Electricity spot prices above $5000/MWh

Victoria,
30 December 2019

19 February 2020

AUSTRALIAN ENERGY REGULATOR

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Amendment Record

Version	Date	Pages
Final report	19/2/2020	20

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 the performance of energy markets, including the annual State of the energy market report and biennial effective competition report, to assist stakeholders and the wider community.

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

The report:

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

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

2 Summary

The wholesale spot price for electricity reached $6443/MWh for the 3.30 pm trading interval on 30 December 2019 in Victoria.

The spot price was significantly higher than forecast due to an unplanned network outage of the Lower Tumut to Wagga 330 kV line in New South Wales which was caused by bushfires in the area.

Before the network outage occurred Victoria was importing around 210 MW of electricity from New South Wales across the Vic-NSW interconnector. Constraints used to manage the outage resulted in flows across the interconnector being reversed to around 370 MW (exports into New South Wales). As a result, high priced generation (greater than $5000/MWh) was dispatched to meet demand in Victoria.

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

Shortly after the outage occurred the market operator, AEMO, declared a Lack of Reserve level 2 in Victoria. Later in the afternoon AEMO invoked the Reliability and Emergency Reserve Trader (RERT) mechanism to ensure there was enough supply to meet demand, however no prices above $5000/MWh occurred during this time.

3 Analysis

The following sections provide analysis of the factors that led to the spot price in Victoria reaching $6443/MWh for the 3.30 pm trading interval.

3.1 Overview of actual and expected conditions

Table 1 shows the actual and forecast spot prices in Victoria, along with generator availability and demand, for the high priced trading interval.

Table 1: Actual and forecast price, availability and demand

Trading interval	Price ($/MWh)			Availability (MW)			Demand (MW)		
	Actual	4 hr forecast	12 hr forecast	Actual	4 hr forecast	12 hr forecast	Actual	4 hr forecast	12 hr forecast
3.30 pm	6443	136	332	8735	8827	8940	8204	8254	8051

Table 1 shows:

- Four and 12 hours forecasts indicated prices would not exceed $340/MWh for the 3.30 pm trading interval
- Generator availability was around 100 MW lower than forecast due to plant issues at Macarthur wind farm
- Demand was close to the four hour forecast

The actual price was significantly higher than forecast because of the unplanned outage in New South Wales causing a decrease in imports and high priced generation in Victoria being needed to meet demand.

3.2 Network Availability

The NEM regions are connected via high voltage interconnectors, through which electricity is transferred. Import and export limits control the maximum amount of electricity that can flow between regions across interconnectors. The market operator, AEMO, manages the flow of electricity across the network using constraints to ensure that system security is maintained. Constraints are mathematical equations that manage or “limit” flows on specific transmission lines (including interconnectors) for each five minute interval. AEMO uses generator offers and SCADA data to determine the optimal flow of electricity across the network.

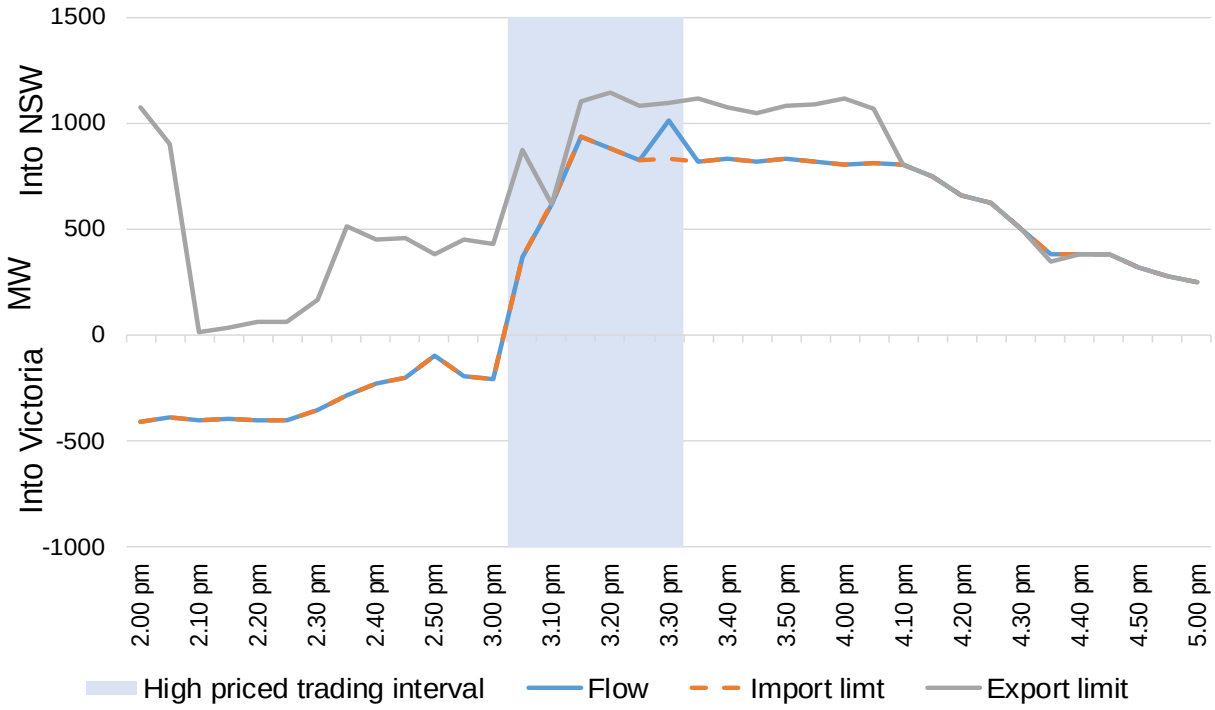
At 2.47 pm there was an unplanned outage of the Lower Tumut to Wagga 330 kV line which was caused by bushfires in the area. AEMO invoked constraints to manage the power system. The effect of these constraints, which were in place from the 3.05 pm dispatch interval, saw the flows on the Vic-NSW interconnector reverse from imports in to Victoria to forced exports in to New South Wales. This was around a 570 MW change.

This 570 MW change in flows on the interconnector had to be replaced by either local generation in Victoria or an increase from other connected regions; South Australia or Tasmania. While there was an increase of around 200 MW from the other regions, local generation in Victoria had to increase output by approximately 420 MW to meet demand and as a result capacity priced above $5000/MWh was dispatched.

Figure 1 shows the import and export limit and flow of electricity for the Vic-NSW interconnector. The import and export limits are dynamically set by constraints for each 5-minute dispatch interval. Typically, the import limit (orange dashed line) is below and the export limit (grey line) is above the 0 MW point on the Y axis. Provided the actual flow (blue line) falls in-between these two limits the interconnector is considered to be operating at a safe level.

The figure shows that once the outage occurred, the import limit line crossed over the 0 MW point on the Y axis, effectively forcing flows into New South Wales.

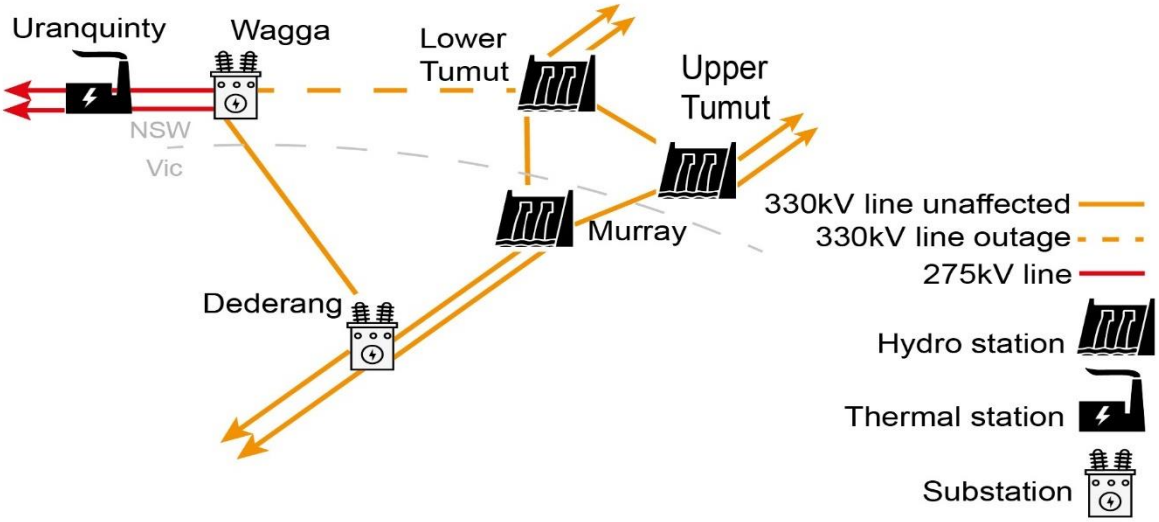
Figure 1: VIC-NSW interconnector limits and flows



The reason flows were being forced into New South Wales is the location of Snowy Hydro's Murray power station compared with the line outage. Figure 2 shows a simplified illustration of the transmission network including the line outage and the location of the Murray Power Station.

While the line outage was in New South Wales, constraints used to manage the system include one which limits the flow of electricity on the Murray to Dederang lines south towards Melbourne (this is done to avoid overloading the lines). Effectively there is a trade-off between generation at Murray power station and imports into Victoria, the more power station generates the less imports are allowed from elsewhere to avoid overloading the network between Murray and Dederang in Victoria.

Figure 2: Simplified transmission network around the Snowy generators



The unplanned outage resulted in the price in the first three dispatch intervals of the 3.30 pm trading interval being above $5000/MWh.

For the 3.05 pm dispatch interval, Murray's generation target increased due to its low priced offer. However due to the constraint managing the line to the south, some of this generation had to flow north across the interconnector into New South Wales. Subsequently generation priced above $5000/MWh was dispatched to meet demand and the price went to the cap.

In response to forecast and actual high prices at 3.05 pm, Snowy Hydro made two rebids which moved nearly all of the capacity at the Murray power station (1493 MW) to the price floor. However due to the constraints managing the overloading of the Murray to Dederang line AEMO had to substantially decrease Murray's target to generate and as a result the price was again set at the cap for the 3.10 pm dispatch interval.

The price remained at the cap for the 3.15 pm dispatch interval as all lower priced generation in the Victorian region was dispatched and higher priced generation (at around $9000/MWh) from South Australia was needed to meet demand.

The line outage was restored at 6.30 pm that evening and AEMO subsequently removed the constraints which managed the overloading of the Murray to Dederang lines.

3.3 Supply

On the day there was two large generators offline in Victoria, AGL's Loy Yang A2 (530 MW) and Alinta Energy's Loy Yang B1 (490 MW). The A2 unit had been offline since 27 December due to a plant failure while the B1 unit had been offline since 29 December due to a tube leak.

Rebidding of capacity from low to high prices did not contribute to the high prices, in fact capacity was rebid from high to low prices in response to the high prices at the start of the 3.30 pm trading interval. This saw the dispatch price decrease to less than $106/MWh for the second half of the trading interval.

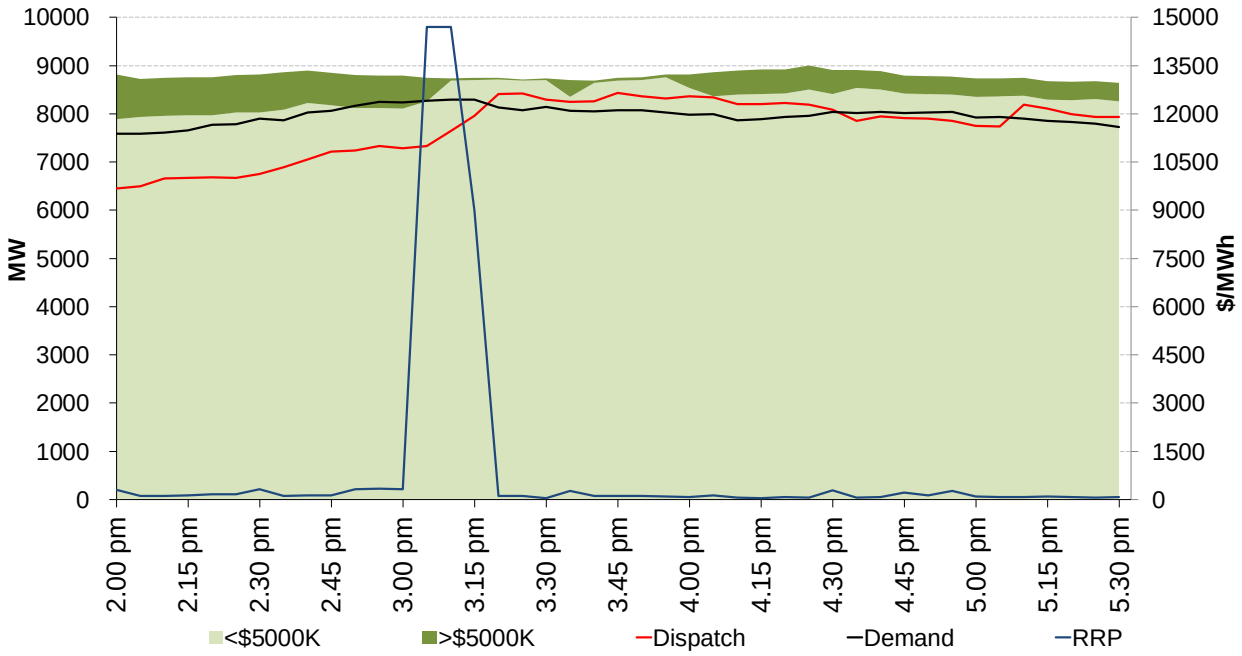
For most of the day generator availability hovered between 8000 and 9000 MW with around 90% of this capacity offered in below $5000/MWh. At the start of the 3.30 pm trading interval

there was only 34 MW of capacity priced between $425/MWh and $10 000/MWh, which meant a small change in supply or demand could have a very large impact on price.

As shown in Figure 3, following the price spike at 3.05 pm, participants rebid from high to low prices which saw capacity offered in under $5000/MWh increasing to around 8700 MW (with less than 100 MW of capacity being left above $5000/MWh). Capacity offered in at the price floor rose from around 4800 MW at 3.05 pm to over 7000 MW at 3.10 pm.

Significant rebids can be found in Appendix A.

Figure 3: Energy offered at different price ranges, MW dispatched and demand



3.4 Demand

High temperatures in Melbourne led to high demand in Victoria. The temperature exceeded 40°C[1] in Melbourne and demand reached 8204 MW at 3.30 pm. This was 50 MW lower than was forecast for 3.30 pm, and 264 MW less than the forecast peak demand (which was forecast to occur at 5 pm).

Demand was a factor that contributed to AEMO's decision to enact the RERT later in the day.

3.5 Events following the unplanned network outage

Following the unplanned outage of the Lower Tumut to Wagga 330 kV line, at 3.16 pm AEMO notified the market of a forecast Lack of Reserve 1 (LOR1) from 3.30 pm to 7 pm and a forecast Lack of Reserve 2 (LOR2) from 3.30 pm to 6.30 pm in Victoria.

At the same time, AEMO notified the market of its intention to negotiate for additional reserve in Victoria through the RERT mechanism. The RERT is an intervention mechanism under the National Electricity Rules that allows AEMO to contract for emergency services such as

1 Melbourne, Victoria – Dec 2019 (Bureau of Meteorology)

generation or demand response that are not otherwise available in the market. AEMO can use these emergency reserves as a safety net in the event that a shortfall in market reserves is forecast.

At 4 pm AEMO activated reserve contract(s) to maintain the power system in a secure and reliable operating state. An actual LOR1 was declared from 4 pm to 5.15 pm. The reserve contract(s) applied until approximately 11 pm and cost around $3.5 million with an estimated 283 MWh of reserve contracts delivered to the market.[2]

Details on the market notices published by AEMO can be found in appendix D.

Australian Energy Regulator

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2 AEMO 2019, Quarterly Energy Dynamics Q4 2019 and AEMO, 2019 Estimated payments and volumes for RERT activation on 30 Dec 2019

Appendix A: 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 being offered, and the rebid reason.

Table 2: Significant rebids for the 3.30 pm trading interval

Submitted time	Time effective	Participant	Station	Capacity rebid (MW)	Price from ($/MWh)	Price to ($/MWh)	Rebid reason
11:45 am		AGL Energy	Macarthur WF	-42	-96	N/A	1140~P~020 Reduction in avail cap~206 unexp ambient temp effects
12:09 pm		AGL Energy	Macarthur WF	-39	-96	N/A	1205~P~020 Reduction in avail cap~203 plant failure
1:36 pm		EnergyAustralia	Yallourn	-30	<16	N/A	1335~P~Adj avail due to ambient conditions sl~
2:18 pm		AGL Energy	Loy Yang A	60	N/A	-1000	1415~P~030 Increase in avail cap~301 plant limit lifted
2:29 pm		AGL Energy	Macarthur WF	-66	-96	N/A	1427~P~020 Reduction in avail cap~206 unexp ambient temp effects
2:32 pm		EnergyAustralia	Jeeralang A	80	14500	426	1425~A~Adj bands, vic p5 rrp ahead of p30@hhe1500, $245 vs 105 sl~
2:52 pm		Snowy Hydro	Laverton North	150	14700	-1000	14:51:00 A Vic 5min pd price $463.50 higher than 30min pd 15:05@14:32 ($568.53)
2:56 pm	3:05 pm	Snowy Hydro	Murray	85	14700	300	14:51:00 A Vic 5min pd price $320.80 higher than 30min pd 15:00@14:32 ($425.83)
2:59 pm	3:10 pm	AGL Energy	Macarthur WF	27	N/A	-96	1455~P~030 Increase in avail cap~301 plant limit lifted
3:01 pm	3:10 pm	Snowy Hydro	Murray	1493	>61	-1000	15:00:06 A Vic 5min actual price $14,413.71 higher than 5min pd 15:05@14:56 ($14,700.00)
3:01 pm	3:10 pm	Origin Energy	Mortlake	299	33	-1000	1500 A Unforecast dispatch volatility sl

3:01 pm	3:10 pm	Snowy Hydro	Laverton North	150	14700	-1000	15:01:39 A Unforecast change to market - reason to follow
3:02 pm	3:10 pm	Snowy Hydro	Valley Power	285	14700	-1000	15:00:06 A Vic 5min actual price $14,413.71 higher than 5min pd 15:05@14:56 ($14,700.00)
3:09 pm	3:20 pm	EnergyAustralia	Yallourn	180	>9	-1000	1500~A~Adj bands, mat change in vic rrp@hhe1530, $7886 vs 91~
3:11 pm	3:20 pm	EnergyAustralia	Newport	200	0	-1000	1510~A~Adj bands, mat change in vic rrp@hhe1630, $7886 vs 91~
3:14 pm	3:25 pm	AGL Energy	West Kiewa	32	606	-1000	1510~A~040 Chg in aemo disp~45 price increase vs pd vic $14700 for 15:15
3:18 pm	3:25 pm	AGL Energy	Somerton	132	0	-989	1515~A~040 Chg in aemo disp~45 price increase vs pd [vic] [$9007.99 vs $294.61 15:30]
3:22 pm	3:30 pm	Snowy Hydro	Valley Power	20	N/A	-1000	15:22:38 P Revised station capability due to changed ambient temperature

Appendix B: Closing bids

Figures B1 to B3 highlight the half hour closing bids for participants in Victoria 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 B1: EnergyAustralia (Ballarat Battery Energy, Gannawarra Energy Storage, Jeeralang A, Jeeralang B, Newport, Yallourn) closing bids, dispatch and spot price

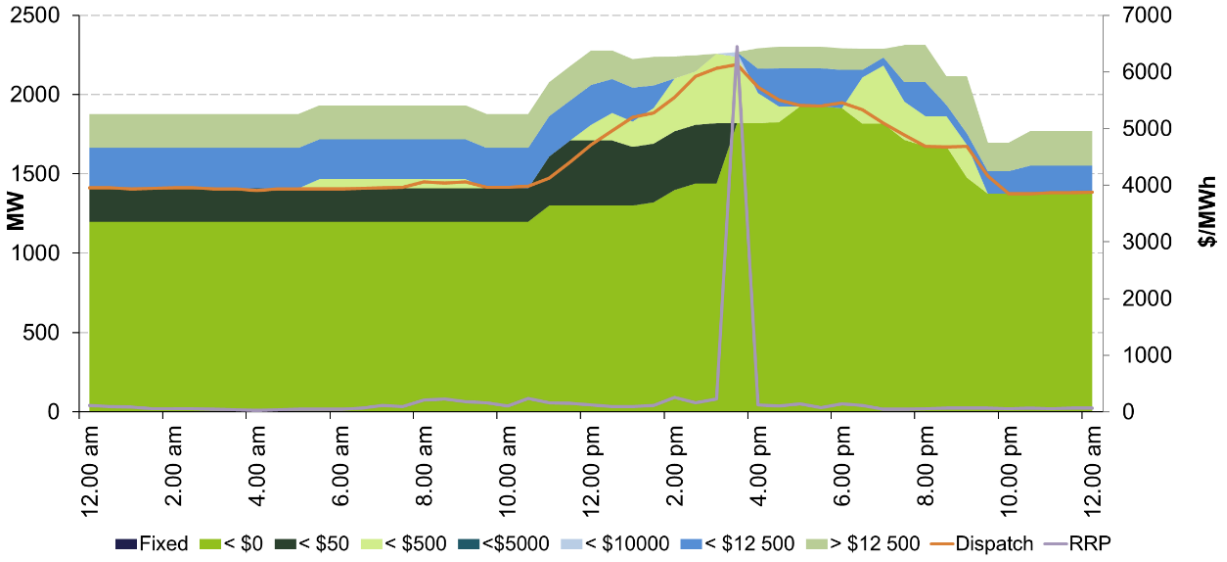


Figure B2: Snowy Hydro (Laverton North, Murray, Valley Power) closing bids, dispatch and spot price

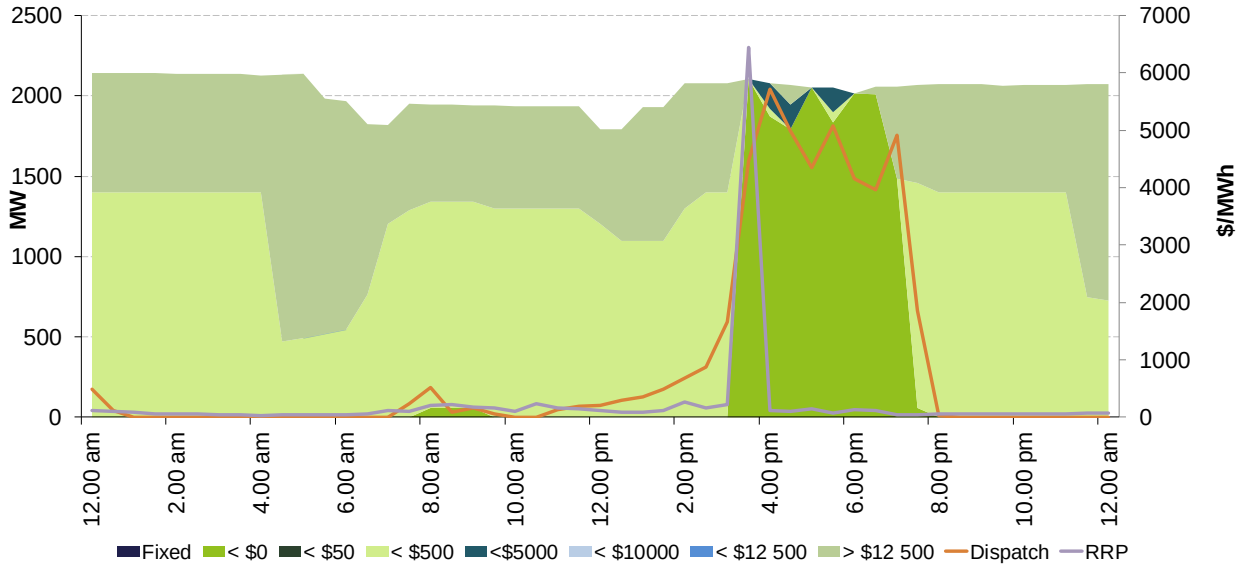
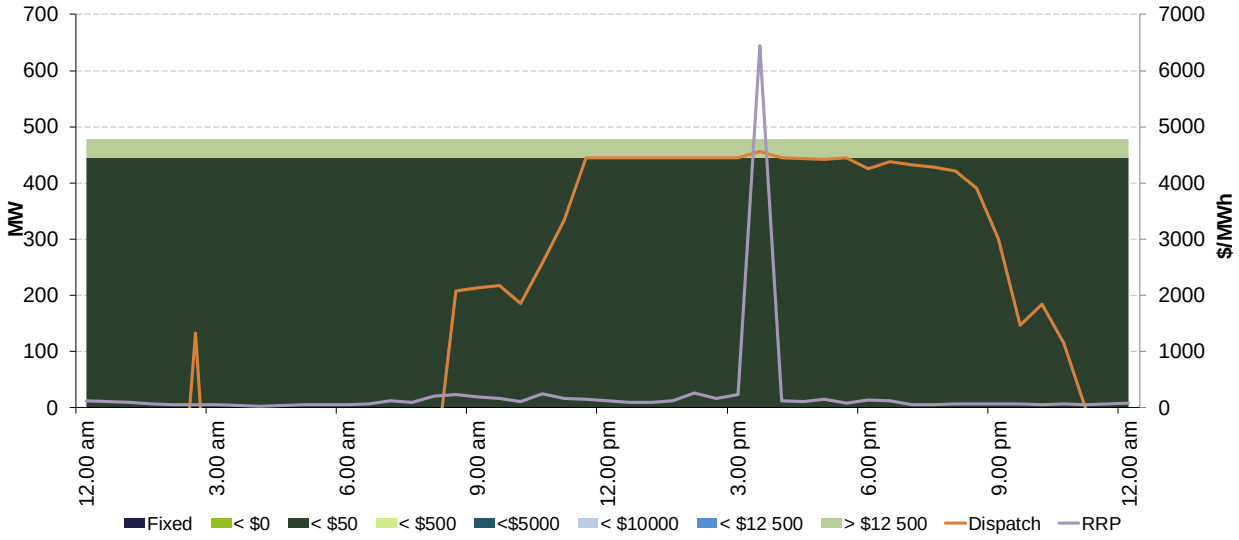


Figure B3: Basslink closing bids, dispatch and spot price

*Only shows offers and dispatch when flows were going from Tasmania to Victoria.



Appendix C: 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. The 30-minute spot price is the average of the six dispatch interval prices. The dispatch prices that are in italics are capped at the price cap of $14 700/MWh when published by AEMO.

Table 3: Victoria price setter 3.30 pm

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
3.05 pm	*$14 700*	Basslink	T-V-MNSP1	Energy	$14 700	1.03	$15141
		Hydro Tasmania	REECE2	Energy	$11.44	1.13	$12.93
		Hydro Tasmania	JBUTTERS	Lower reg	$33	1.03	$33.99
		EnergyAustralia	MP1	Lower reg	$31.81	-1.03	-$32.76
		AGL Energy	LD02	Lower 60 sec	$0.04	-1.03	-$0.04
		Hydro Tasmania	POAT220	Lower 60 sec	$0.16	1.03	$0.16
		Hydro Tasmania	POAT220	Lower 6 sec	$0.03	1.03	$0.03
		EnergyAustralia	YWPS4	Lower 6 sec	$0.03	-1.03	-$0.03
		Snowy Hydro	TUMUT3	Raise 5 min	$0.99	1.03	$1.02
		AGL (SA)	TORRB1	Raise 60 sec	$5	1.03	$5.15
		CS Energy	GSTONE5	Raise 6 sec	$9.49	1.03	$9.77
3.10 pm	*$14 700*	CS Energy	CALL_B_1	Energy	$16.62	204.28	$3395.13
		Snowy Hydro	MURRAY	Energy	-$1000.00	-190.74	$19 0740.00
		AGL Hydro	MCKAY1	Energy	-$1000.00	-0.14	$140.00
		AGL Hydro	WKIEWA1	Energy	-$1000.00	-0.01	$10.00
		CS Energy	GSTONE5	Raise 60 sec	$5.89	78.31	$461.25
		CS Energy	CALL_B_1	Raise 60 sec	$0.45	-78.31	-$35.24
		CS Energy	GSTONE3	Raise 6 sec	$9.49	78.31	$743.16
		CS Energy	CALL_B_1	Raise 6 sec	$0.45	-78.31	-$35.24
3.15 pm	$9007.99	Greentricity	DALNTH01	Energy	$7739.08	1.16	$8977.33
		Cleanco	W/HOE#2	Raise 5 min	$0.89	1.16	$1.03
		Greentricity	DALNTH01	Raise 5 min	$0.00	-1.16	$0.00
		Delta Electricity	VP5	Raise 60 sec	$5.00	1.16	$5.80
		Greentricity	DALNTH01	Raise 60 sec	$0.00	-1.16	$0.00
		CS Energy	GSTONE5	Raise 6 sec	$5.89	1.16	$6.83
		Greentricity	DALNTH01	Raise 6 sec	$0.00	-1.16	$0.00
3.20 pm	$105.03	EnergyAustralia	JLB01	Energy	$105.03	0.33	$34.66
		EnergyAustralia	JLB02	Energy	$105.03	0.33	$34.66
		EnergyAustralia	JLB03	Energy	$105.03	0.33	$34.66
3.25 pm	$105.03	EnergyAustralia	JLB01	Energy	$105.03	0.33	$34.66

DI	Dispatch Price ($/MWh)	Participant	Unit	Service	Offer price ($/MWh)	Marginal change	Contribution
		EnergyAustralia	JLB02	Energy	$105.03	0.33	$34.66
		EnergyAustralia	JLB03	Energy	$105.03	0.33	$34.66
3.30 pm	$39.37	Origin Energy	ER02	Energy	$42.61	0.92	$39.20

Spot price $6 443/MWh

Appendix D: Relevant market notices

The following market notices were used to notify the market of the unplanned network outage, lack of reserves and engagement of Reliability and Emergency Reserve Trader contracts. Further detail can be found on AEMO's Market Notices website.[3]

Market Notice	Type	Date of issue	Last Changed
72138	Inter-regional transfer	30/12/2019 15:05:05	30/12/2019 15:05:05

External Reference

Inter regional transfer limit variation - 051 Lower Tumut to Wagga 330 kV line - NSW region

Reason

AEMO ELECTRICITY MARKET NOTICE

Inter regional transfer limit variation - 051 Lower Tumut to Wagga 330 kV line - NSW region

At 1447 hrs there was an unplanned outage of the 051 Lower Tumut to Wagga 330 kV line in the NSW region

The following Constraint sets were invoked at 1500 hrs until further notice.

N-LTWG_RADIAL

V-DBUSS_L

V-DBUSS_L

The constraint set contains equations with the following interconnectors on the LHS

VIC1-NSW1

V-S-MNSP1

V-SA

T-V-MNSP1

NSW1-QLD1

Refer to the AEMO Network Outage Schedule for further information.

Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
72142	RESERVE NOTICE	30/12/2019 15:16:18	30/12/2019 15:16:18

External Reference

PDPASA - Forecast Lack Of Reserve Level 1 (LOR1) in the Victoria Region on 30/12/2019

3 AEMO market notices

Reason
AEMO ELECTRICITY MARKET NOTICE AEMO declares a Forecast LOR1 condition under clause 4.8.4(b) of the National Electricity Rules for the Victoria region for the following period: At 1530 hrs and 1900 hrs 30/12/2019. The forecast capacity reserve requirement is 1129 MW. The minimum capacity reserve available is 611 MW. Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
72143	RESERVE NOTICE	30/12/2019 15:16:06	30/12/2019 15:16:06

External Reference
PDPASA - Forecast Lack Of Reserve Level 2 (LOR2) in the Vic Region on 30/12/2020

Reason
AEMO ELECTRICITY MARKET NOTICE AEMO declares a Forecast LOR2 condition under clause 4.8.4(b) of the National Electricity Rules for the Vic region for the following period: From1530 hrs 30/12/2019 to 1830 30/12/2019 The forecast capacity reserve requirement is 569 MW. The minimum capacity reserve available is 223 MW. AEMO is seeking a market response. AEMO has not yet estimated the latest time at which it would need to intervene through an AEMO intervention event. Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
72145	MARKET INTERVENTION	30/12/2019 15:16:34	30/12/2019 15:16:34

External Reference
INTENTION TO COMMENCE RERT CONTRACT NEGOTIATIONS

Reason
AEMO ELECTRICITY MARKET NOTICE. Reliability and Emergency Reserve Trader (RERT) Intention to negotiate for additional reserve - VIC1 Region- 30/12/2019 Refer to AEMO Electricity Market Notice no. 72143. AEMO intends to commence negotiations with RERT Panel members for the provision of additional reserve by issuing requests for tender for the following period of time; 15:30 to 23:30 hrs 30/12/2019 If reserve is required, the period of activation or dispatch will be within this period but may not be for the entire period. AEMO will issue a further advice if reserve is contracted. Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
72167	MARKET INTERVENTION	30/12/2019 16:01:12	30/12/2019 16:01:12

External Reference
INTENTION TO COMMENCE RERT CONTRACT NEGOTIATIONS

Reason
AEMO ELECTRICITY MARKET NOTICE. AEMO Intervention Event, Reliability and Emergency Reserve Trader (RERT) - VIC1 Region- 30/12/2019 Refer AEMO Electricity Market Notice no. 72143 AEMO has dispatched/activated reserve contract(s) to maintain the power system in a Secure and Reliable operating state. The reserve contract(s) was dispatched/activated at 16:30 hrs 30/12/2019 and is forecast to apply until 23:00 hrs 30/12/2019 AEMO has implemented an AEMO intervention event for the duration the reserve contract(s) is dispatched/activated/ To facilitate the RERT process, constraints commencing with the following identifiers may be evident at various times in dispatch, #RT_VIC1 Manager NEM Real Time Operations

Market Notice	Type	Date of issue	Last Changed
72169	RESERVE NOTICE	30/12/2019 16:27:49	30/12/2019 16:27:49

External Reference
Actual Lack Of Reserve Level 1 (LOR1) in the VIC region - 30/12/2019

Reason
AEMO ELECTRICITY MARKET NOTICE Actual Lack Of Reserve Level 1 (LOR1) in the VIC region - 30/12/2019 An Actual LOR1 condition has been declared under clause 4.8.4(b) of the National Electricity Rules for the SA region from 1900 hrs. The Actual LOR1 condition is forecast to exist until 1600 hrs. The capacity reserve requirement is 1129 MW The minimum capacity reserve available is 617 MW   Manager NEM Real Time Operations