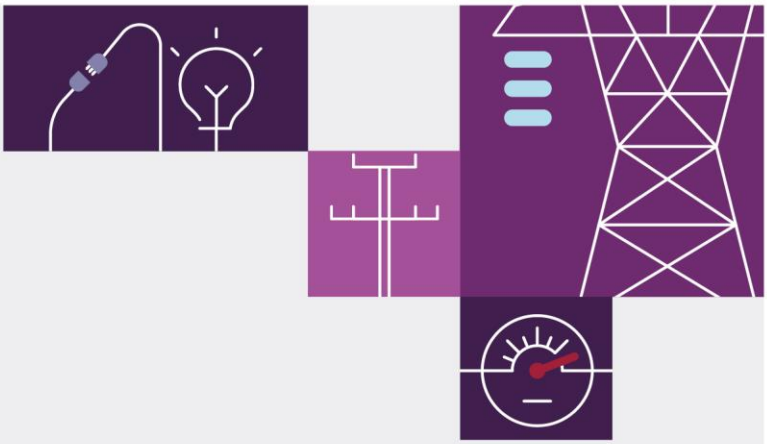
Addendum to the Draft 2024 Integrated System Plan

April 2024

For the National Electricity Market

A report in response to the Australian Energy Regulator's transparency review of the Draft 2024 Integrated System Plan



Important notice

Purpose

The purpose of this publication is to address the issues raised in the transparency review report for the Draft 2024 Integrated System Plan (ISP) published by the Australian Energy Regulator (AER) and provide additional information on how key inputs and assumptions were derived and their contribution to the outcomes in the draft 2024 ISP.

AEMO publishes this Addendum to the Draft 2024 ISP in accordance with clause 5.22.13 of the National Electricity Rules (Rules). This publication is generally based on information available to AEMO as at 12 April 2024 unless otherwise indicated.

Disclaimer

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Modelling work performed as part of preparing this publication inherently requires assumptions about future behaviours and market interactions, which may result in forecasts that deviate from future conditions. There will usually be differences between estimated and actual results, because events and circumstances frequently do not occur as expected, and those differences may be material.

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1 Introduction

AEMO has prepared this report in response to the Australian Energy Regulator's (AER's) "transparency review report"[1] of the Draft 2024 *Integrated System Plan* (ISP)[2]. This section provides an overview of this report, invites stakeholders to provide written feedback, and notes the process to develop the 2024 ISP.

Background

In 2020, reforms to the National Electricity Rules (NER) and the National Electricity Law (NEL) converted AEMO's ISP into an actionable strategic plan. As part of this, the AER is required to review the adequacy of AEMO's explanations of the derivation of key inputs and assumptions, and how key inputs and assumptions influenced outcomes in the Draft ISP[3].

Overall, the AER's Transparency Review of AEMO's Draft 2024 ISP ("transparency review report") concluded that "*AEMO has adequately explained most of its inputs and assumptions, and how they contribute to the draft ISP outcomes*".

In addition, the transparency review report identified several aspects of the Draft 2024 ISP where AEMO could better explain how key inputs and assumptions contributed to the Draft 2024 ISP outcomes. AEMO provides further explanatory material on these matters in this Addendum, as follows:

- Scenarios for sensitivity analysis and presentation of results – see Section 2.
- Consumer energy resources (CER) – see Section 3.
- Jurisdictional policies for renewable energy zones (REZs) – see Section 4.
- Firming and storage in REZs – see Section 5.
- System security remediation costs – see Section 6.

Invitation to written submissions

AEMO has consulted with stakeholders on the Draft 2024 ISP. AEMO now invites stakeholders to provide written submissions giving feedback on the content of this Addendum. Submissions should be provided in PDF format to ISP@aemo.com.au by 5pm (AEST), Friday 3 May 2024.

Where possible, submissions should provide evidence and information to support any views or claims that are put forward. AEMO will publish submissions on its website, subject to materiality and confidentiality requirements[4]. Please identify any parts of your submission that you wish to remain confidential and explain why.

[1] At https://www.aer.gov.au/publications/reports/performance/transparency-review-aemo-draft-2024-integrated-system-plan.

[2] At https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp.

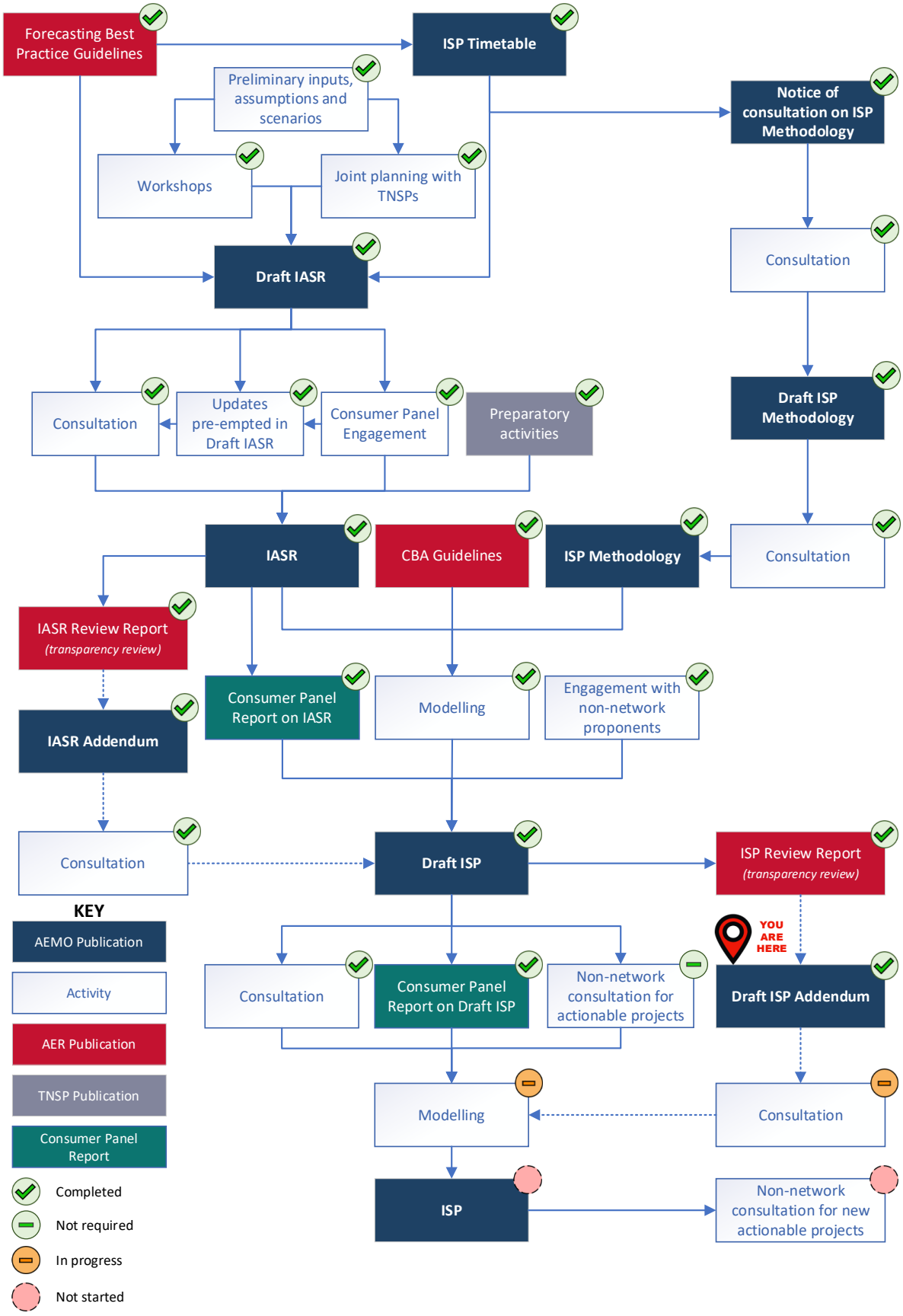
[3] NER 5.22.13(a).

[4] This is consistent with AEMO's obligations under section 54 of the National Electricity Law.

Process to develop the 2024 ISP

This Addendum is published to support the Draft 2024 ISP. Figure 1 displays the process to develop the 2024 ISP, including publications and consultations required under the ISP regulatory framework.

Figure 1 The ISP process



2 Scenarios for sensitivity analysis and presentation of results

This section addresses the transparency review report matters relating to sensitivity analysis and presentation of results.

Matters raised in the transparency review report

"*The draft 2024 ISP explored three scenarios: step change, progressive change and green energy exports scenarios. It assessed the resilience of the [optimal development path] by applying a number of alternative assumptions to the step change scenario through sensitivity analysis. Further, much of the output in the draft ISP and its appendices is only presented for the step change scenario, despite the progressive change scenario having similar weighting.*"

We expect AEMO to provide details … for any sensitivity analysis undertaken for scenarios other than the step change scenario, or explain the reasons for why it has not undertaken this additional analysis."

AEMO's response

The AER's Cost Benefit Analysis Guidelines[5] provide AEMO with flexibility over how it undertakes sensitivity testing and how many sensitivities to test in the ISP. The guidelines also recommend that AEMO should, in deciding how many sensitivities to test, recognise the risk assessment already undertaken through scenario analysis and the resource cost of additional modelling runs. The Draft 2024 ISP includes a number of sensitivities on Step Change alone, as well as on Step Change and other scenarios.

To select which sensitivity analysis to apply to each scenario for the Draft 2024 ISP, AEMO applied the same principles used to develop the scenario collection. These principles, as outlined in the 2023 *Inputs, Assumptions and Scenarios Report* (IASR)[6], ensure that the sensitivities are sound and that they provide additional insights to the core scenarios. As such, AEMO tested each sensitivity and its application to scenario(s) to consider if it was:

- **Internally consistent** – The underpinning assumptions in a scenario (with a sensitivity applied to the scenario) must form a cohesive picture in relation to each other.
- **Plausible** – The potential future described by a scenario narrative (with a sensitivity applied to the scenario) could come to pass.
- **Distinctive** – Individual scenarios (with sensitivities applied to them) must be distinctive enough to provide value to AEMO and stakeholders.
- **Broad** – The scenario set (with sensitivities applied to them) covers the breadth of possible futures.
- **Useful** – The scenarios (with sensitivities applied to them) explore the risks of over- and under-investment.

[5] At https://www.aer.gov.au/industry/registers/resources/guidelines/guidelines-make-integrated-system-plan-actionable.

[6] At https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-inputs-assumptions-and-scenarios-report.pdf

When deciding on sensitivity application to scenarios, AEMO also considered scenario weightings and core scenario outcomes. Ultimately the results of the Draft ISP modelling allowed for a decision to be made about the optimal development path (ODP) using the weighted net market benefit results, meaning that fewer sensitivity analyses were needed to fully assess the robustness of the ODP. That is, AEMO decided that undertaking a higher number of sensitivities on the most likely scenario would provide a fuller assessment of the robustness of the ODP than fewer sensitivities on all scenarios[7].

Finally, AEMO considered modelling timeline constraints when deciding how much analysis to prepare and report on for the Draft 2024 ISP. Results of the full sensitivity analysis are presented in Appendix 2, Appendix 6, and the Draft 2024 ISP generation and storage outlook files. Other appendices presented *Step Change* results only, to allow for provision of a deeper analysis on the most likely scenario while also keeping content size and modelling timelines manageable.

Table 1 below presents the list of sensitivity analyses and explains why each was applied to certain scenarios and not others. AEMO is considering exploring additional sensitivities in the final 2024 ISP, based on stakeholder feedback received through the Draft 2024 ISP consultation.

Table 1 List of sensitivities in the Draft 2024 ISP

Sensitivity	Scenario(s) to which the sensitivity was applied	Explanation
Rapid Decarbonisation	*Step Change*	This sensitivity explores the impact of bringing forward decarbonisation of the National Electricity Market (NEM) by applying a carbon budget to limit global temperature rise to 1.5°C consistent with *Green Energy Exports*. The scenario settings for *Progressive Change* are not internally consistent with a rapid amount of action linked to a 1.5°C temperature rise limitation, as the *Progressive Change* scenario is underpinned in its scenario settings by a narrative of a slower rate of transition to net zero emissions, limiting temperature increases to 2.6°C by the end of the century. Therefore, applying a *Rapid Decarbonisation* sensitivity to the *Progressive Change* scenario would not be internally consistent. As a *Rapid Decarbonisation* sensitivity uses the carbon budget from the *Green Energy Exports* scenario, a *Rapid Decarbonisation* sensitivity to the *Green Energy Exports* would not be distinct nor provide additional value to the ISP assessment.
Reduced Energy Efficiency	*Step Change*	This sensitivity explores the impact of lower levels of energy efficiency investments[8] compared to what is forecast in the *Step Change* scenario. The total efficiency savings applied to the electricity consumption forecast for this sensitivity already follows a similar trajectory to the forecast applied to the *Progressive Change* scenario for most of the modelling horizon. This large similarity in the energy efficiency saving assumptions does not make a *Reduced Energy Efficiency* sensitivity to the *Progressive Change* scenario sufficiently distinct from the *Progressive Change* scenario itself. Therefore, it would not provide additional insight in evaluating the robustness of the ODP. The *Green Energy Exports* scenario requires significant rapid transformation of the energy system to align with limiting temperature rises to 1.5°C by the end of the century, including reliance on energy efficiency savings to achieve this transformation. Limiting the amount of energy efficiency further would increase energy consumption, which is already significantly higher in this scenario compared to all others. As such, AEMO considered there would be limited value in assessing even higher levels of energy consumption for this book-end scenario, and so decided not to apply this sensitivity to *Green Energy Exports*.

[7] All the sensitivities in the Draft 2024 ISP were applied to the *Step Change* scenario, which was identified through extensive stakeholder engagement as the most likely scenario.

[8] Figures 31 and 32 of the 2023 IASR provide a comparison of the energy savings trajectories applied. At https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-inputs-assumptions-and-scenarios-report.pdf

Sensitivity	Scenario(s) to which the sensitivity was applied	Explanation
Electrification Alternatives	*Step Change*	This sensitivity explores the role of biomethane in a world where industrial electrification is delayed and deferred relative to *Step Change*. This sensitivity to the *Step Change* scenario as a result features lower electricity consumption. An *Electrification Alternatives* sensitivity to the *Progressive Change* scenario does not provide a distinctive future as the level of electrification in the *Progressive Change* scenario is already broadly aligned to that in *Electrification Alternatives* sensitivity to the *Step Change* scenario, particularly over the outlook period to the 2040s. The *Green Energy Exports* includes a strong level of electrification to support decarbonisation efforts, as well as significantly higher levels of biomethane use (and much earlier deployment) than the other scenarios in the collection. As such it was considered that applying an *Electrification Alternatives* sensitivity to this scenario could be internally inconsistent with the rest of the scenario settings and as such was not prioritised for the Draft 2024 ISP.
Constrained Supply Chains	*Step Change*	This sensitivity explores the impact of supply chain restrictions and limited workforce availability, by assuming a delay for delivery of transmission augmentation projects and a capped rate of new generation and storage development across the NEM, to understand the risks posed by supply chain constraints. The annual build of new renewable energy build under the *Progressive Change* scenario is 4.6 gigawatts (GW) until 2029-30 which is similar to the NEM-wide annual build limit applied to this sensitivity. AEMO considers that a *Constrained Supply Chains* sensitivity to the *Progressive Change* scenario does not provide a sufficiently distinct narrative to that of the *Progressive Change* scenario and therefore does not provide additional value to the assessment. For *Green Energy Exports*, a future with delays in infrastructure development is internally inconsistent with the scenario narrative that reflects a rapid pace of decarbonisation activity, hence it is not considered.
Reduced Social Licence	*Step Change*	This sensitivity explores the impact if social licence risks are not adequately addressed. The outcomes of the modelling demonstrated the resilience of the ODP to this sensitivity when applied to *Step Change*. Appendix 8 of the Draft 2024 ISP provides an overview of the topic and seeks feedback on opportunities to better integrate social licence consideration in the capacity outlook models. Separately, AEMO published the principles and parameters applied to develop the social licence sensitivity in the IASR Addendum[9]. AEMO engaged with the Advisory Council on Social Licence and the ISP Consumer Panel to develop these principles and parameters. As this is the first time the ISP has considered analysis of reduced social licence, AEMO deemed it appropriate to only implement it on the *Step Change* scenario. This is because of modelling timelines, the fact that this is a novel sensitivity, and because AEMO does not currently hold specific data about social licence and community acceptance as it relates to individual projects across the NEM throughout the ISP planning horizon.
Higher Discount Rate	*Step Change* *Progressive Change* *Green Energy Exports*	This sensitivity is applied to all scenarios.
Lower Discount Rate	*Step Change* *Progressive Change* *Green Energy Exports*	This sensitivity is applied to all scenarios.
Development of Pioneer-Burdekin Pumped Hydro Project	*Step Change* *Progressive Change*	This sensitivity explores the impact of treating Pioneer-Burdekin Pumped Hydro Project in North Queensland as an anticipated project. Because the *Green Energy Exports* scenario has medium and deep storage capacity development as high as the capacity of the pumped hydro of interest, a *Pioneer-Burdekin* sensitivity to the *Green Energy Exports* is not considered sufficiently distinct from the *Green Energy Exports* scenario.

[9] At https://aemo.com.au/-/media/files/major-publications/isp/2023/addendum-to-2023-inputs-assumptions-and-scenarios-report.pdf?la=en.

Sensitivity	Scenario(s) to which the sensitivity was applied	Explanation
Development of Cethana Pumped Hydro Project	*Step Change*	This sensitivity explores the impact of treating the Cethana Pumped Hydro Project in Tasmania as an anticipated project. The sensitivity was not part of the proposed list of sensitivities in the 2023 IASR and it is only implemented to assess the impact of this project on the actionability of Project Marinus. The sensitivity is not applied to *Progressive Change* and *Green Energy Exports* because the development of the two stages of Project Marinus is optimal within the actionable window in the least-cost DP for these scenarios.
Transmission cost uncertainty	*Step Change* *Progressive Change* *Green Energy Exports*	This sensitivity is applied to all scenarios.

3 Consumer energy resources

This section addresses the transparency review report matters relating to CER orchestration assumptions and costs.

Matters raised in the transparency review report

"Appendix 2 of the draft 2024 ISP identifies that in the longer term existing, committed, and anticipated battery solutions will reach their own point of retirement and renewal of these assets may not be needed if the scale of CER and CER orchestration is achieved. The draft ISP also identifies varying levels of CER orchestration across the three scenarios assessed. However, we expect AEMO to provide details on the underlying assumptions of CER orchestration as forecast across the different scenarios.

We also note that AEMO has not explained how or whether the cost of these assumptions were modelled. AEMO notes that, without significant policy changes and increased social licence, a high level of orchestration is not possible … We therefore expect AEMO to provide further explanation on these matters …"

AEMO's response

Underlying assumptions of CER orchestration

AEMO assumes that a degree of CER 'orchestration' will occur in the NEM, which is varied by scenario and consistent with each scenario's narrative. CER orchestration refers to technical and commercial integration of consumer battery storage into the power system, synonymous with the establishment of virtual power plants (VPPs).

AEMO's forecasts for orchestrated CER was determined through:

- Design, in consultation with stakeholders, of scenarios that explored a range of consumer engagement for VPP and demand-side participation in the NEM. The range is evident in the scenario narratives, and levels of engagement and participation are set out in Table 4 of the 2023 IASR.
- Consultants (CSIRO and Green Energy Markets, or GEM) prepared forecasts for anticipated CER adoption that aligned with these levels, considering:
  - PV and battery forecasts[10], which are based on their payback to the consumer.
  - The assumed level of VPP incentives that a consumer will be exposed to in each scenario, and its relative attractiveness and effectiveness to encourage orchestrated battery solutions to be preferred by consumers rather than more passive consumer investments.

AEMO selected CER orchestration projections for use in each of its scenarios by taking a blend of the consultants' forecasts. The selection was made based on alignment with scenario narratives, retention of appropriate forecast relativities between scenarios, and suitability in reflecting the uncertainty inherent in long-term forecasts. The underlying assumptions to inform these projections are shown below as follows:

[10] For modelling purposes, AEMO and its consultants treat residential and commercial battery storages as optional add-ons for distributed photovoltaics (PV), rather than stand-alone technologies.

- Table 2 shows the mapping of consultant forecasts for each of AEMO's scenarios[11],
- Table 3 shows CSIRO's assumed proportions of battery storage operating modes, including for VPPs, and
- Table 4 shows GEM's assumed proportions of battery storage operating modes, including for VPPs.

Table 2 Consultant scenario mapping for CER[11]

Scenario	*Green Energy Exports*	*Step Change*	*Progressive Change*
PV forecast mapping	GEM	Average	CSIRO
PVNSG forecast mapping	GEM	GEM	CSIRO
Battery and VPP forecasts mapping	Average	Average	CSIRO

Table 3 CSIRO table of assumed proportions of tariffs and subsequent battery storage operating modes by scenario[12]

	Flat Tariff (Solar shift mode)		Time of use tariff		VPP contract (Aggregated mode)	
	Residential	**Commercial**	**Residential**	**Commercial**	**Residential**	**Commercial**
2030						
Progressive Change	59%	18%	30%	72%	10%	10%
Exploring Alternatives	56%	17%	28%	68%	15%	15%
Step Change	50%	15%	25%	60%	25%	25%
Hydrogen Export	51%	16%	26%	62%	23%	23%
2050						
Progressive Change	53%	16%	26%	64%	20%	20%
Exploring Alternatives	46%	14%	23%	56%	30%	30%
Step Change	33%	10%	17%	40%	50%	50%
Hydrogen Export	36%	11%	18%	44%	45%	45%

Table 4 GEM table of assumed proportions of battery storage operating modes by scenario[13]

	Solar Shift		Tariff Optimisation		VPP	
	Residential	**Commercial**	**Residential**	**Commercial**	**Residential**	**Commercial**
2030						
Progressive Change	45%	45%	23%	24%	32%	32%
Exploring Alternatives	15%	14%	25%	26%	59%	60%
Step Change	7%	7%	24%	24%	69%	70%
Hydrogen Export	7%	7%	24%	24%	69%	70%
2050						
Progressive Change	20%	20%	20%	20%	60%	60%

[11] Reproduced from Table 18 in AEMO's 2023 Inputs, Assumptions and Scenarios Report at https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-inputs-assumptions-and-scenarios-report.pdf

[12] Reproduced from Table 4-2 in CSIRO's report available here: https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2022/2023-inputs-assumptions-and-scenarios-consultation/supporting-materials-for-2023/csiro-2022-solar-pv-and-battery-projections-report.pdf?la=en

[13] GEM's figures are not explicitly stated in their report, but are summarised in Table 4 for comparison with the CSIRO figures

	Solar Shift		Tariff Optimisation		VPP	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
Exploring Alternatives	2%	2%	23%	23%	75%	75%
Step Change	2%	2%	8%	8%	90%	90%
Hydrogen Export	2%	2%	8%	8%	90%	90%

AEMO's resulting CER orchestration projections that applied in the Draft 2024 ISP are subsequently reported in the 'Aggregated energy storages' worksheet of the 2023 Inputs and Assumptions Workbook that was published alongside the 2023 IASR[14]. The proportion of VPPs in operation can be calculated by dividing the 'Aggregated energy storages' worksheet values by the 'Embedded energy storages' worksheet values. All stages of the process, including scenario design, the consultants' work, the blending and results, were consulted on and determined through the IASR process, considering stakeholder feedback.

The CER capacity forecasts and the energy outcomes from these resources across three different scenarios, including 18 different candidate development paths (CDPs) for each scenario, can be found in the Draft 2024 ISP Generation and Storage Outlook workbooks[15]. Further information can be found in the Draft 2024 ISP Appendix 4 (System Operability), which shows the evolution of CER and its impact on demand profiles[16].

Treatment of CER costs

Regarding the modelling of CER costs, AEMO notes that the direct cost of CER investments to consumers was considered in the development of the CER uptake forecasts. In these forecasts, as conducted by each of the respective consultants, CER investments have regard to the relative costs and anticipated payback of each device, considering consumer incentives assumed in each scenario, including tariff settings and additional revenue that may be offered to VPP customers. Each consultant report describes the forecasting methodology that considers the interaction of costs and benefits to each consumer's purchasing decision.

The Draft ISP has then taken the CER forecasts as an input to the Draft ISP modelling process. The Draft 2024 ISP notes the role of government support in enabling high levels of orchestration, for example in Section 8.3 of the Draft 2024 ISP as well as in Appendix A8 Social Licence[17]. To provide additional information regarding the overall value of orchestration of CER and what the alternative investments to orchestration would be, the final 2024 ISP will include the results of a 'Low CER Orchestration' sensitivity exploring the impacts on the NEM outlook should high levels of orchestration not be achieved.

[14] At https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-iasr-assumptions-workbook.xlsx

[15] At https://aemo.com.au/consultations/current-and-closed-consultations/draft-2024-isp-consultation; see zip files for each of the three scenarios, with options to view the CER modelling results for 18 different CDPs and one counterfactual.

[16] See page 9, at https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/draft-2024-isp-consultation/appendices/a4-system-operability.pdf?la=en.

[17] At https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/draft-2024-isp-consultation/appendices/a8-social-licence.pdf?la=en.

4 Jurisdictional policies for renewable energy zones

This section addresses the transparency review report matters relating to jurisdictional policies for renewable energy zones.

Matters raised in the transparency review report

"*Appendix 3 of the draft 2024 ISP presents information about the development of renewable energy zones (REZ) in the NEM. While we note that this development is largely underpinned by state-based frameworks, as noted in the IASR, the outlook in each jurisdiction is not consistently related back to the planning documents, legislation and ministerial orders in each jurisdiction. As an example, the draft ISP notes the Victorian offshore wind targets, however, the Queensland SuperGrid Infrastructure Blueprint and Queensland REZ Roadmap are not mentioned and treated as options.*

It is also not clear in the draft ISP how the development paths relate to these state-based policy commitments. For example:

- *The offshore wind target of the Victorian government results in 9 GW of generation capacity, but the offshore zones in all other states have no modelled generation capacity despite significant resources and progress on delivery.*
- *For NSW, the reported Illawarra REZ generation capacity does not match the REZ network capacity declared by the NSW Energy Minister despite a mechanism to directly support its development through the auction of long-term energy service agreements to generators and storage operators under the Electricity Infrastructure Investment Act 2020 (NSW).*
- *In Queensland, the draft ISP identifies a concentration of capacity in a few REZs, where the REZ Roadmap identifies multiple smaller rather than larger capacity zones."*

We expect AEMO to show how the draft ISP modelling results align with the policy commitments in each jurisdiction, including the overall size of zones, the flexibility of the timing of infrastructure delivery and the rate of capacity increase.

AEMO's response

In determining power system needs[18] and how the ISP would contribute to achieving the National Electricity Objective, AEMO considers:

- Jurisdictional policies that meet, or that it anticipates will meet by the time of the publication of the final ISP, the public policy clause criteria[19] that determine which environmental or energy policies AEMO must consider, and

[18] NER 5.22.3

[19] NER 5.22.3(b)(2)

- Policies in the AEMC Targets Statement for Greenhouse Gas Emissions[20].

Policies are considered as inputs to the ISP modelling, usually as over-arching emission limits or generation development requirements, or transmission options to be considered. Only committed or anticipated projects are included consistent with specific timings across all scenarios in the Draft ISP modelling. This means requirements for new generation and transmission are optimised across the modelling timeframe to meet the over-arching policy requirements, and ultimately the Draft ISP treats most generation, storage and transmission as an output from the model, not a strictly enforced input.

Table 5 provides a listing of the jurisdictional policies applied in the Draft 2024 ISP as they relate to REZ outcomes. A complete list of all policies, with further details and discussion, is also included in section 3.1 of the 2023 IASR[21]. The table is followed by specific commentary on the Victoria, New South Wales and Queensland matters raised by the AER.

Table 5 Policies by jurisdiction as they apply to REZs in the Draft 2024 ISP

Policies by jurisdiction	Draft 2024 ISP modelling and results (*Step Change* scenario)
Australian Government	
• Emission reduction of 43% below 2005 levels by 2030 and net zero by 2050 under the *Climate Change Act (2022)* (Cth).	Emission reduction targets are explicitly modelled, results show these being met.
• Complementing the 2030 emissions target is the Federal Government's commitment to achieve an 82% share of renewable generation by 2030, announced in the Powering Australia Plan.	NEM Renewable energy targets are explicitly modelled, results show share of renewable generation by 2030 is 82%.
• Offshore renewable energy zones as declared by the Commonwealth Government for potential development (only geographic areas are declared, no targets are legislated). Current zones declared are for Gippsland, Hunter, Southern Ocean, Illawarra and Bass Strait.	Zone locations and resource quantities calculated and modelled using the Commonwealth consultation outcomes[22] as candidate zones where offshore wind can be developed for Gippsland Coast, Hunter Coast, Portland Coast, Illawarra Coast and North Tasmania Coast. An additional candidate zone was modelled in the South East South Australia Coast due to developer interest at the time.
• Announcements made under the Rewiring the Nation framework to support transmission infrastructure.	Impacts of concessional finance not included explicitly, consistent with AEMO's ISP Methodology consultation completed in March 2023.
New South Wales Government	
• New South Wales REZs as declared by the New South Wales *Electricity Infrastructure Investment Act 2020* (NSW EII Act).	REZs declared in New South Wales modelled as per the published geographic locations, including Central West Orana, New England, South West New South Wales, Hunter and Illawarra. Additional REZs as per earlier ISP definitions maintained in the modelling.
• Emission reduction targets of 50% by 2030 and net zero by 2050 (legislation is pending).	Emission reduction targets are explicitly modelled, results show these being met.
• New renewable generation that can produce the same electricity as 8 GW in New England REZ, 3 GW in Central-West Orana REZ, and 1 GW elsewhere by end of 2029 under the New South Wales *Electricity Infrastructure Investment Act 2020* (NSW EII Act).	Modelled as a total New South Wales target of 33,600 GWh per year by 2029-30. Results show 55,468 GWh from eligible VRE in 2029-30 [A].
• Target of 2 GW of deep storage by 2030 under the NSW EII Act.	Target explicitly modelled, results show 2 GW in 2030.

[20] At https://www.aemc.gov.au/regulation/targets-statement-emissions

[21] At https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-inputs-assumptions-and-scenarios-report.pdf?la=en

[22] At https://www.dcceew.gov.au/energy/renewable/offshore-wind/areas

Policies by jurisdiction	Draft 2024 ISP modelling and results (*Step Change* scenario)
• Treatment of offshore renewable energy zones as declared by the Commonwealth Government off the New South Wales coast.	No New South Wales targets are specified for offshore wind. Offshore wind can be selected by the model in the Hunter Coast and Illawarra Coast offshore zones if this is part of the least-cost solution. No offshore wind developed in results.
• Consideration of various transmission development options under the NSW Electricity Infrastructure Roadmap, including Renewable Energy Zone network infrastructure projects and priority transmission infrastructure projects (PTIPs) under the NSW EII Act. • Waratah Super Battery System Integrity Protection Scheme will be treated as a committed project, and Central-West Orana Transmission Project will be treated as an anticipated project.	Network options considered are consistent with the EnergyCo Network Investment Strategy options. Network options for Central West Orana are modelled as Anticipated, while upgrades for other New South Wales REZs are not forced in, but selected by the model if optimal. Both included in the modelling.
Queensland Government	
• REZ proposals as per the Queensland Energy and Jobs Plan REZ (QREZ) Roadmap.	Proposed Queensland REZ connection node locations taken into account in aligning network limits and REZ network upgrade options. REZ resource limits modelled as per existing ISP Queensland REZ definitions.
• Expansion of the Queensland Renewable Energy Target (QRET) to 50% by 2030, 70% by 2032, and 80% by 2035 under the Queensland Energy and Jobs Plan (QEJP); legislation is under consultation.	QRET explicitly modelled, results show 82% by 2030, 89% by 2032, and 105% by 2035.
• Development of Borumba Pumped Hydro Energy Storage (PHES – now classified as an Anticipated project under AEMOs' generation commitment criteria). • Pioneer-Burdekin Pumped Hydro Project is not yet classified as anticipated, and instead pumped hydro energy storage 24-hour capacity in Central Queensland can be developed up to Pioneer-Burdekin's size as part of the ISP optimisation methodology.	Borumba Pumped Hydro Energy Storage is an anticipated project in all modelling.
• Consideration of various transmission development options and QREZ infrastructure, as described in the SuperGrid Infrastructure Blueprint and QREZ Roadmap. • CopperString 2032 will be treated as an Anticipated project with the Townsville to Hughenden connection being modelled quantitively as a REZ network expansion.	The SuperGrid infrastructure projects have been considered as upgrade options. Network options are not forced in, but selected by the model if optimal. Included as an anticipated project in all modelling.
Victorian Government	
• Treatment of REZs in Victoria consistent with the VicGrid Renewable Energy Zones Development Plan Directions paper.	VicGrid notes the ISP identification of candidate REZs in Victoria. REZs are not legislated in Victoria. REZs are modelled as per the IASR locations and sizes.
• Target of emissions reduction of 28-33% below 2005 levels by 2025, 50% by 2030, 75-80% by 2035 and net zero by 2050 under Victoria's *Climate Change Act 2017*; and the net zero emission target by 2045 that is intended to be legislated.	Emission reduction targets are explicitly modelled, results show these being met.
• Victorian Renewable Energy Target (VRET) of 40% by 2025, 50% by 2030 under the Renewable Energy (Jobs and Investment) Act 2017, and intentions to update VRET with 65% of the state's generation to come from VRE by 2030 and 95% by 2035.	VRET explicitly modelled, results show 52% by 2025, 80% by 2030, 99% by 2035.
• Storage target of 2.6 GW by 2030 and 6.3 GW by 2035 (legislation is pending).	Implemented as a trajectory as laid out in the 2023 Inputs and Assumptions Workbook (targets are met in modelling results).
• Offshore wind targets for Victoria of 2 GW by 2032, 4 GW by 2035, and 9 GW by 2040 as stated in the Offshore Wind Policy Directions Paper and Implementation Strategy Statements One and Two (legislation is pending), and treatment of offshore renewable energy zones as declared by the Commonwealth Government off the Victoria coast	Offshore wind targets explicitly modelled. Offshore wind can be selected by the model in the Gippsland Coast and Portland Coast offshore zones to meet these targets. Results show 2 GW in 2032, 4 GW in 2035, and 9 GW in 2040 across both offshore zones.

Policies by jurisdiction	Draft 2024 ISP modelling and results (*Step Change* scenario)
• Consideration of various transmission development options, including coordinating the planning and development of REZs through VicGrid, supported by the *National Electricity (Victoria) Act 2005* (NEVA).	AEMO has co-ordinated developments with VicGrid on REZ developments. Network options are not forced in, but selected by the model if optimal.
• The Western Renewables Link and the Mortlake Turn-in are treated as Anticipated projects	Both included in the modelling as Anticipated projects
South Australian Government	
• Target of 60% (40% of 1990 levels) by 2050 under the *Climate Change and Greenhouse Emissions Reduction Act 2007*.	Emission reduction targets are explicitly modelled, results show these being met.
• Treatment of offshore renewable energy for South Australia based on Commonwealth Government consultation for a potential declaration for the Southern Ocean off both Victorian and South Australian coast. .	No South Australian targets are specified for offshore wind. Offshore wind can be selected by the model in the South East South Australia Coast offshore zone if this is an optimal outcome. No offshore wind developed in results. AEMO notes that the Commonwealth Government's declaration for the Southern Ocean, made in March 2024 after the release of the Draft 2024 ISP and following consultation by the government, included a declaration off the Victorian coast but not the South Australian coast. An additional candidate zone was modelled in the South East South Australia Coast due to developer interest at the time.
• Establishing hydrogen production and hydrogen-fuelled power generation and hydrogen storage capacity in South Australia's Whyalla region as per the Hydrogen Jobs Plan.	The output from a 250 MW electrolyser project is included in the hydrogen production forecasts for each scenario. A 200 MW hydrogen fuelled generator is also incorporated into the model.
Tasmanian Government	
• REZ options in Tasmania in accordance with the process being delivered by the Renewables, Climate and Future Industries Tasmania (ReCFIT) body as REZ Coordinator for Tasmania.	Although there are no legislated REZs in Tasmania, ReCFIT as the REZ coordinator for Tasmania has nominated the North West REZ to be the first region to be explored for the development of a REZ in that state. REZs are modelled as per the IASR locations and sizes, with North West REZ options included as options for the model to select, consistent with joint planning between AEMO and TasNetworks.
• Target of 150% of consumption by 2030 (on 2020 levels) and 200% by 2040 under the *Energy Co-ordination and Planning Amendment (Tasmanian Renewable Energy Target) Act 2020*.	Modelled as a Tasmanian target of 15,750 GWh by 2030, and 21,000 GWh by 2040. Results show 18,994 GWh by 2030, and 23,883 GWh by 2040[B]
• Battery of the Nation (BOTN) will be considered as a generation development option.	Included as an option (results show 371 MW of pumped hydro being built by 2052).
• Treatment of offshore renewable energy zones as declared by the Commonwealth Government off the coast of Tasmania.	No Tasmania targets are specified for offshore wind. Offshore wind can be selected by the model in the North Tasmania Coast offshore zone if this is an optimal outcome. No offshore wind developed in results.

A. Modelled as a total New South Wales target of 33,600 GWh per year by 2029-30.
B. Modelled as a Tasmanian target of 15,750 GWh by 2030, and 21,000 GWh by 2040.

Regarding the jurisdictionally specific matters raised by the AER, AEMO provides the following information:

- **Offshore wind treatment outside of Victoria.** Only Victoria has an explicit policy target for developing offshore wind capacity that is enforced in the modelling, as its target for offshore wind development is in the process of being legislated for by the *Climate Change and Energy Legislation Amendment (Renewable Energy and Storage Targets) Bill 2023*, and supported by the Offshore Wind Energy Implementation Statements. Due to the higher relative cost of offshore wind generation, the Draft ISP modelling has not utilised offshore wind in other regions. This is an economic outcome of the ISP modelling.

- **Alignment with New South Wales Government REZ capacities.** AEMO notes that:
  - The Illawarra REZ in the ISP has a REZ transmission limit of 1,000 megawatts (MW), which is the same as the declared network capacity for this REZ.
  - The ISP has ensured generation capacity requirements in New South Wales (as per the *Electricity Infrastructure Investment Act 2020*) are modelled as a requirement for 33,600 gigawatt hours (GWh) from variable renewable energy (VRE) by 2029-30 within New South Wales. Although the capacities are specified in a number of REZs in the *Electricity Infrastructure Investment Act 2020*, the generation constructed and operated under Long-Term Energy Service Agreements (LTESAs) are not required to be located in those REZs, or any REZ if the project demonstrates "outstanding merit", nor to match the capacities specified. As such, generation plantings across REZs in the ISP model is an optimised outcome (subject to constraints), and no set amount is forced into specific REZs as that is not a required element of the New South Wales policy.
  - Where LTESAs have been awarded, these are incorporated into the model. It is noted the Illawarra REZ does not yet have any LTESAs awarded for generation or storage; the declaration of the REZ only notes that these agreements can be used.
  - As this REZ has a very small land area, the largest nearby renewable resource is the adjacent offshore wind zone, which is not yet seen to be economic in comparison to the other REZ resources available.
- **Alignment between AEMO, Queensland Government and Powerlink identification of REZs.**
  - AEMO continues to work with the Queensland Government and Powerlink to ensure alignment of the ISP modelled REZ outcomes with the Queensland REZ Roadmap. Currently the proposed Queensland Renewable Energy Zones (QREZs) are detailed as nodes for renewable generation to connect to the electrical network, and do not include a geographical area or resource potential such as that used in the ISP REZ modelling. ISP REZ modelling for Queensland has been defined in a way that is appropriate for representing the resource limits in the ISP modelling.
  - While the ISP REZ definitions may not exactly reflect the currently proposed QREZ node locations, the assumptions on new VRE connection locations within the ISP REZ definitions do closely align. Network limits and upgrade options have been a matter of close consultation with Powerlink to ensure close alignment with the proposed Queensland SuperGrid. The SuperGrid North and SuperGrid South 500 kilovolts (kV) upgrade options are included as sub-regional upgrade options (see CQ-NQ Option 2, and SQ-CQ Option 5).
  - As proposed REZ developments become approved and finalised in the Queensland region, these will also be reflected in subsequent ISPs.

Finally, AEMO notes that the timing for transmission network investments and capacity requirements in the ODP are generally outputs of the modelling process, except for committed or anticipated projects. For all other network augmentations, the modelling takes into account advice relating to network investment lead times, and required generation capacity as an outcome of the various policy commitments. AEMO uses the earliest in-service dates for each upgrade option as advised by the jurisdictional planning body to inform decisions on actionable timing for transmission projects.

5 Firming and storage in renewable energy zones

This section addresses the transparency review report matters relating to firming and storage in renewable energy zones.

Matters raised in the transparency review report

"*In Appendix 3 of the draft 2024 ISP, REZs are reported in terms of installed wind and solar generation capacity. Except for pumped storage, the published data does not cover the localisation of grid-scale storage in renewable energy zones. There is significant evidence that many new projects include battery storage[23] , and established state[24] and Commonwealth policies[25] promote investment in firming infrastructure. This includes tenders completed in 2023 for long-term energy services contracts for firming infrastructure and long duration storage.*

We expect AEMO to explain in an addendum to the draft ISP how or whether storage and firming capacity was included in the modelling, and its impact on the capacity and energy generation in each REZ."

AEMO's response

AEMO models existing, committed and anticipated storage and firming capacity in the relevant REZs so the impact on REZ transmission limits and congestion can be determined. The mapping of this storage capacity to REZs is detailed in the 2023 Inputs and Assumptions Workbook.

Where LTESAs have been awarded, these are incorporated into the model in a similar manner to committed and anticipated projects, and mapped to REZs if required.

Where jurisdictional policies considered by AEMO[26] contain a requirement for new storage developments, these policies are also modelled to ensure the level of storage/firming specified is included in the regional storage developments. These may not be mapped to specific REZs, because they are still future projects that do not have a defined location.

The ISP generally performs market modelling of new storage or firming capacity candidates allocated on a sub-regional basis, and not to individual REZs. This was consulted on in the ISP Methodology, where it is stated that it is not currently computationally tractable to model new storage options in all REZs. This is due to the significant increase in modelling complexity and runtime requirements to undertake a more granular level of optimisation if done at the REZ level, and could result in a reduction in the level of sensitivity analysis that could be undertaken. AEMO has struck a balance between these two aspects by generally modelling storage at a sub-regional rather than REZ level.

[23] AEMO, NEM Generation Information October 2023, November 2023 at

[24] Electricity Infrastructure Investment Act 2020 (NSW).

[25] At https://www.dcceew.gov.au/energy/renewable/capacity-investment-scheme.

[26] Further detail is provided in Section 4.

As REZ network upgrades are progressed after the publication of the final 2024 ISP, whether through a regulatory investment test for transmission (RIT-T) process or by government action, there may still be a need to consider non-network options like battery energy storage systems (BESS) to reduce congestion, delay network expenditure or reduce overall cost of any network upgrades.

6 System security remediation costs

This section addresses the transparency review report matters relating to system strength and system security.

Matters raised in the transparency review report

"AEMO forecasts that approximately $8 billion is required by 2039−40 for system strength remediation (under the step change scenario) … AEMO states that this cost estimate may be an upper bound, as it is based on synchronous condenser technology, and over time alternative technologies, such as grid-forming inverters may become commercially viable at scale.

In its ISP Methodology, AEMO sets out how the ISP will assess requirements for power system security services. For system strength, AEMO calculates the synchronous three phase fault level from the market modelling outputs and forecasts the investments required to both operate the network and to connect inverter-based resources.

While AEMO transparently sets out how system security remediation services are forecast from a set of market modelling outputs, it is not clear how or whether the draft 2024 ISP market modelling and ODP has been iteratively informed by, and updated to reflect, system security remediation costs.

We expect AEMO to further explain how or whether the selection of the ODP is informed by the forecast of system security remediation costs."

AEMO's response

AEMO has confirmed with the AER that this matter refers specifically to system strength. System strength is one of six power system security services that are evaluated in the preparation of the ISP, as outlined in the ISP Methodology. System strength requirements in the NEM are expressed as two distinct components – a forecast of minimum required three phase fault levels, and an optimised forecast of future inverter-based investment.

The Draft 2024 ISP market modelling results and ODP:

- Include the incremental system strength costs associated with connecting new inverter-based generation, and
- Do not include the system strength costs related to operating the network, and
- Do not include iterative studies to optimise these system strength costs.

Inclusion of incremental system strength costs for new inverter-based generation

For the costs associated with delivering system strength to support sufficient investment for an optimised forecast of future inverter-based generation investment, the ISP modelling applies an incremental cost approach to effectively penalise modelling decisions that would increase system strength costs. These penalty costs are based on pro-rata synchronous condenser costs as an economic proxy for meeting system strength requirements. These values are applied in two ways depending on the appropriate driver of the need:

- As an outcome of new inverter-based generation connections in weaker parts of the grid – remediation costs for new generation developments.

  - For future inverter-based generation projects built in locations where available system strength is low, the ISP modelling applies an incremental system strength remediation cost to the build of each new wind or solar project planted nearby. These costs are specified as $/MW of increased generation capacity. The base values for these system strength connection costs were consulted on through the 2023 IASR process and are recorded in the "Connection cost" worksheet of the Inputs and Assumptions Workbook[27]. Remediation costs are applied to the generation build cost for each megawatt of new wind and solar generation planted in the REZ.

- As a component of new REZ development projects – remediation costs for REZ network expansions.

  - REZ system strength remediation costs in electrically strong parts of the grid (where existing system strength availability is likely sufficient to support a reasonable quantity of new connections) have been modelled either explicitly (where the REZ augmentation scope includes system strength assets), or through an incremental REZ expansion cost that reflects growing system strength needs. These costs are specified as $/MW of increased network capacity. The base values for these system strength connection costs are presented in the "REZ Augmentation Options" worksheet of the Inputs and Assumptions Workbook[28].

These approaches cover all REZs, both on and offshore.

System strength required to operate the network

AEMO does not include the costs associated with meeting the minimum required three phase fault levels in the ISP (i.e., the system strength required to operate the network). This system strength has traditionally come from large synchronous generators (i.e., coal and gas-fired generation), which will reduce in operation over time. In ISP modelling, the reduced operation of coal and gas generation is largely driven by carbon budgets. A set of unit commitment constraints are described in the Inputs and Assumptions Workbook[29], these are designed to reflect operational security needs for some synchronous generators to remain online. These constraints are consistent within each scenario, and are reduced over time to reflect delivery of alternative security services by the network businesses. As such, the cost of replacing this system strength is common across development paths, and is cancelled out when evaluating the optimal development path (i.e., under any development path for a given scenario, the system strength costs for operating the network will be similar).

The ISP modelling assumes that minimum fault current requirements will continue to be met through the system strength framework[30], including the delivery of location-specific options across the NEM under reliability corrective

[27] The 2023 IASR web page shows the workbook as consulted on in July 2023, at https://aemo.com.au/en/consultations/current-and-closed-consultations/2023-inputs-assumptions-and-scenarios-consultation. The Draft 2024 ISP web page shows the workbook as applied to prepare the draft ISP, at https://aemo.com.au/consultations/current-and-closed-consultations/draft-2024-isp-consultation.

[28] The 2023 IASR web page shows the workbook as consulted on in July 2023, at https://aemo.com.au/en/consultations/current-and-closed-consultations/2023-inputs-assumptions-and-scenarios-consultation. The Draft 2024 ISP web page shows the workbook as applied to prepare the draft ISP, at https://aemo.com.au/consultations/current-and-closed-consultations/draft-2024-isp-consultation.

[29] The 2023 IASR web page shows the workbook as consulted on in July 2023, at https://aemo.com.au/en/consultations/current-and-closed-consultations/2023-inputs-assumptions-and-scenarios-consultation. The Draft 2024 ISP web page shows the workbook as applied to prepare the draft ISP, at https://aemo.com.au/consultations/current-and-closed-consultations/draft-2024-isp-consultation.

[31] AEMO notes that the use of synchronous three phase fault level projections in Appendix 7 of the Draft 2024 ISP was used to identify potential future shortfalls against existing minimum requirements as an indicator only.

action regulatory investment tests for transmission (RIT-Ts). These RIT-Ts will be undertaken by transmission network service providers outside of the ISP actionability framework[31].

Decision not to iterate to optimise system strength costs

While adding an iterative refinement process to the ISP modelling treatment of system strength costs could improve the accuracy of the estimate, AEMO considers that it would not drive material changes in the candidate development paths or ODP. This is because meeting system strength needs is a mandatory requirement across all futures and is largely driven by non-negotiables in the model, such as synchronous generation retirements, the need to supply consumer demand, and renewable generation investments driven by long-term policy objectives.

The current approach balances these drivers by minimising the system strength requirements themselves (as represented by the proxy synchronous condenser costs), while not adding additional complexity to the ISP modelling process. AEMO is considering future ISP enhancements that would include iteration and power system analysis to represent system security investment options (including for system strength) to allow the ISP to provide more complete information on the expected total system costs.

[31] AEMO notes that the use of synchronous three phase fault level projections in Appendix 7 of the Draft 2024 ISP was used to identify potential future shortfalls against existing minimum requirements as an indicator only.