Meeting Agenda

Meeting Title:	Capability Class 2 Technologies (CC2T) Review Working Group
Date:	Thursday 23 October 2025
Time:	9:30 AM – 11:30 AM
Location:	Online

Item	Item	Responsibility	Type	Duration
1	Welcome and Agenda • Conflicts of interest • Competition Law	Chair	Noting	2 min
2	Meeting Apologies/Attendance	Chair	Noting	1 min
3	Welcome and introductions	Chair	Discussion	5 min
4	Scope of Work and role of the working group	Chair	Discussion	5 min
5	Purpose of this review	Chair/RBP	Noting	10 min
6	AEMO's contribution to the CC2T Review	AEMO	Discussion	90 min
7	Next steps	RBP	Noting	5 min
8	General Business	Chair	Noting	2 min

Please note, this meeting will be recorded.

Competition and Consumer Law Obligations

Members of the Capability Class 2 Technologies Review Working Group (**Members**) note their obligations under the *Competition and Consumer Act 2010* (**CCA**).

If a Member has a concern regarding the competition law implications of any issue being discussed at any meeting, please bring the matter to the immediate attention of the Chairperson.

Part IV of the CCA (titled "Restrictive Trade Practices") contains several prohibitions (rules) targeting anti-competitive conduct. These include:

(a) **cartel conduct**: cartel conduct is an arrangement or understanding between competitors to fix prices; restrict the supply or acquisition of goods or services by parties to the arrangement; allocate customers or territories; and or rig bids.

(b) **concerted practices**: a concerted practice can be conceived of as involving cooperation between competitors which has the purpose, effect or likely effect of substantially lessening competition, in particular, sharing Competitively Sensitive Information with competitors such as future pricing intentions and this end:

- a concerted practice, according to the ACCC, involves a lower threshold between parties than a contract arrangement or understanding; and accordingly; and
- a forum like the MAC is capable being a place where such cooperation could occur.

(c) **anti-competitive contracts, arrangements understandings**: any contract, arrangement or understanding which has the purpose, effect or likely effect of substantially lessening competition.

(d) **anti-competitive conduct (market power)**: any conduct by a company with market power which has the purpose, effect or likely effect of substantially lessening competition.

(e) **collective boycotts**: where a group of competitors agree not to acquire goods or services from, or not to supply goods or services to, a business with whom the group is negotiating, unless the business accepts the terms and conditions offered by the group.

A contravention of the CCA could result in a significant fine (up to $500,000 for individuals and more than $10 million for companies). Cartel conduct may also result in criminal sanctions, including gaol terms for individuals.

Sensitive Information means and includes:

(a) commercially sensitive information belonging to a Member's organisation or business (in this document such bodies are referred to as an Industry Stakeholder); and

(b) information which, if disclosed, would breach an Industry Stakeholder's obligations of confidence to third parties, be against laws or regulations (including competition laws), would waive legal professional privilege, or cause unreasonable prejudice to the Coordinator of Energy or the State of Western Australia).

Guiding Principle – what not to discuss

In any circumstance in which Industry Stakeholders are or are likely to be in competition with one another a Member must not discuss or exchange with any of the other Members information that is not otherwise in the public domain about commercially sensitive matters, including without limitation the following:

(a) the rates or prices (including any discounts or rebates) for the goods produced or the services produced by the Industry Stakeholders that are paid by or offered to third parties;

(b) the confidential details regarding a customer or supplier of an Industry Stakeholder;

(c) any strategies employed by an Industry Stakeholder to further any business that is or is likely to be in competition with a business of another Industry Stakeholder, (including, without limitation, any strategy related to an Industry Stakeholder's approach to bilateral contracting or bidding in the energy or ancillary/essential system services markets);

(d) the prices paid or offered to be paid (including any aspects of a transaction) by an Industry Stakeholder to acquire goods or services from third parties; and

(e) the confidential particulars of a third party supplier of goods or services to an Industry Stakeholder, including any circumstances in which an Industry Stakeholder has refused to or would refuse to acquire goods or services from a third party supplier or class of third party supplier.

Compliance Procedures for Meetings

If any of the matters listed above is raised for discussion, or information is sought to be exchanged in relation to the matter, the relevant Member must object to the matter being discussed. If, despite the objection, discussion of the relevant matter continues, then the relevant Member should advise the Chairperson and cease participation in the meeting/discussion and the relevant events must be recorded in the minutes for the meeting, including the time at which the relevant Member ceased to participate.

Department of Energy and Economic Diversification

GOVERNMENT OF WESTERN AUSTRALIA

Energy Policy WA

Review of Capability Class 2 (CC2) Technologies

23 October 2025

Working together for a **brighter** energy future.

Meeting protocols

- Please place your microphone on mute, unless you are asking a question or making a comment
- Please keep questions relevant to the agenda item being discussed
- If there is not a break in discussion and you would like to say something, please ‘raise your hand’
- Questions and comments can also be emailed to energymarkets@deed.wa.gov.au after the meeting
- The meeting will be recorded and minutes will be taken and published on the CC2TRWG webpage
- Please state your name and organisation when you ask a question
- If you are having connection/bandwidth issues, you may want to disable the incoming and/or outgoing video

ESR technologies pose challenges and opportunities

1. **Higher penetration of weather dependent (intermittent) resources is making power system planning more uncertain and challenging:**
   - System operations are generally more challenging for AEMO – greater forecast uncertainty
   - Coordinating and planning charge/discharge behaviour is more challenging for ESR operators
2. **As the level of thermal/dispatchable generation falls, ESR and DSPs will become an increasingly important component of managing power system security and reliability**
3. **While key to the transition, ESR have unique operational challenges due to their duration limited nature.**
   - To extract value from ESR, they must be operated in a manner that supports power system operations and results in lower long-term costs for consumers.
   - For this to occur, both capacity and real-time market settings must provide ESR operators with incentives that are aligned to power system and consumer needs
4. **Both ESR and DSPs are treated as duration/energy limited (Capability Class 2) technologies in the WEM Rules:**
   - Availability obligations and capacity compensation reflect this
5. **This review focuses on the RCM settings relating to Capability Class 2 technologies – ESR and DSPs**

Review empowered by ESMR 4.13B

Review requirement first added in November 2021, then updated on 15 January 2025 reflecting RCM review outcomes

Rules prior to 15 January 2025: Coordinator must review the effectiveness of the approach for certification of Reserve Capacity for ESR

Clause	Item	In Scope?
4.13.B.3(a)	Methodology for rating the capacity of ESR for the CRC consistent with SEO?	✓
4.13.B.3(b)	Obligation Duration consistent with SEO?	✓ **(DSP only)**
4.13.B.3(c)	ESR Obligation Intervals for ESR consistent with SEO?	✓
4.13.B.3(d)	ESROI methodology and processes used by AEMO consistent with SEO?	✓

Rules after 15 January 2025: Coordinator must review the effectiveness of the approach for certification, RCOQ, refunds and operation of ESMR 4.5.12 for CC2 technologies

Clause	Item	In Scope?
4.13.B.1(a)	Certification of ESRs and DSPs	✓
4.13.B.1(b)	RCOQ determination of ESRs and DSPs	✓
4.13B.1(c)	Effectiveness of RC refunds for ESR and DSPs	✓
4.13B.1(d)	Operation of ESMR 4.5.12 (in context of 4.5.9(b))	✓
4.13B .3(a)	CC2 capacity rating method consistent with SEO?	✓ **(ESR only)**
4.13.B.3(b)	Dynamic ESROD consistent with SEO?	×
4.13.B.3(d)	AEMO method for setting Mid Peak ESROI consistent with SEO?	✓
4.13B.3(f)	Year to year ADG trends and impact on certification	×
4.13B.3(g)	Methodology for Peak and Flex DSP Dispatch Requirement consistent with SEO?	×

This review is focused on the RCM only

Criteria	In scope?	Rules
Does reliability standard capture capacity and energy adequacy, and potentially extreme right tail events*	✓	ESMR 4.5.9*
Approach to rating ESR capacity (for certification) reasonably approximates battery contribution to reliability	✓	ESMR 4.10, 4.11
STEM/RTM availability requirements for ESRs and DSPs are aligned to system operations needs	✓	ESMR 4.12, 4.25
Payment and refund settings incentivize availability and disincentivize delivery failure	✓	ESMR 4.26, 4.29

**ESMR 4.5.15 requires Coordinator to review Planning Criterion. We do not envisage a detailed review as part of this project. However, there may be changes proposed to the Planning Criterion in the context of this review.*

- This review will not cover Chapters 3, 6, 7 or 9 (except consequentially) -> STEM and RTM are out of scope as is operational forecasting (which is the subject of a separate project).
- Instead, the focus is on **incentives provided by the RCM** and the **interaction between RCM and RTM/STEM obligations**
- Review of STEM and RTM rules may well be conducted at a later date – the purpose of this review is to ensure adequacy of RCM settings (as they relate to CC2 technologies only) before touching other market settings.

Next steps

Stage		Timing
International review	• Capacity derating approaches for ESRs • PSSR challenges & mitigating measures relating to ESRs	Deliverable 1 & 2: • Draft: Oct 24, CC2TWG: Nov 21, Final: 13 Feb
Evaluation framework	Develop criteria to evaluate: • ESR derating approach and availability obligations against SEO • PSSR challenges & mitigating measures relating to ESRs	
Evaluation 	• Evaluate ESR capacity derating approaches against SEO • Evaluate existing approach to ESROI determination against SEO	Deliverable 3: • Draft: 7 Nov, CC2TWG: 30 Jan, Final: 13 Feb
Technical Analysis (in collaboration with AEMO) 	• Duration, start and end-time of peak demand event • Evaluate ESROIs timing against SEO • Evaluate 12-hour obligation and availability requirements on DSPs • Evaluate interaction between ESR and DSP availability requirements • Model impact of different design options on PSSR	Deliverable 4: • Draft: 5 Dec, CC2TWG: 30 Jan, Final: 13 Feb
Design options analysis	Identify and evaluate different design options relating to: • Process and method used to determine ESROIs in peak demand day • Availability obligations placed on ESRs and DSPs	Deliverable 4: • Draft: 16 Jan, CC2TWG: 30 Jan, Final: 13 Feb
Consultation paper	Develop Consultation Paper and assist with public consultation	Deliverables 5 & 6: • Draft: 27 Feb, MAC: 6 Mar; Final: 20 Mar • Submission summary: 26 May

Appendix

International review update

Evaluation Framework update

International review – approaches to capacity derating/allocation

1. **Currently reviewing the following approaches to capacity de-rating and allocation methods:**

- UK Capacity Market – Equivalent Firm Capacity
- PJM – Effective Load Carrying Capacity (ELCC)
- Ireland – ELCC-based Marginal de-rating approach
- ISO-NE – Marginal Reliability Impact (MRI)
- IESO – Availability De-rating Factor is calculated based 5 years of historical data on either the equivalent forced outage rate on demand, the resource's production and scheduled operating reserve data from the top 200 hours of Ontario demand, or the resource's bid data from the top 200 hours of Ontario demand

2. **The review is also looking into capacity market design aspects, including incentives and obligation penalties, that the above-mentioned markets are utilising to address key storage issues.**

Evaluation Framework

The State Electricity Objective has three limbs that we want to capture in our framework

The State Electricity Objective is to promote efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers of electricity in relation to:

a) The quality, safety, security and reliability of supply of electricity

b) The price of electricity

c) The environment, including reducing greenhouse gas emissions.

SEO Evaluation Criteria

Capacity certification/derating approach

Outcome sought	Map to SEO
1. Provides value for money by reasonably approximating contribution of batteries to reliability	Over-estimating contribution can lead to under-procurement, adversely affecting the security & reliability limb Under-estimating contribution can lead to over-procurement, adversely affecting the pricing limb
2. Method is transparent and predictable	Complex opaque methods may deter investment in new batteries which could adversely affect the security & reliability, pricing and environment limbs of the SEO.
3. Method does not result in volatile allocation from year to year	Uncertainty and volatility of capacity revenue streams may deter investment in new batteries which could adversely affect the security & reliability, pricing and environment limbs of the SEO.
4. Approach does not distort RCM and RTM investment signals	The RCM and RTM provides scarcity pricing signals to investors. Policies involving frequent intervention or off-market procurement to provide the same service (e.g. getting energy/capacity through SRC/NCESS) will erode investment signals in the WEM and could result in higher than otherwise long-term costs for the consumer therefore affecting the pricing limb of the SEO.
5. Cost and complexity of implementation is reasonable	Costly implementation will add to market participant costs (through increased market fees) which adversely affects the pricing limb of the SEO

SEO Evaluation Criteria

CC2 duration and availability obligations

Outcome sought	Map to SEO
1. Duration and availability obligations are aligned with power system and consumer needs	Failing to make ESR/DSPs available during intervals of system stress will adversely affect the security & reliability limb
2. Approach is flexible enough to change as power system needs evolve and change	Power system characteristics are evolving rapidly with more uncertainty due to the Energy Transition. Approaches to setting duration and availability obligations must be flexible enough to adapt to such changes so that the alignment with system need is maintained. Failure to do so would adversely affect the security & reliability limb
3. Approach is transparent and predictable	Opaque approaches to setting dynamic duration and availability obligations could deter battery entry if operators are unable to plan operations efficiently. This could adversely affect the security & reliability, pricing and environment limbs of the SEO.
4. Approach does not distort RCM and RTM investment signals	The RCM and RTM provides scarcity pricing signals to investors. Policies involving frequent intervention or off-market procurement to provide the same service (e.g. getting energy/capacity through SRC/NCESS) will erode investment signals in the WEM and could result in higher than otherwise long-term costs for the consumer therefore affecting the pricing limb of the SEO.
5. Cost and complexity of implementation is reasonable	Costly implementation will add to market participant costs (through increased market fees) which adversely affects the pricing limb of the SEO

AEMO's contribution to the Certification of Capability Class 2 Technologies (CC2T) Review

October 2025

Submission to the CC2T Review Working Group

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1 Purpose of this submission

AEMO's analysis of Wholesale Electricity Market (WEM) operations highlight the strong likelihood of the South West Interconnected System (SWIS) becoming increasingly storage resource constrained, due to the likely connection of up to 40% of total capacity comprising new storage facilities that will replace existing firm capacity. While storage capacity is considered within the Reserve Capacity Mechanism (RCM), limited regulatory or market actions are available to mitigate risks associated with storage resource coordination in operational planning or real time processes.

AEMO is progressing a longer-term workstream on storage resource coordination via the SWIS Engineering Roadmap program of work, to identify risks and inform risk mitigation strategies. AEMO considers that this work can inform and contribute to the delivery of the Certification of Capability Class 2 Technologies (CC2T) Review and its recommended actions.

This purpose of this submission to the CC2T Review Working Group is therefore to:

1. **AEMO contribution to the CC2T Review:** Highlight AEMO's ability to draw upon its analysis to date in making contributions to the CC2T Review, through participation on the Working Group, assisting with the technical analysis (Deliverable 4), and through subsequent contributions to help inform review outcomes and recommendations for further actions.
2. **Case for change**: Articulate a 'case for change' in how storage is managed in market processes, based on SWIS Engineering Roadmap work. This work considers the implications of storage facilities' operational limitations in the context of regulatory obligations under RCM, as well as within the wider market context, where participation over different time horizons must ultimately translate into a capacity figure.
3. **Issues and Risks**: Provide visibility of AEMO's approach to identifying the issues and risks associated with storage coordination as part of its SWIS Engineering Roadmap work program. In doing so, the submission seeks to inform the Working Group of the related, longer-term or 'strategic' matters that the CC2T Review should also take into consideration.
4. **Options Analysis**: Provide a summary of the options considered by AEMO's Storage Coordination Workstream for mitigating the risks associated with storage coordination, based on experience in real-time operations and the storage outlook over the coming five years. The options analysis indicates touch points with the CC2T Review, highlighting there is potential for the CC2T Review process to receive support from the Storage Coordination Workstream's program of work.
5. **Additional AEMO Lines of Enquiry**: Present a structured framework to consider and resolve challenges of storage coordination, through additional lines of enquiry being investigated by AEMO's workstream, around the elements of storage resource behaviour that emerge from the tension between the need to balance 'the capacity problem' with 'the coordination problem.'

2 AEMO contribution to the CC2T Review

The Coordinator of Energy's CC2T Review will be reviewing the effectiveness of the approach to certification of Reserve Capacity for Energy and Availability Limited Technologies.[1] The scope of work for the CC2T Review focusses on the ESM Rules that were in effect prior to 15 January 2025, including whether:

- the method for rating the ESR capacity for setting Certified Reserve Capacity remains consistent with the State Electricity Objective (SEO);
- the Obligation Duration for ESR remains consistent with the SEO (modified for Demand Side Programmes (DSP) only);
- the ESR Obligation Intervals for ESR remain consistent with the SEO; AEMO's method and processes to determine the ESR Obligation Intervals, in which the Reserve Capacity Obligation Quantity (RCOQ) for ESR applies, remain consistent with the SEO; and
- the existing Reserve Capacity refund rules provide sufficient incentives to storage operators to ensure availability (including maintaining adequate state of charge) during periods of system stress.

The review will also develop and assess options to maintain Power System Security and Power System Reliability (PSSR) with the growing share of ESR capacity in the SWIS, including during the peak demand periods. This will also address the issues raised by AEMO In its Engineering Roadmap FY2026 Priority Actions, which identified that the significant growth of ESR capacity by 2027 may require appropriate solutions to mitigate PSSR issues.

The CC2T Review will provide some welcome insights into the utility of current arrangements for storage in delivering on the SEO and aligns with elements of the work being undertaken by AEMO's Storage Coordination Workstream under the SWIS Engineering Roadmap, to inform broader lines of inquiry on storage behaviour and coordination.

2.1 AEMO input to the CC2T Review

AEMO welcomes the opportunity to contribute to the CC2T Review through participation on the CC2T Review Working Group and assisting with the delivery of the CC2T Review's technical analysis (Deliverable 4). AEMO also considers it can provide additional contributions to help inform the CC2T Review outcomes and recommendations for further actions. These are summarised in Table 1 below.

Table 1 AEMO contribution to the CC2T Review

CC2T Review scope items	Detail of CC2T Review scope items	AEMO Contribution
1. Method for rating ESR capacity [former clause 4.13B.3(a)]	• Alternative methods for certifying ESR capacity. • Determine whether linear derating remains the most effective method for the WEM compared to alternative.	• Operational experience which includes observations of ESR behaviour and instances of limitations in the current rules in achieving dispatch outcomes (including those comprising ESR dispatch) that align with the SEO.
2. DSP Facility obligation duration	Assess the most efficient obligation period of DSPs:	

[1] The coordinator of Energy's review in accordance with section 4.13B of the ESM Rules, which must be completed by 1 October 2026.

CC2T Review scope items	Detail of CC2T Review scope items	AEMO Contribution
[former clause 4.13B.3(b)]	• Model DSP dispatch (including DSPs with behind the meter (BTM) storage). • Assess if a DSP's BTM storage has sufficient recharge time. • Assess if obligation period 'splitting' (6am-10am and 2pm-10pm) would create a barrier to DSP entry. • Consider how the DSP obligation period works with ESR Obligation Intervals.	• Retrieval of data sets, expert modelling and insights to inform key policy decisions. • Outcomes of any modelling and/or investigations undertaken by the Storage Coordination Workstream within the CC2T Review timeframe. • Storage Coordination Workstream outcomes, which may be leveraged in the development and implementation of CC2T Review recommendations and actions.
3. ESROI for ESR – SEO consistency [former clause 4.13B.3(c)]	• Determine the duration, and start and end time, of the typical peak demand event. • Together with AEMO, EPWA will develop and assess options to maintain PSSR with the growing share of ESR capacity in the SWIS, including during peak demand periods.	
4. ESROI method and processes – SEO consistency [former clause (4.13B.3(d)]	• Determine whether the methodology and processes used by AEMO are consistent with the SEO (to be undertaken in conjunction with review item 3).	

2.1.1 Demand Side Programmes (DSPs)

The CC2T Review will assess the most efficient duration / availability obligation period for DSPs, to ensure DSP availability requirements align with:

- how the timing and duration of system stress events are changing;
- the charge and discharge behaviour of aggregated DER portfolios acting as DSPs in the RCM; and
- changes made to ESR availability obligations.

AEMO welcomes this assessment and any consideration that might be given to alternative obligation periods than those proposed for investigation in the CC2T Review technical analysis, to understand their suitability based on DSP composition.

AEMO also welcomes the opportunity to assist the review in undertaking the necessary DSP modelling activity, and suggests there may be opportunity to gain insights into the risks associated with coordinating storage and DSP obligations, in light of Supplementary Capacity arrangements, to ensure these risks are mitigated and the SEO can continue to be met.

3 Case for Change

AEMO is progressing a longer-term workstream on storage resource coordination via the SWIS Engineering Roadmap program of work, to identify risks based on its operational experience and inform risk mitigation strategies.

AEMO considers this work can inform and contribute to the delivery of the CC2T Review and its recommended actions. A summary of this work to date is provided below.

3.1 Overview of the SWIS Engineering Roadmap

In August 2024, AEMO published the SWIS Engineering Roadmap[2] which provides an overview of the engineering actions required to enable the SWIS to operate securely and reliably in the transition to net zero, leveraging work undertaken as part of AEMO's National Electricity Market (NEM) Engineering Roadmap.[3]

In developing the SWIS Roadmap, AEMO considered the likely characteristics of the future power system, informed by the WA Government's Whole of System Plan[4] and SWIS Demand Assessment,[5] and findings from AEMO's WEM Electricity Statement of Opportunities (ESOO).[6] These documents highlight the pathway for the SWIS's transition to a renewables-dominated power system, supported by significant storage and backup generation. They provide the foundational work upon which the Storage Coordination Workstream is building.

3.1.1 AEMO's Storage Coordination Workstream

SWIS Engineering Roadmap implementation is being undertaken via several workstreams. Noting the critical role of storage in the transition, the objective of the Storage Coordination Workstream is to quantify the risk at forecast 'transition points' commensurate with low, moderate and high levels of storage penetration, and to recommend any necessary changes to market forecasts and market arrangements to prevent the risks associated with high penetration scenarios from occurring.

The workstream has established a working group to undertake modelling and investigations based on critical and peripheral lines of enquiry on storage behaviour in light of the regulatory and/or contractual obligations on ESR and their operational limitations, across the various planning and operational timeframes.

The peripheral lines of enquiry contemplate edge-cases like the one that occurred on 25 August 2025 (see example below) and seek to understand the significance of edge-cases and their associated risks to PSSR. As these edge-cases trigger the need for AEMO intervention, the circumstances in which they are likely to occur, and their likely frequency in future are

[2] See AEMO | SWIS Engineering Roadmap

[3] While the SWIS Roadmap leverages AEMO's work on the NEM Engineering Roadmap, as outlined in the 2022 Engineering Roadmap to 100% Renewables and associated reports, it respects that the SWIS:
- is an isolated power system;
- comprises different market arrangements and mechanisms (i.e. a capacity mechanism with associated obligations for participation); and
- operates under separate, independent legislation and governance models.

[4] See Whole of System Plan

[5] See SWIS Demand Assessment

[6] See AEMO | WEM Electricity Statement of Opportunities

worth investigating. The future outlook is an additional area of focus for the workstream, the main (or critical) task being to resolve the tension between the 'capacity problem' and the 'coordination problem' to prevent risks associated with high penetration scenarios - see section 5 for further detail on the lines of enquiry being investigated by the Storage Coordination Workstream. AEMO expects to publish a Position Paper for the WEM operational storage requirements in mid-2026.

Edge-case example: Monday 25 August 2025

On this day, peak operational demand occurred at 5:10 PM, approximately 1.5 hours before the "normal" peak as storage attempted to charge in the previous hour to meet their duration / availability obligations. Energy prices were above $~300 for most of the day, such that there was insufficient MWh at 'acceptable' prices for storage to fully charge. This outcome reflected commercial decisions that had been weighed against the penalties for non-availability. While the rules contemplate that 100% of storage reserve capacity will be available at the start of the Electric Storage Resource Obligation Duration (ESROD) period, the average state of charge across all storage facilities was 50%, creating a shortfall of approximately 750MW.

Presently, there is no treatment (other than generic market intervention) to guide AEMO's decision-making in the event that the required reserve capacity does not eventuate.

AEMO is investigating the incident under clause 3.8 of the ESM Rules and will publish an incident report.

3.1.2 Storage resource trajectory, coordination and urgency for action

AEMO is taking steps to analyse the trajectory of storage penetration in the SWIS and to identify resulting risks and impacts on power system and market operation under the Storage Coordination Workstream. AEMO is also leveraging operational experience accrued via its WEM Real Time Operations (RTO - Perth Control Room) team in managing storage resources in times of declared energy scarcity. Work to date demonstrates that a fundamental rethink of operational planning and dispatch process design is necessary to better integrate the behaviour of Electric Storage Resources (ESR).

AEMO considers that it would be preferable for the new long-term approach to include a combination of stronger regulated (capacity) obligations for ESR while accounting for the limitations of storage technology via dispatch forecast signalling.

Through detailed analysis of operational requirements and the existing dispatch system architecture, AEMO could inform simplified and low impact changes (regulatory and system build) to better integrate ESR into the existing planning and dispatch processes. In any case, the overarching aim of AEMO's work is to avoid reliance of close to real-time actions (interventions) to mitigate risks associated with storage limitations in maintaining PSSR.

3.2 Issues and Risks – storage and AEMO real-time operations

AEMO's WEM RTO has implemented an active storage intervention threshold that applies under declared Lack of Reserve (LOR), which is a formal threshold for AEMO to signal peak demand conditions. After LOR conditions are forecast and declared to the market, AEMO simultaneously monitors:

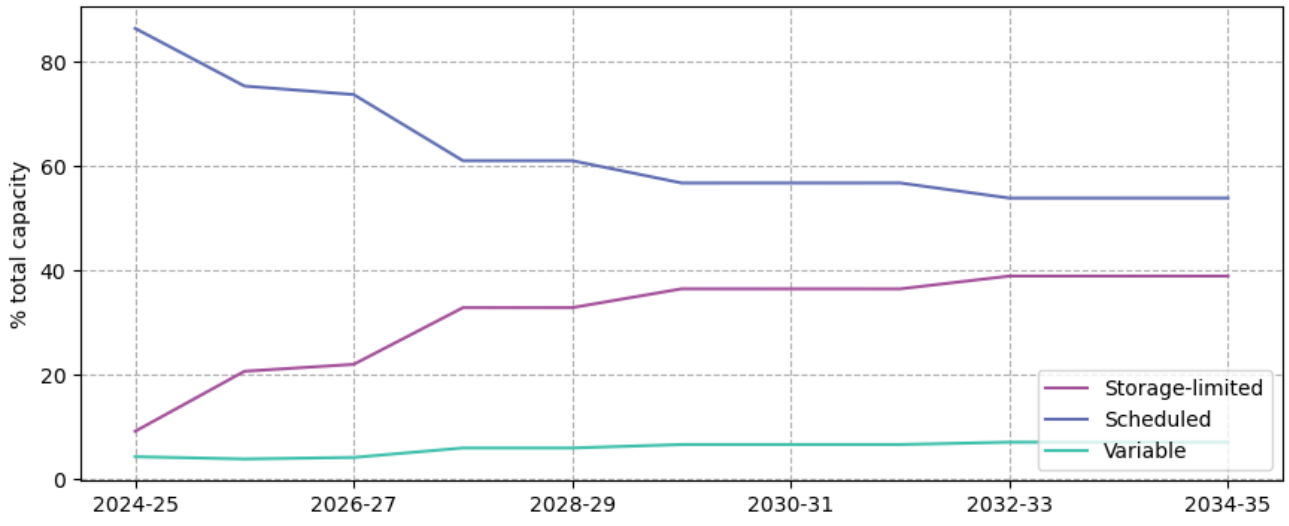
- Real time storage levels (state-of-charge via Supervisory Control and Data Acquisition (SCADA)) from ESR facilities; and
- Forecast demand and fleet dispatch from the Market Schedules.

Where necessary to maintain PSSR, AEMO will intervene by directing forced Withdrawal (charging) of any storage facility where it identifies a risk that commercial positions and market outcomes are likely to result in security issues. For example, a shortfall of capacity that results in AEMO-directed load shedding.

This policy was developed in advance of the 2024/25 summer cycle, the first high-risk peak demand LOR conditions with storage facilities participating in co-optimised dispatch. With a relatively low storage penetration level of approximately 10% at peak system output:

- Both the risk and consequence of storage coordination failure was determined to be relatively low, and a simple ad-hoc intervention threshold was set: on the day of a forecast LOR2 declaration, an operator assessed the reasonable likelihood a facility would fail to achieve a charge level of at least 80% by 16:00. A primary objective of AEMO's Storage Coordination workstream is to consult on and formalise the conditions under which intervention would be required at the current (and forecast) levels of storage penetration,
- All active storage facilities managed state of charge through commercial offers such that the intervention threshold was never breached in the 2024/25 summer.

Of critical note, at the time, all storage facilities were subject to supply capacity under an AEMO-procured Non-Co-optimised Essential System Service (NCESS) contract for "Peak Demand Reliability Services". The contract added significant incentives and obligations beyond "normal" real-time market prices and offer construction requirements. While these obligations apply 100% of the time, in practice, the obligations bind infrequently in a small number of extreme scenarios (of either very high or very low demand). This led to significant payments for availability, contingent on capability being provided at specific times.



Source: 2025 WEM ESOO input data

Figure 1 Forecast capacity proportions in the SWIS

The above figure shows an indicative outlook of overall capacity levels over the next 10 years, in which storage penetration is likely to increase to as much as 40% of total Capacity Credits in the RCM, as distinct from nameplate.

In this data, the proportions are relative to a total capacity for each year that reflects a forecast peak demand target and margin, while the "Variable" category includes all intermittent and non-scheduled generation facilities, after capacity factor adjustment (see section 3.1 for more detail). For example, in 2024/25:

- The total capacity target was approximately 5.3 GW, for a summer that ultimately saw a 4.4 GW peak.
- The 4% of Variable capacity represents approximately 230 MW from an installed nameplate of 1,660 MW.
- 9% of Storage Limited represents 480 MW of battery capacity.

At present, system operations' risk levels decreased with the increased volume of storage technology in the system, as capacity volumes are roughly equivalent (approximately 400 MW total) to the required quantities of Frequency Co-Optimised Essential System Services (FCESS). Between the very fast ramping performance of inverter facilities and near-zero net energy requirement of these services,[7] there is limited risk of storage constraint (i.e. insufficient or too much charge resulting in insufficient head / foot room), even under extreme system conditions.

Explanatory note – Essential System Service co-optimisation

In developing the descriptive elements of this submission, AEMO has leveraged the concept of *co-optimisation* of FCESS, which is fundament to WEM design. To enable the co-optimisation of FCESS, AEMO reserves spare capacity on various facilities to ensure that sufficient back-up capacity can be dispatched very quickly (within seconds). This is required to ensure that secure operation can be restored following major disturbances (such as a fault on a major generator).

As a facility may lose revenue through the opportunity cost of reserving spare capacity, AEMO enables this spare capacity as a service (and the facility receives the clearing price in the relevant market). For example, where a facility is dispatched at maximum output, it cannot supply any contingency raise services to suddenly further increase output. Similarly, a facility at minimum output cannot suddenly reduce output to respond to the sudden disconnection of a large load (or charging storage facility).

For secure operations, AEMO must always schedule and enable FCESS (noting that a disturbance or disconnection may not eventuate), which adds significant complexity to the co-optimised dispatch of facilities i.e. the optimal mix of those providing FCESS versus those providing energy. Storage-limited facilities add an additional layer of complexity to this dynamic as a fully charged storage facility cannot suddenly increase its withdrawal (or vice-versa if the battery is fully discharged), irrespective of the dispatch target it is required to meet.

3.2.1 Storage outlook over the next 5 years

The 2025 WEM ESOO includes Facility outlooks by technology type, based on Facility status (committed versus probable).[8] These provide a view of the trajectory of ESR capacity in the medium to longer term, which is increasing.

Under a persistent 'do-nothing' scenario, the current trajectory of the ESR proportion of total capacity may lead to the following 'transition points' in the medium-term (<5-year) horizon, as storage penetration levels increase:

- At a low penetration level - during an LOR peak-demand event, AEMO will either:

[7] For example, the Regulation Service generally has a normal distribution of ramping requirements over time, such that net energy flows are roughly 0 MWh.

[8] See Tables 9 and 10 in Appendix A4 of AEMO's 2025 WEM ESOO. https://www.aemo.com.au/-/media/files/electricity/wem/planning_and_forecasting/esoo/2025/appendices-for-the-2025-wem-electricity-statement-of-opportunities.pdf?rev=5f3c79d339164f93bb489ea5531b8ca5&sc_lang=en

- Trigger the existing 80% intervention threshold, potentially resulting in the directed participant violating dispatch obligations (contractual or Real Time Market); or
- Forecast a shortfall and activate high-cost Supplementary Capacity under a scenario that could have been avoided through earlier intervention for storage capacity (and AEMO likely revise the intervention threshold as a result).

- At a moderate penetration level - as intervention frequency starts to increase and reactive real-time process increases in complexity:
  - There will likely be financial impacts from intervention, drawing attention from participants and/or government in regard to:
    - which and how (timing, degree, assumptions in assessment of forecast) specific facilities are selected; and
    - how participants should be compensated.
  - The volume and complexity of manual coordination of multiple storage-based interventions in real time becomes a credible threat to ongoing secure power system operations.
- At a high penetration level – failure of storage coordination can theoretically drive an otherwise unnecessary directed load shedding event (i.e. failure of security and reliability process).
- At extremely high penetration levels, the SWIS may simply run short of MWh needed to meet demand, irrespective of any coordinated charging schedule.

AEMO's Storage Coordination workstream will define, and identify metrics to determine, levels of storage penetration (i.e. low, moderate and high) as part of developing a methodology to meaningfully forecast and quantity risks.

Case for change

A fundamental rethink of operational planning and dispatch process design is required to better integrate the behaviour of ESR, to account for its regulated obligations and the limitations of storage technology. The purpose is to mitigate the occurrence of scenarios that will require close to real-time actions (interventions) to manage risks associated with storage limitations in maintaining PSSR where market-based solutions are unviable.

4 Options Analysis

AEMO's Storage Coordination Workstream has considered options for mitigating the risks associated with storage coordination, based on AEMO's experience in real-time operations and the storage outlook over the coming five years. A summary is provided in Table 2 below for consideration by the CC2T Review Working Group.

It is worth noting that AEMO real-time intervention to manage edge-cases or extreme operational risks associated with storage coordination may be required in the period preceding the implementation of options for partial or full resolution, or during the glidepath from partial resolution to full resolution, where a staged approach is taken. AEMO real-time intervention may also be required as a last resort measure to manage any future edge-cases or extreme risks to PSSR associated storage limitations, following the implementation of resolution options.

Table 2 Options for mitigating edge-cases or extreme PSSR risks associated with storage coordination

Scenario	Do nothing	Partial resolution	Full resolution
Risk management strategy	AEMO real-time intervention where market-based solutions are unviable to fully mitigate RSSR risk	Uplift RCM processes	Uplift operational planning and dispatch processes, and WEMDE uplift
Implementation timeframe	Now	12+ months (A timeframe of 12 or more months will likely impact the 2029/30 Capacity Year)	Up to 24 months
Commencement preconditions	None – Rely on AEMO's current powers under ESM Rules and RTO policy (already in place)	• CC2T Review completion • Redesign of RCM process (prior to outcomes of Storage Coordination Workstream modelling and investigation) • Amendments to ESM Rules and WEM Procedures	• CC2T Review completion • Completion of Storage Coordination Workstream modelling and investigation – AEMO Position Paper scheduled for release mid-2026 • Redesign of market processes • Amendments to ESM Rules and WEM Procedures
Ongoing effectiveness	Only effective where ESR penetration is low and/or number of interventions is low	Likely limited where RCM and related market processes do not fully integrate storage limitations (i.e. 'coordination problem' remains unresolved); the residual risk in real-time operation may not be fully mitigated	Effective once implemented. Interim solution will be required where ESR penetration and/or number of interventions are not low

5 Additional AEMO Lines of Enquiry

The approach of AEMO's Storage Coordination Workstream Working Group has involved making lines of enquiry around those elements of storage resource behaviour that emerge from the tension between the need to balance 'the capacity problem' with 'the coordination problem.'

AEMO has outlined these additional lines of enquiry below for consideration by the CC2T Review Working Group. Each question is weighted as either:

- **critical**: essential for resolving storage limit constraints; or
- **peripheral:** a secondary aspect to be investigated or considered further (as relevant).

The Storage Coordination Workstream will continue to investigate these areas and will inform the CC2T Review Working Group of any new findings. It is expected this work will be completed by mid-2026.

5.1 The capacity problem

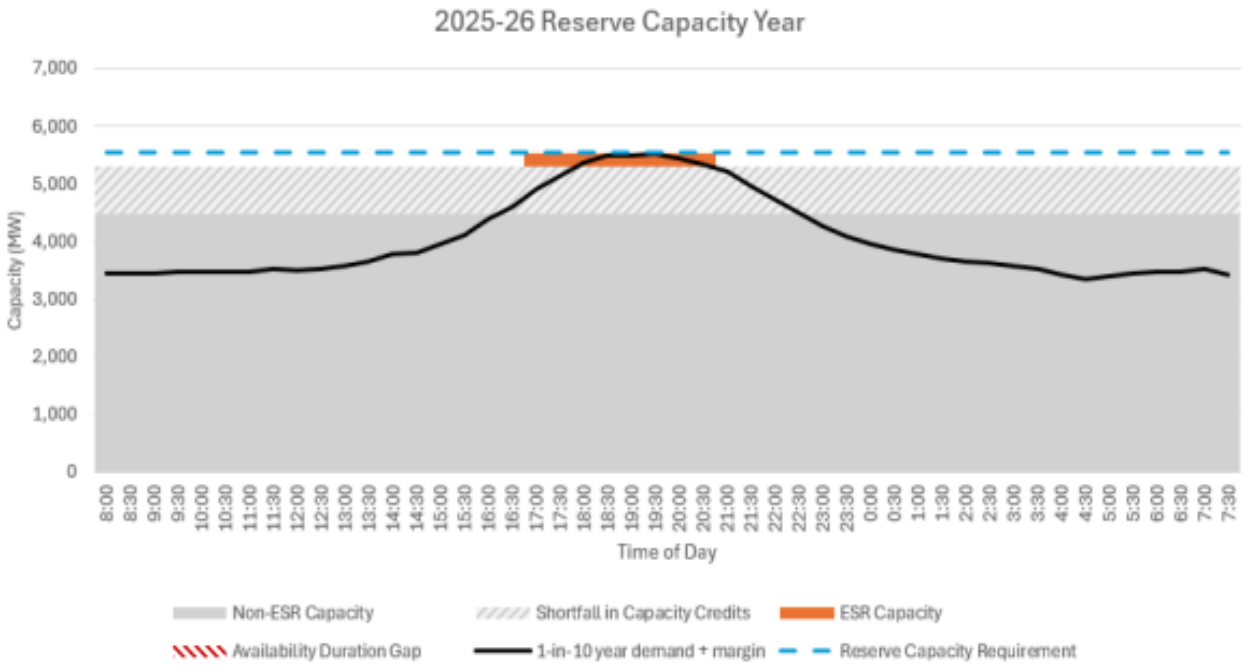
The **capacity problem** describes the difficulty in aligning the duration requirement for ESR participating in the RCM with the capacity that can be made available by ESR given the operational limitations of storage, which must be considered within the context of the overall facility fleet.

Reliability in the WEM is facilitated through the RCM, which ensures the SWIS is supplied by an appropriate mix of technologies that best facilitate the meeting of the SEO. It is a capacity payment scheme which features:

- a benchmark reserve capacity price, re-determined annually by the Economic Regulation Authority to reflect updated market supply price for the lowest cost capacity; and
- a methodology to de-rate intermittent (i.e. wind and solar) facilities to an empirical capacity factor based on measured performance during peak summer events.

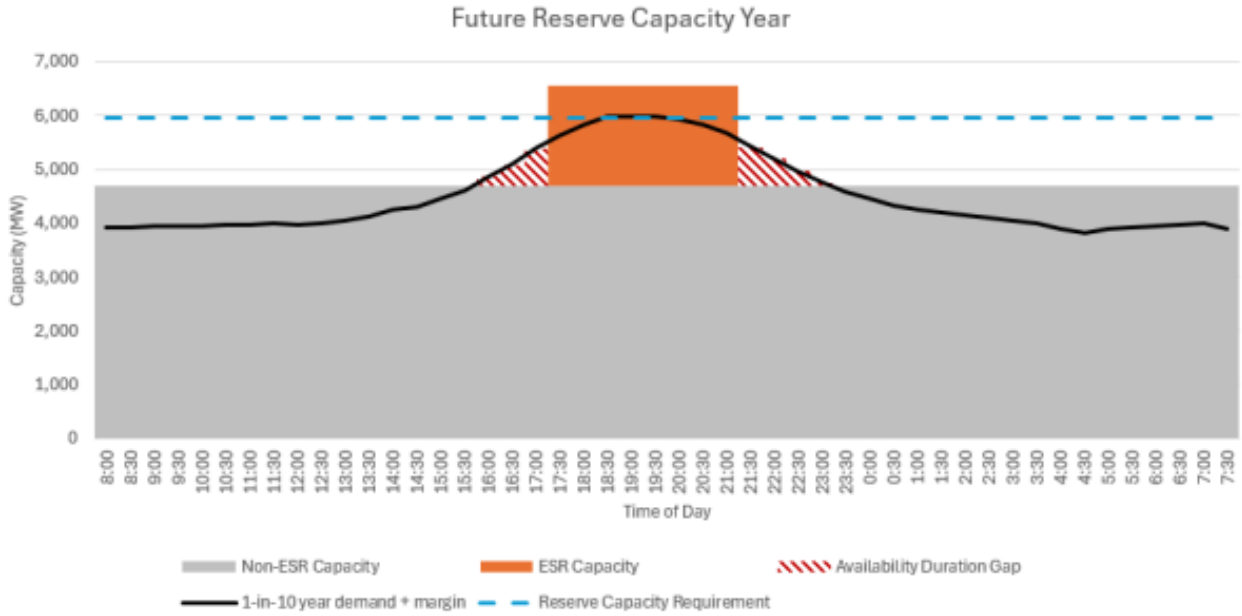
In a series of market reforms introduced in 2022, a 4-hour duration requirement was introduced for storage-limited facilities, to translate and allow these facilities to participate 'MW for MW' within the RCM.

Starting with the 2024 cycle, AEMO must determine and address the 'Availability Duration Gap', which is a new dynamic duration requirement. The move to a dynamic requirement is reflective of the fact that, at increasing penetration levels, a 4-hour requirement would no longer guarantee reliability. This is illustrated in Figure 2 and Figure 3 below.



Source: Energy Policy WA (2025), *TDOWG 54, Tranche 8 – new method to determine the Availability Duration Gap*, 1 May, slide 4.

Figure 2 ESR capacity (with no Availability Duration Gap) for the 2025/26 Reserve Capacity Year



Source: Energy Policy WA (2025), *TDOWG 54, Tranche 8 – new method to determine the Availability Duration Gap*, 1 May, slide 4.

Figure 3 ESR capacity plus Availability Duration Gap for the 2026/27 Reserve Capacity Year

In the 2025/26 capacity year, with most capacity supplied through 'storage-less' technology, a 4-hour limit has no impact on dispatch requirements. As storage-limited capacity quantities increase significantly in the 2026/27 cycle, a portion of the load profile is unserved; this is the Availability Duration Gap.

Given the significant financial flows through the RCM, and the commercial demands for investment certainty, the timeframes and process for the calculating and awarding capacity payments is strictly regulated. This arrangement respects that moving investment signals into shorter timeframes places limitations on the ability of investors to pivot. However, it also results in a relatively rigid and inflexible process that can easily lose alignment with physical system requirements and market development.

Following the identification of potential issues with resetting the storage duration requirements through the regulated process, the RCM Review enabled a rule change (which commenced 4 June 2025) that replaced the 4-hour requirement with a dynamic requirement (updated annually to reflect the latest understanding of system needs and experience).

While these developments buy some time for adjustment, those involved in the analysis advised:

- the current committed trajectory for storage capacity in the WEM already exceeds any rate of gradual and orderly transition; and
- more significantly, a simplistic setting of capacity levels at high storage penetration cannot be divorced from the more complex issue of effective coordination of storage-limited dispatch. In real-time, market forces may be insufficient to deliver full capacity throughout the obligation period.

Further, the current forecast of storage volumes is large enough to distort the 'normal' load profiles – at large enough quantities, it is conceivable that the current concept of managing 'peak dispatch periods' is completely displaced by a problem of aligning charging periods with intermittent generation availability.

With these reforms, certification is somewhat self-correcting; the annual fleet mix impacts treatment of intermittent technologies (through the Relevant Level Methodology) and storage (through the Availability Duration Gap). However, the interdependency between facility classes and the simplistic nature of these assessments may not be fit for purpose to ensure the RCM provides sufficient incentives and disincentives for the market to self-plan the energy transition.

Line of enquiry

Question 1: (**Critical**) Does the capacity metric and/or mechanism need to change to:

a) Does the Planning Criterion and related provisions result in a capacity/capability class mix that enables AEMO to maintain PSSR without the need for regular intervention?

b) Consider a "dynamic" or uncertain peak dispatch period and resolve any **co-ordination problems**?

5.2 The coordination problem

The **coordination problem** describes the full range of incentives, information, opportunity, and actions that must successfully align over different time horizons to translate a capacity figure (i.e. total system MW capacity) into secure real time dispatch. Unlike the capacity problem, coordination solutions must resolve dynamic (i.e. time-sensitive) logistical issues of limited information, opportunity, and uncertainty.

In the current state, storage facilities are bound (both contractually and through regulatory obligations) to bid in ways likely to result in storage facilities charging through specific periods (mid-day trough), then offering discharge capacity over the

peak period. Already, however, AEMO operations perceive these restrictions as onerous and potentially counter-productive for real time operations:

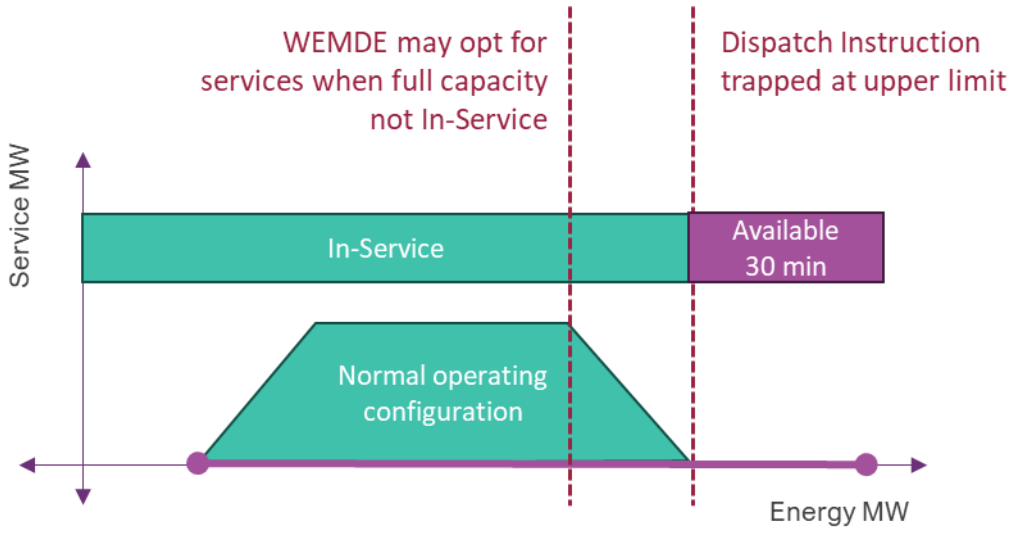
- Participants have taken strict, legally defensible, interpretations of compliance obligations that are harmful to system operations:
    - Requesting extreme (>100's of MW/s) ramp rates to ensure the facility can always reach full charging level within an interval.
    - Charging during higher price and demand conditions during the day i.e. operating irrespective of real-time market signals.
- AEMO has established, based on operational practise applied during the 2024 summer, that it is not always preferable for storage to have 100% state of charge leading into high-risk (peak demand) events, as this restricts contingency and/or regulation lower service capability. A limit of 80% was determined to be 'reasonable'; to simplify dispatch and to eliminate the additional complexity of managing fully charged facilities with limited ability to offer 'lower' service capability.
- Inverter-level state of charge values are not always reflective of true functional capability – for example, some inverters have been observed to shut down at low state of charge, presumably to prevent deep cycling and other related impacts to asset performance.

In general, market dispatch regulations and service contracts do not (and arguably cannot) contemplate this level of dispatch complexity, hence AEMO must resort to direction powers to counteract significant off-market incentives.

Case Study: Trapezium Trapping

The following example concerns real-time dispatch of MW overload capability through the real-time market and highlights the nature and complexity of coordination issues. It is an example of how expected market outcomes do not necessarily eventuate even when market mechanisms exist to facilitate that outcome. It is illustrative only, and while it does not directly relate to storage, there is potential for storage limits to generate material problems of similar complexity in real time dispatch. The problems will likely require intervention to resolve on a small number of days.

The following Figure 4 (below) represents the typical commercial market offer structure of a Facility with overload capability, such as an open-cycle gas turbine with a "wet-compression" operation mode.



Source: AEMO

Figure 4 Typical commercial market offer structure of a Facility with overload capability

Participants receive reserve capacity payments ($216,091.78 / MW in the 2024 cycle) for this extra capacity but may nominate a "Start-Decision Cut-Off" to reflect any physical start-up lead time needed to prepare the facility. For wet compression, this is typically in the order of 30 minutes. Enabling the capacity requires:

- a forecast dispatch instruction (from AEMO) for the capacity; and
- manual change (by the participant) to the facility offer structure.

Facilities that fail to respond to market decisions ahead of their Start-Decision Cut-Off are charged penalty payments.

In practice, participants never triggered this enablement when required under peak (high temperature) conditions. This is likely because:

- Overload configurations are high risk and damaging to the facility.
- There is an opportunity cost as prices for raise services are also high.
- Demand forecasts are uncertain, such that a participant ends up out of pocket if forecasts are incorrect.
- The penalty framework for failing to offer capacity is complex and insufficiently punitive to offset other considerations.

Current market design offers insufficient incentive to bring on the additional capacity that is required during peak demand events. As there are neither sufficient overall incentive nor regulated obligations on the participant to trigger the enablement, AEMO has had to intervene via emergency powers:

- In the 2023/24 summer, this crashed market prices, with significant participant loss of revenue and negative feedback.
- In 2024/25, the approach was adjusted for AEMO to intervene (i.e. direct specific market offers and break trapeziums on select facilities) to preserve prices. This approach is not without issues but is considered acceptable given the relatively limited occurrence of very high demand events.

AEMO notes that Energy Policy WA recently undertook a review of civil penalties provisions in the ESM Rules[9]. The review outcomes, when implemented, will potentially prevent (or otherwise mitigate) the necessity of AEMO intervention.

Market dynamics and balance of regulatory complexity

The WEM has "self-commitment" as a fundamental market design principal, in which the dispatch process:

- only considers optimisation over the immediate Dispatch Interval (i.e. 5-minute period); and
- otherwise assumes active commercial optimisation from participants to manage more complex and inter-temporal issues, such as plant commitment and cycling, scheduling for maintenance etc.

It is not clear if this assumption is fit-for-purpose for systems with a significant portion of both storage limitations and variable (wind, solar) capacity. For example, the dispatch optimisation cannot:

- identify an excess of facilities attempting to charge through midday; or
- opt to stagger charging schedules i.e. opt to charge certain facilities overnight ahead of peak dispatch.

Instead, the present regulatory assumption is that either:

- contractual (off-market) service arrangements mandate charging schedules; or
- market signals will incentivise orderly charging, through market participants commercial planning to structure offers accordingly.

However, in practice, participants have different risk profiles and exposure that generally does not align with government energy policy. In general, this means participants are (simultaneously):

- seeking to avoid directed load shedding (especially during peak heatwaves), essentially at any cost; and
- sensitive to perceptions of extreme price shock.

[9] See https://www.wa.gov.au/government/document-collections/proposed-changes-the-pilbara-gsi-and-esm-regulations

Lines of enquiry

Question 2: (**Critical**) What is the right approach and balance between regulatory obligations and operational flexibility to manage storage coordination:

a) Is the existing framework fit for purpose?

b) If changes are required, what are they?

Question 3: (**Peripheral**) Are there any specific changes or additional detail needed to refine AEMO's powers to direct facilities?

Question 4: (**Critical**) To what extent is it reasonable to plan based on participants behaving "correctly" in response to market signals:

a) Is current market information sufficient?

b) Does AEMO need any additional information from storage facilities to improve forecasts?

Question 5: (**Critical**) Are new regulatory obligations also required and, if so, what prevents these from misaligning with emergent operational issues?

Risk exposure and compensation

The ESM Rules specify the circumstances in which AEMO may intervene for the purpose of maintaining security or reliability, for example, the management of emergency events or a scarcity condition (when LRC prevails). Complex operational situations and the incidence of unanticipated edge-case not normally contemplated by existing prescription, typically contribute to circumstances in which intervention is the appropriate action.

In general, AEMO can effectively adapt these real-time interventions to manage emerging issues and provide insight into ways these issues can be resolved correctly upstream. However:

- Interventions are often costly (needed during periods of high system stress and congestion) and have limited scope and opportunity for economic considerations.
- It should be noted that AEMO is not directly exposed to service or intervention costs and, while aiming to minimise the number of interventions and affected parties, AEMO ultimately prioritises taking actions that mitigate uncertainty in favour of real time security requirements.

Participants are understanding and tolerant of occasional intervention, but the management of high storage levels may require ongoing intervention in lieu of a structured approach to storage optimisation.

In many cases, interventions necessary for security reasons are conflated with considerations regarding economic optimisation. This is not preferable because:

- Real time decisions and interventions generally rely on an element of pragmatic judgment, which is undermined if individuals suspect they may be held commercially liable in retrospect; and
- Resolving issues in real time may mask fundamental policy issues and prevent effective longer-term solutions.

Line of enquiry

Question 6: (**Critical**) How can costs and compensation mechanisms reflect storage limits so that:

a) Participants are not unduly impacted under direction from AEMO, for example, does the capacity refund regime adequately incentivise storage operators to maintain state of charge and be available during system stress events?

b) Real time coordination issues are reflected in market signals or otherwise communicated back into longer-term processes?

Forecast uncertainty and lead time

As WEM design increases in complexity to accommodate variable generation and changes to the distribution system (with less visibility to AEMO and ostensibly less compliance), forecasting and the ability to provide a coordinated response for the timely management of risk is fundamentally becoming more difficult.

All co-ordination issues are characterised by a dynamic in which:

- Many actions and options require planning, cost, and lead time to commit.
- Forecast uncertainty means these actions can end up wasted.

The potential for rare, but extreme, power system consequences create a difficult risk mitigation and assurance issue to optimise. Traditionally, this aspect of power systems is managed through assumptions of failure distribution and application of statistical margins, but this methodology is likely to fail in the presence of significant levels of variable renewable generation sources[10].

A low penetration levels, storage is demonstrably beneficial in providing reserves and in its ability to absorb variability. However, at higher penetration levels, storage coordination issues can create complexity and error in forecasts. In regard to the latter, most reliability models (including that of the WEM/SWIS) assume “perfect foresight” whereas in practice, “imperfect foresight” offers another error source that likely requires management via real-time operations.

AEMO notes that Energy Policy WA recently undertook the Operational Forecasting Review[11]. The review outcomes, when implemented, could potentially reduce the probability and occurrence of forecast errors, helping to reduce uncertainty and the management of associated risk.

Line of enquiry

Question 7: (**Critical**) How does storage capacity help or further exacerbate costs and issues associated with uncertainty and forecast error?

Hybrid Storage Facilities

The SWIS has examples (both operational and committed) of “hybrid” storage facilities, which pair generation sources (generally intermittent renewable) with storage capacity “behind the connection point.” From the abstract market

[10] Mancarella, P (2022), *Considerations in support of the 2022 Reliability Standards and Settings Review*: *Briefing Note prepared for the Australian Energy Market Commission*, University of Melbourne, August. See https://www.aemc.gov.au/sites/default/files/2022-08/Pierlugi%20Mancarella%20-%20Briefing%20note%20-%20form%20of%20the%20reliability%20standard.pdf

[11] See https://www.wa.gov.au/government/document-collections/operational-forecasting-review

perspective, the facility has no storage characteristics (it may not be able to withdraw energy and otherwise operates as a Semi-Scheduled Facility).

Participants choose this configuration (as opposed to connection of two independent facilities) primarily to improve Reserve Capacity outcomes and simplify connection requirements, but also to simplify operations as it eliminates market (AEMO) requirements for power exchange between assets.

While a hybrid configuration improves system outcomes it also creates a potential risk. AEMO cannot intervene under high-stress circumstances (i.e. prolonged periods of limited resource and high demand) to force the facility to charge; the facility may run short of energy to deliver its Reserve Capacity obligation, despite AEMO capability to forecast the event.

Line of enquiry

Question 8: (**Peripheral**) Are special considerations required to facilitate significant proportions of hybrid facilities?

AEMO Submission to CC2T Working Group

Discussion Pack:

Paper summary and illustrative examples

WA Future System Engineering

23 October 2025

Context

- AEMO has proposed a formal submission to the Capability Class 2 Technologies (CC2T) Review Working Group, which summarises:
  - The scope and timeline of parallel activities within the AEMO “Storage Coordination” workstream
  - How these activities support and align with the CC2T scope, but also expand and raise additional storage system challenges into a longer-term horizon
  - Options to efficiently align and coordinate outputs from the Review with AEMO’s longer-term outlook
- AEMO has prepared this discussion pack for the CC2T working group to:
  - Summarise key points from the paper to frame the first working group session
  - Present illustrative examples from operational experience
  - Leverage the working group to seek industry feedback on intended operating policy for the 2026/27 summer risk period

Summary of AEMO Submission

- Ongoing concurrent AEMO SWIS Engineering Roadmap Activities
- Alignment and coordination with CC2T scope and activities

Storage-related AEMO Activities FY2026

Contributions to the CC2T working group

- Report of operational experience and observations
- Retrieval of datasets and expert modelling and analysis
- Outputs and coordination with Storage Coordination workstream

Storage Coordination Workstream

- Long-term outlook under the SWIS Engineering Roadmap
- Standing cross-functional AEMO working group
  - Supporting technical input to CC2T review
- FY26 coordinated outputs:
  - Operational Storage Policy (now)
  - Storage forecast modelling methodology (early 2026)
  - Operational Storage position paper (mid-2026)

High-level outlook and options

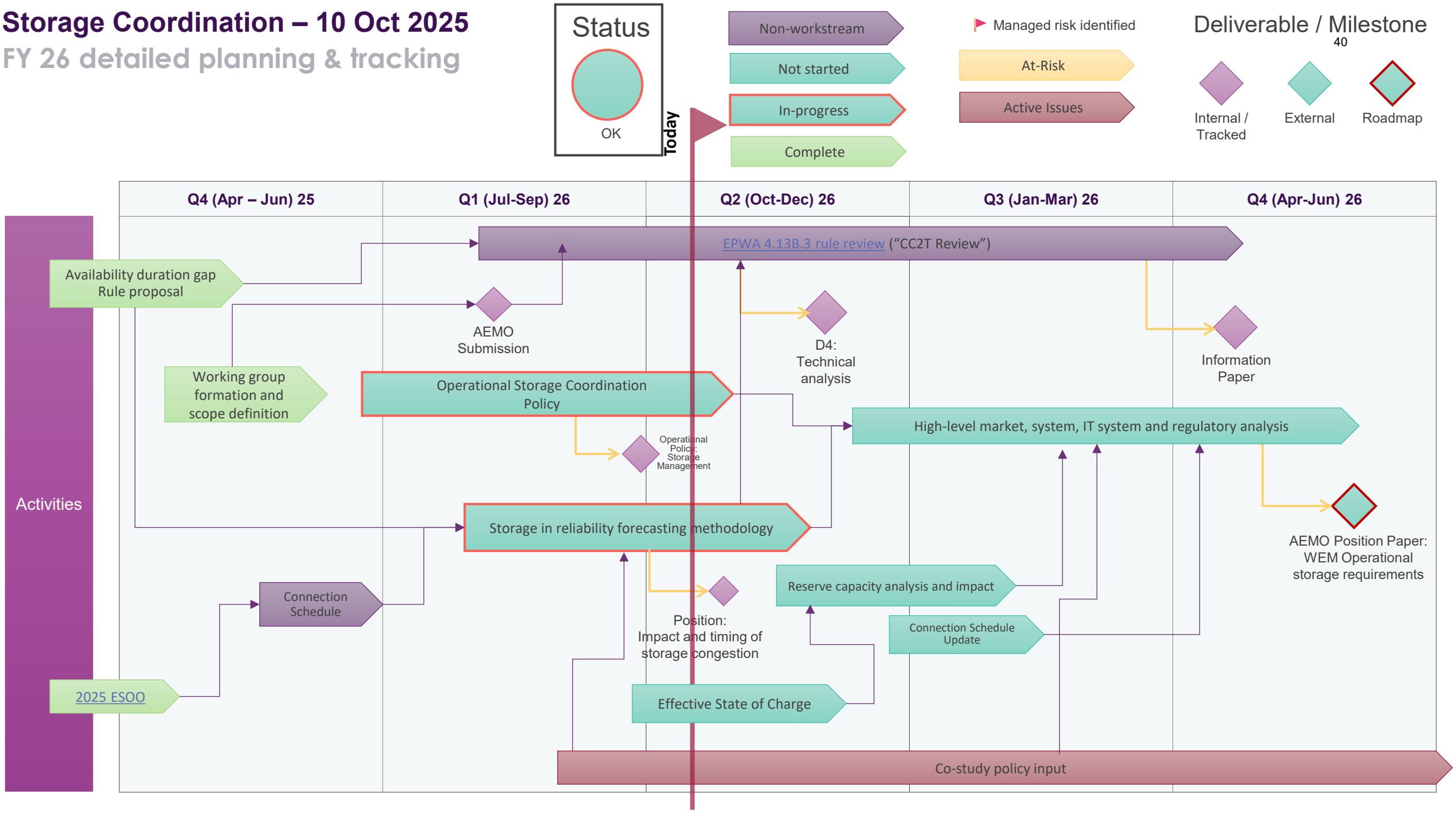
Scenario →	Do nothing	Partial Resolution	Full resolution
Risk management strategy	AEMO real-time intervention where market-based solutions are unviable to fully mitigate PSSR risk	Uplift Reserve Capacity Mechanism	Uplift operational planning and dispatch processes, and WEMDE uplift
Implementation timeframe	Now	12+ months	Up to 24 months

(… refer to paper for more detail on each option)

Overall objective of the Storage Coordination workstream is to forecast risks and propose timely solutions that minimize (or ideally, eliminate) the need for AEMO intervention.

Storage Coordination – 10 Oct 2025

FY 26 detailed planning & tracking



Storage in 2024/25 cycle

Operation during 2024/25 summer:

- Active instruction in RTO-P: Operating under LRC conditions
- Threshold not triggered in practice
  - Approx 10% peak capacity storage limited
    - 480 MW / 4.4 GW actual peak
  - “No withdrawal” constraint invoked initially; determined as expected behaviour
  - Most capacity allocated to ESS
    - will not scale past ~450 MW

2.18. State of Charge Management

The preferred position is that participants monitor and manage state of charge a requirement to meet bidding obligations, noting that to date, all arrangements incentivise this indirectly (e.g. ESROI or NCESS contract terms) through power (MW) availability requirements. However, state of charge management is new a relatively market concept and more complex to manage.

As such, is it necessary to review charge status of all storage Facilities prior to peak, and intervene if it appears possible that a participant will miss-manage their commercial obligations:

- If LOR2 forecast, and for each Facility:
  - Current charge state <80%
  - Pre-Dispatch shows Facility has not bid to ensure full charge by 17:30
- Constrain Facility at charge level required to ensure full charge.

2.19. Notional Peak ESS Fleet

The Notional Peak ESS Fleet is prepared by directing:

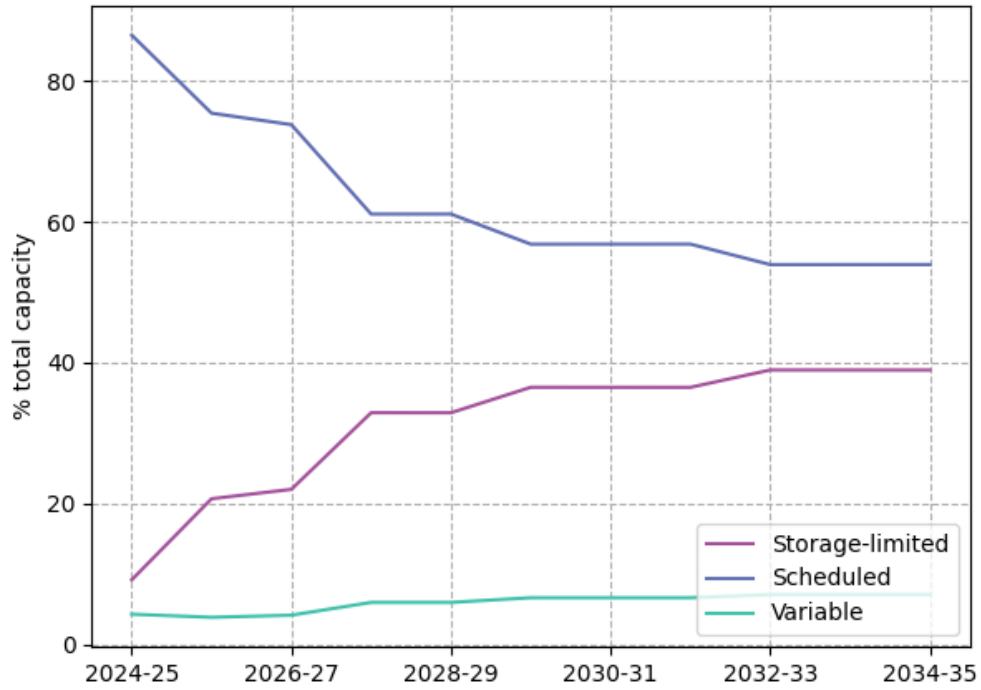
- COLLIE_ESR1, KWINANA_ESR1, SIMCOA_IPT_LD_01, and all remaining (non-outage) Facilities at PINJAR to remain in all ESS markets
- All other facilities offer:
  - all energy capacity as In-Service
  - all non-ROCOF Control service quantities to 0 MW

At the Stage 1 interventions at 12:00 (+6 hours from peak).

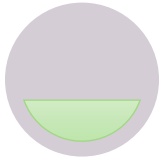
ESOO 2025: Connection outlook

More than 30% of capacity (~2 GW total) storage limited within 5 years

- Using Reserve Capacity allocations
- As of ESOO 2025 “committed” or “probable” capacity
- Determining and establishing standard metrics and language part of workstream



Transition point schedule



Low

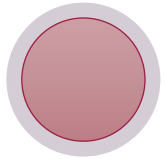
Trigger 80% intervention; or

Forecast a shortfall and activate Supplementary Capacity under a scenario that could have been avoided

Moderate

Intervention frequency grows, impacting market and attracting greater industry / government attention

Increased operational complexity and credible risk of control error or security issues



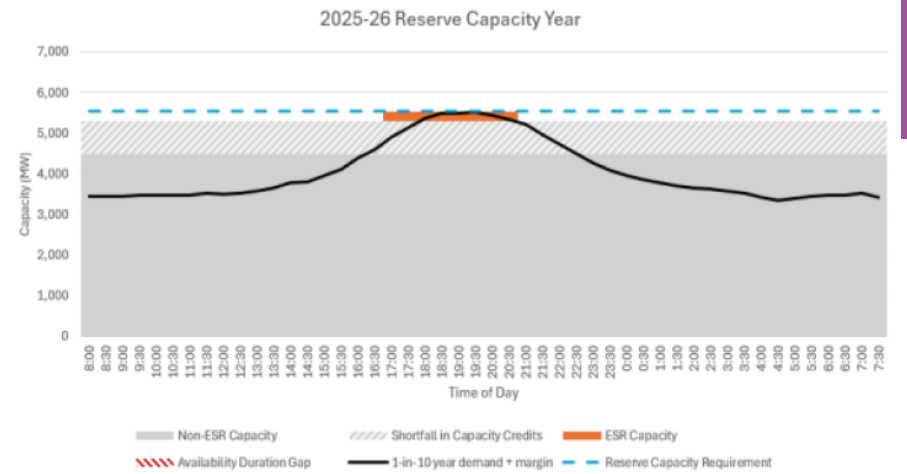
Extreme

Failure of security and reliability obligations, e.g. drive (other unnecessary) load shedding event

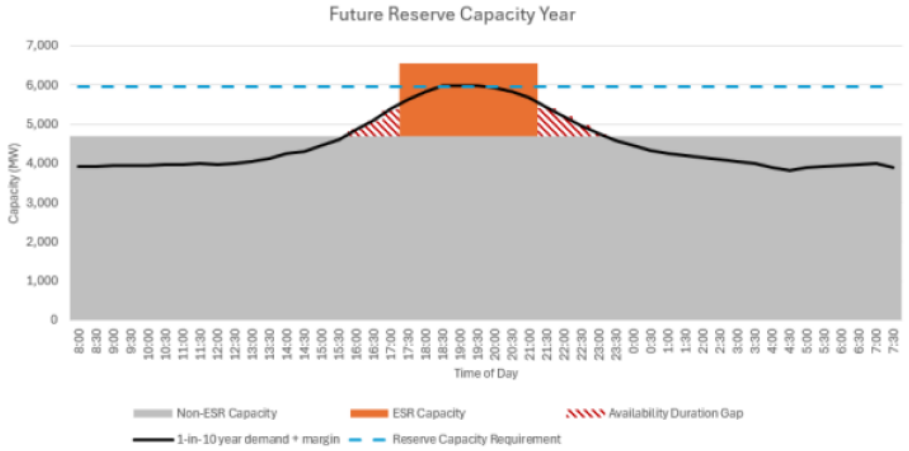
Forecast likelihood and timing to be quantified through roadmap **Storage Forecast Methodology** activity

Issue 1: Capacity Problem

- Aim: set requirements for ESR that translate “MW for MW” within the RCM
- Present rules abstract storage requirements via **Availability Duration Gap** framework
  - Variable storage requirement to set equivalence to “normal” capacity
  - Already identified limitations, moving to dynamic determination (2025 rule change)
- Analysis concludes:
  - Current connection trajectory already exceeds gradual and orderly transition
  - Capacity analysis cannot be divorced from (more difficult) **co-ordination problem**.



Source: Energy Policy WA (2025), *TDOWG 54, Tranche 8 – new method to determine the Availability Duration Gap*, 1 May, slide 4.



Source: Energy Policy WA (2025), *TDOWG 54, Tranche 8 – new method to determine the Availability Duration Gap*, 1 May, slide 4.

Issue 2: Coordination Problem Overview

Coordination of actions to translate capacity into secure dispatch:

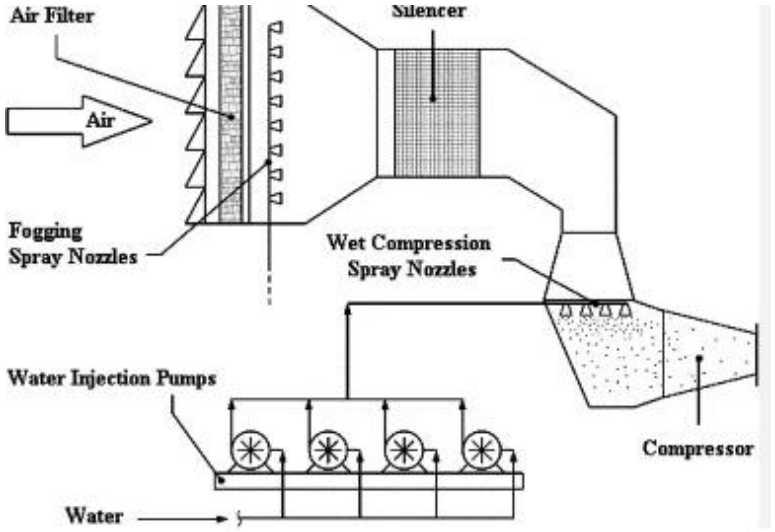
- Incentives, information, opportunity, and actions

Characterised by logistical constraints:

- Time pressure, limited information, opportunity, uncertainty

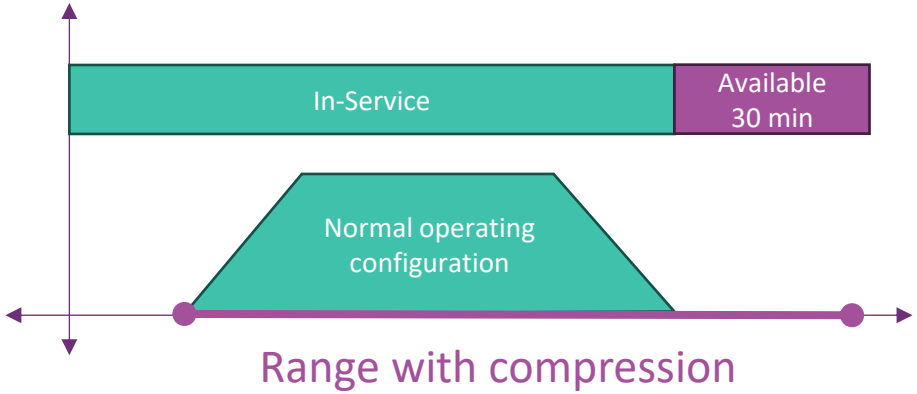
Neil coordinating deactivation of SOCCUI for SCED market

Trapezium limits and commitment (Does not apply to ESR)



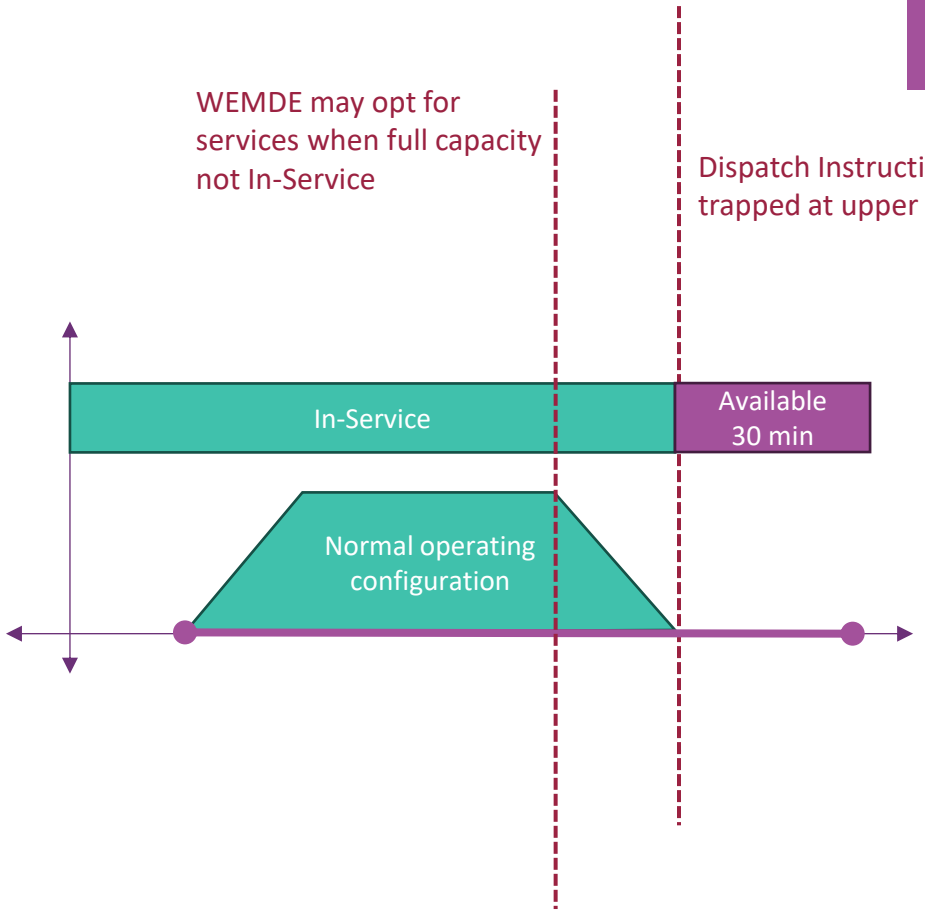
Dispatch requires:

- Forecast Dispatch Instruction from AEMO
- Manual offer update from participant



Intervention Scenario Trapezium limits

- Capacity from facility unavailable due to trapezium trapping
  - Normally occurs at upper bound for overload facility capability
- Participants did not respond to signal:
  - Monitoring single Dispatch Schedule already complex at the best of times
  - Capacity unavailable to WEMDE; facility is co-optimised to supply reserve
  - Reserve price is high due to energy congestion
    - Participant prefers to supply ESS
  - Penalty framework appears insufficient to drive intended behaviour
  - Demand forecasts are uncertain, such that a participant ends up out of pocket if forecasts are incorrect



Issue 2: Coordination Problem
Market dynamics and regulatory complexity

Is self-commitment fit for purpose?

- No inter-interval optimisation (WEMDE) beyond 5-minute Dispatch Interval
- Orderly charging scheduled through off-market arrangements (NCESS) or commercial planning

Fundamental Issues:

- Failure to manage state of change in **advance infrequent, of high-stress conditions**
- Participants not (directly) exposed to consequences of system risks

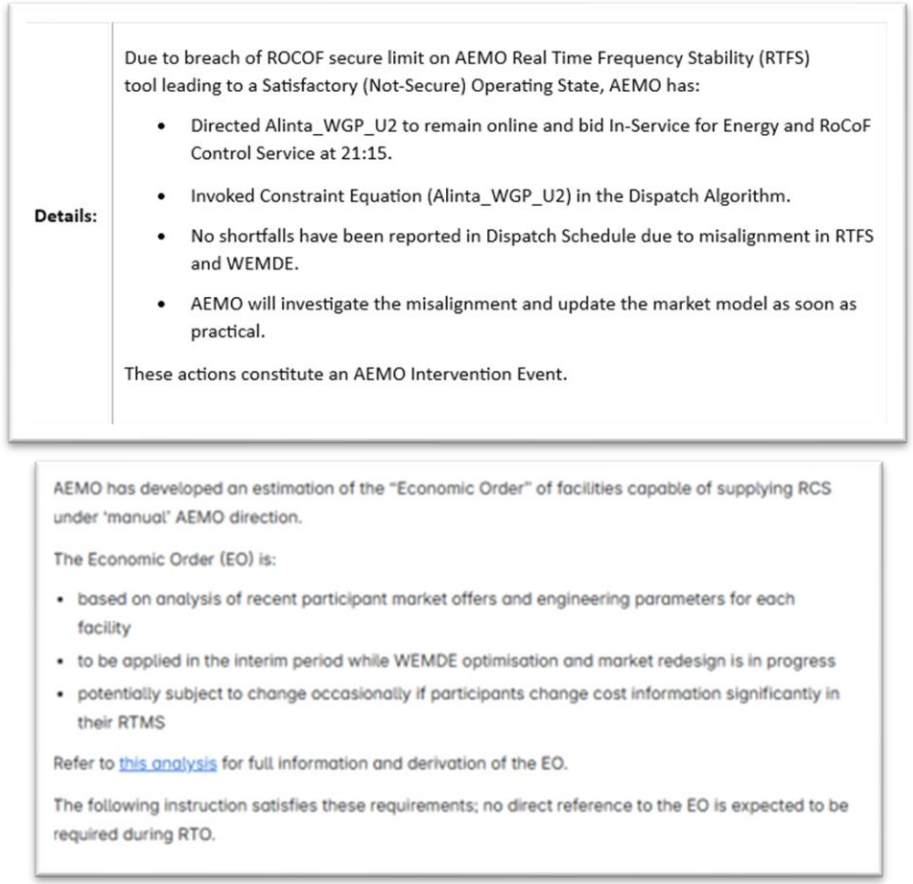
Issue 2: Coordination Problem
Intervention, risk exposure and compensation

Interventions can smooth gaps in market design, however:

- Costly and limited scope for economic consideration
- AEMO prioritises secure operations

Lose-lose end-state:

- Participants have limited ability to forecast AEMO actions for commercial planning
- Real-time operations exposed to cognitive burden and commercial outcomes of time-sensitive decisions
- Interventions can mask fundamental market design limitations



Details:

Due to breach of ROCOF secure limit on AEMO Real Time Frequency Stability (RTFS) tool leading to a Satisfactory (Not-Secure) Operating State, AEMO has:

- Directed Alinta_WGP_U2 to remain online and bid In-Service for Energy and RoCoF Control Service at 21:15.
- Invoked Constraint Equation (Alinta_WGP_U2) in the Dispatch Algorithm.
- No shortfalls have been reported in Dispatch Schedule due to misalignment in RTFS and WEMDE.
- AEMO will investigate the misalignment and update the market model as soon as practical.

These actions constitute an AEMO Intervention Event.

AEMO has developed an estimation of the "Economic Order" of facilities capable of supplying RCS under 'manual' AEMO direction.

The Economic Order (EO) is:

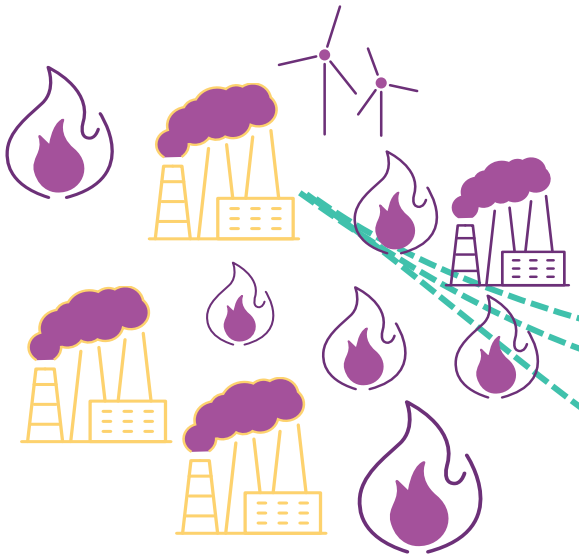
- based on analysis of recent participant market offers and engineering parameters for each facility
- to be applied in the interim period while WEMDE optimisation and market redesign is in progress
- potentially subject to change occasionally if participants change cost information significantly in their RTMS

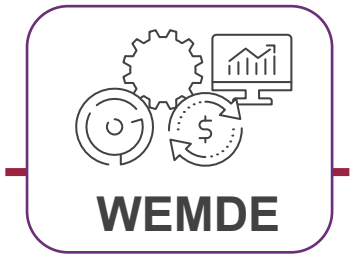
Refer to this analysis for full information and derivation of the EO.

The following instruction satisfies these requirements; no direct reference to the EO is expected to be required during RTO.

Market Advisory and excerpt from AEMO operational policy for analogous ROCOF interventions

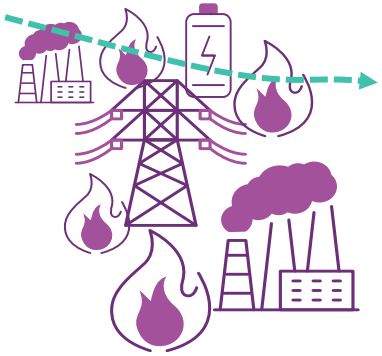
Issue 2: Coordination Problem
Forecast uncertainty

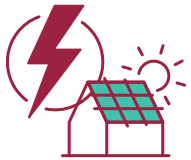




MARKET FAILURE

MSL

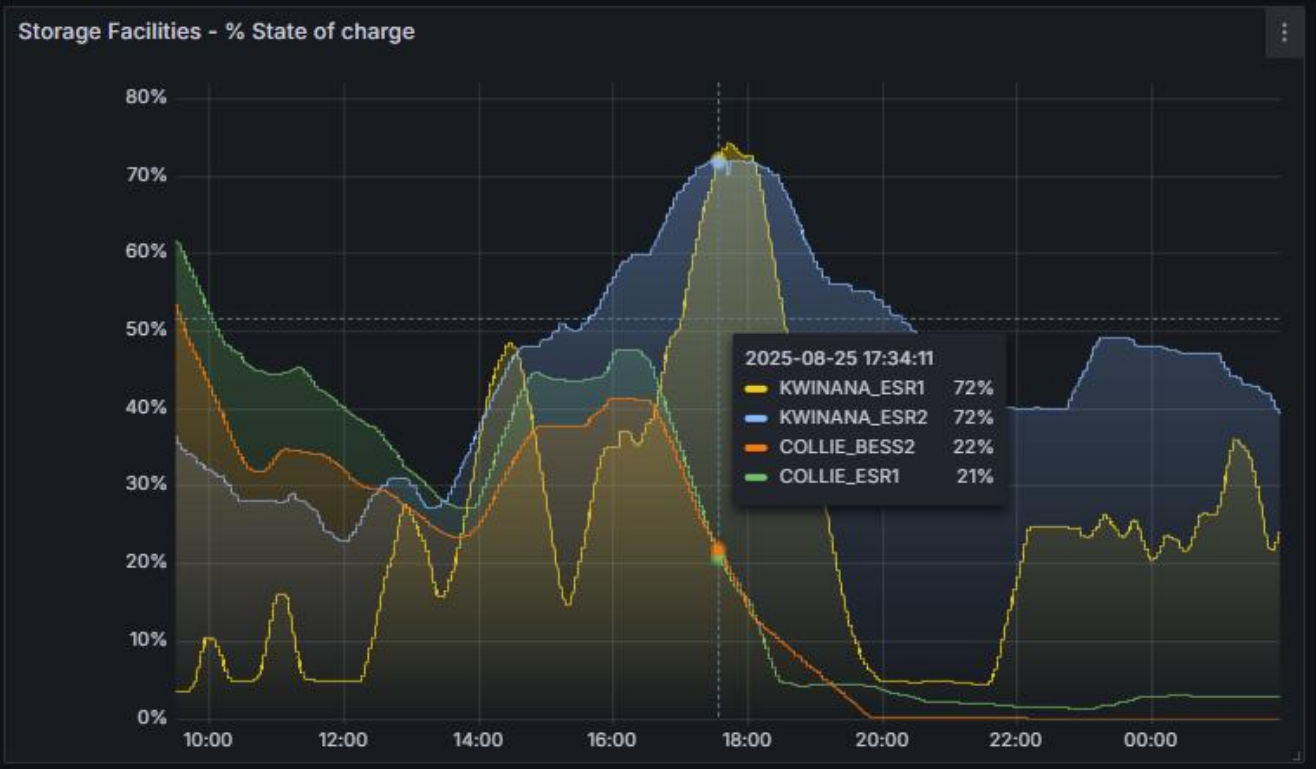


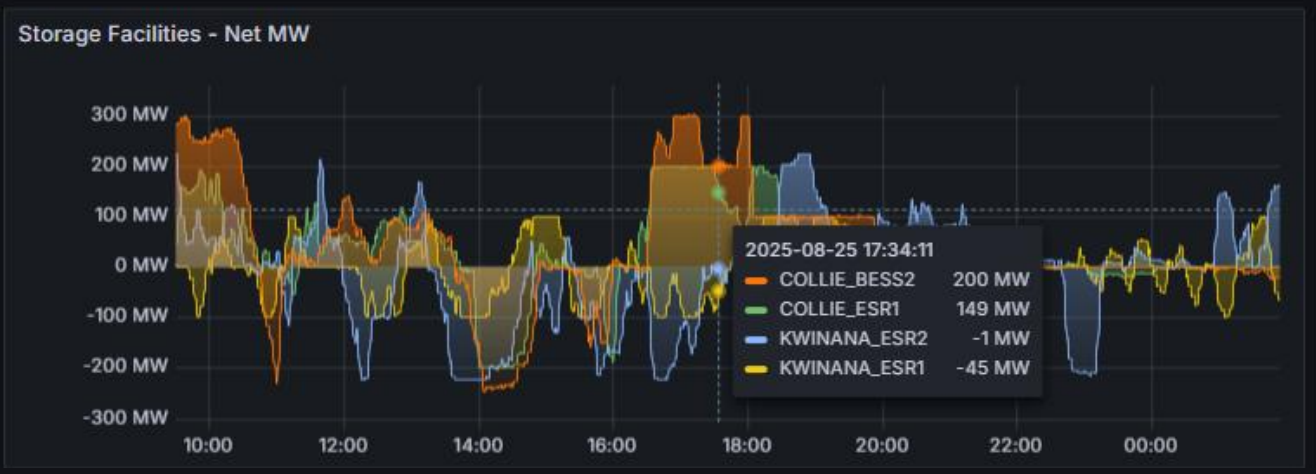


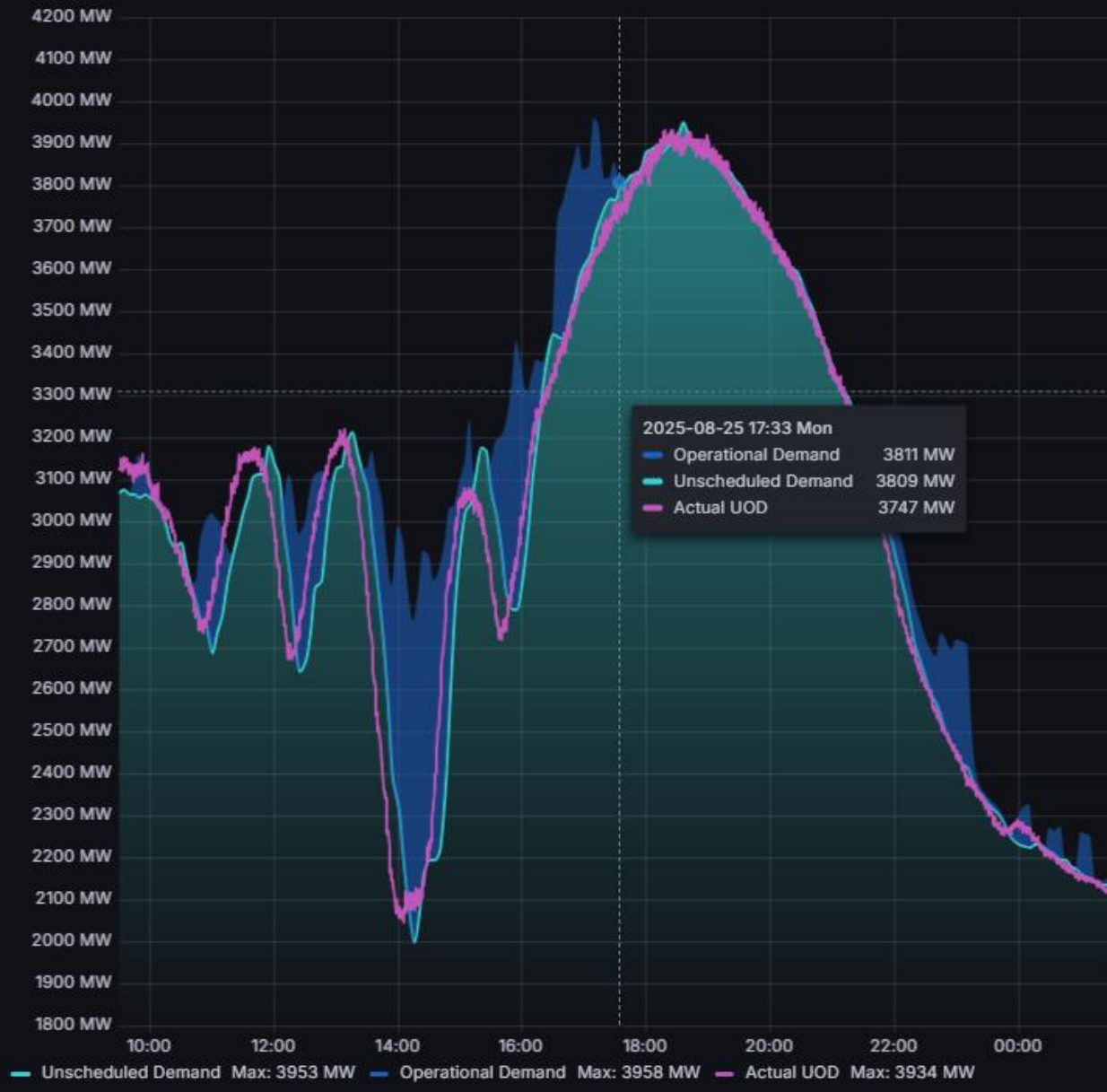
Illustrative examples

Examples of storage coordination issues from recent operational experience

Example: 25 August 2025







Example: 25 August 2025 Schedule outlook as at 17:00 Interval

Dispatch Totals	3638	3679	3721	3761	3800	3837	3871	3904	3935	3968	4003	4035	4070	4095	4116	4129	4136	4138	4130	4121	4108	4092	4074	4054
In-Service Quantities	5323	5323	5323	5323	5323	5356	5366	5366	5366	5366	5366	5366	5313	5313	5313	5313								
Available Quantities	721	721	721	721	721	687	688	688	688	688	688	688	686	686	686	686	686	686	685	685	685	685	685	685
Prices	334	681	689	689	717	717	717	891	891	891	891	900	900	900	900	900	900	900	900	900	900	900	900	900
Market Shortfalls																		YES	YES	YES	YES	YES	YES	YES
Energy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Regulation Raise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	103	41	0	0	0	0
Regulation Lower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency Raise	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	128	156	156	104	69	75	72
Contingency Lower	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RoCof	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Constraints																								

Facility Data

Facility	MIC	MW	17:00	17:05	17:10	17:15	17:20	17:25	17:30	17:35	17:40	17:45	17:50	17:55	18:00	18:05	18:10	18:15	18:20	18:25	18:30	18:35	18:40	18:45	18:50	18:55
NEWGEN_NEERABUP_GT1	342	215	265	315	330	330	342	330	330	330	330	330	330	326	334	332	340	340	340	339	342	342	342	342	342	334
NEWGEN_KWINANA_CCG1	334	327	328	328	328	328	328	328	328	328	328	328	328	328	328	328	328	328	328	335	335	335	335	335	335	334
COLLIE_BESS2	300	300	300	300	300	150	158	166	197	200	200	200	200	226	286	300	300	300	300	300	300	300	300	300	300	300
COCKBURN_CCG1	240	241	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240	240
KWINANA_ESR2	225	-128	-105	-183	-183	-5	0	0	0	0	0	0	0	0	0	0	0	0	0	200	225	156	85	50	56	61
INVESTEC_COLLGAR_WF1	218	73	77	79	81	80	83	83	82	81	86	87	89	89	88	82	82	90	84	79	81	83	85	87	90	93
MUJA_G7	212	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211
MUJA_G8	212	210	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211	211
YANDIN_WF1	205	36	38	41	44	48	51	53	52	55	57	59	62	64	57	59	60	62	64	66	61	63	64	66	68	69
COLLIE_ESR1	200	199	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	5	-98	-51	23	37	7	-15

Example: 25 August 2025

Summary of key events

Monday 25 August 2025:

- 06:00 Unusually cold, overcast, and wet conditions drove high winter demand forecast
  - Standard control room security assessment did **not** identify LOR conditions on 3.7 GW forecast (10% POE)
- 11:00 – 15:00 Cloud conditions create highly volatile conditions, culminating in demand swing of 38% (~1.2 GW) over 1 hour
  - ESR, responding to WEMDE price signals, automatically absorb load swing; no breach of normal operating frequency band
- 13:45 Control room forecasted LOR1 conditions at peak
- 16:30 average state of charge across all storage facilities is ~50%
- 17:30 start of ESROD: average state of charge remains ~50%
- 17:45 AEMO Control Room began verbally directing non-gas facilities to bid In-Service, to be consistent with the lookahead signals. Multiple failed to convert their Available capacity to In-Service
- 18:00 AEMO control room, noting diminishing charge reserves and non-physical dispatch forecasts for ESR, intervene in market to override ESR dispatch
  - WEMDE automatically re-optimises system to dispatch remaining (gas) facilities
- 18:20 SWIS Unscheduled Operational Demand peaked at ~3,918 MW, which was the second highest winter peak
- 21:00 AEMO informed of impending several gas fired power station operators having insufficient access to pipeline services.
  - Gas powered generator operators not prepared for high-demand due to persistent low temperatures and false (non-physical) dispatch forecast for ESR
  - AEMO control room applies a series of further market interventions to alleviate gas pressure shortfall
- 23:40 All AEMO interventions withdrawn
  - Actual load peaked at 3934 MW (instantaneous)
  - Security risk reached actual LOR1 operating conditions; wind resource consistent 350MW+, significantly above forecast

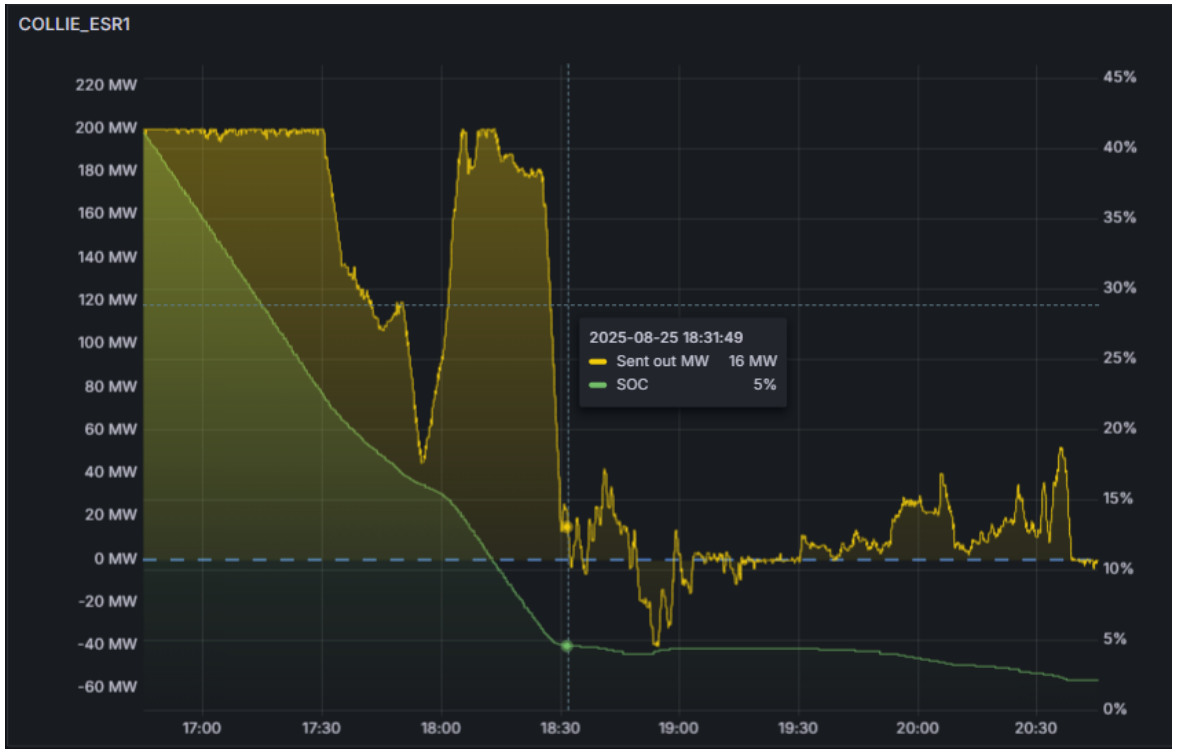
ESR Obligations & behaviour “Charge Shortfalls”

With reference to 4.12.5 (c), which sets the RC Obligation Quantity for an ESR Facility for each Dispatch Interval. The way the Rules are set out:

- The consequences of not meeting your RC Obligation Quantity are RC Refunds.
- Charge Shortfall refunds are calculated on a Dispatch Interval-basis, based on whether your charge was sufficient to Inject at your RCOQ during that Dispatch Interval, *considered in isolation*.
- Therefore, for example, if an ESR Facility commences the ESROI with 10% charge, and does not Inject or Withdraw, and maintains 10% charge for the entire ESROI, they will not incur RC Refunds, because (retrospectively) at the start of each DI, they had enough charge to meet their RCOQ in that DI (in isolation).
- Therefore, *effectively*, in this example, the Rules treat the ESR as if they have met their RCOQ obligations.

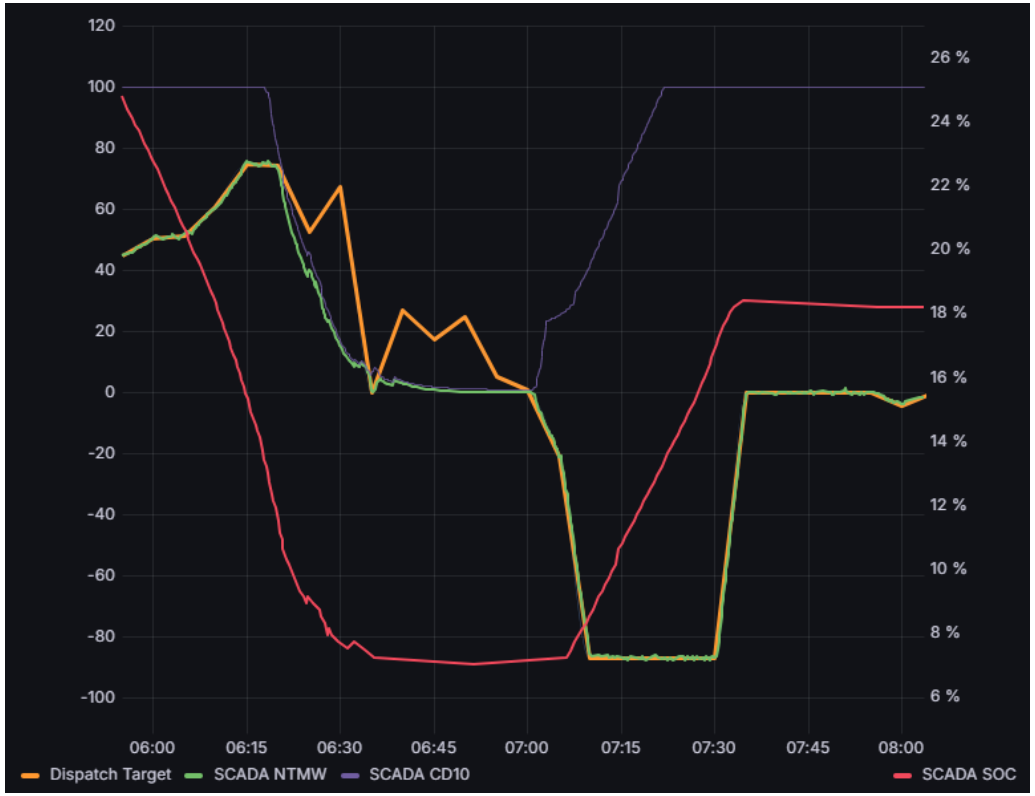
Initial outlook:

- NEOEN paid relatively minimal Charge Shortfall Refunds, and that was only driven between the Dispatch Intervals commencing 20:50 to 21:25 inclusive.
- KWINANA_ESR1 was charged Charge Shortfall Refunds between 19:50 and 21:25 intervals inclusive.
    - Exact figure unclear: what that translates in to (in $) because is mixed in with all their other Facilities. A rough estimate would be in the order of 10 times NEOEN’s refunds.



Example 2: March 2024 "Effective" State of Charge

- Facility unable to meet Dispatch Instruction @ 10% SOC
- Intervention constraint to limit DI to CD10 ("continuous discharge") value
  - Resolved through updates to WEMDE logic (SOC forecasting)
- AEMO to investigate "Effective State of Charge" parameter
  - Storage Coordination workstream activity

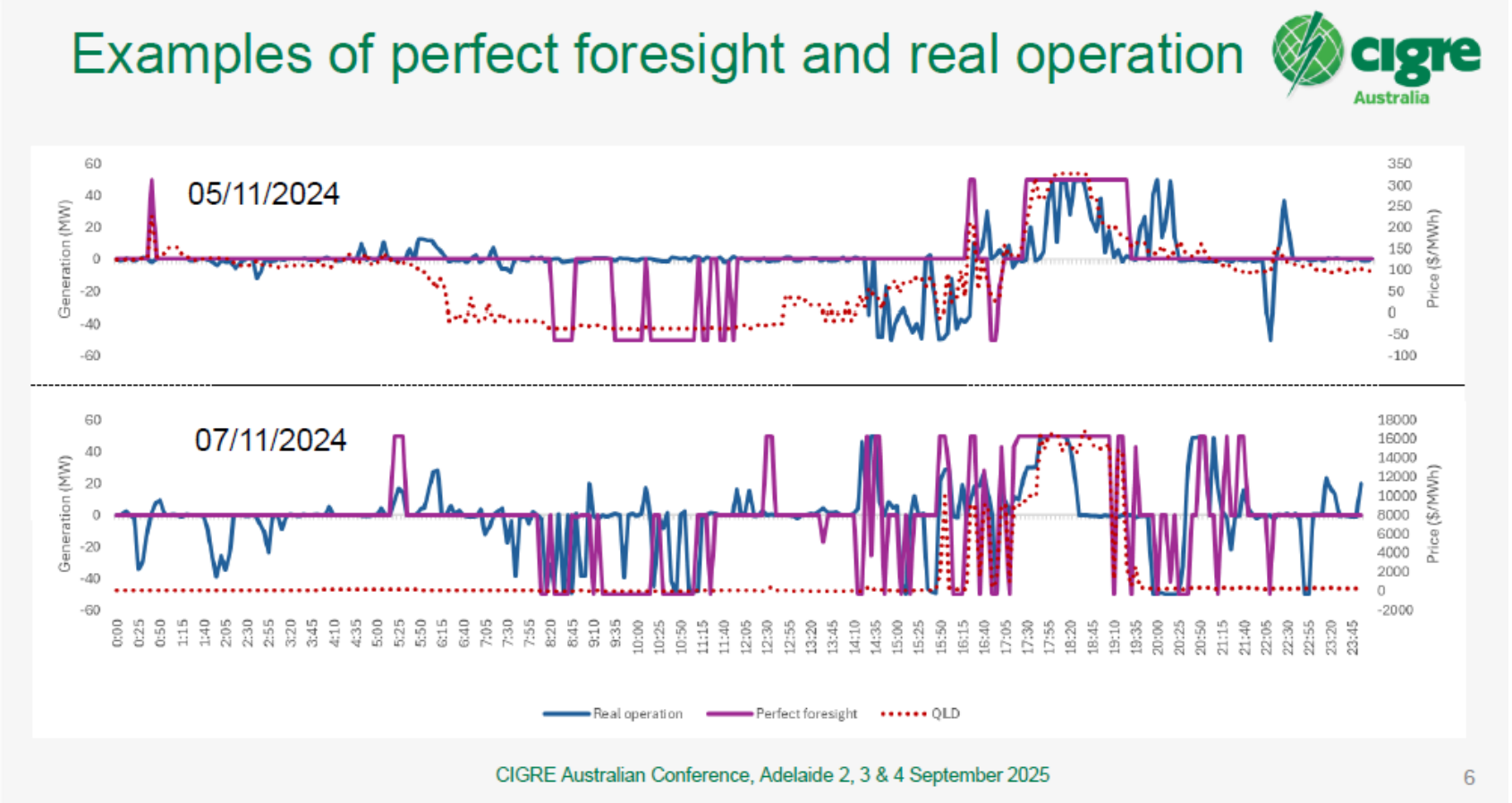


Example 3: 7 October 2025 Failure “auto-bidder”

- Sudden jump from -120 to 0 MW as SOC reaches 100%
- AEMO intervention to correct market dispatch
- Participant investigation identifies “auto-bidding” software defect
  - Will also opt-in to WEMDE SOC forecast

3rd Party Observations (NEM)

Bridging the gap: Analysing differences between investment business case modelling and real-time operation for BESS (CIGRE 2025)



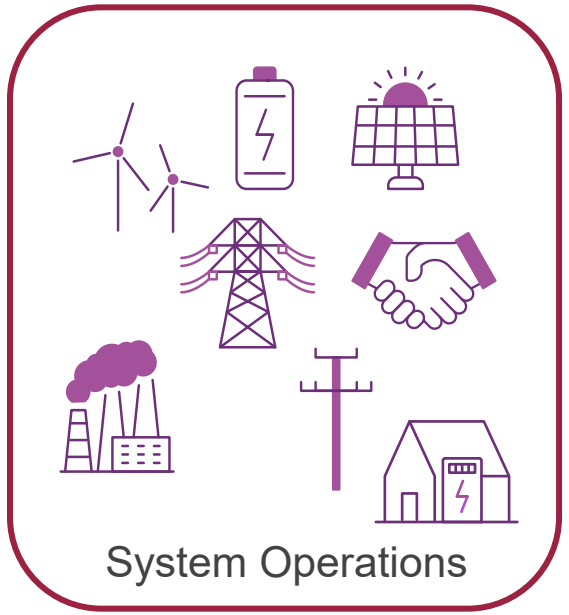
Operational Policy for 2026/27 Summer

Proposed operational approach and intervention policy for industry consultation

Two schools of thought: System under stress

1. Rules keep us civilized (and solvent).
2. Rules as advised by lawyers.

Regulatory design



1. Keep the lights on.
2. Rules as intended over rules as written.

Observations and performance

Two schools of thought
System under stress

Power Systems:

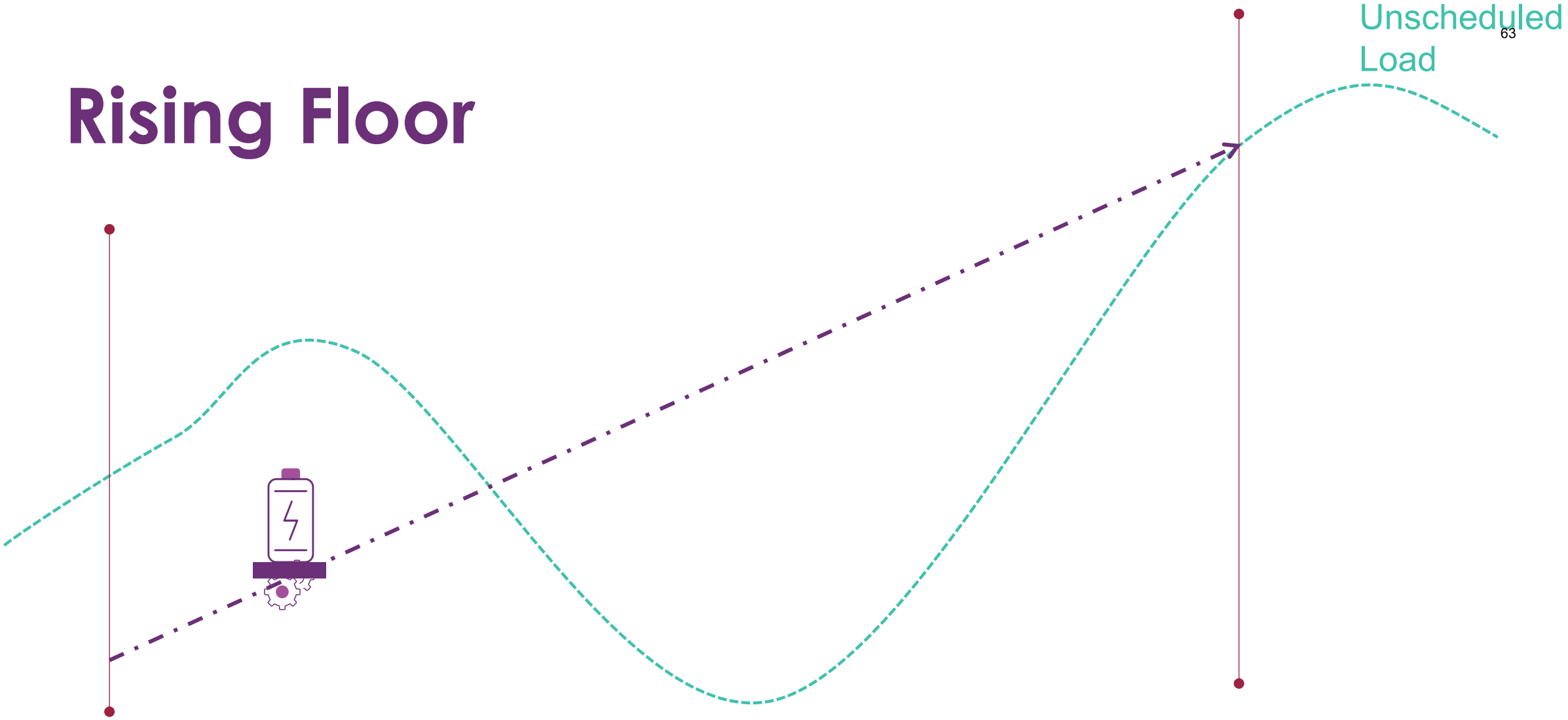
- LOR events are rare and warrant direct AEMO Intervention to "keep the lights on"
- Intent of RCM is that batteries should have full capacity allocation through ESROD
- Applying discretionary constraints as a "Rising floor" is a pragmatic solution:
  - No impact to participants that self-manage charge
  - Binding signalled in advance (pre-dispatch)
  - Little-to-no system changes or build required to support variable ESR capacity levels
- First step is to build back-up dispatch tooling in time for summer

Market Systems:

- Direct AEMO Market Interventions are high-impact and relatively extreme actions:
  - Constraining participants to charge at loss is a major legal risk, and miss-application of WEMDE "Discretionary Constraint" capability
  - Should only be exercised after DSP, Supplementary Capacity, NCESS, Outage recall (but before Emergency State declaration)
- Aim to apply other lower-impact controls
  - Restricting Injections (≤0) significantly lower impact
  - Await to see outcomes from market – August 25th may have been an edge case
  - Fall-back to SC and otherwise apply emergency control (load shedding)
- First step is to seek AEMO legal consultation

Preferred long-term approach is a combination of stronger capacity obligations and dispatch forecast signaling (and *minimize* intervention)

Rising Floor



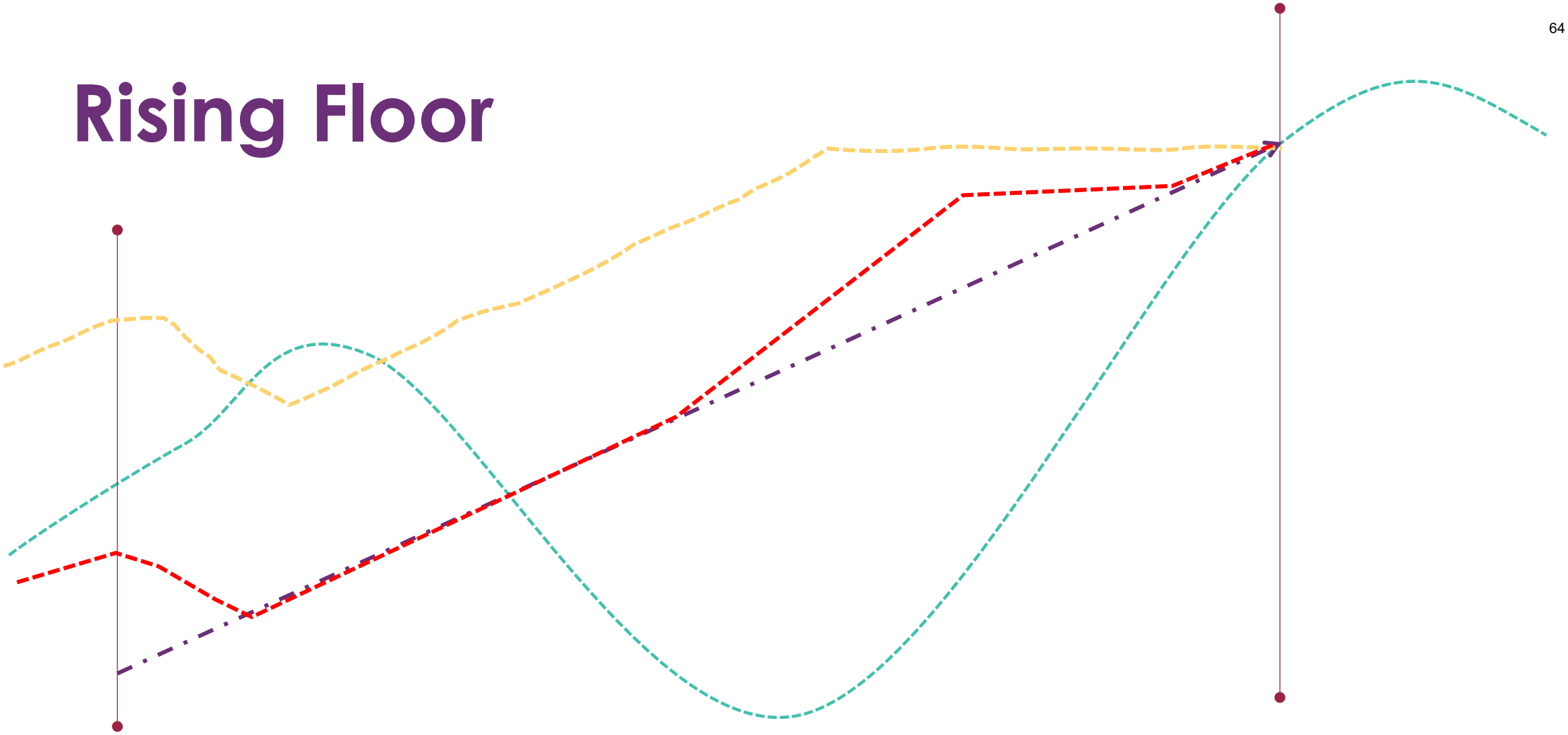
Start of Charging intervention
0% SOC requirement

Example: LOR declared, all ESR required fully charged through 06:00 → 16:00
10% / hour starting from 06:00

- If bound, DI ≤ -(Capacity credits / 10)
- Facility may pre-charge, or over charge to relieve constraint

Start of ESROD
~100% SOC Requirement
(or slightly lower)

Rising Floor



Example SOC profiles:

- **Battery 1**: Unconstrained
- **Battery 2**: Constrained then self-release

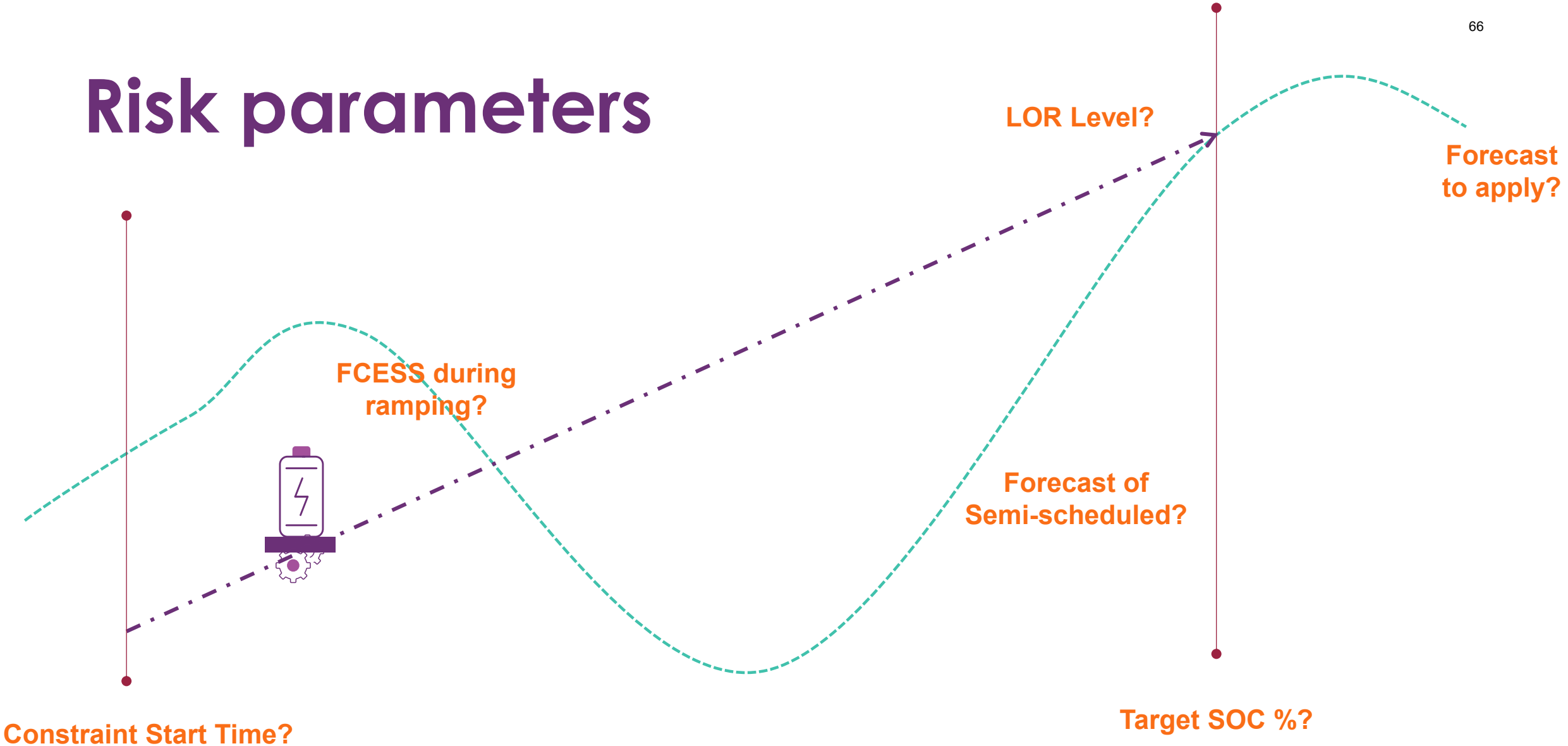
Rising Floor

Full detail to be presented and consulted through upcoming AEMO operational pre-summer forum
(date TBC)

Example risk and parameters to be consulted:

- Handling and limits for facility FCESS
- Trigger threshold for constraints (e.g., LOR1, LOR2)
  - Assumptions for treatment of storage and semi-scheduled capacity
- Forecast probability (POE50, POE10)
- Constrained charge level (100%, 90%, 80%)
- Constraint start (day ahead, 2 days ahead) and invoke time (6AM, 8AM)

Risk parameters



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