



**NEM EVENT – DIRECTION  
TO MORTLAKE  
GENERATING UNIT 12 – 1  
DECEMBER 2016**

**Published: November 2017**





# IMPORTANT NOTICE

## Purpose

AEMO has prepared this report in accordance with clause 3.13.6A(a) of the National Electricity Rules (NER), using information available as at 30 November 2017, unless otherwise specified.

This report uses several terms that have defined meanings in the NER. They have the same meanings in this report.

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

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## 1. PURPOSE

As described in clause 4.8.9 of the National Electricity Rules (NER), AEMO is permitted to intervene in the market and issue a *direction* or a *clause 4.8.9 instruction* to Registered Participants, if satisfied it is necessary:

- To maintain or re-establish the power system to a secure, satisfactory, or reliable operating state.
- For reasons of public safety or otherwise for the security of the power system.

Between 1030 hours and 1545 hours on 1 December 2016, AEMO issued a direction to Origin Energy to reduce generation at Mortlake Power Station (PS) Unit 12 to ramp down to 0 MW and desynchronise. The Direction was issued under clause 4.8.9 of the NER to restore power system security in Victoria.

Where AEMO intervenes in the market through the issue of directions, AEMO must, in accordance with NER clause 4.8.9(f) and 3.13.6A (a), publish a report on the circumstances of the direction, the processes followed, and its impact on dispatch outcomes. This report meets those NER obligations in relation to the Direction to Mortlake PS Unit 12.

AEMO has previously published a reviewable operating incident report<sup>1</sup> which focused primarily on the power system security issues leading up to the Direction to Mortlake PS Unit 12 on 1 December 2016.

Between 0115 hours and 0500 hours on 1 December 2016, AEMO had also issued directions to three participants in South Australia (SA) to restore power system security under clause 4.8.9 of the NER or Section 116 of the National Electricity Law (NEL). AEMO has published a report<sup>2</sup> for those Directions to SA participants in accordance with NER clause 4.8.9(f) and 3.13.6A (a).

## 2. SUMMARY

Following the separation event between 0115 hours and 0500 hours on 1 December 2016 when South Australia separated from the rest of the mainland, the following lines remained out of service:

- Moorabool – Tarrone 500 kV transmission line.
- Tarrone – Alcoa Portland (APD) – Heywood 500 kV transmission line.

Due to the above outages, South Australia was at risk of separation from the rest of the mainland. A maximum allowable flow limit of 250 megawatts (MW) in both directions was applied to the Heywood Interconnector.

At 1021 hours on 1 December 2016, AEMO issued a direction to Origin Energy to reduce generation at Mortlake Power Station Unit 12 to ramp down to 0 MW and desynchronise. The Direction was issued under clause 4.8.9 of the NER to restore power system security in Victoria.

The direction was required to reduce the flow from South Australia to Victoria on the Heywood Interconnector below the limit of 250 MW. The flow exceeded the limit due to violation of network constraint equations managing potential voltage unbalance issues at the APD 500 kilovolt (kV) transmission busbar. The increased flow also caused the South Australia fast lower (L6) and slow lower (L60) frequency control ancillary services (FCAS) requirement constraint equations to violate.

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<sup>1</sup> For a detailed assessment of the system event, please see AEMO's Reviewable Operating Incident Report, *Power system not secure in VIC & SA, 1 December 2016*, published 14 June 2017. Available at: [https://www.aemo.com.au/-/media/Files/Electricity/NEM/Market\\_Notices\\_and\\_Events/Power\\_System\\_Incident\\_Reports/2016/Power-system-in-SA-and-VIC-not-secure-on-30-Nov-and-1-Dec-2016.pdf](https://www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2016/Power-system-in-SA-and-VIC-not-secure-on-30-Nov-and-1-Dec-2016.pdf).

<sup>2</sup> The report for the Directions to SA participants on 01 Dec 2016, *NEM Event – Direction to South Australia participants – 1 December 2016* is available at: <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Market-notices-and-events/Market-event-reports>

The power system was not secure between (and including) the Dispatch Intervals (DIs) ending 1000 hours and 1040 hours<sup>3</sup>, due to the violation of the voltage unbalance and lower FCAS constraint equations.

The direction was cancelled at 1545 hours after the Moorabool – Tarrone and Tarrone – APD – Heywood 500 kV transmission lines were returned to service.

### 3. BACKGROUND

Between 0130 hours and 0500 hours on 1 December 2016, South Australia was separated from the rest of the mainland NEM due to a fault on the Moorabool – Tarrone 500 kV transmission line and subsequent tripping of the Tarrone – APD – Heywood 500 kV transmission line. The fault and trip of the 500 kV transmission lines severed the interconnection between South Australia and Victoria via the Heywood Interconnector.

Following the separation event, the Moorabool – Tarrone and Tarrone – APD – Heywood 500 kV transmission lines remained out of service. Constraint sets V-MLTR, F-V-MLTR, V-HYTR, F-V-HYTR, S-X\_BC\_CP, and V-MACARTHUR\_ZERO were invoked to manage the outage of the 500 kV transmission lines.

At 0941 hours, Origin Energy submitted a rebid for Mortlake PS Unit 12, whereby 270 MW of generation capacity was bid at the Market Floor Price of -\$1,000/MWh. For the DI ending 0950 hours, the National Electricity Market Dispatch Engine (NEMDE) issued a dispatch signal to Mortlake PS Unit 12 to synchronise. Between (and including) the DIs ending 0955 hours and 1000 hours, Mortlake PS Unit 12 received dispatch targets reaching up to 90 MW.

From (and including) the DI ending 1000 hours, a number of constraint equations within the V-HYTR, V-MLTR, F-V-MLTR, and F-V-HYTR constraint sets began to violate. The violating constraint equation V\_HYML1\_4<sup>4</sup> within the V-HYTR and V-MLTR constraint sets forced the flow on Heywood Interconnector to reverse, from 250 MW towards South Australia for the DI ending 0955 hours to 500 MW towards Victoria for the DI ending 1020 hours. The reverse flow also exceeded the maximum allowable limit of 250 MW.

The increased flow from South Australia to Victoria caused the South Australia fast lower (L6) and slow lower (L60) FCAS requirement constraint equations within the F-V-MLTR and F-V-HYTR constraint sets to violate. The constraint equations violated due to insufficient availability of fast lower and slow lower FCAS in South Australia to cover the loss of Heywood Interconnector.

At 1021 hours, AEMO issued a verbal direction to Origin Energy to reduce Mortlake PS Unit 12 output to 0 MW and de-synchronise from 1030 hours. The Direction constraint was invoked from (and including) the DI ending 1040 hours.

The violation of constraint equations ceased and the flow on the Heywood Interconnector reduced below the limit of 250 MW from (and including) the DI ending 1045 hours.

The Direction was cancelled at 1545 hours after the Moorabool – Tarrone and Tarrone – APD – Heywood 500 kV transmission lines were returned to service.

<sup>3</sup> The voltage unbalance constraints did not violate prior to DI ending 1000 hours since Mortlake Unit 12 output was not large enough to cause constraint violation prior to that interval.

<sup>4</sup> The constraint equation limits voltage unbalance at the APD 500 kV transmission busbar during the outage of Heywood – Tarrone or Tarrone – Moorabool 500 kV lines when one Mortlake PS unit is in service.

## 4. NER COMPLIANCE WITH THE INTERVENTION PROCESSES

### 4.1 Circumstances giving rise to the need for the directions

At 1000 hours, following the violation of the voltage unbalance and FCAS constraint equations, AEMO informed Origin Energy about the violations. AEMO asked if Origin would voluntarily reduce output from Mortlake PS to limit the violations. AEMO also informed Origin that a Direction would be issued if a voluntary reduction was not possible.

Origin advised that Mortlake output could not be reduced, since the generating unit had not completed the minimum run time of its fast-start inflexibility profile.<sup>5</sup> Once a Mortlake PS generating unit has synchronised and increased output to minimum load, the unit has to be in service for a minimum time of 38 minutes. Reducing output prior to the minimum run time could result in damage to the generating unit.

To ensure a minimum run time of 38 minutes, Mortlake PS output could only be reduced from the DI ending 1035 hours.

At 1021 hours, AEMO issued a verbal direction to Origin Energy to reduce Mortlake PS Unit 12 output to zero and de-synchronise from 1030 hours (effective for the DI ending 1035 hours).

At 1025 hours, Origin submitted a rebid to reflect the Direction, whereby the maximum availability for Mortlake PS Unit 12 was reduced to 0 MW.

### 4.2 AEMO's determination that a market response would not have avoided the direction and the determination of the latest time for issuing the direction

Under NER clause 4.8.5A (a) and (c), AEMO must notify the market of an anticipated power system security or reliability issue, and the latest time for a market response to address that issue before AEMO would use directions to intervene in the market.

Following the violation of the constraint equations and increased flow across the Heywood Interconnector, AEMO determined that there were no viable market alternatives, since the voltage unbalance issue was a localised issue which could not be resolved through a market response.

### 4.3 Processes implemented by AEMO to issue the Direction

AEMO's procedure for management of Directions is outlined in System Operating Procedure SO\_OP 3707 "Intervention, Direction and Clause 4.8.9 Instruction", section 5.<sup>6</sup>

The procedure requirements are summarised below, with a description of the process followed and compliance of each requirement by AEMO.

- I. *Publish a Market Notice of the possibility that AEMO might have to issue a direction or clause 4.8.9 instruction so that there is an opportunity for a response from Registered Participants to alleviate that need.*

AEMO did not issue a market notice indicating the possibility that AEMO might have to issue a Direction. AEMO determined that the voltage unbalance issues at APD could not be resolved through a market response due to the localised nature of the issue.

- II. *Determine and publish the latest time for intervention.*

<sup>5</sup> All fast-start generating units in the NEM submit a fast-start inflexibility profile in their bids. NEMDE dispatches fast-start units in accordance with the fast-start inflexibility profiles to prevent damage to the generating unit.

<sup>6</sup> [http://aemo.com.au/-/media/Files/Electricity/NEM/Security\\_and\\_Reliability/Power\\_System\\_Ops/Procedures/SO\\_OP\\_3707---Intervention-Direction-and-Clause-4-8-9-Instructions.pdf](http://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3707---Intervention-Direction-and-Clause-4-8-9-Instructions.pdf).

AEMO did not determine and publish the latest time for Intervention since there were no viable market alternatives to resolve the voltage unbalance issues at APD.

*III. Determine which Registered Participant should be the subject of a direction or clause 4.8.9 instruction.*

The violation of the voltage unbalance constraint equations was influenced by increased generation from Mortlake PS. To limit the violation of the constraint equations, NEMDE increased the flow across the Heywood Interconnector from South Australia to Victoria above the flow limit of 250 MW. AEMO determined the quickest way to resolve the constraint violations, and thus reduce the flow across the Heywood Interconnector, was by shutting down Mortlake PS.

*IV. If a direction is to be issued, if reasonably practicable, the determination will aim to minimise the effect on interconnector flows and minimise the number of Affected Participants.*

AEMO did not issue counter-action instructions to minimise effect on interconnector flows or minimise number of affected participants. The Direction was only required to manage a localised voltage issue and did not require counter-actions to minimise the impact to interconnector flows and affected participants.

*V. Issue a direction or clause 4.8.9 instruction verbally to the relevant Registered Participant, confirming whether it is a direction or clause 4.8.9 instruction.*

AEMO control room logs indicate a verbal direction was issued to Origin Energy at 1021 hours to reduce generation at Mortlake PS Unit 12 to zero and de-synchronise from 1030 hours (effective from the DI ending 1035 hours).

*VI. Issue a Participant Notice confirming the direction or clause 4.8.9 instruction.*

AEMO issued the following participant notices in relation to the Direction event in Victoria on 01 December 2016:

- (i) PN 56053: Published at 1109 hours to Origin Energy relating to the Direction issued at 1030 hours to Mortlake PS Unit 12 under Clause 4.8.9 of the NER.

*VII. Issue a Market Notice advising that AEMO has issued a direction or clause 4.8.9 instruction.*

At 1059 hours, AEMO issued market notice MN 56046 advising that a direction had been issued to a participant in the Victoria region under clause 4.8.9 of the NER.

*VIII. Revoke the direction or clause 4.8.9 instruction as soon as it is no longer required.*

At 1545 hours, AEMO issued MN 56067 cancelling the Direction to Mortlake PS Unit 12. The Direction was no longer required after the Moorabool – Tarrone and Tarrone – APD – Heywood 500 kV transmission lines were returned to service.

## **4.4 Basis for AEMO not following any or all processes under clause 4.8 prior to the issuance of the direction**

AEMO considers that it followed all applicable processes under NER clause 4.8 prior to the issuance of the Directions.

## **4.5 Effectiveness of responses to AEMO inquiries under clause 4.8.5A (d)**

AEMO is satisfied that Origin Energy responded to the inquiries made under 4.8.5A (d) in a timely manner.

## **4.6 Notice from Registered Participants of inability to comply with the direction**



At 1000 hours, AEMO contacted Origin Energy to advise about the power system security violations. AEMO asked if Origin Energy would reduce output at Mortlake PS voluntarily and advised that a Direction would be issued if voluntary reduction was not possible.

Origin advised that reduction in output prior to completion of the minimum run time of the fast-start inflexibility profile could damage the generating unit.

Based on the above advice, AEMO directed the generating unit to reduce output to 0 MW and de-synchronise from 1030 hours (effective for the DI ending 1035 hours), after the minimum run time of the fast-start inflexibility profile had been completed.



## 5. DETERMINATION OF WHETHER TO APPLY INTERVENTION PRICING UNDER CLAUSE 3.9.3(B)

Under NER clause 3.9.3(b), AEMO must set the *dispatch price* and *ancillary service prices* for an *intervention price dispatch interval* at the value which AEMO, in its reasonable opinion, considers to have applied for that dispatch interval in the relevant region had the intervention event not occurred (intervention pricing).

AEMO's relevant procedures for intervention pricing are:

- Power System Operating Procedure SO\_OP 3705 “Dispatch”, section 10.<sup>7</sup>
- Intervention Pricing Methodology.<sup>8</sup>

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 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”.*

AEMO issued market notice MN 56060 at 1115 hours to:

- Declare an AEMO intervention event commenced at the DI ending 1035 hours;
  - Declare all the DIs during the AEMO intervention event to be intervention price dispatch intervals; and
  - Declare Intervention pricing will not be implemented during these intervention price dispatch intervals.
- II. *AEMO may initiate ‘intervention’ or ‘What If’ pricing if the RRN test<sup>9</sup> is passed. If the RRN test is passed and AEMO applies intervention pricing, NEMDE will do an intervention price run after completion of the dispatch or outturn run.*

The Regional Reference Node (RRN) test in accordance with Rule Clause 3.9.3(d) was not met for this Direction, that is, a direction at the RRN would not have avoided the need for the Direction. The voltage unbalance issues at APD could only be resolved by reducing output from Mortlake PS, hence a Direction at the RRN would not have avoided the need for the Direction.

Intervention pricing was not implemented for this Direction since the RRN test was not met.

<sup>7</sup> [http://aemo.com.au/-/media/Files/Electricity/NEM/Security\\_and\\_Reliability/Power\\_System\\_Ops/Procedures/SO\\_OP\\_3705---Dispatch.pdf](http://aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3705---Dispatch.pdf).

<sup>8</sup> <https://www.aemo.com.au/-/media/Files/PDF/Intervention-Pricing-Methodology-October-2014.pdf>.

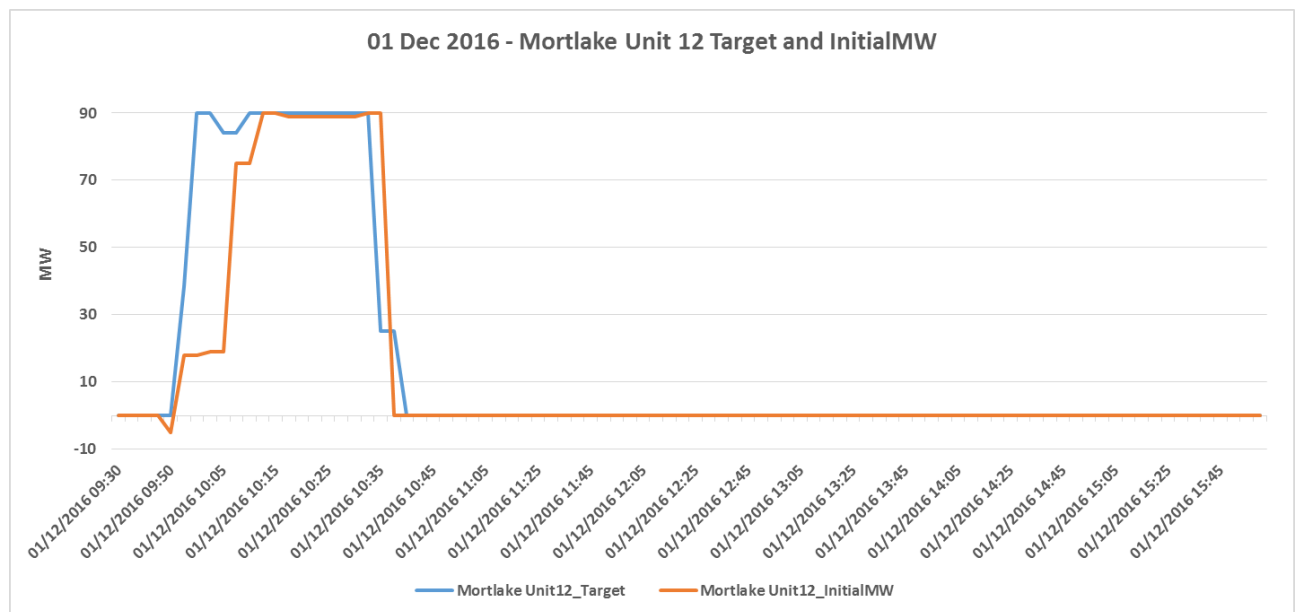
<sup>9</sup> The RRN test is reflected in NER clause 3.9.3(d).

## 6. CHANGES TO DISPATCH OUTCOMES DUE TO THE DIRECTION

### 6.1 Generation outcomes

Figure 1 below shows Mortlake Unit 12 generation output between 0930 hours and 1600 hours on 1 December 2016. Mortlake Unit 12 output could not be reduced prior to 1030 hours, due to the fast-start inflexibility profile of the generating unit.

**Figure 1 Mortlake Unit 12 output during period of Direction**

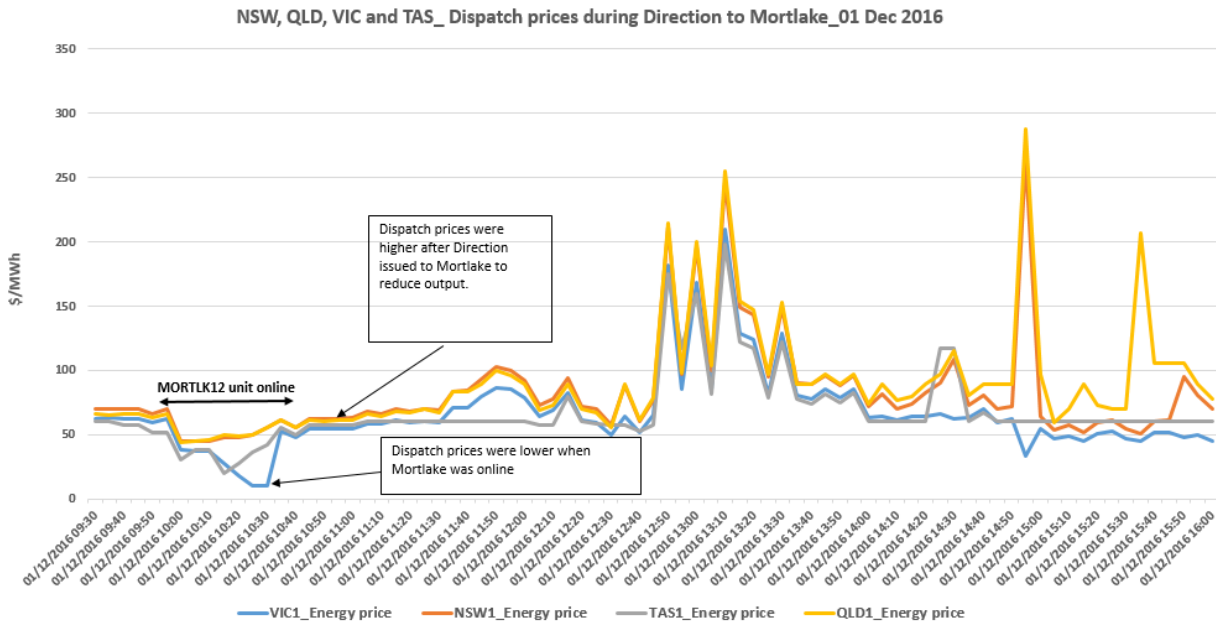


### 6.2 Price outcomes

#### 6.2.1 Energy prices

Figure 2 below shows the 5-minute energy prices across the New South Wales, Queensland, Victoria, and Tasmania regions between 0930 hours and 1600 hours on 1 December 2016.

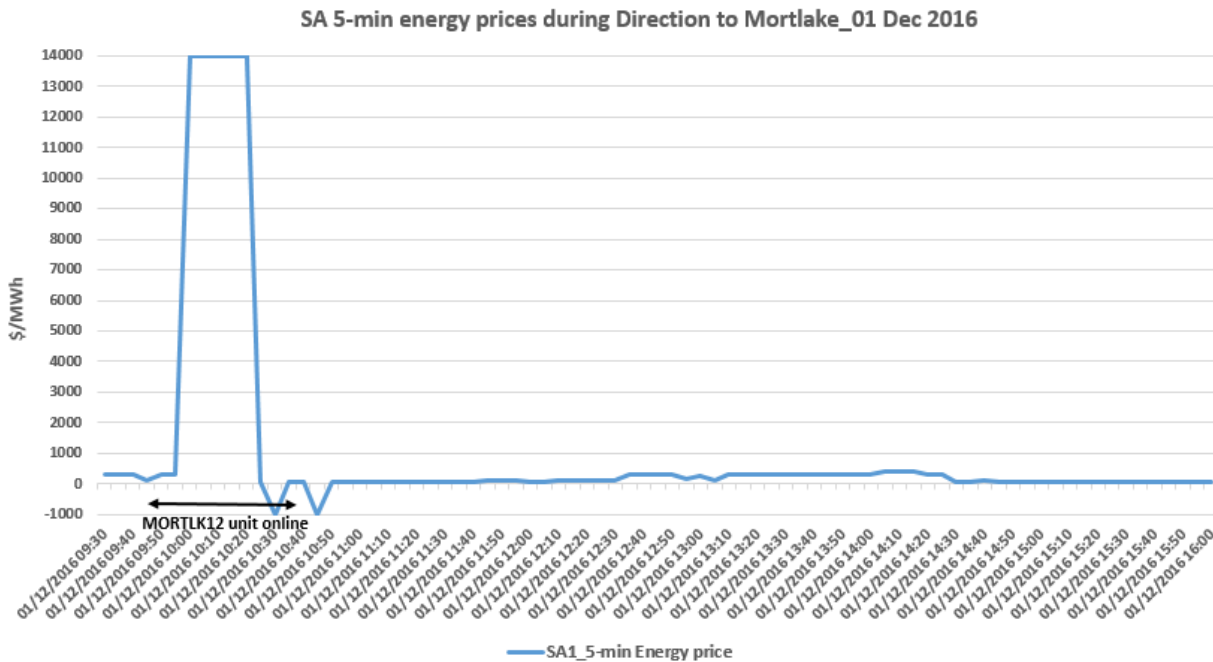
**Figure 2 NSW, QLD, VIC, and TAS 5-min energy prices during Direction to Mortlake**



Energy prices in Victoria when Mortlake Unit 12 was online were lower than the prices in the region after the Direction to Mortlake Unit 12 to reduce output. The energy prices in New South Wales, Queensland and Tasmania followed a similar profile, in that the prices when Mortlake was online were lower compared to the prices after the Direction to reduce output.

Figure 3 below shows the energy prices in the South Australia region between 0930 hours and 1600 hours on 1 December 2016.

**Figure 3 SA 5-min energy prices during Direction to Mortlake**

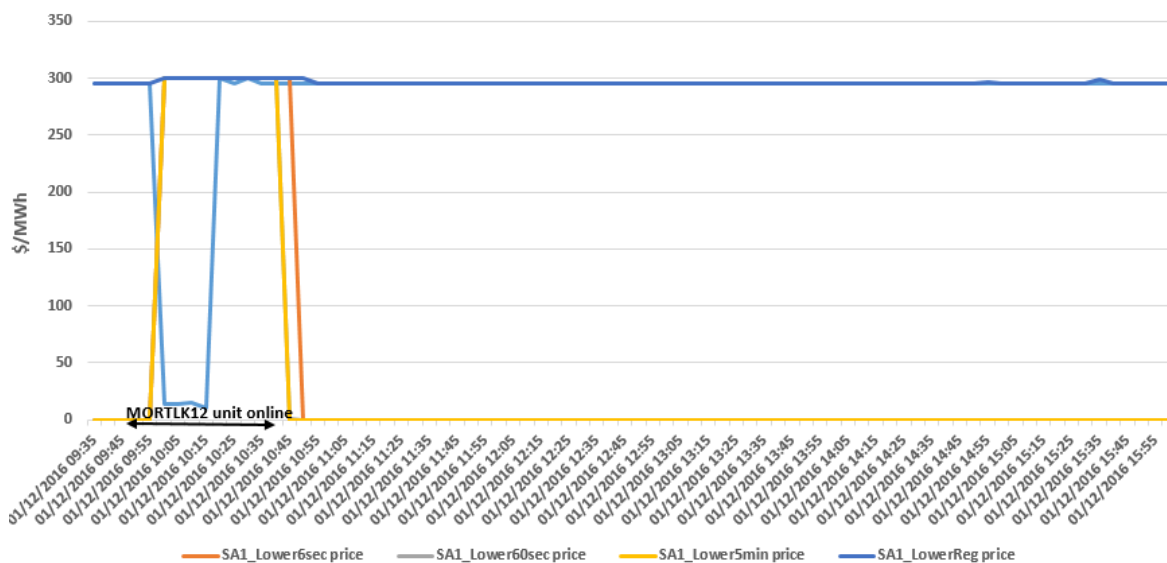


Energy prices in South Australia reached the Market Price Cap of \$14,000/MWh between (and including) the DIs ending 1000 hours and 1020 hours when Mortlake Unit 12 was online. The high flows across the Heywood Interconnector from South Australia to Victoria during this period resulted in expensive generation in South Australia being dispatched, resulting in the high prices.

### 6.2.2 FCAS prices

Figure 4 below shows the lower FCAS prices in the South Australia region between 0930 hours and 1600 hours on 1 December 2016.

**Figure 4 SA lower FCAS prices during Direction to Mortlake**



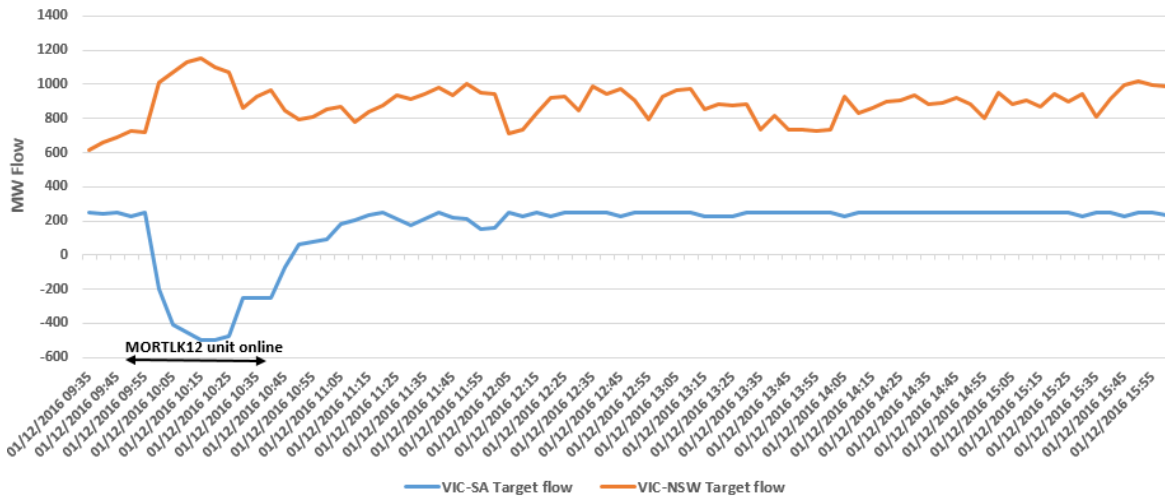
An administered price period had been declared in the South Australia region from (and including) the DI ending at 1135 hours on 25 November 2016 until (and including) the DI ending at 0400 hours on 3 December 2016. During this period, an administered price cap of \$300/megawatt hour (MWh) applied to all market ancillary service prices for all dispatch intervals.

The 5-minute prices for lower FCAS during the direction were capped to the Administered Price Cap of \$300/MWh. Had the administered price period not existed, the 5-minute lower FCAS prices would have been at or close to the Market Price Cap. The 5-minute raise FCAS prices in South Australia and 5-minute raise or lower FCAS prices in other regions were not materially impacted during the Direction.

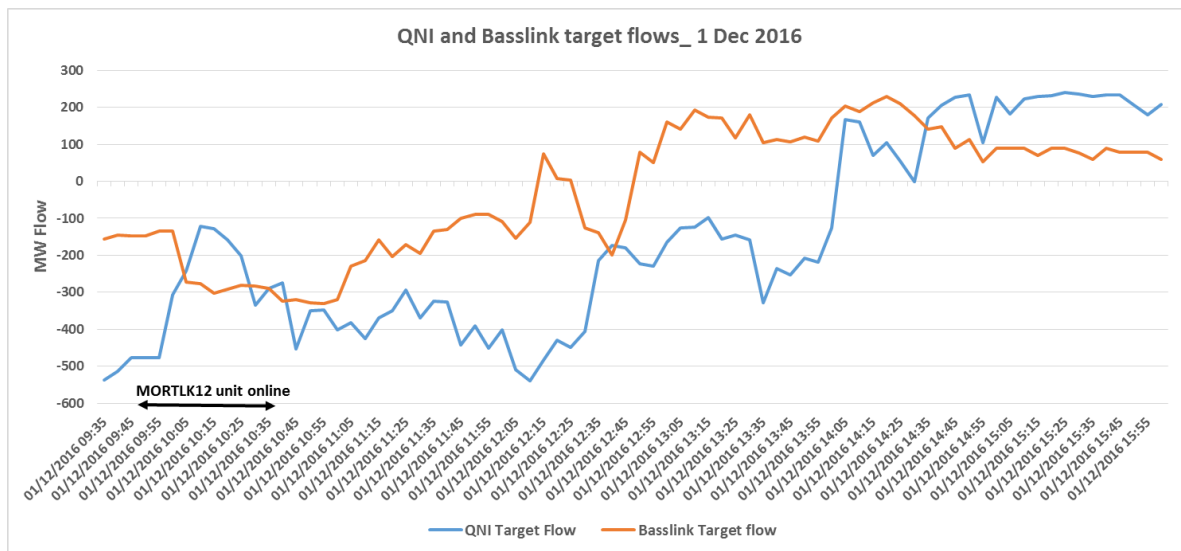
### 6.3 Interconnector flow outcomes

Figure 5 and 6 below shows the target flows across the VIC-NSW, VIC-SA (Heywood), NSW-QLD (QNI) and Basslink interconnectors between 0930 hours and 1600 hours on 1 December 2016.

**Figure 5 Heywood and VIC-NSW target flows during Mortlake Direction\_1 Dec 2016**



**Figure 6 QNI and Basslink target flows during Mortlake Direction\_1 Dec 2016**



As Mortlake Unit 12 synchronised and operated between (and including) the DIs ending 0950 hours and 1040 hours<sup>10</sup>, the flow across the Heywood (VIC-SA) interconnector reversed from +250 MW (in the Victoria to South Australia direction) to -500 MW (in the South Australia to Victoria direction). Due to the excess generation capacity in Victoria, the flow across the VIC-NSW interconnector increased by up to 435 MW into New South Wales, the flow across the Basslink interconnector increased by up to 182 MW into Tasmania and the flow across the QNI Interconnector reduced by up to 354 MW into New South Wales.

<sup>10</sup> As per Mortlake Unit 12 fast-start profile, Mortlake Unit 12 was synchronising for DI ending 0950 hours, moving to minimum load for DI ending 0955 hours before reaching minimum load by DI ending 1000 hours.

## 7. CONCLUSIONS AND FURTHER ACTIONS

The constraint equations to manage voltage unbalance at the APD 500 kV transmission busbar were ineffective on 1 December 2016.

These constraint equations were formulated to constrain off generation from Mortlake PS during such events. However, the dispatch outcomes as a result of the interaction of these constraint equations with the fast-start inflexibility profile was not envisaged.

The voltage unbalance constraint equations had a constraint violation penalty (CVP) factor of 360, in comparison to a CVP factor of 1130 for the fast-start inflexibility profile. The higher CVP factor for the fast-start inflexibility profile meant that when Mortlake PS Unit 12 came online, the voltage unbalance constraint equations were violated while the generating unit was dispatched in accordance with its fast-start profile.

AEMO has reviewed the Direction issued to Origin Energy in relation to Mortlake Power Station Unit 12 on 1 December 2016 and the circumstances surrounding this Direction, as set out in this report.

AEMO assessed its compliance with the applicable procedures and processes for determining to issue the Direction, notification, and the decision not to implement intervention pricing, and is satisfied all requirements were met.

AEMO has also identified and implemented the following improvements.

1. Because of the undesirable dispatch outcomes due to the interaction between the voltage unbalance constraint equations and the fast-start inflexibility profiles, AEMO has removed the voltage unbalance constraint equations and replaced them by constraining Mortlake generation to zero MW during future outages involving the transmission lines between Moorabool and Heywood.
2. System security constraints will be applied to reduce output from generating units to manage power system security violations.



## ABBREVIATIONS

Abbreviation	Expanded name
AC	Alternating Current
DC	Direct Current
DI	Dispatch Interval
LOR	Lack of Reserve
LTTI	Latest Time to Intervene
MN	Market Notice
NEM	National Electricity Market
NEMDE	NEM Dispatch Engine
NEL	National Electricity Law
NER	National Electricity Rules
NSW	New South Wales
PN	Participant Notice
QLD	Queensland
RRN	Regional Reference Node
SA	South Australia
TI	Trading Interval
VIC	Victoria