SHORT DURATION STORAGE METHODOLOGY

FRG CONSULTATION FOR THE 2023 ELECTRICITY STATEMENT OF OPPORTUNITIES (ESOO)

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1. Executive summary

AEMO has consulted on a proposal to derate short-duration storage devices (such as batteries) in reliability assessments. In the proposed approach, AEMO proposed to derate the energy storage capacity (that is, the depth of the stored energy available for discharge) based on the duration of the device, with shallower systems derated at higher values. AEMO's original proposal was:

- For devices with less than 2 hours of storage, reduce storage capacity by 50%.
- For devices with 2 to (less than) 4 hours of storage, reduce storage capacity by 25%.
- For devices with 4 to (less than) 8 hours of storage, reduce storage capacity by 10%.

This is aimed to address limitations in modelling to better reflect likely operational outcomes, where modelling will achieve optimum dispatch (with perfect foresight) to optimally reduce Unserved Energy (USE).

This consultation was originally enveloped in consultation on the Update to the ISP Methodology, however following feedback to this assessment AEMO determined to only consider derating battery storage in reliability assessments and not in the ISP, pending further analysis. 25 submissions were received in this consultation, with 18 providing feedback on the short-duration storage proposal. Responses were mixed.

The proposal was also discussed at the Forecasting Reference Group (FRG) in April 2023 with a further submission received from Shell.

This document summarises the feedback received from these two consultation processes and provides AEMO's response. In response to this feedback AEMO has determined:

- There is a need to derate short-duration storage in reliability assessments, to address issues of imperfect foresight.
- The precise timing and requirements of participant response to reliability incidents are not as forecastable as model outcomes suggest.
- Storage capacity is more appropriate to derate, rather than power, as a battery could dispatch at full power during a USE event, regardless of its state of charge.
- Consumer Energy Resources (Virtual Power Plants), CER (VPP), should be derated to the same extent as the shortest duration storages, given their reliance on disparate households having the appropriate state of charge at periods of USE.
- AEMO will use the derating amounts as originally proposed, with 50% being the maximum derating applied to very short duration storages and CER (VPP).
- AEMO has determined that 1.5 hours, rather than 2 hours, is a more reasonable threshold for applying the larger tranche of the storage duration limit. 2 hours was determined to be a problematic threshold given the large amount of batteries either side of 2 hour durations.
- System Integrity Protection Scheme (SIPS) batteries are modelled as reserving the SIPS component of the storage, and only allowing the remainder of the battery storage/power to contribute to the energy market. The reliability component of the storage is derated based on the battery duration, in the same way as other batteries.
- It is not appropriate to apply similar deratings to other generator categories (such as coal and gas generators), as they do not face the same finite energy limitations on their dispatch and therefore do not have to optimise limited energy sources in the same way.

Based on this consultation process, AEMO will apply the below deratings to short-duration storage in reliability assessments, including the 2023 Electricity Statement of Opportunity (ESOO):

- For all CER (VPP) and devices with less than 1.5 hours of storage, reduce storage capacity by 50%.
- For devices with 1.5 to (less than) 3.5 hours of storage, reduce storage capacity by 25%.
- For devices with 3.5 to (less than) 7.5 hours of storage, reduce storage capacity by 10%.

The deratings specified above would incorporate the auxiliary power use and storage efficiency losses that are already included in AEMO's models.

2. Stakeholder consultation process

AEMO has conducted a Forecasting Reference Group (FRG) Consultation on the methodology for short term storage forecasting, according to Section 2.3.2 of AEMO's Reliability Forecast Guidelines[1]. This consultation was conducted alongside a consultation on the same topic for the updates to the 2024 ISP methodology[2].

AEMO's timeline for this consultation is outlined below.

Deliverable	Indicative date
Notice of FRG Consultation circulated to registered FRG stakeholders	30 March 2023
Distribution of meeting material	20 April 2023
Forecasting Reference Group Presentation and discussion	26 April 2023
FRG Consultation Submissions due	10 May 2023
FRG Consultation Report published	4 August 2023
2023 ESOO publication	31 August 2023

3. Consultation details

Current forecasting methods make batteries entirely available for dispatch within an optimised model of supply with perfect foresight. These methods forecast daily battery charge and discharge profiles using the limited available storage in ways that perfectly align with power system reliability requirements. Short duration storages are therefore likely to be overly effective at improving forecast reliability in reliability models. Actual dispatch profiles are shown to be inconsistent with those forecast. AEMO proposed to derate batteries in its reliability assessments to better model the lack of perfect foresight and the likelihood that batteries will not be dispatched perfectly at periods of unserved energy.

To limit the perfect foresight inherent in AEMO's forecasting approach for the dispatch of storage devices, AEMO proposed in the consultation paper to limit storage capacity as follows:

- For devices with less than 2 hours of storage, reduce storage capacity by 50%.
- For devices with 2 to (less than) 4 hours of storage, reduce storage capacity by 25%.
- For devices with 4 to (less than) 8 hours of storage, reduce storage capacity by 10%.

[1] Available at: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-approach
[2] See https://aemo.com.au/consultations/current-and-closed-consultations/consultation-on-updates-to-the-isp-methodology

AEMO originally planned to apply these factors in both the ISP models as well as in its reliability assessments. This consistent approach was considered as part of the consultation on the Update to the ISP Methodology. Following stakeholder feedback, AEMO decided not to apply the proposed methodology change to limit the foresight of storage devices in the ISP models, and advised that further analysis is required to project accurate storage behaviour for capacity planning in the ISP. AEMO concluded that the approach should only apply to reliability assessments at this time. For ISP purposes, AEMO identified that it conducts reliability assessments periodically during the ISP development and may refine the minimum reserve level to ensure a reliable system is achieved within the ISP models.

As the approach between the ISP and reliability assessments differ, these are presented as separate consultation reports. This report provides additional information about AEMO's deliberations on feedback from the Update to the ISP Methodology related to reliability assessments, as well as feedback from the Forecasting Reference Group (FRG) consultation on the topic of short-duration storage in reliability models.

During the FRG presentation, AEMO outlined specific questions to guide stakeholder understanding and consideration:

- Do you consider it reasonable for AEMO's reliability models to reduce the reliable contribution from storage devices (particularly shallow storage devices) to reflect imperfect foresight? If not, why not?
- Do you consider a limit on the storage capacity of storage devices, particularly on short-duration devices, to be the most appropriate way to restrict the performance of energy storage to approximate limited foresight and reservation of energy?
- In what other ways could AEMO reduce the 'perfection' of foresight in its time-sequential model to improve model accuracy?
- Do you agree that an 'up to 50%' limit on storage capacity is an appropriate limit value? If not, what should the limit be, and what evidence can be used to support an alternative limit?

The consultation material and minutes of the resulting discussion points are available in the "FRG meeting 2 – meeting pack" from the 26/4/2023 meeting under "FRG Consultations" at: https://aemo.com.au/en/consultations/industry-forums-and-working-groups/list-of-industry-forums-and-working-groups/forecasting-reference-group-frg

4. Submission responses

AEMO received a total of 25 submissions to the Update to the ISP Methodology consultation, with 18 of these discussing the proposed update to the way short duration storage devices are modelled. Following the Short duration storage methodology FRG presentation[3], AEMO asked for feedback during the FRG meeting or during the subsequent two-week written submission window. One written submission was received from Shell Energy.

There were three types of response, with roughly even numbers of submissions in each.

[3] Available at: https://aemo.com.au/en/consultations/industry-forums-and-working-groups/list-of-industry-forums-and-working-groups/forecasting-reference-group-frg

- **Several submissions expressed support for the proposed update**, with some noting that derating factors of up to 50% are appropriate and reflective of historical storage behaviour.
- **Others expressed support for the principle of accounting for perfect foresight.** These submissions held that the proposed derating factors were too extreme, put forward alternative approaches or derating values or raised queries as to how the proposed derating factors had been derived.
- **Others did not support the update.** These submissions raised several arguments, including that storage technology may improve over time and that historical storage behaviour may not reflect future behaviour.

4.1. Several submissions expressed support for the proposed update.

Powerlink, Transgrid, Hydro Tasmania and PIAC expressed support for the proposed update. Transgrid and Hydro Tasmania commented that derating factors of up to 50%, depending on the duration of storage, are reflective of historical storage behaviour. Hydro Tasmania pointed to analysis it conducted on the impact of imperfect forecasting on arbitrage optimisation for storage devices with varying storage durations. PIAC reasoned that although the proposed derating factors are large, in its opinion, the risk of overbuilding storage is likely to be a non-regrettable error. Powerlink commented that the proposed approach is a “positive first step”, but that further work is required to refine the solution to perfect foresight in the ISP.

4.2. Others expressed support for the principle of accounting for perfect foresight, but had reservations.

Origin, Shell Energy and Flow Power offered the most feedback on reservations.

Origin supported the proposal “in principle” but raised several queries regarding:

- how the derating limits where chosen,
- why AEMO prefers derating capacity (MWh) rather than power output (MW), and
- why VPPs would be derated in the same way as grid scale storage.

Origin made two recommendations. First, that AEMO should analyse dispatch behaviour of short duration storage and VPPs regarding storage capacity (MWh) and release this analysis. Second, that AEMO should consider a hybrid approach of derating power output (MW) and capacity (MWh).

Origin also put forward several views:

- Short duration batteries are likely to be able to discharge more than 50% of their capacity during major power system events.
- Historical analysis of storage dispatch behaviour is limited, since "significant power systems events are rare, and dispatch behaviour may change in the future as battery penetration increases".
- Storage is more likely to reserve some capacity during a smaller system event when prices are lower and dispatch all its capacity during a large system event, when prices are higher. Therefore, the derating factor shouldn't be the same across all power system events.
- Known existing constraints on storage units (such as participation in a System Integrity Protection Scheme) should be incorporated in the methodology.
- VPPs should be treated differently from grid-scale storage.

Flow Power agreed that it is important to consider storage capacity limitations to reflect imperfect foresight. However, in Flow Power's opinion, AEMO's proposed level of derating will underestimate the level of battery capacity that is available during reliability events. Flow Power gave evidence that past reliability events have been anticipated at least six hours in advance, due to forecasts from AEMO, and noted that this provided battery operators with sufficient notice to preserve capacity for the forecast reliability event.

Shell Energy agreed with AEMO's assessment that the current methodology might overestimate the potential contribution of low storage capacity storage devices. However, in Shell's opinion, based on its own analysis, a derating factor of no more than 20% should be applied to power output (MW), with no derating applied to storage capacity (MWh). Shell further recommended the following storage capacity derating factors be applied:

- 2-3 hours: 20%
- 3-4 hours: 10%
- 4 or more hours: 5%

Shell noted that AEMO derates storage capacity available for storage devices to which network support contracts apply and recommended that AEMO only apply these deratings in the specific situations where those contracts would be active at dispatch.

4.3. Others did not support the update

Various stakeholders offered different reasons for not supporting the update.

- QCC, Nexa Advisory, IEEFA and CANA presented a view that it is not suitable to derate storage capacity of short duration storage devices based on historical dispatch behaviour of such devices. QCC, IEEFA and Nexa Advisory put forward that a derating factor of 50% is too high. Nexa Advisory, QCC and IEEFA noted that a significant proportion of current short-duration storage devices are optimising for FCAS, rather than optimising for arbitrage, and that this may change as penetration of storage increases, leading to different dispatch behaviour. QCC further commented that short-duration storage is a "nascent" industry, and that its performance may improve over time. On this basis QCC does not agree that a 50% derating factor should be applied across the whole modelling period. Nexa Advisory and CANA similarly argued that the application of a derating factor based on historical behaviour does not provide an allowance for potential improvements in short duration storage technology.
- QCC did note their view that derating storage capacity (MWh) is the most appropriate way to restrict the performance of short-term energy storage, as most batteries will be able to dispatch to full power, if not energy, when required.
- Several submissions (Greenpeace, ACF, CEIG and Nexa Advisory) expressed a view that if storage device capacity (MWh) is derated to mitigate the impact of perfect foresight within ISP modelling, then other technology types should also be derated. These submissions held that the issue of perfect foresight applies equally to other technology types and specifically referenced coal and gas generation. Nexa Advisory cited the 2022 market suspension as evidence that other technology types are energy-limited and are impacted by imperfect foresight and stated that "imperfect forecasting at a gas plant led to load shedding in NSW in recent years". QCC similarly requested that if storage device characteristics are derated, AEMO should also consider constraints to generation output from fossil-fuelled generation.

- The Network disagreed with AEMO's proposal to derate the capacity (MWh) of storage devices. The Network noted that First Nations communities are especially exposed to the benefits of decentralised, short-duration storage (and may therefore be exposed to poor outcomes if storage is underbuilt).
- Windlab strongly disagreed that it is appropriate to derate storage device capacity (MWh) by up to 50% but stated that applying a minimal power output (MW) derating factor may be appropriate. In Windlab's view, the problem of perfect foresight does not have a significant impact on the dispatch behaviour of devices with a short duration of storage. Windlab reasoned that it is reasonably likely that such shallow devices can be fully charged during "peak solar hours", despite the solar profile not being perfectly predictable.

5. AEMO's assessment

5.1. Consideration in ISP models

As outlined in the Consultation Summary Report of the Update to the ISP Methodology[4] AEMO decided to not implement its proposed changes to storage duration for the 2024 ISP. AEMO retained some flexibility that in some cases it may apply limits to storage duration in the time-sequential modelling phase of the ISP modelling to validate the reliability and operability of candidate development paths. AEMO conducts reliability assessment periodically during the ISP development, and may refine the inputs that are applied in capacity outlook modelling (for example, minimum reserve levels) to ensure a reliable system is achieved.

AEMO also noted that further work would be needed to determine the most appropriate implementation of reducing the perfect foresight for short-duration storage for ISP purposes. For ISP purposes, AEMO agreed with stakeholders that more general storage behaviour throughout the rest of the year that enables appropriate use of storage capacity to provide energy shifting capability is needed when determining development needs, and that restricting storage capacity (or power output) for these broader purposes is not prudent for the 2024 ISP.

5.2. Consideration in reliability forecasting

While concluding the above position for ISP modelling, AEMO recognised that there remained appropriate cases for application of storage limits to reflect imperfect storage management for reliability assessment purposes.

AEMO recognises that most feedback received agreed that the current modelling methodology is over optimising short duration storage dispatch. AEMO note while numerous submissions commented on the high level of a 50% reduction that this level of reduction would only apply to a relatively small proportion of devices, particularly for reliability forecasting purposes.

There are currently 44 large scale battery installations that are either In Service, In Commissioning, Committed, Committed* or Anticipated within the NEM[5]:

- 978 MW (955 MWh) of < 1.5 hour storage
- 4,250 (8,158 MWh) of 1.5–3.5 hour storage

[4] At https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/isp-methodology-2023/consultation-summary-report---update-to-the-isp-methodology.pdf?la=en.
[5] Generation Information July 2023, at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information

- 758 MW (3,000 MWh) 3.5-8 hour storage

5.3. Predictability of reliability incidents

Flow Power's claim that reliability events have historically been anticipated with at least six hours' notice is a reasonable one. Shell also suggested that availability would depend on the size of the power system event, with maximum power being close to 100% at a lack of reserve 3 (LOR3) event.

The concern for short-duration batteries during power system events or LOR events isn't that batteries aren't flexible enough to respond to those events, but they may misjudge exactly when that event may occur, or the duration of the event. Short duration storages may have already discharged some of their capacity earlier in the day, prices may have been too high to recharge, so when the power system event occurs there is simply less than the full capacity of energy available to contribute to the event.

AEMO argues that the exact timing and duration of the event is often not always accurately forecast. Having full battery storage available to discharge at exactly the most optimal moment across the entire NEM is an unrealistic outcome, but that is how AEMO's modelling currently operates. AEMO's models also consider the most optimal timing and magnitude of dispatch across the entire storage fleet, when in reality each storage owner will plan dispatch at the most optimal time for their business, and will not coordinate dispatch across the NEM.

5.4. Storage Capacity vs Power

Several participants questioned whether power should be reduced instead of storage. While AEMO noted that many batteries do discharge less than their maximum power during the majority of dispatch periods, it would expect batteries to discharge at maximum power during VoLL or USE periods.

AEMO believes that Windlab, Origin and Shell raise important points backed up by logical reasoning. However, given how AEMO's modelling of storage dispatch works, and the impact on results some trade-offs are required to be made. The downside of Windlab's suggestion of derating power (MW) instead of capacity (MWh) means that during low reserve or reliability periods, a storage unit will be limited to discharging at a limited power which is unlikely to occur during periods of VoLL unless a battery is not fully charged. AEMO believe that it will obtain more accurate results when it models the storage units as discharging at full power for shorter periods of time, rather than having the full energy storage available, but less power at those key peak times. The methodology change is focusing on reducing perfect foresight of the model to account for those periods where the storage may have already been depleted during high but not absolute-peak periods.

Shell also suggested using probabilistic modelling of 'outage rates', much like outage rates are modelled for thermal generators. AEMO believes that the issue with perfect foresight is not that there would be no output available from a battery due to an outage, rather the storage would be partially dissipated due to prior output, and reduced state of charge would be available to market.

For reliability forecasting purposes, where the objective is to identify the ability of the power system to maintain reliable supply for consumers, the importance of accurately and reasonably modelling extreme reliability periods is paramount.

5.5. Consistency of modelling: coal and gas not being treated with the same imperfect foresight

Past analysis has shown that short duration storages typically face one or two cycles per day (one full charge plus one full discharge equals one cycle). For a two-hour battery, this means that between two

and four hours of discharge is available across the entire day. Other fuel types are not as energy-limited; coal or gas fired generation do not typically need to pick a small handful of hours during the day for which to operate. AEMO's reliability forecasting methodologies ensures that where relevant energy limitations exist, these are captured within AEMO's ESOO and/or EAAP models.

This approach does not attempt to incorporate technological limitations, but rather reflects the imperfect dispatch behaviours observed consistently from storage operators. Technological improvements (including failure rates) are incorporated into technical assumptions for storage.

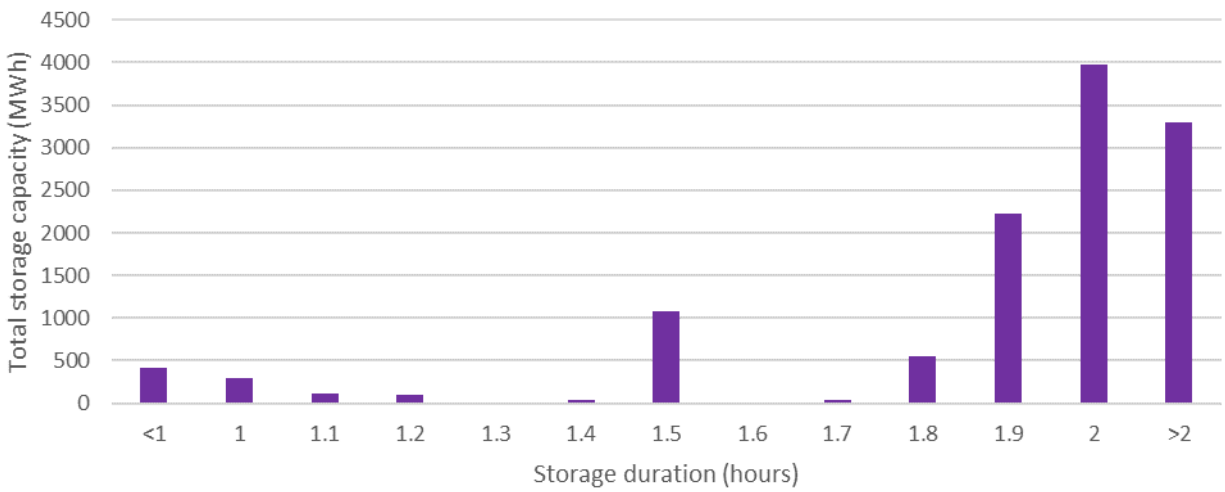
5.6. Level of deratings

The purpose of this methodology change is to limit the perfect foresight of AEMO's model, and to recognise that the full amount of storage capacity is unlikely to be available during times of peak demand.

While AEMO believes that the proposed deratings are appropriate based on the current limited evidence, AEMO has reassessed the duration cut off for the different derating categories. Considering stakeholder feedback, AEMO will apply alternative thresholds.

Figure 1 shows the number of storage installations that are existing, currently undergoing commissioning, or are categorised as committed or anticipated and expected to progress.

Figure 1 The storage capacity of existing, in commissioning, committed and anticipated storage projects in the NEM, by duration[6]



AEMO has determined that 1.5 hours, rather than 2 hours, is a more reasonable threshold for applying the larger tranche of the storage duration limit. 2 hours was determined to be a problematic threshold given the large amount of batteries either side of 2 hour durations, and there is little reason to suggest that a 1.9hour storage would result in substantially different dispatch to a 2.1 hour storage. While some stakeholders agreed with AEMOs concerns regarding very short duration storages, and the need for derating, many stakeholders suggested that the proposed battery derating levels were too high. By adjusting the threshold downwards, the average level of battery derating is reduced, thereby reflecting this stakeholder feedback.

[6] [6] Generation Information July 2023, at https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information

5.7. Participation in System Integrity Protection Schemes

Shell and Origin submitted that where there are known constraints for existing and committed storage units (such as participation in a System Integrity Protection Scheme), these should also be incorporated in the methodology when modelling dispatch. Where a participant has advised it is participating in a SIPS, the portion of the battery reserved for the SIPS is not modelled in AEMO's reliability forecast. The portion of the battery that is available for reliability purposes is derated based on its duration, in the same way as other batteries. As such, AEMO does not consider that further changes to this methodology are required.

5.8. Virtual Power Plants

Shell and Origin submitted that VPPs should be treated differently from grid-scale storage. They suggest that the response from VPPs is unlikely to be as firm as grid-scale storage and this should be incorporated in the methodology when choosing an appropriate derating factor. AEMO agrees, and has determined to use the maximum derating factor for VPPs to reflect this operational concern.

6. Conclusion

Following review of the feedback provided to the Update to the ISP Methodology consultation and the FRG Consultation, including stakeholder engagement during the FRG meeting, AEMO has updated the short duration storage methodology for use in the 2023 ESOO to include stakeholder feedback (yet the methodology change should not apply broadly to the ISP models when determining broader development needs).

AEMO will apply the below revised deratings to short-duration storage in reliability assessments, including the 2023 Electricity Statement of Opportunity:

- For all coordinated DER (VPP) and devices with less than 1.5 hours of storage, reduce storage capacity by 50%.
- For devices with 1.5 to (less than) 3.5 hours of storage, reduce storage capacity by 25%.
- For devices with 3.5 to (less than) 7.5 hours of storage, reduce storage capacity by 10%.

The deratings specified above would incorporate the auxiliary power use and storage efficiency losses that are already included in AEMO's models.

The feedback from this consultation has made it clear that further work must be done to implement storage behaviour dynamics more realistically in future modelling, across both reliability and ISP purposes. AEMO will continue observing the operation of storage in the NEM as more capacity is installed and improving its modelling techniques over time.