AEMC

REVIEW

Reliability Panel AEMC

Draft Determination

Review of the System Restart Standard

4 September 2025

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About the Reliability Panel

The Panel is a specialist body within the Australian Energy Market Commission (AEMC) and 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. The Panel's responsibilities are specified in section 38 of the National Electricity Law.

Acknowledgement of Country

The AEMC acknowledges and shows respect for the traditional custodians of the many different lands across Australia on which we all live and work. We pay respect to all Elders past and present and the continuing connection of Aboriginal and Torres Strait Islander peoples to Country. The AEMC office is located on the land traditionally owned by the Gadigal people of the Eora nation.

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Summary

1 The Reliability Panel (Panel) has determined a revised draft system restart standard (Standard) and made draft recommendations for actions by the Australian Energy Market Operator (AEMO) to support improved system restart preparedness. The proposed changes to the Standard and recommendations for future work are informed by AEMO's System restart technical advice that describes the challenges and opportunities presented by the transitioning power system.

2 System restart refers to the provision of a capability within the power system to re-energise and restore the system following a major supply disruption or black system event. Black system events are rare, but they can and do occur and the consequences for our modern societies can be severe. Australia experienced a black system event in South Australia in 2016, when storm damage led to a state-wide blackout that lasted around 8 hours. Another recent example of a black system event is the widespread outage in Spain and Portugal in April 2025 disrupting electricity supply to more than 50 million customers for around 16 hours.

3 Under the National Electricity Rules (NER), the Panel is responsible for determining the Standard, which guides AEMO's procurement of System restart ancillary services (SRAS) necessary to re-energise generation and network elements to restore the power system following a major supply disruption or black system event.

4 This draft determination responds to the Australian Energy Market Commission's (AEMC) terms of reference which requested the Panel undertake two tasks:

1. **Task 1**: review and update the Standard to reflect an up-to-date understanding of the power system.
2. **Task 2**: consider the broader SRAS regulatory framework and make recommendations on the appropriateness of the framework in the context of the future power system envisaged in the AEMO integrated system plan.

The Panel's draft determination is informed by AEMO's System restart technical advice

5 The draft Standard and recommendations are informed by *System restart technical advice (Technical advice)* from AEMO that sets out how system restoration could work in a future power system dominated by renewable and distributed generation technologies. AEMO's *Technical advice*:[1]

- recommends amendments to the Standard to support increased flexibility for AEMO to procure SRAS, including black start and restoration services
- provides commentary on the future of system restart and recommendations for potential changes to strengthen the system restart regulatory framework.

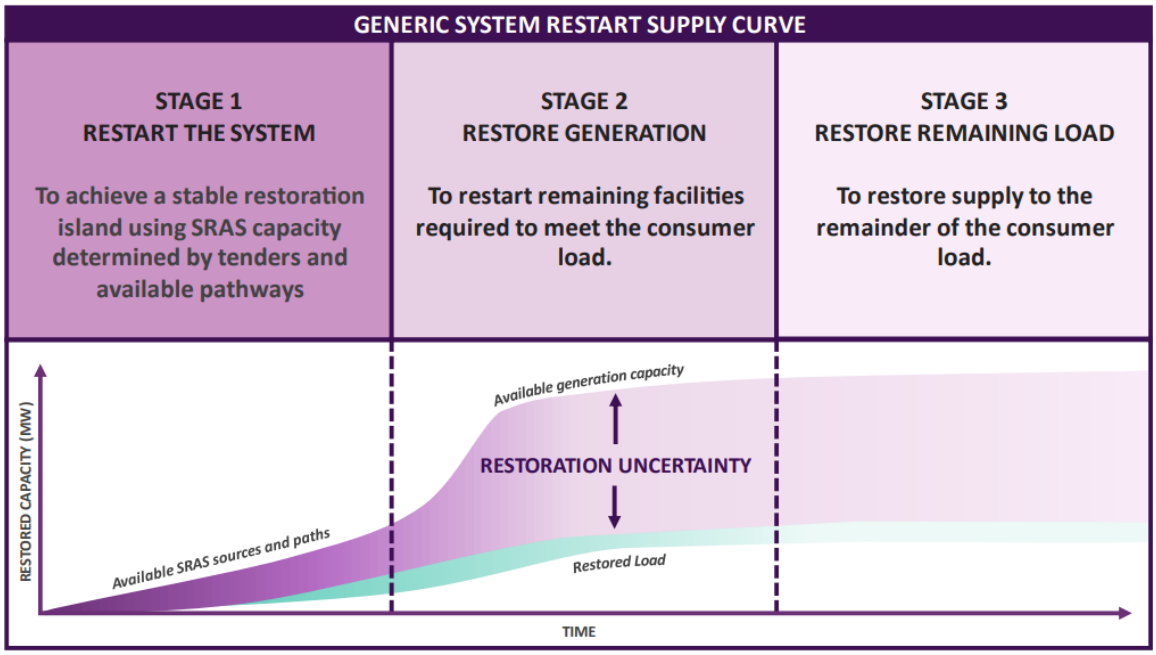
6 AEMO's advice provided an updated description of the conceptual process for restarting the power system, over three stages:

- **Stage 1: Restart** the system by achieving stable restoration islands, using SRAS capacity and available restoration pathways
- **Stage 2: Re-energise** remaining transmission and generation facilities
- **Stage 3: Restore** supply to the remainder of consumer load.

1 AEMO, 2025. System restart technical advice. p.6.

7 The general restoration process can be represented graphically as shown in Figure 1 below.

Figure 1: Conceptualised system restoration process



Source: AEMO,2025. System restart technical advice. p.4.

Task 1 - The revised draft Standard

8 The Panel has determined a revised draft Standard to provide flexibility for AEMO to procure black start and restoration support services

9 Under the NER, the Panel is required to determine, modify as necessary and publish the Standard. The Standard specifies the time, level and reliability of restoring the generation and transmission system following a major supply disruption that results in an uncontrolled full or partial power outage in one or more electrical sub-networks in the NEM.[2] As such, the Standard provides a target for the procurement of SRAS by AEMO. It is a procurement standard rather than an operational standard.

10 The draft Standard addresses AEMO's recommendations and seeks to provide improved guidance and flexibility to support future SRAS procurement and planning to meet the needs of the changing power system. We understand the updated Standard will guide AEMO's next SRAS procurement round, which is expected to commence mid 2026.

11 The revised elements of the draft Standard include:

- **Restoration timeframes:** For each electrical sub-network, AEMO shall procure SRAS with the capacity and capabilities sufficient to support the achievement of the following targets following a major supply disruption:
  - Form one or more restoration islands in an electrical sub-network within 2 hours, and

2 Chapter 10 of the NER defines a major supply disruption as the unplanned absence of voltage on a part of the transmission system affecting one or more power stations and which leads to the loss of supply to one or more loads. Under Chapter 10 of the NER, when the absence of voltage from a major supply disruption extends to a significant part of the transmission system affecting a significant number of customers, this is referred to as a black system.

- Use those restoration islands to restore generation and transmission in that electrical sub-network such that supply in that electrical sub-network is restored to be able to meet 50% of forecast average annual underlying demand within 8 hours.

- **Aggregate reliability:** The aggregate required reliability of SRAS shall meet or exceed 95% in each electrical sub-network (note the aggregate required reliability for each of the mainland NEM regions is set at 90% under the current Standard).
- New **guidelines for the characteristics of restoration islands** that describe the operational features of a restoration island to support AEMO in its planning and procurement of SRAS for stage one of the restoration process.
- **Consideration of sensitive loads:** Additional guidance for AEMO to consult with the relevant jurisdictional system security coordinator (JSSC) in relation to the strategic location of SRAS for each electrical sub-network and the existence of any sensitive loads. AEMO would also be required to report to the Panel in writing how it has considered any JSSC advice.

12 The draft Standard retains the following elements from the existing Standard:

- regionally specific requirements to procure SRAS to be able to support the formation of restoration islands north of Sydney in NSW and north of Bundaberg in QLD
- the requirement that, in meeting the Standard, AEMO may only apply a contracted SRAS for one electrical sub-network at any one time[3]
- guidelines for AEMO on the determination of electrical sub-network boundaries
- guidelines for AEMO on assessing the diversity of services.

13 The Panel's determination is guided by the SRAS Objective in the long term interest of electricity consumers

14 The Panel considers that the proposed changes to the draft Standard are in the long-term interests of consumers. In making this draft determination the Panel has assessed the trade-off between the benefits of a secure and resilient power system and the costs of achieving this. The Panel has considered the risks and opportunities presented by a changing power system and the potential impact of a prolonged disruption of electricity supply on our modern digitised society. Given this context, the Panel considers that the amendments to the draft Standard are important in minimising the potential impact of a major supply disruption or black system event in the NEM.

15 The revised draft Standard is expected to deliver benefits for electricity consumers by:

- Providing AEMO with increased flexibility around how it plans for the initiation of system restart. This will allow AEMO to consider new ways of initiating restart, including via use of smaller restoration islands or sub-sets of the grid.
- Supporting the procurement of additional restoration support services to allow AEMO to address operational challenges throughout stage two of the restoration process. This is expected to provide value to electricity consumers through increased assurance over restoration outcomes.

16 The Panel notes that some increase in SRAS expenditure is expected as a result of:

- the procurement of additional new restoration support services to meet the revised standard
- costs associated with trialling and building new black start SRAS capability to replace the retirement of existing black start capable plant.

17 The Panel's economic analysis demonstrates that the value of providing an effective system

3 NER cl. 8.3.3(aa)(5).

restart capability exceeds the expected increases in SRAS costs. The high level results from this economic analysis demonstrate that:

- the estimated NEM wide annualised total benefit of achieving an ideal restoration is $646m (with sensitivity analysis indicating a range of $81.2m - $1,592m). This far exceeds historical average SRAS expenditure of $35m for 2019/20 to 2023/24 and AEMO's expected 2024 SRAS expenditure of $44m.[4]
- the expected cost increases from increasing aggregate reliability to 95% would be less than the estimated annualised benefit of improved restoration outcomes.
- the impact of these projected SRAS cost increases at a customer level is expected to be minor, noting that historical SRAS costs represent around 0.2% - 0.3% of the value of energy traded in the NEM, or around $1.70 per average NEM customer per year.

18 The Panel proposes that the draft Standard would take effect on 1 July 2027

19 This timing would allow a period of 18 months from the publication of a final determination as planned in December 2025 to the date that the new Standard would take effect. This aligns with the timing provided by the AEMC in the terms of reference for the Review and allows sufficient time for AEMO to update the SRAS Guidelines and make arrangements to procure sufficient SRAS, including black start and restoration support services, to meet the Standard.

Table 1: Summary of changes in the draft Standard

Element of the Standard	Overview of change and rationale
Restoration timeframe	The draft Standard includes revised restoration targets for AEMO to procure SRAS to be able to: • Form one or more restoration islands within 2 hours. • Restore supply to 50% of forecast annual average underlying demand within 8 hours. These changes: • Deliver on AEMO's recommendations to provide flexibility for the creation of stable restoration islands and move the target for the restoration of supply further along the restoration curve • Reflect that forecast annual average underlying demand is proposed as the reference value for the level of supply restoration as this value is expected to reasonably reflect the level of supply required to be restored to meet customer demand.
Aggregate reliability	The draft Standard includes revisions such that the aggregate required reliability of SRAS for the formation of restoration islands shall meet or exceed 95% in each electrical sub-network. The aggregate reliability of SRAS for Queensland (QLD), New South Wales (NSW), South Australia (SA) and Victoria (Vic) is increased from 90% to 95%. The aggregate reliability of SRAS for Tasmania (Tas) is maintained at 95%. This change is supported by the Panel's economic analysis that shows that it would be economic to raise the aggregate reliability of SRAS in the mainland

4 AEMO, 2024. Non market ancillary services (NMAS) report 2023-24, p.11.

Element of the Standard	Overview of change and rationale
	electrical sub-networks to drive additional procurement of SRAS in NSW, SA & Vic.
Guidelines for the characteristics of restoration islands	The draft Standard includes new guidelines on the high level characteristics of a restoration island. These guidelines support the changes to the Standard in relation to AEMO being required to form a restoration island within 2 hours and are informed by AEMO's technical advice on the minimum attributes of stable restoration islands.
Consideration of sensitive loads	The draft Standard includes additional guidance for AEMO to consult with the relevant JSSC in relation to the strategic location of SRAS for each electrical sub-network and the existence of any priority or sensitive loads. AEMO would be required to report to the Panel in writing on how it considered any such advice by a JSSC. This change addresses stakeholder concerns in relation to the importance of restoring sensitive loads within critical timeframes given the potentially significant economic costs. This proposed approach aligns with the NER framework, including the requirement for: • the Panel to determine the Standard in accordance with the SRAS objective • JSSCs to advise AEMO of the priority of loads including any sensitive loads in their region

20 The Panel considers that forward-looking restoration modelling is required to identify future system restart requirements

21 The Panel notes that AEMO's restoration modelling is based on current operational practice, which is focused on re-energising the system using synchronous generation and established restoration pathways. Based on this modelling approach, the Panel is confident that the settings in the draft Standard would be fit for purpose over the period 2027-2030.

22 The Panel recognises the importance of future focused restoration modelling to identify how system restoration capability would be delivered following the exit of coal generation, and support the timely procurement of SRAS. This is supported by AEMO in its general technical advice that supporting restart capability through the transition will require improved understanding of how new technologies can contribute earlier in the restoration process.

23 As set out below, the Panel recommends AEMO undertake future focused restoration modelling which would inform how it plans to deliver system restart capability through the transition to a low- or zero-emissions power system. The Panel invites AEMO to engage with it on the approach to this modelling and for the results to be published in the Transition Plan for System Security (TPSS) from 2026.

Task 2 - Draft recommendations to improve system restart preparedness

24 The Panel considers the current system restart regulatory framework, alongside the revised draft Standard, provides AEMO sufficient flexibility and guidance to deliver adequate system restart capability through the energy transition. The Panel has not identified a clear need for changes to the regulatory framework. However, we are interested in stakeholder feedback on the identified

issues, including whether stakeholders consider that changes to the NER may be required to support effective and efficient provision of system restart capability.

25 The Panel recognises the potential opportunity of the Electricity Services Entry Mechanism (ESEM), proposed by the NEM Review Panel, to support co-investment in new SRAS capable equipment. The Panel supports further work to support investment in Essential System Services through the ESEM, consistent with recommendation 8b in the NEM Review Panel's draft report.[5]

26 At the same time, the Panel has developed a series of recommended actions for AEMO to undertake to improve system restart preparedness and adapt to the changing needs of the power system as it transitions from synchronous-based to one that is inverter based resource (IBR) dominant.

Table 2: Summary of draft recommendations for improving restart preparedness

Issue	Findings and draft recommendations
Procurement and investment	The Panel notes AEMO's advice that there is significant risk of insufficient new SRAS sources coming online prior to the possible exit of existing providers. The current NER SRAS procurement framework and the revised draft Standard provide sufficient flexibility for AEMO to procure sufficient SRAS to meet power system requirements. At the same time, the changes to the revised draft Standard are intended to deliver increased flexibility to support AEMO's procurement of SRAS including black start and restoration support services as required to meet the changing needs of the power system. The Panel recommends AEMO: 1. proactively engage with the market to identify future system restart needs by leveraging flexibility in the existing system restart framework to procure SRAS and meet any identified SRAS gaps in a timely manner. 2. use Type 2 transitional service for trialling new SRAS technologies to understand their potential role in system restoration.
Transparency and reporting	The Panel considers transparency around the future needs of SRAS is critical in delivering the necessary SRAS capabilities. While the current NER requirements for SRAS reporting are mostly backward looking, the NER framework under the TPSS provide an opportunity for improved transparency and reporting on future system restart needs. The Panel recommends: 1. From 2026, AEMO sets out in the TPSS how it plans to deliver system restart capability through the transition to a low- or zero-emissions power system, including: a. setting out the future system restart needs for the NEM based on future focused restoration modelling that accounts for the

5 NEM Review Panel, National Electricity Market wholesale market settings review - Draft Report, August 2025, p.21.

Issue	Findings and draft recommendations
	contribution of IBR and the expected closure of coal-fired generation over the three planning horizons set out in the TPSS. b. engagement with the Panel on the future system restart needs and associated restoration modelling. 1. From 2026, AEMO report on identified SRAS investment opportunities through the Electricity Statement of Opportunities (ESOO) or similar publication.
Local black start procedures	The Panel notes AEMO's view that the Local Black System Procedure (LBSP) processes and obligations should be reviewed to ensure AEMO receives accurate, up to date and reliable information for plant to ensure they can be securely energised during restart. The Panel considers the current NER LBSP framework is sufficiently strong and flexible to support AEMO in obtaining the information it requires from relevant market participants. The Panel recommends: 1. AEMO review the LBSP Guidelines and related processes and investigate opportunities to support the timely provision of accurate information on the capabilities of power system equipment to support system restoration. 2. AEMO determine a set of critical LBSPs that it would audit prior to the commencement of its next procurement round, and that a more fulsome audit of LBSP is performed prior to the revised Standard becoming enforceable on 1 July 2027.
Testing arrangements	AEMO's advice recommended that testing arrangements should be reviewed to expand obligations for system restart network testing to involve existing and potential new restart paths with appropriate mechanisms for cost recovery. The Panel's initial view is that the current SRAS testing arrangements under the NER provide sufficient flexibility for AEMO to undertake SRAS testing and compensate involved parties accordingly. The Panel is interested in stakeholder views on potential changes to the framework that could better support more extensive SRAS testing.
Role of the Standard	The Panel considers: • the Standard is an effective instrument in guiding AEMO's procurement of SRAS and supporting system restart planning. • the current roles for the Panel in setting the Standard and AEMO in procuring SRAS to meet the Standard remain appropriate. The NER provides specific guidance for the Panel in setting the Standard. The Panel is interested in stakeholder views on the appropriateness of these requirements for the changing power system.

The Panel is interested in stakeholder feedback on this draft determination

27 The Panel invites feedback from stakeholders in response to the draft standard and draft recommendations set out in this draft determination.

28 Submissions must be lodged with the AEMC by **16 October 2025.**

29 The Panel will also host an online public forum on our draft determination for this review of the Standard. Further details on how to make a submission and instructions on how to register for the forum are set out in section 1.5 of this draft determination.

Contents

Tables

Figures

1 The Reliability Panel has made a draft Standard and recommendations

The Reliability Panel (Panel) has been directed by the Australian Energy Market Commission (AEMC) to undertake a review of the System Restart Standard (Standard) in accordance with its responsibilities under the National Electricity Rules (Rules).[6] The AEMC has also requested the Panel make recommendations on the appropriateness of the system restart regulatory framework. The Panel's draft findings are set out in this report and the Panel invites comments from stakeholders on its draft findings.

1.1 The AEMC requested the Panel review the Standard and the system restart regulatory framework

On 12 December 2024, the AEMC provided terms of reference to the Panel to initiate a review of the Standard (the Review).[7] The terms of reference require the Panel to consult with as wide a range of stakeholders as possible, including network service providers, generators, consumers, jurisdictional governments and any other relevant bodies.

This draft determination responds to the AEMC's terms of reference which requests the Panel undertake two tasks in this piece of work:

1. **Task 1**: review and update the Standard to reflect an up-to-date understanding of the power system, including consideration of the risks of a major supply disruption and the costs and availability of system restart ancillary services (SRAS), with this Standard to be used in AEMO's upcoming procurement for SRAS.
2. **Task 2**: consider the broader SRAS framework and make recommendations on the appropriateness of the framework in the context of the future power system and the transition underway.

AEMO has identified that it is becoming increasingly challenging to secure the necessary level of SRAS sources at the appropriate level of reliability to meet the current standard across the National Electricity Market (NEM). The associated challenges include an increasing reliance on a limited and shrinking pool of SRAS providers and a scarcity of SRAS capability amongst new transmission-level generation. At the same time, high levels of distribution connected photovoltaic (PV) generation are presenting growing risks to system restoration.

Limited investment in new SRAS sources poses a significant risk to the availability of future SRAS capability. SRAS has historically been provided by large synchronous generating units (coal, gas and hydro power). The physics of the power system is changing as the supply mix transitions from one that is synchronous-based to one that is dominated by inverter based resources (IBR). This requires a rethink of how system restart capability is delivered.

In light of this, the AEMC considers the existing framework may need to evolve to provide the appropriate investment signals to support competitive and efficient provision of system restart services in a transitioning system. Given the Panel's responsibility for determining the Standard, the Commission considers it appropriate that the Panel undertake a review of the Standard and the regulatory arrangements related to system restoration.

6 NER, clause 8.8.3(a)(5).

7 AEMC, 2024. Review of the system restart standard AEMC Terms of Reference to the Reliability Panel.

The terms of reference require the Panel to complete its Review by 30 December 2025. This timing allows AEMO to revise the SRAS Guideline so that it is consistent with the final Standard and incorporate any recommendations the Panel makes in this Review, before AEMO begins the procurement process for SRAS that must be in place by 1 July 2027.

1.2 What is the system restart standard and framework?

In the NEM, system restart capability is provided by SRAS which re-energise parts of the power system affected by a major supply disruption or black system event. SRAS are procured by AEMO from participants in the NEM in accordance with the Standard.

The Standard sets out several key parameters for power system restoration of the NEM in the event of a major supply disruption, including the restoration time and level of available supply from the restored generation and transmission network.[8] The Standard provides a target for the procurement of SRAS by AEMO. The Standard is a procurement standard rather than an operational standard.

The Standard is part of a broader system restart regulatory framework in the NEM that is designed to support planning for, and coordination during, a major supply disruption. This includes:

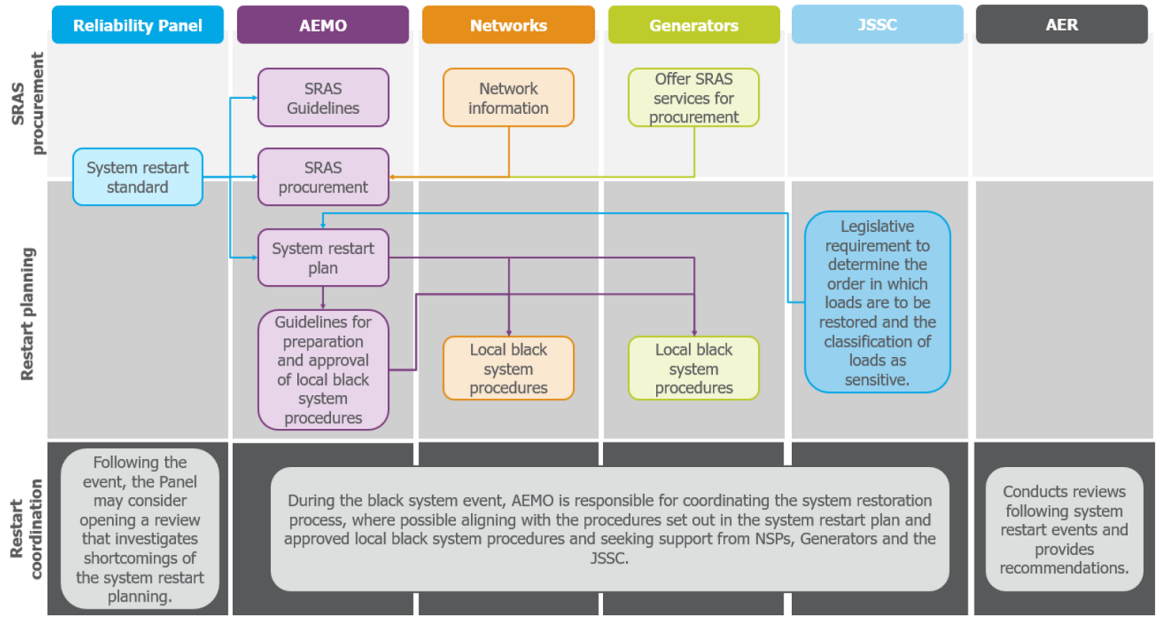
- guiding principles for system restart planning, including definitions for SRAS, and the objectives for procurement and the development of relevant guidelines
- setting out the roles and responsibilities of various market participants and market bodies.

Figure 1.1 provides an overview of the roles and responsibilities of different parties with respect to system restart. The Panel, network service providers, generators and the jurisdictional system security coordinators (JSSCs) play a role in supporting AEMO planning for system restoration following a major supply disruption or black system event.[9]The Australian Energy Regulator (AER) conducts reviews following system restart events and provides recommendations to bolster system restart planning, in preparation for future events.

8 NER, clause 8.8.3(aa)

9 Under Section 111 of the National Electricity Law (NEL), the JSSC must prepare guidelines in relation to load shedding and restoration of loads (which must specify loads or classes of loads as sensitive loads) for the purpose of enabling AEMO to maintain power system security or for reasons of public safety.

Figure 1.1: Governance arrangements under the system restart regulatory framework



Source: Reliability Panel, 2025.

For further detail on the NEM restart framework, refer to Section 4.1 of the Panel's issues paper.

1.3 The Panel's findings are informed by AEMO's technical advice

On 19 June 2025, AEMO published its System restart technical advice to inform this Review. In line with the Review's tasks, the Panel issued a request for technical advice to AEMO to provide: [10]

- general advice to inform an understanding of how system restoration will work under the power system scenarios envisaged in the 2024 Integrated System Plan (ISP)
- specific advice to inform the Panel's determination of a revised Standard, including potential amendments to the form of the Standard and procurement options for SRAS likely to be available in 2027-2032.

AEMO's technical advice report:[11]

- explores restart scenarios with a future technology mix to examine the technical envelope for system restart events and outlines the success criteria for system restoration
- outlines operational restart pathway conditions, processes for reconnecting and re-synchronising sections of the power system, and the short-term challenges and opportunities in providing each
- discusses future investment opportunities in system restart, pathways to support improved confidence in technological capability, and approaches to determining the new Standard, with suggested areas for future policy and regulatory reform.

10 Reliability Panel, 2024. Request for AEMO advice for the Reliability Panel's review of the system restart standard. p. 3.

11 AEMO, 2025. System restart technical advice. p.3.

1.3.1 AEMO recommends the system restart regulatory framework is strengthened to improve system restart preparedness

As part of its advice, AEMO made high level recommendations in relation to how the current regulatory framework may be restricting supply of new sources of SRAS. Specifically, this includes recommendations for the Panel to consider:[12]

- **Procurement and investment** in SRAS, including:
  - options that support adequate investment in SRAS capability, given the current Standard has delivered limited investment in new SRAS sources and the significant risk of insufficient new SRAS sources coming online prior to the possible exit of existing providers.
  - co-investment decisions so that the design of new plant, resources and network assets may include capabilities that can support system restart.
- The **local black system procedure (LBSP) process and obligations** to ensure AEMO receives accurate, up to date and reliable information for plant to ensure they can be securely energised during restart.
- **Testing arrangements** to expand obligations under NER clause 4.3.6 for system restart network testing to involve existing and potential new restart paths with appropriate mechanisms for cost recovery.

1.3.2 AEMO recommends the Standard be revised to provide flexibility to determine the SRAS required to create, maintain, and extend restoration islands

In its technical advice to the Panel, AEMO has set out the process for restarting the power system which can be conceptualised in three stages:[13]

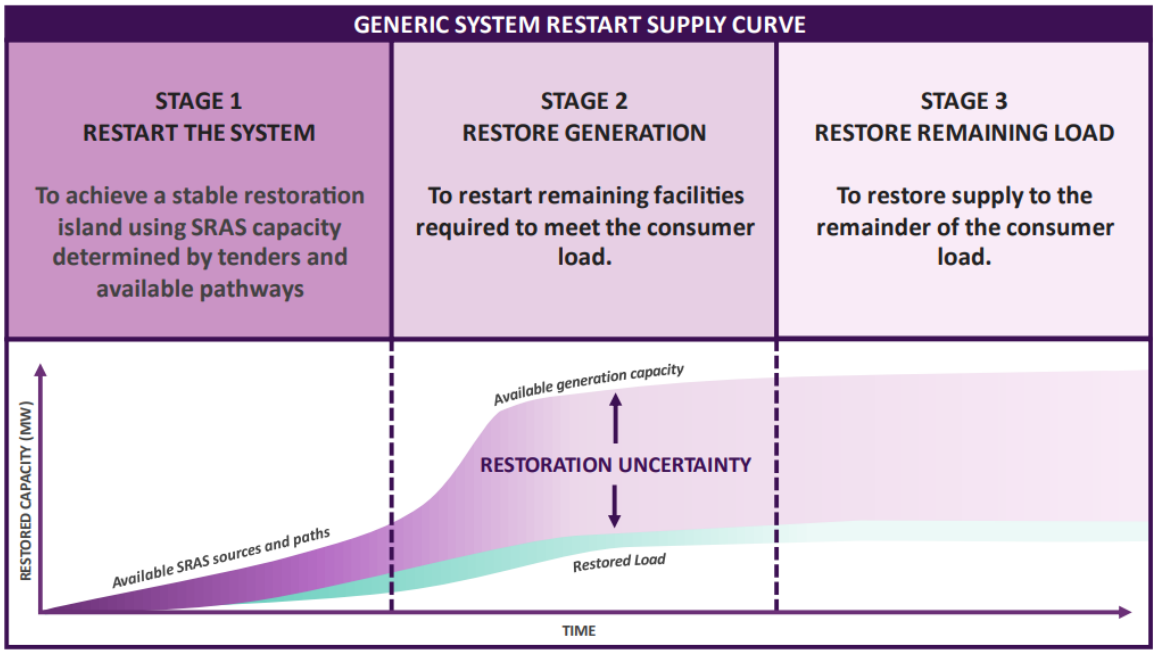
- Stage 1 - Restart the system - achieve a stable restoration island using procured SRAS capacity and available restoration pathways
- Stage 2 - Restoration of generation - restart the remaining facilities that are required to meet consumer load
- Stage 3 - Restore remaining load - restore supply to the remainder of consumer load.

The general restoration process can be represented graphically as shown in Figure 1.2 below.

12 AEMO, 2025. System restart technical advice. p.6.

13 Ibid. p.3-4.

Figure 1.2: Conceptualised system restoration process



Source: AEMO, 2025. System restart technical advice. p.6.

Stages one and two of the restoration process are focused on the restoration of available transmission and generation, whereas stage three is focused on the restoration of remaining consumer load. Despite the different objectives under each stage, AEMO will need to ensure load is brought online throughout the restoration process to meet the generation capacity that is restored.

Key to the commencement of the restoration process (stage one) is the creation of stable restoration islands. AEMO achieves this by:

- initiating the operation of relevant black start capable SRAS units to support energisation of key transmission links to selected generating units
- restarting sufficient stabilising load to maintain these islands.

Stage two of the restoration process is a bridge between the formation of stable restoration islands and the reconnection of remaining consumer load.[14] Once the initial stable restoration is formed at the end of stage one, AEMO focuses on energising sufficient network, generation and other plant that is required to progressively restore consumer load to the remainder of the electrical sub-network. This is achieved by the incremental reconnection of equivalent generation and load blocks.

AEMO's draft advice recommends that the Standard be revised to provide flexibility to be able to respond to novel restoration risks that may emerge throughout the energy transition. Specifically, AEMO proposes that a revised Standard include a requirement to:[15]

- support the formation of stable restoration islands in stage one of the restoration process.

14 AEMO, 2025. System restart technical advice. p.16.

15 Ibid. p.6.

- restore generation to meet a specified level of demand further along the restoration curve (into stage two). This would allow AEMO to address operational and network risks to the re-energising process and support the valuation of restoration support services, such as services to support system security, provide stable load, and value generator flexibility.

1.4 Structure of the determination

The remainder of this determination is structured as follows:

- **Chapter 2** sets out how the draft Standard meets the assessment criteria used by the Panel for the review of the Standard, including the Panel's consideration of the National Electricity Objective and the SRAS Objective.
- **Chapter 3** discusses the structure and settings in the draft Standard and the Panel's rationale for change
- **Chapter 4** discusses the Panel's draft recommendations on the system restart regulatory framework.

1.5 How to make a submission

Due date: The Panel invites feedback from stakeholders in response to this draft determination. Submissions must be lodged with Panel by **16 October 2025**.

How to make a submission: Go to the AEMC's website, www.aemc.gov.au, find the 'lodge a submission' function under the 'Contact Us' tab, and select the project reference code REL0091.[16]

Tips for making submissions are available on our website.[17]

Publication: The AEMC publishes submissions on its website. However, we will not publish parts of a submission that we agree are confidential or that we consider inappropriate (for example offensive or defamatory content or content that is likely to infringe intellectual property rights).[18]

Public forum: The Panel will host an online public forum on our draft determination for this Review of the Standard. Further details on this forum, including instructions on how to register, will be available on our website.

16 If you are not able to lodge a submission online, please contact us and we will provide instructions for alternative methods to lodge the submission.

17 See: https://www.aemc.gov.au/our-work/changing-energy-rules-unique-process/making-rule-change-request/submission-tips.

18 Further information is available here: https://www.aemc.gov.au/contact-us/lodge-submission.

2 The draft Standard promotes the NEO

The Panel has determined a revised draft Standard in accordance with the SRAS objective and the National Electricity Objective (NEO) and NER. This chapter sets out:

- the relevant requirements in the NEL and NER that the Panel needs to consider when determining the Standard
- how the Panel has considered these requirements, including the development of an assessment framework and how this assessment aligns with the relevant requirements in the NER and NEL
- the technical advice from AEMO that informs the Panel's economic assessment.

Box 1: Key points in this section

- The Panel determined that the draft Standard is in the long-term interests of consumers. The Panel's determination contributes to meeting the NEO by managing the trade-off between the benefits of a secure and resilient power system and the costs of achieving this.
- The Panel considers that the additions and amendments to the draft Standard are crucial to help maintain system security in the context of a rapidly transitioning electricity network. This aligns with the technical advice from AEMO which recommended the Panel develop a Standard that provides it with the flexibility to manage the uncertainties introduced to system restart preparedness by a transitioning system.
- The Panel's determination is based on the assessment principles set out in this paper.

2.1 The SRAS Objective and NEO guide the determination of the draft Standard

The NER requires the Panel to determine the Standard in accordance with the SRAS Objective set out below:[19]

> The objective for system restart ancillary services is to minimise the expected costs of a major supply disruption, to the extent appropriate having regard to the national electricity objective.

The Panel will consider how the standard could most efficiently manage and minimise the extent of the costs associated with a major supply disruption, to meet the long term interests of consumers, having regard to the NEO. The NEO is set out in Section 7 of the NEL as follows:

> "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:
>
> 1. price, quality, safety, reliability and security of supply of electricity; and
> 2. the reliability, safety and security of the national electricity system; and
> 3. the achievement of targets set by a participating jurisdiction—
>   a. for reducing Australia's greenhouse gas emissions; or
>   b. that are likely to contribute to reducing Australia's greenhouse gas emissions."

19 NER, Clause 8.8.3(aa)(1)

In meeting the SRAS Objective, the Panel takes into account various economic factors, including the trade-offs that exist between the cost of procuring restart services against the short term costs of a loss of supply and the longer term costs of economic disruption to electricity customers.[20]

2.2 The Panel has developed assessment criteria in line with the NEO to guide its determination of the draft Standard

In determining the draft Standard, the Panel has considered the following assessment criteria.

System security

The Panel considers the draft Standard should support the availability of an effective restart capability. Effective restoration capability is a necessary insurance for a major supply disruption event. The revised Standard guides AEMO's procurement of SRAS and supports restoration capability. AEMO's restoration modelling shows that within known capabilities of the system, the revised Standard would guide successful restart of the system.

Consumer outcomes

The draft Standard would need to support the timely restoration of the power system in line with consumer expectations. The Panel has determined the Standard with a restoration target that is deeper in the restoration process. The Panel considers this would provide consumers with more certainty of restoration timeframes following a major supply disruption. The Panel considers the revised Standard meets the SRAS Objective, seeking to minimise the cost of a supply disruption. The Panel expects increases in costs under the revised Standard, however considers the economic benefits of restoration capability far outweigh the costs of procuring the SRAS.

Economic efficiency

The draft Standard should be supported by a consideration of the expected costs of SRAS and the value of unserved energy from a potential major supply disruption. The Panel's economic analysis shows that the value of providing an effective system restart capability exceeds the expected increase in costs. The Panel also considers the NER framework supports prudent SRAS investment by bounding the procurement of SRAS capability to the levels set out in the Standard. The Standard acts as a target for SRAS procurement and AEMO procures to meet that target at lowest long term cost (SRAS Procurement Objective). The Panel makes further commentary on the assessment of economic efficiency in section 2.4.

Transparency

The Panel considers the revised Standard provides stakeholders with clear guidance on the objectives for SRAS procurement and provides an insight into planning for system restart events. The Panel has also made recommendations, as part of its assessment of the system restart regulatory framework, for AEMO to enhance its reporting of SRAS needs. The Panel considers these recommendations would provide increased transparency to market participants and energy consumers on SRAS planning, future SRAS needs and associated costs.

Flexibility

The Panel considers the Standard should be fit for purpose over the long term. On the advice of AEMO, the Panel considers the draft Standard would remain fit for purpose from 2027-2030. The revised draft Standard provides AEMO with increased flexibility on how it creates stable

20 AEMC 2015, System Restart Ancillary Services, Rule Determination, 2 April 2015, p.60.

restoration islands early in the restoration process. This has been achieved by setting a restoration objective deeper into the restoration process and removing the MW level target from the early stages of restoration. The Panel considers these changes provide flexibility to AEMO to consider a broader range of SRAS capabilities. The Panel also considers, following its assessment of the system restart regulatory framework, that the current NER framework provides adequate flexibility to AEMO to engage with the market to seek out the system restart services it needs.

Innovation

The Standard should support (or not restrict) the ability to include new technologies and methods to support system restoration. The revised draft Standard would support AEMO in considering procurement of additional new restoration support services to meet the revised Standard and incurring capital costs for trialling and building new black start SRAS capability to replace retirement of existing capability. The Panel considers this would support AEMO in considering new SRAS technologies and approaches in supporting system restoration. The Panel also supports AEMO's suggestion in its technical advice to consider the use of Type 2 contracts under the Transitional Services Framework to trial new candidate SRAS technologies.

2.3 AEMO's restoration modelling recognises uncertainties in modelling outcomes

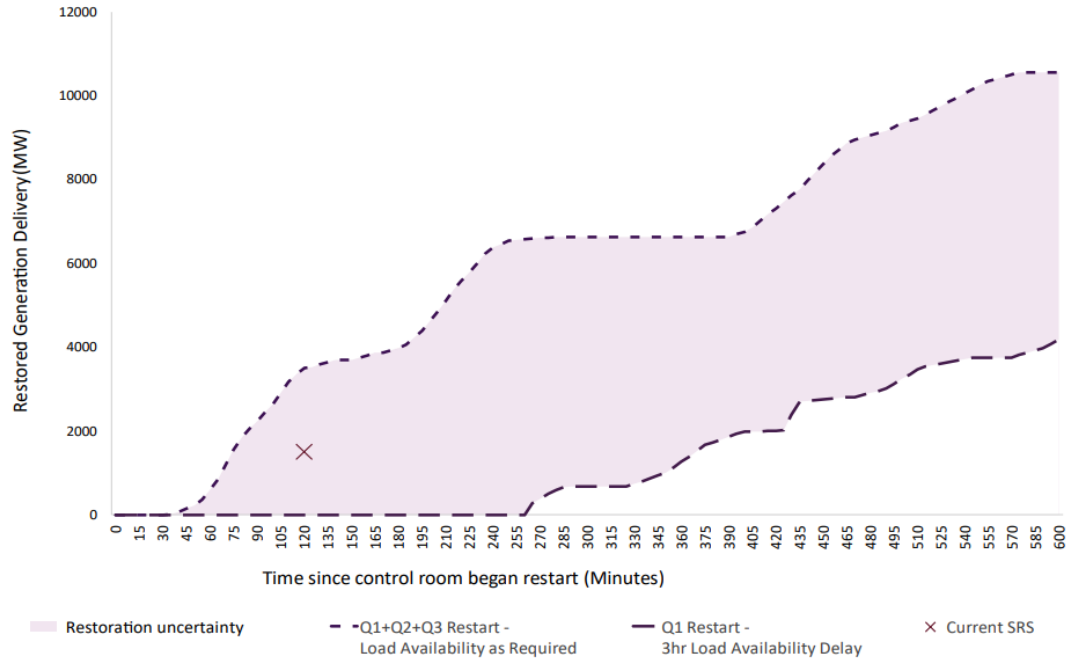
To inform the Panel's determination of the draft Standard, the Panel considered the outcomes of restoration modelling produced by AEMO as part of its technical advice. AEMO's technical advice also provided recommendations to enhance the system restart regulatory framework. This has been considered in chapter 4.

AEMO's modelling outputs sought to capture the uncertainty AEMO considers inherent in planning system restart as the system transitions. For this review, AEMO used the latest restart procedures in each electrical sub-network in the NEM to build indicative restoration supply curves to guide the development of a Standard that would remain fit-for-purpose from 2027.[21] With high synchronous generation still expected to be present in 2027, AEMO assumed the existing restart pathways to still be viable, although this will need to be confirmed over time with AEMO's ongoing restart modelling operation.[22]

AEMO highlighted that conducting detailed restart pathway modelling for incremental levels of black start capability, as was done in the 2016 review of the Standard, was not feasible as part of this Review and would have decreasing relevance into the future as the grid changes.[23] An example of the New South Wales restoration curves is provided below.

21 AEMO, 2025. System restart technical advice. p.64.
22 AEMO, 2025. System restart technical advice. p.65.
23 AEMO, 2025. System restart technical advice. p.63.

Figure 2.1: New South Wales restoration curve



Source: AEMO, 2025. System restart technical advice. p.65.

The purple range shows the uncertainty in expected outcomes from known combinations of restart sources and restart scenarios. The curves do not depict deterministic outcomes for a future restart scenario, and therefore AEMO intends for the Panel to consider the full uncertainty range when determining the Standard.

Box 2: What are restoration supply curves and how are they interpreted?

What are restoration supply curves?

The output of AEMO's restoration modelling included supply curves for each electrical sub-network. These curves provide a representation of a plausible system restart process showing the growth in online generation capacity following a black system event. Restoration modelling outcomes are informed by AEMO's determination of critical re-energisation pathways on the grid, called restart pathways. AEMO noted that finding viable restart pathways through the network is very complex and time-consuming.

To be confident in restart pathways, AEMO undergoes extensive, detailed dynamic modelling of every network element in the pathway (e.g. transformers, protection systems, lines and generators). This complexity in achieving pathway confidence makes it difficult to build supply curves for networks far into the future as differences in single network elements can invalidate pathways.

How are they interpreted?

The supply curves show active power (MW) on the vertical axis and time on the horizontal. The vertical active power (MW) axis represents actual restoring output of generators. The generator names have been excluded for confidentiality and the curves should be interpreted indicatively. Current SRS targets are also plotted for completeness, comparing the exact precision that the current SRS requires against planning uncertainties. Each sub-network depicts a shaded region of uncertainty covering possible scenarios post-black event as well as differing viable synchronous

sources of black start service.

Source: AEMO, 2025. System restart technical advice. p.63-65.

2.4 The Panel's economic assessment approach seeks to value effective restoration capability

The Panel has undertaken an economic analysis that demonstrates the costs of a prolonged power system outage and the value of effective restoration capability supported by the procurement of SRAS.

The economic assessment builds on the Panel's 2016 approach which was focused on a direct cost benefit analysis of different levels of black start procurement. The 2016 economic assessment approach was based on AEMO restoration modelling outputs that considered incremental levels of black start capability. This supported the Panel developing a robust methodology that could compare marginal costs and benefits of black start SRAS capability to determine the "economically efficient" levels within the Standard.

For each electrical sub-network in the NEM, the Panel conducted two distinct assessments:

- an estimate of the total annualised benefit of an ideal restoration outcome
- assessment of the marginal value of reliability, to inform the aggregate reliability settings in the Standard, similar to the approach undertaken in the 2016 review.

Details of the assessment methodology are set out in appendix C, and consideration of the results for the draft Standard are discussed in chapter 3.

2.5 The draft Standard meets the NER requirements

When determining the Standard, the Panel must also consider whether the relevant requirements in the NER have been met. The NER requirements applying to the Panel's determination of the Standard are:

- NER clause 8.8.1(a)(1A) sets out that the Reliability Panel must, on the advice of AEMO, determine the Standard.
- NER clause 8.8.3(aa) which sets out the Standard must:
    1. be reviewed and determined by the Reliability Panel in accordance with the SRAS Objective;
    2. identify the maximum amount of time within which SRAS are required to restore supply in an electrical sub-network to a specified level, under the assumption that supply (other than that provided under a SRAS agreement acquired by AEMO for that electrical sub-network) is not available from any neighbouring electrical sub-network;
    3. include the aggregate required reliability of SRAS for each electrical sub-network;
    4. apply equally across all regions, unless the Reliability Panel varies the system restart standard between electrical sub-networks to the extent necessary:
        a. to reflect any technical system limitations or requirements; or
        b. to reflect any specific economic circumstances in an electrical sub-network, including but not limited to the existence of one or more sensitive loads;

5. specify that a SRAS can only be acquired by AEMO under a SRAS agreement for one electrical sub-network at any one time;
6. include guidelines to be followed by AEMO in determining electrical sub-networks, including the determination of the appropriate number of electrical sub-networks and the characteristics required within an electrical sub-network (such as the amount of generation or load, or electrical distance between generation centres, within an electrical sub-network); and
7. include guidelines specifying the diversity and strategic locations required of SRAS.

As noted, the Panel sought technical advice from AEMO to inform its determination of the draft Standard. This advice can be found on the AEMC's website. The Panel considers the draft Standard aligns with the requirements set out under clause 8.8.3(aa). Chapter 3 provides further detail on the individual elements of the Standard.

3 The draft system restart Standard

The Panel has determined a revised draft Standard that responds to recommendations set out in AEMO's technical advice. This chapter sets out:

- AEMO's recommendations for revisions to the Standard
- the elements of the draft Standard
- proposed arrangements for the implementation of the revised Standard.

The key elements of the revised draft Standard are set out below in the box below.

Box 3: Key elements of the revised draft Standard

The key revised elements of the draft Standard are:

1. **Restoration timeframes:** For each electrical sub-network, AEMO shall procure SRAS with the capacity and capabilities sufficient to support the achievement of the following targets following a major supply disruption:
   a. Form one or more restoration islands in an electrical sub-network within 2 hours, and
   b. Use those restoration islands to restore generation and transmission in that electrical sub-network equivalent to the capacity to supply 50% of the forecast average annual underlying demand in that electrical sub-network within 8 hours.
2. **Aggregate reliability:** Revision such that the aggregate required reliability of SRAS shall meet or exceed 95% in each electrical sub-network.
3. New **guidelines for the characteristics of restoration islands.**
4. **Consideration of sensitive loads:** Additional guidance for AEMO to consult with the relevant JSSC in relation to the strategic location of SRAS for each electrical sub-network and the existence of any sensitive loads.

The draft Standard maintains the following elements from the existing Standard largely unchanged:

1. Regionally specific requirements for SRAS procurement in NSW and QLD.
2. The requirement that in meeting the Standard, AEMO may only apply a contracted SRAS for one electrical sub-network at any one time.[1]
3. Guidelines for AEMO on the determination of electrical sub-network boundaries.
4. Guidelines for AEMO on assessing the diversity of services.

Note: 1. NER cl.8.8.3(aa)(5)

The primary driver for the restoration level and timeframe settings in the standard is AEMO's technical advice on the operational objectives and capabilities for system restoration as set out further in section 3.2. The proposed change to align the aggregate required reliability levels at 95% is driven by the Panel's economic analysis as set out further in section 3.4.

The revised Standard is expected to deliver benefits for electricity consumers by:

- Providing AEMO with increased flexibility around how it plans for the initiation of system restart. This will allow AEMO to consider new ways of initiating restart, including via the use of smaller restoration islands or sub-sets of the grid.

- Improved confidence in the effectiveness and reliability of system restart. This is supported by the proposed increase in the aggregate required reliability of SRAS for the mainland electrical sub-networks.
- Supporting the procurement of additional restoration support services to allow AEMO to address operational challenges throughout stage two of the restoration process. This is expected to provide value to electricity consumers through increased certainty over restoration outcomes.

The Panel notes that some increase in SRAS expenditure is expected in the future as a result of:

- the procurement of additional SRAS, including black start and restoration support services, to meet the revised Standard.
- capital costs for trialling and building new black start SRAS capability to replace the retirement of existing capability.

The Panel's economic analysis demonstrates that the value of providing an effective system restart capability exceeds the expected increases in SRAS costs. The high level results from this economic analysis demonstrate that:

- the estimated NEM wide annualised total benefit of achieving an ideal restoration is $646m (with sensitivity analysis indicating a range of $81.2m - $1,592m). This far exceeds historical average SRAS expenditure of $35m for 2019/20 to 2023/24 and AEMO's expected 2024/25 SRAS expenditure of $44m.[24]
- the expected cost increases related to AEMO procuring SRAS to meet the revised 95% aggregate required reliability in the mainland electrical sub-networks would be less than the estimated annualised benefit of improved restoration outcomes.
- the impact of these projected SRAS cost increases at a customer level is expected to be minor, noting that historical SRAS costs represent around 0.2% - 0.3% of the value of energy traded in the NEM, or around $1.70 per average NEM customer per year.[25]

The Panel notes that the revised Standard would align the settings for the restoration level, timeframe and aggregate required reliability across each of the electrical sub-networks in the NEM. This would deliver the added benefit of reducing the administrative burden required for AEMO to make changes to the electrical sub-network boundaries in future. [26]

3.1 AEMO recommended changes to the standard to provide flexibility

The Panel's revised draft Standard responds to and addresses AEMO's advice to amend the Standard in order to provide AEMO with the flexibility and discretion it needs to procure SRAS and prepare plans to deliver an effective system restart capability for the national electricity system. AEMO's System restart technical advice included recommendations for amendments to the Standard to provide AEMO with increased flexibility to procure SRAS (including black start and restoration services) to deliver an effective system restart capability as the power system transitions. These recommendations are set out in the box below.

24 AEMO, 2024. Non market ancillary services (NMAS) report 2023-24, p.11.

25 SRAS costs are recovered 50% from market customers and 50% from generators based on energy consumed or sent out - NER cl. 3.15.6A(d),(e).

26 This may include splitting or combining electrical sub-networks or varying the sub-network boundaries in accordance with NER clause 3.11.8.

Box 4: AEMO's high level advice for the system restart standard

- The SRS should be amended to allow AEMO the flexibility to create and maintain stable restoration islands, along with an option to procure SRAS further along the restoration curve.
- The Standard should include the following:
  - A requirement for AEMO to determine the amount of SRAS to procure to create and maintain stable restoration islands in stage one and extend the islands through stage two of system restoration.
  - Flexibility for AEMO to determine the quantity of SRAS (both black start and restoration support services) to procure.
  - Specific ability for AEMO to procure a prudent amount of additional or alternative SRAS to cater for reasonable network risks.
  - Improved ability to consider services and implementations that support the restoration of smaller islands or sub-sets of the grid.

Source: AEMO, 2025. System restart technical advice. p.6.

3.2 Revised target timeframes for the restoration of supply

The draft Standard includes revised target timeframes for the restoration of supply following a major supply disruption. These targets support AEMO's procurement of SRAS, including black start and restoration support services, which deliver the capability to independently re-energise the power system in the event of a major outage.

Box 5: Target timeframes for the restoration of supply

The draft Standard includes revised restoration targets for AEMO to procure SRAS to support the achievement of the following targets in each electrical sub-network following a major supply disruption:

- Form one or more restoration islands within 2 hours.
- Use those restoration islands to restore generation and transmission in that electrical sub-network equivalent to the capacity to supply 50% of the forecast average annual underlying demand in that electrical sub-network within 8 hours.

These changes:

- Deliver on AEMO's recommendations to provide flexibility for the creation of stable restoration islands and move the target for the restoration of supply further along the restoration curve
- Reflect that forecast annual average underlying demand is proposed as the reference value for the level of supply restoration as this value is expected to accurately reflect the level of supply required to be restored to meet customer demand.

The targets for the restoration of supply under the existing standard were set based on defining a target for the initial (stage one) restoration of supply to achieve a minimum level of generation to support the ongoing restoration of the power system.[27] This approach to setting a stage one restoration target in the standard was based on the definition of SRAS at that time, which was

27 AEMC Reliability Panel, Review of the System restart standard - Final Determination, 15 December 2016, p.39.

restricted to services with black start capability. However, the definition of SRAS was revised in April 2020 through the *National Electricity Amendment (System restart services, standards and testing) Rule 2020* (*SRAS Rule 2020*). *The SRAS Rule 2020* expanded the definition of SRAS to include restoration support services that support the stable re-energisation of the grid. The capabilities for these restoration support services are defined by AEMO in its SRAS Guideline and include the ability to provide stabilising load and/or control frequency or voltage.[28]

AEMO's advice identified that the current restoration targets in the Standard have acted as a constraint on its efforts to procure restoration support SRAS. The Panel understands that this constraint is related to the current restoration target in the Standard being focused on stage one of the restoration process. While this approach was previously appropriate for the Standard, AEMO has identified that amendments to the Standard are now required to support its procurement of restoration support services required to address emerging operational challenges related to system restoration. These challenges include the availability of stable and consistent load blocks and system security services required to support the operation and restoration of the power system.[29]

The Panel considers that the revised target timeframes for restoration of supply in the draft Standard will better support AEMO to procure the services and capability required to deliver an independent system restart capability to each of the electrical sub-networks in the NEM. This will support quick and effective system restoration which in turn will act to minimise the cost of a major supply disruption.

The two key elements of the revised target restoration timeframes in the draft Standard are:

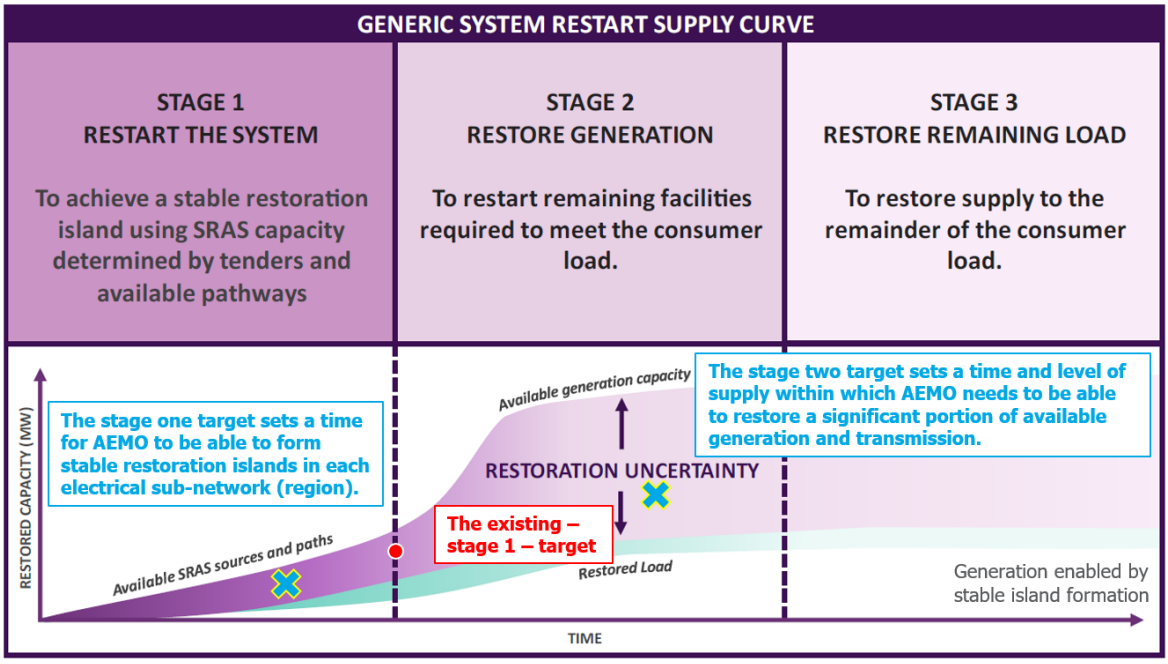
- A "stage one" requirement for AEMO to have the capability to form a restoration island within 2 hours of a major supply disruption or black system event. This requirement is intended to guide AEMO in its procurement of SRAS with black start capability to support the initial energisation of generation and transmission consistent with stage 1 of the restoration process.
- A "stage two" requirement for AEMO to have the capability to restore supply to 50% of forecast annual average underlying demand within 8 hours. This requirement is intended to provide AEMO a restoration target deeper into stage two of the restoration process in order to support the procurement of restoration support services.

These two restoration targets are depicted below as the green crosses in Figure 3.1.

28 AEMO, SRAS Guideline, 8 February 2021, pp.12-13.

29 AEMO, System restart technical advice, 19 June 2025, p.24.

Figure 3.1: Restoration targets under the draft Standard



The following sub-sections provide further detail on the Panel's considerations with respect to each of these restoration targets.

3.2.1 A requirement for AEMO to be able to quickly form restoration islands to initiate system restart

The revised stage one target in the draft Standard provides AEMO with more discretion around the specific operational objectives for the initial phase of system restoration (as compared to the existing targets in the Standard). This is achieved by not prescribing a quantitative target level for the restoration of supply as part of the stage one target. The stage one target in the draft Standard only includes a time (2 hours) within which AEMO would target the formation of restoration islands in each electrical sub-network to initiate the restoration process. AEMO would determine the specific attributes of restoration islands for each electrical sub-network, informed by new guidelines in the Standard for restoration islands which are described further in section 3.3.

3.2.2 A requirement for AEMO to be able to substantially restore supply within a reasonable timeframe

The stage two target in the draft Standard sets a quantitative target for the substantive restoration of supply within a reasonable timeframe. This target is defined in the draft Standard as 50% of the forecast average annual underlying demand in that electrical sub-network within 8 hours. As recommended by AEMO, this element of the draft Standard sets the supply restoration target deeper into the restoration process consistent with AEMO's objective to procure restoration support services to address expected operational challenges associated with system restoration.

The elements of this target can be further broken down to a target level of supply restoration and a target restoration timeframe as described below.

A target level of supply of 50% of forecast average annual underlying demand

The restoration level for the stage two restoration target in the draft Standard is informed by and consistent with the current system restoration capability for each of the electrical sub-networks based on AEMO's restoration modelling outputs.[30] This value represents a target level of supply restoration that will guide AEMO's procurement of restoration support services as required to address operational challenges during the process of meeting this target.

The Panel proposes to represent this supply restoration target as a percentage of forecast average underlying demand to provide an adaptive and forward-looking reference value for the level of supply restoration required to meet customer demand. Importantly, the use of "underlying demand" as the reference value includes the total of electricity consumption defined as operational demand plus rooftop PV generation.[31] This approach is expected to adapt to changes in the power system while reflecting the operational target for restoration to re-energise the power system and restore supply, including that demand met by consumer energy resources, such as rooftop PV.

A target restoration timeframe of 8 hours

The timeframe for the stage two restoration target in the draft Standard aligns with AEMO's advice around the importance of restoring supply to transmission and distribution substations within the time window for backup energy supplies for key network sub-stations. As noted by AEMO:[32]

> The process of power system restoration can become significantly harder once certain time thresholds are passed. If supply is not restored to key substations within approximately 10 hours following the major supply disruption, the restoration process will become significantly more difficult.

The Panel considers that the 8 hour target timeframe for the stage two supply restoration target provides an appropriate setting to guide AEMO's SRAS procurement and restoration planning activities, with the goal of achieving substantive system restoration prior to the 10 hour threshold for substation backup power supplies.The Panel notes AEMO's advice that extended delays to system restoration may occur if supply is not restored to these network assets before backup power supplies are exhausted.

3.3 New guidelines for restoration islands

The revised draft Standard includes new guidelines for the characteristics of a restoration island. These guidelines are based on those included in AEMO's advice with minor changes to improve the clarity of messaging and align with AEMO's existing system security obligations.

Box 6: Guidelines for restoration islands in the draft standard

AEMO shall determine the specific operational characteristics for restoration islands, which shall include the following attributes:

- The ability to maintain a satisfactory operating state for the duration of a successful restoration process. This includes:

30 AEMO, System restart technical advice, 19 June 2025, pp.63-71.

31 Definition of "underlying demand" as set out on AEMO's Operational Demand data webpage - https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/data-nem/operational-demand-data

32 AEMO, System restart technical advice, 19 June 2025, p.18.

  - Self-sufficiency, through maintenance of supply-demand balance, and voltage and frequency within acceptable ranges, including tolerance to reasonable changes to the island
  - The availability of sufficient system security capability to support re-energisation of both transmission and distribution systems.
- The ability to return network and load to service commensurate with the available generation throughout the rest of the restoration process.
- The ability to synchronise with other islands and the main grid.
- Adequate communication systems to facilitate stable operation of islands.

The draft guidelines for restoration islands are based on the minimum attributes for stable restoration islands included in AEMO's system restart technical advice:[33]

> Minimum attributes of stable restoration islands include:
>
> 1. Self-sufficiency, through maintenance of supply-demand balance, and voltage and frequency within acceptable ranges, including tolerance to reasonable changes to the island.
> 2. The ability to maintain a stable state for the duration of a successful restoration process. This includes ensuring sufficient system security capability to support re-energisation of both transmission and distribution systems.
> 3. The ability to return network and load to service commensurate with the available generation throughout the rest of the restoration process.
> 4. The ability to synchronise with other islands and the main grid.
> 5. Adequate communication systems to facilitate stable operation of islands.

The key difference between AEMO's minimum attributes for stable restoration islands and the guidelines for restoration islands in the draft Standard is the clarification that a restoration island shall have "The ability to maintain a satisfactory operating state for the duration of a successful restoration process".[34] As set out by AEMO, this includes having an ability to operate self-sufficiently through balancing supply and demand and maintaining voltage and frequency within an acceptable range, as well as having sufficient system security capability to support the re-energisation of transmission and distribution systems.

The Panel notes that the reference to a restoration island being capable of operating in a satisfactory operating state is consistent with the existing guidelines in the Standard for the determination of electrical sub-networks which includes that:

> "an electrical sub-network should be capable of being maintained in a satisfactory operating state to the extent practicable during the restoration process, and in a secure operating state from a stage in the restoration when it is practicable to do so, as determined by AEMO."

The Panel considers that it is reasonable and appropriate for AEMO to plan for the satisfactory operation of restoration islands, noting that the overall objective for system restoration is to return

33 AEMO, 2025. System restart technical advice. pp.4,17.

34 The power system requirements for a satisfactory operating state are defined in NER clause 4.2.2.

the power system to a secure operating state, but that this is not likely to be practically achievable early in the restoration process.

3.4 Revisions to aggregate required reliability for SRAS

The Panel's draft determination is to increase the aggregate required reliability of SRAS in the mainland electrical sub-networks from 90% to 95%. This change is supported by the Panel's updated economic assessment which supports increased procurement of SRAS in NSW, Vic and SA based on the value this would provide through increased likelihood of a successful restoration following a major supply disruption.

The Panel's draft determination is to maintain the aggregate required reliability of SRAS in Tasmania at 95%.[35]

The results of the Panel's economic assessment are set out in appendix B.

Box 7: Aggregate required reliability of SRAS

The draft Standard includes revised requirements for the aggregate reliability of SRAS for the formation of restoration islands to meet or exceed 95% in each electrical sub-network. This element of the draft Standard would result in:

- the aggregate required reliability of SRAS for QLD, NSW, SA and Vic increasing from 90% to 95%.
- the aggregate reliability of SRAS for TAS being maintained at 95%.

This change is supported by the Panel's economic analysis that shows that it would be economic to raise the aggregate reliability of SRAS in the mainland electrical sub-networks to drive additional procurement of SRAS in NSW, SA and Vic. The Panel's economic analysis supports maintaining the aggregate required reliability for SRAS in Tasmania at 95%.

The drafting of this element of the Standard reflects the Panel's understanding that the aggregate required reliability of SRAS is more practically applicable for the stage one restoration target associated with the formation of a restoration island. This approach recognises the increasing complexity of estimating the aggregate reliability for restoration outcomes deeper into the restoration process due to the increasing number of associated power system elements and services.

The aggregate required reliability of SRAS represents the likelihood that the combined procured SRAS for a given electrical sub-network would be able to restore supply to the level requirement within the specified time, based on the combined reliabilities of each of the SRAS sources. As set out in the standard, AEMO's assessment of the reliability of an individual SRAS is based on:

- the availability of that service,
- where applicable, the expected start-up performance,
- where applicable, the reliability of the network components between the SRAS source and the first location on a shared network from which the SRAS can energise or support the energisation of other generation.

A higher value for the aggregate reliability provides an economic benefit to NEM consumers through an increased likelihood of an effective and timely restoration of the power system following a major supply disruption. However, there are also costs of increasing the aggregate

35 The aggregate required reliability for SRAS in Tasmania was set at 95% through the Panel's 2016 review of the Standard to provide a higher level of restart self-sufficiency than other NEM regions due to Basslink being incapable of supplying power into a de-energised system.

required reliability, as the predominant way of increasing the aggregate reliability of SRAS in an electrical sub-network is through the procurement of additional SRAS. Therefore, the aggregate reliability of SRAS represents the Panel's assessment of the economic trade-off between the benefits of the likelihood of effective restart vs the costs of delivering this capability.

An example of the relationship between individual SRAS reliability and the aggregate reliability of an SRAS portfolio based on the number of SRAS units is set out below in Table 3.1.

Table 3.1: Aggregate reliability of SRAS example

No. of black start SRAS	Indicative Aggregate reliability of SRAS portfolio	Calculation
1	80%	= 1 – (1 – 0.8)
2	96%	= 1 – (1 – 0.8)× (1 – 0.8)
3	99%	= 1 – (1 – 0.8) × (1 – 0.8) × (1 – 0.8)

Note: This example assumes an individual SRAS reliability of 80% which is broadly consistent with historically documented reliabilities for SRAS, which range between 72% and 83%.[36]

This element of the Panel's draft determination is supported by the Panel's economic assessment of the marginal costs and benefits of black start SRAS as set out in appendix B. The high level findings from this economic assessment are:

- that the current level of black start SRAS procurement for QLD and Tasmania is consistent with the economically optimal range of black start SRAS procurement.
- that the marginal annualised benefits of increased black start SRAS procurement in NSW, SA and Vic would be expected to exceed the marginal annualised costs of this additional procurement.

An overview of the high level findings with respect to the economic level of black start SRAS procurement is set out below:

Table 3.2: Economically optimal level of black start SRAS

Electrical sub-network	Current No. of black start SRAS units procured	Current aggregate required reliability	Economically optimal range for black start SRAS procurement	Proposed required aggregate reliability
QLD	3	90%	1-3	95%
NSW	2	90%	1-3	95%
Vic	2	90%	1-3	95%
SA	2	90%	1-3	95%
Tas	2	95%	2	95%

Source: Current SRAS procurement levels based on values published in AEMO's *Non Market Ancillary Services (NMAS) report 2023-24*.

In a general sense, the proposed increase to the aggregate required reliability for SRAS in the mainland electrical sub-networks is expected to lead to an increase in the number of black start

36 Reliability Panel, Review of the System Restart Standard - Final Determination, 15 December 2016, p.54.

SRAS procured in NSW, Vic and SA. At the same time, the Panel's analysis indicates that the 95% aggregate required reliability value would likely be met by historic SRAS procurement levels in QLD and Tasmania.[37]

While it is not practical to accurately predict the actual cost of meeting the proposed revised aggregate required reliability, the historical unit costs of SRAS provide a guide as to the scale of costs as a result of the procurement of additional black start SRAS in NSW, Vic and SA. The estimated total and unit cost for SRAS in 2024-25 are set out below in Table 3.3

Table 3.3: Estimated SRAS costs - (2024-25)

Electrical sub-net-work	No of SRAS	Actual total SRAS costs	Approximate SRAS unit cost
QLD	3	$ 10,495,007	$ 3.5 M
NSW	2	$ 13,027,285	$ 6.5 M
VIC	2	$ 8,803,401	$ 4.4 M
SA	2	$ 4,518,506	$ 2.3 M
TAS	2	$ 7,706,080	$ 3.9 M
TOTAL NEM	11	$ 44,550,279	N/A

Source: AEMO, Non Market Ancillary Services (NMAS) report 2023-24, p.10.

The Panel's economic analysis shows that the estimated annualised benefits from the increased likelihood of effective restoration exceed the expected increased costs due to the proposed increased aggregate required reliability. The results from this analysis are included in appendix B.

3.5 The draft Standard maintains the existing special restoration requirements for QLD and NSW

The draft Standard retains the current special geographic requirements for NSW and QLD electrical sub-networks while aligning the drafting with the revised concept of forming a "restoration island" as the stage one restoration target.

Box 8: Applicability of the Standard in electrical sub-networks

The revised draft Standard maintains additional requirements, similar to the existing additional requirements, that:

- for the New South Wales electrical sub-network, AEMO shall procure SRAS, sufficient to also independently restart, form and maintain at least one restoration island north of Sydney within two hours of a major supply disruption without drawing power from the power system, with an aggregate reliability of at least 75 per cent.
- for the Queensland electrical sub-network, AEMO shall procure SRAS, sufficient to also independently restart, form and maintain at least one restoration island north of Bundaberg

37 The Panel notes that actual SRAS procurement outcomes would be subject to the specific operational characteristics of SRAS offered and AEMO's assessment of the related power system requirements.

> within two hours of a major supply disruption without drawing power from the power system, with an aggregate reliability of at least 80 per cent.

The additional regional requirements for QLD and NSW were previously determined to provide value to consumers in the QLD and NSW regions and reflect the network topography and geography of the respective electrical sub-networks. The value of SRAS in the respective network locations is based on potential restoration delays associated with the absence of a restoration source in these areas of the power system, based on the size and layout of the transmission network.[38] As the Panel noted in its 2016 determination:[39]

> a delay to supplying the auxiliaries of the New South Wales generators north of Sydney would significantly delay the restoration of the sub-network, due to the large distance between these generating units and the generation in the south of the sub-network.

The Panel understands that the reasons for the existing additional restoration requirements in NSW and QLD continue to be valid and true, therefore these requirements are maintained in the draft Standard.

The drafting for these additional requirements has been amended in the draft Standard to remove reference to a specific MW level of supply restoration and instead require AEMO to form at least one restoration island, north of Sydney in NSW and north of Bundaberg in QLD (respectively) within 2 hours. This maintains the existing specific geographic requirement, while providing AEMO with greater flexibility as to the specific operational characteristics required for initiating restoration in each of these locations.

3.6 Consideration of sensitive loads

The Panel has considered the impact on sensitive loads in making its draft determination for a revised Standard. In the context of stakeholder concern highlighting the risks of significant commercial impacts to aluminium smelters following major supply disruptions, the Panel's draft determination is for AEMO to consult with JSSCs on the strategic location of SRAS and the implications for priority and sensitive loads.

Box 9: Consideration of sensitive loads

The draft Standard includes an additional requirement for AEMO to consult with JSSCs in each region in relation to the strategic location of SRAS and the system restart implications for priority loads and sensitive loads.

The proposed drafting for this requirement is:

> AEMO must consult with the relevant jurisdictional system security coordinator (JSSC) in relation to the strategic location of SRAS for each electrical sub-network and the existence of any sensitive loads and/or related energy support arrangements. The JSSC may provide advice to AEMO in relation to the strategic location of SRAS,

38 The rationale for the QLD locational requirement is set out in the Panel's 2021 determination for the system restart standard. The rationale for the NSW locational requirement is set out in the Panel's 2016 determination for the system restart standard.

39 Reliability Panel, Review of the System Restart Standard - Final Determination, 15 December 2016, p.v.

> based on its assessment of the implications for priority loads and any sensitive loads. AEMO must consider any such advice when determining the strategic locations of SRAS, and report to the Panel in writing how it has considered the advice.

This change addresses stakeholder concerns in relation to the importance of restoring sensitive loads within critical timeframes given the potentially significant economic costs. The proposed approach is intended to align with the NER framework, including the requirement for:

- the Panel to determine the standard in accordance with the SRAS Objective
- JSSCs to advise AEMO of the priority of loads including any sensitive loads in their region.
- the roles and responsibilities for AEMO to procure SRAS in accordance with the Standard.

The following sub-sections summarise stakeholder submissions to the issues paper with respect to how sensitive loads are incorporated into the system restart arrangements and the Panel's considerations supporting its draft determination.

3.6.1 Summary of stakeholder submissions with respect to consideration of sensitive loads

The Panel notes concerns expressed by Tomago Aluminium Company (TAC) and The Australian Aluminium Council around appropriately accounting for and integrating key sensitive loads, such as aluminium smelters, through the system restart framework and planning arrangements, including the system restart standard. The Aluminium Council noted that:[40]

> after around 75 minutes without electricity, aluminium begins to "freeze" in the pots, which can force plant/line interruption and potentially freezing cells with a restart which can take months to complete at significant cost. For example, following a prolonged power outage at Portland Aluminium Smelter in 2016, it took more than 6 months to restore the capacity of the smelter.
>
> [...]
>
> While smelters are usually identified as sensitive loads, the timeframes for restoration of energy do not currently reflect either the impact of delayed restoration nor does it reflect the role smelters could have in system restart efforts.
>
> It is imperative that the regulatory framework supports the development and implementation of technologies capable of restarting the network infrastructure in emergency events to mitigate this risk.

TAC also expressed concerns in relation to the risks posed to the operation of its aluminium smelter at Tomago in NSW following a major supply disruption under the current system restart plans.[41]

> the existing regulatory framework does not currently provide viable system restart plans to ensure that power is restored within a critical timeframe to avoid total business loss of our operations due to potline freeze. TAC is identified as a sensitive load in the NEM and has been independently acknowledged as a significant economic risk and liability to the Australian economy should it be impacted by a prolonged power outage.

40 Australian Aluminium Council, submission to the Issues paper, 30 January 2025, p.3.

41 Tomago Aluminium Company, Submission to the Issues paper, 30 January, 2025, p1.

TAC proposed a number of actions to address its concerns and reduce the risk posed to its operations from delayed restoration of supply following a major supply disruption. The TAC proposals included that:[42]

- System restart plans should account for actual critical timeframes needed to restore each unique sensitive load to avoid catastrophic business loss.
- Sensitive loads are appropriately consulted to improve restart modelling, including:
  - technical suggestions for restoring sensitive loads within critical timeframes during system black events, and
  - determining the economic benefit to the NEM from leveraging sensitive loads to help bring nearby generators back into operation following a system black event.
- Integration of TAC at the beginning of system restart in system restart plans could save our operation and may also provide significant advantages to help expedite and secure the system restart effort and should be reflected in the System Restart Standard to be a requirement of future system restart ancillary services.
- The Reliability Panel should also assess whether additional regulatory frameworks may need to be reviewed to provide for the development of technical solutions that are necessary to restore sensitive loads within their critical timeframes. For example, this may include the need for additional resourcing and funding for TransGrid to upgrade infrastructure that serves sensitive loads.
- Techno-economic modelling and scenario analysis should explicitly consider the costs and implications to the broader Australian economy for not successfully restoring sensitive loads.

3.6.2 The Panel's considerations with respect to sensitive loads

The Panel acknowledges the concerns expressed by TAC and The Australian Aluminium Council with respect to the significant economic role of aluminium smelters within the Australian economy and the potentially significant risks posed to these businesses in the event of a delayed restoration of supply following a major supply disruption.

In response to these concerns, the Panel has made a draft determination to include additional requirements in the Standard for AEMO to consult with JSSCs in relation to the strategic location of SRAS and the existence of any sensitive loads and/or related energy support agreements. This draft determination is informed by the NER requirements for the Panel's determination of the Standard guided by the SRAS Objective and the NEO.

The Panel's consideration of sensitive loads is guided by the NER and the NEO

The Panel notes that the NER sets out how the Panel shall determine the Standard, including authorisation for the Panel to vary the standard:[43]

> to reflect any specific economic circumstances in an *electrical sub-network*, including but not limited to the existence of one or more *sensitive loads*;

At the same time, the Panel is required under the NER to determine the system restart standard in accordance with the SRAS Objective.[44]

42 Tomago Aluminium Company, Submission to the Issues paper, 30 January, 2025, p3.
43 NER cl. 8.8.3(aa)(4)(B)
44 NER cl. 8.8.3(aa)(1)

In applying the SRAS Objective and having regard to the NEO, the Panel interprets that it must consider the "efficient operation and use of, electricity services for the long term interests of consumers of electricity". As such, the Panel's assessment of the potential costs associated with a major supply disruption and the costs and benefits of procuring SRAS to minimise these costs is contextualised by the long term interests of all consumers of electricity.

The draft Standard does not include specific supply restoration targets to accommodate sensitive loads

Guided by the SRAS Objective, the Panel does not consider it appropriate to set out specific supply restoration targets in the Standard to account for and prioritise the restoration of sensitive loads. This position is supported by the Panel's view that it would inequitable for other electricity customers to be disadvantaged through additional costs or otherwise on account of providing a service that is intended to primarily benefit one specific electricity customer.

The Panel notes that in the event that an individual customer or customers require an increased level of protection from major supply disruptions over and above that provided to them under the Standard, they may make standalone arrangements for the provision of such a service, either through onsite backup generation or by entering into a contract with a third party for energy support. The NER contemplate the existence of such an "energy support arrangement" which is defined as:

> **energy support arrangement**
>
> A contractual arrangement between a *Generator*, *Integrated Resource Provider* or *Network Service Provider* on the one hand, and a customer or *participating jurisdiction* on the other, under which *facilities* not subject to an *ancillary services agreement* for the provision of *SRASs* are used to assist *supply* to a customer during a *major supply disruption* affecting that customer, or customers generally in the *participating jurisdictions*, as the case may be.

Further, the NER requires that local black system procedures must appropriately incorporate any relevant energy support arrangement to which a Generator, Integrated Resource Provider or Network Service Provider may be party.[45]

The draft Standard would require AEMO to consult with JSSCs in relation to the impact of SRAS procurement on priority and sensitive loads

While the draft Standard does not include specific restoration targets to accommodate sensitive loads, the Panel does support improved consideration of the impacts on sensitive loads throughout the SRAS procurement process. The Panel considers that JSSCs are well placed to advise AEMO of the impact of SRAS procurement on priority and sensitive loads to inform AEMO's consideration of the strategic location of SRAS.

The Panel considers that requiring AEMO to consult with JSSCs in relation to the strategic location of SRAS and impact on priority and sensitive loads aligns with the JSSC's responsibilities under the NER to provide AEMO with information relating to sensitive loads and the priority of load shedding.[46]

The draft Standard would require AEMO to consider any advice provided by a JSSC with respect to priority and sensitive loads and to advise the Panel in writing as to how it has considered this advice. In setting this out in the draft Standard, the Panel recognises the need for clarity around

45 NER cl.4.8.12(f)(2)
46 NER cl. 4.3.2(f)

how AEMO is to act in response to any such advice from a JSSC, while at the same time allowing AEMO to exercise its judgement on SRAS procurement decisions and the strategic location of SRAS.

The Panel notes that due to the sensitive nature of any such advice from the JSSCs and AEMO, it would not be appropriate for the specific details to be made publicly available. As such, the draft Standard does not require publication of the advice.

3.7 Arrangements for implementation of the revised draft Standard

The Panel proposes that the draft Standard would take effect on 1 July 2027. This timing would allow a period of 18 months from the publication of a final determination as planned in December 2025 to the date the new Standard takes effect. This aligns with the timing provided by the AEMC in the terms of reference for the Review and allows sufficient time for AEMO to update the SRAS Guideline and make arrangements to procure sufficient SRAS, including black start and restoration support services, to meet the Standard.

4 Recommendations for a future system restart regulatory framework

The Panel has undertaken a review of the regulatory framework and processes related to system restoration in the NEM. The system restart regulatory framework set out the roles and responsibilities for the delivery of a system restart capability for the NEM, as a precaution against the risk of a major supply disruption leading to a black system affecting all or part of the power system. This includes defined roles for the Panel in determining the Standard, and AEMO in procuring SRAS to meet the Standard and preparing a system restart plan in cooperation with network service providers and market participants.

The Panel's assessment of the system restart regulatory framework is aligned with the Commission's terms of reference for this review in the context of the revised draft standard described in chapter 3. In that context, the Panel has given consideration to:

- The function of the current regulatory framework - and the expected impact of the revised draft Standard in allocating responsibility to support the efficient and effective provision of a system restoration capability in the NEM
- Recommendations and commentary on the system restart regulatory framework provided in AEMO's *System restart technical advice*
- Feedback provided by stakeholder submissions to the consultation paper
- Consideration of relevant issues through previous reviews and rule changes related to the system restart framework.
- Recommendations from the International System Operator Collaboration's (ISON) 2025 International System Restoration Review report.[47]

The Panel has set out its consideration of the system restart regulatory framework with respect to:

- **procurement and investment**, to assess whether the elements of the existing SRAS procurement arrangements enable AEMO to procure existing and new SRAS technologies (see section 4.1 for further discussion).
- **transparency and reporting arrangements**, to assess whether sufficient information is published for market participants to engage effectively in system restart planning (see section 4.2 for further discussion).
- the **LBSP framework,** to assess whether it supports the provision of quality information to support AEMO's restart planning efforts (see section 4.3 for further discussion).
- **testing arrangements**, to assess the flexibility of the current framework to support the consideration of potential new restart pathways (see section 4.4 for further discussion).
- **the role of the Standard**, to assess whether the current governance arrangements and requirements for setting the Standard remain fit for purpose for the transition (see section 4.5 for further discussion).

As set out in chapter 3, the Panel has determined a revised standard that provides AEMO with greater flexibility around how it plans for system restoration and procures SRAS. In the context of the revised draft Standard, the Panel considers that the current system restart regulatory

47 AEMO is one of six founding members of the ISON, formed in 2024. The network also includes CAISO (California), EirGrid (Ireland), Energinet (Denmark), ERCOT (Texas) and NESO (UK) and collectively focuses on real-world, practical solutions to enable the operation of reliable, secure, high-renewable power systems. The 2025 ISON report is available on the AEMO website here.

framework provides AEMO sufficient flexibility and guidance to procure the capability required to support system restart planning into the foreseeable future. The Panel makes draft recommendations for AEMO to leverage the existing arrangements to adapt system restart planning to meet the changing needs of the power system.

4.1 The existing framework supports AEMO's procurement of SRAS

AEMO's advice has identified a need for new ways of incentivising investment in SRAS capability. AEMO has recommended that the Panel consider revising the Standard to provide AEMO with the flexibility to procure SRAS to support system restoration in a transitioning system and to support adequate investment in SRAS capability.

In response to AEMO's advice, the Panel:

- has determined a revised draft Standard to provide AEMO with greater flexibility around how it determines the system restart requirements to unlock its procurement of SRAS.
- reviewed the NER framework that sets out the obligations and requirements for the procurement of SRAS.

The Panel considers the NER provides AEMO with sufficient flexibility and discretion to support the specification and procurement of SRAS. This is provided for by:

- the SRAS definition, which provides AEMO with discretion to consider a broad range of technologies to support system restoration.[48]
- the SRAS Procurement Objective, which supports AEMO in using a range of commercial arrangements including establishing long term contracts and investing in the development of new SRAS capability.[49]
- Type 2 contracts under the Transitional Services Framework, which can be used for trialling technologies to understand whether they may contribute to system restoration.[50]

The Panel makes recommendations to support the trialling and investment in new SRAS capability and the procurement of services required to deliver a system restart capability into the future.

Recommendation 1: Procurement and Investment

The Panel recommends AEMO:

1. proactively engage with the market to identify future system restart needs by leveraging flexibility in the existing system restart framework to procure SRAS and meet any identified SRAS gaps in a timely manner.
2. use Type 2 transitional service for trialling new SRAS technologies to understand their potential role in system restoration.

48 Chapter 10 of the NER.
49 NER, clause 3.11.7(a1).
50 NER, clause 3.11.11(b)(2).

4.1.1 AEMO's advice includes recommendations to support the provision of adequate system restart capability

AEMO points out that the current Standard and associated procurement practices have not delivered consistent investment in new SRAS sources.[51] AEMO has noted that:[52]

- the prescriptive nature of the current Standard acts as a barrier to AEMO considering a broader range of SRAS to respond to transitioning system needs
- the current Standard targets the procurement of SRAS to support early stages of restoration. As the network, generation mix and load availability continues to evolve, confidence in the ability to restore the system beyond this initial target is declining.
- the early-stage targets in the current Standard do not create incentives for the procurement of restoration support services required to stabilise IBR in weak areas of the network
- the settings within the current Standard are set based on possible generation restoration with the historically available fleet of resources and not because these values will allow for a successful and ongoing system restoration. These resources may not be reflective of a future SRAS fleet.
- the system restart framework could better support co-investment decisions so that new plant, resources and network assets are planned and designed considering the capability to deliver multiple system services, including system restart.[53]

Box 10: AEMO's technical advice - procurement and investment

Recommendations to revise the Standard

- The Standard should be amended to allow AEMO the flexibility to create and maintain stable restoration islands, along with an option to procure SRAS further along the restoration curve.
- The Standard should include the following:
  - A requirement for AEMO to determine the amount of SRAS to procure to create and maintain stable restoration islands in stage one and extend the islands through stage two of system restoration.
  - Flexibility for AEMO to determine the quantity of SRAS (both black start and restoration support services) to procure.
  - Specific ability for AEMO to procure a prudent amount of additional or alternative SRAS to cater for reasonable network risks.
  - Improved ability to consider services and implementations that support the restoration of smaller islands or sub-sets of the grid.

Recommendations for regulatory reform

- Options to support adequate investment in SRAS capability should be explored, given the current SRS has delivered limited investment in new SRAS sources and the significant risk of insufficient new SRAS sources coming online prior to the possible exit of existing providers.
- The above options should also consider co-investment decisions so that new plant, resources and network assets are planned and designed considering the capability to deliver multiple system services, including system restart.

51 AEMO, 2025. System restart technical advice. p.5.
52 AEMO, 2025. System restart technical advice. p.54.
53 AEMO, 2025. System restart technical advice. p.6.

Source: AEMO, 2025. System restart technical advice. p.6.

AEMO is also proposing to use Type 2 contracts under the Transitional Services Framework to accelerate demonstration of system restoration capabilities from new technologies.[54] As the network topography changes, including the technologies underpinning the power system, so too must the approach to supporting system restart. AEMO notes that investment in new SRAS sources will be required to deliver new SRAS capability to replace that provided historically by thermal generation that is expected to become less available and retire over the next decade.[55] The technical capabilities of these new technologies would need to be trialled, including through use of Type 2 transitional service contracts, before such technologies could be contracted through SRAS procurement arrangements.

4.1.2 The NER provides AEMO with sufficient flexibility and discretion to support the specification and procurement of SRAS

The Panel considers:

- The draft Standard provides AEMO flexibility to procure additional SRAS, over the current Standard, to meet a deeper restoration target. This includes consideration for additional black start SRAS capability through the increased aggregate reliability requirements in several NEM regions.[56]
- The current framework provides AEMO with discretion in how it defines and procures SRAS, giving AEMO the flexibility to determine the technical and commercial arrangements related to SRAS procurement.

The revised draft Standard provides AEMO with greater flexibility around how it determines the system restart requirements to unlock its procurement of SRAS

The Panel acknowledges the concerns expressed by AEMO in its technical advice on the current Standard. The Panel considers that the current Standard supports the procurement of SRAS to initiate the re-energisation of the power system following a black system event and is likely to continue to drive the procurement of black start SRAS capability. To date, the Standard has driven procurement outcomes that provide confidence in the restoration process. This is because SRAS sources have predominantly been synchronous generation which provides a range of inherent power system characteristics that act to preserve system strength as the system is restored.

However, the Panel also recognises that by 2035, AEMO would need to design a restoration process that supports the energisation of renewable based IBR in early stages of the restoration process and this will require a different fleet of SRAS capability than that presently considered. In the interim, the system restoration process would need to support a power system with a wider variety of operational conditions while drawing on diminishing synchronous capability. For example, in its next procurement process, AEMO would need to consider the procurement of restoration support services that would support the energisation of the system during day-time hours when rooftop PV penetration is high.[57]

To respond to these upcoming challenges, AEMO will need the flexibility to procure both black start and restoration support services to respond to novel SRAS risks identified, that could exist throughout the restoration process. Therefore, the Standard has been revised to alleviate barriers

54 AEMO, 2025. System restart technical advice. p.5

55 Ibid.

56 The draft Standard increases the aggregate reliability from 90% to 95% in NSW, Qld, SA and Vic. This could drive the procurement of an additional black start SRAS source in these regions. For further information refer to chapter 3.

57 AEMO, 2025. 2025 General power system risk review final report. p.13.

to procure black start and restoration support services and provide improved confidence in restoration outcomes.

The Panel considers that the draft Standard addresses AEMO's recommendations for changes and inclusions to provide AEMO the flexibility to create and maintain stable restoration islands, along with an option to procure SRAS further along the restoration curve. The revised Standard is expected to deliver benefits for electricity consumers by:

- providing AEMO with increased flexibility around how it plans for the initiation of system restart. This will allow AEMO to consider new ways of initiating restart, including via the use of smaller restoration islands or sub-sets of the grid.
- supporting the procurement of additional restoration support services to address operational challenges throughout stage two of the restoration process. This is expected to provide value to electricity consumers through increased certainty over the restoration outcome.
- supporting AEMO's consideration of additional black start capability to improve the reliability of restoration outcomes for each electrical sub-network.

As discussed in Chapter 3, the Panel recognises that some increase in SRAS expenditure is expected in the future as a result of:

- the procurement of additional new restoration support services to meet the draft Standard
- capital costs for trialling and building new black start SRAS capability to replace the retirement of existing capability.

However, the Panel notes that the Standard is part of the broader restart framework in the NER that balances the provision of flexibility for AEMO to consider technical and commercial decisions for SRAS procurement with prudent SRAS expenditure. This is explored in the sub-sections below.

The NER provides AEMO with discretion around the technical specification and commercial procurement of SRAS

The elements of the NER that support AEMO's consideration of technical specification and commercial procurement of SRAS include:

- Chapter 10 definition of SRAS, which enables AEMO to procure black start capability and define any other capability it considers necessary for SRAS as a restoration support service.
- The SRAS Objective and SRAS Procurement Objective which guide the Panel's determination of a Standard and AEMO's obligations in meeting that Standard at lowest long-term cost.[58]

These elements set out the governance arrangements that balance the flexibility provided to AEMO to operationalise system restart planning, with guidance that supports prudent investment in SRAS.

The SRAS definition provides AEMO with discretion to consider a broader range of technologies to support system restoration

Chapter 10 of the NER defines SRAS as:

> A service provided by *plant* or *facilities* with:
>
> (a) *black start capability*; or
>
> (b) the capabilities described in the *SRAS Guideline* to supply one or more services to sustain the stable *energisation of generation* and transmission,

58 NER, clauses 3.11.7(a1) and 8.8.3(aa)(1)

sufficient to facilitate the restoration and maintenance of *power system security* and the restart of *production units* following a *major supply disruption*.

While black start capability is defined under Chapter 10 of the NER, part (b) of the definition of SRAS provides AEMO with the discretion to define the services it considers necessary to sustain the stable energisation of generation and transmission. AEMO defines these services as restoration support services in the SRAS Guidelines.[59]

The Panel considers the SRAS definition appropriately encompasses the range of current and future technologies that would be required for system restoration. The definition provides AEMO with the flexibility to adapt to the needs of the transitioning system restart by amending the services it considers as restoration support services to include services such as those provided by network assets, Battery Energy Storage System (BESS) and IBR that could support the restoration process.

The Panel notes stakeholder feedback from its issues paper that the requirements for IBR to participate in SRAS provision is currently not clear.[60] [61]The Panel considers that AEMO is able to provide further clarity to market participants on specific technical requirements for the services it requires for SRAS through the SRAS Guideline. The NER requires AEMO to consult with registered participants and other persons who have identified themselves as having interest in the SRAS Guideline.[62]The Panel encourages AEMO to engage directly with market participants to inform the technical specifications it sets out in the SRAS Guideline.

The Panel also notes the changes that were made to the SRAS definition under the *SRAS Rule 2020*. This rule was made in response to a rule change request from AEMO which requested:

- the definition of SRAS is amended to refer to both black start capability and system restoration support services
- AEMO is to define restoration support services in the SRAS Guideline
- the definition of black start capability is amended to allow for this capability to be provided by both generating units and other facilities.

The Panel notes the Commission's rationale for the expanded definition of SRAS to:[63]

- allow emerging technologies, such as batteries with 'grid-forming' inverters, or plant combinations (e.g. an asynchronous generator combined with a battery storage system) to be procured by AEMO to provide black start capability in the future
- increase competition for the provision of black start capability from an expanded range of facilities, reducing the costs of these services for consumers
- allow AEMO to procure system restoration support services, providing for the capability to support the grid during a restart process to be valued under the NER and available when required
- provide AEMO with the flexibility to define the specifics of system restoration support services in the SRAS guideline, allowing AEMO to determine what capability is needed to support system restoration at any given time and within different electrical sub-networks, and to revise these services as required to adapt to changing system conditions.

59 The current restoration support services are defined in Section 3.4 of AEMO's 2021 SRAS Guideline.

60 Ausgrid submission to the Review of the System Restart Standard Issues Paper, p.7.

61 EnergyAustralia submission to the Review of the System Restart Standard Issues Paper, p.2.

62 NER, clause 3.11.7(f).

63 AEMC, System restart services, standards and testing, Rule determination, 2 April 2020, p.43.

The SRAS procurement objective supports AEMO in considering a range of commercial arrangements including establishing long term contracts and investing in the development of new SRAS capability

The Panel considers the NER framework provides AEMO with considerable flexibility to procure SRAS through commercial arrangements based on any procurement process that it consider will meet the SRAS procurement objective.[64] While AEMO is required to set out its proposed SRAS procurement processes in the SRAS guideline, it has complete discretion and flexibility under the NER around the specifics of any procurement process it considers is fit for purpose.[65]

AEMO is not restricted in the procurement approach it uses to meet the SRAS Procurement Objective. If AEMO proposes to acquire an SRAS:[66]

> AEMO must enter into an ancillary services agreement with a prospective SRAS provider following the completion of **any procurement process to acquire SRAS** which AEMO is satisfied will enable it to meet the SRAS Procurement Objective.

This includes provisions for AEMO to contract both registered and non-registered market participants for the provision of SRAS.[67] AEMO's SRAS procurement may also utilise any competitive or non-competitive process to acquire SRAS, including processes to enter direct negotiations and invite potential SRAS providers to contact AEMO directly to offer SRAS services.[68]

At the same time, AEMO has discretion to determine the contract length for SRAS ancillary services agreements as required to maintain existing capability and support investment in new SRAS capable plant.

The primary restriction on AEMO's procurement of SRAS is the SRAS Procurement Objective, which is defined in the NER as:[69]

> AEMO must use reasonable endeavours to acquire SRASs to meet the system restart standard at the lowest long-term cost

AEMO is required to provide guidance to Registered Participants on how it will achieve the SRAS Procurement Objective in AEMO's SRAS Guideline.[70]The Panel considers that the NER provisions for AEMO to develop the SRAS Guidelines provide AEMO flexibility in its approach to procuring SRAS, enabling AEMO to:

- determine a procurement approach AEMO sees fit in acquiring SRAS and set out this process in the SRAS Guideline[71]
- set out its process to negotiate the provision of SRASs without a competitive tender process[72]
- set out its process for a potential SRAS provider to contact AEMO to offer the provision of SRASs without a competitive tender process, which offer AEMO is in no way obliged to accept.[73]

64 NER cl.3.11.9(a)
65 NER cl.3.11.7(d)(5)
66 NER, clause 3.11.9(a)
67 NER cl. 3.11.9(b) and 3.11.9(c).
68 NER cl. 3.11.7(6) and 3.11.7(7).
69 NER, clause 3.11.7(a1)
70 NER, clause 3.11.7(d)(5A)
71 NER, clause 3.11.9(a) and 3.11.7(d)(5).
72 NER, clause 3.11.7(d)(6)
73 NER, clause 3.11.7(d)(7)

The Panel also notes that the Commission considered and amended the SRAS Procurement Objective through the determination of the *SRAS rule 2020.* This rule amended the SRAS procurement objective through the addition of "lowest long term cost" to provide AEMO with greater flexibility to consider entering into longer term SRAS contracts or paying for capital works, if this would result in lower long term costs. This change was intended to support investment in new SRAS capability through long-term contracts as required to meet future system restart requirements.[74]

The Panel is interested in stakeholder views on whether it would be appropriate for AEMO to be provided greater discretion in the Rules to determine commercial arrangements

The Commission noted in the SRAS Rule 2020 Final Determination that the SRAS Procurement Objective could be amended to provide AEMO further flexibility by referring to the NEO, instead of 'lowest long-term costs' (as originally proposed by AEMO in its rule change request). However, at the time, the Commission noted this would markedly reduce the clarity around AEMO's obligations when procuring SRAS, as it would have a very broad discretion in how it interprets and applies the NEO.

The Panel notes the challenges in procuring new SRAS capability that were identified by AEMO in its system restart technical advice. Given this, the Panel is interested in stakeholder views on whether it would be appropriate or necessary for the NER to provide greater flexibility to AEMO in relation to the processes it may use for the procurement of SRAS and the role of the SRAS Procurement Objective.

The Panel discusses the governance arrangements related to the Standard in section 4.5.

Question 1: Procurement and investment in SRAS capability

The Panel is interested in stakeholder views on the appropriateness of the NER framework that relate to the procurement of SRAS including the SRAS Procurement Objective.

- In the context of the revised draft standard, do stakeholders agree that the NER provides AEMO with sufficient flexibility and discretion to support the specification and procurement of SRAS to meet the needs of the power system through the transition?
- What are stakeholders' views on the appropriateness of the SRAS Procurement Objective - that AEMO procure SRAS to meet the standard at lowest long term cost?

4.1.3 The Panel encourages AEMO to use Type 2 contracts for trialling technologies to understand whether they may contribute to system restoration

The Panel supports AEMO with its plans to undertake a program of priority technology trials for system restart, which may include the use of Type 2 contracts under the NEM's Transitional Services Arrangements.[75]

To improve understanding of some technologies that have not previously been demonstrated for supporting system restart in Australia, AEMO is considering undertaking priority technology trials to identify how they may meet the technical needs of system restart.[76] Such trials would also

74 AEMC, System restart services, standards and testing, Rule determination, 2 April 2020, p.68

75 "Type 2 contracts" are contracts for services pursuant to NER, clause 3.11.11(b)(2).

76 AEMO, 2025. System restart technical advice. p.5.

reduce commercial risks of tendering such services, without first understanding the impact of such technologies.

AEMO notes it intends to conduct specific trials for grid forming inverter (GFM) based plant.[77] The trials would help enhance the understanding of IBR behaviour during stage one and stage two of system restart process to determine when and which IBR can be securely reconnected and re-energised during a system restoration event, potentially unlocking valuable capacity to support network and load restoration. While studies suggest that GFM can establish voltage and frequency reference, energise network components and coordinate with other generation sources, the practical effectiveness of GFM in large-scale black start events has not been sufficiently verified and real-world demonstrations remain limited.[78]

The Panel notes that Type 2 contracts under the Transitional Services Framework can be used in specific circumstances:

- Type 2 contracts can only be used to trial either new technologies or the new application of existing technologies.
- Any existing technology must not have been used to manage system security before 28 March 2024. This does not preclude assets if they are providing security services in a way that is distinct from their previous services.
- Type 2 contracts have a maximum duration of 10 years and must not extend past 1 December 2039. The entire transitional service framework sunsets on 1 December 2039.

The Panel recognises the procurement of transitional services could increase overall expenditure on system restart capability. However, the Panel notes there are several measures embedded in the NER transitional services framework, as well as reporting obligations, which provide guardrails that ensure prudent investment when using Type 2 contracting, including:

- **objective to minimise costs:** the Transitional Services Procurement Objective requires AEMO to minimise the costs of transitional services to end users.[79]
- **competitive and direct procurement:** AEMO is required to publish a Transitional Services Guideline (for procuring Type 1 and 2 contracts) which includes setting out processes for competitive tendering and direct procurement of services under these contracting mechanisms. [80]

Box 11: The Rules set out requirements to support prudent investment in new technology trials

Objective to minimise costs

- AEMO must comply with the Transitional Services Procurement Objective under NER clause 3.11.11(c)(3). It provides that if AEMO identifies a need to acquire transitional services, AEMO must use reasonable endeavours to acquire transitional services to, among other things, minimise the costs of transitional services to end users.

77 Ibid. p.60.
78 Ibid. p.60.
79 NER, clause 3.11.11 (c)
80 NER, clauses 3.11.11(d)-(f)

- AEMO's Transitional Services Guidelines notes that it may consider services that are not the lowest cost in themselves, but through the trial of new technologies or new application of existing technologies, may lead to lower long-term costs to end users.
- Costs will be recovered from market customers, and the framework (including costs) will be reviewed by the AEMC after seven years (2031). Further, AEMO must report on costs in the transitional services annual report.

Competitive and direct procurement

- AEMO's Transitional Services Guideline sets out the procurement process, which includes processes for a competitive tender and direct procurement with anyone who can meet the technical and other requirements set out in the statement of need.
- The Improving security frameworks (ISF) final determination emphasises the importance of achieving a competitive process whenever feasible. On page 68 of the final determination, the Commission noted "Prioritising competitiveness is crucial in ensuring a fair and dynamic environment, contributing to a market that encourages diverse participation and enhances efficient outcomes in the interests of consumers".
- In assessing any tenders submitted, as per NER clause 3.11.11(h), AEMO must ensure they are competitive, which includes ensuring they minimise the overall cost of supply of the service.

4.1.4 The Reliability Panel supports further work to support investment in essential system services through the electricity services entry mechanism

The Reliability Panel recognises the potential opportunity provided by the Electricity Services Entry Mechanism (ESEM), proposed by the NEM Review Panel, to support co-investment in new SRAS-capable equipment.

The ESEM is designed to facilitate the entry of new energy services into the market. This includes provisions for co-investment in essential security services (ESS). The NEM Review Panel considers system restart services to be an ESS.[81]

The Reliability Panel supports further work to support investment in Essential System Services through the ESEM, consistent with recommendation 8b in the NEM Review Panel's draft report, which states.[82]

> Where cost-effective, projects facilitated through the ESEM should also be able to provide Essential System Services. The ESEM administrator should coordinate with transmission network service providers (TNSPs). This should take the form of secondary contracting for the specific elements of the project that relate to providing ESS.

The ESEM has the potential to support the provision of new SRAS capability that AEMO advises will be required to make up for the expected retirement of existing black start capable generation. This support could be in the form of:

- targeted co-investment in SRAS capability to meet specific system needs as identified in advance by AEMO.

81 NEM Review Panel, National Electricity Market wholesale market settings review - Draft Report, August 2025, p.33.

82 Ibid. p.21.

- a generalised requirement for ESEM beneficiaries to have the capability to provide at least one type of SRAS, this could include the capability to provide a black start or restoration support service as determined and specified by AEMO.[83]

4.2 The Panel recommends enhanced forward-looking restart reporting to provide transparent signals for investment in new SRAS capability

The Panel recognises that transparency around the future needs for SRAS are central to stimulating investment in new system restart capability. While the historical approach to SRAS reporting has been generally backward looking, the Panel considers that improved forward-looking reporting by AEMO is critical to identify and meet future system restart needs for the NEM. This draft determination includes draft recommendations for AEMO to report on future system restart needs and investment opportunities through the TPSS and the ESOO (or similar publication) from 2026. The Panel suggests that this forward focused reporting be guided by restoration modelling produced by AEMO that considers SRAS needs as thermal generation retires and is replaced with growing levels of IBR over the next decade.

The Panel notes that stakeholder feedback to the Panel's issues paper encouraged the Panel to review the current reporting arrangements and consider the need for additional forward-looking reporting of SRAS needs.

Recommendation 2: Transparency and reporting

The Panel recommends:

1. From 2026, AEMO sets out in the TPSS how it plans to deliver system restart capability through the transition to a low- or zero-emissions power system, including:
   a. setting out the future system restart needs for the NEM based on future focused restoration modelling that accounts for the contribution of IBR and the expected closure of coal-fired generation over the three planning horizons set out in the TPSS.
   b. engagement with the Panel on the future system restart needs and associated restoration modelling.
2. From 2026, AEMO report on identified SRAS investment opportunities through the Electricity Statement of Opportunities (ESOO) or similar publication.

4.2.1 Stakeholders submissions were supportive of enhanced reporting on future SRAS needs

In the issues paper, the Panel explored transparency and reporting in relation to SRAS sufficiency and emerging system restart risks. The Panel investigated whether the current reporting arrangements provide sufficient transparency to signal the need for investment in new SRAS capability. Stakeholders recognised the importance that transparency and reporting play in creating appropriate market signals for SRAS investment.

CS Energy highlighted that signals and incentives for investment in new system restart capability rely on transparency on future needs and their value, and raised concerns about the current level

83 For reference, AEMO proposed a similar general technical performance standard for SRAS capability in its 2020 SRAS rule change request, further detail on this is set out on page 5 of the AEMC Final Determination - System restart ancillary services, standards and testing Rule 2020, published 2 April 2020.

of transparency over future SRAS needs. CS Energy also emphasised the importance of providing signals over both operational and investment (10+ year) timeframes"[84]

AusNet suggested that the Panel consider two separate forward-looking reporting requirements. For example, the first report could be a 'planning report' that requires planning input with TNSPs to test the identified need and feasibility of SRAS options before procurement decisions are made. The second report could be an updated non-market ancillary services (NMAS) report that summarises outcomes from the planning report for a wider audience, including SRAS investors and electricity consumers.[85]

AEMO considered the reporting requirements to be second order but necessary to support the development of system restart services.[86]

4.2.2 There is an opportunity for enhanced forward looking restart reporting

Each year, AEMO reports on SRAS expenditure for the previous financial year, by electrical sub-network. This reporting provides information on costs associated with the acquisition and testing of SRAS. The Panel recognises there is an opportunity to enhance reporting arrangements by providing a forward outlook on upcoming SRAS needs.

The Panel considers that enhanced forward-looking reporting arrangements would provide improved clarity to market participants to support decisions to invest in the provision of the required SRAS capability.

The historical approach to SRAS reporting has been backward looking

Currently, AEMO is required under the NER to report system restart preparedness and sufficiency through the NMAS annual report. This is a backward looking arrangement, where AEMO reports on the process followed to acquire SRAS, costs of procuring SRAS and whether AEMO has been unable to meet the Standard and reasons for this. The Panel considers this reporting function does not sufficiently work to attract future investment, as it does not set out a forward-looking strategy for future SRAS needs.

The NER requires AEMO to report annually through its non-market ancillary services report on:[87]

- the processes followed by AEMO to acquire SRAS for each electrical sub-network
- the total cost of procuring SRAS in each sub-network and region
- whether AEMO has been unable to procure sufficient SRAS to meet the Standard and the reasons for this.

Forward-looking reporting on system restart needs aligns with international best practise

The Panel recognises the extensive reform to the system restart regulatory framework undertaken by the United Kingdom (UK). On 1 April 2021, the UK government introducing a legally binding target for a new Electricity System Restoration Standard (ESRS). The new ESRS requires the market operator, National Grid Electricity Service Operator (NESO) to have sufficient capability and arrangements in place to restore 100% of Great Britain's electricity demand within 5 days. It was implemented regionally, with an interim target of 60% of regional demand to be restored within 24 hours.[88]

84 CS Energy, 2025. Submission to the system restart review issues paper. p.4.
85 AusNet, 2025. Submission to the system restart review issues paper, p.2.
86 AEMO, 2025. Submission to the system restart review issues paper. p.4.
87 NER, clause 3.11.10.
88 UK Government, 2021. Introducing a new electricity system restoration standard.

The ESRS is underpinned by a robust assurance framework that establishes a baseline level of testing and exercising of restoration capabilities, across the power sector. The assurance framework requires NESO to set out in a public report:[89]

- a forward looking strategy for the provision of Electricity System Restoration for:
  - the upcoming regulatory year
  - two regulatory years after that
  - subsequent regulatory years
- the restoration approach to ensure that the ESRS is capable of being complied with at all times during a regulatory year including the identification of technologies and approaches for the provision of Restoration Services;
- a description of how the licensee (NESO) will monitor its ability to comply with the ESRS at all times during a regulatory year
- ex-ante modelling of restoration times for the subsequent regulatory year using credible projections of the required transmission system data, as well as ex-post modelling of restoration times using actual transmission system data from the previous regulatory year
- sufficient details of the methodology, assumptions and data used in any restoration modelling, to reflect the capabilities of the transmission system during the subsequent regulatory year to allow participants to assess and provide comment on how well the operator is representing the capabilities of the transmission system within the modelling

The Office of Gas and Electricity Markets (OFGEM) is responsible for monitoring the assurance framework on an annual basis, providing the necessary assurance and confidence that the restoration process can be carried out across each region as intended.[90]

For further information on the system restart arrangements in the UK refer to appendix G.

4.2.3 SRAS needs should be identified in advance through the Transition Plan for System Security

The TPSS is a reporting requirement introduced in 2024 for AEMO, under the AEMC's Improving Security Frameworks for the Energy Transition Rule. In the TPSS, AEMO is required to outline the steps it will take to manage system security through the transition, supporting industry understanding of:

- how AEMO is planning to meet the security needs of the power system through the transition to a low- or zero-emissions system
- the current technical understanding of system security and work to improve this understanding and specify services.

AEMO is required to publish a TPSS annually.[91],which must set out:

- AEMO's current understanding of, and work on refining, security services and any operational metrics AEMO uses, or is developing, to manage security.
- a detailed description of AEMO's long-term plan to manage security and the work it is doing to address system security challenges as we transition
- the required capabilities or new entrant resources that could participate in managing system security
- a plan for how AEMO intends to move away from using the transitional services framework

89 Independent System Operator and Planner, Electricity System Operator, Licence Conditions. p.97-98.

90 UK Government, 2021. Introducing a new electricity system restoration standard.

91 NER, Clause 5.20.8

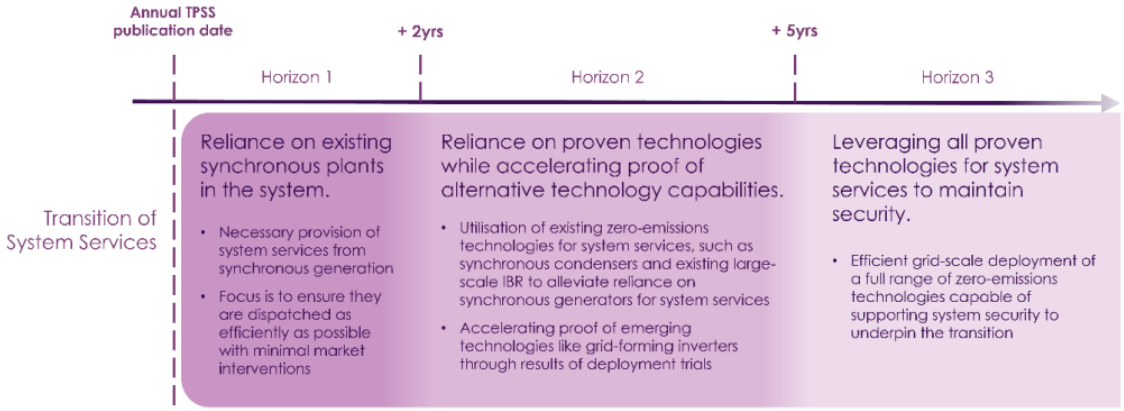
- the outcomes and learnings from the trials conducted through Type 2 contracts, and how this is contributing to long-term security management.

The Panel has the opportunity to provide input on the annual transition plan, with input due six months after the transition plan is published.[92] AEMO is then required to respond to any written commentary in its next TPSS.[93]

AEMO sets out three planning horizons in the 2024 TPSS:

- **Horizon 1** – operational planning for known transition points arising over the next two years which must be managed predominantly with today's assets and technology. This could include services being delivered through Type 1 Transitional Services contracts.
- **Horizon 2** – identifying potential future transition points in the two-to-five-year planning horizon to enable early preparation, and defining capabilities and progressing understanding of the security capabilities and services that will be required to manage them. Type 2 Transitional Services contracts could be used to prove relevant technological capabilities for this horizon.
- **Horizon 3** – progressing understanding of all elements of a low- or zero-emissions power system, initiating long lead-time activities (5+ years) that will enable preparation and investment in solutions to meet emerging needs.

Figure 4.1: System services transition timeline



Source: AEMO, 2024. Transition plan for system security. p.13.

The Panel recommends that starting from the 2026 TPSS, and in each subsequent year following, AEMO includes reporting in the TPSS related to system restart needs. The Panel suggests that this reporting on future SRAS requirements would:

Identify SRAS needs over all future planning horizons, which includes:

- a detailed description of how AEMO will meet the Standard over various planning horizons in each electrical sub-network,
- identifying upcoming SRAS risks in each electrical sub-network for each planning horizon
- supporting its findings by publishing results from future focused restoration modelling (see section 4.2.4 for further commentary on the Panel's recommendations for this restoration modelling)

92 NER, clause 5.20.8(d)
93 NER, clause 5.20.8(e)

Determine options to procure SRAS that meets identified SRAS needs, which includes:

- specific details of the required capabilities or new entrant resources that could participate in meeting identified regional risks. These findings should also be set out in the ESOO or a similar publication (as described further in section 4.2.5).
- details of required SRAS trials and the outcomes from existing trials of new SRAS technologies.

The Panel considers that this enhanced reporting on system restart on future system restoration needs is consistent with the NER requirements for AEMO to set out in the TPSS how it plans to maintain power system security through the transition to a low- or zero-emissions power system.[94]

The Panel is interested in stakeholder feedback on the information participants would need in the TPSS to understand system restart needs and support decision-making on developing SRAS capability.

Question 2: Reporting on future SRAS needs through the Transition plan for system security

- Do stakeholders support the Panel's proposal for enhanced reporting on future SRAS needs through the TPSS?
- What are stakeholders' views on the proposed approach and outputs for this reporting in the TPSS?

4.2.4 Enhanced forward-looking reporting would need to be underpinned by future focused restoration modelling

The Panel recognises the importance of future focused restoration modelling to identify how system restoration capability would be delivered following the exit of thermal generation, and support the procurement of SRAS in a timely manner to meet those needs. This is supported by AEMO in its general technical advice that supporting restart capability through the transition will require improved understanding of how new technologies can contribute earlier in the restoration process.[95]

The Panel considers forward-looking modelling is required to identify system restart needs and provide sufficient lead time to develop new SRAS capability prior to it being required to meet the Standard.

The Panel recommends AEMO undertakes future focused restoration modelling which informs how it plans to deliver system restart capability through the transition to a low- or zero-emission power system. The Panel anticipates AEMO would develop a forward-looking restoration model which identifies system restart needs over various planning horizons, as set out in the 2024 TPSS.

The Panel also invites AEMO to engage with it to develop its modelling approach and discuss preliminary findings prior to the publication of the 2026 TPSS.

The Panel considers this approach aligns with the following commentary in ISON's international system restoration review :[96]

94 NER, clause 5.20.8.

95 AEMO, 2025. System restart technical advice. p.60.

96 ISON, 2025. International system restoration review. p.6.

Overall, the prevalence of new IBR technology across the ISON jurisdictions surveyed will require at least some adaptation of existing restart plans to have robust restart capability with fewer synchronous generators available. Better accounting of IBR during system restart will aid in achieving this. However, the urgency behind such adaptation depends strongly on the specifics of each system, particularly regarding the interconnection to other capable regions, the rate at which traditional restart resources are being displaced by IBR, and changes to the type, amount and performance of load and embedded generation permeating the distribution network. Care must also be taken that non-power system trends such as increased reliance on remote workforces and public communication infrastructure do not undermine the capability of system restart sources when called upon.

Future focussed restoration modelling could align with the planning horizons set out in the TPSS.

Horizon one modelling

The Panel considers that reporting in horizon one (0-2 year outlook) would :

- be supported by detailed power system modelling that:
  - shows how the Standard would be met over a forward-looking two year period, accounting for any reasonable network risks.
  - is based on up to date LBSP information and information available from contracted SRAS providers.
- set out a proactive approach for the integration of IBR in system restoration
- identify any SRAS gaps in this period and set out how AEMO expects to fill these gaps using existing SRAS capability.

At minimum, the Panel considers this modelling would need to account for upcoming contract expiries and any SRAS capability that are forecast to exit over this period. The Panel also notes the 0-2 year outlook period may not provide sufficient lead time to build new SRAS capability.

Horizon two modelling

Horizon two would need to be supported by power system modelling that set out the projected SRAS requirements over a 0-5 year planning horizon.

The Panel considers modelling over horizon two (0-5 year outlook) would include investigations of system restart needs based on power system scenarios envisioned in the most recent publication of the Integrated System Plan (ISP). These scenarios would likely account for a range of timing for the expected retirement of thermal generation as well as other *credible* operating conditions (e.g., very low system load conditions beyond current forecasts). It would be beneficial for this modelling to cover a broader range of scenarios than used for investment planning (for example, beyond 10% probability of exceedance scenarios), and to identify situations where the Standard could not be met efficiently in future.

The Panel considers this horizon two modelling would need to account for:

- black start and restoration support services that will be available over this period
- the exit and reduced availability of existing black start capable resources
- a projection of the changing restart pathways and associated restoration timeframes based on the potential SRAS sources.
- development of new SRAS capability including a high level scoping of related capital works

- renewable energy zone development and the NEM's changing generation and network footprint
- the integration of IBR and DER in the system restoration process.[97]

Specifically, the Panel recommends that 2026 TPSS includes restoration modelling to account for any *potential* thermal plant closures by the end of the next SRAS procurement period. At a minimum, a proxy could be the fastest coal closures modelled in any ISP scenario by 2033. However, given the experiences in procuring SRAS to meet the Standard in the region north of Bundaberg in Queensland, the Panel recommends that AEMO should consider any potential risks to the provision of restart services over this five year horizon. This would allow for any service gaps to be identified in advance and provide at least four years to plan and make arrangements for the provision of new SRAS capability.

Horizon three modelling

AEMO's horizon three restoration modelling would set out a vision for system restoration over a time horizon beyond five years. In this context the Panel encourages AEMO to focus on the "end state" of the grid. That is, from a *planning* perspective, AEMO should understand how the grid will eventually need to operate before focusing on pathways to get there. This means rather than running many scenarios on potential outcomes for the transition, AEMO should focus resources on a scenario that focuses on the restoration of the power system with no coal generation capability.

The Panel considers that understanding the final "destination" (or, more likely, multiple potential "destinations") is critical for understanding whether current framework is fit for purpose, as well as how the procurement of resources through the Commonwealth Capacity Investment Scheme could be co-optimised with future system restart needs. Similarly, if new resources (e.g., batteries, gas peakers, or diesel generators) are being privately developed, there may be opportunities to locate these in areas that would support future restart pathways. With efficient procurement, it may be that the marginal costs of providing system restart in the future could be very low.

The Panel seeks to collaborate with AEMO in developing its approach to the future focused restoration modelling

The Panel invites AEMO to engage with it to help develop its modelling approach and provide feedback on the preliminary modelling outcomes, prior to AEMO's publication of the results and findings in the 2026 TPSS. As previously noted in the Panel's response to AEMO's 2024 TPSS, the Panel considers that AEMO's next priority is to understand the future resources required for the modelling of the grid. The Panel suggests that this engagement include:

- seeking input from the Panel on the proposed forward-looking restoration modelling approach, scope and forecast horizon.
- presenting draft forward-looking modelling results to the Panel for feedback prior to publication.
- responding to any written commentary provided by the Reliability Panel in relation to the forward-looking restoration modelling

97 This aligns with recommendation 3.2.10 from ISON's international system restoration review, which sets out that system operators "develop explicit treatment strategies for DER in restoration plans. Establish clear performance criteria for large industrial or IBR loads used during early restoration to prevent unexpected dynamic performance from destabilising a restoration attempt." Ref ISON, 2025, International system restoration review, p.6.

Question 3: Future focused restoration modelling approach and engagement

The Panel is interested in stakeholder views on the following:

- Do stakeholders support the recommendation for AEMO to undertake forward-looking restoration modelling and to engage with the Panel on the modelling approach and draft results?
- Do stakeholders have views or comments on the modelling approaches discussed in this section?

4.2.5 AEMO should publish identified opportunities for SRAS investment in the Electricity Statement of Opportunities or similar publication

In addition to reporting in the TPSS, the Panel recommends that AEMO report on SRAS investment opportunities through the ESOO or similar publication.

The ESOO provides technical and market data for the NEM over a 10-year period to inform the planning and decision-making of market participants, new investors, and jurisdictional bodies.[98]. Information AEMO must currently report on in the ESOO includes:

- projections of aggregate MW demand and energy requirements for each region
- capabilities of existing, proposed, and planned generating and bidirectional units
- planned plant retirements
- a summary of network capabilities and constraints
- proposed network developments (committed and non-committed)
- operational assumptions made by AEMO.

The Panel considers AEMO could take the ESOO further by reporting on SRAS procurement opportunities, including a description of any SRAS gap, a list of SRAS providers forecast to close, what opportunities are available for procurement, and ways in which costs can be minimised, including how this will be assessed. The Panel recommends that the ESOO, or similar publication, is updated to reflect the SRAS findings in the TPSS in line with the current ESOO publication cycle, or publication cycle of the similar publication, to include:

- a description of any SRAS gap, including a list of SRAS providers forecast to close
- the opportunities available for SRAS procurement and the location these services are required
- ways in which costs can be minimised and how this will be assessed.

The Panel considers this would be beneficial, as it goes beyond procurement for trialling that would be set out in the TPSS and sending investment signals for procuring restart services with known capabilities.

Question 4: Reporting on future SRAS opportunities through the Electricity Statement of Opportunities or similar publication

The Panel is interested in stakeholder views on the following:

98 NER, clause 3.13.3A

- Do stakeholders support the Panel's proposal for AEMO to report on future SRAS opportunities through the annual ESOO or a similar publication?
- What information would stakeholders find valuable in relation to the reporting on future SRAS opportunities?

4.3 The local black system procedure framework can be leveraged to enhance the quality of information provided to AEMO

The system restart plan, and thereby SRAS procurement needs, are informed by local black system procedures (LBSPs) that each generator, integrated resource provider (IRP) and network service provider (NSP) in the NEM is required to develop and provide to AEMO.[99] The LBSP includes all procedures, requirements and relevant performance of plant (including generation and network assets) during their restart. The LBSP information underpins system restart modelling and could go toward supporting the identification of gaps in restoration pathways and identifying opportunities for market participants to provide services to fill those gaps.

Recommendation 3: Local black system procedures

The Panel recommends:

1. AEMO review the LBSP Guidelines and related processes and investigate opportunities to support the timely provision of accurate information on the capabilities of power system equipment to support system restoration.
2. AEMO determine a set of critical LBSPs that it would audit prior to the commencement of its next procurement round, and that a more fulsome audit of LBSP is performed prior to the revised Standard becoming enforceable on 1 July 2027.

4.3.1 AEMO's technical advice suggested a need to review the LBSP process

AEMO's technical advice suggested the process for obtaining LBSPs should be reviewed to ensure LBSPs are available, accurate and up to date for all plant, alongside defined communications and availability protocols to maintain consistent communication during a restart event. Robust LBSP obligations and processes for all plant will also ensure AEMO can consider new viable restart pathways which may include facilities not previously re-energised during early restart.[100]

Box 12: AEMO high level advice - Local black system procedures (LBSP)

The LBSP process and obligations should be reviewed to ensure AEMO receives accurate, up to date and reliable information for plant to ensure they can be securely energised during restart.

Source: AEMO, 2025. System restart technical advice. p.6.

99 NER, clause 4.8.12(d)

100 AEMO, 2025. System restart technical advice. p.59.

4.3.2 The Panel considers the NER LBSP framework supports AEMO in considering enhancements to the LBSP process

The Panel considers the current LBSP framework:

- provides sufficient flexibility for AEMO to determine and seek out the information it requires through the development of the LBSP guidelines.
- imposes significant civil penalties (Tier 1) for non-compliance against this reporting obligation.

The current LBSP framework:

- sets out the governance arrangements for all Generators, IRPs, NSPs to develop and submit LBSP to AEMO in accordance with the LBSP Guidelines[101]
- reguires AEMO to develop and publish a LBSP guideline in consultation with registered Generators, IRPs and NSPs, which sets out:[102]
  - the information AEMO requires to understand the likely condition and capabilities of a plant following a major supply disruption
  - actions that the relevant participant must undertake following a major supply disruption, prior to the energisation or synchronisation to the grid
  - any relevant energy support arrangements to which relevant participants may be a party.
- provides AEMO with the power to approve new LBPSs or amendments to existing ones [103]
- imposes significant civil penalties (Tier 1) for any relevant participants that are non-compliant with this reporting obligation.[104]

The Panel recognises the LBSP forms important inputs into AEMO's system restart modelling and planning. The Panel considers LBSP information would be useful in identifying options for SRAS procurement when SRAS gaps are identified. The Commission's commentary on the LBSP framework from determination for the *SRAS Rule 2020* is set out in the Box below.

Box 13: Local black system procedures help AEMO identify options to fill any SRAS gaps identified

The Commission understands that the process through which AEMO would procure system restoration support services would generally be as follows:

- When determining system restart paths as part of the development of the system restart plan, AEMO will assess whether there is sufficient support capability available along the relevant path to enable an effective restoration. A "gap" in available capability along a restart path could arise if, for example:
  - a generator along the restart path that would historically have provided a restoration capability pursuant to the capabilities in its LBSP has been decommissioned and the service is therefore no longer available from that generator; or
  - improved or more detailed network studies or modelling identify a gap that was not previously identified.

101 NER, clause 4.8.12(d)
102 NER, clause 4.8.12(e)
103 NER, clause 4.8.12(g)
104 NER, clause 4.8.12(d) and *National Electricity (South Australia) Regulations* clause 6(1) and Schedule 1

- If AEMO identifies a gap along a restart path, it will assess whether there are other generators in the vicinity which are capable of providing the relevant support service under their LBSP. If AEMO identifies a generator with that capability specified in its LBSP, it will require that generator to provide that support service.
- If AEMO does not identify any generator in the vicinity that has this capability specified in its LBSP, it will look for generators that have the capability to provide that service (but where this is not explicitly specified in their LBSP), or that have the ability to build this capability into their plant. AEMO may then offer such a generator a contract to provide the relevant system restoration support service (if there is no other generator nearby that already has that capability specified in its LBSP).

Source: AEMC, System restart services, standards and testing, Rule determination, 2 April 2020. p.47.

The Panel recognises there are potential areas in which the LBSP process that could be enhanced including through:

- regular reviews of LBSP information
- stronger governance arrangements to support timely provision of data

The Panel considers that the NER provides AEMO flexibility to enhance its processes for acquiring LBSP information through revising the LBSP Guidelines. Clause 4.8.12(d) of the rules requires generators, integrated resource providers and network service providers to develop LBSPs in accordance with those guidelines.

The Panel considers AEMO has sufficient flexibility in the Rules to determine and seek out the information it requires through revisions of the LBSP guidelines, in consultation with relevant participants. This could include revising the information it requires from relevant participants, setting out clearer governance arrangements and setting out regular review processes of the information provided. The Panel also notes the significant penalties the NER enforces (Tier 1) for participants that do not comply with AEMO's requests for information.

To support timely and accurate provision of LBSP information, the Panel suggests that AEMO investigate opportunities to enhance compliance with the current NER obligations and the LBSP guidelines. The Panel considers this would support timely provision of accurate information on the capabilities of power system equipment to support system restoration.

The Panel also suggests AEMO undertake regular reviews of the LBSP framework to ensure the procedures remain fit for purpose. The Panel considers that understanding the accuracy of the information would support AEMO to identify gaps for system restart which could guide additional procurement efforts. The Panel recognises that some LBSPs are more critical to the function of existing system restart pathways and that the accuracy of the information within these critical LBSPs should be verified on a more frequent basis. Therefore, the Panel considers it would be prudent for AEMO to:

- determine a set of critical LBSPs that it would audit prior to the commencement of its next procurement round
- complete a more fulsome audit of LBSPs prior to the Standard becoming enforceable on 1 July 2027.

The Panel suggests the outcomes of this audit would form inputs into the forward-focused modelling, with outcomes of this modelling being set out in the 2026 TPSS, as set out in section 4.2.

Question 5: Enhancing the local black system procedure framework

- Do stakeholders support the Panel's recommendation for AEMO to update its LBSP guidelines?
- Do stakeholders support the Panel's recommendations for AEMO to undertake audits of LBSPs to support the provision of accurate information on the capability of power system equipment to support system restoration?
- What other actions could be taken to improve the provision of timely and accurate information to AEMO on the capability of power system equipment to support system restoration?

4.4 The Panel is seeking stakeholder feedback on the appropriateness of the SRAS testing framework in the NER

AEMO ensures the viability of the SRAS it procures through SRAS tests. The framework for SRAS testing is set out under NER clause 4.3.6. Regular and extensive framework testing deep into existing restart pathways provides assurances for successful restart following a black system event. AEMO and stakeholders in their submissions to the Panel's issues paper considered that the current testing framework could be expanded to enable more extensive testing of restart pathways. These tests would support AEMO in identifying SRAS gaps that it could procure in upcoming tender processes.

4.4.1 AEMO advice that the NER better support testing of existing and potential new restart pathways

In its technical advice, AEMO highlighted that the current restart pathways in the NEM have remained unchanged for a significant amount of time. In developing these pathways, extensive network testing and detailed modelling was conducted, which provides a high level of confidence in the respective pathways functioning in an actual event.[105] Given the changing pool of SRAS sources, network topography and available plant along existing restoration pathways, AEMO recognises there are:

- risks that existing pathways may have diminishing levels of confidence to rely on in a restart event.
- opportunities for investigating new pathways that have not yet been tested

AEMO has noted in its technical advice that the testing framework under NER clause 4.3.6 should be reviewed to expand obligations for system restart network testing to involve existing and potential new restart paths, with appropriate mechanisms for cost recovery.[106]AEMO considers that there is a strong need for a dedicated ongoing program of work to test new and existing restart pathways. AEMO considers that restart pathway tests should include:[107]

- the ability of BESS to restart nearby network and other generation plant
- the restoration of select IBR from traditional black start providers, and the impact on the stable restoration island, including the nearby network
- the ability to use/procure existing HVDC interconnectors as an SRAS resource
- the ability of REZs to form an independent restoration island.

105 AEMO, 2025. System restart technical advice. p.60.
106 Ibid.
107 Ibid.

AEMO notes that enhanced testing will become increasingly important as the range of SRAS sources and network elements included in restart paths expands.[108]

AEMO considers this requires stronger obligations within the NER.

Box 14: AEMO high level advice - testing arrangements

National Electricity Rules (NER) 4.3.6 should be reviewed to expand obligations for system restart network testing to involve existing and potential new restart paths with appropriate mechanisms for cost recovery.

Source: AEMO, 2025. System restart technical advice. p.6.

In its submission to the Panel's issues paper for this review, AusNet suggested that the Panel explore opportunities to improve the confidence and rigour expected from SRAS testing and system restart pathways, given the increasing operating risks during the energy transformation. One option suggested was to amend NER clause 4.3.6(b) to require AEMO and TNSPs to conduct comprehensive physical system restart testing of black start pathways (i.e. de-energise network segments to test restart outcomes). AusNet considered this would be an improvement on the functional system restart test that typically occurs today, which only tests an SRAS provider's ability to re-energise the bus at the relevant black start site, rather than testing the pathway.[109]

Further, AEMO's technical advice highlighted the role of NSPs for facilitating SRAS testing and AEMO's responsibility to take reasonable steps to facilitate effective deployment of SRAS. [110]AEMO considers changes to the NER to amend clause 4.3.6(b) may better support the recovery of associated costs by TNSPs and enable AEMO to select relevant restart scenarios for testing. [111]

4.4.2 The current arrangements require AEMO to consult with relevant participants in designing testing procedures

AEMO is responsible for designing and implementing system restart tests in consultation with affected participants and incorporating their feedback into the design of the test program.[112] As part of developing a test program AEMO will need to:

- request the relevant test participants to engage with AEMO in conducting a restart test.[113]
- consult with test participants on the test plan, which provides guidance to participants on the types of conditions or circumstances which may necessitate a test being undertaken.[114]
- provide at least 30 business days' notice between a test program being finalised and a test being undertaken (unless an earlier date is otherwise agreed to by all test participants).[115]

The NER also establishes a compensation framework to allow participants to claim compensation for any direct costs incurred as a result of being instructed to participate in a test. AEMO is also required to report on the outcomes of a test via a detailed report to the transmission network service provider (TNSP) and specific reports to test participants on the performance of its

108 AEMO, 2025. System restart technical advice. p.61.
109 AusNet submission. https://www.aemc.gov.au/sites/default/files/2025-02/AusNet.pdf. p.1-2.
110 NER clauses 4.3.4 (a1)(1) and 4.3.4(a1)(3)
111 AEMO, 2025. System restart technical advice. p.61.
112 NER, clause 4.3.6(f)
113 NER, clause 4.3.6(b)
114 NER, clause 4.3.6(d)
115 NER, Clause 4.3.6(h)

facilities. [116]AEMO also reports on the outcome of testing in its non-market ancillary service annual report.[117]

4.4.3 The Panel considers the existing NER framework provides sufficient flexibility to AEMO in expanding testing arrangements to consider potential new restart pathways

The Panel considers that the current Rules framework pertaining to system restart testing obligations under clause 4.3.6(b) and clause 4.3.6(h) provides sufficient discretion for AEMO to:

- establish testing procedures to test deeper into existing restart pathways, so long as this testing procedure is supported by impacted test participants.
- carry out tests of potential new restart pathways, subject to consultation with relevant participants impacted.

The *SRAS Rule 2020* established the current framework for the physical testing of system restart paths. The Rule change was initiated in response to proposals from AEMO and the AER seeking to extend testing arrangements to include services that may not be contracted to provide SRAS but may exist along a restart path. The Commission's final rule sought to:[118]

- provide additional flexibility to AEMO in determining and conducting system restart tests
- support AEMO in working with TNSP, SRAS providers and any other Generators and IRPs that AEMO considers would be required to participate in restart testing.
- establish cost recovery arrangements for participants that are not NSP or SRAS providers to recover direct costs incurred from a system restart test.

The Panel recognises there is a trade-off between the benefits of deeper network testing, with the cost and risk involved in such tests. The Panel notes that the development of deeper restoration testing and testing of new restoration pathways are complex tasks which would take extensive planning and coordination effort to execute. However, the Panel considers:

- AEMO and TNSPs are best placed to determine test programs for deeper network testing, in consultation with impacted participants.
- the Rules requirement for AEMO to consult with impacted participants would provide significant notice of the testing arrangements, which, for complex network testing arrangements, is longer than the formal notice period of 6 weeks.
- the cost recovery arrangements compensate participants for direct costs incurred and seek to provide equity between participants with and without SRAS agreements. In making the Rule, the Commission did not consider that it is pragmatic or economically efficient to compensate generators for opportunity costs (particularly lost market revenue) resulting from participation in restart path testing.[119]

The Panel also notes recommendation 3.2.7 from ISON's 2025 *International system restoration review*, which sets out that sytem operators "prioritise live energisation trials beyond the point of connection, ideally up to the next planned restart unit, in particular involving one or more IBR" and "establish mechanisms for technical and commercial remediation of issues found during testing".[120] The Panel encourages AEMO to act upon the recommendation and considers the current testing framework supports AEMO in establishing the appropriate test plan to enable it to respond to the recommendation.

116 NER, clause 4.3.6(t)
117 NER, clause 3.11.10(b)
118 AEMC, System restart services, standards and testing, Rule determination, 2 April 2020. p.81.
119 AEMC, System restart services, standards and testing, Rule determination, 2 April 2020. p.100
120 ISON, 2025. International system restoration review. p.6.

Question 6: SRAS testing framework

- What considerations do participants make when contemplating whether to participate in SRAS testing?
- What risks do participants undertake when participating in an SRAS test and are these risks compensated appropriately? If not, please elaborate.

4.5 The Panel is seeking stakeholder feedback on the system restart standard governance arrangements

The Panel is seeking stakeholder feedback on the potential role of the Standard in supporting system restart needs in a transitioning system. The Panel considers the draft Standard responds to recommendations from AEMO.

This section focuses on the Panel's assessment of the regulatory requirements underpinning the Standard and the role it plays in supporting system restart planning for a transitioning power system. The Panel does not consider a need for further changes to the regulatory frameworks related to the Standard, noting:

- the Standard is an effective instrument in guiding AEMO's procurement of SRAS and supporting system restart planning.
- the current roles and responsibilities for the Panel in setting the Standard and AEMO in procuring SRAS to meet the Standard remain appropriate.

However, the Panel is interested in stakeholder views on whether the following arrangements underpinning the role of the Standard are likely to remain appropriate in the context of a transitioning power system.

- the division of responsibilities between the Panel and AEMO in determining and operationalising the Standard and the function of the Standard in continuing to guide SRAS procurement
- the requirement for the Panel to set a Standard that guides SRAS procurement for the restoration of all, or part of, available generation and transmission
- the requirement for each sub electrical network to procure sufficient SRAS such that it can be independently re-energised.
- compliance obligations for AEMO to meet the requirements set out in the Standard.

4.5.1 The current framework sets out the governance arrangements, required settings and compliance requirements for the Standard

Under the current arrangements, the Standard acts as a target that guides AEMO in its procurement of SRAS. All of AEMO's SRAS functions, including procurement, guideline development and establishing sub-network boundaries, are guided by the Standard.

The regulatory framework underpinning the intent and development of the Standard can be broken into three key elements - governance arrangements, requirements for the Standard, and compliance arrangements. The Panel is seeking stakeholder feedback on whether alternative arrangements should be considered for the following elements of the regulatory framework:

- Governance arrangements, including the role of the Panel in determining the Standard [121] and responsibilities for AEMO to meet the Standard [122]
- Requirements for the Panel to consider when setting the Standard, including determining settings that:
  - support the restoration of all available generation and transmission following a major supply disruption[123]
  - enable each sub-electrical network to be restarted without support from any neighbouring regions[124]
- Arrangements for AEMO in complying with the Standard.

Roles and responsibilities are divided between the Panel determining and AEMO operationalising the Standard

Under the current framework, the Panel is required to review and determine the Standard in accordance with the SRAS Objective.[125]

As discussed in section 4.1.2, AEMO must use reasonable endeavours to acquire SRAS to meet the Standard at lowest long term cost, consistent with the SRAS procurement objective.[126]

This distribution of responsibilities between the Panel and AEMO is designed to deliver an efficient quantity of SRAS, at an efficient cost. The broader assessment of economic costs associated with major supply disruptions and the benefits of effective restoration capability is undertaken by the Panel when it develops the Standard. The Panel also takes into account the NEO in determining the Standard. This leaves AEMO's focus solely on procuring SRAS that matches the requirements of the Standard, at the lowest long term cost.

The current arrangements require the Panel to determine a supply restoration standard which enables independent restart of each electrical sub-network

Clause 8.8.3(aa) set outs the requirements for when the Panel determines the Standard. This includes clause 8.8.3(aa)(2), which states:

> the system restart standard must identify the maximum amount of time within which SRASs are required to restore supply in an electrical sub-network to a specified level, under the assumption that supply (other than that provided under a SRASs agreement acquired by AEMO for that electrical sub-network) is not available from any neighbouring electrical sub-network;

This clause sets out that the Panel must determine a Standard that:

- guides AEMO's procurement of SRAS to restore available transmission and generation following a black system event
- enables sufficient SRAS to be procured such that each electrical sub-network can be restarted independently.

The Panel is required to set a Standard which focuses on the restoration of supply following a black

121 NER, clause 8.8.1(a)(1A)
122 Chapter 10 definition of the SRAS Procurement Objective.
123 NER, clause 8.8.3(aa)
124 Ibid.
125 NER cl 8.8.3(aa)(1)
126 NER, clause 3.11.7(a1)

system event

The requirements of clause 8.8.3(aa)(2) limit the Panel in determining settings for the Standard that consider the restoration of all available generation and transmission following a major supply disruption (i.e. the Panel can set a Standard up to the end of stage two of the restoration process). While such an objective would require AEMO to consider how it brings online an equivalent quantity of load, this Rule does not support planning and procurement of SRAS required to restore all customer load (i.e. to the end of stage three of the restoration process).

This aligns with the development of the system restart plans, which cover the first two stages of the restoration process following a black system condition, that is, the re-energising of the main transmission network and supplying the auxiliary loads of the major power stations. However, these plans do not cover the full process of returning supply to all consumer loads.

The Panel is required to determine settings which support the procurement of SRAS under the assumption energisation is not available from neighbouring regions

NER clause 8.8.3(aa)(2) requires the Panel to set the Standard under the assumption that the system is unable to be restarted from any neighbouring regions. The requirements for the Standard are designed to support the procurement of SRAS to support energisation of the power system in the event of a worst case scenario - a total NEM-wide black system event.

Arrangements for AEMO in complying with the Standard including relevant reporting arrangements

While not explicitly set out in the NER, the Standard is designed to be a procurement target, rather than act as an operational target. [127] Therefore, it is not expected that AEMO would demonstrate the SRAS procured achieves the targets set out in the Standard, following an actual black system event.

AEMO is required to self-report on its ability to meet the Standard annually.[128] This is reported through AEMO's non-market ancillary report, which sets out:[129]

- the processes followed by AEMO to acquire SRAS for each electrical sub-network
- the total cost of procuring SRAS in each sub-network and region
- whether AEMO has been unable to procure sufficient SRAS to meet the Standard and the reasons for this.

AEMO is also required to use **reasonable endeavours** to procure SRAS to meet the Standard, at lowest long term cost, as set out in the SRAS Procurement Objective.[130] This would provide flexibility for AEMO in the event it encounters unreasonable costs for the procurement of SRAS to meet the Standard.

Further, the NER does not set out civil penalties for AEMO if it fails to comply with the Standard. However, the Panel notes a Court may compel AEMO to comply with the Standard if, for example, a person aggrieved by AEMO's decisions applied for judicial review.[131]

127 AEMC 2015, System Restart Ancillary Services, Rule Determination, 2 April 2015, Sydney. p.48.
128 NER, clause 3.11.10(b)(1).
129 NER, clause 3.11.10
130 NER, clause 3.11.7(a1)
131 NEL, section 70.

4.5.2 The UK and Western Australia offer examples of alternative system restart governance arrangements

The Panel recognises there are alternative frameworks for considering the governance arrangements, requirements and compliance arrangements associated with a Standard:

- The WA Wholesale electricity market (WEM) sets out an alternative governance arrangement which provides more authority to AEMO to manage its procurement of SRAS
- The UK framework sets out alternative arrangements related to:
  - governance arrangements, by providing more flexibility to the market operator to determine and procure the restart services needed
  - the Standard, setting requirements focused on the restoration of load
  - compliance, which treats the Standard as an operational Standard that sets out legal requirements for NESO to meet.

Western Australia offers alternative system restart governance approaches

In the WEM, the system restart governance arrangements provide more authority to AEMO to manage SRAS procurement, as compared to the arrangements in the NEM. In the WEM, AEMO is responsible for determining the Standard and the system restart plan to manage and coordinate restart and restoration of the South West Interconnected System (SWIS). AEMO is also responsible for procuring sufficient SRAS to meet the Standard and support its system restart plan.[132]

> The WEM system restart Standard:
>
> - must identify the minimum length of time for which a System Restart Service may be required to operate continuously following a system shutdown or major supply disruption;
> - must specify the technical requirements that a Registered Facility must demonstrate to be eligible to provide a System Restart Service;
> - must include guidelines addressing the diversity of System Restart Services, including diversity of locations within the SWIS;
> - must include requirements for mitigating against the risk of unavailability of any System Restart Service during a system shutdown or major supply disruption
> - may include any other matters that AEMO determines are necessary to ensure the SWIS is restarted in the event of a system shutdown or major supply disruption

The UK enforces a legally binding load restoration focused Standard

At a high level, the UK framework includes:

- Electricity System Restart Standard (ESRS): NESO must have the capability to restore 60% of regional demand within 24 hours and 100% within 5 days.[133]
- Grid Code and Licence: OFGEM's technical rules and licence conditions that apply to NESO as the system operator.
- Assurance framework: NESO's methodology reports and post-exercise reviews proving ESRS compliance.

132 WEM Rules, clause 3.7.1 and 3.7.2.

133 UK Department of Business, Energy & Industrial Strategy, Introducing a new 'Electricity System Restoration Standard': policy statement, 1 April 2021.

- NSP and interconnector procedures: Network operators' local re-energisation plans and interconnector black-start supplements.

The function of the ESRS and compliance arrangements are discussed further below. For more information on the UK arrangements, please refer to appendix G.

The ESRS is a legally enforceable restoration load standard that will take effect from 31 December 2026

The ESRS policy statement was released by the UK Government in April 2021. This policy statement strengthened the previous restoration framework by introducing a legally binding target for the restoration of electricity **demand** in the event of a nationwide or partial power outage on the national electricity system.[134]

> "NESO must have sufficient capability and arrangements in place to restore 100% of Great Britain's electricity demand within five days. It should be implemented regionally, with an interim target of 60% of regional demand to be restored within 24 hours"

The new standard must be met by 31 December of each reporting year, with initial compliance required no later than 31 December 2026.[135]

OFGEM oversight ensures that the requirements of the ESRS are fulfilled

In the context of system restart, NESO is regulated by the OFGEM and must also comply with directions from the Secretary of State regarding ESRS planning and execution.[136] OFGEM monitors compliance and is responsible for reviewing NESO's assurance framework and performance in meeting the ESRS.[137]

Unlike equivalent bodies in the NEM, OFGEM possesses significant civil penalisation powers. At present, there is no statutory maximum on the amount OFGEM can fine NESO for breaches of the Code, with OFGEM also able to revoke NESO's licence, and therefore status as Operator, for breaches of its licensing conditions.

4.5.3 The Panel considers the system restart standard regulatory arrangements remain fit for purpose

The Panel considers the current system restart governance arrangements remain effective in guiding the efficient procurement of SRAS in the NEM. The Panel does not consider there is a strong rationale for major changes to the current arrangements. The Panel considers:

- the Standard continues to be a necessary instrument in guiding the procurement of SRAS and supporting AEMO's system restart planning efforts
- the current roles and responsibilities remain appropriate and a division of roles should exist between the bodies responsible for setting and operationalising the Standard
- the governance arrangements are purposefully designed to enable the efficient provision of SRAS. In meeting the SRAS Objective, the Panel considers the costs and benefits of procuring additional SRAS and its impact on electricity consumers. In meeting the SRAS Procurement Objective AEMO is required to minimise cost and thereby drive an efficient provision of SRAS services.

134 OFGEM: Decision on licence amendments to facilitate the introduction of an Electricity System Restoration Standard, Aug 2021.
135 NESO: Industry information: Electricity system restoration standard.
136 OFGEM: NESO Roles Guidance 2023-2025, Sep 2024
137 UK Government: Electricity System Operator Licence Conditions, C4.

The Panel notes that further consideration could be given as to the potential for the governance framework in the NEM to evolve to provide AEMO further flexibility in procuring SRAS along the lines of the WEM system restart frameworks.

Question 7: Governance arrangements related to the role of the Standard

- Do stakeholders support the Panel's findings that no further changes are required to the governance arrangements underpinning the Standard?
- If not, the Panel is interested in views on the merits of alternative governance arrangements for further consideration.

A Standard focused on load restoration could align with international best practice and provide greater transparency to stakeholders

The Panel recognises the importance in ensuring the entire process for restoring generation and consumer load is effective. The Panel notes the UK ESRS sets out requirements for the restoration of load and considers such arrangements would provide improved transparency to consumers on the outcome for the restoration of their power following a major supply disruption.

In the 2016 review of the system restart standard, the Panel set out a recommendation for AEMO, the relevant TNSP and DNSPs, as well as the JSSC for each electrical sub-network to develop plans for the complete restoration process from a black system condition being declared to the restoration of all consumers' load. The Panel noted that the existing system restart plans cover the first two stages of the restoration process following a black system condition, that is, the re-energising of the transmission network and restoration of supply from major power stations. The Panel considered this level of planning would be important inputs for state emergency management arrangements developed by jurisdictions, which would need to consider the expected time and rate at which the load can be restored so that appropriate preparations can be made. This would include:

- the impact on emergency power supplies at key government and private facilities such as hospitals, prisons, the police and other emergency services
- the impact on major infrastructure such as water pumping, sewage management, telecommunications, transport (trains and traffic signals)
- whether emergency food and water supplies are likely to be required.

To date, the Panel is not aware of any plans that cover the entire restoration process, and recognises changes to the arrangements for the Standard would drive the development of such plans. However, the Panel considers a load restoration focused objective may:

- require a significant shift to the system restart regulatory framework
- lead to increased costs related to system restart including costs associated with regulatory reform, implementation, extensive and more frequent modelling, testing and additional procurement of SRAS
- present operational challenges noting current levels of visibility in distribution grids are low and there would need to be a significant uplift in communication abilities to provide certainty in load restoration times, particularly in remote areas of the grid.

The Panel invites stakeholder feedback on the considerations for a Standard focused on supporting the procurement of SRAS that supports the energisation of load.

Question 8: Merits of a load restoration standard

- Do stakeholders support the Panel's rationale to not recommending a load restoration standard for the NEM?
- If not, what are stakeholders views on the merits of a load restoration standard ?
- What are some ways in which the current operational challenges in establishing a load restoration standard could be overcome?

There may be an opportunity to reconsider the requirement for each electrical sub-network to be capable of independent restoration

The NER requires that the Panel determine the Standard to support independent restoration of each under the assumption that supply is not available from any neighbouring electrical sub-networks.[138]

The Panel recognises this assumption delivers a layer of redundancy for system restoration capability for the mainland NEM regions, due to the low probability of a NEM-wide black system event. At the same time, this assumption drives an increased need for SRAS procurement along with associated costs.

The Panel considers this is a reasonable assumption to consider when determining the Standard, noting:

- the NER supports AEMO acquiring SRAS from a neighbouring sub-electrical network, if it considers it more cost effective to do so, noting this SRAS unit would not be able to be used for more than one sub-electrical network at a time[139]
- the Panel understands that AEMO develops system restart plans that consider multiple restart options, including energisation from:
  - procured SRAS capability within that electrical sub-network
  - neighbouring electrical sub-networks via interconnector support
  - any stable restoration islands that may form on the day of a black system event.
- the Panel considers the likelihood of a black system event for each electrical sub-network as part of its economic assessment in determining the Standard.

The Panel is interested in stakeholder views on the merits of the current NER requirement for the standard to be determined on the assumption that each electrical sub-network be capable of independent restoration.

Question 9: Procuring SRAS to enable restart of each electrical sub-network independently

- Do stakeholders consider that it continues to be appropriate for the standard to be determined be based on the assumption that each electrical sub-network be capable of independent restoration?
- What are stakeholders' views on the benefits and costs of the assumption that each electrical sub-network be capable of independent restoration?

138 other than that provided under a SRAS agreement acquired by AEMO for that electrical sub-network) ref. NER cl. 8.8.3(aa)(2)

139 NER, clause 8.8.3(aa)(5).

- Do stakeholders consider there to be any viable alternatives to the current approach for independent restoration of each electrical sub-network?

The Panel is interested in stakeholder views on the compliance arrangements for the Standard

The SRAS Procurement Objective requires AEMO use "reasonable endeavours" to meet the Standard. The Panel considers this provides AEMO with flexibility in assessing more extreme instances where the cost of procuring the necessary services to meet the Standard may not be in the long term interest of consumers. AEMO is also required to self-report on whether it meets the Standard. As part of its reporting requirements, AEMO would need to set out the reasons for not meeting the Standard in any given year. The Panel understands that AEMO also notifies the relevant JSSC of instances where it is unable to meet the Standard.

The Panel recognises that AEMO determines whether it meets the Standard based on detailed power system modelling of procured SRAS services. The Panel does not consider any other body to possess the data and technical capabilities to undertake a similar modelling task. Therefore, the Panel considers AEMO's requirement to self-report on instances where it is unable to meet the Standard in any given electrical sub-network is appropriate.

The Panel recognises alternative arrangements in the UK, where OFGEM is required to review NESO's assurance framework and performance in meeting the ESRS. OFGEM is able to enact significant civil penalties for non-compliance, including financial penalties and penalties to revoke NESO's licence, and therefore status as Operator, for breaches of its licensing conditions.

The Panel does not consider stronger compliance requirements for the Standard necessary:

- The draft recommendations are designed to enhance the transparency and reporting of SRAS to drive stronger investment signals to improve competition for SRAS capability. These recommendations are also designed to encourage AEMO to conduct more extensive modelling on a forward looking basis to provide an outlook of SRAS procurement risks that may present challenges in meeting the requirements in the Standard.
- The Panel considers this would likely drive an increase in system restart related expenditure. This could include costs associated with regulatory reform, implementation, extensive and more frequent modelling, testing and additional procurement of SRAS to provide more certainty in restoration outcomes.

The Panel is interested in stakeholder feedback on compliance arrangements related to the Standard.

Question 10: Compliance arrangements related to the Standard

- Do stakeholders have any feedback on the current arrangements for compliance with respect to the Standard?

A Draft restoration targets & restoration curves

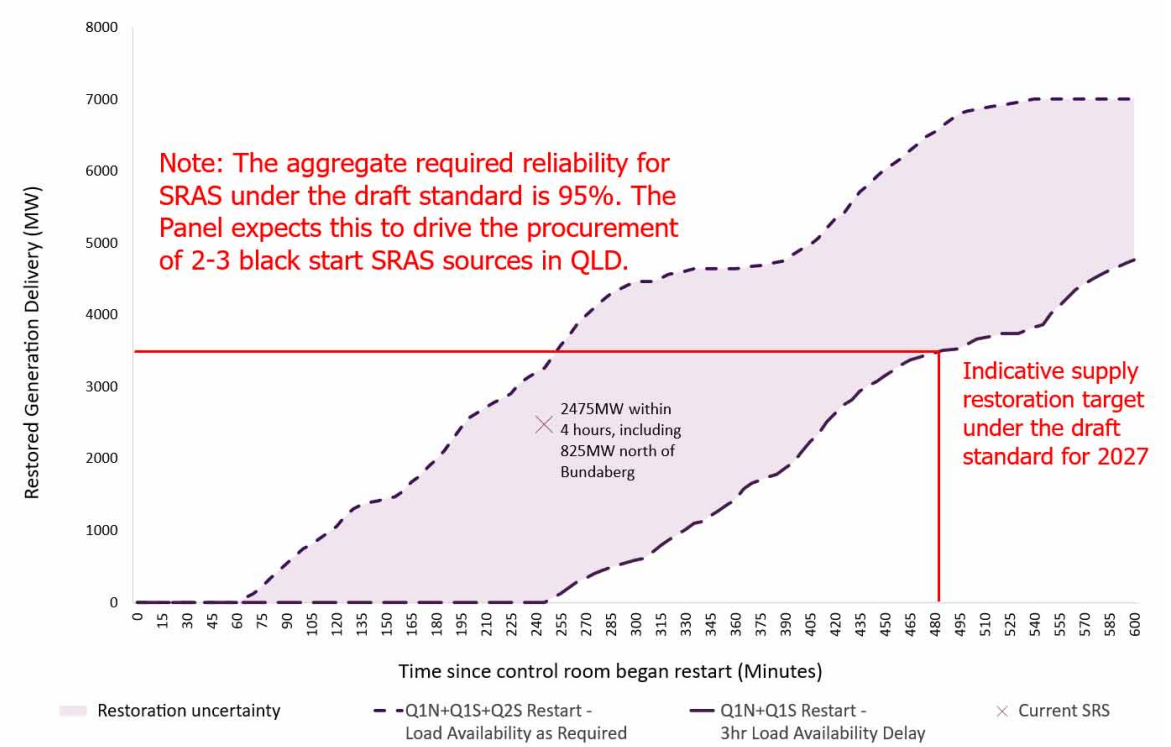
This appendix displays indicative representations of the proposed restoration targets under the draft standard overlaid on AEMO's latest restoration curves for each electrical sub-network as included in its System restart technical advice.

For reference the quantitative restoration target under the draft standard is

> For each electrical sub-network, AEMO shall procure SRAS to support the achievement of the following targets, following a major supply disruption:
>
> 1. Form one or more restoration islands, as described in section 5, in an electrical sub-network within 2 hours, and
> 2. Use those restoration islands to restore generation and transmission in that electrical sub-network equivalent to the capacity to supply 50% of the forecast average annual underlying demand in that electrical sub-network within 8 hours.

A.1 Queensland

Figure A.1: Draft standard - Restoration level and time for QLD

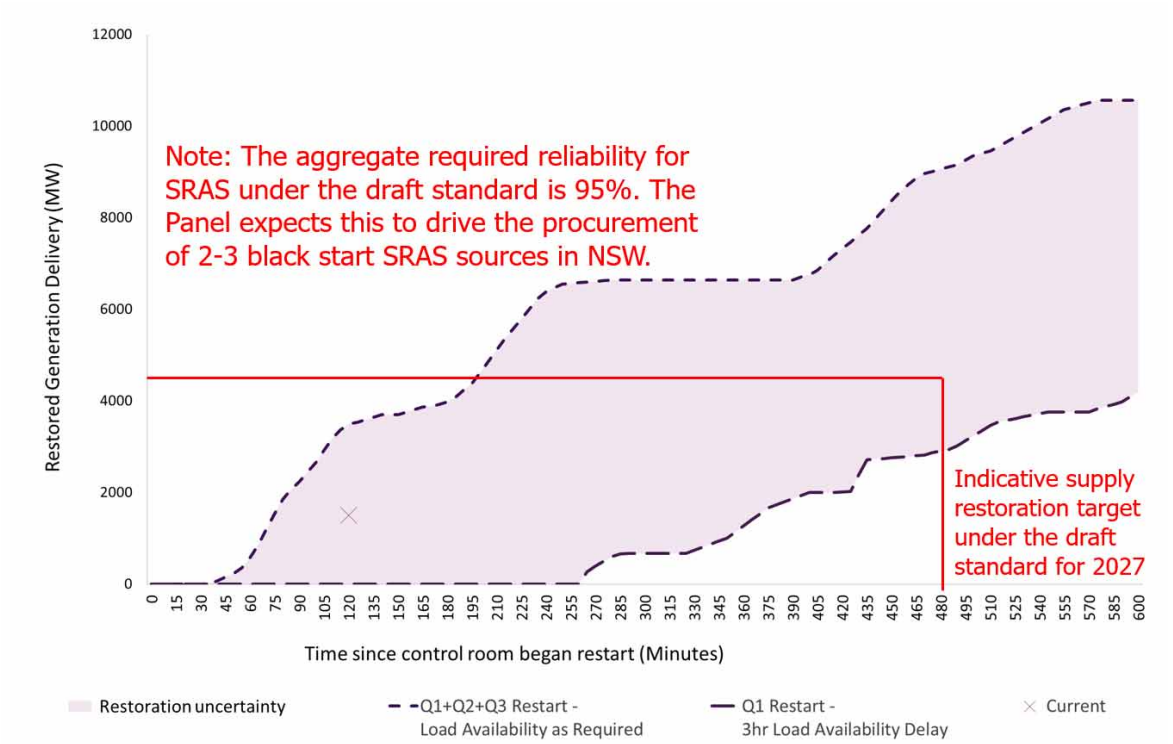


Source: Restoration curve based on summation of the Nth and Sth Queensland restoration curves included in AEMO's *System restart technical advice*, 19 June 2025, pp.66-67.

Note: Indicative restoration level based on 50% of forecast annual average underlying demand in QLD for 2027 which is 3,597MW. (Ref AEMO 2024 ISP Demand forecast, OPSO_PVLITE 2023 Reference year)

A.2 New South Wales

Figure A.2: Draft standard - Restoration level and time for NSW

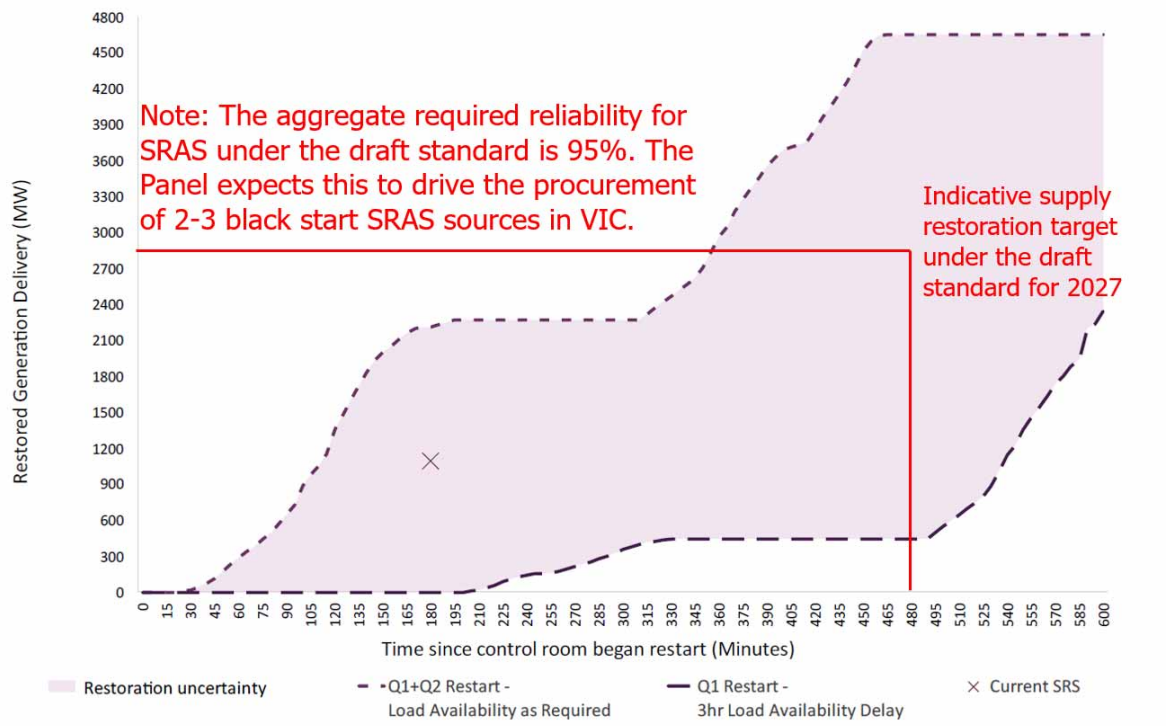


Source: Restoration curve from AEMO's *System restart technical advice*, 19 June 2025, p.65.

Note: Indicative restoration level based on 50% of forecast annual average underlying demand in NSW for 2027 which is 4,499MW. (Ref AEMO 2024 ISP Demand forecast, OPSO_PVLITE 2023 Reference year)

A.3 Victoria

Figure A.3: Draft standard - Restoration level and time for Vic

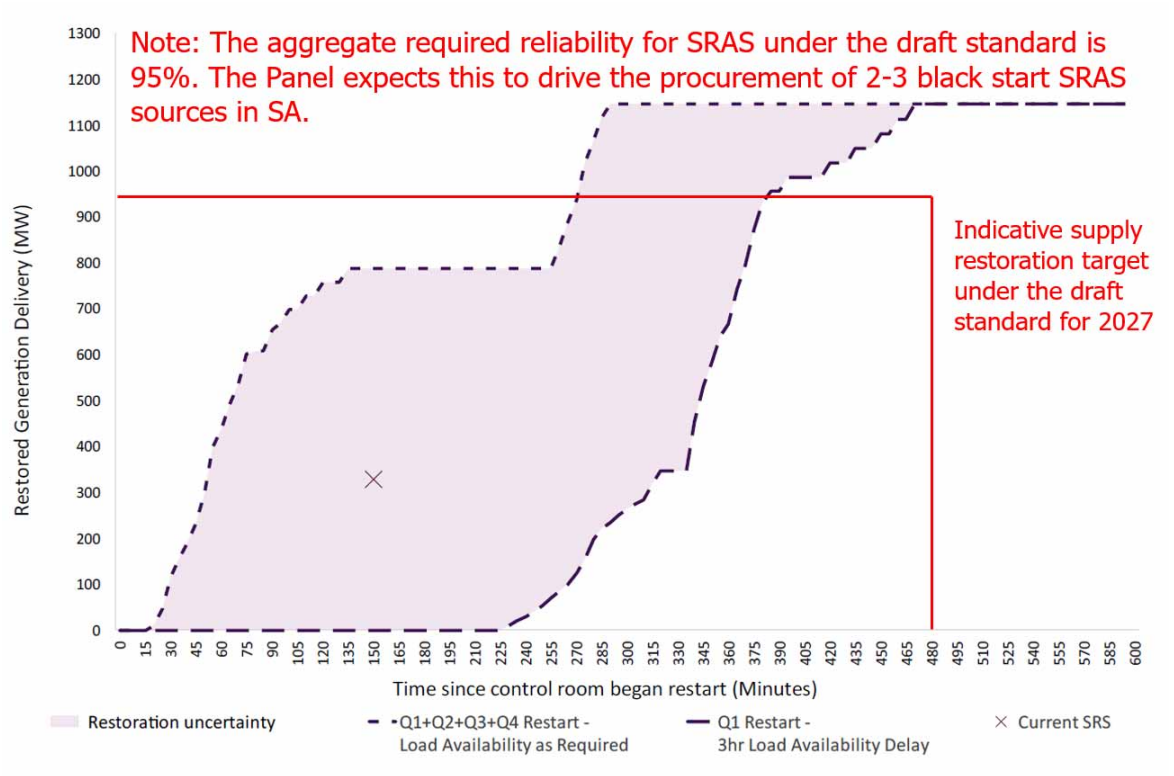


Source: Restoration curve from AEMO's *System restart technical advice*, 19 June 2025, p.68.

Note: Indicative restoration level based on 50% of forecast annual average underlying demand in VIC for 2027 which is 2,859 MW.(Ref AEMO 2024 ISP Demand forecast, OPSO_PVLITE 2023 Reference year)

A.4 South Australia

Figure A.4: Draft standard - Restoration level and time for SA

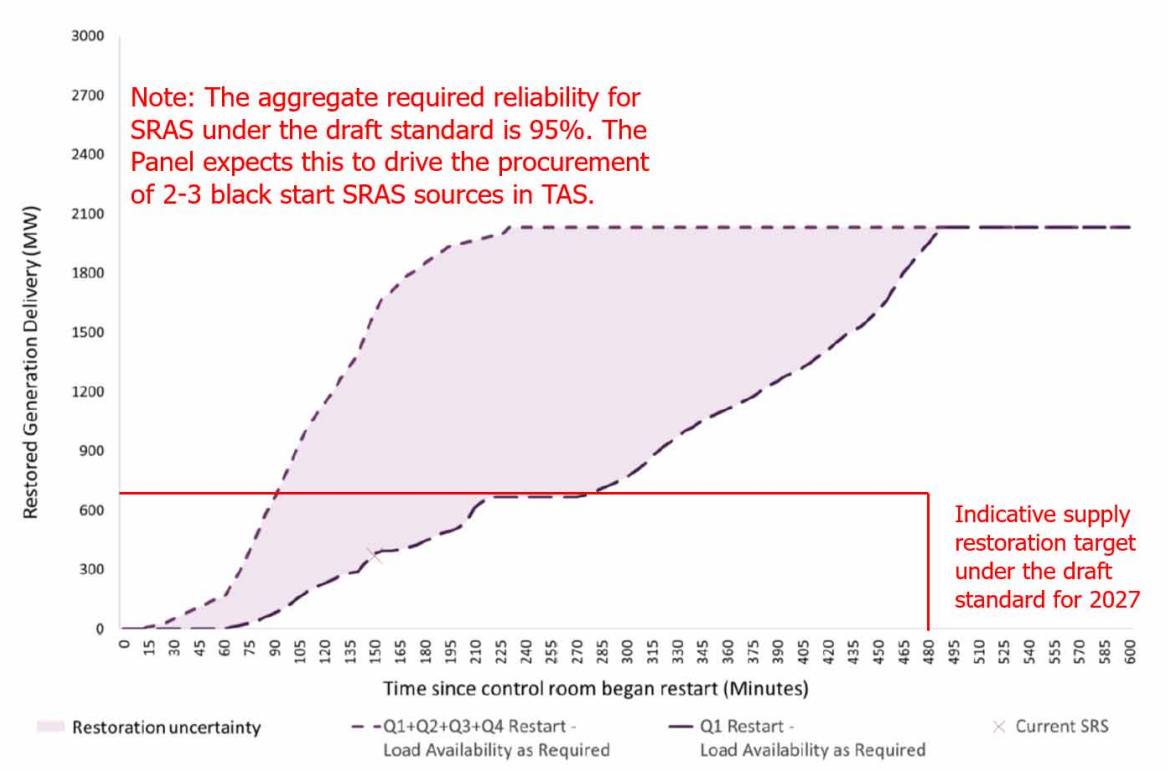


Source: Restoration curve from AEMO's *System restart technical advice*, 19 June 2025, p.66.

Note: Indicative restoration level based on 50% of forecast annual average underlying demand in SA for 2027 which is 948MW.(Ref AEMO 2024 ISP Demand forecast, OPSO_PVLITE 2023 Reference year)

A.5 Tasmania

Figure A.5: Draft standard - Restoration level and time for Tasmania



Source: Restoration curve from AEMO's *System restart technical advice*, 19 June 2025, p.7.

Note: Indicative restoration level based on 50% of forecast annual average underlying demand in TAS for 2027 which is 654MW.(Ref AEMO 2024 ISP Demand forecast, OPSO_PVLITE 2023 Reference year)

B Economic assessment results

This appendix contains figures for the key results from the Panel's economic analysis for each of the current NEM electrical sub-networks, including:

- the annualised marginal benefit of SRAS
- the annualised total benefit of SRAS across a range of outage probabilities from 1:1 to 1:100 years.

The methodology for this economic assessment is described in appendix C.

B.1 Queensland

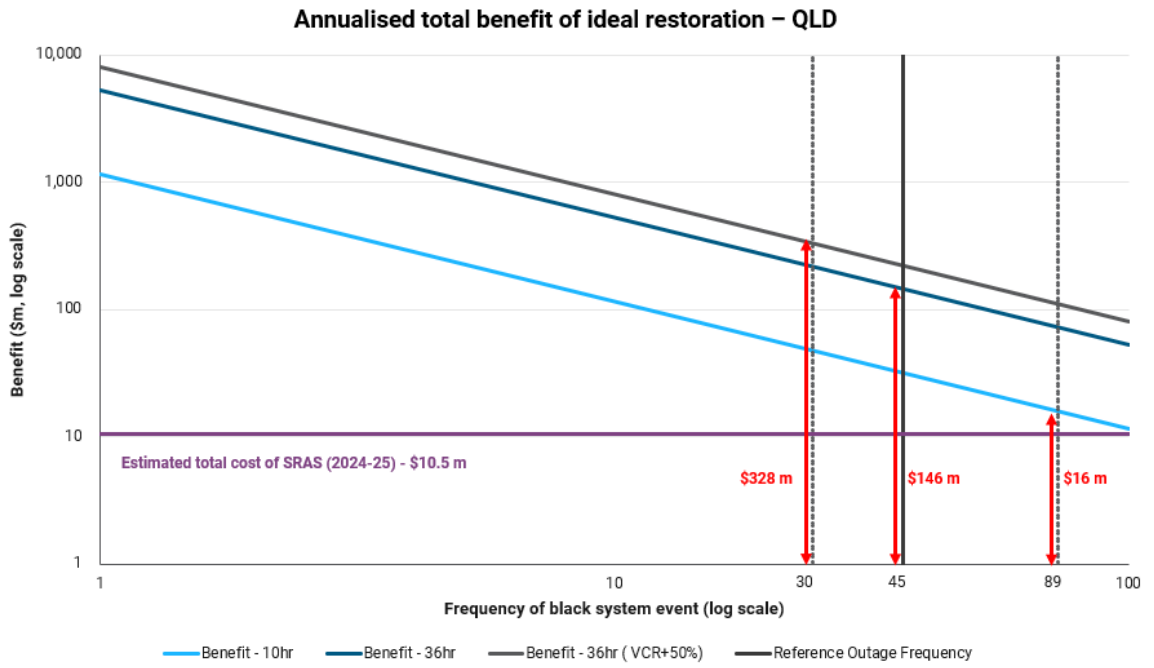
B.1.1 Total cost analysis results - Queensland

The results of the total value analysis (Figure B.1 suggest that the estimated annualised benefit of SRAS in delivering an ideal restoration in Queensland, relative to a 36 hour delayed restoration, is $146m (for a base case outage probability of 1 in 45 years).

The sensitivity analysis estimates a lower bound for this total annualised benefit of $16m (for an outage probability of 1 in 73 years and a 10 hour default outage delay).

The sensitivity analysis estimates an upper bound for this total annualised benefit of $328m (for an outage probability of 1 in 24 years and a 36 hour default outage delay).

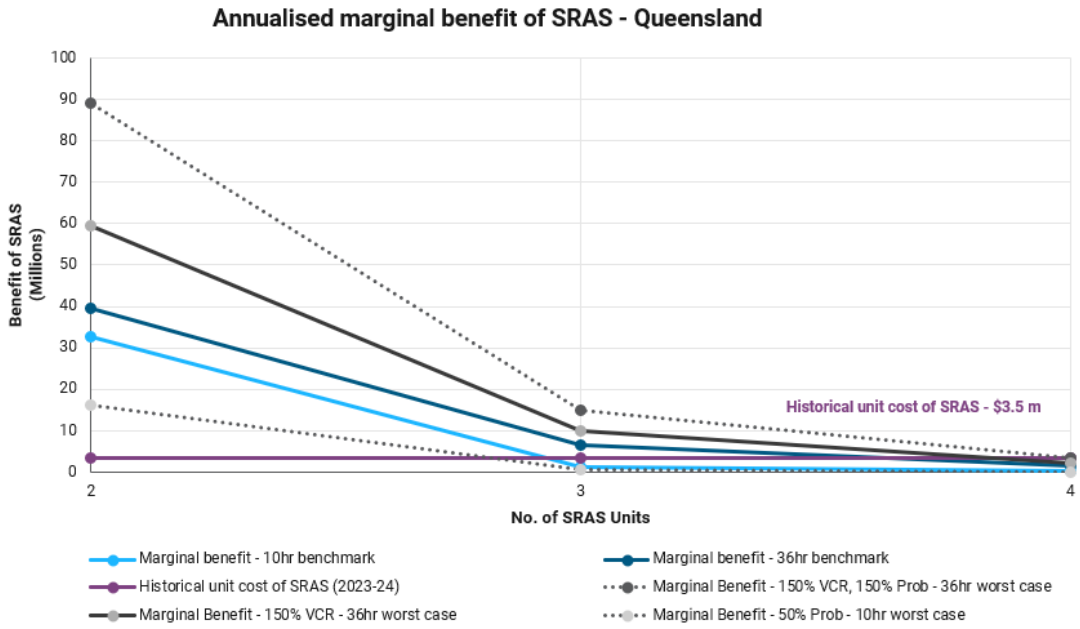
Figure B.1: Annualised total benefit of SRAS - Queensland



B.1.2 Marginal cost analysis results - Queensland

The results of the marginal reliability analysis are shown below in Figure B.2. The estimated annualised marginal benefit of an additional SRAS unit exceeds the historical unit cost of procurement for between 1 and 3 black start SRAS units.

Figure B.2: Annualised marginal benefit of SRAS - Queensland



B.2 New South Wales

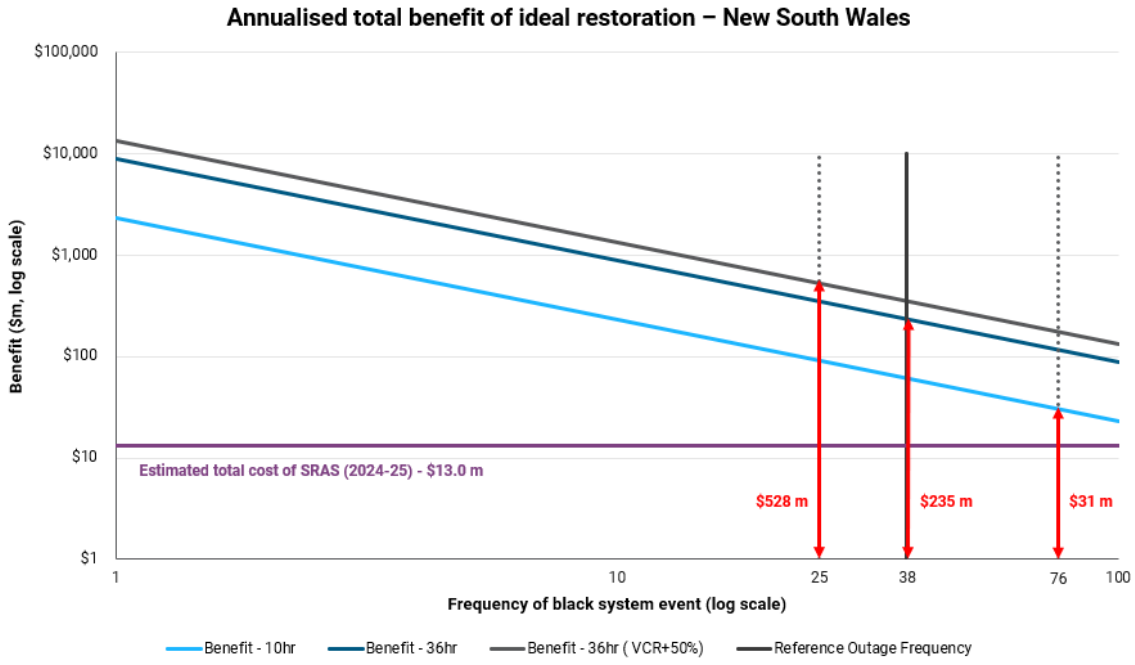
B.2.1 Total cost analysis results - New South Wales

The results of the total value analysis (Figure B.3 suggest that the estimated annualised benefit of SRAS in delivering an ideal restoration in NSW, relative to a 36 hour delayed restoration, is $235m (for a base case outage probability of 1 in 38 years).

The sensitivity analysis estimates a lower bound for this total annualised benefit of $31m (for an outage probability of 1 in 76 years and a 10 hour default outage delay).

The sensitivity analysis estimates an upper bound for this total annualised benefit of $528m (for an outage probability of 1 in 25 years and a 36 hour default outage delay).

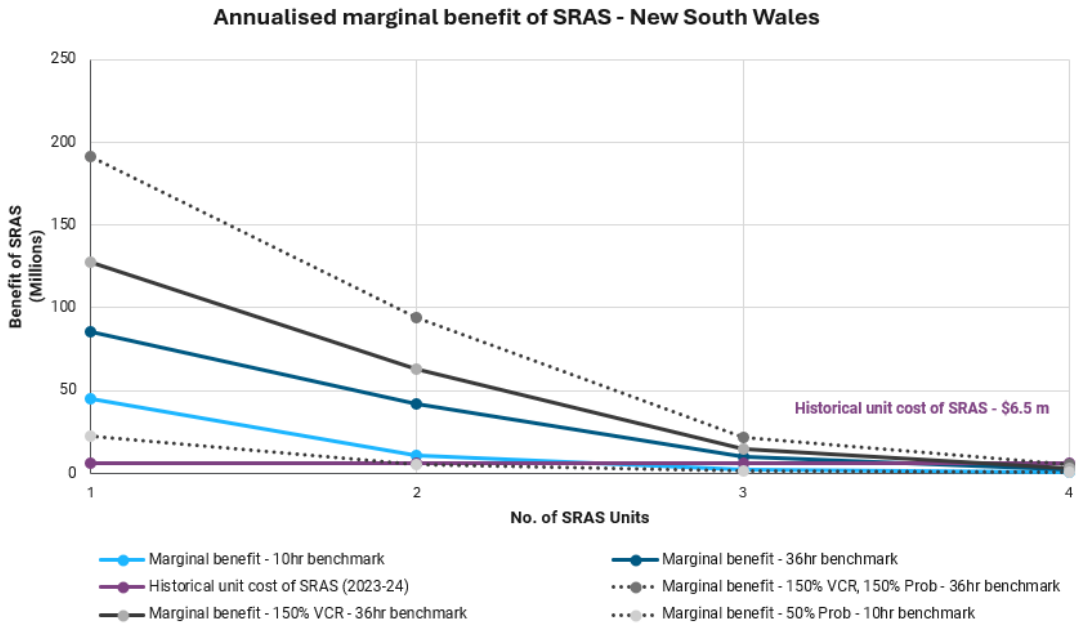
Figure B.3: Annualised total benefit of SRAS - New South Wales



B.2.2 Marginal cost analysis results - New South Wales

The results of the marginal reliability analysis are shown below in Figure B.4. The estimated annualised marginal benefit of an additional SRAS unit exceeds the historical unit cost of procurement for between 1 and 3 black start SRAS units.

Figure B.4: Annualised marginal benefit of SRAS - New South Wales



B.3 Victoria

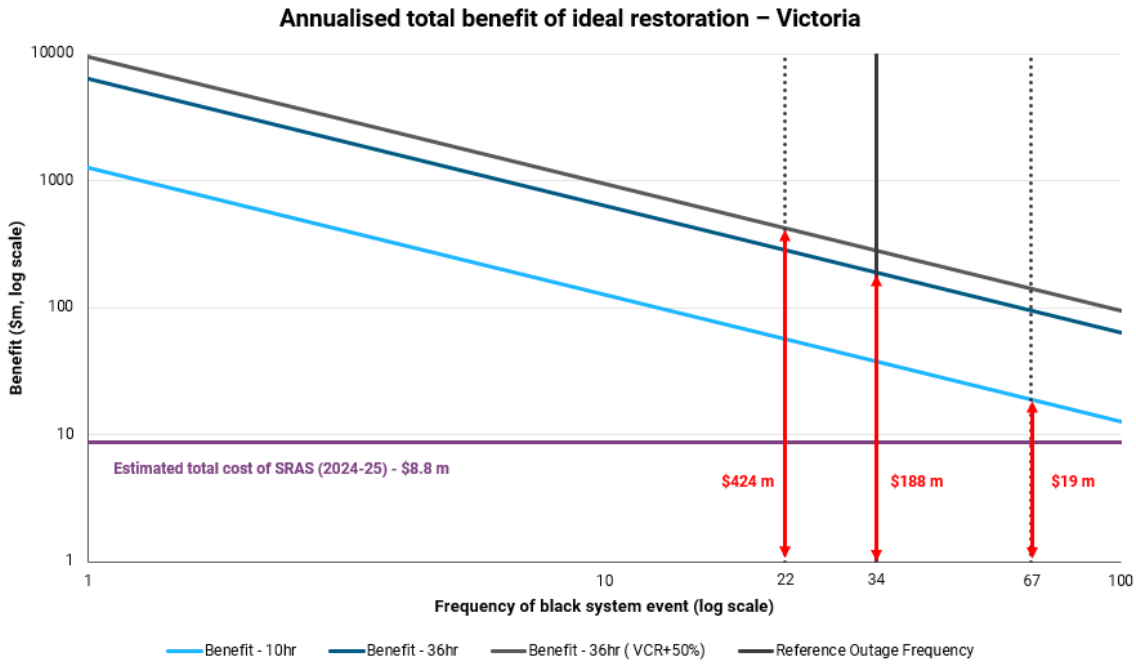
B.3.1 Total cost analysis results - Victoria

The results of the total value analysis (Figure B.5 suggest that the estimated annualised benefit of SRAS in delivering an ideal restoration in Victoria, relative to a 36 hour delayed restoration, is $188m (for a base case outage probability of 1 in 34 years).

The sensitivity analysis estimates a lower bound for this total annualised benefit of $19m (for an outage probability of 1 in 67 years and a 10 hour default outage delay).

The sensitivity analysis estimates an upper bound for this total annualised benefit of $424m (for an outage probability of 1 in 22 years and a 36 hour default outage delay).

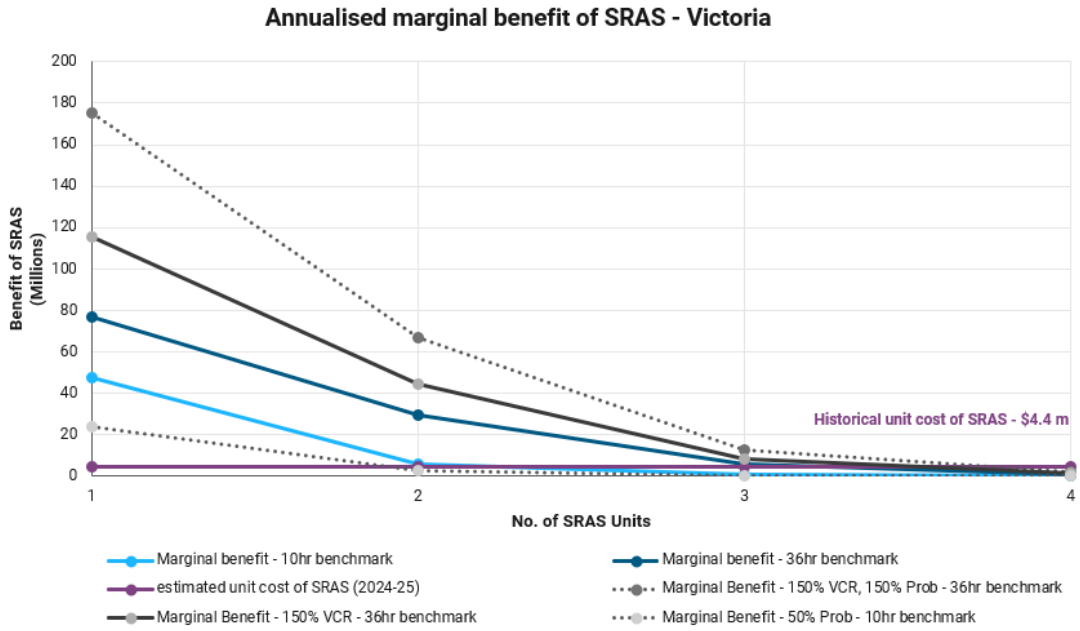
Figure B.5: Annualised total benefit of SRAS - Victoria



B.3.2 Marginal cost analysis results - Victoria

The results of the marginal reliability analysis are shown below in Figure B.6. The estimated annualised marginal benefit of an additional SRAS unit exceeds the historical unit cost of procurement for between 1 and 3 black start SRAS units.

Figure B.6: Annualised marginal benefit of SRAS - Victoria



B.4 South Australia

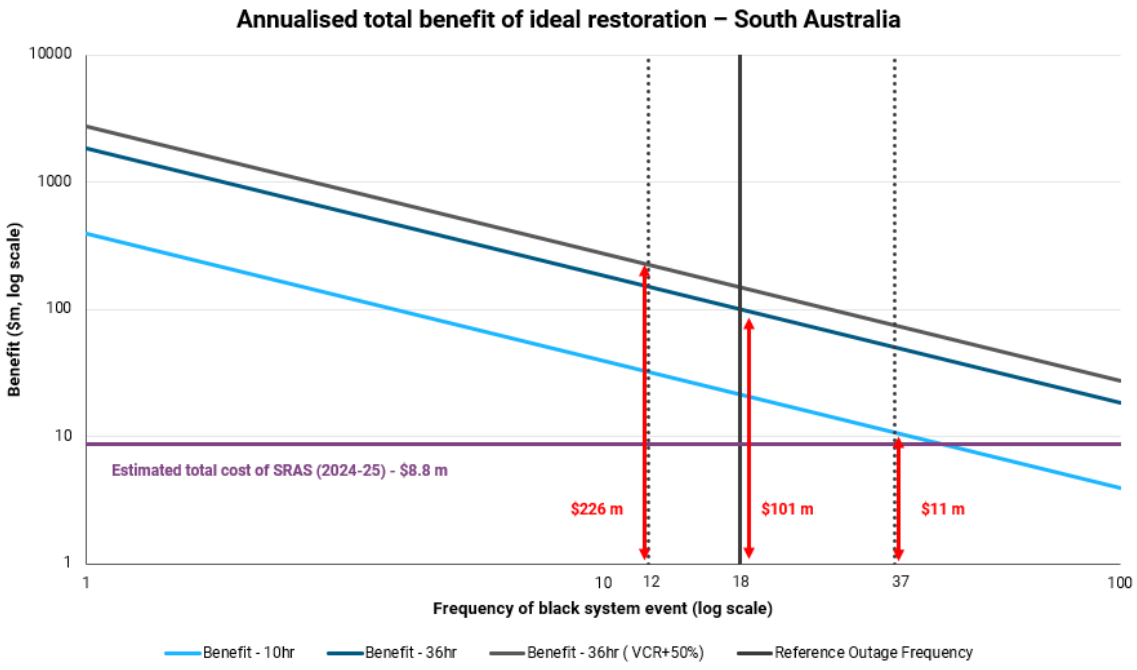
B.4.1 Total cost analysis results - South Australia

The results of the total value analysis (Figure B.7 suggest that the estimated annualised benefit of SRAS in delivering an ideal restoration in South Australia, relative to a 36 hour delayed restoration, is $109m (for a base case outage probability of 1 in 18 years).

The sensitivity analysis estimates a lower bound for this total annualised benefit of $11m (for an outage probability of 1 in 37 years and a 10 hour default outage delay).

The sensitivity analysis estimates an upper bound for this total annualised benefit of $227m (for an outage probability of 1 in 12 years and a 36 hour default outage delay).

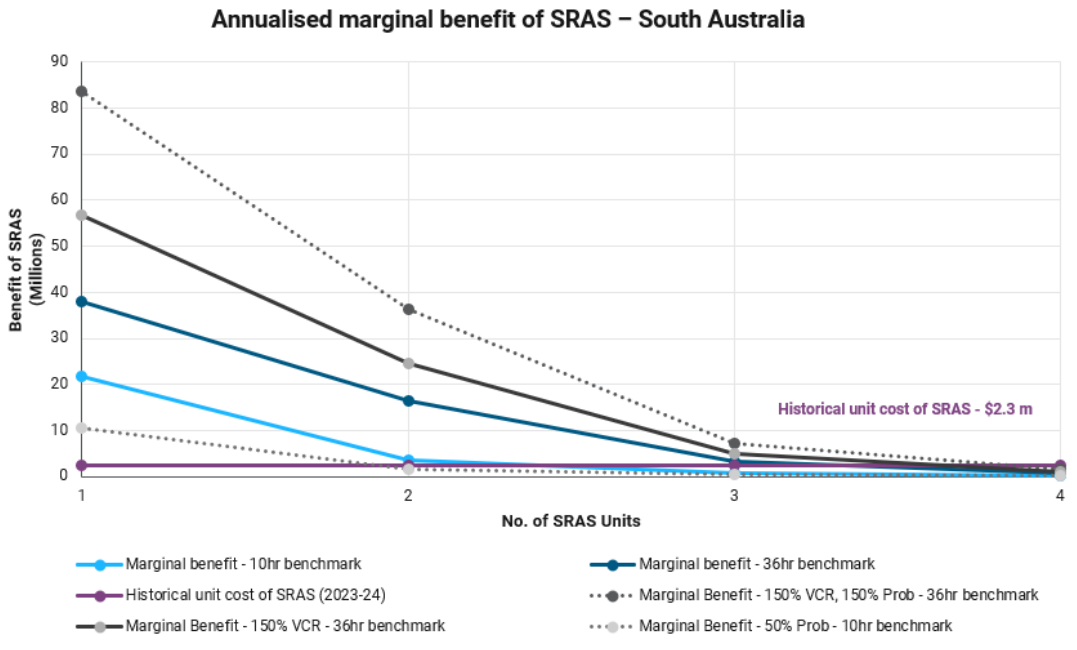
Figure B.7: Annualised total benefit of SRAS - South Australia



B.4.2 Marginal cost analysis results - South Australia

The results of the marginal reliability analysis are shown below in Figure B.8. The estimated annualised marginal benefit of an additional SRAS unit exceeds the historical unit cost of procurement for between 1 and 3 black start SRAS units.

Figure B.8: Annualised marginal benefit of SRAS - South Australia



B.5 Tasmania

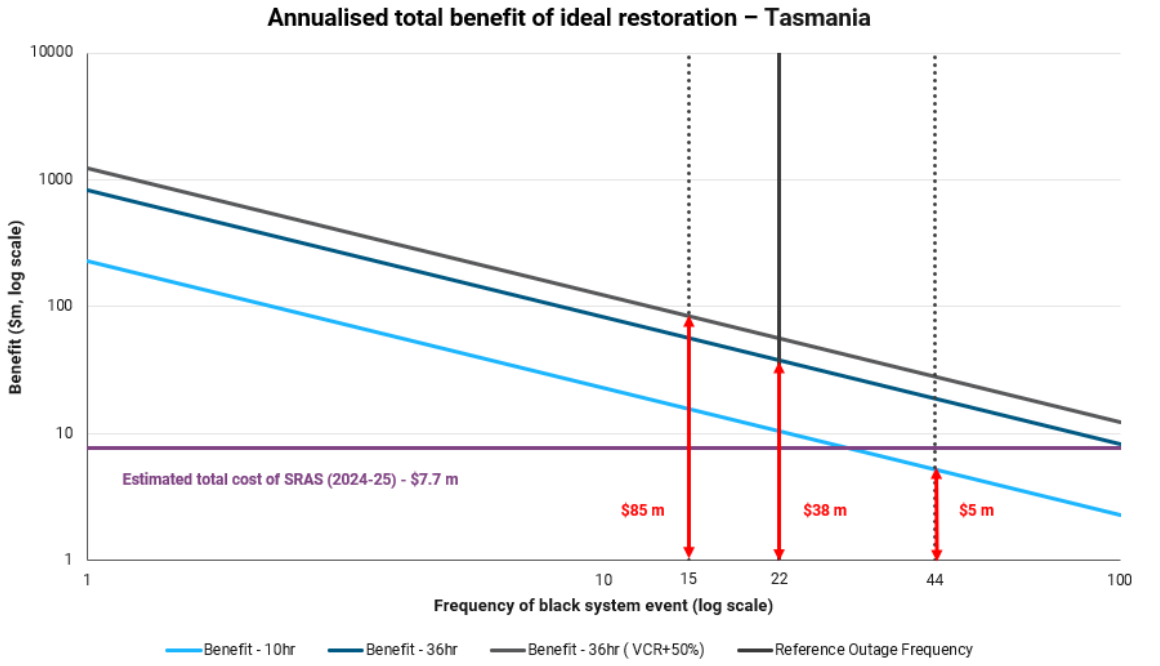
B.5.1 Total cost analysis results - Tasmania

The results of the incremental value analysis (Figure B.9 suggest that the estimated annualised benefit of SRAS in delivering an ideal restoration in Tasmania, relative to a 36 hour delayed restoration, is $38m (for a base case outage probability of 1 in 22 years).

The sensitivity analysis estimates a lower bound for this total annualised benefit of $5.2m (for an outage probability of 1 in 44 years and a 10 hour default outage delay).

The sensitivity analysis estimates an upper bound for this total annualised benefit of to $85m (for an outage probability of 1 in 15 years and a 36 hour default outage delay).

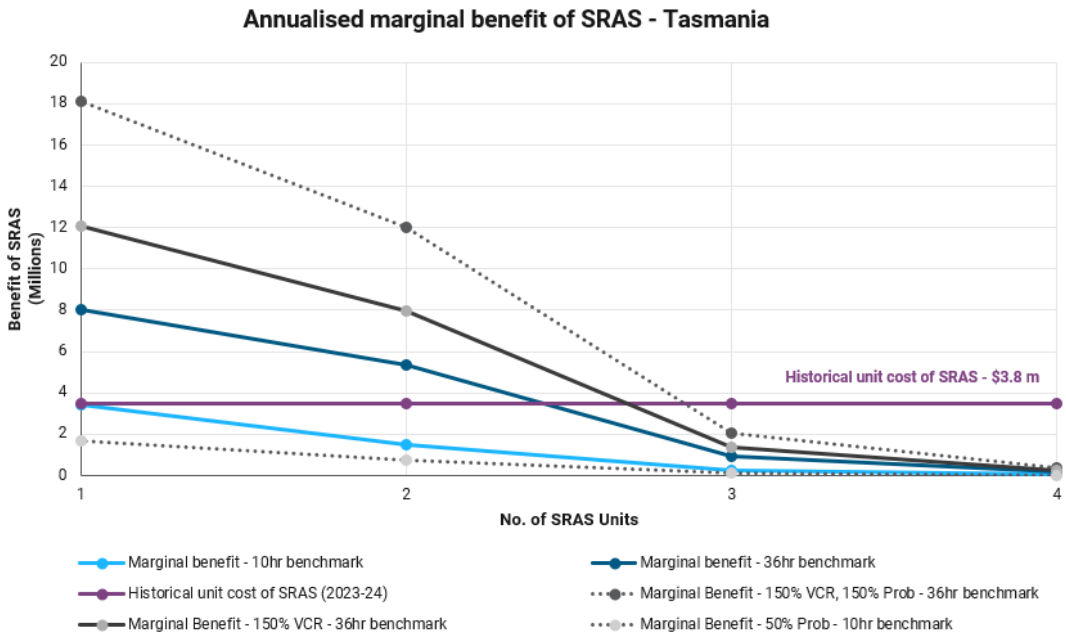
Figure B.9: Annualised total benefit of SRAS - Tasmania



B.5.2 Marginal cost analysis results - Tasmania

The results of the marginal reliability analysis are shown below in Figure B.10. The estimated annualised marginal benefit of an additional SRAS unit exceeds the historical unit cost of procurement for up to 2 black start SRAS units.

Figure B.10: Annualised marginal benefit of SRAS - Tasmania



C Economic assessment methodology

The Panel has undertaken an economic assessment of SRAS. The goal of this assessment was to assess the benefits of establishing an effective restoration plan to re-energise the power system following a major supply disruption.

This appendix presents the inputs, assumptions, and methodologies for the economic assessment performed by the Panel to inform this draft determination. For each electrical sub-network in the NEM, we conducted two distinct assessments:

1. An assessment of the marginal value of additional SRAS based on the reliability benefit of additional redundancy within an SRAS portfolio.
2. An estimate of the total value of procuring SRAS in supporting an ideal restoration outcome, relative to a potentially prolonged outage.

To account for inherent uncertainties present in estimating economic trade-offs for black system events, the Panel has considered a wide range of sensitivities. The broad range of sensitivities also considers uncertainty in the input data that we have used.

C.1 The marginal analysis estimates the marginal benefit of SRAS

The marginal reliability analysis estimates the marginal benefit of procuring additional black start-capable SRAS from improvements in aggregate reliability. It involved:

1. Establishing a central case restoration pathway
2. Quantifying the unserved energy associated with this restoration pathway, and subsequently the cost associated with this unserved energy
3. Calculating the probability of restart failure using the aggregate reliability of each combination of SRAS plant
4. Calculating the marginal benefit of procuring additional black start-capable SRAS as the change in avoided unserved energy
5. Weighting the outcomes by the probability of a black system event to determine an annualised marginal benefit of SRAS.

C.1.1 Inputs

The following inputs were used to inform the assessment.

Restoration curves

AEMO's technical advice to the Panel provided the basis for the ideal restoration curve for each electrical subnetwork. For each electrical subnetwork, AEMO's delayed restoration curve was associated with the procurement of only one black start-capable SRAS unit, combined with a 3 hour restoration delay due to load availability issues. Conversely, the ideal restoration curve assumes that available SRAS performs as expected and there are no restoration delays associated with the availability of stable load blocks.

Average historical underlying demand

To account for any seasonal variation, average underlying demand for each electrical subnetwork was drawn from the four most recent quarters (Q2, 2024 to Q1, 2025) of AEMO's Quarterly Energy Dynamics report. These are provided in the table below:

Table C.1: Underlying demand by electrical subnetwork

Electrical Sub-network	QLD	NSW	VIC	SA	TAS
Average underlying demand (MW)	7191	8266	5649	1682	1215

Source: Based on AEMO's Quarterly Energy Dynamics reports for Q2 2024, Q3 2024, Q4 2024 & Q1 2025.

Value of customer reliability (VCR)

We used the 2024 VCR figures to value unserved energy associated with restoration pathways. These are provided in the table below:

Table C.2: 2024 Value of customer reliability by electrical sub-network

Electrical Sub-network	QLD	NSW	VIC	SA	TAS
VCR ($/kwh)	25.75	30.93	35.78	33.32	18.99

Source: AER, Values of customer reliability – final report, 18 December 2024, p.62.

SRAS unit cost

Finally, we also assumed the nominal historical SRAS costs on a per unit basis from FY2023-24 to be the marginal cost of procuring additional black start-capable SRAS units. These costs are provided in the table below:

Table C.3: Estimated nominal SRAS costs - FY2024-25

Electrical Sub-network	QLD	NSW	VIC	SA	TAS
Total SRAS cost ($M)	10.5	13.0	8.8	4.5	7.7
No of SRAS	3	2	2	2	2
SRAS unit cost ($M)	3.5	6.5	4.4	2.3	3.9

Source: AEMO, Non Market Ancillary Services (NMAS) report 2023-24, 4 October 2024, p.10.

Other inputs taken from the 2016 Review

We carried over a number of input assumptions consistent with the 2016 Review of the System Restart Standard as we considered these values remained applicable for this updated analysis. Specifically, we applied the 2016 inputs for :

- average black start unit aggregate reliability
- minimum stable generation levels
- the probability of a black system event occurring.

These are provided in the table below.

Table C.4: Inputs from the 2016 Review of the standard

Electrical Sub-network	QLD	NSW	VIC	SA	TAS
Average black start unit aggregate reliability (%)	77	77	81	80	83
Minimum stable generation level(MW)	1650	1500	1100	330	300
Probability of a black system event (%)	2.74	2.64	2.98	5.45	4.56

Source: Reliability Panel, Review of the System Restart Standard - Final Determination, 15 December 2016, p.38, 51, 54.

C.1.2 Assumptions

The broad assumptions used in this assessment are as follows:

- No network damage is assumed to have been incurred as a result of the event causing a major supply disruption.
- Failure of generation post-restart or other network issues occurring after or during the system restart are not captured by this assessment.
- We define the baseline 'benchmark' outage duration as the time required to restore the system if all SRAS plants are unsuccessful in restarting the system. This duration is assumed to be equal to the restoration pathway of the one SRAS unit case, but delayed such that the minimum level of generation is reached in 10 hours. [140] Nb. A further sensitivity scenario was included for a 36 hour benchmark outage, as discussed in appendix C.1.3.

C.1.3 Sensitivity analysis

We applied the following sensitivities to our analysis to represent a range of potential outcomes. We assessed that uncertainty was likely asymmetric given the changing nature of the electricity system. This means that we assumed scenarios that increased costs of an outage, length of an outage, or probability of an outage were more probable. As such, we considered the following sensitivities:

- variations to the benchmark delayed outage:
  - a 10 hour delay to system restoration - aligned with the assumed "benchmark outage" from the 2016 economic assessment. This approach to setting a default - worst case outage length assumes that a minimum level of energisation occurs within the timeframe for transmission sub-station battery backup power.[141]
  - a 36 hour delay to system restoration. This more conservative approach to setting the default outage time is informed by the AER's approach to the 2024 Value of Network

140 This is consistent with the economic assessment method applied for the 2016 and 2020 Reviews of the System Restart Standard, ref: Reliability Panel, Review of the System Restart Standard - Final Determination, 15 December 2016, p.50.

141 Reliability Panel, Review of the system restart standard - Final Determination, 15 December 2016, p.50.

Resilience analysis, which noted that customers tended to take 'mitigating' actions for power outages exceeding 36 hours.[142]

- Variation for the 2024 VCR value - we considered a base case VCR based on the 2024 regional values published by the AER. In addition we considered a sensitivity of 150% of the 2024 regional VCR values.
- We considered a range of outage probabilities, including a base case that applied the 2016 outage probabilities unchanged as well as an upper bound with a 150% outage probability.

C.1.4 Detailed methodology

1. Establishing a central case restoration pathway

We assumed that the central case restoration pathway was the pathway corresponding to the maximum procurement modelled by AEMO in their technical advice. This was for two reasons. First, the maximum procurement modelled by AEMO was more closely aligned with historical procurement quantities for each electrical subnetwork. And second, the alternative lower bound modelled by AEMO contains additional assumptions around the level of solar PV in the system that would require adjustment for this analysis.

2. Quantifying the unserved energy associated with this restoration pathways, and subsequently the cost associated with this unserved energy

Unserved energy was calculated at 5-minute increments as the difference between underlying demand and the restoration curve. We assessed that underlying, rather than operational, demand was a more accurate reflection of unserved energy and consumer willingness to pay, as in a system black event distributed energy resources owned by consumers would likely be unavailable. The total amount of unserved energy was then multiplied by the relevant value of customer reliability to determine the cost associated with this unserved energy. Using the same methodology, we also calculated the cost associated with the benchmark outage scenario.

3. Calculating the probability of restart failure using the aggregate reliability of each combination of SRAS plant

Subsequently, we calculated the probability of restart failure using the aggregate reliability of SRAS plant using the equation provided in Figure C.1.

Figure C.1: Equation - probability of restart failure

$$P(failure) = (1 - R)^n$$

where "R" is aggregate reliability and "n" is the number of SRAS plant.

4. Calculating the marginal benefit of procuring additional black start-capable SRAS as the change in avoided unserved energy

We calculated the reliability-weighted benefit of procuring "n" number of black start-capable SRAS units as the probability of failure multiplied by the benchmark outage, plus the probability of success multiplied by the value of unserved energy associated with the central case restoration pathway as shown in Figure C.2.

142 AER, Value of Network Resilience 2024 Final Decision, 30 September 2024, pp.8-9.

Figure C.2: Equation - Total benefit associated with achieving an ideal restoration

$$Total\ benefit = P(failure) \times benchmark\ outage\ cost + P(success) \times ideal\ restoration\ cost$$

The marginal benefit of procuring additional black start-capable SRAS from improvements in aggregate reliability was then calculated as the difference between total benefits for a one-unit increase in the number of SRAS plant procured, as shown in Figure C.3.

Figure C.3: Equation - Marginal benefit of additional SRAS

$$Marginal\ benefit = \frac{\Delta Total\ benefit}{\Delta n}$$

5. Weighting the outcomes by the probability of a black system event

Finally, we weighted each marginal benefit by the probability of a black system event to calculate the annualised, or expected, marginal benefit of procuring "n" number of black start-capable SRAS units, as shown in Figure C.4.

Figure C.4: Equation - Annualised marginal benefit of SRAS

$$Annualised\ marginal\ benefit = P(black\ system\ event) \times marginal\ benefit$$

C.2 The total value assessment estimates the value of achieving an ideal restoration

We estimated the total value of SRAS procurement by comparing expected unserved energy outcomes between an ideal restoration pathway and a worst case prolonged restoration. For each electrical subnetwork, the assessment involved:

1. Establishing supply restoration pathways
2. Quantifying the unserved energy associated with each restoration pathway, and subsequently the cost associated with this unserved energy
3. Probability weighting the cost of unserved energy for each restoration pathway, incorporating the aggregate reliability of each combination of each SRAS plant
4. Calculating the benefit of achieving the ideal restoration as compared to an assumed worst case prolonged outage (in the absence of SRAS). This analysis included two options for the worst case prolonged outage (10 hours and 36 hours).

C.2.1 Inputs, assumptions and sensitivities

The total value analysis used inputs, assumptions and sensitivities consistent with those used in the marginal reliability analysis. The primary difference was with respect to restoration pathways. For each electrical subnetwork, we assumed an upper and lower bound restoration pathway. The upper bound represented the fastest restoration modelled by AEMO in their technical advice, whilst the lower bound was the slowest restoration. These corresponded to the maximum and minimum procurement of black start-capable SRAS modelled by AEMO.

C.2.2 Detailed methodology

1. Establishing supply restoration pathways

As noted above, we assumed an upper and lower bound restoration pathway, consistent with AEMO's modelling. The upper bound represented the fastest restoration modelled by AEMO in their technical advice, whilst the lower bound was the slowest restoration (with any delays due to load availability removed).

Where it was necessary to consider the procurement of black start-capable SRAS not captured by the maximum and minimum quantities, we assumed that the restoration pathway was the midpoint of neighbouring pathways. For example, if the upper bound pathway corresponded to a maximum procurement of 3 units, and the lower bound pathways corresponded to a minimum procurement of 1 unit, we assumed the restoration pathway for 2 units was the midpoint of the 3- and 1-unit pathways.

2. Quantifying the unserved energy associated with each restoration pathway, and subsequently the cost associated with this unserved energy

Unserved energy was calculated at 5-minute increments as the difference between underlying demand and the restoration curve. As in the marginal reliability analysis, we assessed that underlying, rather than operational, demand was a more accurate reflection of unserved energy and consumer willingness to pay.

For each restoration pathway, the total amount of unserved energy was then multiplied by the relevant value of customer reliability to determine the cost associated with this unserved energy.

3. Probability weighting the cost of unserved energy for each restoration pathway, incorporating the aggregate reliability of each combination of SRAS plant

We probability weighted the unserved energy associated with each restoration pathway by considering the aggregate reliability of each combination of SRAS plant and the probability of a black system event occurring.

For example, suppose the upper bound procurement consisted of 3 black start-capable SRAS units, each with reliability (or probability of success) of 80%. The probability that all three units start is 51.2%, implying that there is a 51.2% probability of the upper bound procurement following the restoration pathway associated with 3 units. Similarly, the probability that 2 units start is 38.4%, the probability that only one unit starts is 9.6%, and the probability that no unit starts is 0.8%. For each of these cases, we multiplied the probability of that number of units successfully starting by the corresponding restoration pathway.

After the reliability weighting was complete, we calculated the annualised, or expected, cost of unserved energy by multiplying the reliability-weighted cost by the probability of a black system event.

4. Calculating the total benefit provided by SRAS as the difference between the ideal and default worst case probability weighted outage costs.

Finally, we calculated the total estimated benefit of the upper-bound SRAS procurement relative to the default delayed outage as the difference in the probability weighted costs.

Figure C.5: Equation - Total benefit relative to a prolonged outage

$$Total\ benefit = outage\ cost_{ideal} - outage\ cost_{prolonged}$$

D Review of previous recommendations

The Panel has reviewed the progress of recommendations made under previous reviews related to the system restart regulatory framework. The Panel has considered the recommendations made under the following reviews:

- 2016 Reliability Panel review of the system restart standard (2016 Panel Review)
- 2018 AEMC review of the South Australian black system event (2018 AEMC Review)

D.1 Review of actions from 2016 Reliability Panel review of the system restart standard recommendations

The 2016 Panel Review determined more stringent requirements for the procurement of SRAS which are tailored to the specific requirements of each electrical sub-network. The review was initiated to align the Standard with the 2015 SRAS Rule determination which clarified the roles and responsibilities for the Panel in setting the Standard. Throughout the Panel's review, it became aware of a number of stakeholder concerns related to the restoration process that were outside the scope of the Standard. The Panel made recommendations related to:

- developing plans for the restoration of load
- providing transparency on the expected timeframes for the restoration of load
- increasing engagement with relevant stakeholders to ensure sufficient SRAS capability is procured
- seeking greater opportunities for testing from SRAS providers.

The rationale for these recommendations and actions taken are set out in the sub-sections below.

D.1.1 Developing plans for the restoration of load

While the Standard is only concerned with the restarting of a sub-network, it is also important that the entire process for restoring generation and consumer load is effective.

Existing system restart plans cover the first two stages of the restoration process following a black system condition, this being the re-energising of the transmission network and restoration of supply from major power stations. However, these plans do not cover the full process of restoring supply to all consumer loads. The Panel is not aware of any comprehensive restoration plans to cover the whole of the load restoration from a black system condition.

Box 15: Recommendation - Development of load restoration plans

AEMO, the relevant TNSP and DNSPs, as well as the JSSC for each electrical sub-network develop plans for the complete restoration process from a black system condition being declared to the restoration of all consumers' load.

Source: Reliability Panel, Review of the System Restart Standard, final determination, 15 December 2016, p.vii.

The Panel continues to encourage extending system restart planning to encompass the energisation of load to provide guidance on the time it would take to restore consumer load.

The Panel considers such level of planning would be important inputs for state emergency management arrangements developed by jurisdictions, which would need to consider the expected time and rate at which the load can be restored so that appropriate preparations can be made. This aligns with the Panel's considerations in the 2016 review. This would include:

- the impact on emergency power supplies at key government and private facilities such as hospitals, prisons, the police and other emergency services
- the impact on major infrastructure such as water pumping, sewage management, telecommunications, transport (trains and traffic signals)
- whether emergency food and water supplies are likely to be required.

D.1.2 Providing transparency on the expected timeframes for the restoration of load

During the review process, the Panel became aware that many stakeholders were not generally well-informed about the detailed and involved nature of the restoration process and the various roles of parties involved at each of the three stages.

Given the potential significance of a major supply disruption, evidenced by the black system event in South Australia, it is important that everyone who has a role understands what can be involved in restoring a system, particularly the unpredictability of the timeframe that can occur between restoring generation and returning supply to consumers within large distribution networks, such as a large CBD.

Box 16: Recommendation - Communication of load restoration timeframes

JSSCs' roles in each jurisdiction should, to the extent it doesn't already, extend to communication in relation to expected timeframes for the restoration of load that takes place in Stage 3 of the restoration process.

Source: Reliability Panel, Review of the System Restart Standard, final determination, 15 December 2016, p.vi.

D.1.3 Increasing engagement with relevant stakeholders to ensure sufficient SRAS capability is procured

The Panel was previously made aware that some stakeholders considered that the SRAS procurement may have not been sufficient to meet the restoration targets in the Standard. In response, the Panel recommended AEMO enhance its engagement with stakeholders in relation to SRAS procurement outcomes with respect to the restoration targets set out in the standard.

Box 17: Recommendation - AEMO consultation with TNSPs during procurement process

AEMO explore avenues through which it might be able to increase engagement with key stakeholders, such as network service providers, in relation to its consideration of key elements relevant to its procurement of SRAS.

Source: Reliability Panel, Review of the System Restart Standard, final determination, 15 December 2016, p.v.

The Panel understands that AEMO has met the Standard in all financial years since the 2016 review, with the exception of FY2024, where the Panel noted in its non-market ancillary service report AEMO was not able to procure sufficient SRAS to meet the Standard requirements for the region north of Bundaberg in Queensland. The Panel considers that AEMO would need to engage as necessary with relevant stakeholders in formulating its system restart plan, including NSPs and current SRAS providers. This provides opportunities for concerned parties to engage with AEMO on matters related to the compliance of relevant plant.

D.1.4 Seeking greater opportunities for testing

Testing of SRAS capability is an integral part of the restoration process and is subject to both SRAS guidelines and other contractual obligations between AEMO and SRAS providers.

Box 18: Recommendation - End to end testing of restart services

The Panel recommends that AEMO, SRAS providers and transmission networkservice providers cooperate more fully to identify opportunities to fully test theoperation of restart services when this involves normally in service transmission elements.

The National Electricity Amendment (System restart services standards and testing) Rule 2020 No. 6 introduced a new framework for SRAS testing. The final rule established a transparent framework for the physical testing of system restart paths and included arrangements for enabled participants that incur direct costs as a result of participating in a test to claim compensation using a standalone restart testing compensation process.[143]The final rule also requires AEMO to:

- provide guidance to participants on the frequency with which the tests may occur[144]
- provide at least six weeks' notice to participants prior to a test occurring[145]
- design the test to minimise the cost and operational impacts on participants[146]
- report on the outcomes of a test, including how it sought to achieve the above objective.[147]

The Panel considers this arrangement supports SRAS providers, TNSPs and AEMO to better identify opportunities to deepen network testing and undertake these test as required.

D.2 2018 AEMC Review of the South Australian black system event recommendations

The 2016 South Australian black system event revealed vulnerabilities and emerging system security challenges in the NEM. Triggered by severe weather, the event led to a loss of electricity supply for approximately 850,000 customers at a cost of 367 million dollars. In light of the event, a review of actions by relevant parties and related regulatory arrangements was initiated, with the Commission making the following recommendations for rule changes:

- Implement a General Power System Risk Review (GPSRR)
- Enhance operational resilience through a rule change
- Clarify NER applicability during market suspension.

The details of these proposals and actions taken are explained in detail below.

D.2.1 Implementing a General Power System Risk Review (GPSRR)

The Commission recognised that the power system's risk profile is changing in response to generation, load and system response uncertainty. This change increases vulnerability to extreme weather and other unexpected events as evidenced by the 2018 South Australian system black event.

143 NER cl. 4.3.6(m)
144 NER cl. 4.3.6(d)
145 NER cl. 4.3.6(h)(2)
146 NER cl. 4.3.6(g)(3)
147 NER cl. 4.3.6(t)

Box 19: Recommendation - General power system risk review

Expand existing frameworks to make clear how indistinct events can be a type of protected event and implement protected operation for indistinct events that are related to abnormal conditions.

Proposal: Implement mechanisms for enhancing operational resilience

Source: AEMC, Mechanisms to Enhance Resilience in the Power System - Review of the South Australian Black System Event, Final report, 15 Aug 2019, p.iv.

In alignment with the Commission's recommendation, the Council of Australian Governments (COAG) submitted a rule change package in 2020. The subsequent National Electricity Amendment (Implementing a general power system risk review) Rule 2021 established the GPSRR by requiring AEMO to undertake an annual review of non-credible contingencies. The rule also required NSPs to incorporate AEMO's findings into their planning processes. Specifically, it did this through:

- substituting 5.20A.1 to state the GPSRR must review non-credible contingencies, present priority risk management arrangements and options for future management of non-credible contingencies.
- substituting 5.20A.2 to require AEMO to provide a GPSRR no less than annually and to introduce obligations for NSPs to consider any analysis conducted as part of their planning review.

D.2.2 Enhancing operational resilience through reclassification

The Commission recognised that current regulatory framework is built around contingency events, and therefore it is difficult to manage system security risks that do not qualify as contingency events.

Box 20: Recommendation - Indistinct events

Expand existing frameworks to make clear how indistinct events can be a type of protected event and implement protected operation for indistinct events that are related to abnormal conditions.

Proposal: Implement mechanisms for enhancing operational resilience

Source: AEMC, Mechanisms to Enhance Resilience in the Power System - Review of the South Australian Black System Event, 15 Aug 2019, p.iv.

The 2020 COAG rule change package also included a request to expand the definition of contingency event to improve AEMO's responsiveness. National Electricity Amendment (Enhancing operational resilience in relation to indistinct events) Rule 2022 facilitated this through:

- expanding NER clause 4.2.3 and the definition of 'contingency event',
- expanding the reclassification criteria so AEMO must include information about measures to maintain system security, and
- requiring publication of a report where AEMO describes measures it has implemented to manage a reclassified credible contingency.

D.2.3 Clarifying NER applicability during market suspension

The Commission identified that existing arrangements do not explicitly state the NER applicability during suspension, or the extent to which AEMO must comply with obligations under the NER. In

the 2018 Review, the Commission highlighted that this may create uncertainty for AEMO and Registered Participants in restart scenarios, threatening a successful restart response.

Box 21: Recommendation - Market suspension

Expand existing frameworks to make clear that the arrangements apply during market suspension and provide AEMO with enhanced flexibility to prioritise system security obligations during this period.

Proposal: Clarify applicability of NER arrangements during market suspension

Source: AEMC, Mechanisms to Enhance Resilience in the Power System - Review of the South Australian Black System Event, 15 Aug 2019, p.i.

After consultation, the Commission issued a no-rule determination in its National Electricity Amendment (Prioritising Arrangements for System Security During Market Suspension) Rule 2021. In consultation, stakeholders identified limited confusion regarding NER applicability, and the Commission considered that nothing in the Rules creates uncertainty over how the Rules apply during periods of market suspension. The proposal did not contribute to the NEO, and the Commission reiterated that all NER obligations apply and chose to clarify uncertainty through the draft determination rather than in the Rules.

E Evolution of the system restart regulatory framework

E.1 Overview of previous bodies of work that contributed to regulatory changes to the system restart framework

Previous reviews of the System Restart Standard and related rule change determinations are as follows:

- 2006: AEMO (then NEMMCO) created an interim System Restart Standard in response to the AEMC's system restart ancillary service arrangements rule change.
- 2012: The Panel reviewed the Interim Standard as required under the Rules, and a Standard based on the Interim Standard with minor changes to improve clarity.
- 2013: AEMO reviewed the SRAS guidelines and made several amendments, such as revising sub-network boundaries and clarifying SRAS applicability and reliability.
- 2015: The Commission's SRAS rule change request modified SRAS governance, procurement and cost recovery frameworks.
- 2016: The Panel reviewed the Standard, setting clearer restoration timeframes and performance requirements to improve system restart reliability.
- 2020: The Commission's rule change expanded SRAS to include Restoration Support Services (RSS), introduced a framework for long-term procurement, and mandated physical testing of restart paths.
- 2021: The Panel reviewed the Standard and clarified restoration targets, recognised emerging technologies, and strengthened testing requirements.

E.1.1 2006 – System restart ancillary service arrangements rule change

In 2006, the AEMC made a rule concerning the standards, procurement and use of SRAS. Relevant aspects of the 2006 rule change included changes to the SRAS Objective and a clarification of the contents and purpose of the standard. As required by this rule, AEMO (then NEMMCO) created an Interim Standard in 2006, following stakeholder consultation and Panel approval, which remained in effect until 2012.

E.1.2 2012 – Review of the System Restart Standard

Under the Rules, the Panel was required to review the Interim Standard. This review was completed in 2012 and largely retained most of the Interim Standard that had been developed by AEMO. The Panel made only minor changes to the Standard this time, which were intended to improve clarity.

E.1.3 2013 – Review of SRAS Guidelines

AEMO reviewed the SRAS guidelines. In its final determination, AEMO reconsidered its initial approach and made the following changes to its SRAS Guidelines by:

- clarifying that when AEMO procures SRAS, it would assume supply would not be available from adjoining electrical sub-networks;
- removing the requirement to procure a minimum of two SRAS sources for each electrical sub-network area, with AEMO procuring the optimal quantity of SRAS to efficiently meet the System Restart Standard in each electrical sub-network;
- recognising that individual, lower reliability SRAS may be combined to meet the System Restart Standard;

- assuming that the transmission network would be fully available, subject to standard technical limitations, following a major supply disruption, and;
- clarifying the boundary between Queensland South and New South Wales electrical sub-networks.

E.1.4 2015 – System restart ancillary services rule change

In 2015, the Commission made a rule modifying SRAS governance, cost recovery and procurement frameworks following a rule change request from AEMO and the Group of Generators. This rule change:

- clarified that the Reliability Panel must set the Standard and that AEMO must procure services to meet the Standard;
- removed the requirement for AEMO to procure SRAS exclusively through competitive tenders and allowed contractual negotiations under guidelines;
- implemented regional cost recovery to provide price signals to the market and avoid jurisdictional cross-subsidisation, and;
- eliminated the distinction between primary and secondary SRAS, opening tenders to a broader set of providers with based on technical capability.

E.1.5 2016 – Review of the System Restart Standard

The Panel initiated a Review of the System Restart Standard in 2016 in response to the Commission issuing a Terms of Reference. The 2016 Review aimed to ensure the Standard was adapted to significant changes to the power system, including the integration of non-synchronous generation and evolving network conditions. As part of the review, several recommendations were made for consideration in future reviews of the Standard. These recommendations are outlined in Appendix B.

E.1.6 2020 – System restart services, standards and testing rule

In 2020, the Commission made a rule reforming SRAS testing procedures, asset eligibility guidelines, and the SRAS Procurement Objective in response to AEMO and the AER's rule change request. Key changes from this rule include:

- expanding the definition of black start to include Restoration Support Services (RSS) that provide system strength to IBR-established stable restoration islands;
- amendment of the SRAS Procurement Objective to allow AEMO to procure SRAS from solutions with high capital costs;
- introducing a regulatory framework for the physical testing of restart paths, addressing the limitations of relying solely on modelling to validate restart capability under evolving network conditions, and;
- clarifying the nature of the information included in LBSPs and how this relates to parties' compliance obligations under the rules.

E.1.7 2021 – Review of the System Restart Standard

The Panel initiated a Review of the System Restart Standard in 2021. As part of the review, restoration timeframes were updated to clarify performance expectations in an inverter-dominated system, emerging technologies were recognised in restart and restoration pathways and requirements for physical testing were strengthened.

F Summary of stakeholder feedback

F.1 The Panel developed a framework to systematically consider issues within its issues paper

The Panel published its issues paper on 12 December 2024. In this paper, the Panel invited submissions on three topics within the system restart regulatory framework: restart preparedness and governance, SRAS sufficiency, and restart transparency and reporting.

Restart preparedness refers to the readiness of the power system to be re-energised following a major supply disruption. This includes capabilities and constraints related to the physical network infrastructure and the capabilities of key organisations responsible for system restoration.

Restart sufficiency refers to the availability of black start capability required to restart the power system following a black system event. The Standard defines operational planning objectives for system restart and guides AEMO's procurement of SRAS to deliver restart.

Transparency and reporting considers the visibility of restart preparedness, sufficiency and emerging system restart risks. AEMO's reporting obligations (e.g., the TPSS, ESOO, and Engineering Roadmap) support this, helping revise restart plans and providing signals to the market.

In inviting submissions on these issues, the Panel sought to understand stakeholder views on the current system restart framework to inform the development of a more robust, flexible and future-ready System Restart Standard.

F.2 Stakeholders supported improving restart preparedness through clearer roles, network adaptation, and integrating emerging technologies.

The Panel sought stakeholder feedback on whether current roles and responsibilities remain appropriate and on potential opportunities to enhance system restart through changes to transmission and distribution networks. The following themes emerged from stakeholder feedback:

- Further clarity in roles & responsibilities would enhance the effectiveness of the system restart framework – particularly in relation to restart planning and testing.
- Restart preparedness could be enhanced through review of the LBSP and testing framework.
- REZs should be considered in the design of future system restoration approaches.
- AEMO should reflect new transmission and REZ infrastructure when establishing network boundaries
- Uncontrolled rooftop solar presents challenges to system restoration, however the roll out of emergency backstop controls could largely address these concerns.
- There are opportunities for distribution systems to play a more active role in future restart, but these would require regulatory changes to support investment in enhanced capabilities.

Specific feedback from stakeholders is presented in the sub-sections below.

F.2.1 Further clarity on roles and responsibilities would enhance the effectiveness of system restart framework

Stanwell supported the current allocation of forecasting and procurement roles, describing it as "*appropriate for SRAS to be kept as a contracted service",* but suggested clearer definitions could enhance the effectiveness and adequacy of a system restart response.[148]

The CEC agreed that roles and responsibilities remain appropriate but suggested *"AEMO should take a greater role in outlining system restart requirements for the future power system"* and that *"there could be a greater role for transmission and distribution network service providers"* in black start planning.[149]

Tomago Aluminium raised a continuing concern for limited consultation on restart planning, suggesting it could provide load stabilisation provisions during periods of system restart, especially with increasing CER integration.[150]

F.2.2 Restart preparedness could be enhanced through reviewing the LBSP framework and enhanced restart testing

AEMO and the CEC suggested that enhancement of the existing LBSPs process may better support effective development of system restart plans.[151] The CEC also considered that changes to NER clause 4.8.12 could improve AEMO's LBSPs to better incorporate arrangements for the re-energisation of distribution networks.[152]

AusNet submitted that the Panel explore opportunities for improved restart testing to improve confidence in system restart pathways, given increasing operating risks during the transition.[153]

F.2.3 REZs should be considered in the design of future system restoration approaches

AEMO, PowerLink, Ausgrid, CEC and EnergyAustralia highlighted the importance of considering REZ capability in future restart planning.[154] Ausgrid noted that no current system restart obligations exist for the design and operation of REZs, but expressed willingness to collaborate with AEMO on system restart capability at the Hunter Central Coast (HCC) REZ in future. Specifically, it considered installing up to four synchronous condensers at the HCC REZ "*could play a crucial role in restarting the system by providing vital reactive power support that helps stabilise voltage levels during the initial stages of grid restoration following a blackout"*.However, Ausgrid flagged cost recovery gaps and long lead times as barriers to viability of this investment.[155]

F.2.4 AEMO should reflect new transmission and REZ infrastructure when establishing network boundaries

Ausgrid stated that current electrical sub-network boundaries "*are too broad to understand the complex interdependencies of different elements of the power system"*,[156] noting in particular that the current sub-network boundaries fail to reflect the impact of rooftop solar on distribution, transmission, REZs, and interconnectors. However, Ausgrid also acknowledged procedural

148 Stanwell submission to the Review of System Restart Issues Standard Paper, p.2.
149 CEC submission to the Review of System Restart Standard Issues Paper, p.2.
150 Tomago Aluminium Company, Submission to the Issues paper, pp.2-3.
151 Submissions to the Issues paper: AEMO, p.3.; CEC, p.4.
152 CEC, Submission to the Issues paper, p.4.
153 AusNet, Submission to the Issues paper, p.1.
154 Submissions to the Issues paper: AEMO, p.2.; Ausgrid, pp.2-3.; CEC, p.2.; EnergyAustralia, p.2.; Powerlink, p.2.
155 Ausgrid, Submission to the Issues Paper, pp.2-3.
156 Ibid, p.3.

complexities in updating sub-region boundaries,-suggesting this process could be simplified *"by embedding a level of flexibility in anticipation of future power system changes"*.[157]

The CEC submitted that AEMO is best placed to assess the boundary appropriateness and the strategic location of SRAS as network topology changes, while Powerlink proposed exploring whether REZs could be recognised as independent electrical sub-networks. [158]

F.2.5 Uncontrolled rooftop solar presents challenges to system restoration

Ausgrid, the CEC, and AEMO recognised the challenges for system restart presented by uncontrolled distributed (rooftop) PV.[159] Ausgrid explained that uncontrolled rooftop solar *"can stop the grid from reaching the sufficiently stable state needed for system restoration"* but recognised the impact that the emergency backstop arrangements, being developed by AEMO and DNSPs, could have in enabling PV curtailment under emergency conditions.[160]

QLD, Vic, TAS, SA and ACT have currently implemented backstop arrangements. The implementation of backstop arrangements in NSW is expected in Q3 2025.[161]

F.2.6 There are opportunities for distribution systems to play a more active role in future restart

Ausgrid welcomed the Panel's consideration of a more active role for distribution, highlighting that combined rooftop PV is now the single largest generation source in the NEM at ~22GW as of March 2024.[162] Ausgrid noted that while distribution energy zones could play an important role in future system restart, current regulation would need reform to address limitations on DNSPs' ability to deliver advanced restorative support.[163] Ausgrid and the CEC suggested that AEMO work with DNSPs to resolve issues related to CER integration through pilot testing partnerships that trial new opportunities for enhanced integration of the distribution system to deliver improved system restart preparedness.[164]

CS Energy submitted that the UK's 'Distributed ReStart' program has been successful in delivering restart in the NESO and recommended a similar initiative for the NEM. It argued that a pilot program exploring distributed restart capability could be simpler to implement in the NEM since *"the focus would likely be on transmission and not distribution-connected assets"*. [165] Powerlink and Snowy Hydro identified risks associated with restoration plans that rely on a large number of small and emerging solutions, advising that restart plans should continue to prioritise a small number of large and established generators.[166]

F.3 Stakeholders supported enhancements to restart sufficiency through updated standards, investment signals, and targeted integration of new types of SRAS.

The Panel sought feedback on whether stakeholders viewed current restart sufficiency arrangements as adequate and sought feedback on opportunities to enhance the framework

157 Ibid, p.3.
158 Submissions to the Issues paper: CEC, p.3.; Powerlink, p.2.
159 Submissions to the Issues paper: AEMO, p.3.; Ausgrid, p.4.; CEC, p.3.
160 Ausgrid, Submission to the Issues Paper, pp.2-3.
161 DCEEW: NSW Emergency Backstop Mechanism and CER Installer Portal Consultation Summary, May 2025
162 AEMO: 2024 Forecasting Assumptions Update, Aug 2024.
163 Ausgrid, Submission to the Issues paper, pp.1,6.
164 Submissions to the Issues paper: Ausgrid,p.5.; CEC, p.3.
165 CS Energy Submission to the Review of the System Restart Standard Issues Paper, p.4.
166 Submissions to the Issues paper: Powerlink, p.1.; Snowy Hydro, p.2.

through stronger investment signals and integration of IBR in the system restart process. The following themes emerged from stakeholder feedback:

- The cost and uncertainty of SRAS tendering present a barrier for new technologies to participate in the procurement process
- IBR could play an important role in supporting system restoration and stakeholders are keen to understand the requirements for IBR to participate in SRAS provision
- Opportunity costs for BESS to reserve charge for system restoration could drive up costs
- The Standard would need to evolve to be reflective of present SRAS availability and provide flexibility to AEMO to consider future system restart needs

Specific feedback from stakeholders is presented in the sub-sections below.

F.3.1 The cost and uncertainty of SRAS tendering present a barrier for new technologies to participate in the procurement process

AusNet noted that there is an absence of commercial incentives to support new SRAS capability development, and that costly, unremunerated testing requirements create unacceptable investment risk. In practice, AusNet also highlighted an accompanying lack of industry understanding of IBR system restart capability.[167] Similarly, Ausgrid reported concerns for BESS cost recovery and regulatory enablement. It submitted that despite commencing work with large BESS proponents, these projects do not intend to develop grid-forming capability, *"as this would require additional investment with no clear regulatory or commercial mechanism to recover the associated costs"*. Ausgrid indicated a willingness to revisit its position if a cost recovery pathway is introduced. Alinta submitted that SRAS investment signals require higher value, longer contracting periods, and more detailed information on system requirements to be enhanced.[168]

F.3.2 IBR could play an important role in supporting system restoration

Stanwell, Tesla, and CEC recommended updating the framework and the Standard to explicitly include new technologies, such as BESS for SRAS.[169] The CEC submitted that AEMO has not fully leveraged the revised NER to procure new forms of SRAS.[170] While the 2015 SRAS Rule allows AEMO to innovate by selecting from a wide range of services with varying reliability levels to meet an aggregate reliability target, the CEC remains *"unaware of AEMO utilising this purposeful flexibility"* to support the development or procurement of new SRAS capability.[171] AusNet noted that consensus on the potential for IBR generation and storage to provide SRAS is still developing, *"as are the associated software and control systems used to manage IBR system restart processes"*.[172] When considering onerous testing requirements, AusNet forecast difficulties for IBR proponents seeking to demonstrate capability and participate in the SRAS procurement process.

Snowy Hydro acknowledged the need to consider IBR for system restoration but maintains that gas and hydro will remain the primary providers of SRAS until IBR can provide a competitive service.[173] Likewise, Powerlink noted that system restart from smaller generators in distinct sub-networks will become more viable as automation and technology improve.[174]

167 AusNet, Submission to the Issues paper, p.2.
168 Ausgrid submission to the Review of the System Restart Standard Issues Paper, p.7.
169 Submissions to the Issues paper: CEC, p.6.; Stanwell, p.2.; Tesla, p.1.
170 CEC, Submission to the Issues paper, p.3.
171 CEC Submission to the Issues Paper, p.5.
172 AusNet, Submission to the Issues Paper, p.2.
173 Snowy Hydro, Submission to the Issues Paper, p.2.
174 Powerlink, Submission to the Issues Paper, p.1.

F.3.3 Opportunity costs for BESS to reserve charge for system restoration could drive up costs

Tesla noted it provided black-start capability in other markets, most notably Oahu, Hawaii, with the 185MW/585MWh Kapolei Energy Storage facility (KES). The KES's ability to perform black-start functionality, along with a suite of other grid-forming services, including FFR and synthetic inertia, means it is possible to safely retire and replace coal-fired generation and system strength.[175] However, EnergyAustralia cautioned that BESS is becoming a catch-all for system security issues in the NEM, noting BESS are *"increasingly being seen as a solution for every emerging system problem"*. Further, it highlighted revenue losses in procuring reserve capacity, particularly in ensuring availability during critical system conditions.[176]

F.3.4 The Standard would need to evolve to be reflective of present SRAS availability and provide flexibility to AEMO to consider future system restart needs

AEMO considers that the Standard is set on SRAS availability constraints from nearly a decade ago, and no longer reflects the services available for system restart. Even if the same set of services is procured, AEMO highlighted that it can be difficult to meet the Standard, offering support for the Panel's consideration of the Standard being expressed in a different way or revised through changes to the roles and responsibilities of Registered Participants.

The Australian Aluminium Council raised concern that current system restoration timeframes may result in smelter damage during black system events. Tomago Aluminium recommended that the Panel consider the economy-wide costs associated with potline damage in recommending a Standard. Tomago also noted the ongoing industry concern and perceived lack of action on this issue, stating *"the risk has been known for 20 years by past and present stakeholders... and yet no action has been taken"*[177]

Powerlink considered the restart plan for each electrical sub-network should be assessed to ensure restart pathways are optimised with the available restart capability. Powerlink also noted that restart planning should consider how the electrical sub-network is energised from a neighbouring region, noting the SRAS procured should ensure each electrical sub-network is capable of system restart if it becomes isolated from surrounding networks.[178]

F.4 Stakeholders acknowledged that transparency and reporting are complementary to enhancing restart preparedness and ensuring the sufficiency of SRAS arrangements

The Panel sought feedback on whether current reporting arrangements, including existing obligations and the extent to which they are used, are sufficient to support transparency, coordination, and continuous improvement in system restart planning.

Stakeholders highlighted the importance of reporting and transparency in creating appropriate market signals for SRAS investment. CS Energy recognised the importance of greater transparency for securing investment in system restart services, noting signals and incentives for investment in new SRAS capability rely on transparency around need and value. However, it submitted that participants have *"little to no transparency"* of system restart work progressed

175 Tesla, Submission to the Issues Paper, p.1.
176 EnergyAustralia, Submission to the Issues Paper, p.2.
177 Tomago Aluminium Company, Submission to the Issues Paper, p.2.
178 Powerlink, Submission to the Issues paper, p.2.

under the Engineering Roadmap, noting further concerns with AEMO's underemphasis on managing traditional SRAS provider retirement in the TPSS.[179]

AusNet supported the Reliability Panel's efforts to improve SRAS transparency and recommended the introduction of two prospective reporting requirements, including a planning report *"to test identified need and feasibility of SRAS"* and a revised NMAS report *"that summarises outcomes from the planning report for a wider audience, including SRAS investors and electricity consumers"*.[180] AEMO's submission suggested reporting requirements to be a second-order priority, albeit necessary to support the development of system restart services.[181]

179 CS Energy, Submission to the Issues Paper, p.4.
180 AusNet, Submission to the Issues Paper, p.2.
181 AEMO, Submission to the Issues Paper, p.4.

G Case study of the UK system restart regulatory framework

This appendix summarises the Panel's investigation of the regulatory framework governing system restart in the United Kingdom (UK). The Panel considers the recently revamped restart framework for the UK power system represent an example of international best practice.

The UK is in the process of implementing a new regulatory framework and Electricity System Restoration Standard (ESRS) that will take effect from 31 December 2026. Under the new framework, the National Electricity System Operator (NESO) is subject to clear, enforceable reporting obligations that are set by the regulator, the Office of Gas and Electricity Markets (OFGEM). Despite these obligations, NESO maintains significant discretion in determining how to meet the ESRS. This structure drives accountability without suppressing innovation and avoids regulatory burden within restoration planning and execution.

The Panel also notes the relevance of a new system restoration technology initiatives being led by the UK, such as the Distributed ReStart program. This program of work has developed and demonstrated processes and systems to coordinate groups of distribution-connected generation, including inverter-based renewable generation and batteries, to facilitate distribution-based system restart. The Panel recognises the UK's innovative and world leading work in this area to respond to the operational challenges related to the decarbonisation of the power system.

G.1 The system restart initiatives in the UK are driven by the need to prepare for restoration of a decarbonised power system

The UK's power system is highly interconnected, with 10.3GW of interconnector capacity and HVDC links to France, Belgium, the Netherlands, Ireland, Norway, and Denmark. [182] These interconnectors generally cannot provide system restart capability. Peak demand in 2024 was 58GW, supported by 125GW of installed capacity.[183] The UK is committed to net zero by 2050, embarking on an ambitious decarbonisation strategy that has resulted in 61% of electricity generated from zero-carbon sources as of June 2025.[184] At the same date, wind accounted for the largest share of the generation mix at 31.3%, followed by gas at 17.7% and nuclear at 14.6%.[185]

Like many systems undergoing decarbonisation, the UK faces resilience challenges from the displacement of synchronous generation, traditionally responsible for providing inherent system security services like inertia and minimum fault current. The absence of these characteristics makes it particularly difficult to establish and extend stable restoration islands during the restoration process. As the power system's stable operating envelope evolves, BESS and other distributed energy resources (DER) are becoming increasingly critical to maintaining security and achieving the UK's net zero targets. In recognition of this, UK system restart initiatives, including Distributed ReStart, are being driven by a clear need to develop processes that enable restoration in a decarbonised power system. Distributed ReStart in particular focused on the designing and testing of the frameworks, technical capabilities and commercial arrangements required to integrate DER into system restoration strategies.

182 OFGEM: Electricity interconnectors.
183 NESO: Future Energy Scenarios, Jun 2025.
184 NESO: Britain's Energy Explained, Jun 2025.
185 Ibid.

G.2 The UK's system restart framework balances regulatory flexibility with prescriptive requirements, while supporting innovative approaches to system restoration

The UK's system restart framework serves as a best-practice example for other international frameworks due to its effective governance arrangements, assurance and reporting framework, legal enforceability, and initiatives to test new restoration approaches.

Below is a summary of key elements of the UK's restoration approach. After this, the Panel presents an in-depth case study into relevant elements of the UK's restart framework, including the role of decarbonisation and the implementation of the ESRS, the clear licensing obligations placed on NESO under the System Operator Licence, and the details of the Distributed ReStart program.

G.2.1 Overview of the new UK system restoration framework

This section includes an overview of the features of the UK's system restoration framework. At a high level, the UK framework includes:

- ESRS: NESO must have the capability to restore 60% of regional demand within 24 hours and 100% within 5 days.[186]
- Grid Code and Licence: OFGEM's technical rules and licence conditions that apply to NESO as the system operator.
- Assurance framework: NESO's methodology reports and post-exercise reviews proving ESRS compliance.
- NSP and interconnector procedures: Network operators' local re-energisation plans and interconnector black-start supplements.

The ESRS is a legally enforceable restoration standard that will take effect from 31 December 2026

The ESRS policy statement was released by the UK Government in April 2021. This policy statement strengthened the previous restoration framework by introducing a legally binding target for the restoration of electricity supply in the event of a nationwide or partial power outage on the national electricity system.[187]

> "NESO must have sufficient capability and arrangements in place to restore 100% of Great Britain's electricity demand within five days. It should be implemented regionally, with an interim target of 60% of regional demand to be restored within 24 hours"

The new standard must be met by 31 December of each reporting year, with initial compliance required no later than 31 December 2026.[188]

The ESRS was introduced by the Department for Business, Energy & Industrial Strategy (BEIS) via its April 2021 policy statement, and given legal effect through OFGEM's licence modifications on NESO from 19 October 2021.[189] The implementation of this standard responds to the low-likelihood but high-impact risk of a nationwide blackout by mandating clear, measurable restoration targets, while also reflecting the need to maintain resilience and public safety.[190] Further details on the ESRS are included in appendix G.2.1.

186 UK Department of Business, Energy & Industrial Strategy, Introducing a new 'Electricity System Restoration Standard': policy statement, 1 April 2021.
187 OFGEM: Decision on licence amendments to facilitate the introduction of an Electricity System Restoration Standard, Aug 2021.
188 ESO: Industry information: Electricity system restoration standard.
189 OFGEM: Decision on licence amendments to facilitate the introduction of an Electricity System Restoration Standard, Aug 2021.
190 UK Government: Introducing a new "Electricity System Restoration Standard': policy statement, Apr 2021.

NESO's restoration planning is subject to licensing requirements

Though afforded flexibility in meeting the ESRS, as the system operator, NESO is subject to extensive reporting, compliance, and licensing obligations under Condition C4 of the UK's System Operator Licence.[191] This licence requires NESO to submit an annual Electricity System Restoration Assurance Framework.[192] This Framework must include detailed information on how NESO plans to meet the ESRS, reviews of previous restoration times, expectations for future restoration times, details of self-monitoring, and statements on data transparency.[193]ESO is also required to proactively consult on changes to the Grid Code that will assist it in meeting the ESRS.[194] Further details on the system operator's responsibilities for system restoration are included in section A.2.3

Electricity restoration services (ERS) are procured through a competitive tender

NESO procures Electricity Restoration Services (ERS) through contracting via competitive tenders. This mechanism was introduced in 2018, with tenders subject to extensive Tender Rules.[195]Recent changes to the tendering process have arisen from the findings of Distributed ReStart. In seeking to attain full, consistent compliance with the ESRS, NESO began receiving submissions from a wider range of technologies connected at different voltage levels, including DER.[196]By allowing DER to tender, NESO has tendered ERS in preparation for a world-first, hybrid approach to system restoration. The details of and findings of Distributed ReStart can be found in appendix G.3.

OFGEM oversight ensures that the requirements of the ESRS are fulfilled

In the context of system restart, NESO is regulated by the OFGEM and must also comply with directions from the Secretary of State regarding framework planning and execution.[197] OFGEM monitors compliance with Condition C4 and is responsible for reviewing NESO's assurance framework and performance in meeting the ESRS.[198] Unlike equivalent bodies in the NEM , OFGEM possesses significant civil penalisation powers. At present, there is no statutory maximum on the amount OFGEM can fine NESO for breaches of the Code, with OFGEM also able to revoke NESO's licence, and therefore status as Operator, for breaches of its licensing conditions.

G.2.2 The ESRS was implemented to ensure adequate preparation and resilience in the unlikely event of an electricity failure

The ESRS requires NESO to have sufficient capability and arrangements in place to restore 100% of UK's electricity demand within 5 days, supported by an interim target of 60% of regional demand restoration within 24 hours.[199] Prior to its implementation in October 2021, restoration planning and execution relied on an implied restoration target and more relaxed transparency and reporting requirements under Special Condition C16 of NESO's Transmission Licence.

The pre-2021 UK grid code required that NESO ensure that the power system could be re-energised in the event of a total or partial shutdown and provided for the procurement of black start services to achieve this. However, the specific restoration objectives were determined by NESO, rather than being prescribed through a regulatory obligation. Historically, NESO planned to

191 UK Government: Independent System Operator and Planner Electricity System Operator Licence Condition, C4.
192 Ibid, C4.6
193 Ibid, C4.6 - 4.9.
194 Ibid, C4.14.
195 NESO: Electricity Restoration Services Generic Tender Rules, May 2023.
196 NESO: Industry information: Restoration Services.
197 OFGEM: NESO Roles Guidance 2023-2025, Sep 2024.
198 UK Government: Electricity System Operator Licence Conditions, C4.
199 NESO: Industry Information: Electricity System Restoration Standard.

be able to restore 60% of national demand within 24 hours, subject to regional variations and consideration of economic efficiency.[200]These obligations operated as expectations and were not legally enforceable.

In their April 2021 Policy Statement, the UK's Department for Energy Security & Net Zero (DENZ) and the Department for Business, Energy & Industrial Strategy (BEIS) outlined their motivation for implementing the ESRS. The determination to implement the ESRS acknowledged that while a total or near-total system failure remains an unlikely event, its likelihood is increasing in the context of an energy landscape undergoing transformational change.[201] This evaluation was drawn from lessons learned in a series of high-profile international blackouts, including those in South Australia (2016), Argentina (2019) and the United States (Texas, 2021). Reflecting these developments, the UK Government kept the categorisation of large-scale electricity failures as "high impact, low likelihood" risks in the 2020 National Risk Register, reinforcing their status within national security and resilience planning and catalysing a review of the regulatory framework governing restoration capability.[202] Upon completion, the review found that existing arrangements were not sufficient to prepare for the complexities and security challenges introduced by decarbonisation.[203]

Following extensive industry consultation, a consensus emerged in support of establishing a new standard that would introduce clear, enforceable obligations for the speed and minimum supply targets of system restoration. The multi-party support arising from the review led to the creation of the ESRS as a legally binding requirement, ensuring that restoration is addressed as a critical and credible risk for energy security through the UK's decarbonisation path.[204] The ESRS came into effect in October 2021, with NESO required to develop the capabilities to meet the requirements of the ESRS as soon as possible and no later than 31 December 2026.[205]

G.2.3 The UK grid code licence conditions set clear expectations and obligations for NESO for restoration compliance, implementation and reporting

Condition C4 of the Electricity System Operator Licence outlines the system operator's (NESO's) obligations to comply with the ESRS once directed by the Secretary of State.[206] Specifically, Condition C4 requires NESO to ensure it can respond to a system restoration event through adequate procurement of Restoration Services and proposing necessary modifications to the Grid Code and related frameworks. These actions must be completed in time to meet the compliance date set by the Secretary of State.

A core feature of Condition C4 is the requirement for NESO to prepare and maintain an Electricity System Restoration Assurance Framework. Specifically, within 90 days of receiving a direction from the Secretary of State to designate the ESRS, and annually thereafter, NESO must submit an Electricity System Restoration Assurance Framework for approval by OFGEM.[207] Before submission, NESO must consult with OFGEM and other licensees for at least 30 days on its proposed framework. Once complete, the framework must include:

200 NESO: Black Start Strategy, Apr 2018.
201 UK Government: Introducing a new "Electricity System Restoration Standard': policy statement, Apr 2021.
202 Ibid.
203 Ibid.
204 Ibid.
205 Ibid.
206 UK Government: Electricity System Operator Licence Conditions, C4.
207 Ibid, C4.6.

- "the strategy for the provision of Electricity System Restoration" covering the next regulatory year and beyond, including the Restoration Approach to ensure compliance with the Standard and identification of technologies and approaches;[208]
- "a description of how the licensee will monitor its ability to comply with the Standard at all times" [209]
- both "ex-ante modelling of Restoration Times for the subsequent year" and "ex-post modelling using actual data from the previous year"[210]
- sufficient details of the methodology, assumptions and data to reflect system capabilities [211]

Each submission must also include "a report from an independent auditor of internationally recognised standing" assessing the Restoration Model, including "an ex-ante assessment of how well that model's input data, assumptions and technical calculations represent the characteristics of the transmission system." [212] If rejected, NESO must comply with directions to resubmit a revised Framework for OFGEM's approval within a timeframe specified by OFGEM.[213]

G.3 Distributed ReStart: Leveraging distributed assets to improve system restart performance, lower costs, and abate emissions

Distributed ReStart was a pioneering collaboration aimed at assessing and establishing the technical viability of using DER for system restoration. The project involved NESO, SP Energy Networks, and specialist energy consultancy TNEI, receiving £11.7 million in funding across three main workstreams:[214]

1. **Power Engineering and Trials:** performed the technical evaluation of delivering Distributed ReStart.[215]
2. **Organisational Systems and Telecommunication:** assessed the likely impacts of Distributed ReStart to stakeholders.[216]
3. **Procurement and Compliance:** tested the viability of an end-to-end procurement process that enables buying decoupled services required for Distribution Restoration Zones (DRZs).[217]

It is important to note the subtle yet significant differences in how DER are defined in the NEM in comparison to NESO. These differences influence the scope of resources eligible for participation in system restoration and shape the design of supporting regulatory frameworks.

In the UK, DER refers to "generation or storage resources connected to the distribution system".[218] In the context of leveraging DER in a decarbonising system, this definition applies to distributed solar, wind, BESS, hydro, or biomass with a voltage connection below 132kV, the maximum limit for connecting to the distribution system.[219]In contrast, DER in the NEM are "consumer-owned devices that, as individual units, can generate or store electricity or have the 'smarts' to actively manage energy demand".[220]In other words, DER in the NEM have demand-side capabilities, and

208 Ibid, C4.8(a).
209 Ibid, C.4.8(b).
210 Ibid, C4.8(c).
211 Ibid, C4.8(d).
212 Ibid, C4.9
213 Ibid, C4.10.
214 NESO, Our Projects: Distributed restart.
215 NESO: Electricity System Restoration Assurance Framework 2023/4, Mar 2023.
216 Ibid.
217 Ibid.
218 OFGEM's Future Insight Series.
219 OFGEM: Distribution Code, Dec 2015.

include rooftop solar, home batteries and smart appliances that produce, store or intelligently control load on consumer's side of the meter.

Fundamentally, Distributed ReStart trialled an inversion of traditional restart pathways. Typically, large synchronous generators equipped with black start kits energise down the transmission network, enabling sequential reconnection of smaller generators until local distribution networks and eventually, customer loads, are restored. DER units acting as 'anchor generators' in this process form multiple stable islands which operate collectively as a Dynamic Virtual Power Plant (DVPP).[221]These islands progressively energise assets up the distribution network until transmission, and ultimately, large generators are restored. The coordination of this process is managed by automated Distributed Restoration Zone Controllers (DZRCs).[222]

ESO estimates that DER-led restoration could save consumers at least £115 million and avoid 0.81 Mt of carbon emissions by 2050.[223] The initiative is also expected to break even by 2027.[224]

The program concluded with the Redhouse Live Trial in June 2023, the most advanced technical demonstration of the program. This trial assessed grid-forming BESS capability, operating under DRZC control, to establish and maintain stable network islands. Results confirmed that BESS can reliably anchor restoration zones, delivering superior dynamic stability, island extension capability, and block load pickup performance relative to comparable synchronous units. Following the success of the trial, NESO confirmed that DER-based restoration would complement traditional top-down methods in a convergent strategy designed to meet the Electricity (ESRS) requirement of restoring 60% of demand within 24 hours. Looking ahead, NESO concluded, "This world-first live trial has set a precedent for battery storage systems to be used, not just in the UK, but around the world, as viable network restoration service providers."[225]

220 AEMO: Distributed Energy Resources Program.

221 SP Energy Networks: Distributed Restart.

222 NESO: Distributed ReStart Deliverable 1, DRZC Design and Testing Specification, Sep 2020.

223 NESO: Distributed ReStart, Energy restoration for tomorrow, December 2019.

224 NESO, Distributed ReStart - Redhouse live trial project summary.

225 NESO, World-first live innovation project trial demonstrates battery can help restore network, Jul 2023.

Glossary

Black system event	A black system event is an event that results in the power system, including generation, transmission and distribution being de-energised as the result of a cascading outage following a significant contingency event.
Busbar	A busbar is an electrical conductor in the transmission system that is maintained at a specific voltage. It is capable of carrying a high current and is normally used to make a common connection between several circuits within the transmission system. The rules define busbar as 'a common connection point in a power station switchyard or a transmission network substation'.
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.
Directions	Under s. 116 of the NEL, AEMO may issue directions. Section 116 directions may include directions as issued under clause 4.8.9 of the NER (e.g. directing a scheduled generator to increase output) or clause 4.8.9 instructions (e.g. instructing a network service provider to load shed). AEMO directs or instructs participants to take action to maintain or re-establish the power system to a secure operating state, a satisfactory operating state, or a reliable operating state.
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.
Jurisdictional planning body	The transmission network service provider responsible for planning a NEM jurisdiction's transmission network.
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.
Ministerial Council on Energy (MCE)	The MCE is the national policy and governance body for the Australian energy market, including for electricity and gas, as outlined in the COAG Australian Energy Market Agreement of 30 June 2004.
National Electricity Code	The National Electricity Code was replaced by the National Electricity Rules on 1 July 2005.
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.
Network capability	The capability of a network or part of a network to transfer electricity from one location to another.
Network control ancillary services (NCAS)	Ancillary services concerned with maintaining and extending the operational efficiency and capability of the network within secure operating limits.
Network service providers	An entity that operates as either a transmission network service provider (TNSP) or a distribution network service provider (DNSP).
Network services	The services (provided by a TNSP or DNSP) associated with conveying electricity and which also include entry, exit, and use-of-system services.
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.
Plant capability	The maximum MW output which an item of electrical equipment is capable of achieving for a given period.
Power system reliability	The measure of the power system's ability to supply adequate power to satisfy demand, allowing for unplanned losses of generation capacity.
Power system security	The safe scheduling, operation and control of the power system on a continuous basis.
Probability of exceedance (POE)	POE relates to the weather/temperature dependence of the maximum demand in a region. A detailed description is given in the AEMO ESOO.
Reliable operating state	Refer to operating state.
Reliability of supply	The likelihood of having sufficient capacity (generation or demand-side response) to meet demand (the consumer load).
Satisfactory operating state	Refer to operating state.
Scheduled load	A market load which has been classified by AEMO as a scheduled load at the market customer's request. A market customer may submit dispatch bids in relation to scheduled loads.
Secure operating state	Refer to operating state.
Spot market	Wholesale trading in electricity is conducted as a spot market. The spot market allows instantaneous matching of supply against demand. The spot market trades from an electricity pool, and is effectively a set of rules and procedures (not a physical location) managed by AEMO (in conjunction with market participants and regulatory agencies) that are set out in the NER.
Technical envelope	The power system's technical boundary limits for achieving and maintaining a secure operating state for a given demand and power system scenario.
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.

Abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BESS	Battery energy storage system
CER	Consumer energy resources
Commission	See AEMC
DER	Distributed energy resources
ESOO	Electricity statement of opportunities
FFR	Fast frequency response
GPSRR	General power system risk review
HVDC	High voltage direct current
IBR	Inverter based resources
ISON	International System Operator Network
ISP	Integrated System Plan
LBSP	Local black system procedure
MCE	Ministerial Council on Energy
NEL	National Electricity Law
NEM	National Electricity Market
NEO	National electricity objective
NERL	National Energy Retail Law
NERO	National energy retail objective
NESO	National Energy system operator (UK)
NGL	National Gas Law
NGO	National gas objective
NMAS	Non-market ancillary service
OFGEM	Office of Gas and Electricity Markets (UK)
Panel	Reliability Panel
PV	Photo-voltaic
SRAS	System restart ancillary service
SWIS	South-west interconnected system (WA)
TPSS	Transition plan for system security
REZ	Renewable energy zone
VRE	Variable renewable energy
WEM	Wholesale electricity market (WA)