RELIABILITY PANEL AEMC

DETERMINATION

Reliability Panel AEMC

DRAFT REPORT

AEMO REQUEST FOR PROTECTED EVENT DECLARATION

18 APRIL 2019

INQUIRIES

Reliability Panel
c/- Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

E aemc@aemc.gov.au
T (02) 8296 7800
F (02) 8296 7899

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ABOUT THE RELIABILITY PANEL

The Panel is a specialist body established by the Australian Energy Market Commission (AEMC) in accordance with section 38 of the National Electricity Law and the National Electricity Rules. The Panel comprises industry and consumer representatives. It is responsible for monitoring, reviewing and reporting on reliability, security and safety on the national electricity system, and advising the AEMC in respect of such matters.

RELIABILITY PANEL MEMBERS

Dr Brian Spalding (Chairman), AEMC Commissioner
Trevor Armstrong, Chief Operating Officer, Ausgrid
Stephen Clark, Technical and Economic Lead – Project Marinus, TasNetworks
Mark Collette, Executive Energy, EnergyAustralia
Kathy Danaher, Chief Financial Officer and Executive Director, Sun Metals
Gavin Dufty, Manager Policy and Research, St Vincent de Paul Society, Victoria
John Titchen, Managing Director, Goldwind Australia
Chris Murphy, Strategic Advisor, Meridian Energy; General Manager - Energy Market Interfaces, Telstra
Damien Sanford, Chief Operations Officer, AEMO
Richard Wrightson, Executive General Manager, Wholesale Markets, AGL Energy

SUMMARY

1 On 5 November 2018, the Australian Energy Market Operator (AEMO) submitted a request to the Reliability Panel (Panel) seeking the declaration of a protected event to assist AEMO in maintaining power system security in South Australia.[1]

2 The Panel's draft determination is to declare a protected event that is consistent with AEMO's request.

3 A "protected event" is a high-consequence non-credible contingency event. The category of protected event was introduced to give AEMO additional tools to pre-emptively incur the costs of managing the risks associated with such events, including the purchase of frequency control ancillary services (FCAS), constraining generation dispatch and the use of Emergency Frequency Control Schemes (EFCS). Protected events may be declared by the Panel following a request from AEMO.[2]

4 AEMO's request is an outcome of its 2018 Power System Frequency Risk Review (PSFRR).[3] In the PSFRR, AEMO concluded that the risk of transmission faults in South Australia causing significant loss of generation which may lead to the loss of the Heywood interconnector is heightened during periods where "destructive wind conditions" (i.e. wind speeds above 140km/h) are forecast in the region.[4]

5 AEMO considers that the declaration of a protected event would provide AEMO with a transparent and fit-for-purpose mechanism for the ongoing management of this risk.

6 AEMO's request proposes that the protected event be defined as **"the loss of multiple transmission elements causing generation disconnection in the South Australia region during forecast destructive wind conditions"**.[5]

7 AEMO identified five options for managing the proposed protected event.[6]

8 It assessed the costs of its recommended option for managing the proposed protected event will result in an annual neteconomic benefit of between $1.5 million and $10 million.[7] AEMO's recommended option is to upgrade the System Integrity Protection Scheme (SIPS) and limit total import capacity over the Heywood interconnector to 250MW during destructive wind conditions.

9 The Panel's draft determination is to declare a protected event defined consistently with AEMO's request: **"the loss of multiple transmission elements causing generation disconnection in the South Australia region during periods where destructive wind conditions are forecast by the Bureau of Meteorology."**

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1 AEMO, *AEMO Request for Protected Event Declaration*, November 2018.

2 NER clause 8.8.4.

3 AEMO, Power System Frequency Risk Review Report, June 2018, available from: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/PSFRR/2018_Power_System_Frequency_Risk_Review-Final_Report.pdf.

4 Ibid, p. 36.

5 AEMO, *AEMO Request for Protected Event Declaration*, November 2018, p. 17.

6 Ibid, p. 9.

7 Ibid, p. 16.

10 The Panel is satisfied that AEMO has considered a range of reasonable options for managing the protected event and that, of the options identified, AEMO's recommended option is the most robust and cost-effective approach for managing the identified risk. The Panel also considers that AEMO has undertaken an accurate and comprehensive assessment of the costs and benefits of its recommended option for managing the event.

11 The Panel's declaration will allow AEMO to incur the costs associated with managing the protected event in accordance with the protected event EFCS. The first step in this process is for AEMO to implement the proposed upgrades to the SIPS. Once this has occurred, AEMO will be able to utilise the upgraded SIPS in combination with imposing a 250MW import limit on the Heywood Interconnector during periods of forecast destructive wind conditions in South Australia.

12 The protected EFCS used by AEMO to manage the event will be subject to a number of target capabilities, including:

- The cost of upgrading the SIPS should be justified by the resulting improvement in its ability to manage the risks associated with the protected event. This requirement is satisfied by AEMO's request.
- The pre-contingent import limit applied to the Heywood Interconnector during forecast destructive wind conditions is to be initially set at 250 MW and reviewed by AEMO through the PSFRR or in the event of any power system conditions changing.
- The issuing of forecasts for destructive wind conditions in the South Australia region is an appropriate trigger event for the application of the pre-contingent import limit on the Heywood Interconnector by AEMO.
- The functionality of the upgraded SIPS should reliably detect a protected event and trigger the appropriate control action in accordance with the target capabilities identified in AEMO's request.

13 The Panel's declaration will take effect immediately upon publication of the Panel's final determination in order to allow the protected event EFCS to be implemented in full as soon as possible.

14 The Panel invites written submissions on this draft determination by **9 May 2019**.

CONTENTS

TABLES

1 INTRODUCTION

The Reliability Panel has received a request from AEMO for the declaration of a protected event under clause 5.20A.4 of the NER. A "protected event" is a high-consequence non-credible contingency event. AEMO has proposed that the protected event to be declared by the Panel be defined as ***"the loss of multiple transmission elements causing generation disconnection in the South Australia region during forecast destructive wind conditions"***.[8] AEMO considers that this will address the risks associated with the potential loss of generation due to transmission element failure during destructive wind conditions in South Australia leading to the disconnection of the Heywood Interconnector.

The Panel's draft determination is to declare a protected event in accordance with AEMO's request. The Panel is satisfied that AEMO has considered a range of reasonable options for managing the protected event and that, of the options identified, AEMO's recommended option is the most robust and cost-effective approach. The Panel also considers that AEMO has undertaken an accurate and comprehensive assessment of the costs and benefits of its recommended option for managing the event.

1.1 Protected events framework

In March 2017, the Commission published its final determination on the *National Electricity Amendment (Emergency frequency control schemes) Rule* (the EFCS Rule). The EFCS Rule change introduced "protected events" as a new category of non-credible contingency event in the NER. A protected event is a non-credible contingency event the Panel has declared to be a protected event. The category of protected event was introduced to give AEMO additional tools to manage certain high consequence non-credible contingency events. AEMO must maintain the power system in a secure operating state in relation to protected events, including by managing power system frequency within the frequency operating standard following the occurrence of the event.[9]

The EFCS Rule introduced a requirement on AEMO to undertake, in collaboration with transmission network service providers (TNSPs), an integrated, periodic review of power system frequency risks associated with non-credible contingency events – the PSFRR.

Under the PSFRR, AEMO is required to identify non-credible contingency events that could involve uncontrolled increases or decreases in frequency leading to cascading outages or major supply disruptions.[10] The outcomes of the PSFRR may include a proposal for the declaration of a protected event by the Panel. Where the PSFRR identifies one (or more) non-credible contingency events which AEMO considers it may be economically efficient to manage using ex-ante operational measures in addition to some limited load or generation shedding, AEMO may submit a request to the Panel to have the event declared to be a protected event. Upon receipt of a request, the NER require the Panel to undertake an

8 AEMO, *AEMO Request for Protected Event Declaration*, November 2018, p. 17.
9 NER clause 4.2.4(a)(2).
10 NER clause 5.20A.1(a)(1).

economic assessment of the request by weighing the costs of the options for managing the event (including the costs to the market of any load shedding) against the avoided cost of the consequences of the non-credible contingency event should it occur and not be managed. Where the economic benefits of managing the event outweigh the costs of doing so, the Panel may declare the event a protected event. The Panel does not have the discretion to declare a different protected event to that which is requested by AEMO.

AEMO may use a mixture of ex-ante actions to manage a protected event declared by the Panel. These actions include the purchase of FCAS, constraining generation dispatch, and the use of an EFCS in order to maintain the frequency operating standards applicable to protected events. As part of the declaration of a protected event, the Panel determines the range of ex-ante actions to be used by AEMO in managing the event.

Where the efficient management option for a protected event includes a new or modified EFCS, the Panel also sets a "protected event EFCS standard", which defines the target capabilities for the scheme. Network service providers (NSPs) are then required to design, implement and monitor the scheme in accordance with the standard. NSPs are exempt from a requirement to undertake the regulatory investment test for transmission (RIT-T) or the regulatory investment test for distribution (RIT-D) for a protected event EFCS. However, the protected event framework in the NER permits the Panel to undertake its own cost-benefit assessment of the EFCS when determining the target capabilities. This allows for the efficient assessment of costs and benefits by the Panel and is consistent with the Panel's broader role in setting various power system standards which often require a consideration of the trade-off between costs and security or reliability benefits.

The protected event framework in the NER was introduced to establish an integrated, transparent framework for the consideration and management of power system frequency risks arising from non-credible contingency events. As part of this process, AEMO is required to review the adequacy and necessity of the arrangements for managing existing protected events on an ongoing basis through the PSFRR. The outcomes of this review may include a request by AEMO that an existing protected event declaration be revoked by the Panel. This is the only circumstance in which the Panel can revoke a protected event declaration.

This is the first request for the declaration of a protected event which has been submitted by AEMO to the Panel. The request stems from a recommendation in AEMO's first PSFRR for the NEM, which was published in June 2018.

1.2 Summary of AEMO's request

1.2.1 Background

In June 2018, AEMO released its 2018 PSFRR, in which it identified a number of scenarios that could result in the loss of multiple generators in South Australia, which could lead to a sudden and rapid increase in the power imported over the Heywood Interconnector.[11] Under some circumstances, the increase in power flow may result in an unstable power swing and consequent disconnection of the interconnector, thereby leading to a sudden separation and

11 AEMO, *Power System Frequency Risk Review Report*, June 2018, p. 35.

black system in the South Australian region. The existing SIPS in South Australia was designed to mitigate the risk of the Heywood Interconnector tripping and leading to a black system event under this scenario. The SIPS rapidly identifies conditions that could result in a loss of synchronism between South Australia and Victoria and corrects these conditions by injecting power from batteries or shedding some load to assist in re-balancing supply and demand in South Australia, in order to prevent unstable power swings on the Heywood Interconnector.

However, AEMO identified in the PSFRR that the existing SIPS may be unable to prevent a loss of the Heywood Interconnector under all circumstances.[12] Further, AEMO's analysis suggests that the likelihood of these circumstances occurring is heightened during "destructive wind conditions" (i.e. wind speeds above 140km/h) in South Australia.[13] Wind speeds below 140km/h only pose a risk to some specific transmission lines, which can be managed by reclassifying the loss of those lines as a credible contingency.

In order to manage this risk, AEMO is currently constraining imports to South Australia on the Heywood Interconnector to 250 MW when weather forecasts for destructive winds are issued. This action is currently being performed under one of AEMO's power system security responsibilities in clause 4.3.1(v) of the NER, which is to investigate and review power system operational incidents and initiate an action plan to manage any abnormal situations or significant deficiencies which could reasonably threaten power system security. AEMO has been doing this following the 28 September 2016 South Australian black system event.[14] AEMO does not consider this to be a preferable approach moving forward, as it involves manual processes which may not be sufficiently timely or efficient in all circumstances.

AEMO recommended in its PSFRR that:

- the risk of transmission line failure during destructive wind conditions in South Australia be managed through the declaration of a protected event, as this would provide greater certainty and transparency regarding AEMO's management of the risks associated with such an event
- an upgrade to the existing SIPS be progressed as a protected event EFCS to mitigate the risk of a black system event following a loss of multiple generators in South Australia.

AEMO's request to the Panel is consistent with its recommendation in the PSFRR.

1.2.2 Issues identified by AEMO

AEMO's request identifies a number of characteristics of the South Australian power system which can create challenges from a power system management perspective.[15] These include:

12 This included instances where the Tailem Bend loss of synchronism relay failed to detect unstable power swings. AEMO also identified a risk that the current fixed load shed blocks may cause under or over-tripping and over-voltages, leading to trip of additional generation under some conditions.

13 See AEMO, *Power System Frequency Risk Review Report*, June 2018, p. 36. This is based on advice from ElectraNet that the likelihood of damage to transmission elements in South Australia is increased during periods where wind speeds exceed 140km/h.

14 AEMO, *AEMO Request for Protected Event Declaration*, November 2018, p. 8.

15 AEMO, *AEMO Request for Protected Event Declaration*, November 2018, p. 6.

- the region's high reliance on gas powered generation for system strength and inertia response
- a high penetration of rooftop solar PV and wind generation
- the radial design of the transmission network, with load centres being serviced by transmission elements connecting generation in remote parts of the network with low system strength
- the transmission network's susceptibility to severe storms and destructive winds.

AEMO noted that these characteristics contribute to the South Australian power system being vulnerable to the loss of a large amount of generation. In particular, if the region is importing a significant amount of power from Victoria over the Heywood Interconnector, a sudden increase in power flow and unstable power swings on the interconnector following the loss of generation in South Australia could lead to the disconnection of the interconnector and a potential black system event.

AEMO considers that the risk of a large loss of generation in South Australia leading to the loss of the Heywood Interconnector is increased during destructive wind conditions due to the heightened risk of occurrence and potentially greater magnitude of line failures and other transmission faults.

AEMO has identified historical power system security events in South Australia which have resulted from high flows over the Heywood Interconnector to emphasise the risk to frequency stability in the region.[16] However, AEMO also noted that only one of these events was caused by destructive wind conditions in the region. This was the black system event on 28 September 2016.[17]

AEMO also noted the following factors which it considers support the declaration of a protected event:[18]

- **Reclassification of the relevant non-credible contingency events is not feasible:** The loss of multiple unspecified generating units due to forecast destructive wind conditions in South Australia cannot be reclassified from a non-credible contingency event to a credible contingency event under the current regulatory framework. Reclassification requires AEMO to determine that the occurrence of the event is "reasonably possible" due to the weather conditions. This would require the identification of specific power system equipment which is vulnerable to damage from the destructive winds. However, the geographically widespread nature of destructive wind conditions means the potential impacts on the power system cannot be determined at a sufficiently localised level to enable reclassification. For example, it would be difficult to forecast the potential impact on specific generating units of damage to transmission infrastructure over a large geographic area.
- **The current approach to managing the risks is an interim solution:** AEMO is currently managing the risk of loss of large amounts of generation during destructive

16 Ibid, p. 7.
17 Ibid, p. 8.
18 Ibid, p. 8.

wind conditions by constraining imports into South Australia over the Heywood Interconnector to 250 MW when such conditions are forecast. An interim EFCS was also implemented following the black system event in South Australia in September 2016 to reduce the impact of a similar event occurring in the region. However, AEMO considers that the protected event framework provides a more transparent and fit-for-purpose mechanism for the ongoing management of this risk, as it allows for the regular review of the need for, and level of management of, the protected event by AEMO and the Panel based on stakeholder consultation.

On that basis, AEMO has requested that the Reliability Panel declare a protected event to allow AEMO to manage the risk of loss of transmission elements leading to the loss of the Heywood Interconnector when destructive wind conditions are forecast in South Australia.

AEMO has proposed that the protected event declared by the Panel be defined as **"the loss of multiple transmission elements causing generation disconnection in the South Australia region during forecast destructive wind conditions"**.[19]

AEMO will determine whether destructive wind conditions are present in South Australia in accordance with its existing internal procedures, which are based on weather forecasts issued by the Bureau of Meteorology.[20]

The Panel does not have the discretion to declare a different protected event to that which is requested by AEMO. In its final determination on the EFCS Rule the Commission stated that AEMO, as the power system operator and the body responsible for maintaining power system security, is the appropriate body to identify non-credible contingency events which it may be beneficial for the Panel to declare as a protected event. On the other hand, the Panel is considered to be the appropriate body to determine whether it is economically efficient for the event to be managed as a protected event.

Should the Panel declare a protected event in accordance with AEMO's request, this declaration would be in effect continuously unless it is revoked by the Panel at a later date (at which time the non-credible contingency event would cease to be a protected event).[21] However, the actions taken by AEMO such as constraints to interconnector flows would only need to be taken when the condition of forecast destructive winds occurs.

1.2.3 Options for managing the protected event

AEMO has identified five options for managing the proposed protected event:

1. Rely solely on the existing SIPS
2. Incorporate more load and/or batteries into the existing SIPS
3. Implement a high-speed post-separation tripping scheme
4. Upgrade the SIPS

19 AEMO, *AEMO Request for Protected Event Declaration*, November 2018, p. 17.

20 These procedures are contained in Temporary Operating Advice documents provided to AEMO's control room.

21 The Panel may only revoke a protected event declaration if requested by AEMO under clause 5.20A.5 of the NER.

5. Upgrade the SIPS and limit total import capacity over the Heywood interconnector during destructive wind conditions (AEMO's recommended option).

AEMO considers that combining constraints on Heywood Interconnector flows into South Australia with the proposed SIPS upgrade will deliver a robust and cost-efficient approach to managing power system risks associated with destructive wind conditions. Further detail regarding the Panel's assessment of the options identified by AEMO is set out in section 3.1.1.

1.2.4 AEMO's recommended option

Enhancements to the existing SIPS

The existing SIPS consists of three progressive stages which are intended to operate in an escalating manner:

1. Stage 1: Fast response trigger to inject energy from battery storage systems
2. Stage 2: Load shedding trigger to shed approximately 200 MW to 300 MW of South Australian load
3. Stage 3: Out-of-step trip scheme (i.e. disconnection of the interconnector and islanding of the South Australia region).

AEMO has recommended a number of technological upgrades to the SIPS as part of its recommended option for managing the protected event. Where a request for the declaration of a protected event recommends a new or modified EFCS to manage the event, the request must include the target capabilities for that EFCS.[22] AEMO's request identifies a number of proposed target capabilities for the modifications to the SIPS.[23] One of the target capabilities for the upgraded SIPS proposed by AEMO is that the SIPS should be capable of compensating for the loss of 500 MW of generation in the South Australia region. AEMO has indicated that a number of factors were considered in determining that the loss of 500 MW of generation was an appropriate design standard for the SIPS, including:

- Currently, there are a number of large wind farms in South Australia, such as Lake Bonney wind farm, which has a nameplate capacity of 279 MW, that could be tripped by credible contingencies which may occur elsewhere in the South Australia region. The SIPS needs to be capable of responding to such potentially larger non-credible contingency events.
- Historical non-credible contingency events involving loss of generation have been in the range of 450 MW to 520 MW. However, the loss of 520 MW of generation related to events involving Northern power station, which is no longer in operation. Pelican Point, which has a nameplate capacity of 478 MW, was identified as an example of a current potential non-credible contingency event in South Australia.
- Stage two of the SIPS involves the triggering of load shedding if power imported across the Heywood Interconnector exceeds a defined threshold. AEMO has advised that the amount of load which is available for shedding under the SIPS is expected to be limited

22 26NER clause 5.20A.4(b)(4)(i).

23 AEMO, *AEMO Request for Protected Event Declaration*, November 2018, p. 13.

to 200 MW to 300 MW, as load shedding in excess of this level would likely cause voltage disturbances in the power system which may lead to further load or generation tripping. The combination of this amount of load shedding and the injection of energy from battery storage systems in stage one of the SIPS is considered to represent an upper limit on the amount of generation loss that can be compensated for by the SIPS.

- Extensive studies undertaken under a range of system conditions indicate that a 500 MW target capability will be challenging to meet under all conditions.[24] There are also inherent uncertainties associated with such studies which make it difficult to identify a precise amount of generation loss as the appropriate standard, including:
  - how South Australian load would respond during such an event
  - how embedded generation such as rooftop solar PV would respond during the event
  - actual system conditions prior to the event (including demand, synchronous plant dispatch, interconnector flow and additional line outages)
  - the sequence of tripping events during the event
- Targeting a level of generation loss below 500 MW may result in marginally lower costs, but this would not effectively mitigate the risks associated with the protected event. Conversely, a level of generation loss above 500 MW is less likely to occur and would be very difficult to reliably mitigate against from a technical perspective.

AEMO considers that a target capability for the SIPS which accounts for the loss of 500 MW of generation in the South Australia region to be reasonable, having regard to the above factors.

Constraint on the Heywood Interconnector

AEMO is currently managing the risks associated with the proposed protected event by limiting the maximum flow into South Australia on the Heywood Interconnector to 250 MW during destructive wind conditions. AEMO considers a 250 MW import limit to be necessary, having regard to the limitations on the available load shedding and injection of energy from battery storage systems discussed above, as this allows for a 600 MW head-room up to the 850 MW satisfactory limit of the Heywood Interconnector. AEMO considers that this amount of head-room accounts for the size of historic generation contingency events of between 450 MW and 520 MW, as well as potential increases in interconnector flow due to increased system losses and additional tripping of embedded generation such as rooftop PV.

The import limit of 250 MW was only reached for one per cent of the time the limit was invoked in 2017-18, as South Australia is generally exporting power during periods of high wind speeds.

AEMO also noted in its request that it will review the 250 MW import limit regularly through the PSFRR (which occurs every two years) or in the event of any power system conditions changing.

24 The 500 MW target capability is based on internal work being undertaken by AEMO and ElectraNet. Further information on these studies will be forthcoming at a future date.

1.2.5 Assessment of costs and benefits of managing the event as a protected event

AEMO's request includes an assessment of the costs and benefits of managing the relevant non-credible contingency event as a protected event, as required by the NER.[25]

In particular, AEMO considered:

- the costs of the proposed upgrades to the SIPS and constraining the import capacity of the Heywood interconnector during destructive wind conditions
- the benefits of increasing the likelihood of avoiding a black system event in South Australia during destructive wind conditions.

Based on this assessment, AEMO estimates that implementing its recommended option for managing the protected event will result in an estimated annual net benefit of between $1.5 million and $10 million.

AEMO's calculations, including the relevant assumptions and methodology used, are summarised in Table 1.1.[26]

Table 1.1: Summary of AEMO's cost benefit assessment

	DESCRIPTION	ASSUMPTIONS AND METHODOLOGY	AMOUNT
Costs	Limiting import capacity of Heywood interconnector into South Australia to 250 MW during destructive wind conditions	This action results in the displacement of Victorian brown coal generation (which has a short run marginal cost (SRMC) ~$10.5/MWh) with gas generation within South Australia (which has a SRMC ~$120/MWh). This displacement of generation is assumed to occur for volumes of between 50-400 MW for 13.8-27.6 hours per annum.	$75,000 to $1.2 million per annum
	Proposed SIPS upgrade	Capital costs for the SIPS upgrade are estimated at $4-5	Total annualised cost[1] ≈ $0.58 million to $0.73

25 NER clause 5.20A.4(b)(3).

26 See AEMC, *AEMO Request for Protected Event Declaration* - consultation paper, December 2018, Appendix B, for a copy of AEMO's full cost-benefit assessment.

	DESCRIPTION	ASSUMPTIONS AND METHODOLOGY	AMOUNT
		million. Maintenance costs for the SIPS upgrade are estimated at 1% of capital costs.	million per annum
Benefits	Increased probability of avoiding a system black in South Australia due to the SIPS upgrade	Value of customer reliability (VCR) calculated as two times the estimated VCR for the black system event in 2016 for total unserved energy of 5,200-7,800 MWh (on the basis that average VCR underestimates the cost of widespread outages).[2] Probability of Heywood separation occurring during destructive winds estimated at between 2-4%. SIPS upgrade estimated to increase the probability of avoiding a system black by 20% compared to the existing SIPS.[3]	$3.4 million to $10.5 million per annum
Net cost/benefit	**Estimated annual net benefit between $1.5 million and $10 million**		

Note: 1. Total annualised costs are based on a 10-year lifetime and weighted average cost of capital of 6%.

Note: 2. The Australian Energy Regulator (AER) published a consultation paper on VCR in October 2018, in which the AER sought stakeholder feedback on whether the AER should determine a VCR for prolonged and extensive outages such as a system black event (See AER, Values of Customer Reliability - Consultation Paper, October 2018, p. 17, available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability-vcr).

Note: 3. Operation of SIPS assumes 250 MW of unserved load for a period of one hour before restoration.

1.3 Stakeholder feedback

The Panel published a consultation paper in relation to AEMO's request on 13 December 2018.[27] The Panel received seven submissions from stakeholders in response to the consultation paper.

Stakeholders were generally supportive of AEMO's request and acknowledged the benefits of the protected events framework for the management of power system security.

Stakeholders also raised a number of relevant issues in relation to AEMO's request:

- AGL requested further clarity on how the proposed 600MW headroom on the Heywood interconnector resulting from the 250MW import limit was calculated by AEMO.[28]
- Origin noted that its understanding is that many transmission elements have design tolerances well in excess of 140km/h and examining what design ratings are available across the SA transmission network would provide a greater indication of where the optimal wind speed threshold should lie.[29] Origin also requested that the Panel determine if the 2x VCR value AEMO used in its economic modelling is appropriate, or if another value might be more suitable.[30]
- Origin, AGL and Meridian Energy all suggested that market participants should be notified by AEMO in advance about an impending protected event so that they can plan accordingly.[31]

These issues have been considered as part of the Panel's assessment of AEMO's request, as discussed further in chapters 2 and 3.

1.4 Structure of draft determination

The remainder of this paper is structured as follows:

- Chapter 2 sets out the assessment framework adopted by the Panel
- Chapter 3 summarises the issues considered by the Panel in determining AEMO's request and the Panel's conclusions on these issues
- Chapter 4 sets out the Panel's draft determination in respect of AEMO's request
- Chapter 5 sets out how stakeholders can respond to this draft determination.

The Panel welcomes submissions on this draft determination. All enquiries on this project should be addressed to Mitchell Shannon on (02) 8296 0639 or mitchell.shannon@aemc.gov.au.

27 AEMC, *Request for declaration of protected event*, consultation paper, December 2018.

28 AGL, submission to consultation paper, p. 1.

29 Origin Energy, submission to consultation paper, p. 1.

30 Ibid.

31 Origin Energy, submission to consultation paper, p. 2; AGL, submission to consultation paper, p. 1; Meridian Energy, submission to consultation paper, p. 1.

2 ASSESSMENT FRAMEWORK

This chapter sets out the assessment framework the Panel has adopted when determining AEMO's request for the declaration of a protected event.

2.1 Assessment of options presented by AEMO

The consultation paper proposed a two-stage approach to the Panel's assessment of the options presented by AEMO for managing the proposed protected event. The two stages under this assessment framework included:

- Stage 1: Evaluation of options identified by AEMO for managing the event
- Stage 2: Assessment of the costs and benefits of alternative options for managing the event.

The Panel has completed stage 1 of the assessment process. The results of this assessment have provided sufficient evidence for the Panel to make a determination with respect to AEMO's request.

As discussed in the consultation paper, stage 1 involved the Panel evaluating the options presented by AEMO having regard to:

- whether AEMO's recommended option is the most appropriate option for managing the protected event from a technical perspective
- whether AEMO's assessment of the costs and benefits of managing the protected event in accordance with its recommended option is sufficiently accurate and comprehensive.

The Panel's assessment of the options identified by AEMO for managing the protected event was informed by the analysis provided by AEMO as part of its request, as well as stakeholder feedback on the consultation paper.

In addition, the Panel engaged GHD Advisory (GHD) to provide advice on the technical feasibility of the options presented by AEMO and to provide a peer review of the proposed costs of AEMO's recommended option that were specified in AEMO's request.[32] This process allowed the Panel to undertake a robust, objective assessment of AEMO's request which was informed by independent expert advice on the relevant issues.

The consultation paper noted that the Panel would only proceed with stage 2 of the assessment process if stage 1 identified that:

- AEMO's recommended option for managing the protected event is not the most appropriate option from a technical perspective; or
- AEMO's recommended option for managing the protected event is the most appropriate option from a technical perspective, but AEMO's assessment of the costs and benefits of its recommended option is not sufficiently accurate or comprehensive, or the potential costs of the option are substantially more material than was identified in AEMO's request.

32 GHD Advisory, *Protected Event - Destructive high winds in South Australia leading to multiple generation trips,* March 2019. Available at: https://www.aemc.gov.au/market-reviews-advice/request-declaration-protected-event-november-2018.

If required, stage 2 of the assessment process would involve the Panel undertaking a comprehensive independent assessment of the potential options for managing the protected event, including the technical feasibility and the costs and benefits of AEMO's recommended option and any alternative options identified in stage 1.

Based on the Panel's findings at the conclusion of stage 1 of the assessment process, the Panel does not consider it necessary to proceed with stage 2 of the assessment process.

The key issues which were considered by the Panel during stage 1, with the support of analysis undertaken by GHD, are discussed further in chapter 3. The Panel's conclusions in relation to these issues forms the basis of the Panel's draft determination in respect of AEMO's request, which is set out in detail in chapter 4.

2.2 Consideration of the National Electricity Objective

In making a determination that declares a non-credible contingency event to be a protected event, the Panel must have regard to the national electricity objective (NEO).[33]

The NEO is set out under section 7 of the National Electricity Law (NEL) and prescribes that:

"The objective of this law is to promote efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers of electricity with respect to:

- *price, quality, safety, reliability and security of supply of electricity; and*
- *the reliability, safety and security of the national electricity system."*

The aspects of the NEO relating to the security of supply of electricity and of the national electricity system are particularly relevant to AEMO's request. The power system can be considered to be secure when it is operated within specified technical operating limits, including voltage and other stability limits. Maintaining the power system within these technical limits allows it to operate effectively, efficiently and safely.

Supporting the maintenance of power system security is central to the protected events framework, which was implemented to assist AEMO in maintaining the power system in a secure operating state where a high-consequence non-credible contingency event is efficient to protect against. This is also true of AEMO's request, which seeks to give AEMO the tools to minimise the risk of a black system event in South Australia during periods of forecast destructive winds. Accordingly, the impact of declaring a protected event on power system security has been a key consideration in the Panel's assessment of AEMO's request.

Ultimately, the Panel's responsibility in determining AEMO's request is to identify a reasonable, effective and efficient trade-off between the security benefits of declaring a protected event and the costs that this would impose on consumers. The Panel considers that the assessment process it has undertaken has addressed these considerations.

33 NER, clause 8.8.4(e).

3 ISSUES CONSIDERED BY THE PANEL

As discussed in chapter 2, under stage 1 of the assessment process the Panel considered two key aspects of AEMO's request:

1. **Options for managing the protected event:** The Panel evaluated whether AEMO's recommended option for managing the protected event is the most appropriate option from a technical perspective.
2. **Costs and benefits of AEMO's recommended option:** The Panel considered whether AEMO's assessment of the costs and benefits of managing the protected event in accordance with its recommended option is sufficiently accurate and comprehensive.

This section identifies the specific issues which were considered by the Panel as part of this process. This analysis informed the Panel's conclusions in relation to the above considerations.

3.1 Options for managing the protected event

AEMO's request identified five potential options for managing the event as a protected event. These options are set out in section 1.2.2 of this paper. AEMO's analysis indicated that upgrading the existing SIPS in combination with limiting total import capacity over the Heywood interconnector during destructive wind conditions would deliver a robust and cost-efficient approach to managing the relevant power system security risks.[34] This was the only option identified by AEMO as being technically capable of achieving this objective.

In evaluating this aspect of AEMO's request, the Panel sought an objective analysis of whether any of the other options identified by AEMO could be a technically viable alternative to manage the risks posed to the power system by destructive wind conditions.

The Panel also considered whether other actions or considerations which may impact on the options for managing the protected event had not been taken into account by AEMO.

This section sets out the key issues which were considered by the Panel in relation to the options for managing the protected event.

3.1.1 Options identified by AEMO

The NER require a request for the declaration of a protected event to identify the options for managing the relevant non-credible contingency event as a protected event, as well as AEMO's recommended option and the rationale for this recommendation.[35] This is relevant to the Panel's determination of the request, which may include a determination on the availability and operation of an EFCS and other matters relating to AEMO's operation of the power system for the protected event.[36]

34 AEMO, *AEMO Request for Protected Event Declaration,* November 2018, p. 10.
35 NER clause 5.20A.4(b)(2).
36 NER clause 8.8.4(f).

As discussed in section 1.2.2, AEMO's request identified five potential options for managing the protected event. AEMO's analysis suggests that, of the options identified, its recommended option of upgrading the existing SIPS and limiting total import capacity over the Heywood Interconnector during forecast destructive wind conditions is the most robust and cost-efficient approach to managing the relevant risks to the power system.

Table 3.1 summarises AEMO's analysis in respect of the options identified.

Table 3.1: Summary of AEMO's assessment of the options for managing the proposed protected event

OPTION	CAN THIS OPTION ADEQUATELY MANAGE THE EVENT?	REASONING
Rely solely on the existing SIPS	No	Studies by AEMO and ElectraNet have shown that there are known conditions for which the existing SIPS fails to detect unstable power oscillations, even under system normal conditions.[1] The existing SIPS may be ineffective in managing the risk of separation when there is a loss of generation, which includes synchronous units, while at the same time there are high power flows on the Heywood Interconnector into South Australia.
Incorporate more load and/or batteries into the existing SIPS	No	Approximately 200 MW to 300 MW of load is currently available to the SIPS for tripping if unstable power swings are detected or the power imported across the Heywood Interconnector exceeds a specified level. Increasing the level of load which is tripped would create additional system security risks due to excessively high voltage within the South Australian region, which may lead to tripping of other load, generation or network elements. There are currently no additional utility scale batteries available in the South Australian region for inclusion in the SIPS.
Implement a high-speed post-separation tripping scheme	No	If load tripping and/or battery injection were to be triggered after the loss of generation and subsequent tripping of the Heywood Interconnector had already occurred, the RoCoF

OPTION	CAN THIS OPTION ADEQUATELY MANAGE THE EVENT?	REASONING
		would likely be too high for the scheme to be capable of returning the South Australia region to a satisfactory operating state.[2]
Upgrade the SIPS	No	AEMO recommended a number of upgrades to the SIPS in the PSFRR to improve the scheme's ability to respond more effectively to the loss of generation in the region. However, AEMO considers that the upgraded SIPS would not, on its own, adequately address factors such as transmission lines being out of service, higher levels of generation loss and reduced control action available to AEMO which may eventuate during destructive wind conditions.
Upgrade the SIPS and limit total import capacity over the Heywood Interconnector during destructive wind conditions	Yes	AEMO considers that combining constraints on Heywood Interconnector flows into South Australia with the proposed SIPS upgrade will deliver a robust and cost-efficient approach to managing power system risks associated with destructive wind conditions. AEMO therefore proposes that the SIPS upgrade be progressed as a protected event EFCS. This would mean that the proposed expenditure relating to the EFCS investment would be exempt from the RIT-T.[3] Section 3.2.2 provides further information on AEMO's proposed upgrades to the SIPS. AEMO noted in its request that it considered implementing a second EFCS specifically for destructive wind conditions, but found the solution to be unnecessarily complex and costly.

Note: 1. See AEMO, 2018 Power System Frequency Risk Review, June 2018, section 5.2.3.
Note: 2. See AEMO, Black System South Australia 28 September 2016, March 2017, sections 3.1.3 and 3.3.3, available at: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2017/Integrated-Final-Report-SA-Black-System-28-September-2016.pdf.
Note: 3. See NER clause 5.16.3(a)(8).

The Panel has assessed the options identified by AEMO having regard to the information provided by AEMO in its request and in response to subsequent requests for information by

the Panel, as well as analysis of the options for managing the protected event undertaken by GHD.

The Panel considers AEMO's approach to identifying and evaluating the options for managing the protected event to be reasonable and comprehensive. The Panel agrees with AEMO's assessment of the relevant options and is satisfied that, of the options identified, AEMO's recommended option is the most appropriate and feasible approach to managing the protected event.

The remainder of this section sets out the Panel's assessment of specific issues associated with AEMO's recommended option, as well as other potential options for managing the protected event not identified by AEMO.

3.1.2 Other issues considered by the Panel

Need for enhancements to the SIPS

AEMO's recommended option for managing the protected event includes a proposal to limit energy imports across the Heywood Interconnector to 250MW during periods where the Bureau of Meteorology (BoM) has forecast destructive wind conditions for South Australia. This action is intended to provide a notional margin or "headroom" of 600 MW between the import level across the interconnector and the interconnector's stability limit of approximately 850MW. AEMO proposed that enhancements to the SIPS scheme are required in addition to imposing an import limit on the Heywood Interconnector in order to manage the risks to the power system during such conditions.

AEMO's request identified that historical generation contingency events in South Australia generally involved the loss of between 450MW and 520MW of generation.[37] On that basis, allowing for a 600MW headroom on the Heywood interconnector could be viewed as sufficient to manage this risk without requiring any further action to be taken.

The Panel therefore sought further information from AEMO to clarify:

- why the proposed enhancements to the SIPS scheme are necessary in addition to imposing a 250MW pre-contingent import limit on the Heywood interconnector to address the risk of multiple generation loss due to destructive wind conditions
- in what scenarios the 600MW headroom on the Heywood Interconnector would be insufficient to prevent trip of the interconnector, assuming the proposed enhancements to the SIPS scheme do not proceed.

The Panel's request also addressed the issue raised by AGL in its submission to the consultation paper discussed in section 1.3, which queried how the 600MW headroom on the Heywood Interconnector was calculated by AEMO.

AEMO confirmed that there are a number of variables which may impact on the ability of imposing a pre-contingent import limit on the Heywood Interconnector to prevent the interconnector tripping following the loss of multiple generators in South Australia, including:

37 AEMO, *AEMO Request for Protected Event Declaration, November 2018, p. 7.*

- Actual flows may exceed the import limit set in the NEM dispatch engine (NEMDE), as NEMDE is not always able to keep interconnector flows to within the specified import limit. When this occurs the headroom provided by the import limit is diminished, meaning the headroom may be insufficient to account for the loss of up to 500MW of generation at any given time.
- Wind turbines in South Australia may be "feathered" as a protection measure during periods of high wind speeds, which would reduce generation capacity in the region and thereby increase imports across the Heywood Interconnector.
- Transmission faults during periods of destructive winds may impact on the Heywood Interconnector's technical capability and thereby reduce its stability limit below 850MW.

Where such limitations mean that the 250MW import limit is insufficient to prevent the tripping of the Heywood Interconnector, AEMO proposes utilising the SIPS as a backup control action to manage this risk.

However, electromagnetic transient (EMT) studies performed by AEMO have identified that there are limitations on the technical capabilities of the existing SIPS which mean that it is only effective in mitigating the risk of the Heywood Interconnector tripping approximately 70% of the time.

AEMO's analysis suggests that the following technological enhancements to the SIPS would allow the SIPS to prevent such an outcome in approximately 90% of cases:

- Improvements to the central processing system to better manage the amount of load shedding response available at any given time. The purpose of these improvements is to allow AEMO to monitor the amount of load available to be shed more accurately in order to minimise the risk of over or under load shedding, while also taking into account the amount of embedded generation that may be tripped when shedding specific load blocks.
- The implementation of phasor measurement units to provide a more robust means to detect potential loss of synchronism conditions than existing protection distance relays.

This has been verified by subsequent analysis undertaken by GHD.

On that basis, the Panel is satisfied that the proposed enhancements to the SIPS are required in addition to imposing a pre-contingent 250MW import limit on the Heywood Interconnector during periods of forecast destructive winds in order to satisfactorily manage the risk of the interconnector tripping following the loss of multiple generators in South Australia.

Scope of work for enhancements to the SIPS

The Panel sought to understand a number of other issues relating to the proposed enhancements to the SIPS. In particular, the Panel considered any potential uncertainties regarding the scope of work and the time required to implement the enhanced SIPS. The Panel sought further information from AEMO on these issues, including whether any areas of uncertainty may result in variations to the cost estimates and delivery time frames for the upgrades.

The key area of uncertainty regarding the enhancements relates to the implementation of phasor measurement based triggers. It is proposed that phasor measuring units (PMUs) will

replace the existing loss of synchronism relay detection, as PMUs will provide a more robust method to detect potential loss of synchronism conditions. This is an integral aspect of the proposed protected event EFCS, but there are few examples of this technology being deployed in the manner proposed by AEMO. However, AEMO has developed a staged approach to the implementation of this technology as part of the SIPS upgrades which is designed to address this uncertainty and reduce the risk of any significant cost increases. This includes a number of measures to test the capability and reliability of the technology prior to its final implementation. The Panel is satisfied that AEMO's proposed approach sufficiently minimises any risk associated with the deployment of this technology as part of the enhanced SIPS.

Consideration of controls on the Murraylink Interconnector

AEMO's 2018 PSFRR considered control of the Murraylink Interconnector between South Australia and Victoria as a potential element of the proposed enhancements to the existing SIPS.[38] However, control of Murraylink was not included in the options for managing the protected event identified in AEMO's request to the Panel.

As part of its stage 1 assessment, the Panel considered whether such control of Murraylink could be a technically feasible input into any option for managing the protected event, including as part of the proposed enhancements to the existing SIPS.

Additional information provided by AEMO in relation to this proposal confirmed that there are a number of issues which impede AEMO's ability to incorporate control of flows over Murraylink in any option for managing the protected event. In particular, AEMO noted the following complications with this approach:

- Uncertainty regarding the technical capability of the power system upstream and downstream of Murraylink to accommodate increased power transfers means that only "run-back" control schemes which reduce imports into South Australia across Murraylink to zero are currently viable. This effectively removes the possibility of implementing a "run-forward" control scheme which increases imports across Murraylink following the loss of multiple generating units in South Australia, which could otherwise assist in preventing the tripping of the Heywood Interconnector.[39]
- The flows across Murraylink prior to the non-credible contingency event would impact on the effectiveness of a run-back control scheme. Such a scheme would also only be effective if Murraylink was exporting power to Victoria prior to the event.
- Activating a run-back control scheme on Murraylink following the loss of multiple generators in South Australia would only benefit power system security where the Heywood Interconnector was importing power from Victoria and the Murraylink Interconnector was exporting power to Victoria immediately before the event. This scenario would incur counter price flows and negative settlement residues across Murraylink, thereby imposing additional costs on the market.

38 AEMO, *Power System Frequency Risk Review Report*, June 2018, p. 34.

39 A "run-forward" control scheme is defined as a control scheme which will increase the power flow in a given direction, whereas a "run-back" control scheme is defined as a control scheme which will reduce the power flow in that direction.

- The Murraylink Interconnector would need to be upgraded to enable a run-back control scheme to be implemented, as such action currently requires a manual reset to re-establish dispatch control via NEMDE. Inclusion of Murraylink in a run-back scheme without the necessary upgrades would therefore reduce dispatch control and may introduce difficulties in managing the power system after the occurrence of the protected event.

Given the issues identified above, the Panel is satisfied that it is not currently technically feasible for a control scheme on the Murraylink Interconnector to be incorporated in the options for managing the protected event.

Impact of Project EnergyConnect

Project EnergyConnect is a proposed new high voltage alternating current (HVAC) interconnector between Robertstown in South Australia and Wagga Wagga in New South Wales, with a connection into Victoria. ElectraNet and TransGrid are partnering to deliver this project.

The Project is currently undergoing a RIT-T overseen by the Australian Energy Regulator (AER). The Project Assessment Conclusions Report (PACR) for the project was published by ElectraNet in February 2019.[40]

As part of the assessment process, the Panel considered whether Project EnergyConnect would impact on the options for managing the protected event, assuming the new interconnector is built in the future. This assessment was informed by the information published in the PACR for the project and additional information provided by AEMO, which confirmed that loss of synchronism in South Australia following the loss of multiple generators during destructive wind conditions is not expected to require import limits to be imposed on either the Heywood Interconnector or the new interconnector with New South Wales. Should such an event occur, the additional import capacity provided by the new interconnector should be capable of accommodating a sufficient increase in electricity imports into South Australia in response to the loss of local generation.

If the proposed interconnector is built, the high-impact low-probability non-credible contingency event in South Australia would become the loss of both circuits of either interconnector. This scenario may therefore require the revocation of any existing protected event declaration and the making of a new protected event declaration by the Panel, at AEMO's request. AEMO would consider whether this is required following the construction of the proposed interconnector in its future PSFRRs.

In relation to AEMO's current request, it is therefore relevant for the Panel to consider whether any enhancements to the existing SIPS may be stranded in the future if the SIPS is no longer required following the construction of a new interconnector. The Australian Energy Regulator (AER) received written notification on 15 March 2019 from the South Australian

40 ElectraNet, SA Energy Transformation RIT-T: Project Assessment Conclusions Report, February 2019. Available at: https://www.electranet.com.au/wp-content/uploads/projects/2016/11/SA-Energy-Transformation-PACR.pdf.

Council of Social Service (SACOSS) disputing conclusions made in ElectraNet's Project Assessment Conclusions Report (PACR) for the RIT-T for the project.[41]

The PACR for Project EnergyConnect confirmed that a Special Protection Scheme (SPS) would be implemented to manage the risk of the loss of both circuits on either the Heywood interconnector or the new interconnector by ensuring that the other interconnector remains connected. The SPS would utilise similar actions to the SIPS, including limited load shedding and the injection of power from batteries, to arrest the resulting increase in flows across the remaining interconnector before its stability limit is reached. Given these similarities, AEMO has confirmed that many of the elements of the enhanced SIPS will be able to be utilised in the future as part of the SPS, should the new interconnector be built. AEMO has also clarified that the phasor measurement units which form part of the enhancements to the SIPS are required for a separate project to provide wide area measurements for South Australia, irrespective of the SIPS upgrade.

On that basis, the Panel is satisfied that, should Project EnergyConnect proceed, this will not result in the stranding of a material portion of the capital used to enhance the SIPS.

3.2 Costs and benefits of AEMO's recommended option

As discussed in section 1.2.5, AEMO's assessment of the costs and benefits of its recommended option resulted in an estimated weighted annual net benefit of $5.4 million, accounting for a range of potential outcomes.[42] AEMO determined that the worst, neutral and best case scenarios result in estimated annual net benefits of between $1.5 million and $10 million per year.[43]

The Panel has evaluated AEMO's assessment of the costs and benefits of its recommended option to determine whether its assessment is sufficiently accurate and comprehensive.

The Panel has considered a number of aspects of AEMO's analysis, including:

- the input data used by AEMO to calculate the costs and benefits
- the use of a value of customer reliability (VCR) which is twice the level recommended in the 2014 VCR assessment undertaken by AEMO
- the estimated costs of implementing the enhanced SIPS
- the improvement in the confidence level that the SIPS will be capable of mitigating the risks associated with the protected event following the implementation of the proposed enhancements.

The Panel considers AEMO's calculation of the costs of its recommended option to be reasonable, taking into account the scope of work to implement the proposed enhancements to the SIPS. The Panel is also satisfied that AEMO has provided sufficient reasoning to justify

41 SACOSS, SA Electricity Transformation RIT-T Notice of Dispute, March 2019. Available at: https://www.aer.gov.au/system/files/190314_SACOSS_SA%20Electricity%20Transformation%20RIT-T%20Notice%20of%20Dispute.pdf.

42 AEMO, *South Australia Protected Event - AEMO submission to the Reliability Panel: Supporting data for the Cost/Benefit Analysis*, November 2018, p. 3.

43 Ibid.

the use of 2 x VCR to estimate the costs of widespread outages in South Australia during a black system event. In any case, the Panel has determined that applying an input assumption of 1 x VCR to the relevant calculations still results in an overall weighted annual net benefit of $1.9 million for AEMO's recommended option.

On that basis, the Panel is satisfied that AEMO has undertaken an accurate and comprehensive assessment of the costs and benefits of its recommended option. This assessment supports the implementation of AEMO's recommended option for managing the protected event.

4 DRAFT DETERMINATION

4.1 Declaration of protected event

The Panel's draft determination is to declare a protected event in accordance with AEMO's request.

The Panel's declaration will:

- contribute to the maintenance of power system security by allowing AEMO to manage risks relating to transmission faults causing generation disconnection and subsequent islanding and widespread outages during destructive wind conditions in South Australia
- provide the market with a greater level of transparency of AEMO's contingency management action by allowing for regular review of the need for, and level of, management of the protected event in accordance with the protected events framework as the characteristics of the power system change over time
- provide a more fit-for-purpose mechanism for managing the risks associated with the protected event than current arrangements employed by AEMO
- promote the NEO by facilitating the efficient operation of the power system, thereby providing security and reliability benefits which are in the long-term interests of consumers.

This section sets out the following details of the Panel's declaration:

- the definition of the protected event declared by the Panel
- the conditions of the Panel's declaration
- the target capabilities of the protected event EFCS
- the timing for the Panel's declaration to come into effect.

4.2 Definition of protected event

The protected event declared by the Panel is defined as:

"The loss of multiple transmission elements causing generation disconnection in the South Australia region during periods where destructive wind conditions are forecast by the Bureau of Meteorology"

This is consistent with the definition proposed by AEMO in its request.[44] The Panel considers that this definition appropriately reflects the risk to the power system that the Panel's declaration, and the associated protected event EFCS, is intended to protect against.

4.3 Conditions of declaration

The Panel's declaration is subject to the following conditions:

- AEMO may only take action to manage the protected event:

44 AEMO, *AEMO Request for Protected Event Declaration*, November 2018, p. 17.

  - in accordance with the actions permitted under the protected event EFCS specified in section 4.4
  - when destructive winds are forecast in the South Australia region by the Bureau of Meteorology.
- Upon confirming that the protected event will be triggered and action will be taken under the protected event EFCS, AEMO must provide written notice to market participants as soon as practicable.
- AEMO must notify the Panel as soon as practicable after the upgrades to the SIPS identified in AEMO's request have been implemented.

4.4 Target capabilities for protected event EFCS

An EFCS includes any facilities for initiating automatic load shedding to prevent or arrest uncontrolled increases or decreases in frequency (alone or in combination) leading to cascading outages or major supply disruptions. A request for the declaration of a protected event may recommend an option for managing the event which includes a new or modified EFCS.

In this case, AEMO's recommended option, being the combination of the enhanced SIPS and the import limit on the Heywood Interconnector during forecast destructive wind conditions, constitutes a modified EFCS for the purpose of managing the protected event. Accordingly, the Panel must determine the protected event EFCS standard which is applicable to this action.[45]

A protected event EFCS standard sets out:

- a general description of the scheme, including how it is proposed to operate and the new, existing or modified facilities likely to comprise the scheme
- the target capabilities applicable to the scheme.

Target capabilities for an EFCS are defined as the technical parameters required to define the intended (but not guaranteed) service provided by the scheme, which may include:

- power system conditions within which the scheme is capable of responding
- the nature of the scheme's response (load shedding or generation shedding for the purposes of managing frequency)
- the speed of the response
- the amount of load shedding or generation shedding that may occur when the scheme responds
- capability to dynamically sense power system conditions.

Having regard to these factors and the information provided by AEMO about its recommended option for managing the protected event, the Panel has determined that the following target capabilities are to apply to the protected event EFCS:

45 NER, clauses 8.8.4(g) and 8.8.4(h)(2).

- AEMO's cost benefit assessment indicates that the enhancements to the SIPS will provide a 20% increase in confidence in the ability of the upgraded SIPS to manage the risk associated with the protected event (from 70% to 90%). The Panel considers that the improved confidence level should be sufficient to justify the proposed expenditure on the upgraded SIPS. The Panel's analysis suggests that a 12% improvement in the confidence that the SIPS will capably manage this risk is required to justify the proposed expenditure under the worst case scenario modelled by AEMO. Accordingly, this requirement is satisfied by the option recommended by AEMO.
- The pre-contingent import limit applied to the Heywood Interconnector during forecast destructive wind conditions is to be initially set at 250 MW. This limit will be reviewed by AEMO through the PSFRR (which occurs every two years) or in the event of any power system conditions changing. AEMO's review is to take into account the extent to which the constraint binds the interconnector and the demonstrated capability of the SIPS to support a less restrictive import limit.
- The issuing of forecasts of destructive wind conditions in the South Australia region is an appropriate trigger event for the application of the pre-contingent import limit on the Heywood Interconnector by AEMO.
- The functionality of the upgraded SIPS should deliver the targeted level of confidence in the ability of the SIPS to manage the risk associated with the protected event by reliably detecting a protected event and triggering the appropriate control action, recognising the available battery energy storage system (BESS) and load shedding capacity. In doing so, the protected event EFCS should meet the target capabilities specified by AEMO in its request to the Panel.[46]

4.5 Timing of declaration

The Panel's declaration will allow AEMO to take action in accordance with the protected event EFCS to manage a protected event. This includes implementing the upgrades to the SIPS to ensure it is able to respond as required.

AEMO has estimated that the enhancements to the SIPS can be completed in approximately two years, subject to any potential delays arising from the testing and implementation of certain technologies. Given that the SIPS upgrades are an integral component of the protected event EFCS, the Panel considers it appropriate for the protected event declaration to take effect immediately in order to allow the protected event EFCS to be implemented in full as soon as possible.

On that basis, the Panel's declaration will take effect upon the publication of the Panel's final determination in respect of AEMO's request.

The Panel notes that, as discussed in section 1.2.2, AEMO is currently managing this risk through a different mechanism under the NER. Once the Panel's declaration takes effect, this will provide a more fit-for-purpose and transparent framework for AEMO to manage this risk.

46 AEMO, *AEMO Request for Protected Event Declaration*, November 2018, pp. 17-18.

Upon taking effect, the Panel's declaration will be in effect continuously unless it is revoked by the Panel at a later date (at which time the relevant non-credible contingency event would cease to be a protected event).[47]

47 The Panel may only revoke a protected event declaration if requested by AEMO under clause 5.20A.5 of the NER.

5 LODGING A SUBMISSION

Written submissions on this request must be lodged with the Panel by **9 May 2019** via the Commission's website, www.aemc.gov.au, using the "lodge a submission" function and selecting the project reference code REL0069.

The submission must be on letterhead (if submitted on behalf of an organisation), signed and dated.

The Commission publishes all submissions on its website, subject to a claim of confidentiality.

All enquiries on this project should be addressed to Mitchell Shannon on (02) 8296 1639 or mitchell.shannon@aemc.gov.au.

ABBREVIATIONS

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BESS	Battery energy storage system
BoM	Bureau of Meteorology
Commission	See AEMC
EFCS	Emergency Frequency Control Scheme
EMT	Electromagnetic transient
FCAS	Frequency control ancillary services
FOS	Frequency operating standard
HVAC	High voltage alternating current
NEL	National Electricity Law
NEMDE	National electricity market dispatch engine
NEO	National electricity objective
PSFRR	Power System Frequency Risk Review
RIT-D	Regulatory investment test for distribution
RIT-T	Regulatory investment test for transmission
RoCoF	Rate of change of frequency
SIPS	System Integrity Protection Scheme
SPS	Special Protection Scheme
TNSP	Transmission network service provider

GLOSSARY

Cascading outage	The occurrence of a succession of outages, each of which is initiated by conditions (e.g. instability or overloading) arising or made worse as a result of the event preceding it.
Contingency events	These are events that affect the power system's operation, such as the failure or removal from operational service of a generating unit or transmission element. There are several categories of contingency event, as described below: • credible contingency event is a contingency event whose occurrence is considered "reasonably possible" in the circumstances. For example: the unexpected disconnection or unplanned reduction in capacity of one operating generating unit; or the unexpected disconnection of one major item of transmission plant • non-credible contingency event is a contingency event whose occurrence is not considered "reasonably possible" in the circumstances. Typically a non-credible contingency event involves simultaneous multiple disruptions, such as the failure of several generating units at the same time.
Distribution network	The apparatus, equipment, plant and buildings (including the connection assets) used to convey and control the conveyance of electricity to consumers from the network and which is not a transmission network.
Distribution network service provider (DNSP)	A person who engages in the activity of owning, controlling, or operating a distribution network.
Frequency control ancillary services (FCAS)	Those ancillary services concerned with balancing, over short intervals, the power supplied by generators with the power consumed by loads (throughout the power system). Imbalances cause the frequency to

	deviate from 50 Hz.
Interconnector	A transmission line or group of transmission lines that connect the transmission networks in adjacent regions.
Load	A connection point (or defined set of connection points) at which electrical power is delivered, or the amount of electrical power delivered at a defined instant at a connection point (or aggregated over a defined set of connection points).
Load shedding	Reducing or disconnecting load from the power system either by automatic control systems or under instructions from AEMO. Load shedding will cause interruptions to some energy consumers' supplies.
National electricity market (NEM)	The NEM is a wholesale exchange for the supply of electricity to retailers and consumers. It commenced on 13 December 1998, and now includes Queensland, New South Wales, Australian Capital Territory, Victoria, South Australia, and Tasmania.
National Electricity Law (NEL)	The NEL is contained in a schedule to the National Electricity (South Australia) Act 1996. The NEL is applied as law in each participating jurisdiction of the NEM by the application statutes.
National Electricity Rules (NER)	The NER came into effect on 1 July 2005, replacing the National Electricity Code.
Network	The apparatus, equipment and buildings used to convey and control the conveyance of electricity. This applies to both transmission and distribution networks.
Operating state	The operating state of the power system is defined as satisfactory, secure or reliable, as described below. The power system is in a **satisfactory** operating state when: • it is operating within its technical limits (i.e. frequency, voltage, current etc are within the relevant standards and ratings) •

	• the severity of any potential fault is within the capability of circuit breakers to disconnect the faulted circuit or equipment. The power system is in a **secure** operating state when: • it is in a satisfactory operating state • it will return to a satisfactory operating state following a single credible contingency event. The power system is in a **reliable** operating state when: • AEMO has not disconnected, and does not expect to disconnect, any points of load connection under NER clause 4.8.9 • no load shedding is occurring or expected to occur anywhere on the power system under NER clause 4.8.9 • in AEMO's reasonable opinion the levels of short term and medium term capacity reserves available to the power system are at least equal to the required levels determined in accordance with the power system security and reliability standards.
Participant	An entity that participates in the national electricity market.
Power system security	The safe scheduling, operation and control of the power system on a continuous basis.
Satisfactory operating state	Refer to operating state.
Secure operating state	Refer to operating state.
Transmission network	The high-voltage transmission assets that transport electricity between generators and distribution networks. Transmission networks do not include connection assets, which form part of a transmission system.
Transmission network service provider (TNSP)	An entity that owns operates and/or controls a transmission network.
Unserved energy (USE)	The amount of energy that is required (or demanded) by consumers but which is not supplied due to a shortage of generation or interconnection capacity. Unserved energy

does not include interruptions to consumer supply that are caused by outages of local transmission or distribution elements that do not significantly impact the ability to transfer power into a region.