_2	Energy	$10.44	-1.00	-$10.44
		Millmerran	MPP_2	Raise reg	$1.00	1.00	$1.00
		AGL (SA)	TORRB1	Raise reg	$0.00	-0.52	$0.00
		AGL (SA)	TORRB2	Raise reg	$0.00	-0.48	$0.00
11:25	$11 865.52	AGL (SA)	TORRA2	Energy	$12 100.00	0.33	$3993.00
		AGL (SA)	TORRA3	Energy	$12 100.00	0.33	$3993.00
		AGL (SA)	TORRA4	Energy	$12 100.00	0.33	$3993.00
		Snowy Hydro	CG2	Energy	$290.00	-0.50	-$145.00
		Snowy Hydro	CG3	Energy	$290.00	-0.50	-$145.00
		AGL Energy	BW01	Energy	$59.52	1.00	$59.52
		AGL Energy	BW01	Raise reg	$4.00	-1.00	-$4.00
		AGL (SA)	TORRA2	Raise reg	$0.00	0.33	$0.00
		AGL (SA)	TORRA3	Raise reg	$0.00	0.33	$0.00
		AGL (SA)	TORRA4	Raise reg	$0.00	0.33	$0.00
11:30	$10 669.98	Snowy Hydro	LONSDALE	Energy	$10 669.98	1.00	$10 669.98

Spot Price **$11 340/MWh**

Appendix B: Closing bids

Figures B1 to B3 highlight the half hour closing bids for participants in Victoria and 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 6: AGL (Torrens Island, The Bluff, Hallett WF and North Brown Hill WF) closing bids, dispatch and spot price – South Australia

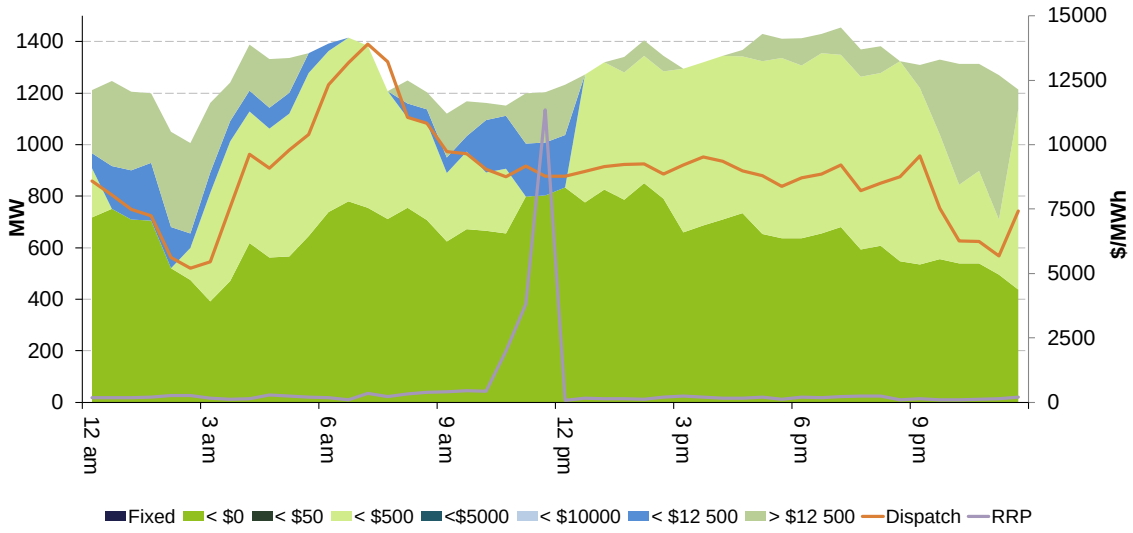


Figure 7: Snowy Hydro (Angaston, Lonsdale, Port Stanvac) closing bids, dispatch and spot price - South Australia

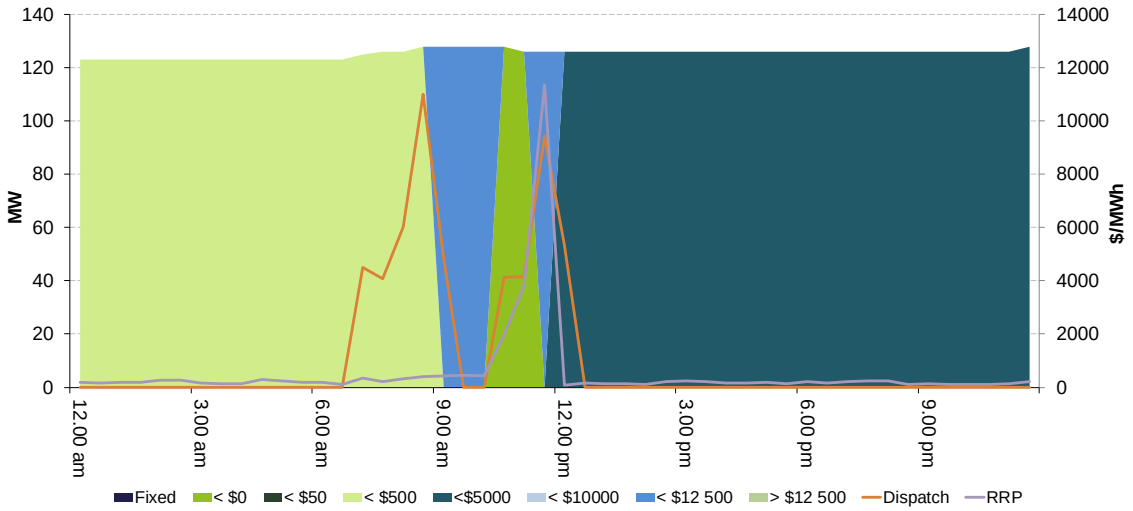
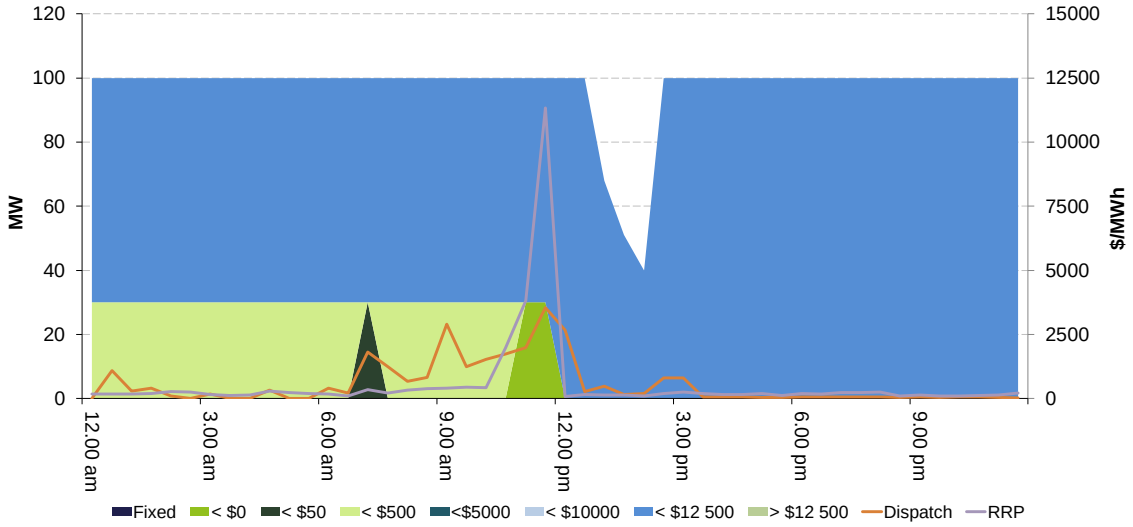


Figure 8: Hornsdale Power Reserve (Hornsdale battery) closing bids, dispatch and spot price – South Australia*



*Only 30 MW of the 100 MW battery is offered to the market on a commercial basis. The remaining 70 MW is reserved for the SA Government and therefore has not been included in Figure B3.

Appendix C: 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 for each region.

Table 9: Significant energy rebids for 11 am in Victoria

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
07.26 am		Snowy Hydro	Laverton North	-4	-1000	N/A	07:25:58 p revised station capability due to changed ambient temperature
07.26 am		Snowy Hydro	Laverton North	-4	-1000	N/A	07:26:26 p revised station capability due to changed ambient temperature
07.53 am		AGL Energy	Somerton	6	N/A	143	0750~p~030 increase in avail cap~301 plant limit lifted 6mw
08.16 am		Ecogen Energy	Jeeralang A	6	N/A	-1000	0810~p~adj avail, pasa revised ambient conditions at station sl~
08.35 am		AGL Energy	Loy Yang A	-10	9	N/A	0830~p~020 reduction in avail cap~206 unexp ambient temp effects
08.46 am		Ecogen Energy	Jeeralang B	-2	-1000	N/A	0845~p~adj avail revised ambient conditions sl~
09.02 am		Ecogen Energy	Jeeralang A	-8	-1000	N/A	0900~p~adj avail, pasa due to revised ambient conditions at station sl~
09.02 am		Ecogen Energy	Jeeralang B	-13	-1000	N/A	0900~p~adj avail, pasa due to revised ambient conditions at station sl~
09.03 am		AGL Energy	Somerton	-4	143	N/A	0900~p~020 reduction in avail cap~206 unexp ambient temp effects 4mw
09.20 am		AGL Energy	West Kiewa	17	N/A	-1000	0915~p~060 increased water avail~601 pondage limitations
09.22 am		AGL Energy	Oaklands Hill WF	-19	-897	N/A	0915~p~010 unexpected/plant limits~turbine availability
09.26 am		AGL Energy	Loy Yang A	-10	-1000	N/A	0925~p~020 reduction in avail cap~203 plant

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
							failure 10mw
09.28 am		Snowy Hydro	Murray	25	N/A	-1000	09:27:12 p following assessment by engineering on previous day performance, m1u1 additional capacity made available to market
09.33 am		Alinta Energy	Loy Yang B	-5	-151	N/A	0930~p~update avail: current ambient temperature~
09.45 am		Alinta Energy	Loy Yang B	-10	-151	N/A	0940~p~update avail: current ambient temperature~
09.47 am		Ecogen Energy	Jeeralang A	-3	-1000	N/A	0945~p~adj avail, pasa due to revised ambient conditions at station sl ~
09.50 am		Alinta Energy	Bairnsdale	-1	104	N/A	0949p plant capability different to expectation: tvps and bairnsdale
09.50 am		EnergyAustralia	Yallourn	-5	-1000	N/A	0945~p~adj avail due to ambient conditions sl~
09.53 am		Alinta Energy	Loy Yang B	-5	-151	N/A	0950~p~update avail: current ambient temperature~
09.57 am		Snowy Hydro	Laverton North	-1	-1000	N/A	09:57:04 p revised station capability due to changed ambient temperature
09.57 am		Snowy Hydro	Laverton North	-1	-1000	N/A	09:57:46 p revised station capability due to changed ambient temperature
10.00 am		Alinta Energy	Loy Yang B	-10	-151	N/A	0955~p~update avail: current ambient temperature~
10.07 am		Alinta Energy	Loy Yang B	-10	-151	N/A	1005~p~update avail: current ambient temperature~
10.14 am		EnergyAustralia	Gannawarra Energy Storage System	7	N/A	-986	1010~p~adj avail, bands, pasa due to revised commissioning profile sl ~
10.15 am		Alinta Energy	Loy Yang B	-10	-151	N/A	1010~p~update avail: current ambient temperature~
10.16 am		Ecogen Energy	Jeeralang B	-11	-1000	N/A	1015~p~adj avail, pasa due to revised ambient conditions at station sl~

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
10.20 am		Origin Energy	Mortlake	3	N/A	88	1016p change in avail - ambient conditions sl
10.27 am	10.35 am	Alinta Energy	Loy Yang B	-10	-151	N/A	1015~p~update avail: current ambient temperature~
10.40 am	10.50 am	Alinta Energy	Loy Yang B	-15	-151	N/A	1035~p~update avail: current ambient temperature~
10.46 am	10.55 am	Snowy Hydro	Laverton North	-1	-1000	N/A	10:45:52 p revised station capability due to changed ambient temperature
10.46 am	10.55 am	Snowy Hydro	Laverton North	-1	-1000	N/A	10:46:34 p revised station capability due to changed ambient temperature

Table 10: Significant energy rebids for 11.30 am in Victoria

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
07.33 am		Trustpower	Hume	2	N/A	-1000	0730p changed irrigation requirements
07.48 am		EnergyAustralia	Yallourn	10	N/A	-1000	0745~p~adj avail, pasa low exit temp limit sl~
08.17 am		Snowy Hydro	Valley Power	-5	-1000	N/A	08:16:23 p revised station capability due to changed engine temperature - high bearing temperature
08.35 am		AGL Energy	Loy Yang A	-10	9	N/A	0830~p~020 reduction in avail cap~206 unexp ambient temp effects
08.46 am		Ecogen Energy	Jeeralang B	-2	-1000	N/A	0845~p~adj avail revised ambient conditions sl~
09.02 am		Ecogen Energy	Jeeralang B	-13	-1000	N/A	0900~p~adj avail, pasa due to revised ambient conditions at station sl~
09.22 am		AGL Energy	Oaklands Hill WF	-19	-897	N/A	0915~p~010 unexpected/plant limits~turbine availability
09.26 am		AGL Energy	Loy Yang A	-10	-1000	N/A	0925~p~020 reduction in avail cap~203 plant failure 10mw

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
09.28 am		Snowy Hydro	Murray	25	N/A	-1000	09:27:12 p following assessment by engineering on previous day performance, m1u1 additional capacity made available to market
09.31 am		AGL Energy	Loy Yang A	-10	9	N/A	0930~p~020 reduction in avail cap~206 unexp ambient temp effects
09.46 am		Snowy Hydro	Valley Power	-1	-1000	N/A	09:46:41 p revised station capability due to changed ambient temperature
09.50 am		Alinta Energy	Bairnsdale	-1	104	N/A	0949p plant capability different to expectation: tvps and bairnsdale
09.53 am		Alinta Energy	Loy Yang B	-5	-151	N/A	0950~p~update avail: current ambient temperature~
09.59 am		Snowy Hydro	Valley Power	-1	-1000	N/A	09:59:02 p revised station capability due to changed ambient temperature
10.00 am		Alinta Energy	Loy Yang B	-10	-151	N/A	0955~p~update avail: current ambient temperature~
10.07 am		Alinta Energy	Loy Yang B	-10	-151	N/A	1005~p~update avail: current ambient temperature~
10.15 am		Alinta Energy	Loy Yang B	-10	-151	N/A	1010~p~update avail: current ambient temperature~
10.16 am		Ecogen Energy	Jeeralang B	-11	-1000	N/A	1015~p~adj avail, pasa due to revised ambient conditions at station sl~
10.18 am		Trustpower	Hume	8	N/A	-1000	0730p changed irrigation requirements
10.20 am		Origin Energy	Mortlake	3	N/A	165	1016p change in avail - ambient conditions sl
10.27 am		Alinta Energy	Loy Yang B	-10	-151	N/A	1015~p~update avail: current ambient temperature~
10.40 am		Alinta Energy	Loy Yang B	-15	-151	N/A	1035~p~update avail: current ambient temperature~

Submit time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
10.54 am	11.05 am	EnergyAustralia	Gannawarra Energy Storage System	8	N/A	-986	1050~p~adj avail due to revised commissioning profile sl~
11.01 am	11.10 am	Trustpower	Hume	1	N/A	-1000	1059p changed irrigation requirements
11.02 am	11.10 am	AGL Energy	Somerton	-5	-988	N/A	1100~p~020 reduction in avail cap~206 unexp ambient temp effects
11.11 am	11.20 am	Alinta Energy	Bairnsdale	-2	-1042	N/A	1111p plant capability different to expectation: bairnsdale and tvps.
11.13 am	11.20 am	Snowy Hydro	Laverton North	-1	-1000	N/A	11:13:18 p revised station capability due to changed ambient temperature
11.17 am	11.25 am	Snowy Hydro	Valley Power	-5	-1000	N/A	11:17:08 p revised station capability due to changed ambient temperature
11.21 am	11.30 am	Alinta Energy	Loy Yang B	-10	-151	N/A	1120~p~revise unit output based on ambient conditions~

Table 11: Significant energy rebids for 11.30 am in South Australia

Submit time	Time	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
10.38 am		AGL Energy	Torrens Island	-45	-1000	N/A	1035~p~010 unexpected/plant limits~108 load/ramp variation during rts

Appendix D: Lack of Reserve

AEMO is required to monitor the level of reserve, or spare capacity, within each region of the NEM. Reserves are defined as the difference between the volume of electricity that can be made available to consumers, either by local generation or through the network from other regions of the NEM, and the regional customer demand at that time.

Reserves are an indicator of the supply demand balance and an important tool to communicate with the market potential and actual shortfalls. This is achieved through the release of LOR notices by AEMO. Forecast LOR notices are designed to elicit a market response from generators to increase their declared available capacity or retailers to reduce demand to address any forecast reserve shortfalls. Actual LOR notices are also issued when the thresholds are actually triggered.

There are three reserve thresholds, which relate to managing power system security following a defined number of unplanned failures of either transmission or generating equipment (credible contingencies). An example of a credible contingency would be the failure of a large generator or the failure of a transmission line that would reduce interconnector capacity.

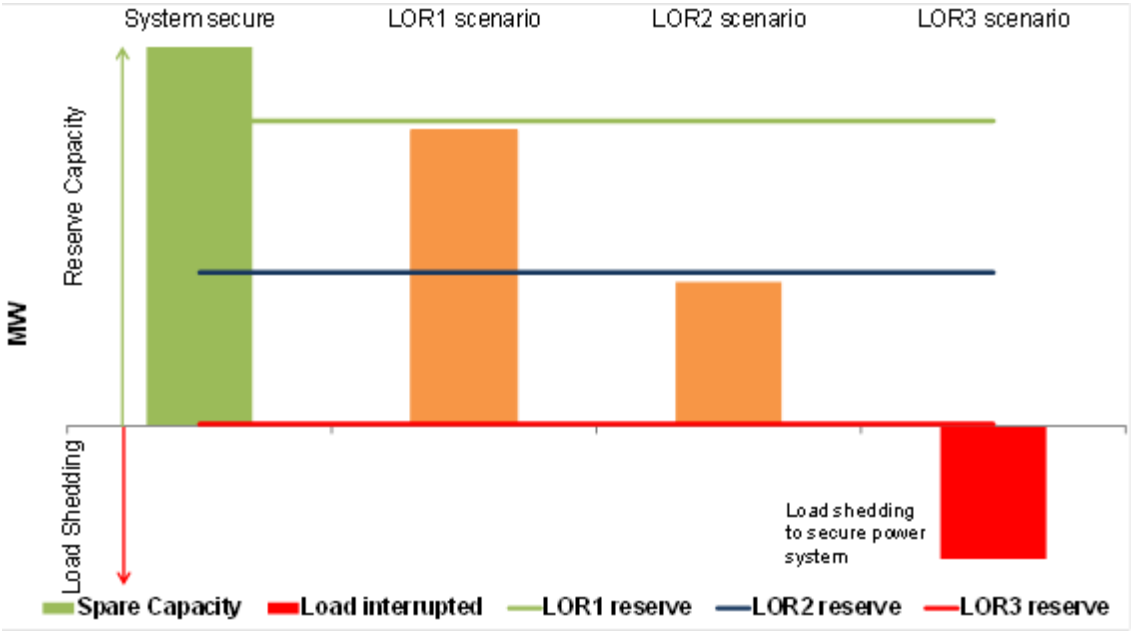
The three LOR levels are broadly categorised as follows:[8]

- An LOR1 is declared when AEMO considers load shedding is likely to occur after two single credible contingencies.
- An LOR2 is declared when AEMO considers load shedding is likely to occur after a single credible contingency.
- An LOR3 is declared when customer(s) load would be, or is, shed in order to maintain the security of the power system.

Figure 9 shows the four possible spare capacity and the lack of reserve threshold situations graphically.

8 These definitions have been simplified for the sake of readability. An interactive glossary of electricity market terms can be found on the AEMO website at: https://www.aemo.com.au/Datasource/Archives/Archive1767#

Figure 9: Spare capacity and lack of reserve



Assuming that the horizontal axis line represents a situation when supply equals demand, then excess generating capacity (above the x axis) amounts to spare or reserve capacity. As discussed above, the three reserve levels are shown as three horizontal lines, reserve requirements for LOR1 in green, for LOR2 in blue and where there are no reserves and all capacity is being used to meet demand, LOR3, in red.

The solid green and amber blocks represent spare capacity. As the spare capacity drops below a reserve line (the horizontal lines) either by a reduction in available capacity or an increase in demand, a new reserve condition exists. AEMO monitors this situation continuously and issues LOR notices to inform participants.

When there is insufficient capacity to meet demand load must be shed (customers interrupted) and an LOR3 is issued.

Appendix E: Relevant Market Notices

Table 12 lists the market notices were notifying the market of lack of reserves, engagement of RERT contracts, load shedding and administered price periods in Victoria and South Australia. Further detail can be found on AEMO's Market Notices website.[9]

Table 12: Market Notices relating to 25 January

Market Notice	Date	Time	Description	Region	Time affected
66500	22-Jan	3:26 PM	LOR2 (Forecast)	Victoria	12.30 pm - 2.00 pm
66503	22-Jan	4:48 PM	LOR2 (Forecast update)	Victoria	11.00 am - 3.30 pm
66532	23-Jan	7:41 AM	LOR2 (Forecast update)	Victoria	10.30 am - 4.00 pm
66534	23-Jan	10:44 AM	LOR2 (Forecast update)	Victoria	11.30 am - 4.00 pm
66559	23-Jan	4:29 PM	LOR2 (Forecast update)	Victoria	10.00 am - 5.00 pm
66573	24-Jan	2:13 AM	LOR2 (Forecast update)	Victoria	10.30 am - 5.00 pm
66600	24-Jan	9:36 AM	LOR2 (Forecast update)	Victoria	10.30 am - 3.00 pm; 3.30 pm - 6.00 pm
66608	24-Jan	11:52 AM	LOR2 (Forecast update)	Victoria	10.00 am - 1.00 pm; 1.30 pm - 2.00 pm; 2.30 pm - 3.00 pm; 3.30 pm - 6.00 pm
66614	24-Jan	1:46 PM	LOR2 (Forecast update)	Victoria	10.30 am - 12.30 pm; 2.30 pm - 4.30 pm
66615	24-Jan	1:46 PM	LOR1 (Forecast)	Victoria	9.30 am - 10.30 am; 4.30 pm - 5.00 pm
66714	24-Jan	9:25 PM	LOR3 (Forecast)	Victoria	12.00 pm - 3.00 pm
66716	24-Jan	9:29 PM	LOR2 (Forecast update)	Victoria	10.30 pm - 12.00 pm; 3.00 pm - 3.30 pm
66717	24-Jan	9:31 PM	LOR1 (Forecast update)	Victoria	9.30 am - 10.30 am; 3.30 pm - 4.30 pm
66728	25-Jan	4:40 AM	LOR3 (Forecast update)	Victoria	2.00 pm - 3.00 pm
66729	25-Jan	4:40 AM	LOR2 (Forecast update)	Victoria	11.00 am - 2.00 pm; 3.00 pm - 3.30 pm
66731	25-Jan	7:52 AM	LOR2 (Forecast update)	Victoria	9.00 am - 12.00 pm; 3.00 pm - 3.30 pm
66743	25-Jan	7:37 AM	RERT (Intention to negotiate for additional reserve)	Victoria	9.00 am – 6.00 pm
66744	25-Jan	7:51 AM	LOR3 (Forecast update)	Victoria	12.00 pm - 3.00 pm
66745	25-Jan	7:52 AM	LOR1 (Forecast update)	Victoria	8.00 am - 9.00 am; 3.30 pm - 4.30 pm
66746	25-Jan	8:21 AM	LOR1 (Actual)	Victoria	8.00 am - 4.30 pm
66747	25-Jan	8:50 AM	LOR3 (Forecast update)	Victoria	10.00 am - 3.00 pm
66748	25-Jan	8:51 AM	LOR2 (Forecast update)	Victoria	9.00 am - 10.00 am; 3.00 pm - 4.00 pm
66749	25-Jan	8:57 AM	RERT (Activated)	Victoria	9.00 am - 4.30 pm
66751	25-Jan	9:50 AM	LOR2 (Actual)	Victoria	9.45 am - 3.30 pm
66752	25-Jan	10:01 AM	LOR3 (Forecast update)	Victoria	10.30 am - 3.00 pm
66767	25-Jan	10:49 AM	LOR3 (Forecast update)	Victoria	10.30 am - 3.00 pm

[9] AEMO Market Notices

Market Notice	Date	Time	Description	Region	Time affected
66768	25-Jan	11:04 AM	LOR3 (Actual)	Victoria	11.00 am - 3.00 pm
66773	25-Jan	11:14 AM	Load Shedding (Direction)	Victoria	11.00 am - 2.00 pm
66779	25-Jan	11:25 AM	Administered Price Period (Start)	Victoria	11.30 am - 1 Feb
66780	25-Jan	11:26 AM	Administered Price Period (Start)	SA	11.30 am - 1 Feb
66817	25-Jan	1:26 PM	Load Shedding (Cancelled)	Victoria	11.00 am - 2.00 pm
66819	25-Jan	1:50 PM	LOR3 (Cancelled)	Victoria	11.00 am - 2.00 pm
66820	25-Jan	2:22 PM	LOR1 (Update)	Victoria	2.00 pm - 3.30 pm
66821	25-Jan	4:15 PM	LOR1 (Update)	Victoria	4.00 pm - 5.00 pm
66822	25-Jan	2:42 PM	RERT updated	Victoria	9.00 am – 5.00 pm
66827	25-Jan	4:30 PM	RERT (Cancelled)	Victoria	9.00 am - 4.30 pm
66828	25-Jan	4:01 PM	LOR2 (Cancelled)	Victoria	9.45 am - 4.00 pm
66832	25-Jan	6:05 PM	LOR1 (Cancelled)	Victoria	8.00 am - 6.00 pm
67054	1-Feb	3:55 AM	Administered Price Period (End)	SA	25 Jan - 4.00 am
67055	1-Feb	3:56 AM	Administered Price Period (End)	Victoria	25 Jan - 4.00 am

Appendix F: Pricing during an intervention

At times, AEMO, may need to override the normal dispatch process to maintain system security. In accordance with the National Electricity Rules a dispatch interval where an AEMO intervention event occurs, must be declared an intervention price dispatch interval and set the energy and FCAS prices for all regions as if AEMO had not intervened in the market. An intervention pricing interval is declared when AEMO directs a participant to operate plant other than in accordance with dispatch instructions, or activates a reliability and emergency reserve trader (RERT) contract.

RERT contracts refer to specific arrangements by AEMO by which additional capacity may be made available under special circumstances. AEMO may dispatch or activate RERT contract(s) to address a power system security situation.

Under normal operations AEMO sets targets for generation and interconnectors and determines wholesale electricity market prices (energy and FCAS) in a single calculation for every five minute dispatch interval. Under “Intervention pricing” these are calculated twice for each dispatch interval, one taking into account the direction called “Intervention” and one that does not include the direction called “What-if”.

The “Intervention” calculation takes into account the intervention by AEMO (in this case engaging RERT contracts and load shedding) and is used to set targets for generation in order to meet demand. The pricing outcome of this calculation is not received by the generators.

The “What-If” calculation does not take the direction into account and is used to calculate the wholesale electricity market price and is received by generators. The generation targets calculated are not used to dispatch generation.

These calculations dispatch generation to meet demand (intervention calculation) while providing the pricing signal to indicate a shortage of supply (what-if calculation).

Table 13: "What-if" and intervention pricing outcomes

Trading interval	What-if pricing ($/MWh)		Intervention pricing ($/MWh)	
	Victoria	South Australia	Victoria	South Australia
9.30 AM	504	441	442	391
10.00 AM	477	423	307	277
10.30 AM	2520	1986	257	221
11.00 AM	7433	3817	362	-199
11.30 AM	14 500	11 340	14 500	10 627
12.00 PM	300	88	300	44
12.30 PM	300	157	300	149
1.00 PM	300	141	300	130
1.30 PM	300	145	300	121

Trading interval	What-if pricing ($/MWh)		Intervention pricing ($/MWh)	
2.00 PM	216	110	187	42
2.30 PM	232	206	151	130
3.00 PM	293	248	290	235
3.30 PM	293	202	290	202
4.00 PM	290	164	288	138