
Trip of Ararat – Crowlands 220 kV Line and Wemen Solar Farm on 20 August 2020

March 2021

Reviewable Operating Incident Report under the
National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of Incident	1235 hrs on 20 August 2020
Region of incident	Victoria
Affected regions	Victoria
Event type	Protection mal-operation
Generation impact	247 MW was disconnected as a result of this incident
Customer load impact	No customer load was disconnected as a result of this incident

ABBREVIATIONS

Abbreviation	Term
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEO	Australian Energy Operations
AEST	Australian Eastern Standard Time
ARTS	Ararat Terminal Station
CWTS	Crowlands Terminal Station
DSPs	Design Service Providers
Hz	Hertz
kV	Kilovolt
MW	Megawatt
NEM	National Electricity Market
NER	National Electricity Rules
NSP	Network Service Provider
OEMs	Original Equipment Manufacturers
TNSP	Transmission Network Service Provider

Important notice

PURPOSE

AEMO has prepared this report in accordance with clause 4.8.15(c) of the National Electricity Rules, using information available as at the date of publication, unless otherwise specified.

DISCLAIMER

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Contents

1.	Overview	5
2.	The incident	6
2.1	The incident	6
2.2	Analysis	6
3.	Power system security	7
3.1	Frequency	8
3.2	Reclassification	8
4.	Market information	8
5.	Conclusions	9
A1.	System diagram	10

Figures

Figure 1	Overview of part of the power system	10
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1. Overview

This report relates to a reviewable operating incident¹ that occurred on 20 August 2020 in Victoria. The incident involved the trip of the Ararat – Crowlands 220 kilovolt (kV) line (ARTS-CWTS line) in north west Victoria, and operation of the Generator Fast Trip (GFT) control scheme. Operation of the GFT resulted in disconnection of wind generation between Ararat and Murra Warra terminal stations as designed to prevent overloading of remaining in-service elements. The event also resulted in an unexpected trip of the Wemen Solar Farm, which is connected between Red Cliffs and Kerang terminal stations.

There was 247 megawatts (MW) of generation output disconnected as a result of this incident. No customer load was lost as a result of this incident.

As this was a reviewable operating incident, AEMO is required to assess the adequacy of the provision and response of facilities and services and the appropriateness of actions taken to restore or maintain power system security².

AEMO has concluded that:

1. The trip of ARTS-CWTS line was caused by an unexpected operation of X current differential protection due to its sensitive current differential threshold setting. There was no fault on the line.
2. The trip of Wemen Solar Farm was due to an unexpected operation of the anti-islanding scheme where no islanding condition existed. This was caused by the voltage vector shift protection and its sensitivity to power system disturbances. The vector shift protection has since been disabled to prevent a recurrence of the incident.
3. AEMO correctly reclassified the trip of the ARTS-CWTS line and Wemen Solar Farm as a credible contingency from 1912 hrs on 20 August 2020.
4. The power system remained in a secure operating state throughout this incident.

AEMO is concerned about potential inadvertent operation of anti-islanding schemes such as vector shift or Rate of Change of Frequency (RoCoF) protection for external disturbances which do not result in islanding. This has the potential to exacerbate disturbances on the power system by increasing the impact of the contingency event. AEMO plans to engage further with NSPs to understand the issue and subsequently consider actions that may be required.

Through the review of this event, AEMO identified intermittent 19 Hertz (Hz) oscillations in the West Murray area. These oscillations are limited in magnitude and duration, and AEMO continues to work with relevant NSPs, participants, and Original Equipment Manufacturers (OEMs) to identify the cause.

This report is prepared in accordance with clause 4.8.15(c) of the National Electricity Rules (NER). It is based on information provided by AusNet Services³, Wemen Asset Co Pty Ltd as Trustee for Wemen Solar Unit Trust⁴, and AEMO.

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

¹ See NER clause 4.8.15(a)(1)(i), as the event relates to a non-credible contingency event; and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.

² See NER clause 4.8.15(b).

³ AusNet Services is the Transmission Network Service Provider (TNSP) in the Victoria region. Note that "Information provided by AusNet Services has been provided on a without prejudice basis and nothing in this report is intended to constitute, or may be taken by any person as constituting, an admission of fault, liability, wrongdoing, negligence, bad faith or the like on behalf of AusNet Services (or its respective associated companies, businesses, partners, directors, officers or employees)."

⁴ Wemen Asset Co Pty Ltd as Trustee for Wemen Solar Unit Trust is the operator of Wemen Solar Farm.

2. The incident

2.1 The incident

At 1235 hrs 20 August 2020, the ARTS-CWTS line tripped which resulted in operation of the Generator Fast Trip (GFT)⁵ control scheme. The operation of the GFT control scheme tripped the Crowlands and Bulgana Wind Farms and tripped designated feeders at the Murra Warra Wind Farm resulting in the automatic disconnection of 184 MW of generation.

The incident also resulted in the trip of the Wemen Solar Farm from 63 MW of generation. The trip of Wemen Solar Farm was not the expected outcome of the trip of the ARTS-CWTS line. Refer to Appendix A1 for a diagram of the relevant part of the power system.

In total, 247 MW of generation output was disconnected as a result of this incident.

The ARTS-CWTS line was returned to service at 1742 hrs on the same day. AEMO issued clearance to restore the Murra Warra Wind Farm at 1402 hrs⁶ and the Crowlands Wind Farm at 2210 on 20 August 2020. The Bulgana Wind Farm was given clearance to restore from AEMO at 1414 hrs on 21 August 2020.

The Wemen Solar Farm was returned to service at 1535 hrs on 21 August 2020.

2.2 Analysis

The following is based on information provided by AusNet Services and Wemen Asset Co Pty Ltd as Trustee for Wemen Solar Unit Trust.

2.2.1 Trip of the Ararat – Crowlands 220 kV line

At 1235 hrs on 20 August 2020, the ARTS-CWTS line tripped due to an unexpected operation of its X current differential protection. There was no fault on the line and the line Y protection did not operate.

The operation of the ARTS-CWTS line X current differential protection was due to an incorrect setting at the CWTS end. The ARTS-CWTS line was restored to service at 1742 hrs on the same day after disabling the X current differential protection and enabling X distance protection. The line Y protection also remained in-service.

AusNet Services advised that the line X current differential protection setting at the CWTS end was corrected to match the setting at the ARTS end, and all protection returned to normal on 2 September 2020.

The protection systems at ARTS and CWTS are owned by Australian Energy Operations (AEO)⁷ and AusNet Services respectively, and the protection settings were set independently of each other, resulting in a lack of protection coordination. Additionally, AusNet Services uses a protection Design Service Provider (DSP) to determine protection settings for their equipment. Subsequent to this event, AusNet Services has established a process of checking protection settings provided by DSPs. AEMO recommends that all Network Service Providers (NSPs) ensure processes are established to ensure protection coordination is maintained.

The GFT scheme is designed to reduce constraints on generation that would otherwise apply, whilst maintaining power system security following contingencies between Horsham and Ballarat. In this event, the GFT scheme operated as designed, automatically disconnecting 184 MW of generation at the Crowlands, Bulgana and Murra Warra Wind Farms.

⁵ The Crowlands and Bulgana GFT schemes operate if the Ararat – Crowlands 220 kV line tripped at the Ararat end or the Crowlands end.

⁶ Provided that the wind farm maintains the <=115 MW limit as per constraint due to the trip of the ARTS-CWTS line.

⁷ Australian Energy Operations (AEO) is the owner/operator of ARTS.

2.2.2 Trip of Wemen Solar Farm

The trip of Wemen Solar Farm was not expected to result from the trip of the ARTS-CWTS line. The National Electricity Rules (NER)⁸ require generating systems to remain in continuous uninterrupted operation for any disturbance caused by a credible contingency event, provided that the event is not one that would disconnect the generating unit from the power system by removing network elements from service.

Wemen Solar Farm tripped due to the unexpected operation of its anti-islanding scheme where no islanding condition existed. The anti-islanding scheme should only operate and disconnect the generating system if the generating system loses connection through to the 220kV network.

The Wemen Solar Farm was returned to service at 1535 hrs on 21 August 2020, prior to the root cause of the trip being identified. Until the root cause of the trip of Wemen Solar Farm had been identified, the reclassification remained in place.

It was later determined that the root cause of the unexpected operation of the anti-islanding scheme was related to the voltage vector shift protection and its sensitivity to power system disturbances. To prevent a recurrence of this issue, the operators of Wemen Solar Farm disabled the voltage vector shift protection, and further advised that this would not negatively impact the performance of the solar farm. Evidence was provided to AEMO on 23 October 2020 that the vector shift protection element had been disabled.

AEMO is concerned about potential inadvertent operation of anti-islanding schemes such as vector shift or Rate of Change of Frequency (RoCoF) protection for external disturbances which do not result in islanding. This has the potential to exacerbate disturbances on the power system by increasing the impact of contingency events. AEMO plans to engage further with NSPs to understand the issue and subsequently consider actions that may be required.

2.2.3 19 Hz voltage oscillations

During investigation of this incident, AEMO identified 19 Hz voltage oscillations in the West Murray area⁹. The oscillations were not the result of the incident however they were identified for the first time during investigation of the incident. These oscillations are characterised as nonpersistent, poorly damped and irregular with peak-to-peak magnitudes of up to 2%. At the time of preparing the incident report, the oscillations are still present from time to time, however the magnitude of the oscillations is typically limited to approximately 0.5% magnitude for durations less than 2 minutes. AEMO is working with the NSPs, participants and OEMs to identify the cause and any required mitigation measures.

3. Power system security

AEMO is responsible for power system security in the National Electricity Market (NEM). This means AEMO is required to operate the power system in a secure operating state to the extent practicable and take all reasonable actions to return the power system to a secure state following a contingency event in accordance with the NER¹⁰.

⁸ In accordance with NER clause S5.2.5.5(b).

⁹ The West Murray Zone is an area of the National Electricity Market (NEM) with low system strength, extending across parts of Victoria and New South Wales. See: https://aemo.com.au/-/media/files/electricity/nem/network_connections/west-murray/wmz-nsw_map.pdf?la=en&hash=9246DCFB744BD19A3F03DC8A23E6D02D.

¹⁰ Refer to AEMO's functions in section 49 of the National Electricity Law and the power system security principles in clause 4.2.6 of the NER.

The power system was in a secure operating state throughout this incident. The only action required by AEMO in relation to power system security was to invoke constraint sets V-ARCW¹¹ and V-WEMENSF_ZERO¹².

3.1 Frequency

In response to the loss of 247 MW of generation the NEM mainland frequency dropped to 49.74 Hz and remained below 49.85 Hz for 212 seconds and the Tasmania region frequency reduced to 49.78 Hz and remained below 49.85 Hz for 210 seconds. The Frequency Operating Standards (FOS) were maintained for this multiple contingency event¹³.

3.2 Reclassification

AEMO assessed whether to reclassify this incident as a credible contingency event given the abnormal event¹⁴.

As Wemen Asset Co Pty Ltd as Trustee for Wemen Solar Unit Trust could not determine why the Wemen Solar Farm tripped, AEMO determined that the trip of the ARTS-CWTS line and Wemen Solar Farm was likely to recur and correctly reclassified the trip of the ARTS-CWTS line and Wemen Solar Farm as a credible contingency from 1905 hrs on 20 August 2020.

After the root cause of the trip of Wemen Solar Farm had been identified, the Wemen Solar Farm operators advised AEMO on 23 October 2020 that the issue has been rectified and the incident was unlikely to recur. The reclassification of the trip of the ARTS-CWTS line and Wemen Solar Farm as a credible contingency was cancelled at 1619 hrs on 17 November 2020.

4. Market information

AEMO is required by the NER and operating procedures to inform the market about incidents as they progress. This section assesses how AEMO informed the market¹⁵ over the course of this incident.

For this incident, AEMO informed the market on the following matters:

1. A non-credible contingency event – notify within two hours of the event¹⁶.
 - AEMO issued Market Notice 76867 at 1426 hrs on 20 August 2020, 111 minutes after the event, to advise of the non-credible contingency event.
2. Reclassification, details, and cancellation of a non-credible contingency – notify as soon as practical¹⁷.

¹¹ Out=Ararat to Crowlands 220kV line.

¹² Wemen Solar Farm upper limit of 0 MW.

¹³ See the Frequency Operating Standards (FOS): <https://www.aemc.gov.au/sites/default/files/content/c2716a96-e099-441d-9e46-8ac05d36f5a7/REL0065-The-Frequency-Operating-Standard-stage-one-final-for-publi.pdf>.

¹⁴ AEMO is required to assess whether or not to reclassify a non-credible contingency event as a credible contingency event – NER clause 4.2.3A(c) – and to report how the reclassification criteria were applied – NER clause 4.8.15(ca).

¹⁵ AEMO generally informs the market about operating incidents as they progress by issuing Market Notices – see <https://www.aemo.com.au/Market-Notices>.

¹⁶ AEMO is required to notify the market of a non-credible contingency event within two hours of the event – AEMO, Power System Security Guidelines, Section 7.3.

¹⁷ AEMO is required to notify the market of a reclassification – NER clause 4.2.3(g), details of the reclassification – 4.2.3(c), and when AEMO cancels the reclassification – 4.2.3(h).

- AEMO issued Market Notice 76883 at 1912 hrs on 20 August 2020 to advise that AEMO had reclassified the incident as a credible contingency. In the same Market Notice, AEMO also advised that constraint set V-WEMENSF_ZERO was invoked at 1905 hrs on 20 August 2020.
 - AEMO issued Market Notice 76989 at 2154 hrs on 23 August 2020 to advise that it had revoked constraint set V-WEMENSF_ZERO at 1500 hrs on 21 August 2020.
 - AEMO issued Market Notice 80076 at 1619 hrs on 17 November 2020 to advise that the reclassification of the trip of the Ararat – Crowlands 220 kV and Wemen Solar Farm had been cancelled, because a reoccurrence of the incident was no longer reasonably possible.
3. Constraints invoked with interconnector V-S-MNSP1, VIC1-NSW1, T-V-MNSP1, and V-SA on Left Hand Side¹⁸.
- AEMO issued Market Notice 76865 at 1312 hrs on 20 August 2020 to advise it had invoked constraint set V-ARCW at 1245 hrs on 20 August 2020. The constraint set contains constraint equations with interconnector V-S-MNSP1, VIC1-NSW1, T-V-MNSP1, and V-SA on the LHS. Constraint set V-ARCW was revoked at 1755 hrs on 20 August 2020.

5. Conclusions

AEMO has assessed this incident in accordance with clause 4.8.15(b) of the NER. In particular, AEMO has assessed the adequacy of the provision and response of facilities or services, and the appropriateness of actions taken to restore or maintain power system security.

AEMO has concluded that:

1. The trip of ARTS-CWTS line was caused by an unexpected operation of X current differential protection due to its sensitive current differential threshold setting (as discussed in Section 2.2.1). There was no fault on the line.
2. The trip of Wemen Solar Farm was due to an unexpected operation of its anti-islanding scheme where no islanding condition existed (as discussed in Section 2.2.2). This was caused by the voltage vector shift protection and its sensitivity to power system disturbances. The vector shift protection has since been disabled to prevent a recurrence of the incident.
3. AEMO correctly reclassified the trip of the ARTS-CWTS line and Wemen Solar Farm as a credible contingency from 1912 hrs on 20 August 2020.
4. The power system remained in a secure operating state throughout this incident.

AEMO is concerned about potential inadvertent operation of anti-islanding schemes such as vector shift or Rate of Change of Frequency (RoCoF) protection for external disturbances which do not result in islanding. This has the potential to exacerbate disturbances on the power system by increasing the impact of contingency events. AEMO plans to engage further with NSPs to understand the issue and subsequently consider actions that may be required.

Through the review of this event, AEMO identified intermittent 19 Hz oscillations in the West Murray area. These oscillations are limited in magnitude and duration and AEMO continues to work with relevant NSPs, participants, and OEMs to identify the cause.

¹⁸ For short notice outages, AEMO is required to notify the Market of variances to interconnector transfer limits as per section 22 of AEMO's Power System Security Guidelines.

A1. System diagram

Figure 1 provides an overview of relevant areas of the power system.

Figure 1 Overview of part of the power system

