

Preliminary Report – Load Shedding Event in Northern New South Wales on 8 July 2024

July 2024

A preliminary operating incident
report for the National Electricity
Market – information as at
15/07/2024





Important notice

Purpose

AEMO has prepared this preliminary report as part of its review of the reviewable operating incident that occurred on 8 July 2024, involving transmission outages and subsequent load shedding in northern New South Wales, as a first step in reporting under clause 4.8.15(c) of the National Electricity Rules.

The observations in this report will be updated in AEMO's final operating incident report, where new information becomes available.

Disclaimer

AEMO has been provided with preliminary data by Registered Participants as to the status and response of some facilities before, during and after the event in accordance with clause 4.8.15 of the National Electricity Rules. In addition, AEMO has collated preliminary information from its own systems. Any analysis and conclusions expressed in this document are also of a preliminary nature.

While AEMO has made reasonable efforts to ensure the quality of the information in this report, its investigations are incomplete, and any findings expressed in it may change as 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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Abbreviations

Abbreviation	Term
AC	alternating current
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEST	Australian Eastern Standard Time
BESS	battery energy storage system
CA	contingency analysis
CB	circuit breaker
DC	direct current
DNSP	Distribution Network Service Provider
ECS	Emergency Control Scheme
EMS	energy management system
ETS	Emergency Tripping Scheme
kV	kilovolt/s
MN	Market Notice
MW	megawatt/s
NEL	National Electricity Law
NEM	National Electricity Market
NEMDE	National Electricity Market dispatch engine
NER	National Electricity Rules
PS	power station
QNI	Queensland – New South Wales Interconnector
SF	solar farm
TNSP	Transmission Network Service Provider
VNI	Victoria – New South Wales Interconnector
WF	wind farm

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1 Overview

This preliminary report relates to a reviewable operating incident¹ that occurred on 8 July 2024 in New South Wales.

At 0511 hrs, the Coffs – Lismore 330 kilovolt (kV) line tripped and remained out of service. This unplanned outage restricted flows from other areas of New South Wales to the Lismore area. Between approximately 1625 hrs and 1835 hrs, the Terranora Interconnector² failed to meet its dispatch target. The Directlink direct current (DC) link is designed to adjust its flow to reflect the Terranora Interconnector dispatch target, and flows across the Directlink DC link remained close to 0 megawatts (MW) throughout the evening. This limited the flow from Queensland to the Lismore area. The combination of flow limitations from Queensland and other areas of New South Wales to the Lismore area caused system security issues over the evening peak load. This ultimately resulted in AEMO instructing Transgrid³ to shed 30 MW of load at 1817 hrs to resolve system security issues.

After load shedding had commenced and during operational switching to manage network loading in the Lismore area, at 1834 hrs the Armidale – Metz – Koolkhan 132 kV No. 966 tee-connected line tripped at Armidale and Metz ends. Subsequently the line auto reclosed approximately 4 seconds later at the Armidale end. The trip of Armidale – Metz – Koolkhan 132 kV No. 966 line resulted in islanding of the Lismore area and momentary interruption of approximately 84 MW of load. Due to loss of the alternating current (AC) reference signal prior to the auto-reclosure, all three DC systems⁴ of Directlink tripped and remained out of service. The auto reclosure of Armidale – Metz – Koolkhan 132 kV No. 966 line restored supply to the load.

Following the trips of the Armidale – Metz – Koolkhan 132 kV No. 966 line and Directlink, AEMO re-assessed system security and at 1855 hrs instructed Transgrid to shed a further 10 MW of load in the Lismore area. AEMO subsequently instructed the load to be progressively restored at 1930 hrs, 2000 hrs and 2105 hrs.

Approximately 24,500 customers in the Lismore area were affected for a portion of the time between 1828 hrs and 2151 hrs by the load shedding.

Separate to this event, at 1940 hrs, also in New South Wales, the Eraring – Newcastle 330 kV No. 90 line also tripped. AEMO advised the market of this trip via Market Notice (MN) 117325. This trip did not have an impact on the incident that is the subject of this incident review.

Given the significance of this event, AEMO has prepared this preliminary report. This preliminary report provides a summary of the facts relating to the incident as known at the date of publication and does not attempt to provide any final analysis or recommendations.

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

¹ See NER clause 4.8.15(a)(1)(v), as the event relates to an AEMO issued clause 4.8.9 instruction for load shedding; and the Australian Energy Market Commission (AEMC) Reliability Panel Guidelines for Identifying Reviewable Operating Incidents.

² The Terranora Interconnector is an alternating current (AC) interconnection between Mudgeeraba and Terranora.

³ Transgrid is a Transmission Network Service Provider (TNSP) for New South Wales.

⁴ Directlink has three pairs of bipolar DC transmission cables known as “DC systems”. Each DC system has a 60 MW maximum capacity, giving Directlink a total rating of 180 MW.

2 Pre-event conditions

2.1 Generation and demand

Table 1 summarises the New South Wales system conditions at 1815 hrs on 8 July 2024, just prior to the incident. Table 2 provides a summary of the New South Wales generator dispatch as at 1815 hrs on 8 July 2024.

Table 1 New South Wales key system parameters at 1815 hrs on 8 July 2024

Quantity description	Value (MW)
New South Wales operational demand	11,053
New South Wales scheduled and semi-scheduled generation	10,400
Terranora Interconnector flow into New South Wales	75
Directlink flow towards Queensland	6.5
Queensland – New South Wales Interconnector (QNI) flow into New South Wales	503
Victoria – New South Wales Interconnector (VNI) flow into New South Wales	61

Table 2 New South Wales generation dispatch at 1815 hrs on 8 July 2024

Station Name	Dispatched generation (MW)	Station Name	Dispatched generation (MW)
Bango 973 Wind Farm (WF)	61.6	Mt Piper PS unit 1	727.5
Bango 999 WF	21.1	Mt Piper PS unit 2	699.4
Broken Hill Battery Energy Storage System (BESS)	40	Queanbeyan BESS	0.1
Boco Rock WF	39.3	Riverina BESS 1	60.1
Bodangora WF	80.4	Riverina BESS 2	65.1
Bayswater Power Station (PS) unit 1	657.1	Rye Park Renewable Energy	137
Bayswater PS unit 3	683.9	Sapphire WF	201.1
Bayswater PS unit 4	682.9	Shoalhaven PS	201.5
Capital BESS	0.2	Smithfield Energy Facility	116.9
Collector WF 1	26.1	Silverton WF	22.4
Crudine Ridge WF	37.7	Tallawarra "A" PS	366
Darlington Point BESS	21.8	Taralga WF	8.2
Erating PS unit 1	678.4	Tumut 3 PS	485.3
Erating PS unit 2	679.9	Tumut PS	545.6
Erating PS unit 3	688.8	Uranquinty PS unit 3	164.8
Erating PS unit 4	637.3	Uranquinty PS unit 4	167.2
Flyers Creek WF	43.6	Vales Point "B" PS unit 5	559.3
Gullen Range WF unit 1-73	11.3	Vales Point "B" PS unit 6	659.7
Gullen Range WF unit 74-104	11.1	Wallgrove BESS 1	7.8
Gunning WF	8.5	Woodlawn WF	4.9
Guthega PS	31.2	White Rock WF	60.2

3 Event

3.1 Sequence of events

The sequence of events is outlined below in Table 3.

Table 3 Sequence of events

Market time (hhmm)	Event
8 July 2024	
0511	<ul style="list-style-type: none"> The Coffs – Lismore 330 kV No. 89 line tripped. All three DC systems of Directlink tripped.
0750	<ul style="list-style-type: none"> All three DC systems of Directlink returned to service.
0753 to 0821	<ul style="list-style-type: none"> Contingency analysis (CA) violations occurred on the Armidale – Lismore 132 kV subsystem.
1625	<ul style="list-style-type: none"> The Terranora Interconnector started failing to meet its dispatch target.
1705 to 1851	<ul style="list-style-type: none"> CA violations occurred on the Armidale – Lismore 132 kV subsystem.
1739	<ul style="list-style-type: none"> Transgrid off-loaded the Lismore – Tenterfield 132 kV No. 96L line at the Lismore end to address CA violations. This resolved the intended CA violations but other CA violations began to appear.
1817	<ul style="list-style-type: none"> AEMO instructed Transgrid to shed 30 MW of load, to resolve CA violations.
1828	<ul style="list-style-type: none"> Essential Energy^A commenced load shedding as requested by Transgrid.
1834	<ul style="list-style-type: none"> Transgrid split the Koolkhan 132 kV bus to radialise the network. The Armidale – Metz – Koolkhan 132 kV No. 966 tee-connected line tripped at the Armidale and Metz ends, and auto reclosed approximately 4 seconds later at the Armidale end. Metz Solar Farm, which was not generating at the time, was disconnected. All three DC systems of Directlink tripped. Approximately 84 MW of load in the Lismore area was islanded and disconnected for approximately 4 seconds.
1835	<ul style="list-style-type: none"> Transgrid reclosed the split bus at Koolkhan. The Terranora Interconnector started meeting its dispatch targets.
1855	<ul style="list-style-type: none"> AEMO instructed Transgrid to shed 10 MW in addition to the load that had been shed to this point.
1930	<ul style="list-style-type: none"> AEMO instructed Transgrid to begin load restoration, starting with 20 MW of load.
2000	<ul style="list-style-type: none"> AEMO provided permission to Transgrid to restore a further 10 MW of load.
2105	<ul style="list-style-type: none"> AEMO provided permission to Transgrid to restore all remaining load.
2151	<ul style="list-style-type: none"> Essential Energy had restored all shed load.
2240	<ul style="list-style-type: none"> Directlink DC system 1 returned to service.
9 July 2024	
1320 hrs	<ul style="list-style-type: none"> All three DC systems of Directlink returned to service.
10 July 2024	
1521 hrs	<ul style="list-style-type: none"> The Coffs – Lismore 330 kV No. 89 line returned to service.

^A Essential Energy is the Distribution Network Service Provider (DNSP) for the Lismore area.

3.2 Trip of the Coffs – Lismore 330 kV No. 89 line

At 0511 hrs on 8 July 2024, the Coffs – Lismore 330 kV No. 89 line tripped. In the seconds afterwards, all three DC systems of Directlink tripped. The trip of the Coffs – Lismore 330 kV No. 89 line triggered the Directlink Emergency Control Scheme (ECS) and tripped all three Directlink DC systems as designed.

Preliminary findings indicate that an insulator failure on the Coffs – Lismore 330 kV No. 89 line caused a flashover of a post insulator and trip of the line.

All three DC systems of Directlink returned to service at 0750 hrs on 8 July 2024. The Coffs – Lismore 330 kV No. 89 line remained out of service for the rest of the incident (see Section 7 for more details).

3.3 Morning contingency analysis violations

Between 0753 hrs and 0821 hrs on 8 July 2024, AEMO's energy management system (EMS) alerted operators to contingency analysis (CA) violations during the unplanned outage of the Coffs – Lismore 330 kV No. 89 line. The EMS highlighted that a trip of the Lismore – Koolkhan 132 kV No. 967 line could cause overloads on the Glen Innes – Tenterfield 132 kV No. 96R line and the Lismore – Tenterfield 132 kV No. 96L line. The security issue was resolved in 28 minutes and AEMO used constraint automation to develop constraint CA_SYDS_559DA1A7 to manage the overload of the Lismore – Tenterfield 132 kV No. 96L line for the loss of the Lismore – Koolkhan 132 kV No. 967 line. CA_SYDS_559DA1A7 was invoked between 0825 hrs and 1125 hrs on 8 July 2024 while the constraints in the area were reviewed, but did not bind. At 1052 hrs, AEMO updated constraints N>89_96R_967 and N>89_96L_967, and AEMO implemented further updates at 1535 hrs to improve the constraints' performance under the network conditions at the time.

3.4 Evening contingency analysis violations and load shedding

From 1705 hrs on 8 July 2024, CA violations in AEMO's EMS showed that a trip of the Lismore – Koolkhan 132 kV No. 967 line could overload the Glen Innes – Tenterfield 132 kV No. 96R line and the Lismore – Tenterfield 132 kV No. 96L line.

AEMO proceeded to investigate the cause of the CA violations and assess options to alleviate the potential post-contingent overloads. Transgrid provided increased ratings for the Glen Innes – Tenterfield 132 kV No. 96R line and the Lismore – Tenterfield 132 kV No. 96L line. AEMO identified that the Terranora Interconnector had been off-target and contacted APA Group⁵ regarding Directlink active power output. AEMO and Transgrid considered switching arrangements as the CA violations persisted.

At 1739 hrs, Transgrid off-loaded the Lismore – Tenterfield 132 kV No. 96L line at the Lismore end, resolving the CA violations for loss of the Lismore – Koolkhan 132 kV No. 967 line.

From 1741 hrs (the next CA run after 1739 hrs), CA violations showed that a trip of the Armidale – Metz – Koolkhan 132 kV No. 966 tee-connected line could overload the Coffs – Grafton East 132 kV No. 96H line and the Grafton East – Koolkhan 132 kV No. 9W0 line.

⁵ APA Group is the owner of the Directlink DC link.

AEMO continued to remain in contact with APA Group, which was investigating a Directlink control issue, however APA Group was unable to resolve the issue at this time.

AEMO and Transgrid continued to assess options to securely supply the Lismore load. Transgrid provided increased ratings for the Coffs – Grafton East 132 kV No. 96H line and the Grafton East – Koolkhan 132 kV No. 9W0 line, however the CA violations persisted. There was enough generation in the New South Wales region to meet demand, however, due to constraints on the network and Directlink's inability to adjust its flow to reflect the Terranora Interconnector dispatch target, this was not able to supply the load in the Lismore area.

At 1817 hrs on 8 July 2024, AEMO issued a direction under section 116 of the National Electricity Law (NEL) (deemed a clause 4.8.9 instruction under National Electricity Rules (NER) 4.8.9(a1)(2)) to Transgrid to shed 30 MW of load in the Lismore area to maintain the system in a secure operating state. Following Transgrid's request, Essential Energy began load shedding at 1828 hrs.

3.5 Trip of Armidale – Metz – Koolkhan 132 kV No. 966 tee-connected line at Armidale and Metz

Following the load shedding instruction, Transgrid completed operational switching at Koolkhan to radialise the supply of Koolkhan load from Grafton. At 1834.44 hrs on 8 July 2024, Transgrid opened Koolkhan circuit breaker (CB) 4122, which split the Koolkhan 132 kV bus and radialised the supply as intended.

At 1834.52 hrs, 8 seconds after the bus was split, Armidale CB 9662 opened and Metz CB 4412 opened, which off-loaded the Armidale – Metz – Koolkhan 132 kV No. 966 line at Metz and Armidale, and disconnected Metz Solar Farm (SF), which was not generating at the time. Preliminary findings from Transgrid indicate these CBs may have opened due to a power swing caused by splitting of the Koolkhan 132 kV bus. The opening of Armidale CB 9662 resulted in islanding of the Lismore area, and approximately 84 MW of load in the Lismore area was interrupted for 4 seconds. Due to loss of the AC reference signal, all three DC systems of Directlink tripped as designed.

At 1834.56 hrs, 4 seconds after Armidale CB 9662 tripped, the CB successfully auto-reclosed and restored supply to the load, excluding load which was shed for system security. As designed, Metz CB 4412 did not attempt auto-reclosure. At 1835.13 hrs, Transgrid closed Koolkhan CB 4122 and returned Koolkhan to the original meshed supply configuration.

At 1845 hrs, AEMO invoked constraint set N-X_MBTE_3 to manage the Directlink outage and re-assessed system security. AEMO assessed that a further 10 MW of load needed to be shed to operate the power system in a secure state. As Transgrid was unable to immediately confirm to AEMO how much of the 30 MW had been shed (under the instruction referred to in Section 3.4), at 1855 hrs AEMO issued a direction to Transgrid under section 116 of the NEL (deemed a clause 4.8.9 instruction under NER 4.8.9(a1)(2)) to shed 10 MW more load than had been shed to this point in the Lismore area to maintain the system in a secure operating state.

Directlink remained out of service for the rest of the incident (see Section 7 for more details).

3.6 Load restoration

As the evening peak load reduced over time, it became possible to progressively restore the shed load. AEMO assessed system security as the load reduced and issued directions to Transgrid under section 116 of the NEL (deemed to be clause 4.8.9 instructions under NER 4.8.9(a1)(2)) to restore load. AEMO issued the following instructions to Transgrid on 8 July 2024:

- At 1930 hrs to commence restoration of 20 MW of the load in the Lismore area.
- At 2000 hrs to commence restoration of a further 10 MW of load in the Lismore area.
- At 2105 hrs to commence restoration of all remaining load in the Lismore area.

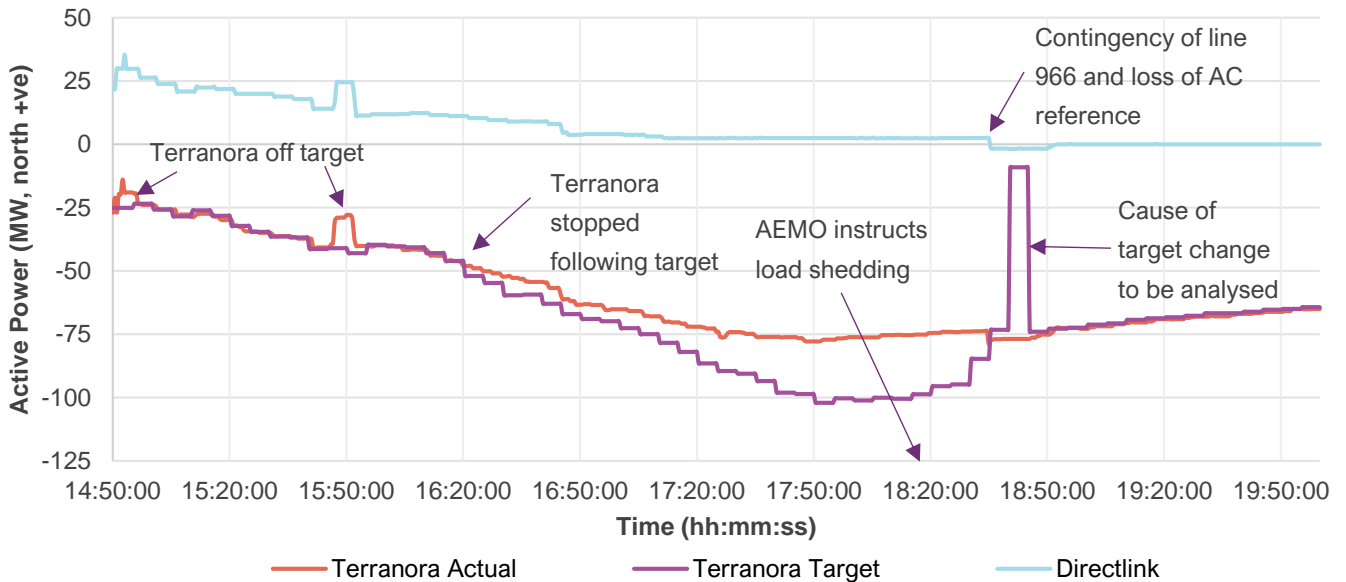
The final load block was restored by Essential Energy at 2151 hrs.

4 Analysis of Directlink flow

Preliminary post-incident review of AEMO’s data shows that between 1625 hrs and 1835 hrs on 8 July 2024, the Terranora Interconnector actual flows were mismatched with the dispatch target by up to 25 MW. The Directlink DC link is designed to adjust its flow to reflect the Terranora Interconnector dispatch target. The mismatch in actual flow resulted in higher northerly flows on the 132 kV network between Armidale and Lismore than the NEM dispatch engine (NEMDE) was expecting. Subsequent network loading issues were identified via CA violations rather than violation of constraints.

Flow on Directlink remained close to 0 MW throughout the evening peak, and this coincided with the ongoing outage of the Coffs – Lismore 330 kV No. 89 line. This limited the amount of power that could be supplied to the Lismore area.

Figure 1 Terranora output throughout the event



5 Constraints

Table 4 shows the constraints that were invoked on 8 July 2024 to manage the incident.

Table 4 Constraints invoked to manage the incident

Constraint set	Time invoked	Time revoked	Description
N-CHLS_89	0525 hrs 8 July 2024	1540 hrs 10 July 2024	Manage outage of Coffs Harbour – Lismore 330 kV No. 89 line.
N-DLETS_OS	0525 hrs 8 July 2024	1540 hrs 10 July 2024	Manage outage of Directlink Emergency Tripping Scheme (ETS).
N-X_MBTE_3	0525 hrs 8 July 2024	0750 hrs 8 July 2024	Manage outage of all three Directlink cables.
N-X_MBTE_3	1845 hrs 8 July 2024	2240 hrs 8 July 2024	Manage outage of all three Directlink cables.
N-X_MBTE_2	2240 hrs 8 July 2024	1320 hrs 9 July 2024	Manage outage of two Directlink cables.
CA_SYDS_559DA1A7	0825 hrs 8 July 2024	1105 hrs 8 July 2024	Automated constraint set to manage the overload of the Lismore – Tenterfield 132 kV No. 96L line for the loss of the Lismore – Koolkhan 132 kV No. 967 line during the unplanned outage of the Coffs – Lismore 330 kV No. 89 line.

6 Market operations

6.1 Market notices

AEMO issued the MNs in Table 5 on 8 July 2024 as a consequence of the event.

Table 5 Market Notices issued on 8 July 2024 in relation to this incident

Time	Market Notice	Details
0541	117313	Notification of the potential variation to interconnector transfer limits following invoking of N-CHLS_89, N-DLETS_OS and N-X_MBTE_3 at 0525 hrs on 8 July 2024. These constraints were invoked following the unplanned outage of the Coffs – Lismore 330 kV No. 89 line.
0828	117314	Notification of the potential variation to interconnector transfer limits following invoking of CA_SYDS_559DA1A7 at 0825 hrs on 8 July 2024. This constraint was invoked to maintain the power system in a secure operating state in the New South Wales region.
1113	117317	Notification of cancellation of the potential variation to interconnector transfer limits following revocation of CA_SYDS_559DA1A7.
1908	117321	Notification of AEMO’s direction to shed load in New South Wales at 1817 hrs on 8 July 2024. The direction was given under section 116 of the NEL (deemed a clause 4.8.9 instruction under NER 4.8.9(a1)(2)) to maintain power system security.
1934	117322	Notification of AEMO’s direction for load restoration in New South Wales at 1930 hrs on 8 July 2024 given under section 116 of the NEL (deemed a clause 4.8.9 instruction under NER 4.8.9(a1)(2)).
1941	117323	Notification of the potential variation to interconnector transfer limits following invoking of N-X_MBTE_3 at 1845 hrs on 8 July 2024. These constraints were invoked following an unplanned outage of all three cables of Directlink.
2158	117324	Notification that load restoration in New South Wales was complete.

6.2 Market pricing

AEMO determined this event did not meet the “regional reference node test”⁶ which would have required AEMO to set the spot price at the relevant regional reference node to equal the market price cap. Under the test, the central dispatch process would have needed to determine that all load in a region could not otherwise be supplied and that AEMO had issued instructions to shed load in the region.

Although AEMO had instructed Transgrid to shed load, this was required to respond to a network violation rather than to a general supply shortfall in New South Wales. Therefore, AEMO set the spot price for all regions using the central dispatch process⁷.

⁶ Refer NER 3.9.2(e)(1).

⁷ Refer NER 3.9.2(c) and 3.8.21(b).

7 Operation of the Lismore area following the event

Following the event, AEMO continued to work with APA Group regarding the restoration of Directlink and rectifications of the Directlink control issue. Directlink DC system 1 returned to service at 2240 hrs on 8 July 2024. All DC systems of Directlink returned to service at 1320 hrs on 9 July 2024. At 1405 hrs on 9 July 2024, APA Group advised AEMO that it had identified and rectified the Directlink control issue.

Transgrid developed a contingency plan for management of peak demand on 9 July 2024, should Directlink and the Coffs – Lismore 330 kV No. 89 line simultaneously be out of service for the evening peak. However, the contingency plan was not required to be implemented as Directlink had returned to service.

APA Group subsequently advised AEMO at 1115 hrs on 10 July 2024 that Directlink was encountering a further control issue. APA Group advised AEMO at 1220 hrs on 10 July 2024 that it had identified and rectified the Directlink control issue. AEMO invoked constraint set I-CTRL_ISSUE_TE between 1120 hrs and 1220 hrs to manage the outage. As part of the next steps of the investigation, AEMO will work with APA Group to understand the cause and rectifications of control issues experienced by Directlink throughout this event.

Immediately following the event, Transgrid worked to identify the cause of the fault and dispatched repair crews and equipment to site to repair the faulty insulators. As the faulty insulators were located in a difficult to access location, these repairs were completed over the following days. Following repairs, Transgrid returned the Coffs – Lismore 330 kV No. 89 line to service at 1521 hrs on 10 July 2024.

8 Next steps

AEMO intends to undertake analysis relating to this event and prepare a final incident report⁸ in due course with the input and support of Transgrid, APA Group, Essential Energy and any other relevant participants. The investigation is expected to include, but not be limited to:

- Confirmation of the exact timing and sequence of events based on available high speed data.
- Review of power system security, including actions taken to address CA alarms and load shedding.
- Review of Directlink performance and trips throughout the incident.
- Confirmation of the root cause of the Coffs – Lismore 330 kV No. 89 line trip.
- Confirmation of the root cause of the Armidale – Metz – Koolkhan 132 kV No. 966 line trip at Armidale and Metz.
- Review of MNs issued by AEMO throughout the event.
- Review of any embedded generation loss.

⁸ As required by NER 4.8.15(c).

A1. System diagram

Figure 2 provides an illustration of the key events associated with the incident.

Figure 2 Incident overview

