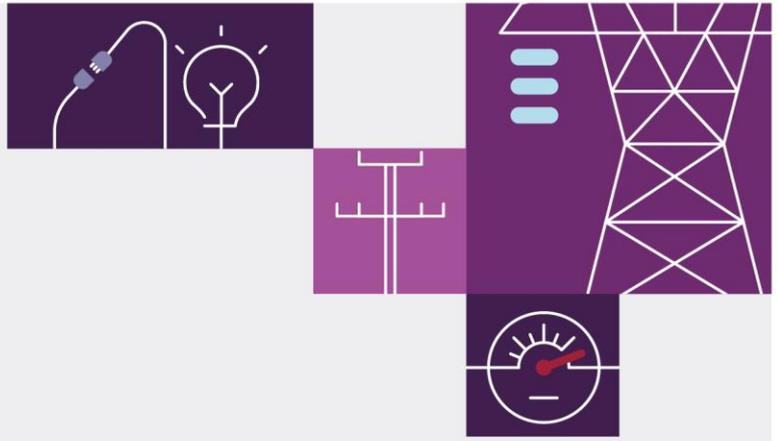


Preliminary report: Victoria market suspension on 22 April 2023

July 2023

A market event report for the
National Electricity Market –
information as at 03/07/2023





Important notice

Purpose

AEMO has prepared this preliminary report as part of its review of the 22 April 2023 Victoria region market suspension, as a first step in reporting under clauses 3.14.3(c) and (d) and 3.14.4(g) of the National Electricity Rules.

If material new information becomes available AEMO will prepare a supplementary report and the observations in this report will be updated as necessary.

Disclaimer

AEMO has been provided with data by Registered Participants as to the performance of some equipment leading up to, during and after the event in accordance with clause 3.14.3(f) of the National Electricity Rules. In addition, AEMO has collated information from its own systems. While AEMO has made reasonable efforts to ensure the quality of the information in this report, investigations may not be complete, and any findings expressed in it may change if further information becomes available and further analysis is conducted. 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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If you have any questions or comments in relation to this report, please contact AEMO at nemintervention@aemo.com.au.

Abbreviations

Abbreviation	Term
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
AGC	Automatic Generation Control
DNSP	Distribution Network Services Provider
EMMS	Electricity Market Management System
FCAS	Frequency Control Ancillary Service
FOS	Frequency Operating Standard
HMI	Human-machine Interface
ICCP	Inter-Control Centre Communications Protocol
IT	Information Technology
MN	Market Notice
MW	megawatts
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
NER	National Electricity Rules
NSP	Network Service Provider
PSSWG	Power System Security Working Group
SCADA	Supervisory Control and Data Acquisition
TI	Trading Interval
TNSP	Transmission Network Service Provider

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Version release history

Version	Date	Summary of changes
2.0	19 July 2023	Update to include results of AusNet investigation and to add a resulting additional recommendation.
1.1	17 May 2023	Minor update to 'Pricing during the market suspension' to more clearly describe price scaling.
1.0	3 May 2023	Initial version.

1 Overview

This report relates to a market suspension in Victoria on 22 and 23 April 2023. AEMO is required to report on this event in accordance with clauses 3.14.3(c) and (d) and 3.14.4(g) of the National Electricity Rules (NER).

At approximately 1546 hrs on 22 April 2023, multiple pieces of network equipment at AusNet's¹ primary and secondary data centres failed. This resulted in those data centres being unable to communicate with AusNet sites and AEMO, and consequently led to the total loss of Supervisory Control and Data Acquisition (SCADA) across all Victorian electricity transmission assets and AusNet's electricity distribution network in Victoria. This incident had no impact on AEMO's visibility of the Victorian gas transmission system or market. While AusNet also lost all SCADA relating to AusNet's gas distribution network, under normal conditions AEMO has no visibility of that network.

AEMO subsequently suspended the electricity spot market in Victoria from 1620 hrs on 22 April 2023 to 1700 hrs on 23 April 2023, on the basis that it was not possible to operate the market in accordance with the NER.

Based on AEMO's initial review, AEMO has not identified any power system security issues, including any disconnection of generation or load, associated with this incident. During the event Victorian prices were set using market suspension schedule pricing from trading intervals (TI) 1620 hrs on 22 April 2023 to TI 0435 hrs on 23 April 2023. Victoria resumed dispatch pricing from trading interval 0440 hrs on 23 April 2023. The Victorian electricity market suspension ended at 1700 hrs on 23 April 2023.

This report provides a summary of the facts relating to the incident as known at 03 July 2023 and has been updated to include the results of AusNet's investigation, steps taken to address the cause of the event, and a further recommendation.

National Electricity Market (NEM) time (Australian Eastern Standard Time [AEST]) is used in this report.

2 Pre-event conditions

Prior to the SCADA failure the power system was in a secure operating state, no reserve conditions existed, and no power system risks due to the presence of abnormal conditions had been identified. In addition, AusNet was not conducting any maintenance activities in relation to SCADA prior to the incident.

3 Event

Table 1 outlines the timeline of key events which formed part of this market suspension. The information in Table 1 is based on AEMO's operational logs and information provided by AusNet.

Table 1 Sequence of key events on 22 April 2023

Time	Event
1546 hrs	AEMO became aware of total loss of SCADA in the Victoria region and commenced investigations.
1600 hrs	AEMO issued Market Notice (MN) 107544 advising AEMO was experiencing a service interruption relating to all Victorian SCADA.

¹ AusNet is the Declared Shared Network Operator for Victoria.

Time	Event
1606 hrs	AEMO advised Loy Yang A, Loy Yang B, Yallourn Power Station, Victorian Big Battery to move to local control and follow 5-minute dispatch targets manually.
1608 hrs	AusNet confirmed to AEMO that it was investigating the loss of SCADA and had also lost visibility of distribution network services provider (DNSP) data and its gas distribution network data.
1612 hrs	AEMO advised AusNet that AEMO would suspend the Victorian spot market if SCADA data was not available by 1616 hrs.
1617 hrs	AEMO declared the electricity spot market in the Victorian region suspended with market suspension schedule pricing from TI 1620 hrs on 22 April 2023 until further notice. AEMO issued MN 107545 advising the market of the spot market suspension in Victoria.
1627 hrs	AEMO advised AusNet to monitor voltage levels at major terminal stations in Victoria. AusNet confirmed that it was able to switch reactive plants from its backup Human-machine Interface (HMI) SCADA system.
1658 hrs	AusNet confirmed to AEMO that staff were heading to major terminal stations to monitor changes to transmission system conditions and equipment.
23 April 2023 0233 hrs	AEMO issued MN 107550 advising the market of the electricity market suspension change of pricing regime from market suspension schedule pricing to dispatch pricing from TI 0435 hrs 23 April 2023.
0435 hrs	Dispatch pricing resumed in Victoria.
0534 hrs	AusNet requested Inter-Control Centre Communications Protocol (ICCP) failover to Brisbane link from AEMO.
0537 hrs	AusNet confirmed to AEMO that both ICCP links were indicating OK, however AusNet was waiting for confirmation that the cause of the Victorian SCADA failure had been rectified.
0700 hrs	AEMO requested the Victorian units that were currently on local control move to remote control and follow dispatch targets.
1530 hrs	AusNet informed AEMO that the SCADA systems had full redundancy and the risk of recurrence was minimal.
1609 hrs	AEMO issued MN 107556 declaring that the suspension of the spot market in Victoria would end at 1700 hrs on 23 April 2023.
1700 hrs	Spot market resumed in Victoria.
24 April 2023 1451 hrs	Prices for Victoria and South Australia energy and Victoria FCAS revised in TI 1620 hrs on 22 April 2023.

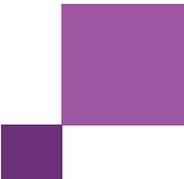
SCADA failure and loss of AEMO SCADA visibility

AusNet has confirmed that the disruption to Victorian SCADA was a result of a firmware issue in the primary device at the AusNet backup data centre. This resulted in those data centres being unable to communicate with AusNet sites and AEMO, and consequently led to the total loss of SCADA across all Victorian electricity transmission assets and AusNet's electricity distribution and gas distribution networks in Victoria. Other electricity distribution networks and gas transmission networks were not impacted.

Declaration of market suspension

The market suspension was triggered by a loss of Victoria SCADA visibility at AEMO. AEMO became aware of the SCADA failure at 1546 hrs on 22 April 2023.

AEMO assessed that the ongoing lack of SCADA meant it was no longer possible to operate the spot market in Victoria in accordance with NER 3.8 and 3.9. The Market Suspension and Systems Failure Procedures 3706



(Market Suspension Procedures 3706)² state that if a large number of SCADA points have failed, AEMO will consider suspending the spot market where:

- At least 30 minutes have elapsed since AEMO became aware of the SCADA failure; and
- The SCADA system is not expected to be restored within a further 10 minutes.

AEMO issued Market Notice (MN) 107545 at 1617 hrs on 22 April 2023, declaring that:

- The spot market in Victoria was suspended (refer NER 3.14.5(b)) from TI ending 1620 hrs on 22 April 2023 until further notice;
- Market suspension schedule pricing would apply;
- Dispatch prices in Victoria for the first one or two dispatch intervals of this market suspension would be reviewed manually; and
- The cause of the suspension was a failure of SCADA systems.

MN 107545 complied with NER 3.14.4(a).

Market operation during the market suspension

During the market suspension, scheduled plant were able to receive and follow dispatch instructions using AEMO's Electricity Market Management System (EMMS). In accordance with Market Suspension Procedures 3706, when the NEM Dispatch Engine (NEMDE) does not receive a SCADA value for the output of a generating unit at the start of a TI, NEMDE uses the dispatch target from the previous interval as the initial MW value for the current interval, thereby assuming all generators are perfectly following their dispatch targets.

Pricing during the market suspension

During a spot market suspension, spot prices and ancillary service prices may be determined in accordance with NER 3.9, or where it is not practicable to determine market prices in the suspended region, in accordance with the market suspension pricing schedule published under NER 3.14.5(e).

As advised in MN 107545, market suspension schedule pricing was initially used to set the Victoria spot prices and ancillary service prices during the market suspension. In accordance with AEMO's published Market Suspension Pricing Methodology³, this market suspension pricing schedule is based on a four-week rolling average of historic regional prices, separated into business and non-business days, with a half-hourly resolution⁴. AEMO used the market suspension pricing schedule published on 1 April 2023. From TI 0435 hrs on 23 April 2023 until resumption of the market, AEMO used dispatch pricing under NER 3.9.

Price scaling during market suspension pricing is applied to regions that have a net energy flow in a TI towards the suspension node, under NER 3.14.5(f). During the application of market suspension pricing for this market suspension, price scaling was applied to South Australia, New South Wales and Queensland in respect of the TIs when that region had net energy flows towards the Victorian suspension node. Price scaling does not apply to Tasmania as it is connected by an interconnector which is a market network service provider. Additionally, price

² See Section 8.2 of https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3706%20Failure-of-Market-or-Market-Systems.pdf.

³ See <https://aemo.com.au/-/media/files/electricity/nem/data/mms/estimated-price-methodology-suspension-ner-3-14-5.pdf?la=en&hash=1642CB140EE80C552C341D30443D33F1>.

⁴ See https://www.nemweb.com.au/REPORTS/CURRENT/MKTSUSP_PRICING/.

scaling does not apply to ancillary service prices. MN 107563 issued at 1451 hrs on 24 April 2023, advised the market of the revised prices in Victoria and South Australia.

Victoria spot price outcomes resulting from applying the market suspension schedule during the affected TIs were, on average, \$46.65 lower compared to what they would have been, had the market not been suspended. South Australia, New South Wales, and Queensland prices were, as a result of the price scaling, \$9.44, \$34.72, and \$35.75 lower on average, respectively.

Table 2 Spot price outcomes during market suspension

Region	Average effective spot price	Average spot price without market suspension and scaling	Average price difference
VIC	\$81.78	\$128.43	\$46.65
NSW	\$94.66	\$129.38	\$34.72
SA	\$119.15	\$128.59	\$9.44
QLD	\$92.59	\$128.34	\$35.75

Because a declaration of market suspension may be made partway through a TI but will apply from the start of that TI (when the prices for the TI were published), the first one or two trading intervals may be flagged as “non-firm” and must be revised manually. The manual revision will generally require application of the market suspension pricing to those intervals and may require price scaling in other regions under NER 3.14.5(f).

For TI 1620 on 22 April 2023, AEMO revised Victoria spot prices and ancillary service prices using the market suspension pricing schedule. For this TI, South Australia had a net energy flow towards the Victorian suspension node and the spot price in South Australia was automatically scaled after manual revision of the Victorian spot price.

Table 3 Adjusted spot prices of the first interval of the market suspension (22 April 2023 TI 1620)

Region	Original price	Adjusted price
VIC	\$94.42	\$44.94
SA	\$92.11	\$45.06

Table 4 Adjusted Victoria FCAS prices of the first interval of the market suspension (22 April 2023 TI 1620)

Market	Original price	Adjusted price
LOWER5MIN	\$0.39	\$2.38
LOWER60SEC	\$0.38	\$4.24
LOWER6SEC	\$0.38	\$0.53
LOWERREG	\$25.13	\$13.67
RAISE5MIN	\$0.39	\$0.37
RAISE60SEC	\$2.25	\$1.00
RAISE6SEC	\$2.96	\$1.28
RAISEREG	\$60.00	\$33.61

Changes in calculated Victorian demand

Victoria remained connected to the rest of the NEM during the event. Interconnectors in the direction of New South Wales, South Australia, and Tasmania were operating as normal. There were several 200 MW changes in calculated Victorian demand between 1848 hrs and 1934 hrs on 22 April 2023. During periods of failed SCADA affected generation terms in the regional demand calculation were using persisting last target values. The sudden changes in demand were likely due to intermittent restoration of SCADA where the demand calculation returned to using actual measurements. This will need further investigation.

Power system operation during the market suspension

All information available to AEMO indicates that the Victorian power system remained in a secure operating state and the Frequency Operating Standard⁵ (FOS) was met throughout the SCADA outage and market suspension. The system frequency monitored at Murray was maintained within 49.955-50.045 hertz (Hz) during the incident, consistent with frequency measurements from other mainland NEM locations outside Victoria. AEMO is not aware of any generation or load that was disconnected or of any unplanned outages of transmission equipment during the Victorian SCADA failure.

NEMDE remained operational and all scheduled generating units in the NEM continued to receive their dispatch targets through EMMS. The loss of SCADA meant that units in Victoria were unable to receive AGC signals from AEMO via AusNet. As such, AEMO informed the market of the SCADA failure and requested Loy Yang A, Loy Yang B, and Yallourn Power Stations, and the Victorian Big Battery move to local control and follow 5-minute dispatch targets manually.

AEMO considers the response from participants adequate and confirms it did not need to take any other action to restore or maintain power system security during the incident.

Restoration of Victorian SCADA visibility

AusNet confirmed that under the recommendation of equipment vendors, the network switches were restarted in an organised manner to restore the SCADA service. At approximately 1530 hrs on 23 April 2023, AusNet informed AEMO that the SCADA systems now had full redundancy and the risk of recurrence was minimal.

Rectification

AusNet updated the firmware of the relevant equipment to fix the identified firmware issue. The firmware of the devices at the backup site was updated between 29 and 31 May 2023 and the firmware of the primary site devices was updated between 27 and 29 June 2023.

While waiting for the permanent firmware update to occur, to mitigate the impact of any re-occurrence of this incident, AusNet implemented a temporary procedure. If this SCADA failure incident re-occurred, this procedure would have allowed AusNet to promptly restart the affected equipment (with equipment vendor support available) and restore SCADA visibility.

AEMO shared the findings from this incident and the key recommendations with the Power System Security Working Group (PSSWG) on 12 May 2023.

⁵ See <https://www.aemc.gov.au/sites/default/files/2020-01/Frequency%20operating%20standard%20-%20effective%201%20January%202020%20-%20TYPO%20corrected%2019DEC2019.PDF>.

Resumption of the spot market

At 0233 hrs on 23 April 2023, AEMO issued MN 107550 declaring that the Victoria spot market remained suspended with pricing regimes changing from market suspension schedule pricing to dispatch pricing from 0435 hrs on 23 April 2023. AEMO maintained the market suspension as the cause of the original issue which affected all Victoria SCADA had not yet been determined and may have still influenced market processes. However, AEMO determined it was practicable to dispatch and price the suspended region in accordance with NER clauses 3.8 and 3.9.

At 1530 hrs on 23 April 2023, AusNet advised AEMO that the SCADA systems now had full redundancy and that the risk of recurrence was minimal. On the basis of this information, AEMO determined another market suspension would be unlikely and that it would be appropriate to resume the market from TI 1700 hrs on 23 April 2023.

AEMO issued MN 107556 at 1609 hrs on 23 April 2023 declaring that the spot market in Victoria would resume from 1700 hrs on 23 April 2023. MN 107556 complied with NER 3.14.4(d).

The timing of the restoration of the market aligned with the recommended general principles of timing outlined in Section 10.2(b) of the Market Suspension Procedure 3706. The decision to resume the spot market also complied with Section 10.1(c) of the same Market Suspension Procedure 3706 that requires AEMO to assess the likelihood of having to suspend the spot market within the next 24 hours due to the same cause. AEMO assessed this likelihood and upon receiving confirmation from AusNet of ICCP connectivity restoration, deemed it to be minimal.

The practical effect of the timing of these events meant that 297 trading intervals (between 1620 hrs on 22 April 2023 and 1700 on 23 April 2023) were affected by market suspension due to the SCADA failure.

4 Market notices

Table 5 below outlines the relevant market notices AEMO issued for this market suspension.

Table 5 Summary of relevant market notices

MN	Summary of content
107544	AEMO advised of the service interruption relating to all Victorian SCADA.
107545	AEMO declared the spot market in the Victorian region suspended with market suspension schedule pricing from TI 1620 hrs on 22 April 2023 until further notice.
107550	AEMO advised of the electricity market suspension change of pricing regime from market suspension schedule pricing to dispatch pricing from TI 0435 hrs 23 April 2023.
107556	AEMO declared that the market suspension in Victoria would end at 1700 hrs on 23 April 2023.
107563	Price adjustments for energy in Victoria and South Australia, and FCAS in Victoria for TI 1620 hrs, issued at 1451 hrs on 24 April 2023.

5 Next steps

- SCADA outages result in additional risks to power system operation and cause market impacts given the criticality of these systems. As such, to mitigate the risk of reoccurrence, AEMO recommends:
 - AusNet to share the root-cause of this incident and factors that impacted the time to restore SCADA services with the PSSWG.
 - AusNet to undertake a review of the procedures relating to SCADA failure response to identify any potential opportunities to improve overall speed of response. The review should also consider SCADA failure root-cause analysis, issue rectification, and remediation. In this incident, it took more than 13 hours from AEMO becoming aware of the Victorian SCADA loss (from 1546 hrs 22 April 2023 to approximately 0537 hrs 23 April 2023) for normal SCADA visibility in the AEMO control room to return. It is important to promptly rectify SCADA failures, and as far as practicable to ensure the critical outages do not exceed the time limits specified in the Power System Data Communication Standard⁶.
 - AusNet to undertake a broader review of the procedures relating to SCADA system operation and control to identify any additional controls to be implemented to improve reliability, availability and restoration times of SCADA services.
- AEMO recommends network service providers (NSPs) undertake routine failover testing to help identify possible issues following failover from primary to secondary and secondary to primary SCADA links.
- Since January 2021, there have been five SCADA failures resulting in impacts on the market and additional complexities to the operation of the power system. AEMO is concerned about the integrity of NSP's critical information technology (IT) systems. As such, AEMO recommends all NSPs review their critical IT systems. This review should consider any improvements to ensure high reliability of systems and effective, timely responses to system issues.
- AEMO is investigating options to improve visibility of market events such as suspension, administered pricing, and price revisions.
- AEMO recommends all NSPs maintain/implement processes to update the firmware of all devices associated with critical infrastructure (such as SCADA systems) to the latest firmware version in a prompt and controlled manner.

AEMO is also required under NER 3.14.3(d) to report the payments made to each Market Suspension Compensation Claimant under the market suspension pricing schedule and on market suspension compensation payments and funding. These details are not expected to be finalised until November 2023, after completion of all routine settlement revisions. AEMO will publish a supplementary report when full and final details of these amounts are available.

If any issues relating to power system security are identified, they will be reported on under NER 4.8.15 as necessary.

⁶ See https://www.aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Transmission-and-Distribution/AEMO-Standard-for-Power-System-Data-Communications.pdf.