AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Activation of unscheduled reserves for Victoria – 30 November 2017

May 2018

Event report for the National Electricity Market
Annexure A of *Summer 2017-18 operations review*

Important notice

PURPOSE

This report has been prepared for the purposes of providing information about the 30 November 2017 Reliability and Emergency Reserve Trader (RERT) activation in accordance with clause 3.20 of the National Electricity Rules (NER) in the Summer 2017-18 Operations Review, and includes information that was previously provided to participants about this event in accordance with clause 3.20.6(a) of the NER.

Unless otherwise indicated, terms in this report have the same meanings as those defined in the NER.

All references to time in this report are based on Australian Eastern Standard Time (AEST).

DISCLAIMER

AEMO has made every effort to ensure the quality of the information in this report but cannot guarantee its accuracy or completeness. Any views expressed in this report are those of AEMO unless otherwise stated, and may be based on information given to AEMO by other persons.

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VERSION CONTROL

Version	Release date	Changes
1	23/5/2018	

Summary

Throughout November 2017, Victoria and South Australia experienced unseasonably warm weather. This was particularly the case at the end of the month, resulting in high demand for electricity across the two regions.

The high demand, and generation unavailability, resulted in persistent forecasts of low reserve conditions in Victoria and South Australia for 30 November 2017. This culminated on 29 November 2017, when AEMO declared a forecast lack of reserve (LOR) 2 condition for the Victoria region between 1530 and 1700 hours on 30 November 2017.

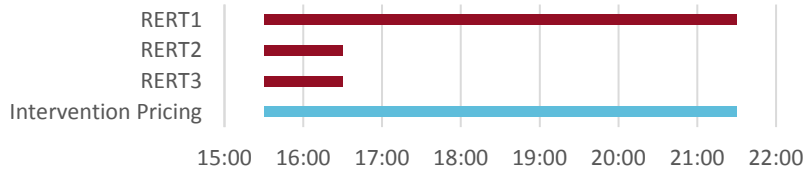
AEMO subsequently published Market Notices (MNs) seeking market response(s) to alleviate the LOR 2 condition, and determined the latest time for AEMO to intervene to be 1230 hours on 30 November 2017 (MN 60123)[1].

As there was insufficient market response to alleviate the risk to supply reliability, AEMO activated a total of 32 megawatts (MW) of unscheduled reserves from three Reliability and Emergency Reserve Trader (RERT) reserve contracts, as shown in Figure 1. The reserve was activated at 1530 hours (MN 60142). The first reserve contract (RERT1) was deactivated at 2130 hours, after the completion of its minimum continuous run time of six hours. The second and third reserve contracts (RERT2 and RERT3) were deactivated at 1630 hours, after completion of their minimum continuous run times of 1 hour.

Intervention pricing was implemented between dispatch intervals (DIs) ending 1535 hours and 2130 hours on 30 November 2017. The procurement and activation of reserves aligns with AEMO's obligations under the Reliability Standard Implementation Guidelines (RSIG) and National Electricity Rules (NER).

AEMO considered the relevant lead time, minimum run time, size, and activation costs associated with each reserve contract, and attempted to address the reserve requirement while minimising cost to market customers in relation to pre-activation and activation. The total activation cost associated with this event was approximately $0.89M.

Figure 1 Timing of enablement of reserve contracts and intervention pricing



The timing of the peak electricity demand and period of low electricity reserves coincided with changes in forecast weather conditions, and ultimately a lower demand. A cool change, coupled with a wind ramping event in South Australia, improved supply conditions and reduced demand for electricity. In particular, supply availability in South Australia improved by approximately 800 MW between 1530 and 1730 hours due to a wind ramping event. This ultimately resolved the identified reserve shortfalls in both regions.

AEMO has assessed the actions taken to manage the risk posed to the power system on 30 November 2017, and is satisfied that all applicable procedures and processes were followed in assessing the need for market intervention, determining the latest time to intervene, and enacting and managing the intervention itself.

Intervention using RERT is rare and, following the event on 30 November 2017, AEMO will review its internal procedures to improve the integration between related systems, the timeliness of communications to the Market, and continue to work with weather service providers to improve the management of uncertainty associated with the timing of cold fronts at the tail end of heat events.

AEMO's backcast of the event[2] highlighted that the underlying uncertainty was a magnitude of 1,094 MW in Victoria, which exceeded the 594 MW minimum reserve requirement on the day. Using this new methodology, additional RERT would be required to be dispatched.

[1] AEMO's Market Notices are available at http://www.aemo.com.au/Market-Notices.

[2] Using the Australian Energy Market Commission's recently approved rule changes regarding Declaration of LOR conditions as described in Section 2.3.2 of AEMO's Summer 2017-18 Review.

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1. Background

Reserve represents the amount of available supply in excess of demand, and therefore the amount available to maintain system reliability if there are credible contingency events on the system.

Forecast reserve levels change over time as expectations of supply and demand change in response to changes in ambient conditions (such as temperature and weather), or plant changes (such as generator and network outages).

The following sections outline the risks and uncertainties associated with these factors on 30 November 2017.

1.1 Weather

Throughout November 2017, Victoria and South Australia experienced unseasonably warm weather. This was particularly the case at the end of the month, resulting in high demand for electricity across the two regions. The high demand, in addition to generating unit unavailability, led to low reserve conditions in Victoria and South Australia on 30 November 2017.

Forecast temperatures issued by the Bureau of Meteorology at 0500 hours on Wednesday 29 November 2017 indicated:

- Sunny conditions on 29 November, with a maximum temperature for Melbourne CBD of 35°C, Laverton 34°C, and Geelong 31°C.
- Forecast maximum temperatures for Thursday 30 November of 35°C for Melbourne CBD and Laverton, and 34°C for Geelong.

The forecast issued for Thursday at 0500 hours Thursday 30 November was unchanged.

Several warnings were issued later on Thursday 30 November for severe thunderstorms and expected severe weather over Victoria.

Figure 2 Scale of heat above average temperatures 29 and 30 November 2017

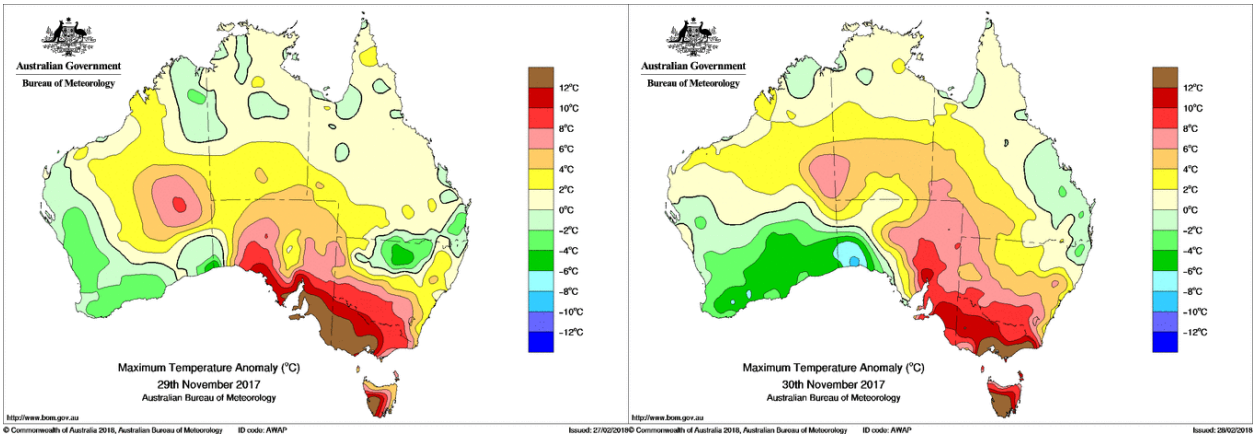


Figure 2 above gives an indication of the scale of the heat event, by showing the difference between the observed maximum temperature and November average temperatures. There were large parts of southern South Australia and Victoria (highlighted in brown on these charts) where maximum temperatures were more than 12°C above the November averages.

The largest deviations between maximum temperature forecasts and actual temperatures were on Wednesday 29 November, with Geelong reaching a maximum of 35°C after a forecast of 31°C, and Laverton reaching 37°C after a forecast of 34°C.

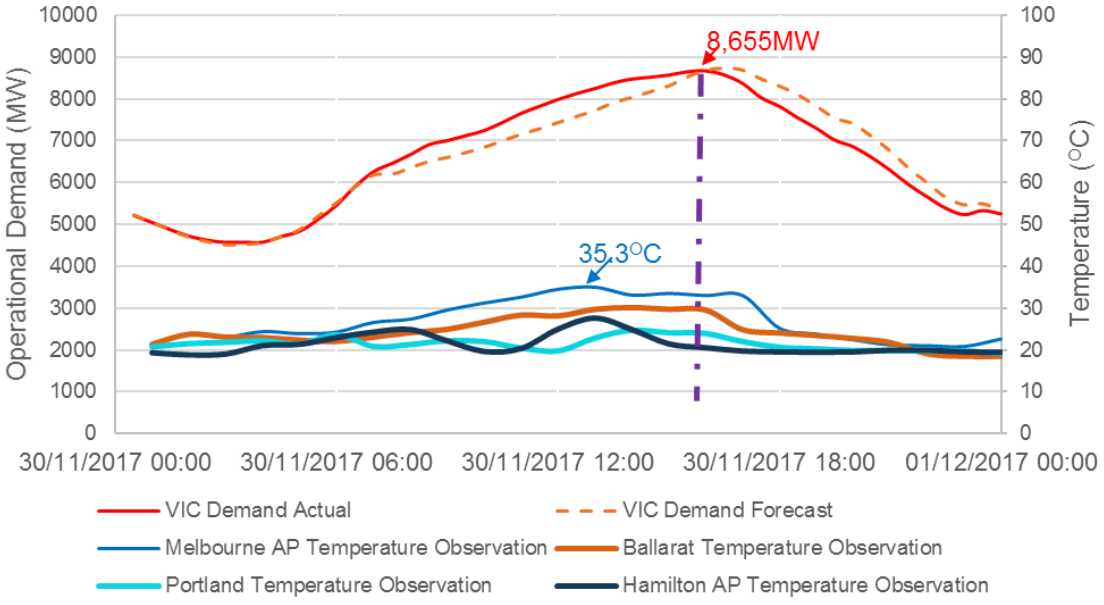
At Laverton, on the western outskirts of Melbourne, the wind direction shifted to a southerly component at 1555 hours on 29 November 2017, and temperatures there dropped from the mid-30s to the high-20s at that time. In Melbourne, this change of wind direction and temperature drop from the mid-30s to the high-20s took place at 1625 hours.

The development and timing of this type of wind change ahead of time is a significant weather forecast challenge. While the maximum temperature outcomes on Thursday 30 November were well forecast, the development of the

southerly breeze over the major population centres around Port Phillip Bay lead to a progressive decline in temperatures during the afternoon. This was more pronounced at locations near the southern parts of the Bay where the change occurred earlier, and the exact timing of these changes was highly unpredictable.

Figure 3 below illustrates the forecast and actual values for temperatures and operational demand in Victoria on 30 November 2017. The cool change in south-west Victoria, which arrived earlier than expected, resulted in a significant drop in forecast temperature, especially in Geelong and western parts of Melbourne. Prior to this cool change, which tapered demand off early, actual demand was higher than forecast.

Figure 3 Victorian temperature and demand forecast profiles for Thursday 30 November 2017



1.2 Availability of generating units and network assets

Except for approximately 1,000 MW across four units, all generating units were available for dispatch in Victoria and South Australia on 30 November 2017. Due to the high ambient temperatures, some available thermal units had reduced capacities.

There were no planned or unplanned network outages which could have an impact on generation or interconnector availability in Victoria during the event.

1.3 Wind ramping in South Australia

The cool change noted above, coupled with a wind ramping event in South Australia, improved supply conditions and resolved the identified reserve shortfalls on 30 November 2017. In particular, supply availability in South Australia improved by approximately 800 MW between 1530 and 1730 hours, significantly exceeding forecast levels, as shown in Figures 4 and 5.

Figure 4 Semi-scheduled wind forecast at 1130 hrs and actual generation on 30 Nov 2017 in Victoria

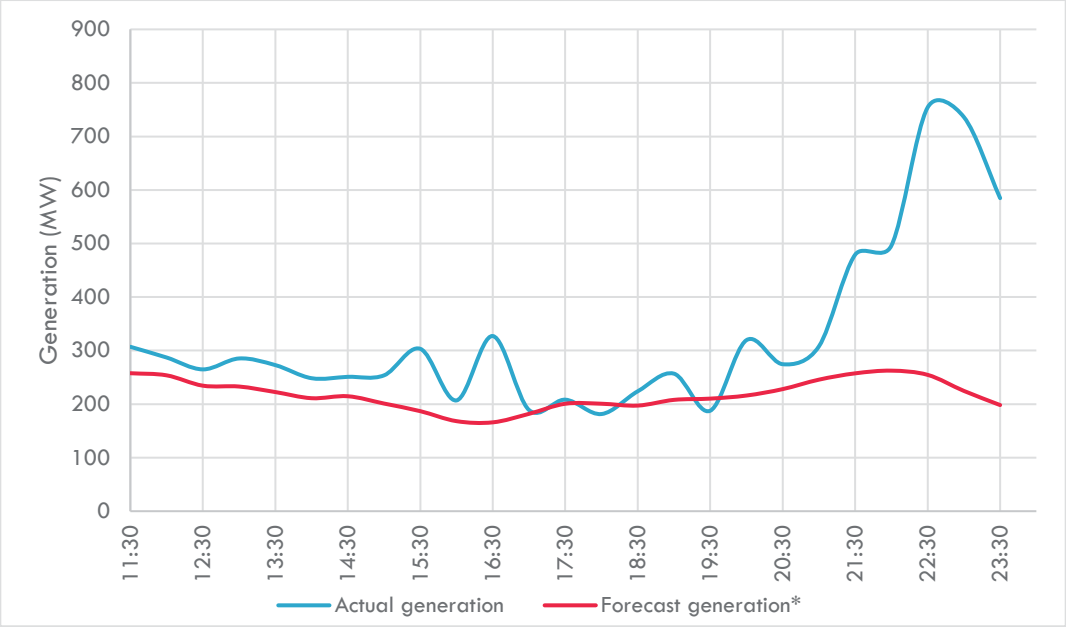
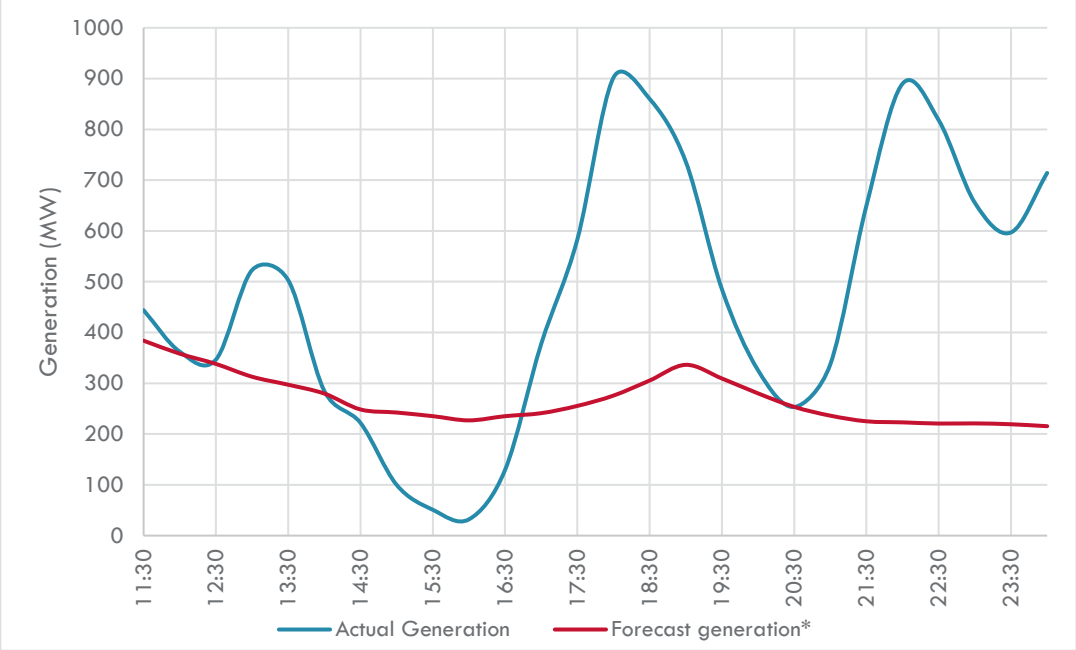


Figure 5 Semi-scheduled wind forecast at 1130 hrs and actual generation on 30 Nov 2017 in South Australia



2. Intervention assessment

2.1 The need for intervention

From 28 November 2017, LOR conditions were forecast for Victoria for 30 November 2017.

By 29 November 2017, forecast reserve conditions had worsened. The minimum reserve available was forecast to be 472 MW, which was 122 MW lower than the LOR 2 trigger level[3] of 594 MW. A minimum reserve of 594 MW was required to cover the loss of the largest credible contingency AEMO deemed in Victoria, which was the loss of the Basslink interconnector from Tasmania[4]. Without the additional reserve, a loss of Basslink may have resulted in a supply shortfall (reliability), and overload of the interconnectors to make up for the deficit of energy in Victoria after the loss of the generators (security issues), and potentially load shedding of 88 MW.

A summary of the LOR forecasts and their timings is in Appendix A.

To maintain power system reliability, and in accordance with the Reliability Standard Implementation Guidelines (RSIG), AEMO determined that activation of RERT contracts would be required to alleviate the risk to supply reliability should insufficient market response be provided.

2.2 Assessment of market response and latest time to intervene

AEMO assessed the latest time to intervene based on the time that LOR 2 conditions were forecast to begin, and on the lead time required to activate sufficient RERT contracts to remove LOR conditions at the least cost to market customers.

Under NER 4.8.5A(a) and (c), AEMO must notify the market of any anticipated power system security or reliability issue that may require intervention, and the latest time for market response before AEMO would need to intervene.

AEMO's internal process where RERT may be required is to develop a RERT schedule with the aim of meeting the largest forecast reserve shortfall (that is, below the LOR 2 trigger level) in a period plus 10%. The RERT schedule also takes into account the cost of reserves, and seeks to meet the reserve requirements from the reserves that can best respond to the prevailing circumstances at the lowest cost.

AEMO issued a Market Notice on 28 November 2017 declaring a forecast LOR 1 condition for the Victoria region between 1600 hours and 1630 hours on 30 November 2017 and seeking market response (MN 60075).

On 29 November 2017, AEMO issued several additional Market Notices declaring LOR conditions for 30 November and seeking further market response (MN 60092, 60094):

- Forecast LOR1 for the Victoria region between 1400 hours and 1530 hours.
- Forecast LOR2 for the Victoria region between 1530 hours and 1700 hours.
- Forecast LOR1 for the Victoria region between 1700 hours and 1800 hours.

AEMO also issued a Market Notice declaring a forecast LOR 1 condition for the South Australia region between 1530 hours and 1630 hours on 30 November 2017 (MN 60091).

Reserves were forecast to be below the LOR 2 trigger level from the trading interval (TI) ending 1600 hours on 30 November 2017. Based on a three-hour commitment lead time for one of the RERT contracts, the latest time to intervene was 1230 hours.

Between the 1500 hrs and 1530 hrs pre-dispatch projected assessment of system adequacy (PD PASA) runs, Victorian demand forecasts decreased by over 300 MW due to the early onset of a cool change hitting the Bellarine Peninsula and western outskirts of Melbourne. AEMO subsequently cancelled the forecast LOR 2 condition for the Victoria region (MN 60144), however activation of the RERT contracts had already occurred by this time due to the contract commitment lead times.

[3] The level of capacity reserves below which AEMO may declare an LOR 2 condition. An LOR 2 condition exists when the occurrence of the largest relevant credible contingency event within a region would result in load shedding.

[4] Basslink reduced its capacity from 594 MW for imports into Victoria from Tasmania to 478 MW from 20 December 2017 for the remainder of summer.

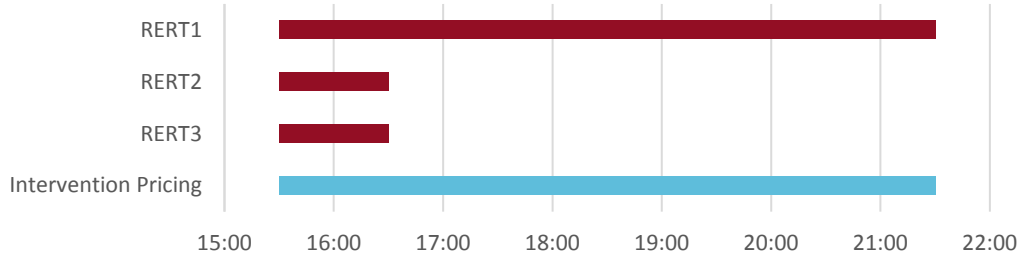
2.3 Decision to intervene

By late morning on 30 November 2017, insufficient market response had been provided, and LOR conditions were still forecast to apply. In response, AEMO determined that additional reserves were required to maintain the reliability of the power system.

AEMO issued activation instructions under three reserve contracts for activation of 32 MW of unscheduled reserves from 1530 hrs. The first reserve contract (RERT1) was deactivated at 2130 hours, after the completion of its minimum continuous run time of six hours. The second and third reserve contracts (RERT2 and RERT3) were deactivated at 1630 hours, after completion of their minimum continuous run times of 1 hour.

As these contracts are commercial in confidence, they are referred to as Contract 1 to 3 for the purposes of this report.

Figure 6 Timing of enablement of reserve contracts and intervention pricing



A further two reserve contracts (RERT4 and RERT5) were available to AEMO on the day. At the required time of activation for these reserve contracts, AEMO considered these reserves would not be required, and did not activate them.

2.4 Cost of intervention

NER clause 3.20.2(b)(2) requires that when AEMO activates reserve contracts, it should aim to maximise the effectiveness of the activation at the least cost to end use consumers of electricity. Accordingly, AEMO activated reserve contracts based on cost, capacity, time to activate, minimum activation time, and the profile of the forecast lack of reserve.

The cost associated with intervening through the RERT on 30 November 2017 was approximately $0.89 million. These costs exclude ongoing RERT availability costs which do not apply to any one specific event, and are accurate as at 15 May 2018 (subject to finalisation with RERT providers).

Table 1 Costs associated with the 30 November 2017 RERT event ($ million)

	Pre-activation costs	Activation costs	Other costs	Total cost
30 November 2017	0	0.89	0	0.89

3. Intervention process

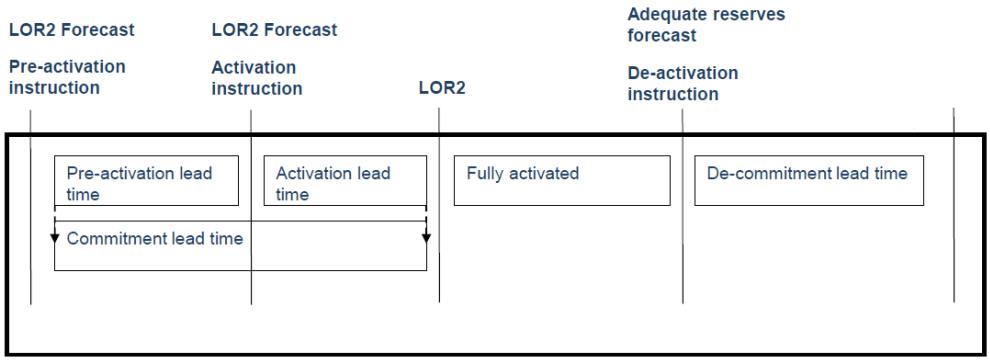
AEMO's general process for deploying RERT is documented in its Procedure for the Dispatch and Activation of Reserve Contracts.[5] AEMO considers that it followed all applicable processes under NER clause 4.8 prior to the activation of reserves.

Table 2 provides a high-level timeline of the intervention event. Figure 7 below outlines the process of pre-activation, activation, and de-activation for slow activation reserves.

Table 2 Timeline of key events on 30 November 2017

Time	Event/ Comment
1130 hrs	Following the 1130 hours PD PASA run, AEMO again sought a market response, noting that the latest time to intervene through an AEMO intervention event was at 1230 hours on 30 November 2017 (MN 60123).
Between the 1200 and 1230 hrs PD PASA runs	South Australia's demand forecast increased. This resulted in an increase in forecast LOR imports into South Australia (from Victoria), and hence lower forecast reserve levels for Victoria.
Following the 1230 hrs PD PASA run	With no adequate response from the market, AEMO gave the instruction to pre-activate the first reserve contract. The pre-activation lead time of this reserve contract was one hour, with an activation lead time of two hours.
Following the 1400 hrs PD PASA run	AEMO gave the instruction to activate the second and third reserve contracts. Both these reserve contracts had activation lead times of one hour, with no pre-activation required.
Between the 1400 and 1430 hrs PD PASA runs	South Australia's wind generation forecast decreased (see Figure 5). This resulted in an increase in forecast LOR imports into South Australia (from Victoria), and hence lower reserve levels for Victoria.
Between the 1500 and 1530 hrs PD PASA runs	Victoria's demand forecast decreased by over 300 MW due to the early onset of the cool change hitting the Bellarine Peninsula and western outskirts of Melbourne. This resulted in higher reserve levels for Victoria, and no LOR 2 forecast. AEMO cancelled the forecast LOR 2 condition for the Victoria region (MN 60144).
1530 hrs	Due to the minimum activation times associated with the reserve contracts, activation of unscheduled reserves under all three reserve contracts continued.
Between 1530 and 1730 hours	Unforecast wind ramping event improved reserves in Victoria and South Australia by approximately 800 MW – clearing all reserve issues, including LOR 1s (see Figures 4 and 5 in Section 1.3)
1630 hrs	Reserves under the second and third reserve contracts were deactivated after minimum activation time.
2130 hrs	Reserve under the first reserve contract was de-activated after minimum activation time. Intervention pricing ended.

Figure 7 Process of pre-activation, activation and de-activation for slow activation reserves



[5] http://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3717---Procedure-for-the-Dispatch-and-Activation-of-Reserve-Contracts.pdf.

4. Changes in dispatch outcomes

4.1 Application of intervention pricing

AEMO declares intervention pricing for periods subject to an AEMO intervention event, including activation of the RERT. Under intervention pricing, NER 3.9.3(b) requires that AEMO set the dispatch price and ancillary service prices at the value which AEMO, in its reasonable option, considers would have applied had the intervention event not occurred. AEMO determines and publishes these prices in accordance with the Intervention Pricing Methodology[6].

Under NER clause 3.9.3(f)(2), AEMO should determine and publish the prices that apply during a period of intervention in accordance with the Intervention Pricing Methodology developed in accordance with NER clause 3.9.3(e). Section 10 of SO_OP 3705 "Dispatch" requires AEMO to do the following:

I. *In accordance with NER Clause 3.9.3(a), "In respect of a dispatch interval where an AEMO intervention event occurs AEMO must declare that dispatch interval to be an intervention price dispatch interval".*

At 2113 hours on 30 November 2017, AEMO published Market Notice MN 60158 declaring:

- The AEMO intervention event commenced at 1530 hours.
- All dispatch intervals during the AEMO intervention event are intervention price dispatch intervals.
- The AEMO intervention event is expected to affect dispatch quantities for intervention pricing purposes from DI ending 1535 hours.

II. *In accordance with NER clause 3.8.1(b)(11), where practical, the number of Affected Participants and effect on interconnector flows resulting from an AEMO intervention event should be minimised.*

Because the activated reserves were unscheduled, no counter action under this clause was practical.

4.2 Changes to dispatch outcomes

During intervention pricing, AEMO performs two runs to generate dispatch targets and spot prices. Dispatch targets are produced from a run which includes the physical impact of the intervention; while energy and ancillary service prices are produced from an intervention pricing run, which attempts to remove the impact of the intervention.

The following sections compare these two runs to assess the impact of RERT on dispatch outcomes.

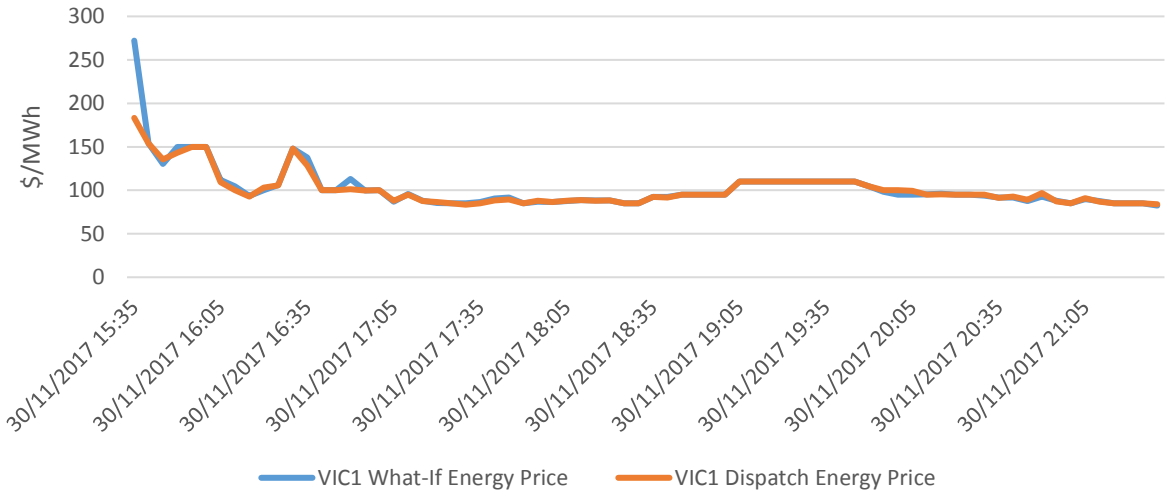
The generation dispatched across the entire National Electricity Market (NEM) was similar between the dispatch and intervention pricing run. Similarly, the flows across all interconnectors were similar between the dispatch run and the intervention pricing run.

The intervention pricing run considers what would have happened had the intervention event not occurred. Thus, depending on which of the three RERT contracts was active at a given time, Victorian demand in the intervention pricing run would be either 32 MW or 15 MW higher than Victorian demand in the dispatch run. The increased demand would require increased dispatch of generation, resulting in slightly higher prices in the intervention pricing run.

Figure 8 below compares the 5-minute energy prices in the intervention (what-if) pricing run and the dispatch run for Victoria. The what-if energy prices in Victoria were slightly higher than the dispatch run for 24 DIs, were equal to the energy prices in the dispatch run for 32 DIs, and were less than the energy prices in the dispatch run for 16 DIs (out of a total of 72 DIs).

[6] Intervention Pricing Methodology https://www.aemo.com.au/-/media/Files/PDF/Intervention-Pricing-Methodology-October-2014.pdf.

Figure 8 Victoria 5-minute energy prices in the intervention (what-if) pricing run and dispatch run



The what-if energy prices and frequency control ancillary services (FCAS) prices in the other regions were similar to their respective dispatch run prices.

Settlement in the NEM energy market is based on the what-if prices produced in the intervention run.

5. Conclusions and further actions

Due to high temperatures and uncertain supply conditions, on 29 November 2017, AEMO declared a forecast LOR 2 condition for the Victoria region between 1530 and 1700 hours on 30 November 2017.

AEMO subsequently published Market Notices seeking market response(s) to alleviate the LOR 2 condition, and determined the latest time for AEMO intervene to be 1230 hours on 30 November 2017 (MN 60123).

As there was insufficient market response to alleviate the risk to supply reliability, AEMO activated a total of 32 MW of unscheduled reserves from three reserve contracts. Intervention pricing was implemented between DIs ending 1535 hours and 2130 hours on 30 November 2017.

A cool change, coupled with a wind ramping event in South Australia, improved supply conditions and resolved the identified reserve shortfalls. In particular, supply availability in South Australia improved by approximately 800 MW between 1530 and 1730 hours. AEMO continues to work with weather service providers to improve the management of uncertainty associated with the timing of cold fronts at the tail end of heat events.

AEMO is satisfied that all applicable procedures and processes were followed in assessing the need for intervention, determining the latest time to intervene, and enacting and managing the intervention itself.

Intervention using RERT is rare and, following the event on 30 November 2017, AEMO will review its internal procedures to improve the integration between related systems, and the timeliness of communications to the Market.

AEMO's backcast of the event[7] highlighted that the underlying uncertainty was a magnitude of 1,094 MW in Victoria, which exceeded the 594 MW minimum reserve requirement on the day.

[7] Using the Australian Energy Market Commission's recently approved rule changes regarding Declaration of LOR conditions as described in Section 2.3.2 of AEMO's Summer 2017-18 Review.

A1. PD PASA runs for Victoria

In Table 3, each column represents a Pre-Dispatch Projected Assessment of System Adequacy (PD PASA) run for 30 November 2017. Comparing successive columns moving to the right represents AEMO's evolving view of forecast reserve conditions. For example, at 1430 hrs (column heading), AEMO estimated that by 1630 hrs (row heading) only 484 MW of reserve would be available in Victoria.

Table 3 Victoria forecast reserve levels for 30 November 2017 (MW)

		PD PASA Run								
		1130 hrs	1200 hrs	1230 hrs	1300 hrs	1330 hrs	1400 hrs	1430 hrs	1500 hrs	1530 hrs
VIC LOR Reserve (MW) for trading intervals (TIs) ending	1130 hrs	2,426								
	1200 hrs	2,212	2,264							
	1230 hrs	1,969	2,035	1,751						
	1300 hrs	1,746	1,812	1,593	1,752					
	1330 hrs	1,399	1,547	1,422	1,559	1,670				
	1400 hrs	1,193	1,237	1,235	1,343	1,432	1,368			
	1430 hrs	1,090	1,104	1,093	1,207	1,281	1,217	1,139		
	1500 hrs	954	968	910	1,023	1,077	1,033	940	896	
	1530 hrs	751	761	694	790	852	817	715	722	1,038
	1600 hrs	563	577	492	579	665	640	545	554	916
	1630 hrs	507	521	434	513	570	570	484	524	906
	1700 hrs	590	604	517	594	643	626	558	560	961
	1730 hrs	779	793	709	783	816	796	757	757	1,188
	1800 hrs	1,011	1,023	961	1,033	1,037	1,018	991	994	1,439
	1830 hrs	1,178	1,193	1,191	1,261	1,270	1,292	1,272	1,278	1,715

VIC LOR1 Trigger	1,154
VIC LOR2 Trigger	594
VIC LOR3 Trigger	0

Abbreviations

Abbreviation	Expanded name
DI	Dispatch Interval
MN	Market Notice
NEM	National Electricity Market
NEL	National Electricity Law
NER	National Electricity Rules
PD PASA	Pre-Dispatch Projected Assessment of System Adequacy
RERT	Reliability and Emergency Reserve Trader
SA	South Australia
TI	Trading Interval
VIC	Victoria