AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Power system in South Australia not in a secure operating state on 5 May 2019

January 2020

Reviewable Operating Incident Report under the National Electricity Rules

INCIDENT CLASSIFICATIONS

Classification	Detail
Time and date of incident	5 May 2019, 1030 to 1145 hrs
Region of incident	South Australia
Affected regions	South Australia
Event type	Power system not in a secure operating state
Generation impact	No generating unit was disconnected or had its output limited because of this incident
Customer load impact	No customer load was disconnected because of this incident
Associated reports	Nil

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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1. Overview

This report relates to a reviewable operating incident[1] that occurred on 5 May 2019 in South Australia where the power system was not in a secure operating state for greater than 30 minutes.

No generation or customer load was lost because 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 security[2].

AEMO has concluded that:

1. Wind generation in the Northern area of South Australia unexpectedly reduced to zero or near zero output, causing voltage levels in the area to rise.
2. The power system in northern South Australia was not in a secure operating state for 75 minutes.
3. AEMO took all reasonable actions to restore the power system to a secure operating state. However, there were limited voltage control actions available to AEMO, due to the unavailability of reactive power absorption capability of the wind farms in the area and the delay in switching out of capacitor banks.
4. AEMO has updated its operating procedures to provide additional information on the available voltage control actions for wind and solar farms and battery installations. This additional information will enable AEMO to manage these type of voltage control issues during similar events of low wind generation.

This report is prepared in accordance with clause 4.8.15(c) of the National Electricity Rules (NER). It is based on information from AEMO's Energy and Market Management Systems.

National Electricity Market time (Australian Eastern Standard Time [AEST]) is used in this report. At the time of this incident, local time in South Australia was AEST minus 30 minutes.

2. The incident

2.1 Pre-incident conditions

Prior to and during this incident, the Davenport – Brinkworth and Brinkworth – Templers West 275 kV transmission lines were out of service for planned work by ElectraNet[3]. These outages commenced on 28 April and 30 April 2019 respectively and were due for completion on 9 May and 11 May 2019 respectively. Short notice recall of these outages was not available due to the nature of the work being carried out. Appendix A1 provides an overview of the relevant part of the power system.

[1] See NER clause 4.8.15(a)(1)(i) and the AEMC Reliability Panel Guidelines for Identifying Reviewable Operating Incidents. The incident was classified as a non-credible contingency event (see NER 4.2.3(e)).

[2] See NER clause 4.8.15(b).

[3] The Brinkworth – Templers West line was open at Brinkworth but remained energised from Templers West.

2.2 The incident

On 5 May 2019, between 1030 hrs and 1145 hrs, the power system was not in a secure operating state as AEMO's Contingency Analysis (CA)[4] tools showed post-contingent voltage levels at Blyth West, and Willalo substations would have exceeded the satisfactory operating limit[5] of 303 kV, as shown in Tables 1-3.

Table 1 CA results for loss of the Blyth West – Munno Para 275 kV line

Contingency Analysis run time	Post contingent voltage at Blyth West (kV)	Satisfactory voltage limit (kV)	Violation (kV)
1031 hrs	304	303	1
1033	304	303	1
1038	304	303	1
1044	304	303	1
1048	305	303	2
1050	305	303	2
1055	305	303	2
1101	304	303	1
1105	304	303	1
1107	304	303	1

Table 2 CA results for loss of the Para – Munno Para 275kV line

Contingency Analysis run time	Post contingent voltage at Blyth West (kV)	Satisfactory voltage limit (kV)	Violation (kV)
1031 hrs	304	303	1
1033	304	303	1
1038	304	303	1
1044	304	303	1
1048	305	303	2
1050	305	303	2
1055	305	303	2
1101	304	303	1
1105	304	303	1
1107	304	303	1

Table 3 CA results for loss of the Mokota – Robertstown 275kV line

Contingency Analysis run time	Post contingent voltage at Willalo (kV)	Satisfactory voltage limit (kV)	Violation (kV)
1050 hrs	304	303	1
1055	304	303	1
1101	305	303	2

[4] While contingency analysis tools may provide conservative results, these are the tools AEMO bases its operational decisions on.

[5] See NER clause 4.2.2(b).

Contingency Analysis run time	Post contingent voltage at Willalo (kV)	Satisfactory voltage limit (kV)	Violation (kV)
1105	306	303	3
1107	306	303	3
1109	306	303	3
1113	306	303	3
1119	306	303	3
1123	306	303	3
1125	306	303	3
1130	306	303	3
1136	305	303	2
1137	305	303	2
1141	304	303	1
1143	304	303	1

3. Power system security

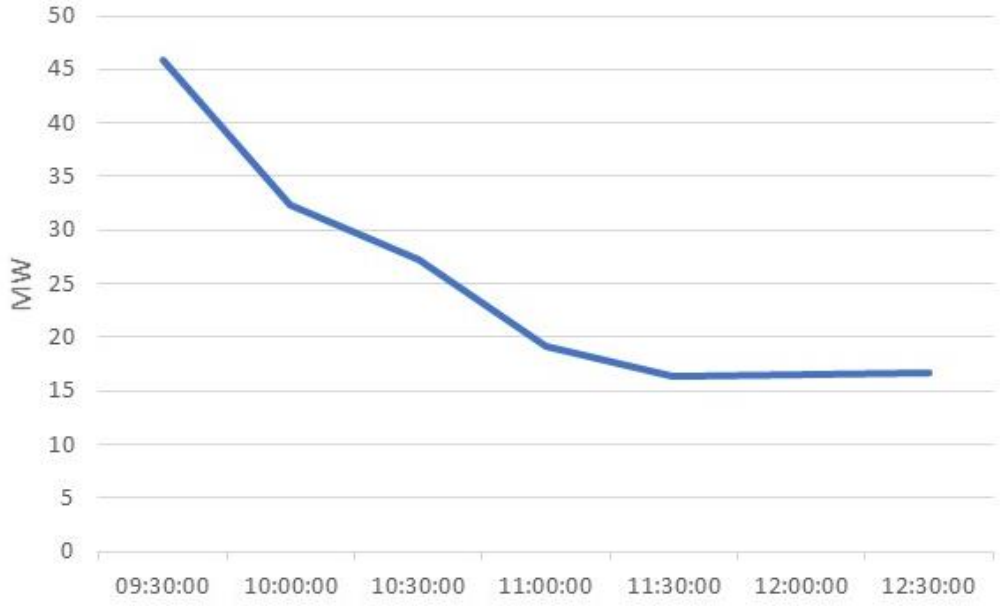
AEMO is responsible for power system security in the National Electricity Market (NEM). This means AEMO is required to operate the power system in a secure operating state to the extent practicable and take all reasonable actions to return the power system to a secure state following a contingency event in accordance with the NER[6].

In the period prior to this incident, the wind farms in the northern area of South Australia[7] were forecast to be generating at low outputs but would remain above zero, as shown in Figure 1.

[6] 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.

[7] Includes North Brown Hill, Bluff, Willogoleche, Hallett Hill, Hallett, Hornsdale, Snowtown North, and Snowtown South wind farms.

Figure 1 Forecast output of Northern area wind generation



From approximately 1015 hrs on 5 May 2019, the output of the Northern area wind farms reduced to zero or near zero. For the majority of wind farms, the reactive power capability is defined as +/- 0.395 x P, where P is the active power output. As such, when P approaches zero, so does the reactive power capability. Therefore, as the generation from the wind farms reduced to zero, the ability of the wind farms to absorb reactive power to limit voltages in the area was reduced.

This problem was further exacerbated by capacitor banks that were in service at Willogoleche and Snowtown North wind farms, resulting in a net rise in reactive power output from the wind farms (shown in Figure 2) and an increase in voltages in the area. As an example, Figure 3 shows the voltage levels at Willalo substation.

Figure 2 Northern area wind farm generation – active and reactive power output

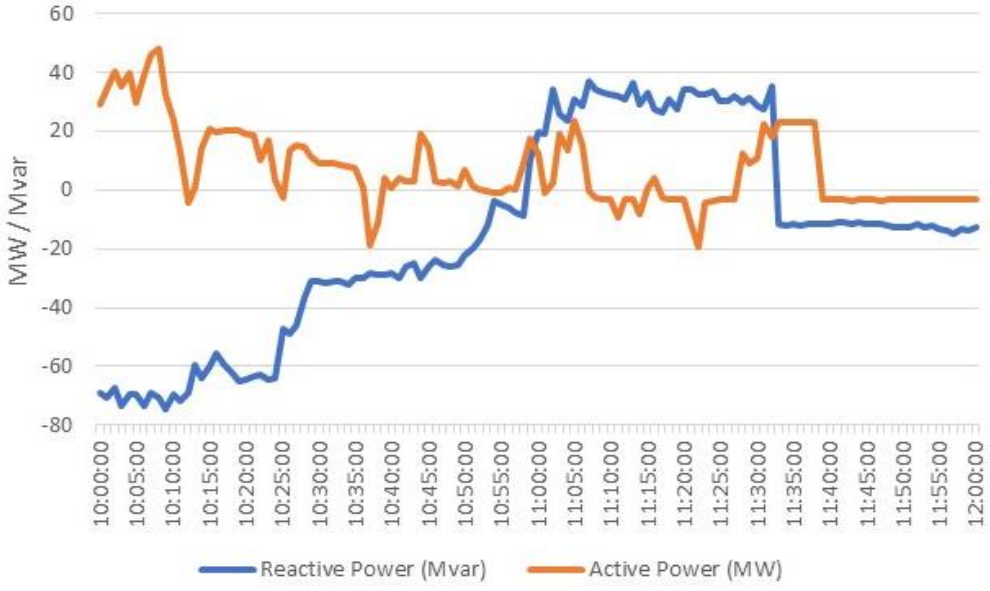
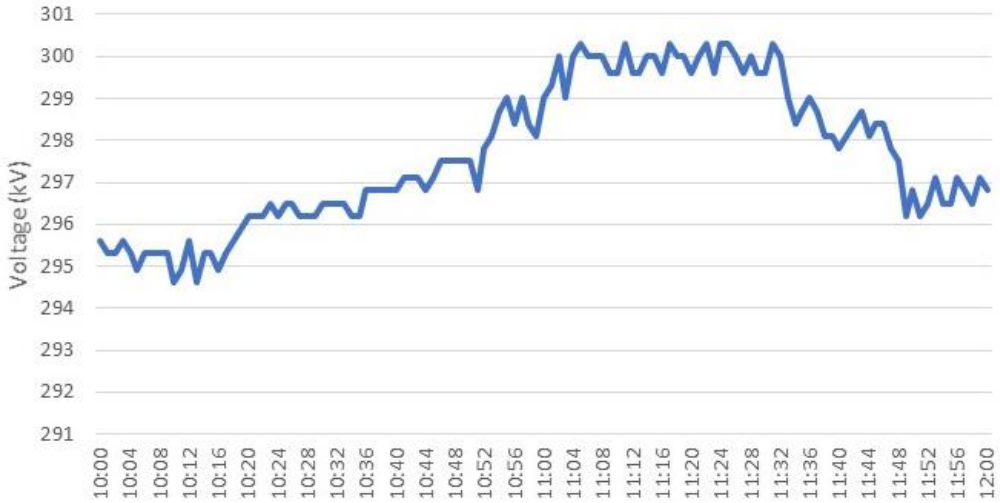


Figure 3 Voltage level at Willalo 275 kV substation



In response to the contingency violations occurring from 1031 hrs, AEMO explored ways to reduce voltage levels in the area, including:

- Reduction in reactive power from generation in the Adelaide area – not viable as these generating units were already at their under-excitation limits.
- De-energising the Templers West – Para 275 kV transmission line – studies showed this would have little impact[8].
- Tap changing on the 275/132 kV Transformer at Bungama – this was actioned by ElectraNet but was insufficient to clear the CA violations.
- Switching out of a capacitor bank on 66 kV network in Adelaide – this was actioned by ElectraNet but was insufficient to clear the CA violations.

At 1107 hrs, AEMO requested ElectraNet to open circuit breaker (CB) 8001 at Blyth West. With this CB open, the outage of the Blyth West – Munno Para 275 kV transmission line would also result in the loss of the Blyth West – Snowtown North and South 275 kV transmission line and reduce the post-contingent voltages at Blyth West substation to acceptable levels. CB 8001 at Blyth West was closed again at 1329 hrs, after studies showed no further post-contingent voltage violations.

AEMO did not initially consider switching out the in service filters (capacitors) at Willogoleche and Snowtown North, because these filters were in service in accordance with the wind farms' normal voltage control strategy, and AEMO was unsure if they could be switched out of service. However, after seeking advice from ElectraNet, AEMO requested these filters be removed from service at 1123 hrs. AEMO was advised this would take 30 minutes and 60 minutes respectively to occur, because staff needed to be called to site. The Snowtown capacitor was switched out of service at 1223 hrs and the Willogoleche capacitor was switched out at 1454 hrs.

Similarly, after seeking further advice on the operation of the Hornsdale Battery, at 1127 hrs AEMO requested the Hornsdale Battery be switched from power factor control mode to voltage control mode and the voltage setpoint be lowered to 293 kV to reduce the pre-contingent voltages in the area. This action resulted in the Hornsdale Battery absorbing up to 40 megavolt amperes reactive (Mvar), reducing both pre-contingent and post-contingent voltages at Willalo substation to acceptable levels, with all violations cleared by 1145 hrs.

[8] This line was already deloaded at Brinkworth for planned work

At 1522 hrs, studies indicated that the pre-contingent voltages were now low enough to allow the Hornsdale Battery to return to normal operation in power factor control mode.

In response to the above, AEMO has updated its operating procedures to provide better advice on the operation of wind farms in relation to available voltage control actions, and on the operation of the Hornsdale Battery to ensure a more timely response This information will also be used by AEMO to plan requests for filter outages or control mode changes ahead of time during periods of forecast low wind generation.

Further to this, AEMO recommends that TNSPs ensure the voltage control strategy documents developed in consultation with wind and solar farm operators contain clear statements as to when capacitor/filter banks may be switched in or out of service and when alternative control modes may be used outside of the normal voltage control strategy. To assist with this, AEMO is in the process of developing a template for voltage control strategy documents. This template will be made available to TNSPs in the near future.

4. 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. Wind generation in the Northern area of South Australia unexpectedly reduced to zero or near zero output, causing voltage levels in the area to rise.
2. The power system in northern South Australia was not in a secure operating state for 75 minutes.
3. AEMO took all reasonable actions to restore the power system to a secure operating state. However, there were limited voltage control actions available to AEMO, due to the unavailability of reactive power absorption capability of the wind farms in the area and the delay in switching out of capacitor banks.
4. AEMO has updated its operating procedures to provide additional information on the available voltage control actions for wind and solar farms and battery installations. This additional information will enable AEMO to manage these type of voltage control issues during similar events of low wind generation.

A1. System diagram

The diagram below shows an overview of the relevant part of the South Australian power system.