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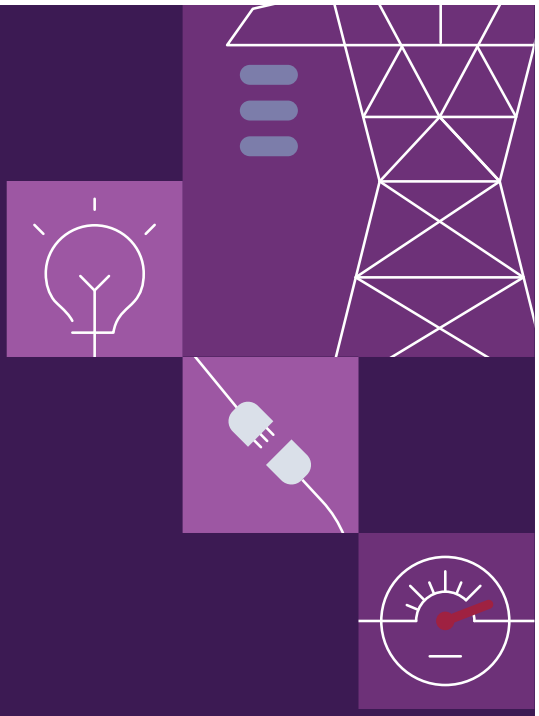

Draft ISP Methodology

Consultation Paper

Published: 13 March 2025

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New South Wales | Queensland | South Australia | Victoria | Australian Capital Territory | Tasmania | Western Australia

Australian Energy Market Operator Ltd ABN 94 072 010 327

We acknowledge the Traditional Custodians of the land, seas and waters across Australia. We honour the wisdom of Aboriginal and Torres Strait Islander Elders past and present and embrace future generations.

We acknowledge that, wherever we work, we do so on Aboriginal and Torres Strait Islander lands. We pay respect to the world's oldest continuing culture and First Nations peoples' deep and continuing connection to Country, and hope that our work can benefit both people and Country.

'Journey of unity: AEMO's Reconciliation Path' by Lani Balzan

AEMO Group is proud to have launched its first Reconciliation Action Plan in May 2024. 'Journey of unity: AEMO's Reconciliation Path' was created by Wiradjuri artist Lani Balzan to visually narrate our ongoing journey towards reconciliation - a collaborative endeavour that honours First Nations cultures, fosters mutual understanding, and paves the way for a brighter, more inclusive future.

Important notice

Purpose

AEMO publishes this consultation paper on a review of the ISP Methodology pursuant to National Electricity Rules (NER) 5.22.8(b) and (d) and the Australian Energy Regulator's *Forecasting Best Practice Guidelines*. This paper attaches a Draft ISP Methodology incorporating changes proposed in this paper, which are consistent with the Australian Energy Regulator's *Cost Benefit Analysis Guidelines*. This paper includes key information and context for the methodology used in AEMO's *Integrated System Plan* (ISP).

Disclaimer

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Executive summary and consultation notice

Published every two years, AEMO's *Integrated System Plan* (ISP) is a roadmap for the transition of the National Electricity Market (NEM) power system. The ISP is underpinned by an integrated approach to energy market modelling and power system analysis, detailed in the *ISP Methodology*, which is used to identify an optimal development path for the NEM.

The publication of this consultation paper commences the second stage of the consultation process conducted by AEMO to review the *ISP Methodology*. This consultation paper is published pursuant to National Electricity Rules (NER) 5.22.8(b) and (d) and in accordance with the Australian Energy Regulator's (AER's) *Forecasting Best Practice Guidelines* (FBPG).

AEMO provides a Draft *ISP Methodology* as an attachment to this consultation paper, incorporating the proposed updates consistent with the AER's *Cost Benefit Analysis Guidelines*. This consultation paper seeks feedback on the draft methodology and includes targeted consultation questions.

AEMO welcomes feedback on the Draft *ISP Methodology* and on the matters considered in this paper.

AEMO thanks stakeholders for their submissions

AEMO has considered all 37 submissions (written and verbal) to the *ISP Methodology* issues paper. A summary of the issues which AEMO considers to be material, and AEMO's response to each issue, are outlined below.

Stakeholder feedback	AEMO's response
AEMO should provide locational signals for **distribution network augmentations that are needed to support CER and other distributed resources**, and should consider co-optimising distribution network investment outcomes against other investment options and CER uptake.	**No change from the issues paper proposal, as locational signals will already be provided by the use of distribution network data** – AEMO proposes to model distribution network capabilities aggregated at the sub-regional level of the ISP model, based on locational data to be provided by distribution networks. AEMO's initial approach will allow for some optimisation of distribution network augmentations in the ISP model to allow higher levels of CER operation and higher uptake of other distributed resources. AEMO expects ISP treatment of distribution network capabilities to be enhanced over successive ISPs, as analysis and data evolve, including considering full co-optimisation of outcomes in future ISPs.
AEMO should assess a range of **gas development** projections, and consider options to include gas infrastructure costs in the ISP assessment process. AEMO should also consult widely and transparently on any **gas information to be incorporated in the ISP**. Further, AEMO should consider the interplay of gas infrastructure with other sectors of the economy and the electricity system as part of the ISP, and should consider whether **gas price treatment** in the ISP should vary across different gas development projections.	**Change proposed compared to the issues paper, to ensure assessment of a range of gas development projections and enhanced cross-sector integration** – AEMO has adjusted the proposed interaction between the gas supply development model and the electricity sector capacity outlook model to enhance integration between the sectors across the models. AEMO will consider whether there is likely to be an impact on gas prices across different gas development projections, and will incorporate gas infrastructure costs in the identification and selection of the projections. AEMO remains committed to extensive and transparent consultation throughout the ISP development process, including on gas inputs for the 2026 ISP.
Mixed views were expressed on **testing previously actionable projects** only at the **project proponent's timing within the actionable window, and after a new 'restart timing'**. Some stakeholders	**Change proposed compared to the issues paper, by avoid the ambiguity introduced by the 'restart timing' proposal** – While AEMO continues to propose that the *ISP Methodology* only test previously actionable projects at the project proponent timing and at timings beyond the actionable window,

Stakeholder feedback	AEMO's response
suggested AEMO should revert to the original definition of a fixed two-year actionable window which does not expand with consecutive ISPs, and some noted the ambiguity introduced by the 'restart timing' proposal.	AEMO agrees with stakeholders that the concept of a 'restart timing' noted in the issues paper introduces ambiguity, and has removed the proposal. AEMO continues to consider that an extendable actionable window for previously actionable projects is appropriate to reflect the time taken to restart regulatory and development approval processes if actionability were removed and the project were paused.
Stakeholders considered that AEMO should address **perfect foresight in the ISP model** by modelling for imperfect foresight via both headroom and footroom reserves, and the proposed energy planning with error approach.	**No change from the issues paper proposal, as the original proposal already included headroom and footroom reserves and an energy planning with error approach** – AEMO's original proposal aligns with stakeholder feedback, and is reflected in the Draft *ISP Methodology*.
No further feedback was received on **period of hydrogen production targets**, and stakeholders held mixed views on how (and if) to apply **minimum utilisation factors for hydrogen electrolysers** in the ISP model. Several stakeholders suggested that assumptions about hydrogen production location should be revisited.	**Change proposed compared to the issues paper, to implement weekly balancing targets in the model for hydrogen electrolysers** –AEMO now proposes to model weekly balancing of hydrogen production targets rather than daily balancing, after further examination of advice received in response to the 2024 ISP. AEMO proposes on balance to retain the application of minimum utlilisation factors. Regarding location of hydrogen loads, AEMO has aligned with stakeholders' views (and a review of external studies), and now proposes to model these loads within renewable energy zones (REZs) unless a location outside of a REZ is already identified for a particular project. This approach reflects that it will be less expensive to pipe hydrogen long distances (to ports or other consumers) rather than to transmit electricity.
Stakeholders recommended enhancements to equations proposed to **model directional REZ transmission constraints**, and supported the improved representation of wind resource diversity in REZs.	**Change proposed compared to the issues paper, to implement stakeholders' proposals to REZ constraint expression in the model** – AEMO will adopt the stakeholder proposal to include the explicit impacts of major transmission flowpaths within the modelling of REZ transmission network constraints, and clarifies that the proposed constraints do not presume that all load connected within a REZ is dispatchable.
Stakeholders noted the risk that **unit commitments for synchronous generators, and assumptions about the use of alternative system security service providers**, may lead to the model over-planting alternative providers and that lead time delays on key equipment such as synchronous condensers may not be appropriately incorporated.	**Change proposed compared to the issues paper, to address stakeholders' concerns about the risk of system security service delivery timelines and technology mix** – AEMO's previous approach used synchronous condensors as a proxy for system strength costs in meeting both minimum and efficient system strength requirements. AEMO now proposes to address stakeholder feedback by applying a retirement cost adjustment to thermal units to capture minimum fault level remediation costs, and applying a separate cost adjustment to the capital cost of future developments to reflect stable voltage waveform remediation needs. Both cost trajectories include technology mix and lead-time assumptions, as consulted on through the *Inputs, Assumptions and Scenarios Report* (IASR).

AEMO is now proposing eight key updates to the ISP Methodology

The proposed *ISP Methodology* to be applied for the 2026 ISP includes the following updates, compared to the current version applied for the 2024 ISP:

- **Adjusting the sub-regional topology and sub-regional electricity demand allocation approach** to follow the proposal in the Draft 2024 *Electricity Demand Forecasting Methodology*.
- **Introducing representation of distribution network capacity**, and opportunities for increased levels of consumer energy resources (CER) operation and higher uptake of other distributed resources.

- **Expanding the gas supply model** to determine gas development projections, including project developments from the *Gas Statement of Opportunities* (GSOO) and potential further investment options such as gas network, storage and supply augmentation opportunities.
- **Testing transmission projects previously identified as actionable** at the project proponent's timing within the actionable window, and beyond the actionable window, to determine the optimal timing of projects in development paths. This will help align the ISP and ISP Feedback Loop process with the latest proponent advice.
- **Modelling future hydrogen electrolysers within a renewable energy zone (REZ) rather than at a port**, to reflect the current market understanding that it is generally a lower cost to pipe hydrogen than transmit electricity.
- **Implementing 'imperfect foresight' in the model for storage devices** to better reflect what may happen in reality, using headroom and footroom reserves for devices as well as deliberate 'energy planning with error'.
- **Adjusting representation of transmission network capabilities for REZs** to better reflect the treatment of large dispatchable loads, wind diversity across geographically large REZs, and the impact of nearby transmission flow paths.
- **Applying a minimum synchronous unit constraint to reflect replacement asset lead times**, while also applying system security remediation costs that evolve with technology advancements and account for changes to power system security as renewables connect and fossil fueled generators retire.

Consultation notice

All stakeholders are invited to provide a written submission on any matters discussed in this consultation paper, or in the attached Draft *ISP Methodology*. AEMO has also provided guidance consultation questions below for reference. **Submissions should be sent via email to ISP@aemo.com.au and are required to be submitted by 5:00 pm (AEST) Monday 14 April 2025**.

Consultation questions

1. Do you agree with AEMO's proposal for the *ISP Methodology*, considering responses to stakeholder feedback received from the *ISP Methodology* issues paper and the scope and limitations of the ISP modelling process described in this consultation paper? If not, what alternatives do you suggest?
2. What further enhancements could be made to the *ISP Methodology*, considering the scope and limitations of the ISP modelling process described in this consultation paper?

Submissions may make alternative or additional proposals you consider may better meet the objectives of this consultation and the National Electricity Objective in Section 7 of the National Electricity Law. Please include supporting reasons or evidence.

Before making a submission, please read and take note of AEMO's consultation submission guidelines, which can be found at https://aemo.com.au/consultations. Subject to those guidelines, submissions will be published on AEMO's website.

Please identify any parts of your submission that you wish to remain confidential, and explain why. AEMO may still publish that information if it does not consider it to be confidential, but will consult with you before doing so. Material identified as confidential may be given less weight in the decision-making process than material that is published.

Submissions received after the closing date and time will not be valid, and AEMO is not obliged to consider them. Any late submissions should explain the reason for lateness and the detriment to you if AEMO does not consider your submission.

Prior to submissions closing, AEMO will host a 90-minute webinar from 3:30 pm to 5:00 pm (AEDT) on Thursday 3 April 2025. At the webinar, AEMO will present the key changes proposed for the update to the *ISP Methodology*, and and allow time for questions. Stakeholders can register to attend the webinar here.

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1. Consultation process

This consultation paper has been prepared for the second stage of the consulation being conducted by AEMO to review its *ISP Methodology*, in accordance with the Australian Energy Regulator's (AER's) *Forecasting Best Practice Guidelines* (FBPG)[1].

This paper outlines how AEMO has taken stakeholder feedback into account in its preparation of the Draft *ISP Methodology*, and seeks any further feedback before the methodology is finalised and applied for the delivery of the 2026 *Integrated System Plan* (ISP). This section provides the stakeholder consultation process for this review, and the overall 2026 ISP development process.

1.1. Stakeholder consultation process

The FBPG require the *ISP Methodology* to be reviewed through a two-stage consultation process at least every four years in accordance with the consultation procedures in Appendix A of the FBPG. The *ISP Methodology* was most recently consulted on through a single-stage process in March 2023, and was originally established in July 2021.

This paper considers feedback received from stakeholders in response to the *ISP Methodology* issues paper and proposes changes to the *ISP Methodology*, a marked up version of which is released for consultation alongside this consultation paper. This document uses terms defined in the National Electricity Rules (NER), which are intended to have the same meanings.

AEMO's process and expected timeline for this consultation is outlined below. Future dates may be adjusted and additional steps may be included as needed, as the consultation progresses. In the event that these dates change, AEMO will clearly identify the timeline on the webpage for this consultation[2].

Table 1 Consultation process and timeline

Consultation steps	Dates
Issues paper published	23 October 2024
Post-publication webinar	1 November 2024
Consumer advocate verbal submission	20 November 2024
Submissions closed on issues paper consultation	22 November 2024
Draft *ISP Methodology* and Consultation Paper published	13 March 2025
Post-publication webinar	3 April 2025
Submissions due on Draft *ISP Methodology* consultation	14 April 2025
Final *ISP Methodology* and Consultation Summary Report published	25 June 2025

AEMO's consultation webpage for the *ISP Methodology*[3] contains all previous published papers and reports, written submissions, and other consultation documents or reference material.

[1] AER. Forecasting Best Practice Guidelines. August 2020, at https://www.aer.gov.au/system/files/AER%20-%20Forecasting%20best%20practice%20guidelines%20-%2025%20August%202020.pdf.

[2] At https://aemo.com.au/consultations/current-and-closed-consultations/2026-isp-methodology.

[3] At https://aemo.com.au/consultations/current-and-closed-consultations/2026-isp-methodology

In response to the *ISP Methodology* issues paper released on 23 October 2024, AEMO received 37 published submissions, including verbal submissions from four consumer advocates, and one confidential submission. Stakeholders who provided non-confidential submissions are listed in Table 2.

Table 2 Stakeholders who provided submissions

Submissions		
ACT Government	Clean Energy Council (**CEC**)	Institute for Energy Economics and Financial Analysis (**IEEFA**)
Alan Pears	Climateworks Centre (**Climateworks**)	**ISP Consumer Panel**
Alliance of LDES Companies	**Coalition for Community Energy**	Justice and Equity Centre (**JEC**)
Andrew Fletcher and Huyen Nguyen (**Fletcher and Nguyen**)	**CS Energy**	**Lighter Footprints**
Anne Smith	Darebin Climate Action Now (**DCAN**)	**Martin Kamener**
APA Group	**David Close**	**Nexa Advisory**
Ausgrid	**EnergyAustralia**	Origin Energy (**Origin**)
AusNet Services (**AusNet**)	Energy Consumers Australia (**ECA**)	Powerlink Queensland (**Powerlink**)
Australian Gas Industry Group (**AGIG**)	**Environment Victoria**	SA Power Networks (**SAPN**)
Australian National University (**ANU**)	Ergon Energy and Energex (**Ergon and Energex**)	Sumitomo SHI FW Energia Oy (**Sumitomo**)
Australian Pipelines and Gas Association (**APGA**)	**Essential Energy**	**Transgrid**
Centre for Independent Studies (**CIS**)	**Etrog Consulting**	
Centre for New Energy Technologies (**C4NET**)	**Hydro Tasmania**	

AEMO thanks all stakeholders for their feedback on proposed changes to date, which have been considered in preparing this consultation paper, and looks forward to further engagement. A summary of material issues raised in submissions, and AEMO's response, is detailed in Section 3 and Section 4 of this paper.

As part of the 2025 *Inputs, Assumptions and Scenarios Report* (IASR) scenarios consultation undertaken in 2024[4], AEMO received feedback from a number of stakeholders relevant to the review of the *ISP Methodology*. The themes of this feedback were also raised across the submisions received in response to the *ISP Methodology* issues paper, and so are responded to in this draft report. The relevant stakeholder feedback provided to the 2025 IASR scenarios consultation, and section references for this draft report where these issues are addressed by AEMO in response to *ISP Methodology* issues paper submissions, are as follows:

- **CIS** suggested that consumer energy resources (CER) forecasts should be co-optimised alongside large-scale generation and storage in the ISP model, given the high proportion of CER as a total of projected new generation and storage capacity in the 2024 ISP (Section 4.1).

[4] AEMO released a consultation paper in July 2024 seeking feedback on how the 2023 IASR scenarios should evolve to best fit the purpose of modelling Australia's energy future. Submissions were requested by August 2024. The consultation paper and submissions are available via https://aemo.com.au/consultations/current-and-closed-consultations/2025-iasr-scenarios-consultation.

- Several stakeholders (**Iberdrola Australia**, **Hydro Tasmania**, **Etrog Consulting**, **CIS**, **ISP Consumer Panel**) requested analysis of mitigations for risks facing 'critical' projects to support government energy and emisisons reduction policies, and/or analysis of alternate scenarios under which government policies are not met (Section 4.3).

1.2. 2026 ISP development process

The *ISP Methodology* developed for the 2026 ISP may also be used in the 2028 ISP and ISP updates. Figure 1 shows the process to develop the ISP, and current progress on all elements for the 2026 ISP[5].

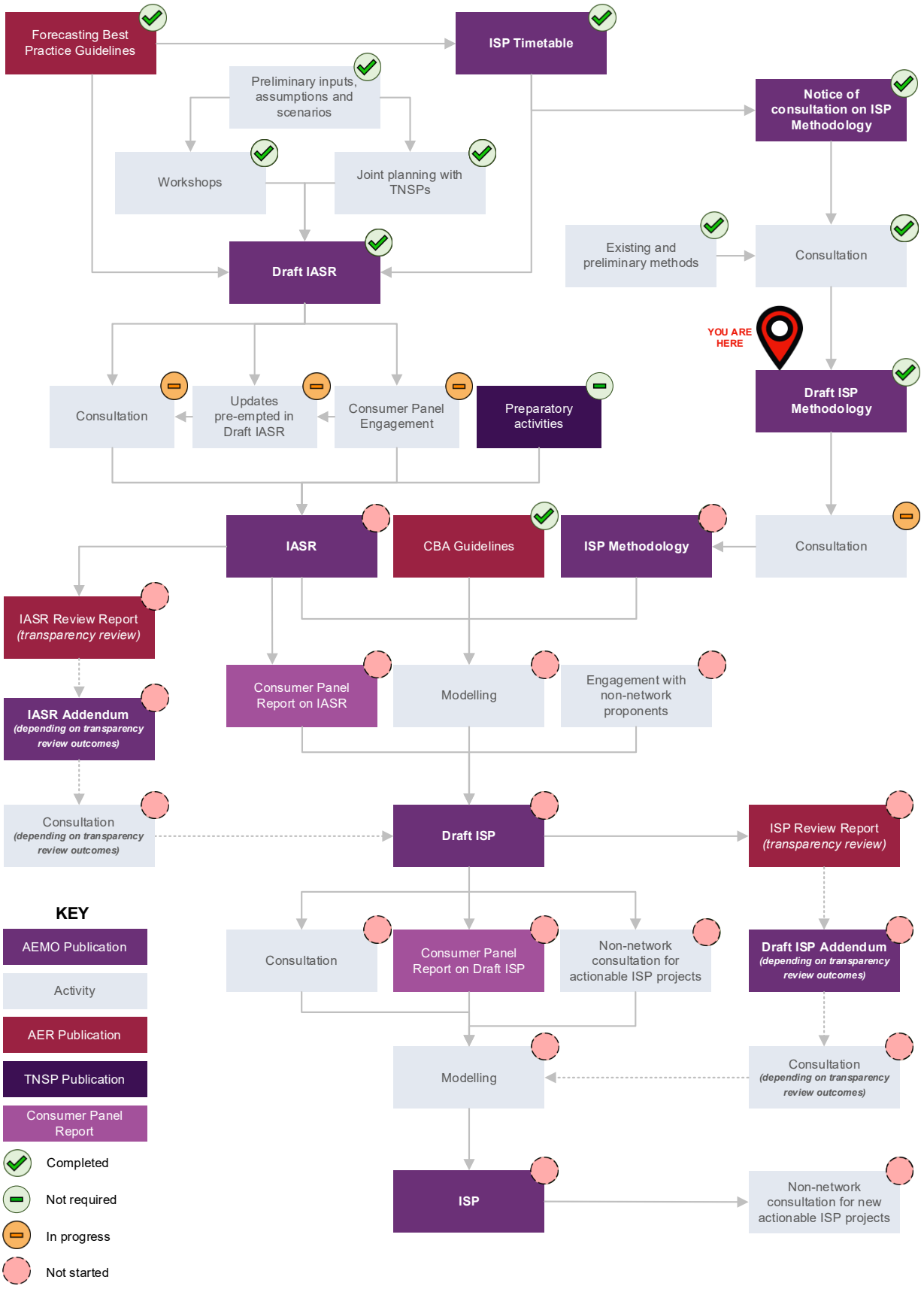
Before developing and consulting on the Draft 2026 ISP, AEMO is required to:

- **Consult on inputs, assumptions and scenarios** – AEMO received consultation submissions from 36 stakeholders on Stage 1 of the Draft 2025 *Inputs, Assumptions and Scenarios Report* (IASR), and is currently consulting on Stage 2 of the Draft 2025 IASR. AEMO will also release the Draft 2025 *Electricity Network Options Report* on 16 April 2025, for consultation. AEMO will publish the final versions of these reports with accompanying consultation summary reports in July 2025.
- **Consult on the *ISP Methodology*** – AEMO received 37 stakeholder submissions on the *ISP Methodology* issues paper that was published in October 2024. AEMO released the Draft *ISP Methodology*, which accompanies this consultation paper, on 13 March 2025. The final version will be released on 25 June 2025.
- **Demand-side Factors Information Guidelines issues paper –** the Australian Energy Market Commission's (AEMC's) final rules determination on improving consideration of demand-side factors in the ISP[6] requires that AEMO publish guidelines to drive a more consistent approach to the collection of relevant information, by December 2025. AEMO is currently assessing when it will undertake consultation on the guidelines.

[5] The 2026 ISP Timetable provides more information on the key milestones of the 2026 ISP development process, at https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2026-integrated-system-plan-isp.

[6] AEMC. *Improving consideration of demand-side factors in the ISP. Final determination*, December 2024. At https://www.aemc.gov.au/rule-changes/improving-consideration-demand-side-factors-isp.

Figure 1 Navigating the ISP process



2. Background

The *ISP Methodology* was first released in 2021, and was updated in 2023. This current consultation provides an opportunity to ensure that the ISP modelling and cost benefit assessment processes are fit for purpose in the context of the ongoing energy transition. The scope includes implementation of changes needed to deliver on the outcomes of the Australian Energy Ministers' *Response to the Review of the Integrated System Plan*[7] (Response to the ISP Review), including new rules made by the AEMC.

In this section:

- Section 2.1 provides context for this consultation.
- Section 2.2 sets out a brief overview of the current ISP modelling approach.
- Section 2.2 discusses the Federal Government's ISP Review.
- Section 2.4 notes matters which are not considered within the scope of this consultation, and why.

2.1. Context for this consultation

Published every two years, AEMO's ISP is a roadmap for the transition of the power system that underpins the National Electricity Market (NEM), with a clear plan for essential infrastructure that will meet future energy needs. The ISP draws on a comprehensive set of inputs, including all relevant federal and state government policies for emissions reduction, and the ISP modelling seeks the optimal mix of generation, storage and network infrastructure investment.

Australia's energy transition has accelerated significantly since the release of the first ISP in 2018, and the first *ISP Methodology* in 2021. Growth in new rooftop solar systems has averaged 12% year on year over the past five years, and these resources contributed more electricity to the grid in the fourth quarter of 2024 (17%) than did grid-scale solar, wind, hydro or gas. In 2024, large- and small-scale renewables accounted for almost 39% of the total electricity delivered through the NEM, compared to around 31% in 2021.

In 2024, Energy Ministers endorsed the findings of the Federal Government's review of the ISP (ISP Review), which considered how the ISP could "best support the energy transformation" in the NEM. Actions out of the review are intended to expand the scope of the ISP to include enhanced incorporation of gas market conditions and further consideration of demand-side opportunities.

This consultation provides an opportunity to ensure that the modelling and cost benefit analysis approaches used to prepare the ISP remain fit for purpose, and to incorporate the outcomes of the Federal Government's ISP Review.

2.2. ISP modelling overview

AEMO's current *ISP Methodology* sets out the methodologies for the:

- **Modelling applied in the ISP.** This includes the capacity outlook model, time-sequential model, gas supply model and power system assessments.

[7] At https://www.energy.gov.au/sites/default/files/2024-04/ecmc-response-to-isp-review.pdf.

- **Cost-benefit analysis used in the ISP.** This includes:
  - AEMO's approach to applying the steps outlined in the AER's Cost Benefit Analysis (CBA) Guidelines.
  - Differentiating scenarios and sensitivities and their treatment in informing the optimal development path (ODP).
  - Outlining the use of scenario weights to determine the ODP.

The combination of the processes described above leads to the determination of the ODP for an ISP.

The preparation of fixed and modelled inputs is not consulted on as part of the *ISP Methodology*. Instead, these are covered extensively in AEMO's IASR consultation processes and the *Electricity Demand Foreasting Methodology*.

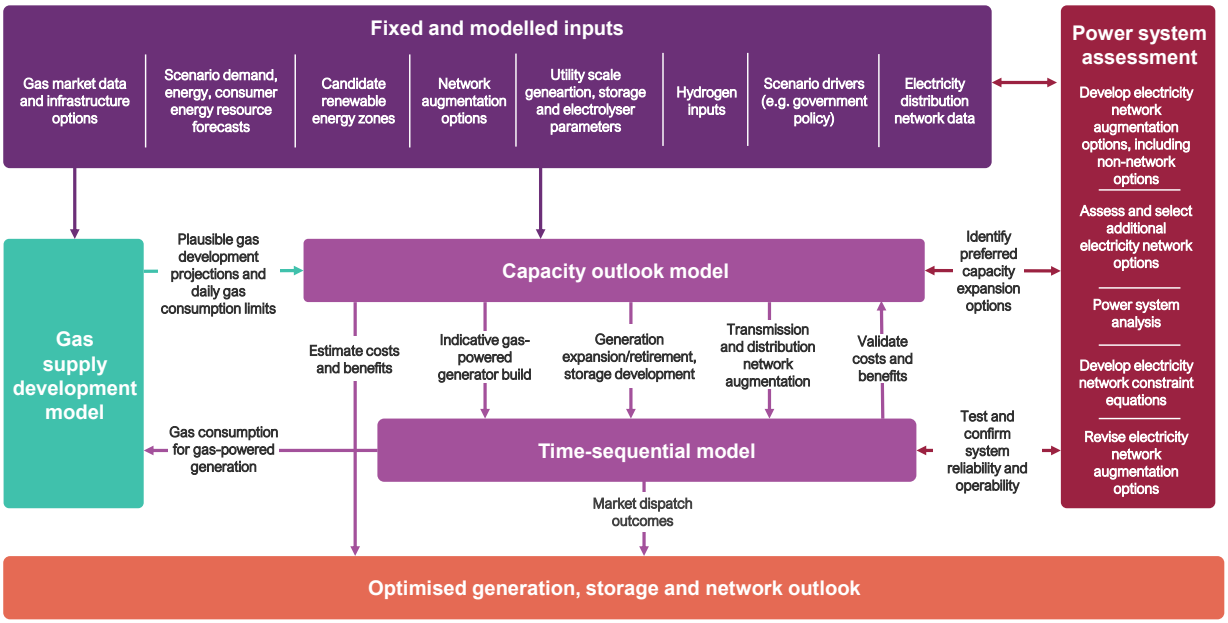
In this consultation paper, AEMO proposes to retain the overarching modelling approach in the current *ISP Methodology*, with some key enhancements to incorporate the outcomes of the ISP Review.

Figure 2 provides an overview of the proposed ISP modelling methodology. The overall ISP process is an iterative approach, where the outputs of each of the different models or analytical processes are used to determine or refine inputs into the other models and processes. Using the colours shown in Figure 2:

- The **fixed and modelled inputs** and **consulted-on inputs** are the inputs, assumptions and scenarios published in the IASR. These are influenced by earlier power system assessments used to describe the existing capability of the NEM and to develop a set of network and non-network development options.
- The **capacity outlook** model (Section 2 of the *ISP Methodology*) uses all the available inputs to develop projected generation, transmission, distribution to increase opportunities for distributed resources, generation retirement, and dispatch outcomes in each of the ISP scenarios. The aim when doing so is to minimise capital expenditure and operational costs over the longterm outlook while achieving the objectives (social, political, and economic) within each scenario.
- The **time-sequential** model (Section 3 of the *ISP Methodology*) then optimises electricity dispatch for every hourly or half-hourly interval. In so doing, it validates the outcomes of the capacity outlook model and feeds information back into it. The model is intended to reflect participant behaviour hour-by-hour, including generation outages, to reveal performance metrics for both generation and transmission.
- The **gas supply development** model (Section 4 of the *ISP Methodology*) identifies gas infrastructure limitations and gas development projections to be used in the capacity outlook and time-sequential models.
- The **power system assessment** (Section 5 of the *ISP Methodology*) tests the capability outlook and time-sequential outcomes against the technical requirements for the power system (network constraints, security, strength, inertia) as well as assessing future marginal loss factors (MLFs) to inform new grid connections. These assessments feed back into the two models to continually refine outcomes.
- The **cost-benefit analyses** (Section 6 of *ISP Methodology*) test each individual scenario and development plan considered by the ISP to determine the ODP and test its robustness.

Further detail on the components of the *ISP Methodology* that would be affected by the proposed changes is discussed in Section 3 of the *ISP Methodology* issues paper[8].

Figure 2 Overview of proposed ISP modelling methodology



2.3. Federal Government's ISP Review

Over 2023 and early 2024, the Federal Government undertook a review of the ISP[9], and on 5 April 2024, the Energy and Climate Change Ministerial Council published the Energy Ministers' Response to the ISP Review[10]. The response outlined a series of actions to enable the ISP to set a direction for the energy system as a whole, while maintaining the critical function of the ISP in transmission planning.

The ISP Review focused on supporting emissions reduction, integrating gas and electricity planning, enhancing demand considerations, transformation of Australia's energy mix, jurisdictional policy interactions, and the timely delivery of ISP projects.

In December 2024, the AEMC published final determinations on changes to the NER and National Gas Rules (NGR) to implement aspects of the review of the ISP:

- For **improving consideration of demand-side factors in the ISP**[11], the rules now require AEMO to publish a demand-side factors statement in the ISP (and information guidelines to explain which categories of information will be collected to inform the statement and how the information will be collected). In addition, the rules place an obligation on distribution network service providers

[8] At https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2024/2026-isp-methodology/isp-methodology-issues-paper.pdf.

[9] Australian Government, Department of Climate Change, Energy, the Environment and Water. *Review of the Integrated System Plan – Final Report*, January 2024. At https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Energy_Planning_and_Regulation_in_Australia/EnergyPlanning/Additional_Documents.

[10] At https://www.energy.gov.au/sites/default/files/2024-04/ecmc-response-to-isp-review.pdf.

[11] AEMC. *Rule determination. National Electricity Amendment (Improving consideration of demand-side factors in the ISP) Rule 2024*, December 2024. At https://www.aemc.gov.au/rule-changes/improving-consideration-demand-side-factors-isp.

(DNSPs) to provide relevant information to AEMO for the statement, and AEMO is required to publish the information provided by DNSPs.

- For **better integration of gas and community sentiment into the ISP**[12], the rules now enable AEMO to access, use and disclose specified gas information collected under the NGR, subject to confidentiality provisions, to expand and deepen gas analysis included in the ISP. The information will be used by AEMO to develop gas development projections that will be included in the ISP. No rule changes were made for enhancing inclusion of community sentiment information in the ISP, as the AEMC considers that existing rules and joint planning processes between AEMO and transmission network service providers (TNSPs) are already sufficient for this purpose.

As the final rules were ultimately broadly consistent with the draft rules published by the AEMC for consultation, AEMO considers that the options included in the *ISP Methodology* issues paper, which aligned with the draft rules requirements, can now be progressed for further consideration in this draft report without a further consultation period. That is, AEMO considers that the feedback on the issues paper options is relevant for both the draft and final rules determinations These matters are further explored and refined in this Consultation Paper, including responding to stakeholder feedback received in response to the *ISP Methodology* issues paper.

AEMO also welcomes any feedback from stakeholders in response to this Consultation Paper, for example if the final rule in December 2024 raises further stakeholder views on any necessary or desirable changes to the *ISP Methodology*.

Not all endorsed actions or new rules resulting from the Review of the ISP will require a change to the *ISP Methodology* to be implemented. Table 3 shows the publications that AEMO proposes to amend to address each ISP Review action or rule change, to help inform engagement by stakeholders on appropriate publications.

Table 3 Proposed implementation for actions in the Energy Ministers' Response to the ISP Review

Action in the response to the Review of the ISP	Process for implementation				
	2025 IASR	*ISP Methodology*	2025 *Electricity Network Options Report*[A] and 2025 *Gas Infrastructure Options Report*	*Enhanced Locational Information* report[B]	Draft ISP and final ISP
Integrating gas into the ISP	✔	✔	✔		✔
Enhanced demand forecasting and optimising for the demand-side	✔	✔	✔		✔
Better data on industrial and consumer electrification					✔
Coal-fired generation shutdown scenarios					✔

[12] AEMC. *Final report. National Electricity Amendment (Better integration of gas and community sentiment into the ISP) Rule 2024 and National Gas Amendment (Better integration of gas and community sentiment into the ISP) Rule 2024*, December 2024. At https://www.aemc.gov.au/rule-changes/better-integration-gas-and-community-sentiment-isp-0.

Action in the response to the Review of the ISP	Process for implementation				
	2025 IASR	*ISP Methodology*	2025 *Electricity Network Options Report*[A] and 2025 *Gas Infrastructure Options Report*	*Enhanced Locational Information* report[B]	Draft ISP and final ISP
Improving locational information				✔	✔
Enhanced analysis of system security	✔	✔			✔
Jurisdictional policy transparency	✔[D]				✔
Clarifying policy inclusions	✔[D]				✔
Improving the accessibility of the ISP[C]	✔				✔
Incorporating community sentiment			✔		✔
Additional planning inputs	✔				✔

A. The *Electricity Network Options Report* is consulted on as part of the IASR. This was previously known as the *Transmission Expansion Options Report*, but has been renamed to reflect the inclusion of both transmission and distribution in future ISPs.
B. The *Enhanced Locational Information* report provides a consolidated set of locational information about where to locate projects in the NEM.
C. AEMO will consider opportunities throughout the ISP development process to enhance consumer understanding of key elements.
D. These actions are to be implemented, in parallel with the IASR process, through the publication of a guideline on AEMO's policy inclusion consultation process with jurisdictions.

2.4. Related consultation processes

This consultation is limited to matters AEMO needs to consider to determine any revisions to the *ISP Methodology*. There is a range of matters relating more generally to the ISP which should be considered through other processes, such as consulation on inputs and assumptions, or consultation on a Draft ISP, rather than through consultation on the *ISP Methodology*. Figure 1 (in Section 1.2) shows consultation opportunities through the ISP development process.

An example of a change that is out of scope of this consultation would be whether AEMO should run a particular new sensitivity analysis. The *ISP Methodology* already broadly outlines how AEMO may conduct sensitivity analyses, and how such analysis is considered in selecting the ODP. However, the specifics of individual sensitivities to be conducted, including parameters to vary and their justification, are considered through other processes including through the consultations on the Draft IASR and Draft ISP.

3. List of material issues

The key material issues arising from stakeholder submissions in response to the *ISP Methodology* issues paper are listed in the following table.

Table 4 List of material issues

No.	Issue	Description	Raised by
1.	CER, distributed resources, and distribution network capabilities	• Clarify approach to integrate distribution network capabilities into the ISP model and how this will be compared with trade-offs of investment in transmission and other generation technologies. • Multiple stakeholder suggestions for sourcing distribution level data and augmentation options including existing regulatory investment test for distribution (RIT-D) projects, consideration of non-network options and demand-side participation. • Recommend CER uptake to not be considered as a fixed input to account for uncertainty of CER uptake growing at the forecast rate.	Alan Pears, Anne Smith, Ausgrid, AusNet, C4NET, CIS, CS Energy, ECA, Essential Energy, Etrog Consulting, Hydro Tasmania, IEEFA, ISP Consumer Panel, JEC, Martin Kamener, Origin, SAPN, Sumitomo, Transgrid
2.	Gas-powered generation (GPG) and infrastructure	• Consider cost of gas sector investments when modelling a least-cost pathway for the electricity sector. • Develop more than one gas development projection per scenario including an additonal conterfactual. • Evaluate trade-offs between gas and electricity sector over a long-term horizon and account for emission reductions when assessing competing options.	ACT Government, AGIG, Alan Pears, Alliance of LDES Companies, Anne Smith, APA, APGA, Ausgrid, CEC, CIS, Climateworks, Coalition for Community Energy, CS Energy, David Close, DCAN, EnergyAustralia, Environment Victoria, Fletcher and Nguyen, Hydro Tasmania, IEEFA, ISP Consumer Panel, JEC, Lighter Footprints, Nexa Advisory, Origin, Powerlink, Sumitomo, Transgrid
3.	Selecting the ODP	• Mixed views for testing previously actionable projects only at the proponent timing inside the actionable window. • Consider the risk of delays to project delivery date based on historical evidence of delays against developer timeframes and adjusted for increased global demand. • Models a policy non-compliant pathway with higher associated emissions and costs in line with Value of Emissions Reduction.	CIS, Climateworks, CS Energy, EnergyAustralia, JEC, Nexa Advisory, Powerlink
4.	Perfect foresight for the ISP model	• Provide more clarification on proposed approach to modelling energy planning with error and headroom and footroom reserve. • Test the headroom/footroom reserve approach with storage asset operators to determine whether it reflects operational realities. • Model energy reserves as soft constraints such that it is accessible to the market during periods of low reserve or high demand.	Alliance of LDES Companies, ANU, Ausgrid, CEC, CIS, EnergyAustralia, Fletcher and Nguyen, Hydro Tasmania, IEEFA, ISP Consumer Panel, Nexa Advisory, Origin, Powerlink, Sumitomo
5.	Treatment of hydrogen	• Mixed views on application of minimum utilisation factors for hydrogen electrolysers. • Reconsider and clarify assumptions for location of hydrogen production.	AGIG, APGA, CIS, Fletcher and Nguyen, IEEFA, ISP Consumer Panel, Powerlink, Sumitomo, Transgrid

No.	Issue	Description	Raised by
6.	Representation of REZs	• Support for proposed multiple wind resource quality trances for REZs with greater diversity. • Consider load within a REZ to not be dispatchable if required to be fed via import into the REZ.	CEC, CIS, Fletcher and Nguyen, Hydro Tasmania, IEEFA, ISP Consumer Panel, Origin, Powerlink, Sumitomo, Transgrid
7.	System security	• Consider draft outcomes from regional system security regulatory investment tests for transmission (RIT-Ts) and associated delivery timing of synchronous condensers when evaluating replacement of synchronous units. • Suggestions to consider alternate technologies as potential system strength and inertia service providers including repurposed hydro and gas generators.	Alliance of LDES Companies, APA, CEC, CEC, Powerlink, Sumitomo, Transgrid

Each of the material issues in Table 4 and AEMO's response is discussed in Section 4.

A detailed table of additional items of specific feedback raised by stakeholders in written submissions to the consultation paper, with AEMO's responses, is in Section 5.

4. Discussion of material issues

AEMO identified over 150 individual points of feedback across 37 submissions to the *ISP Methodology* issues paper. This section provides a summary of material issues raised in stakeholder submissions, and AEMO's response to each issue, presented in seven broad categories:

- CER, distributed resources, and distribution network capabilities (Section 4.1).
- Gas-powered generation (GPG) and infrastructure (Section 4.2).
- Selecting the ODP (Section 4.3).
- Perfect foresight in the ISP model (Section 4.4).
- Treatment of hydrogen (Section 4.5)
- Representation of REZs (Section 4.6).
- System security (Section 4.7).

4.1. Consumer energy resources, distributed resources, and distribution network capabilities

4.1.1. Issue summary and submissions

In their Response to the Review of the ISP, Energy Ministers agreed with a recommendation for AEMO to enhance demand forecasting in the ISP to improve the consideration of electrification and accessing the benefits of CER and distributed resources.

In particular, Energy Ministers requested analysis on how distribution network investments, programs and plans may impact CER and distributed resources development, as well as inclusion of these findings in the ISP.

In December 2024, the AEMC made a final rule determination[13] to implement this change, including requiring DNSPs to provide relevant information to AEMO, and AEMO to include a demand side factors statement in the ISP, providing information about opportunities for the development of distribution network that AEMO considers consistent with the efficient development of the power system.

In the issues paper for the review of the *ISP Methodology*, AEMO proposed to include analysis of how CER and other distributed resources may be facilitated by distribution network investments. The proposal involved introducing representation of distribution network capabilities and opportunities for CER and other distributed resources in the ISP models. The intention of the proposed changes was ultimately to facilitate the provision of more comprehensive information regarding the utilisation of CER and development of additional distributed resources in the NEM and their role in the power system, as well as to inform distribution network planning.

Distribution network augmentation and co-optimising investment

In general, stakeholders were interested in more detail on how AEMO will model existing distribution network capability and future augmentation potential.

[13] At https://www.aemc.gov.au/rule-changes/improving-consideration-demand-side-factors-isp.

Consideration of hosting capacity and associated infrastructure upgrades was recommended by **Essential Energy** and **Transgrid**, who also suggested 'locational factors' be accounted for when augmentation options are proposed, citing that extra hosting capacity in load centres usually brings more benefit than at other locations. **Powerlink** acknoweldged the difficulty of applying complex and granular information that appropriately represents a distribution network in the ISP model which presents a relatively abstracted view of the underlying power system.

AusNet proposed AEMO consider the projects for which AusNet has conducted regulatory investment tests for distribution (RIT-Ds)[14] as an input, and focus on DNSP network augmentations as outlined in draft or final regulatory proposals to the AER.

C4NET expressed support for AEMO's proposed aggregation of distribution capabilities and augmentation at the sub-regional level to enable a consistent and replicable approach across Australia.

ECA suggested distribution network augmentation to unlock CER should consider a combination of network, non-network and consumer investments and should not be only limited to DNSP network augmentations.

Several submissions recommended varying levels of co-optimisation of distribution investment:

- **AusNet** and the **ISP Consumer Panel** suggested co-optimising distribution augmentation capability with the other CER parameters in the distribution network constraint proposed in the issues paper.
- **CS Energy** and **CIS** recommended AEMO consider co-optimising distribution investments (including incentives) with utility-scale generation and storage, and transmission.
- **Hydro Tasmania** and **CIS** called for AEMO to consider the costs of distribution as they are a highly material part of the cost to consumers, and should not be ignored due to treatment of CER as exogenous.
- **Etrog Consulting** recommended the ISP should include cost of investments required by consumers for CER noting this will allow a more realistic co-optimisation of how people and the grid can work together.
- **ECA** noted any cost benefit analysis involving CER should consider multiple different perspectives from all types of participating consumers.

Data inputs and consideration of CER technologies

The **ISP Consumer Panel** and the **Justice and Equity Centre** highlighted the importance of sufficient data such that modelling of demand-side potential is effective, and suggested that in addition to DNSPs, AEMO seek input from providers of demand response, home batteries, virtual power plant (VPP) services, retailers, and CER infrastructure providers, as well as providers of energy efficiency and energy management systems.

SAPN recommended that AEMO include actionable investments in distributed generation and network capacity at the transmission node identifier in the ODP.

Stakeholders gave feedback on how AEMO should consider the different CER and distributed resource technologies:

[14] At https://www.ausnetservices.com.au/projects-and-innovation/regulatory-investment-test.

- **Powerlink** suggested AEMO explore, test, and demonstrate the impact of each CER component on the system, including the associated trade-offs for transmission.
- **Martin Kamener** recommended AEMO focus analysis on household battery contribution to create certainty around demand-side contribution.
- The **ISP Consumer Panel** called for AEMO to distinguish between, and give attention to, distributed and distribution resources, where they define distribution resources as sub-transmission assets owned and operated by DNSPs, and distributed resources as CER, distributed energy resources (DER), energy efficiency and demand response.

Impacts of forecast CER growth

In general, stakeholders expressed concern around the treatment of CER as a fixed input, considering the uncertainty regarding the pace and scale of uptake that will occur. AEMO's proposed approach to manage this uncertainty was by varying levels of CER uptake across the scenario collection.

Several submissions (**Ausgrid, IEEFA, JEC, Sumitomo**) sought further information on how AEMO will consider the interaction of assumptions around CER growth and distribution network capacity, with a recommendation that the uncertainty around forecast CER uptake be explored, for example via a high CER sensitivity.

Origin and the **ISP Consumer Panel** raised concern about the potential increasing impact of CER curtailment, and **Origin** recommended AEMO consider minimum system load in CER forecasts, as periods of low demand may necessitate CER curtailment. **SAPN** proposed that distribution networks' capability to host CER should be shared annually with AEMO in the form of a 'MW value of peak coincident curtailment', aggregated at the transmission node identifier.

In regard to modelling operational demand to manage existing distribution capacity and minimum demand events, **CS Energy** proposed AEMO consider operational models such as dynamic operating envelopes, while **Ausgrid** recommended consideration of the impact of flexible export limits.

Stakeholders (**Origin**, **Transgrid, Alan Pears**) encouraged AEMO to also consider the likely impacts of consumer behaviour on forecast CER growth, beyond the economic assumptions made in the scenarios. **Anne Smith** suggested that AEMO tailor its models to varied adoption rates of CER based on region-specific factors such as local policies, economic incentives and community engagement levels.

4.1.2. AEMO's assessment

Distribution network augmentation and co-optimising investment

AEMO recognises the merit of **Essential Energy** and **Transgrid**'s preference for 'locational factors' to be accounted for when distribution network augmentations are considered, and agrees that it would make sense for CER hosting in load centres to provide more benefits to the overall system than more sparsely located hosting capacity. AEMO considers that the proposed approach to aggregate distribution network capabilities at the sub-regional level in the ISP model provides a pragmatic way to apply locational signals in the model, particularly for this first inclusion of distribution network data in the ISP, while stopping short of replicating the full locational diversity of the distibution networks in the NEM.

AEMO agrees that, as noted by **Powerlink**, representing the full diversity of the distribution networks in the ISP model is not currently a practical endeavour. AEMO is continuing to consider how best to represent the underlying local details about DNSPs at the sub-regional level in the ISP model, and

considers that the approach may need to be developed and enhanced over successive ISPs as data availability and modelling practices evolve.

AEMO notes the feedback from **AusNet** to include its key connections enablement projects and its RIT-D projects as an input while analysing distribution network capabilities and network augmentation. AEMO will continue to engage with **AusNet** to understand this data and its potential application, as part of the working group established in 2024 between AEMO and distribution networks to discuss the treatment of distribution network data in the 2026 ISP.

AEMO agrees with feedback from **Hydro Tasmania** and **CIS** that AEMO should consider the cost of the distribution network, and that the need to expand or adapt distribution systems should not be ignored due to the treatment of CER as exogenous. AEMO notes that the proposed methodology will explicitly incorporate a cost for the augmentation of distribution networks to support efficient levels of CER operation, and/or increased uptake and operation of distributed resources.

While AEMO agrees with the **ECA** that a range of mechanisms will be needed in the NEM to effectively unlock CER and other distributed resources, including network, non-network options and consumer investments, the changes proposed to the *ISP Methodology* are focused on incorporating distribution network capabilities and opportunities consistent with the ISP Review and rule determination requirements.

In regard to feedback on the co-optimisation of investment decisions (**Ausnet, ISP Consumer Panel, PowerLink, CS Energy, CIS, Hydro Tasmania, ECA**), AEMO notes that the proposed methodology trades off expenditure in distribution network augmentations against the benefits of higher levels of CER operation (effectively allowing for a reduction in potential curtailment of CER for new CER investments), as well as further development of the transmission network, utility-scale generation and storage developments.

Finally, regarding feedback **from Etrog Consulting** regarding the inclusion of costs for CER for the co-optimisation of how people and grid can work together, AEMO considers that it is not appropiate to optimise uptake of CER within a broader system-wide optimisation, as CER investments are driven by household and consumer drivers that sit outside of the ISP's cost-benefit analysis. Rather, AEMO recognises the range of potential CER uptake levels (and their costs) through the forecast uptake diversity across scenarios, observing the impact of such diversity on system-wide investments that are optimised.

Data inputs and consideration of CER technologies

In regard to feedback from the **ISP Consumer Panel** and the **Justice and Equity Centre** to seek inputs from other stakeholders in addition to DNSPs, AEMO notes that it will include consultation on the DNSP inputs as part of the Draft 2025 *Electricity Network Options Report.*

In regard to feedback from **Powerlink, Martin Kamener** and the **ISP Consumer Panel** on the consideration of CER technologies, the proposed methodology covers a number of sub-components: new distributed resources and distribution network augmentations (both as candidate builds), and CER output (not as build candidates but still subject to potential curtailment). The proposed approach will allow for potential trade-offs between these assets as well as with transmission network augmentations and utility-scale assets.

AEMO does note that the proposed methodology does not suggest that bespoke distribution network augmentation options be modelled across the NEM to connect renewables that might otherwise

connect directly to the transmission network (that is, the concept of significantly expanding the reach of a distribution network to connect renewables in new areas, modelled equivalently to a REZ, is not incorporated in the proposed methodology). Rather, AEMO will continue to incorporate sub-transmission scale augmentation options where they are provided in a relatively specified and designed form by DNSPs or other jurisdictional planning bodies. AEMO proposes this approach continue as it considers that it strikes the balance between available information and modelling effort, and acknowledging that larger augmentations are the subject of ongoing joint planning between TNSPs and DNSPs.

Regarding **Martin Kamener's** feedback, AEMO notes that inclusion of batteries is within the scope of the ISP consideration of distribution network capabilities and opportunities for CER and other distributed resources, but that it is not yet clear how much data is available about opportunities for modelling batteries 'in front of the meter' in the distribution network as part of the ISP. AEMO is currently working with DNSPs to understand the available data on this matter.

'Behind the meter' consumer-owned batteries within households and small businesses are already included within AEMO's CER forecasts, and AEMO is working with DNSPs to understand opportunities for the distribution network to facilitate these consumer-owned assets.

In regard to **SAPN**'s suggestion to include actionable investments in distributed generation and network capacity within the ODP, AEMO does not have an NER function of declaring actionable distribution network augmentations and in addition considers that this is not currently feasible due to limitations on data and modelling capability. AEMO intends to consider the distribution capacity parameters at the transmission node identifier (TNI) level to derive and aggregate the distribution limits up to the sub-regional level. AEMO considers that this modelling approach is not sufficiently granular to test for the actionability of most distribution network investments.

Impacts of forecast CER growth

AEMO appreciates feedback seeking further information on the consideration of assumptions around CER growth and distribution network capacity (**Ausgrid, IEEFA, Justice and Equity Centre, Sumitomo**). AEMO will continue to develop its methodology for forecasting CER growth, consistent with the actions identified in the ISP Review. AEMO also welcomes any further feedback on the Draft *ISP Methodology*. As discussed above, the methodology assumes CER uptake is a fixed input, and the model will analyse distribution network capabilities and augmentation options, and their impact on CER operation. AEMO does not consider the CER uptake forecast to be generally contingent on sufficient network capability to export CER at all times, given feed-in tariffs. Given existing uncertainty AEMO will assess the impact of alternative CER uptake assumptions via sensitivity analysis.

When also considering feedback by **Origin**, **Transgrid**, **Alan Pears** and **Anne Smith** on the drivers of uptake, AEMO considers the development of CER is not likely to be driven as much by system-level cost minimisation, but instead by individual household-level drivers. AEMO considers that it would be inaccurate to determine future CER investment levels through system-wide cost-minimisation, and that a forecasting approach, rather than cost optimisation, can better capture broader consumer investment trends.

AEMO proposes to plan for forecast levels of CER uptake, and incorporate DNSP data relating to augmentation opportunities to enable CER operation. This approach will consider potential trade-offs between those DNSP assets as well as with transmission network augmentations and utility-scale assets. Further detail on the derivation of CER projections is covered in the IASR, and the supporting

consultant reports. Projections of CER take into account a number of factors that consumers may consider beyond purely economic considerations. Feedback on the specific processes used to develop them is best considered via the IASR consultation.

AEMO welcomes **SAPN**'s recommendation to receive CER hosting capacity data which is aggregated to the TNI level and notes that this information is currently being requested from DNSPs through a separate data request process. AEMO notes that while some DNSPs may already have this analysis and information available, others may not, and that the final treatment of DNSP data in the ISP will need to accommodate a variety of DNSP data sets.

AEMO considers that feedback by **Origin** and the **ISP Consumer Panel** regarding the potential increasing impact of CER curtailment is warranted. AEMO's proposed methodology aims to consider the cost of distribution network augmentations against the benefit of increased levels of CER operation, potential for additional distributed resources, and consideration of investments in the transmission network.

In regards to **Origin**'s feedback regarding the need to consider minimum system load requirements in CER forecasts, AEMO notes that the CER forecasts are currently being consulted on via the IASR process, and that they will not include any curtailment as a result of minimum system load requirements. The ISP models do, however, include minimum generating unit combinations for maintaining power system security, and do include minimum stable operating levels of large generators. In undertaking the ISP analysis, AEMO may be able to extract useful messages to inform long-term trends regarding minimum system load. AEMO considers that actions to address minimum system load conditions are best addressed through the ongoing process established with industry and governents[15].

Further to the recommendation from **CS Energy** about including dynamic operating envelopes for CER, the proposed approach is to determine a constraint that will allow changing levels of operation over time, based on conditions such as time of day (and impact on generation and demand). The constraint itself will also affect the optimisation of the behaviour of coordinated batteries, vehicle-to-grid (V2G) and other distributed resources, considering these limits. AEMO does expect that the incorporation of distribution capabilities for facilitating CER and other distributed resources will need to be enhanced over successive ISPs, as this is an evolving area of modelling and data availability, and that this approach may not be applicable for all DNSPs for the first iteration of DNSP data in the ISP.

4.1.3. AEMO's conclusion

AEMO's proposed approach optimises distribution network augmentations to allow higher levels of CER operation and uptake of other distributed resources.

Section 2.4.7 of the Draft *ISP Methodology* includes the proposed constraint equations applying the proposed approach for modelling distribution network capaibilities and augmentations for CER at the sub-regional level of the ISP model.

AEMO considers that individual household-level decisions drive the uptake of CER, and that these decisions are driven by a combination of financial and non-financial factors. AEMO therefore considers that it would be inaccurate to determine future CER investment levels through system-wide cost minimisation, and that a forecasting approach can better capture broader consumer investment trends

[15] AEMO. Minimum system load fact sheet, December 2024. At https://aemo.com.au/learn/energy-explained/fact-sheets/minimum-system-load.

(that is, with levels of investment that vary across scenarios – similar to how consumer demand is tested).

Stakeholder feedback regarding the development of CER projections themselves is covered by the IASR consultation, and will be addressed through that process.

4.2. Gas-powered generation and infrastructure

4.2.1. Issue summary and submissions

In December 2024, the AEMC published a final determination and rule change[16] supporting the better integration of gas into the ISP. The rule change amends the NER by adding a requirement for the ISP to include gas development projections, and it allows access to gas information collected under the NGR, subject to confidentiality provisions with the aim to expand AEMO's consideration of gas market conditions in the ISP.

In the *ISP Methodology* issues paper, AEMO proposed to develop and apply a gas supply development model to establish gas development projections based on optimised outputs. The model would incorporate gas development options for pipeline, gas storage and/or production augmentations, informed by industry engagement, to consider cost-efficent gas supply and transportation development options to establish gas development projections based on optimised outputs.

The intention of the methodology was not to be a co-optimisation of gas and electricity developments, as the proposed gas supply development model would develop a guide to plausible gas development projections for each ISP scenario. The gas development projections would inform electricity investments in generation, (electrical) storage and electricity network developments.

Gas development projections

Hydro Tasmania and **CIS** said that AEMO should develop more than one gas development projection per scenario when electricity sector development paths have material differences in GPG.

Powerlink and **APA** said that using gas development projections as inputs to the capacity outlook model may constrain GPG capabilities, and the market should be left to determine best outcomes including technology solutions and risks that market participants are prepared to take.

JEC, APA and **APGA** raised concerns that there is a risk of gas development projections being treated as outputs signaling investment in gas infrastructure or projects, rather than 'considerations'. They recommended letting the gas market decide the nature of any infrastructure developments to meet identified needs.

DCAN and **EnergyAustralia** suggested AEMO consider alternative pathways for providing the fuel for GPG, and the extent to which power stations and energy sources can be co-located, and advantages associated with options like liquefied natural gas (LNG) import terminals. **EnergyAustralia** also recommended AEMO model a development pathway, for information purposes only, which constrains any new gas generation, to highlight potentially higher system costs or risks from a reliability/security perspective.

[16] At https://www.aemc.gov.au/rule-changes/better-integration-gas-and-community-sentiment-isp-0.

Prof David Close recommended AEMO assess the supply and demand uncertainties rather than best or reference case assessments for gas development projections.

The **ISP Consumer Panel** suggested that AEMO includes development pathways for a mix of natural gas, green hydrogen and biogas.

Inclusion of gas costs

CEC and **CIS** argued that not including the cost of gas development projections in the ODP may not account for the trade-offs that can occur between investments in renewables and electricity networks, as opposed to gas generation and the gas network. **CEC** also argued that gas sector investments will have a flow-on effect to the cost of electricity generated from gas, and consideration should be given to these costs when modelling a least-cost pathway for the electricity sector.

Sumitomo said the costs associated with gas network infrastructure enhancements need to be included in the capital and operating costs of various gas turbine technologies.

Alliance of LDES suggested AEMO incorporate the transmission costs of gas supply in addition to production costs, and said accounting for the supply of interstate gas and associated cost will ensure a reasonable indication of cost of supply.

Gas supply and augmentation information

APA supports existing information provided under the NGR being used for the purpose of developing the ISP, but not gas information that AEMO receives informally as part of operating the Declared Transmission System.

APGA and **CS Energy** suggested that AEMO leverage data collected for the *Gas Statement of Opportunities* (GSOO) and Gas Bulletin Board to increase consideration of transport and storage capacities in the ISP, and consider introducing earlier timing for developers' reporting obligations for the GSOO.

The **Coalition for Community Energy** and **Lighter Footprints** noted AEMO should test all information received about renewable gas and hydrogen transparently.

Granularity of gas modelling

Powerlink noted that AEMO's current reserve requirement modelling approach will be less viable in the future due to increasing reliance on weather-dependent supply and energy limited storage. It recommended AEMO consider assessing available generation reserves over every time interval period to better understand what least-cost remediations can cover these periods to effectively meet reserve requirements. This will provide better input into gas supply requirements.

APA said that AEMO should consider gas and GPG demand at greater granularity, including the impact of renewable droughts, to the extent it impacts factors related to servicing energy supply under the ISP scenarios.

Reliability assessment

Powerlink recommended AEMO consider extending the resource adequacy studies conducted as part of time-sequential modelling and publish them, to address reliability gaps and proposed remediations in the form of dispatachable capacity such as GPG.

Interactions between gas and other sectors

AGIG recommended AEMO evaluate the extent to which gas usage is being moved from existing assets (distribution networks) to assets requiring new investment (GPG) to meet new maximum winter peak demand levels, given the improved ability to integrate gas and electricity planning available to AEMO. The analysis would make clear the contribution of gas distribution networks to times of peak winter demand, informing planning and investment decisions.

Ausgrid, CEC, Climateworks Centre and **IEEFA** recommended AEMO consider the impact of demand-side variable such as electrification and energy efficiency, including their effect on gas demand. **IEEFA** also recommended that AEMO consider introducing more iterations between the multi-sectoral model and capacity outlook model, based on an electricity and/or gas price feedback loop.

Environment Victoria and **Nexa Advisory** recommended the ISP move towards co-optimisation of supply and demand, for both electricity and gas.

EnergyAustralia said AEMO should consider modelling a pathway involving high rates of green gas uptake by mass market customers to compare against electrification, to ensure a balanced debate and proper policy responses.

The **ACT Government** said AEMO should consider the application of green gases to address their effect on distribution network capabilities and other demand side impacts. The **ACT Government** also said AEMO should consider the impact of gas prices in demand-side modelling, providing a more accurate reflection of electrification and the uptake of CER.

Emissions

Powerlink recommended AEMO apply a penalty cost for greenhouse gas emissions, instead of a hard carbon constraint.

Hydro Tasmania suggested AEMO should include the use of liquid fuel in its emission budgets (if not already the case).

JEC said that trade-off comparisons between gas and electricity sectors must take a long-term horizon, and take emission reductions into account when assessing competing options.

CEC asked for clarification as to whether and how the 2026 ISP will account for the upstream emissions associated with fossil methane extraction, compression and transmission through pipelines.

Dr Anne Smith suggested AEMO produce a clear timeline for reducing gas dependency with annual targets that progressively decrease reliance on gas.

Project eligibility

DCAN recommended AEMO explicitly exclude new gas projects if they depend on household gas consumption through distribution networks for 5-10 years to be financially viable.

Dr Anne Smith said AEMO should mandate a lifecycle assessment of gas projects, ensuring transparency in methane emissions and water contamination risks, to be updated every five years.

Gas price forecast

IEEFA recommended AEMO feed cost back from the gas development model into AEMO's gas price forecast. In addition, stakeholders (**IEEFA and Nexa Advisory**) suggested AEMO apply the updated gas

price forecasts to the multi-sectoral modelling, or embed gas infrastructure costs in the capacity outlook model.

EnergyAustralia recommended AEMO explore whether current gas price forecasts adequately capture the increasing need to recover fixed costs of existing and new gas supply infrastructure.

Hydro Tasmania said AEMO should apply a gas price uplift to GPG when there are material differences in the level of GPG across gas development projections.

Counterfactual

ISP Consumer Panel asked AEMO to clarify the development of gas specific counterfactuals for each scenario.

Other matters

Origin and the **ISP Consumer Panel** recommended AEMO align weather variability modelling with the *Electricity Statement of Opportunities* (ESOO) methodology, and test a "worst case" variable renewable energy (VRE) output forecast. Some stakeholders (**Powerlink, APA, Fletcher and Nguyen**) suggested AEMO test multiple single weather reference years (even synthetic weather traces), potential outages and periods of low renewable generation, instead of a rolling reference year horizon, to explore and enhance investments outlined in the capacity outlook model, including GPG needs.

CEC said AEMO should more fully account for what other forms of energy storage might be accounted for to complement and potentially substitute gas and GPG, in particular long-duration energy storage.

Hydro Tasmania said AEMO should not assume all new gas units will be dual-fuel capable, given cost and environmental considerations will be prohibitive for some new investments. They also suggested that existing gas units that are not dual-fuel capable should not be allowed to be retro-fitted with dual-fuel capability which would be cost-prohibitive.

The **ISP Consumer Panel** recommended AEMO separate domestic, commercial and industrial gas use from gas forecasts for electricity generation.

CEC suggested AEMO engage with debt providers and insurers to understand their perceptions regarding costs and risks associated with major fossil fuel investment to ensure advice provided by the gas industry is consistent with independent financial analysis.

CS Energy requested detail in the *ISP Methodology* on how AEMO will apply risk to the gas development projections.

Prof David Close noted that it is appropriate to consider gas availability, but focusing on transport and storage capacity is too narrow, and the timeframe of the ISP upstream supply risk also needs to be considered. He also asked AEMO to clarify what is meant by "fuel usage for gas generation" in consultation question 5.

APA said the ISP under-forecasts the amount of GPG required in the NEM, and only looks at GPG demand rather than overall gas demand, under-estimating future gas volumes. **APA** suggested that considering potential outages and periods of low renewable generation in the modelling would provide a more robust and realistic representation of the energy system's needs.

Alan Pears raised concern about heavy reliance on gas used for limited periods, and considered this to be commercially unrealistic and environmentally detrimental.

Sumitomo suggested AEMO explain the interactions between the models using clear mathematical equations, for stakeholders to fully understand the approach being proposed and offer constructive suggestions. **Sumitomo** also said AEMO should make clear the division of gas consumption between electricity and other sectors, which can be critical in times of peak demand where pipelines are not designed to service peak consumption across multiple sectors.

Transgrid asked AEMO to clarify whether the GSOO will consider ISP planning results as an input, as this would better reflect the impact conversely.

APA and **Prof David Close** said AEMO should better align gas forecasts from the GSOO with the ISP and include flexible gas forecasts.

The **ACT Government** and **CEC** asked AEMO to consider the impact of short-term investment in infrastructure that may become stranded prior to the end of its effective life.

Stakeholders (**CEC, ISP Consumer Panel, Environment Victoria, IEEFA, Prof David Close, Nexa Advisory**) raised concern that limiting engagment to the gas industry on proposed gas development modelling may yield information that does not account for the full suite of costs associated with gas investment.

CIS suggested the ISP project only necessary constraints and inputs to gas development that are outside of its control, and should model (co-optimise) the best outcomes for the system as a whole.

The **ISP Consumer Panel** recommended that while gas generation will be important to system security, it should be seen as replacement for other supply options, including enhanced coordination of CER.

4.2.2. AEMO's assessment

Gas development projections

AEMO acknowledges feedback provided by stakeholders regarding the gas development projections.

In regard to **Hydro Tasmania** and **CIS** suggestions that AEMO should develop more than one gas development path per scenario when there are material differences in GPG developments, as discussed in the Draft *ISP Methodology* the gas supply development model will inform a set of potential gas development projections, which will be incorporated in the capacity outlook model as maximum daily sub-regional gas supply limits. To demonstrate resilience on the ODP, AEMO may consider alternative gas development projections per scenario during AEMO sensitivity analysis to test the impact of alternative gas projections. The number of gas development projections developed would depend on both insights observed in the modelling and time availability during the ISP process.

Regarding feedback from **Powerlink** and **APA**, AEMO's intention is to provide general insights on gas infrastructure requirements in the NEM to meet long-term electricity investment needs in response to the final rules that support the better integration of gas into the ISP, published by the AEMC[17]. As part of the development of the gas development projections, AEMO will consider existing and proposed gas infrastructure submitted by market participants as part of the GSOO, as well as potential gas infrastructure from stakeholder engagement that would be consulted on through the IASR and ISP process.

[17] At https://www.aemc.gov.au/rule-changes/better-integration-gas-and-community-sentiment-isp-0.

The Federal Government's ISP Review "*does not require AEMO to carry out a multi-sector co-optimisation of infrastructure development across the entire electricity and gas sectors*", and suggested that "*there would be limited benefits to AEMO producing an 'optimal development path' for gas as the drivers for investment in the gas sector are very different to electricity*". As such, AEMO does not intend to provide an assessment of the optimal combination of specific gas investment projects, but instead to provide a forecast of the gas market in the capacity outlook model based on the gas development projections.

In relation to AEMO providing investment signals for gas infrastructure developments (**JEC, APA** and **APGA**), as noted above, AEMO's intention is to identify a set of plausible gas development projections as a combination of supply, transport and storage options to inform electricity investment decisions in the ISP. In accordance with the Federal Government's ISP Review findings quoted above, AEMO does not intend to identify and/or assess what specific gas investment projects the system needs, or determine the optimal gas investment outcome.

With regard to the **DCAN** and **EnergyAustralia** proposal to explore different pathways, AEMO notes that the sub-regional topology of the gas supply development model allows the model to capture locational benefits when evaluating trade-offs between gas infrastructure options. The available gas supply for GPG, based on sub-regional outcomes from the gas supply development model, would be reflected in the electricity investments decision in the capacity outlook model. AEMO aims to investigate combinations of gas development projects identified by the GSOO to highlight impacts to the ISP.

With regard to feedback from **ISP Consumer Panel** on considering the inclusion of natural gas, green hydrogen and biogas, AEMO will consider assessing renewable gases as part of investigating gas development projections.

Finally, regarding the recommendation from **Prof David Close**, the development of plausible gas development projections includes assessing different levels of supply and demand via the inputs and assumptions from the ISP scenarios. AEMO's proposal is to assign a development projection (from the suite developed by the gas model) to each scenario and test the resilience of the ODP to alternative gas development projections via sensitivity testing.

Inclusion of gas costs

Some submissions (**CEC, CIS, Sumitomo**) recommended the incorporation of gas infrastructure costs from the gas supply development model into the capacity outlook model and as part of the cost benefit analysis for electricity transmission. AEMO acknowledges stakeholders' concerns on this matter and notes that the proposed approach will include some consideration of the potential trade-offs between each sector when developing a plausible gas development projection for each scenario, and will then evaluate the benefits of individual electricity sector investments based using those gas development projections.

The gas supply development model will determine the gas development projections considering uncertain investments identified in the GSOO, and additional investments in possible infrastructure options such as pipelines, gas storage, and/or supply augmentations that consider capital and operational costs, and their impact on the operational capabilities of the East Coast Gas Market. The gas development projections would then be incorporated in the capacity outlook model as a maximum sub-regional daily gas supply limit; these limits may impact the daily gas generation available across the NEM, influencing the electricity investments for firm capacity (including GPG and electricity storage

devices, for example). The introduction of limits in the gas delivery for GPG will reflect more realistic gas system conditions and will enable greater consideration of fuel availability on electricity investments.

As mentioned above, gas infrastructure costs are considered as part of the gas development model to identify the plausible gas development path(s), but will not be subsequently re-optimised when the capacity outlook model is used to determine the optimal development path for the electricity sector or evaluate the optimal timing of transmission projects. This approach is consistent with the AER's CBA Guidelines that require, when estimating the benefits of electricity transmission, that only those costs that can be measured as a cost to generators, DNSPs, TNSPs and consumers of electricity be included in the ISP analysis. It is also consistent with the definition of *net economic benefit* in the NER.

AEMO agrees with stakeholders that gas sector investments will have an impact on the cost of electricity generated from gas. AEMO may explore impacts on gas prices as a result of the gas development projections and include these within the capacity outlook model.

Regarding the **Alliance of LDES** suggestion on including transmission costs, AEMO confirms that the gas supply development model does take into account transport cost, in the form of pipeline tariffs. The information is prepared as part of the GSOO process[18]. The gas system information has also been published as part of the Draft 2025 IASR consultation process[19].

Gas supply and augmentation information

In relation to the use of gas information from the GSOO and the Gas Bulletin Board in the ISP process (**APA, APGA, CS Energy, Coalition for Community Energy, Lighter Footprints**), in December 2024 the AEMC published a final rule that supports the better integration of gas into the ISP[20]. The new rules require AEMO to have regard to 'gas industry information publications' as an input for analysis in the ISP. To support this, AEMO will be able to access gas information that it collects under the NGR and use it to prepare the ISP.

In regard to adjusting reporting obligations for the GSOO (**CS Energy**), AEMO appreciates the recommendation, however, will not change or increase reporting obligations or timing of data collection for the GSOO. AEMO recognises that the current requirements for stakeholders to report to AEMO are already onerous. The data collected is primarily for the GSOO, and the current survey timing is most efficient and effective for the gas adequacy assessment it provides.

Granularity of gas modelling

Regarding the **Powerlink** recommendation on assessing available generation reserves over every time interval period, the assessment of reserves does consider interval level data subject to aggregation techniques employed in the capacity outlook model. AEMO is also considering allowing for the modification of firm capacity factors throughout the modelling phase in response to observed outcomes to ensure they remain appropiately reflective of underlying challenging renewable energy conditions. In addition, AEMO assesses reliability during the ISP development through the time-sequential modelling and may refine minimum reserve requirements used in the capacity outlook model so projected generation mix achieves the reliability standard.

[18] At https://aemo.com.au/energy-systems/gas/gas-forecasting-and-planning/gas-statement-of-opportunities-gsoo.

[19] At https://www.aemo.com.au/consultations/current-and-closed-consultations/2025-iasr.

[20] At https://www.aemc.gov.au/rule-changes/better-integration-gas-and-community-sentiment-isp-0.

In regard to **APA** feedback about considering gas and GPG demand at a greater granularity, GPG consumption projections are developed by the time-sequential model that has higher resolution than the capacity outlook model. The increased granularity using half-hourly intervals allows the model to capture periods of low VRE output and hence more requirements for GPG. It also applies market participants' bidding behaviour and affine linear heat rate curves to reflect a better overall gas consumption for GPG.

Reliability assessment

In regard to **Powerlink**'s feedback about extending the resource adequacy studies, AEMO conducts reliability assessments during the development of the ISP, including sensitivities of renewable energy drought conditions, to validate the candidate development paths, and will consider this feedback in the ISP modelling process.

Interactions between gas and other sectors

Regarding **AGIG**'s recommendation about providing insights at distribution network level, AEMO's gas supply model does not consider the gas distribution network, due to the scope of the GSOO being limited to the east coast transmission system, and data being unavailable at the distribution network level. Therefore, AEMO will not be able to provide insights on gas usage in distribution networks.

In regard to the impact of demand-side variables **(Ausgrid, CEC, Climaworks Centre, IEEFA)**, AEMO's modelling approach includes electrification assumptions as one of the key parameters of the ISP scenarios collection. These parameters are developed as part of the IASR process and are considered as an input into the ISP, developed by multi-sectoral modelling. AEMO appreciates the feedback provided, but at this stage AEMO's forecasting and modelling methodologies are unable to introduce iterative loops between the multi-sectoral modelling and the ISP modelling (including interactions with gas development projections) within the timelines required to deliver the Draft and final ISP.

Regarding **EnergyAustralia**'s recommendation on incorporing a pathway with high rates of green gas uptake and compare against electrification, AEMO acknowledges the recommendation and will consider this feedback during the ISP development subject to modelling timelines.

Some feedback suggested the impact of gas prices and green gas developments should impact demand-side modelling (**ACT Government**). The development of demand-side modelling inputs such as electrification or CER is discussed in the IASR, which is currently going through consultation, and relevant feedback from the *ISP Methodology* issues paper consultation will be addresssed in the IASR consultation. Aditionally, as mentioned above, iterations between multi-sectoral modelling and ISP modelling are not possible due to ISP timelines.

Emissions

Regarding **CEC**'s clarification request about treatment of emissions in the gas supply development model, AEMO notes that the gas supply development model does not consider upstream emissions and this assumption will not be applied for the 2026 ISP. AEMO does not have the available data to incorporate emissions into the model. In addition, transport and gas production emissions are comparatively small compared to combustion emissions. AEMO may explore the consideration of emissions in the gas supply development model in future ISPs.

AEMO notes **Powerlink**'s suggestion of applying a penalty cost for greenhouse emissions, but argues that the carbon budget approach allows for consideration of emissions in the power system relative to the wider energy system, which is considered by the multi-sectoral modelling. By adding a penalty to

the constraint, the model may choose to breach the constraint and increase emissions, disconnecting from the other sectors.

Regarding **Hydro Tasmania**'s recommendation, the use of liquid fuels is already included in emission budgets for liquid fuel generators. For those generators that breach the constraint and switch to liquid fuel, AEMO is considering further changes to the implementation of the constraint which would account for the impact in emissions.

In regard to **JEC**'s suggestion about trade-offs in the comparison between gas and electricity and the consideration of emissions, AEMO notes that emissions reductions are included as part of the optimisation in the capacity outlook model through the carbon budget constraint. This constraint allows the model to reflect investment trade-offs between technologies since GPG would be subject to the carbon budget even in cases where a potential gas development projection could lead to higher gas generation.

In relation to the recommendation from **Dr Anne Smith** about considering emissions, the capacity outlook model considers the policies that Australia's governments have commited to in order to transition Australia's economy to net zero emissions by 2050.

Project eligibility

In regard to **DCAN** feedback about excluding projects if they depend on household gas consumption to be financially viable, AEMO notes that the purpose of the proposed approach is to identify gas development projections, including gas requirements for GPG. Similar to other supply side investments in electricity, the financial viability of gas projects will not be considered as part of the gas supply development model. The gas supply development model will instead indicate the availability of gas supply, based on gas development projections, to better inform electricity investment decisions in the ISP on a least cost basis.

Regarding feedback from **Dr Anne Smith** about AEMO mandating a lifecycle assessment of gas projects, AEMO's proposal to identify plausible augmentations in the gas sector aims to provide greater consideration of the gas system in the ISP. The proposal is also to address actions placed on AEMO by the new rules, published by the AEMC, that supports the better integration of gas into the ISP[21]. It is not part of AEMO's planning function to mandate market participants and/or developers to assess enviromental impacts on gas infrastructure projects.

Gas price forecast

In reference to gas price forecast considerations due to the new gas supply infrastructure in the gas supply development model (**EnergyAustralia**, **IEEFA, Hydro Tasmania** and **Nexa Advisory**), AEMO acknowledges the recommendations and notes that the 2024 gas price projections consulted on as part of the Draft 2025 IASR include consideration of fixed costs of existing and new gas supply infrastructure, and AEMO may consider further analysis on gas prices as a result of different gas development projections during the ISP development process.

Counterfactual

In relation to the counterfactual (**ISP Consumer Panel**), AEMO may identify that an alternative gas development projection (of the set developed by the gas supply development model) is more

[21] At https://www.aemc.gov.au/rule-changes/better-integration-gas-and-community-sentiment-isp-0.

appropriate for use in the capacity outlook model when modelling the counterfactual development path for a scenario (where no new electricity transmission is developed), compared to the rest of the development paths. This could be due to the counterfactual development path having reasonably different GPG requirements without investment in transmission augmentations (other than committed and anticipated projects). This alternate gas development projection, if identified, would be similarly considered to other plausible gas development projections, where relevant, when considering the ODP selection process.

Other matters

In regards to feedback by **Origin**, **ISP Consumer Panel, Powerlink**, **APA** and **Fletcher and Nguyen** on weather reference years and testing weather variability, AEMO tests a rolling horizon sequence and also tested a worst weather sequence during the 2024 ISP, and may continue the use of this or a similar sensitivity going forward. AEMO may test all weather years in the time-sequential model, to validate the suitability of results from capacity outlook model to weather uncertainties.

In regard to the **ISP Consumer Panel** feedback on gas use from domestic, commercial and industrial sectors separate from gas forecast for GPG, AEMO notes that the gas supply development model considers the gas consumption for GPG as a separate input for other sectors. The annual gas consumption and maximum gas demand information for all sectors can be found in the GSOO[22].

Regarding the consideration of risk in the gas development projections (**CEC**, **CS Energy**), AEMO engaged Oxford Economics Australia to undertake a survey of the different investment risks of energy technologies in the NEM and how those risks are translated into the weighted average cost of capital (WACC). In addition, AEMO may explore a range of risks and uncertainties by considering alternative gas development projection per scenario during ISP sensitivity analysis to test the impact of alternative gas supply availability on electricity investments.

About feedback from **CEC** on alternative forms of storage, AEMO considers long duration energy storage (in particular pumped hydro) as a potential technology candidate to develop. The IASR provides further detail on the technologies available to the ISP modelling.

In relation to **Prof David Close**'s suggestion on upstream supply and facilities capacity, and question on fuel usage, the gas supply development model considers daily and annual gas reserve and resource availability, as well as pipeline, storage and processing infrastructure constraints. AEMO will also consider new gas supply, taking knowledge of potential new gas resources from the GSOO. More information is provided in the Draft *ISP Methodology*. In addition, fuel usage from Question 5 in the *ISP Methodology* issues paper refers to the gas consumption for GPG forecast, referring mainly to natural gas.

About feedback from **Sumitomo** on the use of mathematical equations, AEMO notes that the model formulation is available in the PLEXOS documentation provided to support the ISP publication (referred to as the "ISP model" in the publication materials).

In regard to feedback from **Hydro Tasmania** on dual fuels, AEMO agrees to not allow existing gas units to use secondary fuels via retrofitting, and points to the latest Aurecon report that has supported the 2025 Draft IASR advising new gas unit candidates being dual-fuel capable.

[22] At https://aemo.com.au/energy-systems/gas/gas-forecasting-and-planning/gas-statement-of-opportunities-gsoo.

About **APA**'s concern about GPG being under-forecast in the ISP, AEMO's proposal to expand the interaction between the gas and electricity models seeks to enhance the assessment of GPG requirements required by the system. The GPG forecast is developed using the time-sequential model which has a higher modelling resolution (half-hourly intervals) than the capacity outlook model. It considers multiple weather reference years and incorporates outages through stochastic modelling. These features allow it to capture different system conditions and improve the accuracy of the GPG requirements. As part of the assessment of pausible gas development projections, AEMO will consider different system conditions via the ISP scenarios.

Regarding **Alan Pears**'s concern about gas used for limited periods, AEMO acknowledge stakeholder concerns about commercial viability of gas infrastructure. Gas peaking stations are generally designed to run at low capacity factors during relatively infrequent periods when supply/demand balance is tight. While AEMO recognises that the financial viability of gas projects will not be considered as part of the gas supply development model, the proposed approach to incorporate new gas infrastructure developments in the ISP, recognising the infrastructure needs for low utilisation gas use, will address **Allen Pears'** feedback on this matter.

Relating to the **Sumitomo** suggestion about the gas demand differentiation between electricity and gas sectors, AEMO acknowledges that while gas demand for GPG is a separate input into the gas supply development model, it may be difficult to identify which demand sector is being met or constrained by pipeline limitations.

In regard to **Transgrid**'s clarification request, the gas consumption for GPG forecast that is used in the GSOO is based on the most recent ISP capacity expansion plan. Therefore, improvements in the GPG forecast from the 2026 ISP will feed into the GSOO modelling.

In relation to suggestions from **APA** and **Prof David Close** on alignment between the ISP and the GSOO gas forecasts, GPG consumption projections are developed by the time-sequential model that has higher resolution than the capacity outlook model. It also applies market participants' bidding behaviour and affine linear heat rate curves to better reflect overall gas consumption for GPG. Regarding flexible gas forecasts, it is worth noting that the gas demand forecasts for residential, commercial, industrial and LNG sectors are developed in the GSOO process, and these demands will also influence the manner in which the gas infrastructure is able to deliver gas for GPG and other gas consumers. The ISP will consider the same forecast for these sectors as the GSOO and will not be adjusted as a result of different gas development projections during the ISP modelling.

About the **ACT Government** and **CEC** request to consider impacts of short-term investments, AEMO acknowledge stakeholders' concern about the commercial viability of gas infrastructure, and AEMO notes that market and policy settings may need to evolve to enable the gas investment required.

In reference to industry engagement in the gas development projection process (**CEC, ISP Consumer Panel, Environment Victoria, IEEFA, Prof David Close, Nexa Advisory)**, AEMO acknowledges the recommendation and as part of the ISP development process, all stakeholders have the opportunity to provide feedback on the gas infrastructure input parameters. The information will be consulted on through various consultations including the 2025 IASR, 2025 *Electricity Network Options Report* and Draft 2026 ISP.

In regard to feedback by the **ISP Consumer Panel** on the role of gas generation, the ISP is technology neutral and aims to build the optimal outcome taking into account a number of key parameters such as costs, emissions and policy constraints. The model determines the need for gas generation, while trading off against other technologies.

Relating to **CIS**'s suggestion on co-optimised modelling**,** AEMO acknowledges the recommendation. However, benefits in the gas sector are outside the classes of benefits that may be considered in the ISP cost benefit analysis. The AER's CBA Guidelines require AEMO to exclude benefits that do not accrue to those who consume, produce and transport electricity in the NEM, thereby prohibiting co-optimisation. This is consistent with the AEMC's recent rule changes to support the better integration of gas into the ISP which require AEMO to make improvements to the ISP analysis to optimise investment in the electricity network, not the gas system. The AEMC's final determination makes clear that the new rules do not include an ODP for gas or propose that AEMO develop policy positions on gas developments. [23]

4.2.3. AEMO's conclusion

AEMO appreciates stakeholder feedback and recommendations in integrating gas in the ISP. On this topic, AEMO will:

- Provide more information about the configuration and inputs of the gas supply development model in the Draft *ISP Methodology*.
- Adjust the modelling process and interaction between the gas supply development model and the capacity outlook model to identify the gas development projections.
- Explore the impact on gas prices as a result of different gas development projections.

Section 4 of the Draft *ISP Methodology* includes the proposed incorporation of the gas supply model in the ISP modelling.

4.3. Selecting the optimal development path

Stakeholders commented on issues relating to how the ODP is selected for the ISP – AEMO's proposal to assess actionability of transmission projects by aligning with project proponent timings for projects which have previously been identified as actionable, as well as general advice on scenario analysis.

4.3.1. Issue summary and submissions

In the *ISP Methodology* issues paper, AEMO proposed a new approach for testing the actionability of projects that have previously been identified as actionable (either actionable ISP projects or actionable projects progressing under a jurisdictional framework[24]). Under the proposed approach, AEMO would test for actionability at the project proponent's timing and at a 'restart timing' after the end of the actionable window, instead of optimising project timing within the actionable window for these previously actionable projects, and also instead of testing immediately after the actionable window.

The intention of the proposed change to test only at the project proponent's timing for these projects was to reflect the most credible timing from the proponents and to improve ISP assessment efficiency in testing whether a project should remain actionable in the next ISP. That is, this approach would avoid undertaking optimisation studies for multiple years throughout the full actionable window, and make

[23] AEMC. Final report National Electricity Amendment (Better Better integration of gas and community sentiment into the ISP) Rule 2024, National Gas Amendment (Better integration of gas and community sentiment into the ISP) Rule 2024. Page 2. At https://www.aemc.gov.au/sites/default/files/2024-12/erc0395_final_determination_-_better_integration_of_gas_and_community_sentiment_into_the_isp.pdf.

[24] See Glossary, Appendix A for explanations of these terms.

resources available for other ISP assessments. AEMO considered this approach to be appropriate as the project delivery date nominated by the project proponent would be informed by regulatory and engagement activities that are already underway as a result of the project being actionable (or as a result of other factors).

The intention of the proposed change to test only at the 'restart timing' was proposed to be informed through the *Electricity Network Options Report* consultation process. The 'restart timing' was intended to represent the time taken to begin development and regulatory processes after a project is paused.

Assessing actionability of transmission projects

Powerlink and **CIS** broadly supported the proposed approach to test previously actionable projects at the proponent's timing, and at a later restart timing rather than all the in-between years as well. **CIS** also recommended that AEMO revert to its former approach in determining the actionable window for a project, such that the actionable window does not continuously expand with every consecutive ISP.

Two stakeholders (**Justice and Equity Centre** and **Nexa Advisory**) opposed the approach, and said that it undermines the intention of the ISP as it creates uncertainty around transmission network development. The **Justice and Equity Centre** said the proposal outsources the determination of the optimal timing of a project "to actors with a vested interest in projects proceeding as early as possible", and that this change does not best promote the consume interest.

CS Energy proposed AEMO consider the risk of delay to project delivery dates based on historical evidence of delays against developer timeframes and adjusted for growing demand for resources and impact of public objection to developments. **Nexa Advisory** said AEMO must clearly identify the cost impacts of any delays in timing of actionable projects if expected timing of the project continues to slip from its original proponent date.

Scenario analysis

Climateworks Centre said AEMO should commission modelling of an additional 1.5°-aligned scenario, or additional sensitivity analysis for the *Green Energy Exports* scenario, and suggested multi-sector modelling should be expanded to analyse sensitivities across all scenarios.

EnergyAustralia recommended that AEMO model a policy non-compliant pathway to highlight the associated emissions and costs, and avoid undermining the plausibility of ISP projections to meet 2030 targets.

The **Justice and Equity Centre** recommended that AEMO should amend the *ISP Methodology* to ensure that no scenario which breaches Australia's commitments is included in any modelling or analysis.

Other issues

The **Justice and Equity Centre** recommended that AEMO allow investment in non-network options (batteries or demand response) as well as network investments.

4.3.2. AEMO's assessment

Testing for actionability

The **Justice and Equity Centre** and **Nexa Advisory** oppose the proposed approach to test previously actionable projects at the proponent's timing and at a 'restart timing' after the end of the actionable

window, whereas **Powerlink** and **CIS** broadly support this approach (although **CIS** prefer that actionable windows not extend beyond two years).

In considering the merits of including project restart timing, AEMO re-examined the broader purpose of the actionable window itself as explained in AEMO's 2023 ISP Methodology Consultation Summary Report. The purpose of the actionable window is to:

- allow the ISP cost benefit analysis to take into account that actionable projects on a critical path cannot be paused for two or more years and subsequently resumed without adversely affecting project lead time,
- allow for the potential to delay an actionable project to be appropriately considered in AEMO's decision on the project's actionability, without needing to pre-emptively adjust the project earliest in-service date (EISD) in response to uncertain project delay factors, and
- apply to previously actionable projects to reflect that regulatory processes for previously actionable projects have already begun and may need to be repeated if the project is delayed and later restarted, but not newly actionable projects which would not have yet begun the regulatory approval process.

AEMO considers this purpose remains valid and overlaps with the intended purpose of including project restart timing. AEMO's *ISP Methodology* issues paper provided that the "*restart timing would represent the additional time required to re-start a project after it has already been started, and then paused*". Therefore, AEMO proposes not to include restart timing when testing previously actionable projects.

However, AEMO does propose to simplify the testing of previously actionable projects by testing actionability at the proponent's timing and immediately after the end of the actionable window, instead of optimising project timing by testing every year within the actionable window. In addition to saving significant time and modelling effort, AEMO considers this approach better aligns with the purpose of testing the project in the ISP – to determine whether the previously actionable project should remain actionable or whether its optimal delivery timing suggests the project should be delayed[25].

For clarity, if initial testing suggests the previously actionable project should be delayed, AEMO will continue to test for the optimal delivery timing outside of the actionable window, consistent with modelling for previous ISPs. Similarly, AEMO will continue to determine the optimal timing for all newly actionable projects and future projects. AEMO considers the proposed approach strikes an appropriate balance between transparency and rigour, and mantains consistency with the reasoning for earlier consulted-upon amendments to the *ISP Methodology*.

In response to **Nexa Advisory** and **CS Energy** feedback that AEMO identify and account for the cost impacts of delays to actionable projects due to slippage of the proponent's expected project timing, AEMO considers a key aspect of the actionable window's purpose is that it does not require AEMO to pre-emptively adjust the project EISD to address the uncertainty of project slippage. AEMO agrees that uncertainty around project delivery timing is an important consideration. However, rather than attempt to address this uncertainty by adjusting application of the actionable window, AEMO proposes to investigate the implications of delays to actionable projects and consequential impacts on the ODP via the *Constrained Supply Chains* sensitivity analysis.

[25] This is also consistent with testing of the project in the ISP feedback loop which retests the project at both the RIT-T proponent's project timing and immediately after the end of the actionable window to assess ODP alignment and confirm that the project cost does not change the project's actionable status.

Scenario analysis

AEMO considers that feedback on specific scenarios and sensitivities received by **Climateworks Centre**, the **Justice and Equity Centre**, and **Energy Australia** will be best addressed via the separate IASR consultation,and will provide an assessment and response through that process.

Other issues

On the **Justice and Equity Centre's** 's suggestion that AEMO should allow investment in non-network options (such as batteries or demand response) as well as network investment to be considered, AEMO considers that non-network options were a subject of consultation in the 2025 IASR and are facilitated through the existing ISP and RIT-T frameworks, and that no changes are required to the *ISP Methodology* to further facilitate the uptake of non-network options in this methodology.

4.3.3. AEMO's conclusion

In response to stakeholder feedback, AEMO proposes to assess for previously actionable projects using the project proponent timing. Section 6 of the Draft *ISP Methodology* includes the proposed approach.

AEMO agrees with stakeholder views that the restart timing concept proposed in the issues paper is not an appropriate method to consider lead time uncertainty, and also considers on reflection that the concept could be double-counting with the concept of the actionable window extension to account for time required to re-start a project after it is begun and then paused, and so the concept is not applied in the draft methodology.

If non-network options are proposed in in response to the call for non-network options in the Draft 2025 IASR, and if these options include meet a project need and there is sufficient evidence for the cost, capacity and timing of the option, AEMO will include these options in the ISP modelling.

4.4. Perfect foresight in the ISP model

4.4.1. Issue summary and submissions

In the *ISP Methodology* issues paper, AEMO proposed to incorporate two approaches in the time-sequential modelling to better represent the potential for suboptimal dispatch outcomes of storage devices across the modelling horizon and provide insight into the impact of imperfect foresight, particularly ahead of long winter periods of high residual demand:

- Introducing headroom and footroom energy reserves to storage devices, wherein a small margin of energy at the upper and lower states of charge remains accessible only if required during conditions that would otherwise result in unserved energy.
- Applying an imperfect energy plan to different weather reference years to test the capability of the generation, storage and transmission investments to respond during unpredictable periods of energy scarcity.

Headroom/footroom reserves

Stakeholders expressed mixed perspectives on introducing headroom and footroom energy reserves to storage devices. **Hydro Tasmania**, **IEEFA** and **Ausgrid** supported the headroom/footroom energy reserves as a reasonable approach to reduce the perfect foresight issue. **ANU** and **Nexa Advisory** did not support this approach as they believed it would not bring the model closer to reality.

Ausgrid, CEC, and **IEEFA** proposed AEMO should test the headroom/footroom reserve approach with storage asset operators to determine whether it reflects operational realities.

Fletcher and Nguyen recommended that AEMO consider modelling footroom energy reserves as time-varying, to not unnecessarily impact storage duration in periods where imperfect foresight is not a cost to the system, while **Origin** and **Sumitomo** voiced similar concerns that withheld energy reserves should be accessible to the grid during peak demand periods.

Hydro Tasmania suggested AEMO should apply higher headroom/footroom energy reserve restrictions to shorter duration energy storage (less than 8 hours)**.**

The **ISP Consumer Panel** proposed AEMO should model to allow for footroom in reflecting imperfect information, but should not model for headroom as it is optimal for batteries to be fully charged when prices are low.

Sumitomo suggested that AEMO consider implementing a system-wide reserve constraint instead of applying headroom/footroom reserves to energy storages.

Ausgrid sought further clarification on “increased flexibility” offered by reserving proportions of available storage, and the interplay with the concept of “energy planning with error”.

Energy planning with error

Stakeholders had differing opinions on the approach of energy planning with error which is implemented in time-sequential modelling**.** Some stakeholders (**Powerlink, Alliance of LDES**, **IEEFA**, and **ISP Consumer Panel**) supported this approach, but **Origin** and some members of the **CEC** did not support incorporating energy planning with error and recommended this approach would be better considered in sensitivity analysis.

Hydro Tasmania suggested AEMO could consider constraining a portion of a NEM region’s storage capacity that can generate or store load in each dispatch, instead of modelling imperfect energy targets.

EnergyAustralia recommended that AEMO investigate current day and day-ahead settings in short-term time-sequential modelling, instead of relying on the medium-term schedule.

Other issues

EnergyAustralia and **Sumitomo** asked AEMO to clarify if perfect foresight implications are being explored for long duration energy storages in addition to shorter duration technologies such as batteries. The **ISP Consumer Panel** similarly recommended the energy planning with error approach be extended to community level storage.

CIS said the ISP should model profit-maximising behaviour to address the problem of perfect foresight for capacity expansion.

Fletcher and Nguyen and **Sumitomo** encouraged AEMO to consider reducing the look-ahead period and to calibrate this against historical forecasts and levels of unserved energy observed.

Fletcher and Nguyen suggested AEMO should explore the impact of imperfect foresight on multiple scenarios and potentially sensitivities of lower CER orchestration.

Ausgrid asked AEMO to provide further justification for the claim that "battery operators make dispatch decisions with uncertainty about market conditions in future periods", with regard to factors like warranty terms (minimum and maximum state of charge) that limit battery utilisation, and recommended

a change in approach so battery storage degradation factors in the age of individual battery units, rather than being applied on an aggregated basis of 16% over 20 years.

Impact on capacity expansion and other generation

Stakeholders expressed interest in the impacts of imperfect foresight on capacity expansion for batteries and alternative firming technology like GPG.

Fletcher and Nguyen said AEMO should consider whether imperfect foresight results in additional GPG, and if it does, consider this in the gas development projection for the relevant scenario.

CIS raised concern that AEMO's perfect foresight allows the model to delay GPG additions until the last moment they are needed (even with limited annual GPG capacity additions), and indicated that battery capacity should be built for each year to ensure demand can always be met regardless of when the 'worst' weather occurs, rather than being fine-tuned to a particular set of weather sequences.

ANU suggested that the capacity outlook model should retain full chronology and high time resolution to improve energy storage system modelling.

4.4.2. AEMO's assessment

Headroom/footroom reserves

AEMO welcomes support for the headroom/footroom reserves approach offered from **Hydro Tasmania**, **IEEFA** and **Ausgrid**, and appreciates the concern expressed by **ANU** and **Nexa Advisory** that the approach does not account for rebidding nor allow for a technological and forecasting learning.

AEMO's analysis indicates that the headroom/footroom reserve approach aligns modelled battery behaviour more closely to actual historical behaviour, compared to modelling with perfect foresight. AEMO acknowledges that grid dynamics continue to change (for example, more competition between storage operators, new frequency control ancillary services [FCAS]) markets) and forecasting and bidding strategies will continue to improve. The appropriate size of the headroom/footroom reserve will accordingly be calibrated against recent market behaviour.

In regard to feedback from **Ausgrid, CEC** and **IEEFA** to validate this approach with storage operators, AEMO notes that asset operators are not required to submit information about actual operational strategies, which could be related to commercial positions. The headroom/footroom reserve approach has been inferred by inspecting actual dispatch and state of charge of large batteries in the NEM.

AEMO agrees with the recommendation by **Fletcher and Nguyen**, **Origin** and **Sumitomo** to model energy reserves as soft constraints. During periods of low system reserve or high demand, the capacity withheld remains accessible – this prevents undue cost from being added to the system. During moderate demand or moderate VRE availability periods, imposing a treatment for imperfect foresight, as in the form of headroom/footroom reserves – and effectively having less storage depth available across the system – is less consequential, as storages would not need to be fully utilised.

AEMO also agrees with **Hydro Tasmania**'s suggestion that short-duration storages are more impacted by "perfect foresight" effects. AEMO proposes to apply reserve restrictions as a percentage, proportional to the device's power rating to energy capacity rating. In this way, high-power, short-duration devices are more impacted compared to long-duration devices.

Regarding feedback from the **ISP Consumer Panel** that modelling a headroom is unnecessary, AEMO considers that a headroom reserve reflects operational uncertainties of periods of both very low energy

prices, or high FCAS prices, which prevent storage systems from fully and optimally charging. The headroom reserve also prevents storages devices from optimally charging up in preparation for an unknown future period of high residual demand. In reality, energy devices may be unprepared for a sudden market event, and enter a period of tight supply with reduced energy levels.

AEMO welcomes the alternative modelling option raised by **Sumitomo**. To avoid possible confusion, AEMO has interpreted the suggestion to incorporate a "system-wide reserve constraint" as applying to only the time-sequential model, noting that capacity outlook models already incorporate minimum regional capacity reserve level requirements as a proxy for reliability. AEMO acknowledges that applying a system (or regional) level reserve constraint offers a simpler implementation compared to using unit-specific constraints proposed for modelling headroom/footroom reserves. However, AEMO also expects that a NEM (or regional) level reserve would be disproportionately allocated to longer duration energy storage systems which are typically less likely to fully deplete anyway. This would satisfy the NEM level reserve constraint and allow energy management for shorter duration energy storage systems to largely remain optimised, or "perfect". Accordingly, AEMO retains the preference to apply unit-level constraints as part of the headroom/footroom reserves approach.

Ausgrid sought clarification on how reserving proportions of storage provided ‘increased flexibility’, and on the interaction with the energy planning with error approach. To elaborate, encouraging the model to set aside a margin of energy at the upper and lower ends of a storage device provides the asset operator the option – or ‘increased flexibility’ as phrased in the issues paper – to access and capitalise on the unutilised capacity in a future period of very high or very low prices. During other periods, it discourages full charge or discharge events, hence preventing the 'perfect' dispatch. The margin of headroom or footroom also remains available when modelling alongside the energy planning with error approach.

Energy planning with error

AEMO appreciates the feedback in support of the energy planning with error approach received from **Powerlink, Alliance of LDES**, **IEEFA**, and **ISP Consumer Panel**, and will implement an approach that is realistic, reasonable, and sound. AEMO recognises the additional processing complexity introduced via this proposed methodology change, as raised by **Origin** and the **CEC**, and proposes that it be applied towards the end of the ISP development process as part of ODP validation to asses system resilience during difficult weather reference years. This will explore whether energy levels in short-duration devices are unprepared for prolonged or peak demand conditions.

AEMO welcomes the alternative approach suggested by **Hydro Tasmania** to constrain regional level storage capacity, and recognises that it offers a simpler implementation compared to modelling energy planning with error in a two-stage approach. However AEMO's preference is to allow the model to decide on the degree of imperfect energy planning – with the possibility for some intervals of high levels of storage contribution when a compatible energy plan is produced – rather than specifying this exogenously for all time periods.

AEMO has previously explored modelling the energy planning with error approach using interleaved real-time and day-ahead settings in the short-term (ST) phase only, as recommended by **EnergyAustralia**, however found this option to be technically incompatible with AEMO’s current suite of modelling tools and systems. Accordingly, the proposal to adopt the medium-term (MT) schedule to ascribe storage energy targets was preferred, which provides a lower resolution plan of battery energy, and also can be more simply integrated into AEMO’s internal cloud modelling architecture.

Other issues

In response to comments from **EnergyAustralia**, **Sumitomo**, and the **ISP Consumer Panel** about the types of storages impacted, the imperfect foresight approaches are aimed at all consumer-owned, shallow (less than 4 hours), and medium (4 to 12 hours) storage. AEMO expects that long duration storages (more than 12 hours), such as pumped hydro, are more robust to forecast uncertainty, as these can sustain high utilisation with fewer stops and starts, while arbitraging over a longer period of time. Long duration assets also principally focus on intra-seasonal balancing that require discharges to be planned across the year, hence are less likely to be impacted by small changes in short-term spot price forecasts.

In response to the suggestion by the **CIS** to model profit-maximising behaviour, AEMO considers that the core challenge of perfect foresight remains regardless of whether storage is dispatched to optimise cost or profit (that is, the storage operator will have uncertainty about future conditions). Further, time-sequential modelling with imperfect foresight will be used to test and validate the outcomes of build rates from the capacity outlook model, avoiding computational expense in upstream models.

Regarding **Fletcher and Nguyen** and **Sumitomo**'s recommendation to reduce the modelling look-ahead period, AEMO notes that market models have look-ahead in both the MT planning phase, and the ST time-sequential phase. The look-ahead period in the ST schedule is a global setting that applies to dispatch decisions for all generators. While short-duration storages do typically target intra-day arbitrage opportunities, retaining a sufficient look-ahead period allows storage devices to maximise their charge on high VRE output days in preparation for a following period of high residual demand. The ST schedule look-ahead also informs unit commitment decisions for generators to remain online overnight during low demand levels to avoid the cost of restart to meet peak demand the next morning. Further, the MT schedule planning horizon is important in time-sequential modelling for scheduling outages and stored volumes in hydro reservoirs. These require intra-seasonal visibility to maintain energy reserves during dunkelflaute or high residual demand periods, hence time-sequential modelling needs to persist a sufficient planning horizon.

AEMO agrees with **Fletcher and Nguyen**'s comment that imperfect foresight impacts should be tested on not just the central scenario, and propose to implement the imperfect foresight approach as a systemic methodology change, such that it is applied across all time-sequential modelling, rather than as a sensitivity option only, as was done in the 2024 ISP.

In response to **Ausgrid**'s request for information about consideration of battery warranty terms, AEMO is aware that battery energy storage systems may be subject to terms for degradation management (for example, depths of discharge, number/frequency of deep discharge events, minimum/maximum states of charge, maximum daily or annual cycles, daily discharge limits, and annual throughput limits) that may impose restrictions on operating windows. However, AEMO expects that ongoing development of battery degradation warranty structures may offer greater flexibility to battery operators as they continue to pursue short-term market volatility, for example, new strategies or contracting structures. Analysis of actual battery behaviour also demonstrates operators are not absolutely confined to typical warranty limits[26]; for example, installed NEM batteries can access their full capacity if required, and have been observed to cycle more frequently during winter months compared to summer months to satisfy

[26] AEMO does not have visibility of actual warranty structures for individual NEM-connected battery energy storage systems, and have inferred requirements of typical warranty terms from observed behaviour and operational reports, for example for Ballarat Battery Energy Storage System (see https://arena.gov.au/projects/ballarat-energy-storage-system/) and Gannawarra Energy Storage System (see https://arena.gov.au/projects/gannawarra-energy-storage-system/).

perhaps an overall annual or average cycling limit, rather than a daily cycling limit. Accordingly, the proposed approach is to exclude specifically modelling for these operational constraints, in the interest of avoiding over-design. Further, imposing headroom/footroom reserves is also intended to indirectly address and replicate some aspects of warranty structures.

Finally, **Ausgrid**'s recommendation about treatment of battery degradation is out of scope for this imperfect foresight methodology change consultation, and is addressed via the Draft IASR consultation process.

Impact on capacity expansion and other generation

AEMO will take into account **Fletcher and Nguyen**'s comments about the impacts from imperfect foresight on GPG, and will pay attention to whether the imperfect foresight changes affects technology builds, then accordingly report on this through the ISP.

In response to concern expressed by the **CIS** about perfect foresight of weather outcomes in the capacity outlook model and the impact on the timing for GPG and storage new build and retirements, AEMO acknowledges that not all possible permutations of weather sequences are practically modelled, and that this may have drawbacks on consideration of system reliability if a different sequence beyond those included in the modelling suite were to occur. To address this, AEMO may check what is needed if the worst sequence were to occur (as was conducted in the 2024 ISP), to ensure resilience in the development of the ODP. Development paths are further tested in time-sequential modelling, which will run with imperfect foresight, and additionally assesses all weather reference years. This more detailed assessment serves to validate outcomes from capacity expansion models, and ensures that build decisions adequately meets demand across different and uncertain weather conditions.

Regarding **ANU**'s suggestion for the capacity outlook model to retain full chronology and high resolution, AEMO notes the challenge of tractability of simulations, especially when running large and complex models such as the ISP. AEMO continues to explore how to address this technological barrier.

4.4.3. AEMO's conclusion

Considering the balance of stakeholder feedback, AEMO considers it appropriate to:

- Model for imperfect foresight via both headroom and footroom reserves, and energy planning with error approaches, in only the time-sequential model and not the capacity outlook model:
  - Headroom and footroom energy reserves will be implemented in all time-sequential modelling.
  - Energy planning with error will be implemented in only key validation time-sequential modelling due to the additional time and computing resource constraints. Energy level targets will be created in the MT schedule.
- Implement headroom and footroom reserves as soft constraints and apply reserve restrictions as a percentage.
- Retain a sufficient look-ahead period to ensure that unit commitment decisions, outage scheduling and hydro reservoir modelling are planned appropriately.
- Apply the imperfect foresight modelling approaches to all consumer-owned, shallow (less than 4 hours), and medium (4 to 12 hours) storage.
- Add additional commentary and/or analysis in the ISP publication on the changes (if any) to the capacity outlook planning due to the introduction of imperfect foresight.

This conclusion is aligned with the approach proposed in the issues paper. Section 3.3.3 of the Draft *ISP Methodology* includes this approach.

Stakeholder issues related to battery degradation rates are covered by the IASR consultation and feedback will be addressed through that process.

AEMO has developed a separate document as an attachment to this draft report, to provide a detailed analysis of imperfect foresight for storage, available on AEMO's website[27].

4.5. Treatment of hydrogen

4.5.1. Issue summary and submissions

In the *ISP Methodology* issues paper, AEMO proposed the following changes to hydrogen electrolyser load modelling to allow AEMO to provide further detail and unbundle the drivers for meeting different hydrogen components over the modelling horizon:

- Explicitly disaggregating hydrogen demand for green commodity production (such as steel) from hydrogen demand for export, providing greater clarity and transparency in the model outputs.
- Applying minimum utilisation factors developed and consulted on in the IASR to represent electrolyser operation that meets economic investment requirements.
- Considering adjusting the timeframe of production requirements from monthly to a daily basis to reflect stakeholder feedback received during the consultation on the 2024 ISP, to improve consideration of hydrogen storage needs.

Utilisation factors

Stakeholders shared mixed views on AEMO's proposed approach to apply utilisation factors to hydrogen modelling. **Powerlink** and **CIS** supported the approach of applying minimum utilisation factors to hydrogen loads and making production requirements more granular. **CIS** further noted hydrogen proponents need to demonstrate the technology is viable at low utilisation factors. On the other hand, **Fletcher and Nguyen** said AEMO should not apply minimum utilisation factors for electrolyser operation, as daily balancing of production requirements is reasonable only for use cases with a flat hydrogen demand profile.

Cost of hydrogen

Fletcher and Nguyen raised the concern that electrolyser capex has been materially underestimated in CSIRO GenCost, with the full scope of system costs accounted for insufficiently, and recommended including the hydrogen storage cost in the single-stage long-term model (SSLT) combined with an assumed flat hydrogen demand profile to optimise electrolyser capacity, rather than a daily balancing assumption.

Hydrogen use case

IEEFA, Transgrid and the **ISP Consumer Panel** raised concern regarding the inclusion of direct hydrogen exports in the core ISP scenarios, as it is highly speculative new load.

[27] At https://aemo.com.au/en/consultations/current-and-closed-consultations/2026-isp-methodology .

AGIG recommended that AEMO have regard to hydrogen as a source of energy supply as well as electricity demand, and the benefits it can provide to the grid such as by reducing spilled solar or curtailed load. **AGIG** also suggested that AEMO consider that hydrogen can be used as a replacement for natural gas in existing distribution networks.

Location

APGA said AEMO should reconsider its assumptions on hydrogen production location.

Transgrid requested clarification on AEMO's assumptions around any off-grid sources catering to electrolyser load.

Other matters

AGIG suggested AEMO could consider establishing a framework to collect hydrogen project data over future iterations of the ISP.

Fletcher and Nguyen and **Sumitomo** recommended hydrogen demand should be disaggregated into at a minimum transport, green ammonia, green fuels, green iron, alumina calcination and cement, and in particular any export green ammonia and methanol should be noted.

APGA said AEMO should reconsider the assumption regarding 10% blending limit of hydrogen within distribution pipelines.

No particular feedback was received regarding period of hydrogen production targets.

4.5.2. AEMO's assessment

Utilisation factors

Regarding feedback from stakeholders on minimum utilisation factors, AEMO notes support and opposition to the proposal. On balance, AEMO considers it appropriate to implement minimum utilisation factors, as they align with AEMO's understanding of economic and operational parameters impacting the production requirements of hydrogen projects.

Period for hydrogen production targets

On the concept of daily, weekly or monthly balancing to implement a modelling period for hydrogen production targets, AEMO now considers it appropriate to instead model weekly balancing to enable appropriate balance between hydrogen production and storage costs, and electricity infrastructure costs. A shorter, less flexible production target period would necessitate greater electrical infrastructure costs, whereas a longer, more flexible production target period would necessitate greater hydrogen infrastructure costs. AEMO considers a weekly balancing target strikes an appropriate balance between these.

This revised assumption is based on an analysis made by stakeholders in response to the results of the 2024 ISP (which assumed a monthly balancing timeframe). The stakeholders' response suggests that there is only a need for storages capable of storing five to 12 days worth of hydrogen or an average of approximately eight days[28].

[28] Andrew Fletcher and Huyen Nguyen. Draft 2024 ISP submission, February 2024. At https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/draft-2024-isp-consultation/draft-submissions/andrew-fletcher-and-huyen-nguyen.pdf?la=en, Figure 14.

Cost of hydrogen

Feedback from **Fletcher and Nguyen** on the capital cost of electrolysers will be best addressed via the separate IASR and GenCost consultation.

Feedback related to the inclusion of hydrogen storage costs in the SSLT is welcomed. The CBA Guidelines[29] provide AEMO with a very specific and strict list of cost that AEMO can and must account for when developing the ISP; it is only the costs borne by those who produce, transport, and consume electricity that should be included in the cost accounted for in the ISP. AEMO deems that the cost of hydrogen storage is not primarily for the purpose of managing electricity and should be excluded from the cost accounted for in the ISP.

Multi-sectoral modelling incorporates a hydrogen storage cost component within the cost of hydrogen development and production, and therefore for the ISP's modelling purposes, it is considered reasonable for the ISP modelling to be able to assume that sufficient hydrogen storage is available to enable flexible hydrogen production to meet hydrogen consumer's needs, as hydrogen storage costs have been considered in determining the hydrogen demand inputs.

Hydrogen use case

IEEFA, Transgrid and the **ISP Consumer Panel** expressed concerns about the inclusion of hydrogen export load in core ISP scenarios. This feedback will be best considered in the IASR consultation, but AEMO notes that the scenario collection generally reflects lower hydrogen assumptions than in the 2023 IASR, and has proposed two variants to the *Green Energy* scenario, with one assuming that hydrogen exports, particularly as an energy carrier rather than a value-add commodity, do not eventuate.

Regarding feedback from **AGIG**, hydrogen as a source of energy supply is already considered in multi-sectoral modelling commissioned by AEMO which then feeds into ISP modelling as exogenous demands. Increasing the blending assumption may require increased social licence around appliance changeover. Given uncertainty on this matter, AEMO considers it appropriate to conservatively limit blending to 10%. The multi-sectoral model explicitly considers the trade off between hydrogen, electrification and natural gas for residential and commercial loads. AEMO will monitor and review assumptions relating to this process through the IASR process.

Location

In regard to **APGA** feedback regarding assumptions on hydrogen production location (suggesting that limiting production locations to ports is an unrealistic model for the majority of domestic hydrogen production), AEMO notes this aligns with Federal Government and other hydrogen infrastructure assessments. AEMO proposes to model hydrogen loads at the REZ going forward, taking into consideration the cost of transporting hydrogen from the REZ in the electrolyser capex.

This represents a change from the previous methodoloy, where AEMO assumed that many electrolysers would be located at ports, supplied with electricity via transmission from REZs. AEMO has made this change following stakeholder feedback, and review of external studies[30] on the optimal choice

[29] At AER - Cost Benefit Analysis guideline (clean) - 21 November 2024.pdf

[30] DeSantis et al, 2021, Cost of long-distance energy transmission by different carriers, https://doi.org/10.1016/j.isci.2021.103495; Patonia et al, 2023, Hydrogen pipelines vs. HVDC lines:Should we transfer green molecules or electrons?

of pathway. The majority of studies found that it is cheaper to transport molecules, although this can be project-dependent.

In regard to **Transgrid**'s feedback, given modelling constraints, AEMO notes that in practice some electrolyser sites may be completely on-grid or completely off-grid, and others may combine on- and off-grid supply, either temporarily or for the longer term. However for modelling purposes, AEMO assumes that modelling electrolyers as either fully on-grid or fully off-grid is sufficient for planning purposes. For this reason, AEMO does not need to make assumptions regarding the type of off-grid generation servicing the off-grid electrolysers. AEMO only models the on-grid electrolysers.

Other matters

Regarding **Fletcher and Nguyen** and **Sumitomo** feedback, when assessing the suitability of developments of the capacity outlook model, AEMO must balance ensuring simulation times remain manageable with detailed representation of modelling components. AEMO considers that given modelling constraints and to manage model complexity, hydrogen demand for these commodities needs to be aggregated.

Relating to **AGIG**'s suggestion on project data, AEMO has the framework to collect hydrogen project information via the GSOO survey process, but only as far as the hydrogen is directly connected to the east coast gas system, or a direct replacement for an east coast gas customer. Also, AEMO uses HyResource from CSIRO to understand uncertain projects that may exist, requesting further information would constitute a duplication of effort. AEMO may study the possibility of extending the framework to collect data from all hydrogen proponents.

Regarding **APGA** feedback on blending assumptions, stakeholders can provide feedback to the IASR consultation.

4.5.3. AEMO's conclusion

On balance, AEMO still considers it appropriate to impose minimum utilisation factors on hydrogen loads, consistent with AEMO's proposal in the issues paper.

Regarding the period for hydrogen production targets, AEMO proposes to switch to weekly balancing rather than daily. In addition, AEMO proposes to model electrolyser loads in REZs.

These changes are implemented in Section 2.4.8 of the Draft *ISP Methodology.*

4.6. Representation of renewable energy zones

4.6.1. Issue summary and submissions

In the *ISP Methodology* issues paper, AEMO proposed introducing a separate REZ transmission constraint to represent limitations on flow into a REZ (import) and accommodate appropriate treatment of import limitations into the REZ and corresponding augmentation options. The intention of the proposed changes is to have import and export REZ transmission constraints to provide bi-directional limits for the ISP model to optimise REZ augmentation.

https://www.oxfordenergy.org/publications/hydrogen-pipelines-vs-hvdc-lines-should-we-transfer-green-molecules-or-electrons/; DCCEEW, 2023, National Hydrogen Infrastructure Assessment, https://www.dcceew.gov.au/energy/publications/national-hydrogen-infrastructure-assessment; Net Zero Australia, 2023, https://www.netzeroaustralia.net.au/final-modelling-results/.

Seven stakeholders (**Powerlink, CEC, CIS, Hydro Tasmania, Sumitomo, IEEFA** and **Origin**) expressed support for AEMO's proposed multiple wind resource quality tranches for REZs.

In the case where REZ loads require imports from other sources in the network to power them, **Transgrid** proposed including the $Flow_{Flowpath}$ term in the REZ import constraint equation, while **CIS** recommended such loads should not be considered "dispatchable".

Fletcher and Nguyen recommended AEMO should consider adding a validation step for build limits and the level build limit breach that is possible by incurring a penalty factor using proposed project data and further noted the *Green Energy Exports* scenario may be building wind projects over the developable resource footprints and capacity.

The **ISP Consumer Panel** noted the need for the *ISP Methodology* to allow for multiple wind resource traces to be applied for single REZs, in some cases.

4.6.2. AEMO's assessment

AEMO agrees with the **Transgrid** proposal for the inclusion of a $Flow_{Flowpath}$ term in a REZ import constraint equation, for situations where a flowpath impacts on potential congestion in the relevant part of the network.

AEMO does not agree with **CIS** that any load requiring to be fed via import to a REZ should not be deemed dispatchable, as allowing the model to include the output of dispatchable loads can highlight where network upgrades may be able to be deferred. AEMO also does not intend to assume all load in a REZ will be dispatchable in an operational sense and the proposed treatment is to consider loads that are flexible or curtailable. AEMO responses related to feedback on hydrogen load modelling assumptions are in Section 4.5.

AEMO appreciates **Fletcher and Nguyen**'s observations on the land use limit assumptions in the REZs under the Green Energy Exports scenario noting the assumption of 25% of the total REZ land area available for development in this scenario could be larger than the entire area within the REZ that has quality wind resources. AEMO is proposing to review the land use limits as part of the draft IASR consultation, and will take into account proponent input on this aspect.

AEMO considers that the **ISP Consumer Panel**'s request regarding multiple wind resource traces is already permitted within the proposed change to the *ISP Methodology*, with multiple wind resource 'tranches' now accounted for in the Draft *ISP Methodology* where appropriate.

4.6.3. AEMO's conclusion

AEMO generally applies averaging of wind resources and traces over a number of locations for a REZ, and is only proposing to include additional wind tranches in large REZs where the diversity of generation location can impact on the ODP[31]. This could be either due to the diversity of supply, or where these different generation areas impact differently on areas of the network that may require augmentation.

AEMO will review the land use limit calculation for REZs in the Green Energy Exports scenario and potentially cap the land use limit for some REZs below 25%

[31] AEMO has proposed for several REZs to receive this treatment for the 2026 ISP, as part of the stage 1 IASR consultation. For further information, please see section 3.9.1 of Draft 2025 IASR Stage 1, December 2024, at https://aemo.com.au/consultations/current-and-closed-consultations/2025-iasr.

4.7. System security

4.7.1. Issue summary and submissions

In their Response to the Review of the ISP, Energy Ministers called for "greater consideration of system security in assessing the optimal mix of generation, storage, transmission and other infrastructure".

In the *ISP Methodology* issues paper, AEMO proposed reformulating the previous minimum synchronous units constraint to allow the model to reflect the build of equivalent synchronous condensers to replace the system security contributions from retiring synchronous machines. AEMO considered that the reformulated constraint would sufficiently meet both system strength and inertia requirements while providing a more direct proxy for security remediation needs.

Unit commitment and use of alternative security service providers

Three stakeholders (**Transgrid, APA** and **Sumitomo**) broadly supported AEMO's approach to using a revised system security constraint to allow to the model to replace retiring synchronous machines with alternative security service providers. However, **CEC** and **Sumitomo** raised concerns that AEMO's use of synchronous condensers as the proxy for this replacement could lead to locking-in excessive volumes of synchronous condensers while other technologies remain viable options. **Transgrid** recommended that any such constraint should also consider the draft outcomes from regional system security RIT-Ts, and the associated delivery timing of synchronous condensers, which may limit how quickly existing synchronous units could be replaced.

Several stakeholders suggested specific alternate technologies that AEMO should consider as potential system strength and inertia service providers. **APA** and **Sumitomo** proposed that AEMO not limit itself to new synchronous condensers, but to also include both new or repurposed hydro and gas generators, potentially fitted with clutches that enable operation as synchronous condensers when needed. **Transgrid** encouraged AEMO to consider the potential for low-cost hydro units, or static VAR compensators (SVCs) when calculating fault current needs.

Additional security considerations

Powerlink encouraged AEMO to consider additional security risks, such as protection operation, network stability and power quality when assessing the impact of future IBR on system strength and inertia.

Transgrid highlighted potential risks for IBR in some areas of the network that already have relatively low synchronous fault levels, and separately requested that AEMO provide further advice on planning for non-linearities in grid forming batteries when providing synthetic inertia.

Alliance of LDES proposed that long duration energy storage (LDES) technologies, such as solar thermal and compressed air, could play a role in meeting black start requirements, while **CEC** urged AEMO to accelerate its work on the capabilities of grid-forming technology to provide fault current, inertia and related support services.

4.7.2. AEMO's assessment

Based on stakeholder feedback and further internal analysis, AEMO is proposing several revisions to the system security methodology in the issues paper. These changes seek to capture security contributions from a more diverse set of technology options, while balancing against the impacts on model complexity and practical solve times.

Unit commitment and use of alternative security service providers

The issues paper proposed reformulating the 2024 ISP's *minimum synchronous unit constraint* to allow the model to more explicitly consider the magnitude and costs of replacement synchronous condenser equivalents when deciding whether to retire or decommit existing thermal units. While stakeholders generally supported this type of modelling improvement, they raised concerns that this would overly focus on synchronous condensers, and may not appropriately capture the delivery lead times, nor the contributions expected from hydro, gas, and grid-forming technology.

AEMO explored several options to address this stakeholder feedback – including enhancements to the security constraint that would explicitly model contribution and costs from these additional security providers. However, the simulation complexity of co-optimising a full fault-current balance alongside the ISP put model solve times at risk, and was likely to have a similar impact on ODP outcomes as the 'cost component' approach that AEMO now proposes in the Draft *ISP Methodology* and IASR.

This cost component approach manages model complexity by precalculating some security inputs based on known technology lead times and costs, while still capturing the intent of the original methodology proposal – that is, allowing the model to trade off the cost of replacement security services when making investment and disinvestment decisions; and allowing these costs to be captured as part of the total cost of each development pathway.

In the Draft *ISP Methodology*, AEMO now proposes to:

- **Continue to apply minimum synchronous unit commitment constraints.**
  - These constraints will leverage the market testing and analysis conducted by TNSPs in their system strength RIT-Ts, and reflect the latest available information on the costs and lead times of replacement system security services. This will allow AEMO to explicitly capture the delivery timing risks highlighted in the submission from **Transgrid**, and to ensure total costs reflect the need to operate these units for security services until alternative sources become available.
  - A proposed trajectory of unit-commitment requirements is being consulted on through the IASR.
- **Include a new *security remediation component* to the retirement cost of thermal generation.**
  - This cost increase will allow the model to consider the cost of replacement system security services when making retirement decisions. To capture feedback from **APA**, **CEC** and **Sumitomo** regarding the inclusion of broader technology options, the proposed security remediation cost component will be a composite average value reflecting the costs of multiple technologies, with proportions that change over time to reflect readiness and uptake.
  - This cost trajectory will decrease over time as the range of technology options increase. In particular, while the trajectory does begin mostly reflective of synchronous condenser costs, this changes substantially over time as higher proportions of grid-forming and clutch/retrofit options become available.
  - The proposed technology mix, relative costs, and resulting trajectory assumptions are currently being consulted on through the IASR.
- **Adjust the capital cost for future IBR projects and REZ developments based on a trajectory of system strength remediation costs.**
  - While including security remediation costs was already part of the proposed methodology for future IBR and REZ development costs, these costs were previously based directly on

synchronous condenser equivalents. To capture stakeholder feedback, AEMO now proposes to use a similar *composite* trajectory approach, like that proposed above for minimum security remediation costs.

- However, in contrast to the above, the technology mix assumed to provide remediation for future IBR and REZ developmens starts with a significantly higher propotion of grid-forming technology options rather than synchronous condenser equivalents. This reflects that the technology requirements and readiness for stable voltage waveform services (future IBR) differ from that required to deliver minimum fault current services (replacing retiring synchronous units). Synchronous condenser and clutch/retrofit costs are still considered as a component in these costs, however these represent a significantly smaller proportion of the cost trajectory.
- The proposed technology mix, relative cost, and resulting trajectory assumptions are currently being consulted on through the IASR.

Overall, AEMO considers that this revised approach provides the same investment and disinvestment incentives that a complex system security constraint would have done, better considers delivery lead times and contributions from alternative technologies, and balances these improvements against model solve time and complexity.

Additional security considerations

Stakeholders raised several important additional security issues as part of their submissions which AEMO believes sit outside the scope of the ISP modelling and methodology. AEMO has considered these topics below, but has not further modified the methodology in response:

- Consideration of system restoration providers – AEMO agrees with comments from **Alliance of LDES** that alternative technologies have the potential to provide future system services such as system restoration. However, as those services are subject to a separate competitive tender process, with costs that are not expected to vary significantly between network development outcomes, system restoration requirements are not independently assessed as part of the ISP.
- Acceleration of grid-forming technology trials and specifications – AEMO notes the **CEC** request for accelerated work to validate the security capabilities of grid forming technology, and the related request from **Transgrid** for additional information to assist when modelling synthetic inertia sources to meet minimum security requirements.
  - Substantial work was undertaken through the Inertia Methodology Consultation in 2024 to develop and document an assessment approach for quantifying the capabilities of synthetic inertia providers when meting minimum inertia requirements. Further work is underway to demonstrate grid forming technology in practice through pilot projects and investigations under the Engineering Roadmap and as outlined in AEMO's *Transition Plan for System Security* in December 2024.
- Consideration of power quality and other technical characteristics – AEMO agrees with **Powerlink** that system security includes a broad range of power system characteristics, including power quality, stability, harmonics, and the operation of protection schemes. However, while some of these are already built into existing security constraints in the ISP (for example minimum fault levels are already designed to ensure adequate protection system operation), others are likely second order in terms of driving ISP outcomes or are factored into external mechanisms or connection negotiations (for example harmonics and power quality).

- AEMOs high-renewable penetration analysis as part of the 2022 and 2023 network support and control ancillary services (NSCAS) reports identified that system strength (both fault current and stable voltage waveform) was likely to be the most onerous security requirement over coming decades by an order of magnitude. This was validated in the 2024 ISP Appendix 7 security analysis.

4.7.3. AEMO's conclusion

In response to stakeholder feedback and further internal analysis, AEMO has made several revisions to the system security approach proposed in the *ISP Methodology* issues paper. In particular, AEMO will continue to apply a minimum synchronous unit constraint to reflect replacement asset lead times, but will now also apply a security remediation cost to generator retirements and IBR/REZ capital investment decisions to allow the model to consider these costs in its optimisation.

The cost components themselves follow a trajectory that considers a mixture of future technologies, and their expected performance, costs, and readiness to provide each service. The specific trajectories, costs and assumptions are under consultation through the IASR.

5. Other matters

This section lists feedback received from stakeholders on matters other than those raised in the issues paper, and AEMO's assessment of these matters.

AEMO has also tracked additional minor edits in the Draft *ISP Methodology* to show where minor enhancements have been proposed to clarify meaning, update wording, or otherwise provide minor enhancements to the methodology.

Table 5 Specific feedback on ISP Methodology

Feedback received	AEMO response
Transgrid recommended AEMO should provide more detail on interactions between the "Single-stage long-term (SSLT) model", "Detailed long-term (DLT) model" and the "time-sequential model" in the final *ISP Methodology* paper.	AEMO welcomes this feedback and has included additional detail in the Draft *ISP Methodology* on the interactions between these models.
CIS said AEMO should re-issue the *ISP Methodology* Consultation Paper to have regard to the original Federal Government review of the ISP, not just the Energy Ministers' Response to the Review, and should include "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."	AEMO considers that the Energy Ministers' Response to the ISP Review and AEMC rule changes provided stakeholders with significant information relating to the ISP Review. Further, stakeholders are welcome to provide feedback on all matters outlined in the ISP Methodology draft report during this second stage of consultation. AEMO notes that recommendation 14 describes an opportunity to highlight and clarify the role of the Forecasting Assumptions Update and its relationship to the IASR and ISP. This can be achieved by appropriate commentary and links on AEMO's website.
Sumitomo suggested using time domain reduction techniques to identify representative periods in the year which could be modelled, in order to reduce computational burden.	AEMO appreciates this feedback, aimed at reducing computational burden. Model development is an ongoing process, and while AEMO aims to capture as many periods as possible across all reference years using the current grouping techniques in the DLT, consideration will be given to alternative time domain reduction techniques across its modelling suite.
The **ISP Consumer Panel** recommended AEMO should update the methodology to more overtly include 'mid-scale' (100 kilowatts [kW]-30 megawatts [MW]) DER in forecasts.	PV systems in the range 100 kW-30 MW are termed PV non-scheduled generation (PVNSG). The term PVNSG is used where relevant in AEMO's *Electricity Demand Forecasting Methodology*, and a dedicated sub-heading exists to describe how the forecast is developed. Battery storage in the same output range is considered under the commercial segment of the battery forecasts.
Fletcher and Nguyen suggested AEMO consider modelling demand response of major current and future forecast industrial load based on demand response price, duration constraints, ramping constraints and minimum monthly and/or annual load factors.	AEMO appreciates this approach and may consider it in the demand side participation (DSP) forecast methodology based on the availability of the data.
AusNet recommended AEMO consider the modelling and conclusions from the Energy Network Association's "The Time is Now: Getting smarter with the grid"[32] report on benefits from demand-side generation playing a larger role.	AEMO welcomes feedback and notes its proposed approach for inclusion of distribution netwok capabilities and augmentation in its modelling for the 2026 ISP will be taking a similar approach while comparing trade-offs with investments in transmission and generation technologies.

[32] At https://www.energynetworks.com.au/assets/uploads/The-Time-is-Now-Report-ENA-LEK-August-2024.pdf.

Feedback received	AEMO response
CEC recommended AEMO establish a reference group with DNSPs to discuss information building capacity with each consecutive ISP, which includes the AER and other stakeholder groups.	AEMO appreciates this feedback and notes that it is currently in process of collecting distribution level data from DNSPs and working with a consultant to convert this into a format that can be used in the ISP model. AEMO will continue to refine its approach for future ISPs.
Ergon and Energex recommended AEMO leverage DNSPs' ongoing preparations fo the first Annual Information Orders data submissions, with first data available late 2025 for their granularity and to ensure the *ISP Methodology* is linked to a single verifiable data source.	AEMO appreciates this approach and may consider it for future ISPs, but is unable to apply it for the 2026 ISP as the data from the ongoing process may oly be available in late 2025, while AEMO needs to finalise its inputs by July 2025 through publication of the fial IASR. AEMO is collecting information from DNSPs throught a separate data consultation process.
C4NET suggested AEMO consider adjusting its language within the system from supply and demand side to more readily reflect the evolving, bi-directional nature of the market.	AEMO welcomes this suggestion and will continue to highlight the role of consumers and contribution of distributed resources to the energy transition in its reports.
Etrog consulating recommended AEMO modify the glossary definition of "Actionable project progressing under a jurisdictional framework" to not include the word "committed", as it may be confused with a "Committed project" in the regulatory framework.	AEMO has modified its glossary definition of "Actionable project progressing under a jurisdictional framework" to remove "committed" from its description.

A number of submissions discussed issues not covered in this *ISP Methodology* issues paper, which are being consulted on in parallel via the IASR consultation. This feedback is listed in Table 6 below. Unless otherwise identified and responded to in Table 6, AEMO will address this feedback through the IASR consultation.

Table 6 Feedback on issues discussed in *Inputs, Assumptions and Scenarios Report* consultation

Feedback received	AEMO response
ANU suggested AEMO and CSIRO should update the cost model used in GenCost 2023-24 to reflect the most recent version of the Global Pumped Hydro Energy Storage (PHES) Atlases, as well as the locational cost factors for PHES to demonstrate potential for new build PHES in other NEM sub-regions than Tasmania. ANU also said AEMO should include costings for energy-focused (gigawtt hours [GWh]) rather than just power-focused (gigawatts [GW]) pumped hydro systems, and should also develop a cost-curve for pumped hydro costs for each sub-region based on the PHES Atlases.	AEMO considers that these issues pertain to the inputs detailed in the Draft IASR. These submissions will be considered as part of the IASR consultation process.
Dr Anne Smith said AEMO should establish regulated buffer zones in its modelling to protect ecologically sensitive marine areas from the impacts of offshore installations.	
Transgrid encouraged AEMO to apply realistic time-based build limits to REZs and transmission developments.	
CIS said that inconsistencies between CSIRO's and GEM's projections on network constraints and policy assumptions raise significant concerns about the robustness and coherence of the ISP's CER forecasting approach	
Alliance of LDES recommended AEMO consider applying zero or low-cost transmission tariffs for LDES providers to incentivise its deployment.	

Feedback received	AEMO response
Coalition for Community Energy and **Lighter Footprints** suggested AEMO include newly released information from the Australian Conservation Foundation on the carbon intensity of gas[33].	
Fletcher and Nguyen recommended AEMO disaggregate large industrial loads into key major industries where current or future forecast load is material and flexibility input assumptions are or may become available in the future.	AEMO notes this is not possible as demand forecasts will be developed at a sub-regional level and further disagrregation of large industrial loads into key major industries may divulge confidential information.
Some stakeholders (**ISP Consumer Panel**, **Flectcher and Nguyen**) found AEMO's proposal to be insufficiently detailed to provide feedback, and asked for clarification on the resource quality threshold definition, and how the materiality of this wind modelling issue compares to others such as incorporation of external wake losses, site steepness, or proposed wind project data. In general, **Fletcher and Nguyen** proposed AEMO include a metric in the REZ scorecards on the impact of site steepness on wind farm balance.	AEMO considers that wake losses and site steepness are not relevant to the application on import limitations for REZs, which represent the limits on the amount of electric power that could be transferred into the REZ.
CIS expressed concerns that additional sensitivity testing on CER assumptions would be insufficient and obscure critical trade-offs, biasing the analysis towards CER.	In regard to the feedback by **CIS**, AEMO considers that modelling alternative CER assumptions via sensitivity testing may allow for insights to be developed, depending on the results of the core scenario modelling. AEMO will consider how and if to undertake sensitivity testing on the CER inputs and DNSP augmentation capabilitiy data at a later stage in the ISP development process, depending on initial results and materiality and impact of the potential sensitivity.

[33] At https://www.superpowerinstitute.com.au/news/new-groundbreaking-satellite-monitoring-tool-shows-significant-underestimation-of-methane.

Appendix A. Glossary

This glossary has been prepared as a quick guide to help readers understand some of the terms used in the ISP. Words and phrases defined in the National Electricity Rules (NER) have the meaning given to them in the NER. This glossary is not a substitute for consulting the NER, the AER's Cost Benefit Analysis Guidelines, or AEMO's *ISP Methodology*.

Term	Acronym	Explanation
Actionable ISP project	-	Actionable ISP projects optimise benefits for consumers if progressed before the next ISP. A transmission project (or non-network option) identified as part of the ODP and having a delivery date within an actionable window. For newly actionable ISP projects, the actionable window is two years, meaning it is within the window if the project is needed within two years of its earliest in-service date. The window is longer for projects that have previously been actionable. Project proponents are required to begin newly actionable ISP projects with the release of a final ISP, including commencing a RIT-T.
Actionable project progressing under a jurisdictional framework	-	A transmission project (or non-network option), other than an actionable ISP project, which optimises benefits for consumers if progressed before the next ISP, is identified as part of the optimal development path (ODP), and which will progress under a jurisdictional policy that AEMO considers under NER 5.22.3(b) and includes in the ISP.
Candidate development path	CDP	A collection of development paths which share a set of potential actionable projects. Within the collection, potential future ISP projects are allowed to vary across scenarios between the development paths. Candidate development paths have been shortlisted for selection as the ODP and are evaluated in detail to determine the ODP, in accordance with the ISP Methodology.
Capacity	-	The maximum rating of a generating or storage unit (or set of generating units), or transmission line, typically expressed in megawatts (MW). For example, a solar farm may have a nominal capacity of 400 MW.
Committed project	-	A generation, storage or transmission project that has fully met all five commitment criteria (planning, construction, land, contracts, finance), in accordance with the AER's Cost Benefit Analysis Guidelines. Committed projects are included in all ISP scenarios.
Consumer energy resources	CER	Generation or storage assets owned by consumers and installed behind-the-meter. These can include rooftop solar, batteries and electric vehicles (EVs). CER may include demand flexibility.
Consumption	-	The electrical energy used over a period of time (for example a day or year). This quantity is typically expressed in megawatt hours (MWh) or its multiples. Various definitions for consumption apply, depending on where it is measured. For example, underlying consumption means consumption being supplied by both CER and the electricity grid.
Cost-benefit analysis	CBA	A comparison of the quantified costs and benefits of a particular project (or suite of projects) in monetary terms. For the ISP, a cost-benefit analysis is conducted in accordance with the AER's Cost Benefit Analysis Guidelines.
Counterfactual development path	-	The counterfactual development path represents a future without major transmission augmentation. AEMO compares candidate development paths against the counterfactual to calculate the economic benefits of transmission.

Term	Acronym	Explanation
Demand	-	The amount of electrical power consumed at a point in time. This quantity is typically expressed in megawatts (MW) or its multiples. Various definitions for demand, depending on where it is measured. For example, underlying demand means demand supplied by both CER and the electricity grid.
Demand-side participation	DSP	The capability of consumers to reduce their demand during periods of high wholesale electricity prices or when reliability issues emerge. This can occur through voluntarily reducing demand, or generating electricity.
Development path	DP	A set of projects (actionable projects, future projects and ISP development opportunities) in an ISP that together address power system needs.
Dispatchable capacity	-	The total amount of generation that can be turned on or off, without being dependent on the weather. Dispatchable capacity is required to provide firming during periods of low variable renewable energy output in the NEM.
Distributed resources	-	Includes both CER and other distributed resources. Both of these include solar photovoltaic (PV) generation and battery energy storage (BESS) assets, with CER generally understood to be 'behind the meter' and other distributed resources to be 'in front of the meter'. For other distributed resources, these are generally between 100 kW and 30 MW in capacity for solar PV, and between 5 MW and 30 MW for BESS.
Firming	-	Grid-connected assets that can provide dispatchable capacity when variable renewable energy generation is limited by weather, for example storage (pumped-hydro and batteries) and GPG.
Future ISP project	-	A transmission project (or non-network option) that addresses an identified need in the ISP, that is part of the ODP, and is forecast to be actionable in the future.
Identified need	-	The objective a TNSP seeks to achieve by investing in the network in accordance with the NER or an ISP. In the context of the ISP, the identified need is the reason an investment in the network is required, and may be met by either a network or a non-network option.
ISP development opportunity	-	A development identified in the ISP that does not relate to a transmission project (or non-network option) and may include generation, storage, demand-side participation, or other developments such as distribution network projects.
Net market benefits	-	The present value of total market benefits associated with a project (or a group of projects), less its total cost, calculated in accordance with the AER's Cost Benefit Analysis Guidelines.
Non-network option	-	A means by which an identified need can be fully or partly addressed, that is not a network option. A network option means a solution such as transmission lines or substations which are undertaken by a Network Service Provider using regulated expenditure.
Optimal development path	ODP	The development path identified in the ISP as optimal and robust to future states of the world. The ODP contains actionable projects, future ISP projects and ISP development opportunities, and optimises costs and benefits of various options across a range of future ISP scenarios.
Regulatory Investment Test for Transmission	RIT-T	The RIT-T is a cost benefit analysis test that TNSPs must apply to prescribed regulated investments in their network. The purpose of the RIT-T is to identify the credible network or non-network options to address the identified network need that maximise net market benefits to the NEM. RIT-Ts are required for some but not all transmission investments.
Renewable energy	-	For the purposes of the ISP, the following technologies are referred to under the grouping of renewable energy: "solar, wind, biomass, hydro, and hydrogen turbines". Variable renewable energy is a subset of this group, explained below.

Term	Acronym	Explanation
Renewable energy zone	REZ	An area identified in the ISP as high-quality resource areas where clusters of large-scale renewable energy projects can be developed using economies of scale.
Renewable drought	-	A prolonged period of very low levels of variable renewable output, typically associated with dark and still conditions that limit production from both solar and wind generators.
Scenario	-	A possible future of how the NEM may develop to meet a set of conditions that influence consumer demand, economic activity, decarbonisation, and other parameters. For the 2024 ISP, AEMO has considered three scenarios: *Progressive Change*, *Step Change* and *Green Energy Exports*.
Secure (power system)	-	The system is secure if it is operating within defined technical limits and is able to be returned to within those limits after a major power system element is disconnected (such as a generator or a major transmission network element).
Sensitivity analysis	-	Analysis undertaken to determine how modelling outcomes change if an input assumption (or a collection of related input assumptions) is changed.
Spilled energy	-	Energy from variable renewable energy resources that could be generated but is unable to be delivered. Transmission curtailment results in spilled energy when generation is constrained due to operational limits, and economic spill occurs when generation reduces output due to market price.
Transmission network service provider	TNSP	A business responsible for owning, controlling or operating a transmission network.
Utility-scale or utility		For the purposes of the ISP, 'utility-scale' and 'utility' refer to technologies connected to the high-voltage power system rather than behind the meter at a business or residence.
Value of greenhouse gas emissions reduction	VER	The VER estimates the value (dollar per tonne) of avoided greenhouse gas emissions. The VER is calculated consistent with the method agreed to by Australia's Energy Ministers in February 2024.
Virtual power plant	VPP	An aggregation of resources coordinated to deliver services for power system operations and electricity markets. For the ISP, VPPs enable coordinated control of CER, including batteries and electric vehicles.
Variable renewable energy	VRE	Renewable resources whose generation output can vary greatly in short time periods due to changing weather conditions, such as solar and wind.

Attachment. Addressing perfect foresight for storage devices in the time-sequential model

Published separately and available at https://aemo.com.au/en/consultations/current-and-closed-consultations/2026-isp-methodology.