THE CENTRE FOR INDEPENDENT STUDIES

(Limited by Guarantee) A.B.N. 15 001 495 012
Level 1, 131 Macquarie St, Sydney NSW 2000
Phone: 61 2 9438 4377 **Email:** cis@cis.org.au

cis.org.au

29 November 2024

Mr Daniel Westerman

Chief Executive Officer

Australian Energy Market Operator

Lodged by email: ISP@aemo.com.au

Dear Mr Westerman

Submission to ISP Methodology Consultation Paper

The Centre for Independent Studies (CIS) appreciates the opportunity to provide a submission to the Australian Energy Market Operator on its ISP Methodology Consultation Paper.

The CIS is a leading independent public policy think tank in Australia. It has been a strong advocate for free markets and limited government for more than 40 years. The CIS is independent and non-partisan in both its funding and research, does no commissioned research nor takes any government money to support its public policy work.

The review of the Methodology of the ISP comes at a critical time. Serious shortcomings in the ISP's method are being exposed or confirmed though findings of the ECMC's Review of the ISP, as well as the Senate Select Committee on Energy Planning and Regulation in Australia.

We would also highlight that the AEMC has now listed a Rule Change that we have proposed which would clarify how the ISP 'considers' government policy.

Given the very large volume of new information emerging from these processes, and the seriousness of the shortcomings in the ISP being exposed, we feel that it is inappropriate for the consultation stage to be proceeding with only one month for submissions following the issues paper, particularly with the full ISP Review only coming to public notice after the close of the consultation period.

Nevertheless, we have endeavoured to provide initial feedback within the period allowed.

Yours sincerely

Aidan Morrison

Director

Centre for Independent Studies Energy Program

Consumers cannot provide informed feedback because the ISP review has been kept secret

To restore credibility and accountability to the ISP process, CIS strongly urges AEMO to re-issue the ISP Methodology Consultation Paper.

This consultation asks energy consumers to respond to a proposal based on an ECMC response to the "Supercharged ISP Review" (the review) which remained, until recently, unpublished. Consumers without access to the original reasons for the proposed changes are unable to provide informed feedback. This is particularly concerning because the AEMC deferred a statutory review which would have consulted the public to make way for this review. AEMO should re-issue this consultation, but in response to both the review itself and the ECMC response. We have referred to the review throughout this document.

Specifically, the statutory review was postponed to "allow better alignment with the recommendations resulting from the Energy and Climate Change Ministerial Council's (ECMC) review of the ISP and allow for current reforms to settle." [1]

Instead of a public review engaging the consumers affected by the proposed changes, a review was conducted which bypassed the broader public consultation expected of a statutory review. It was administered by the Department of Climate Change, Energy, the Environment and Water (DCCEEW), guided by a working group established by the Energy Ministers, and conducted in collaboration with AEMO and only "targeted" stakeholders.

The terms of reference for the unpublished review, set by the ECMC, heavily emphasised emissions reduction and embraced the notion that the ISP's primary objective is, in part, to meet "any emissions trajectory determined by policy makers at an acceptable level of risk."[2] Consequently, the scope determined by the ECMC was limited to predefined outcomes that risks prioritising emissions reduction over the cost, security, and reliability issues faced by consumers. By conducting the ISP review behind closed doors, the ECMC effectively sidestepped submissions that might have challenged these trajectories or called for baselines to expose their true costs.

By failing to publish the ECMC review of the ISP on which AEMO's proposals are based, AEMO has compromised transparency and public accountability in this critical process. Stakeholders, including consumers and businesses directly affected by these decisions, are left without access to the evidence or rationale underpinning the proposed methodology changes.

Two ignored recommendations from the review should be actioned

Recommendation 14 and 15 from the "Supercharged ISP Review" have been ignored by the ECMC response to the review. This is concerning because they ensure transparency and accountability, respectively. CIS supports actioning both recommendations, as outlined below.

> ***Recommendation 14:*** *That AEMO take steps to increase the visibility of the latest Forecasting Assumptions Update on its website, linked clearly from material relating to the ISP and in time for the 2026 ISP.*

CIS supports AEMO implementing *Recommendation 14*. The review found that there was a lack of awareness amongst stakeholder about the 'upstream' inputs to the IASR reports, and that these were often relied on for commercial purposes. This is a simple change for AEMO to make and it is unclear why the recommendation was dropped. Particularly as the ISP considers expanding its scope, ensuring that stakeholders clearly understand how the modelling process works will become increasingly important.

> ***Recommendation 15:*** *That the System Planning Working Group undertake a further review following the release of the 2026 ISP to determine if this review's*

recommendations have been appropriately implemented, and whether the format and purpose of the ISP report remains fit-for-purpose.

While Recommendation 15 is not AEMO's direct responsibility, we still wish to express our concern that the key accountability recommendation has been entirely ignored in the ECMC's response to the ISP review.

Responses to consultation paper questions

1. Do you consider that the proposal to develop a gas supply expansion model appropriately addresses the action in the Energy Ministers' response to the Review of the ISP for additional gas analysis to be incorporated in the ISP? If yes, why? If not, why not, and how could this action otherwise be achieved?

The action would be appropriately addressed if the model outputs costs for optimisation.

The proposal does not appropriately address the action in the response, because it does not provide useful information about the cost-benefit trade-offs between gas expansion and electricity expansion without explicitly including cost in the iterative modelling process. Doing so would result in outputs which trade-off gas generation and supply, and help the ISP to become a "genuine whole of system plan" which informs policymakers.

We consider that any trade-off is necessarily about cost. The review suggested that AEMO use gas projections *in* combination with its electricity modelling to identify and analyse cost/benefit trade-offs between projects in the gas and electricity sectors.[3] The ECMC response includes this in the action, saying that AEMO should improve gas development projections and use these to "iteratively analyse the gas sector project trade-offs with electricity development needs". While the review clarifies that this need not involve co-optimised development paths because of the added complexity, it (along with the response) also clearly recommends that the iterative process is expected to analyse cost benefit trade-offs.

Unfortunately, the proposal plays down both co-optimisation and costs. It says explicitly that costs or benefits from gas supply expansion will be excluded from the ODP, and gas will not be co-optimised. It also excludes cost from the iterative modelling in Figure 3.

The steps in the interaction between the electricity and gas supply expansion models should include cost in step three to ensure that the capacity outlook model is able to appropriately identify trade-offs between gas and other generation. This would allow for some optimisation using the gas cost database and other fixed inputs to the gas supply expansion model, but without the complexity of full development path co-optimisation.

We note that the foreword to the review says "there is considerable scope for the ISP framework ... to become a genuine whole of system plan". We agree and would add that continuing to identify an "optimal development path" that ignores the trade-off the ISP claims to analyse is likely to be misleading to policy-makers who are increasingly depending on the plan.

This is because it is expected to guide electricity system development which will increasingly depend on intensive, occasional use of gas capacity, supply, and storage.

2. Do you agree with the proposal for AEMO to develop at least one gas development projection per ISP scenario, and apply the projection as an input to the capacity outlook model? If yes, why? If not, what method would you recommend for the inclusion of gas development projections in the ISP?

No, as an optimisation would be more appropriate than a projection for a model which will be interpreted as "optimal" when used for decision making. As with the answer to (1) this should include, and be largely determined by cost, as it is critical to any cost/benefit trade-off. At the very least, the inputs to the capacity outlook model should include gas development costs as part of the iterative process outlined to allow the model to trade them off appropriately within feasible constraints.

Having said that, if forecasts are used, then at least two forecasts for each scenario would provide a diversity of outcomes and better reflect the options facing decision makers. In particular, allowing only one gas projection to be paired with each scenario may bias the outcome investment choices in that scenario without that trade-off being detectable. For example, if an ISP scenario assumes a projection that has no gas development to support peaking behavior, it will always tend to model much higher benefits associated with electricity investments that might mitigate that need. At least two projections can expose the sensitivity of such a choice.

3. What alternative approaches should AEMO consider for enhancing the incorporation of gas in the ISP to address the action in the Energy Ministers' response?

Enhance the modelling of the dynamics that drive gas capacity.

The review notes that "there is considerable scope for the ISP... to become a genuine whole of system plan", and the ECMC response notes that GPG will play a critical role, that "significant peaks" in demand are expected, and understanding the "dynamics" is critical. AEMO's current modelling approach severely distorts the dynamics of gas, and underestimates the need for gas (and other forms of backup) because of uncompensated perfect foresight.

Perfect foresight, even with limited annual GPG capacity additions, allows the model to delay GPG additions until the last moment they're needed. In reality, the system always needs to be ready for the next year to be a bad weather year. Weather forecasting only justifies perfect foresight on the timescale of days to a week. We cannot forecast the weather a year ahead, much less 20 years.

The review agrees, noting on page 36 that "the outputs of the model may be limited in how they respond to an increasingly volatile energy system." We believe that this is one area where the simplifying assumptions AEMO has chosen to make are inappropriate. This will be all the more true as the ISP builds an edifice of accurate gas modelling around the shaky foundation of perfect foresight of weather and climate.

Recognise that models for decision making are not forecasts.

The ECMC expects the ISP to help in "determining the role that gas may play in supporting the energy transition."[4] This increased role in decision making should prompt AEMO to consider changing its approach from forecasting to optimisation where possible.

This change is necessary because it is inappropriate for a model where the outcomes drive decision making to assume the decisions it will be used to make. Forecasting, rather than allowing optimisation within reasonable limits, can inadvertently fall into this circular logic trap and mislead decision makers. So while exogenous inputs and assumptions about feasibility are necessary, they should be limited.

The ISP should project only necessary constraints and inputs to gas development that are outside of its control, and should model (i.e. co-optimise) the best outcomes for the system as a whole. The ECMC response makes it clear that this system includes both the gas and electricity systems.

4. What improvements could be made to AEMO's proposed approach to increase consideration of gas availability, considering gas transportation and storage capacity?

See above.

6. What are your views on AEMO's proposed inclusion of distribution network capabilities and their impact on CER within the ISP model? What further enhancements could be made?

The CIS has previously voiced concerns about the omission of critical cost components in the ISP, particularly consumer energy resources (CER) and distribution network upgrades.[5] We have highlighted that while AEMO heavily relies on CER to reduce the need for utility-scale solar, wind generators and large-scale batteries, it excludes the costs of those CER investments borne by households and businesses, thereby misrepresenting the true system cost of the energy transition reported in the ISP.

The CIS has also advocated for the inclusion of distribution network augmentation costs, which are crucial for accommodating CER and mitigating potential over-voltage issues from excess rooftop solar export. The ISP Consumer Panel highlighted this flaw in the ISP, stating that: "While AEMO describe the ISP as a 'whole of system' plan, it is in practice, a 'whole of transmission' plan with limited involvement of distribution networks."[6] The ISP Review also highlights that there is "considerable scope for the ISP ... to become a genuine whole of system plan."[7]

The CIS therefore welcomes the intention expressed in the ISP Methodology Issues Paper to expand details on distribution network capabilities and the need for distribution network augmentation as they relate to CER operation. However, we remain concerned that AEMO's proposals fall short of fully addressing the critical need for co-optimising distribution network upgrades and CER costs with transmission and generation investments in determining the Optimal Development Path (ODP).

AEMO should commit to co-optimising CER and distribution network costs with generation and transmission costs in the 2026 ISP.

While AEMO acknowledges the significance of distribution network upgrades and intends to provide more costing detail in future ISPs, we are deeply concerned that AEMO does not commit to co-optimising these costs with transmission and generation investments in the least-cost Development Paths and ODP for the 2026 ISP. As such, the approach still fails to meet the standard of a "whole-of-system" plan that consumer advocates and other stakeholders have long demanded. This shortfall is particularly striking given the directives from the ECMC's response to the ISP Review, which stated that "a truly whole-of-system plan must consider the relative merits of additional investment on *both sides of the market*", and thus AEMO is asked to enable "investment optimisation *that spans the demand- and supply-sides* of the market" (emphasis added).[8]

This is notwithstanding AEMO's own acknowledgement of DNSP investments and measures in relation to CER as key factors affecting the ODP:

> *The Energy Ministers' response to the Review of the ISP requested that AEMO analyse how distribution network service provider (DNSP) investments, programs and annual plans may impact CER and distributed resources development,* ***and therefore the ODP of the ISP****. These findings are to be included in the ISP to send clearer signals to inform distribution network planning, and to communicate to the market and policy-makers about the expected development of CER and distributed resources. (emphasis added)*[9]

We submit that AEMO's current proposal with respect to expanding details on distribution network capabilities is vague and inadequate in addressing both the ECMC's directive and broader stakeholder demands for a whole-of-system plan that optimises both demand and supply-side investments.

While AEMO has committed to including indicative cost curves for distribution augmentation in the *Network Expansion Options Report*, it is unclear whether distribution augmentation costs will be factored into ISP modelling to enable co-optimisation, but AEMO once again fails to commit to including the cost of CER in its analysis, despite repeated calls from stakeholders to address this omission. Such omissions undermine the ISP's ability to provide the "clear signals" necessary for optimal investment across both supply- and demand-side resources and to confidently deliver a genuine least-cost system plan.

CER installation and costs should be endogenised in the ISP model.

AEMO has provided no indication in the Methodology Issues Paper that CER costs will be included in the ISP, let alone co-optimised with broader system investments. Instead, CER uptake remains treated as an exogenous input to the model. This is despite the ISP Review calling for a more "integrated analysis of the risks and trade-offs between electricity transmission, generation, storage, CER and distributed resources... [which enables] the ISP to promote the least cost delivery of electricity, in the long-term interests of consumers".[10] The need for reform to co-optimise demand-side planning (CER) with supply-side planning in the ISP has been widely endorsed by stakeholders, including climate change and environmental advocacy groups, academic and research organisations, and consumer advocates.[11] And as discussed above, the ECMC response to the ISP Review clearly recognised the importance of co-optimising CER with broader system investments.

Nevertheless, AEMO failed to address or even discuss the inclusion of CER costs or their co-optimisation with broader system investments in the ISP. The lack of co-optimisation leaves the ISP fundamentally flawed as a whole-of-system plan, particularly given its heavy reliance on consumers purchasing rooftop solar, home batteries, and EVs to provide generation and storage in the coming decades while excluding the costs of these assets from the system's overall calculations. The outcome is inevitably a sub-optimal plan that risks under-investment in utility-scale capacity and firming, potentially compromising the system's reliability and affordability for the end-users.

Using 2023–24 GenCost capital cost figures, the CIS estimates the total capital cost for CER under *Step Change* over the forecast horizon to be approximately $347.5 billion.[12] This is significantly higher than the estimated $83 billion capital cost for large-scale solar and batteries up to 2050.[13] In net present value terms, CER capital costs amount to $121 billion, annualised to 2050 with a 7% discount rate. Given that adding CER costs (even without considering distribution augmentation costs) nearly doubles the ISP's headline capital cost figure, it is perplexing that AEMO continues to ignore repeated calls to incorporate CER costs into its modelling and treat them as integral components of a truly co-optimised 'whole-of-system' plan.

If CER remains an exogenous input to the ISP model, the utility-scale generation and network investments can only be optimised around fixed CER assumptions in each scenario. However, a genuine whole-of-system plan must evaluate the trade-offs between CER and associated distribution network augmentation costs versus utility-scale generation and storage investments. Treating CER as endogenous variables within the model would allow the ISP to truly co-optimise these trade-offs and better align with the goal of delivering a least-cost system.

Introducing additional sensitivity testing would be insufficient; it explores limited variations in CER outcomes but continues to treat CER investments as the de facto favoured investments, forcing other system components (i.e. utility-scale generation, storage, and network investments) to optimise around fixed CER assumptions. This obscures critical trade-offs and biases the analysis towards CER without adequately testing whether it represents the most cost-effective pathway.

Recognising the additional modelling complexity this approach could introduce, a feasible solution would be to first model utility-scale generation, storage, and network investments as the baseline least-cost solution, and then substitute with CER such as rooftop solar and residential storage where net benefits — including distribution augmentation costs — can be demonstrated. For example, utility-scale batteries co-located near load centres could be compared to distributed residential batteries to assess their relative costs and system impacts. Similarly, utility-scale solar farms could be evaluated against rooftop solar installations. This approach ensures that CER are incorporated into AEMO's whole-of-system energy transition plan only when they demonstrate clear comparative advantages, avoiding the naive assumption of their status as default solutions.

Such sequential modelling would ensure a more transparent and sensible assessment of trade-offs, delivering a genuinely least-cost and optimised outcome for the broader energy system.

Current CER projections are inconsistent with each other and with the ISP

AEMO currently obtains CER forecasts from CSIRO and Green Energy Markets (GEM), aligning them with ISP scenarios based on their differing levels of ambition. GEM's more aggressive forecasts are matched to the *Green Energy Exports* scenario, while CSIRO's less ambitious forecasts align with the *Progressive Change* scenario. For the *Step Change* scenario, AEMO averages the forecasts from CSIRO and GEM for rooftop PV, battery, and Virtual Power Plant (VPP). AEMO claims that the "two consultant forecasts utilise the same underlying assumptions and scenario narratives, and encompass usage patterns and uptake rates."[14]

Contrary to AEMO's claim, there are significant discrepancies in CSIRO and GEM's underlying assumptions which fundamentally influence their respective projections. We focus on two examples:

- **Network constraints**: CSIRO explicitly accounts for hosting capacity constraints in the distribution network as a direct cap on CER uptake.[15]. In contrast, while GEM acknowledges these constraints by projecting curtailment of solar output due to export limits and adjusting uptake in areas with high grid saturation, it does not explicitly model the physical or technical hosting capacity limits of the distribution network as a direct ceiling on CER uptake.
- **Policy assumptions**: GEM's forecasts are shaped by the inclusion of aggressive policy-driven incentives that drive up CER uptake – policy incentives that are not assumed in the ISP. For example, GEM models a national battery rebate, providing a 50% subsidy on battery capital costs starting in 2026 under *Step Change* and *Green Energy Exports* scenarios.[16] It also integrates Australian Carbon Credit Units (ACCUs) as a subsidy mechanism, assuming future reforms that make smaller CER systems eligible.[17] These assumptions significantly boost projected CER uptake, particularly for batteries. CSIRO, by contrast, does not speculate on future policy interventions but simply models uptakes under current policy settings.

The inconsistencies between CSIRO's and GEM's CER projections raise significant concerns about the robustness and coherence of the ISP's CER forecasting approach. These discrepancies also highlight the importance of integrating, endogenising, and co-optimising CER projections within the ISP modelling.

7. Do you agree with AEMO's proposals to improve its hydrogen electrolyser load modelling, or have further enhancements to suggest? Please provide any supporting evidence.

CIS agrees that disaggregating industrial and export demand for hydrogen and adjusting production requirements so they are daily are good changes.

While applying minimum utilisation factors is a step in the right direction, recent developments in Hydrogen suggest that it faces significant barriers to commercial viability not reflected in existing modelling. Many large projects are currently being cancelled or deferred indefinitely despite government policy commitments, and it is not clear that any Hydrogen electrolyser load will materialise any scale. It seems particularly unlikely that any Hydrogen demand will be economically viable at low capacity factors, allowing it to behave flexibly and absorb surplus electricity at times convenient to the grid.

Essentially, we believe that it is incumbent on the proponents of hydrogen to demonstrate that the technology is feasible

8. What are your views on AEMO's proposal to test previously-actionable projects for actionability at the project proponent's timing within the actionable window, and at a later re-start timing?

The CIS considers the proposal to test projects at the proponent's timing and a restart timing as a major improvement, and commends AEMO on the proposal.

We nonetheless continue to encourage AEMO to revert to the old actionable window method such that it does not continuously expand. Alongside this, the AER and AEMC should develop appropriate processes to allow, as far as is appropriate, for the RIT-T process to be continued rather than restarted where a project regains actionable status after losing it. This way, an expanding window is not required, and "symmetry" would be restored to actionable/non-actionability. At the moment it is asymmetric because a project only needs to be actionable for one year to be kicked off, and then has an ever-expanding window within which it will be considered actionable.

We note that the AER indicated in the consultation to the previous changes to the actionable window that restarting the RIT-T process "may" be required. These changes reinforce the idea that a restart would certainly be required.

9. Do you agree with AEMO's approach to model storage devices with headroom and footroom energy reserves and imperfect energy targets in the time-sequential modelling component? What improvements should be made to model energy storage limits to better reflect actual behaviour and address issues of 'perfect foresight'? Please provide any supporting evidence.

The CIS considers including headroom and footroom energy reserves and imperfect energy targets as a step in the right direction. However, the ISP should also model profit-maximising behaviour, and fix the problem of perfect foresight for capacity expansion.

Consumer batteries in VPPs and large-scale storage operators are interested in maximising profit rather than minimising total system costs. This means they will operate their storage assets to maximise profit, which will cost consumers more than the model indicates if it assumes storage is available at the convenience of the grid.

Battery capacity expansion because the methodology perfectly times large-scale battery construction and retirement so that extra storage capacity is available for apparently cloudy future years, before it drops off just afterwards.

The 2024 ISP, there is a noticeable drop in average solar capacity factor in 2030-31 and 2044-45 (Figure 1). These years presumably represent past weather years with cloudy conditions. By 2044-45, the ISP model has phased out coal so storage becomes much more important for grid reliability. The storage capacity forecast in the ISP grows steadily before declining slightly for a few years after 2044-45 (Figure 2).

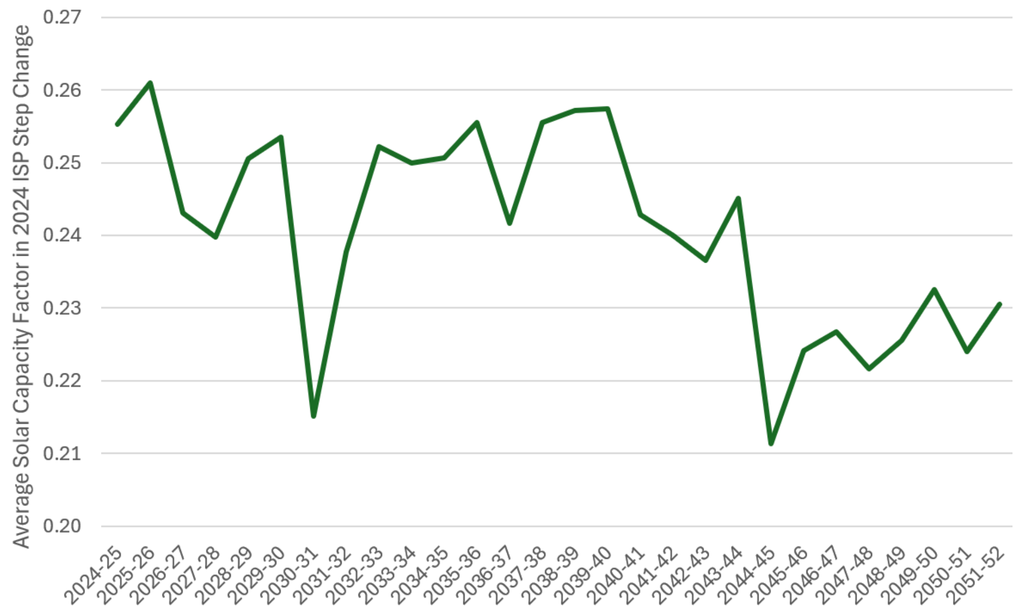

Figure 1. Average capacity factor of all solar farms in 2024 ISP Step Change ODP.

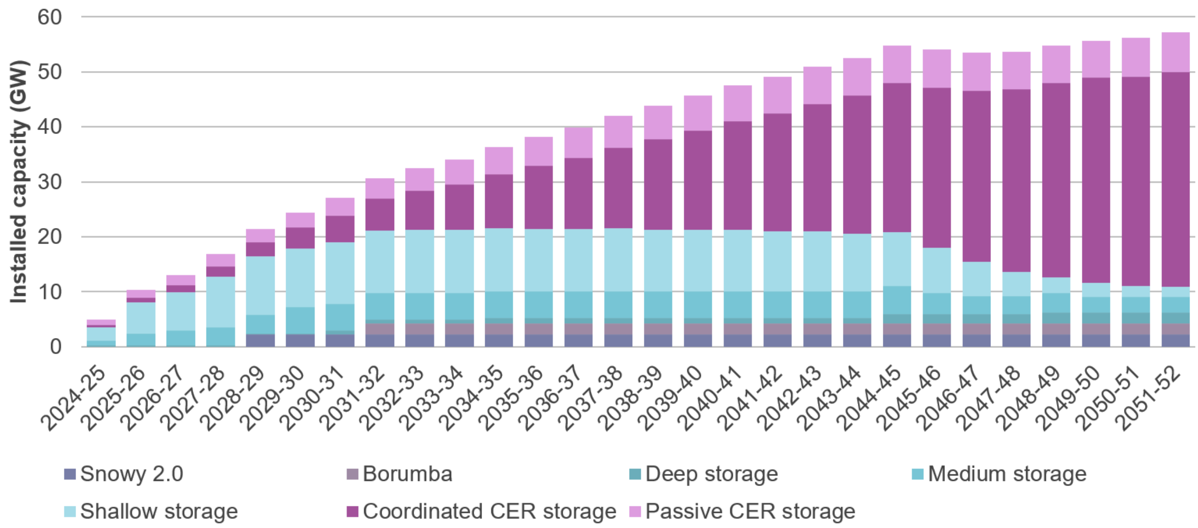

Figure 2. 2024 ISP forecast for NEM storage capacity in GW by year under Step Change.

This occurs mostly as a result of shallow storage capacity dropping significantly immediately following the ‘bad weather’ year, falling from 10.5 GW in 2044-45 to 4.5 GW in 2047-48 and then 1.8 GW by 2051-52. This represents the mass-retirement of batteries built between 2025-26 and 2030-31, as they have an assumed economic life of 20 years. Battery capacity is therefore built to ensure the grid survives the ‘bad weather’ year in 2044-45 and then is retired without replacement shortly after, leading to a dip in total storage capacity for the following three years.

Realistically, battery capacity buildout should not be fine-tuned to a particular set of weather sequences. Instead, capacity should be built for each year to ensure demand can always be met regardless of when the ‘worst’ weather occurs.

When batteries run out in such a situation, the grid will still need backup to ensure blackouts. It is yet to be proven that this will not involve building dispatchable generation capacity to meet 100% of demand.

Responses to consultation paper proposals without questions

The CIS tentatively agrees with the proposed approach, and would like to see the method clarified further.

It is essential that AEMO make a clear distinction between the costs and benefits of interconnection and renewable energy zone capacity expansion.

In the information provided to us, including the clarification made by email, it's now clear that this has not been done in the past. This is a significant flaw in the ISP, as there has been considerable testimony before the Senate EPRA committee (for example from Professor Bruce Mountain) to suggest that the case for interconnection is not credible.

To the extent that previously interconnector projects have included benefits that are derived from expansion of renewable energy capacity, with no alternative development which allows for just the expansion of capacity without the long-distance interconnection, the business case to support interconnection projects has been artificially inflated. This is because no credible alternative which allows the separated investments to be tested was allowed.

To the extent that the proposed change does remediate this shortcoming, it is welcomed.

REZ Transmission Constraints

The CIS supports the ISP considering import constraints for REZs if loads are co-located. However, we do not agree that loads should be deemed "dispatchable" if imports are required to power them. The only named example of hydrogen electrolysers is unlikely to be dispatchable, as the business case for hydrogen typically requires the plant to be operating near-continuously, as explained in the section above.

---

[1] AEMC 2024, Rule determination – National Electricity Amendment (Bringing early works forward to improve transmission planning) Rule 2024, p. i.

[2] ECMC 2023, Terms of Reference – Review of the Integrated System Plan, p. 1. https://www.energy.gov.au/energy-and-climate-change-ministerial-council/energy-ministers-publications/review-integrated-system-plan

[3] DCCEEW 2024, *Review of the Integrated System Plan: Final Report*, Department of Climate Change, Energy, the Environment and Water, Canberra

[4] ECMC 2024, *Response to the Review of the Integrated System Plan*, p. 6.

[5] Centre for Independent Studies. 2024. "Submission to Draft 2024 Integrated System Plan." https://www.cis.org.au/publication/submission-to-draft-2024-integrated-system-plan/.

[6] Hughson, Bev, Craig Memery, Mark Grenning and Mark Henley. 2023. "ISP Consumer Panel Report on AEMO's Inputs Assumptions and Scenarios Report (IASR) for the 2024 Integrated System Plan – Final Report". 2024 ISP Consumer Panel. https://aemo.com.au/-/media/files/major-publications/isp/2023/isp-consumerpanel-report-on-2023-iasr.pdf?la=en

[7] DCCEEW 2024, *Review of the Integrated System Plan: Final Report*, p. ii.

[8] ECMC 2024, *Response to the Review of the Integrated System Plan*, p. 8.

[9] AEMO 2024, *Integrated System Plan (ISP) Methodology Issues Paper*, p. 23.

[10] DCCEEW 2024, *Review of the Integrated System Plan: Final Report*, p. 26.

[11] DCCEEW 2024, *Review of the Integrated System Plan: Final Report*, p. 80.

[12] The $347.5 billion total capital cost for CER is calculated by multiplying the new capacity of rooftop solar and consumer batteries installed under the Step Change scenario by the projected capital costs based on available data in 2023-24 GenCost. For rooftop solar, GenCost provides annual capital cost forecasts, which we used to project the total capital costs over the period. For consumer batteries, however, GenCost does

not provide a forecast of future costs. It reports the current installation cost at $1,455/kWh (p. 58). As a result, we assumed this installation cost remains constant throughout the projection period for calculating the total capital cost of consumer batteries. If the learning rate of 1-hour utility-scale battery is applied to small-scale battery, this would reduce the total capital cost for CER to $211 billion.

[13] As the ISP does not provide a detailed breakdown of generator and storage capital costs, we estimated the $83 billion by calculating the annual increase in utility solar (GW), deep storage (GWh), medium storage (GWh), and shallow storage (GWh) in the *Step Change* scenario. These annual capacity increases were then multiplied by the corresponding capital costs from the 2023-24 GenCost report to derive the total capital cost for large-scale solar and batteries up to 2050.

[14] AEMO, *2023 Inputs, Assumptions and Scenarios Report*, p. 68.

[15] CSIRO 2022, *Small-scale solar PV and battery projections 2022*, p. 20.

[16] GEM 2023, *Projections of distributed solar PV and battery uptake for AEMO*, p. 31.

[17] GEM 2023, *Projections of distributed solar PV and battery uptake for AEMO*, p. 36.