AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

2023 Inputs, Assumptions and Scenarios Report

15 December 2023

Addendum

For use in Forecasting and Planning studies and analysis

Important notice

Purpose

AEMO publishes this addendum to the 2023 Inputs, Assumptions and Scenarios Report (IASR) pursuant to National Electricity Rules (NER) 5.22.9(c)(1). This report includes key information and context for the inputs and assumptions used in AEMO's Forecasting and Planning publications for the National Electricity Market (NEM).

Disclaimer

AEMO has made reasonable efforts to ensure the quality of the information in this publication but cannot guarantee that information, forecasts and assumptions are accurate, complete or appropriate for your circumstances.

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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Version control

Version	Release date	Changes
1	15/12/2023	Initial release

AEMO acknowledges the Traditional Owners of country throughout Australia and recognises their continuing connection to land, waters and culture. We pay respect to Elders past and present.

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1 Introduction

AEMO is required by the National Electricity Rules (NER) to publish the *Inputs, Assumptions and Scenarios Report* (IASR)[1] to be used to prepare the *Integrated System Plan* (ISP)[2].

The Australian Energy Regulator (AER) is required to publish a report on the transparency of the IASR, including whether AEMO has adequately explained how it has derived key inputs and assumptions, whether and how key inputs and assumptions have changed since the previous ISP, and whether key inputs and assumptions are based on verifiable sources, or that AEMO has provided stakeholders with adequate opportunity to propose alternative inputs and assumptions where verifiable sources are not readily available[3]. The AER report is referred to in this document as the 'Transparency Review'. If the Transparency Review identifies issues with the IASR, AEMO must provide further explanatory information in an addendum to the relevant IASR and consult on these issues in the Draft ISP[4].

Accordingly, this addendum to the 2023 IASR provides further explanation in response to issues highlighted in the AER's Transparency Review[5] published in August 2023.

The AER assessed the 2023 IASR as comprehensive but said some further explanation can improve transparency

The AER stated in its 2023 Transparency Review:

> *Overall, [the AER] consider that AEMO has taken into account key uncertainties in the development of its revised scenario narratives and has undertaken a comprehensive assessment of the ISP parameters relevant to each scenario.*
>
> *[The AER's] review concludes that the majority of AEMO's inputs and assumptions have been adequately explained and AEMO has demonstrated that it has taken into account stakeholder feedback.*

The AER noted that additional explanation is required for some aspects of the IASR to improve transparency. Chapter 2 onwards of this document provides additional explanation on each of the issues noted in the Transparency Review.

1.1 Invitation for written submissions

All stakeholders are invited to provide a written submission on any aspect of the Draft 2024 ISP[6], and the content of this 2023 IASR addendum, which should be sent in PDF format to ISP@aemo.com.au by 6pm (AEST) on

[1] Available at: https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp/current-inputs-assumptions-and-scenarios.

[2] NER 5.22.8. Australian Energy Market Commission (AEMC) Energy Rules, at https://energy-rules.aemc.gov.au/ner/347/37933.

[3] NER 5.22.9(a). AEMC Energy Rules.

[4] NER 5.22.9(c). AEMC Energy Rules.

[5] AER. *Transparency review report – Inputs Assumptions and Scenarios Report for the Integrated System Plan*, at https://www.aer.gov.au/system/files/2023-09/AER%20-%20Transparency%20review%20-%20AEMO%202023%20Inputs%20Assumptions%20and%20Scenarios%20Report%20-%2028%20August.pdf.

[6] Available at: https://aemo.com.au/consultations/current-and-closed-consultations/draft-2024-isp-consultation.

Friday, 16 February 2024. Additional information on 2024 ISP engagement opportunities is available on AEMO's website[7].

1.2 Process to develop the 2024 ISP

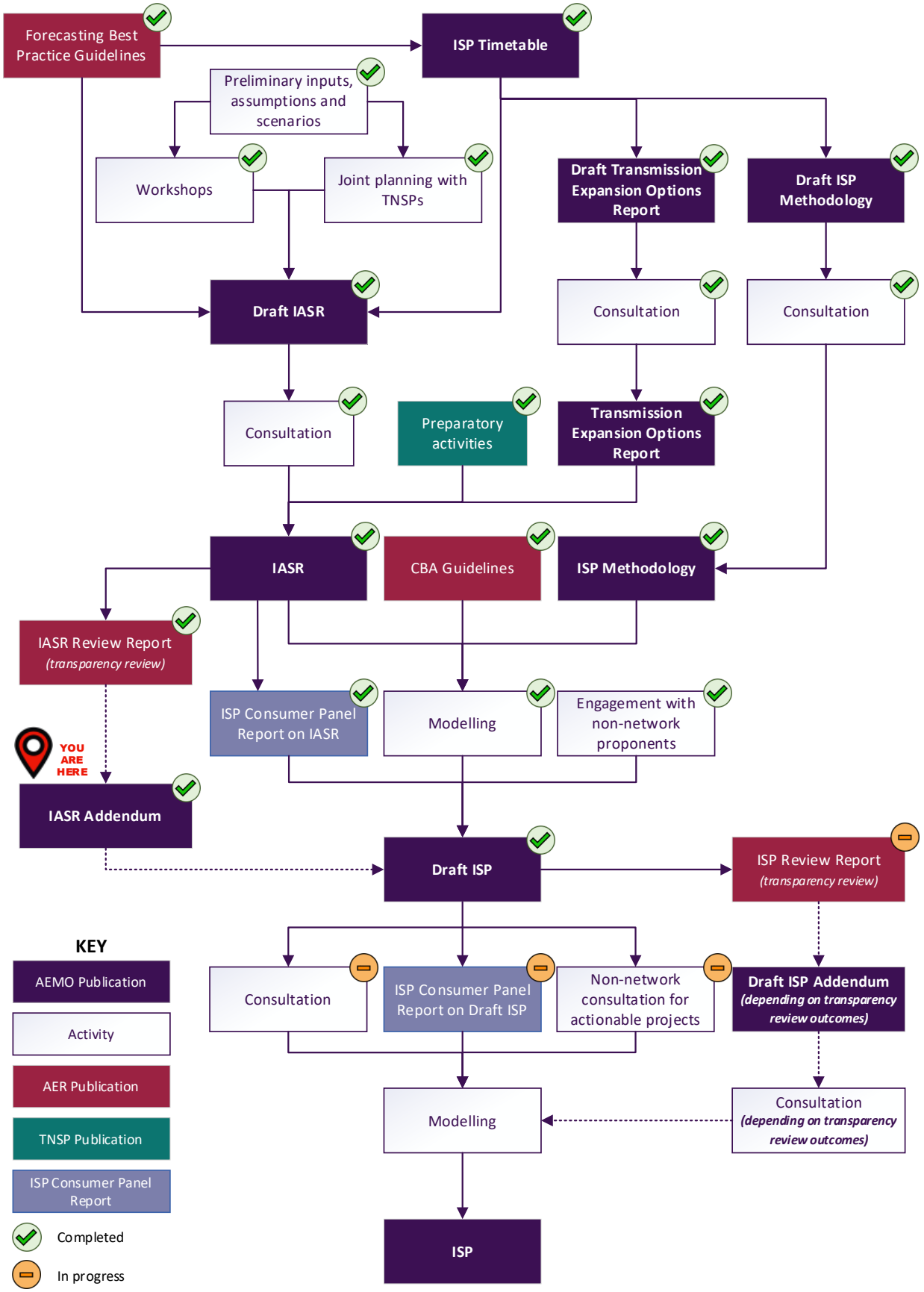
The 2023 IASR, supplemented by this document, has been used to prepare the Draft 2024 ISP[8]. Figure 1 below provides a visual representation of the 2024 ISP development and engagement process, including both the elements of the regulatory framework (in blue, red and green boxes) and the activities undertaken by AEMO and stakeholders (in white boxes).

The remainder of this document sets out further explanation in response to issues identified in the AER's Transparency Review.

[7] AEMO. *2024 ISP – Stakeholder Engagement*, at https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp/opportunities-for-engagement.

[8] See https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp.

Figure 1 The ISP process



2 Public policies

AER Transparency Review

"The IASR states that it has included policies that do not meet the 'public policy' requirements in the NER but are expected to meet requirements of the NER and in the event these policies are not committed by the time of the final 2024 ISP, AEMO will exclude these policies and instead may include the impact of these policies in its sensitivity analysis. We expect AEMO to explain how any sensitivities would be used to inform the ODP in the event that a public policy initiative does not meet the requirements in the NER."

AEMO's response

AEMO included some policies in the 2023 IASR which do not yet meet the NER requirements to be considered in determining power system needs ("the NER requirements")[9]. Examples of these additional policies are Victoria's offshore wind targets, the Victorian Energy Storage Target, and the New South Wales emission reduction targets ("additional policies").

AEMO included additional policies in the 2023 IASR for several reasons:

- AEMO considered that these policies are likely to meet the NER requirements by the time the final 2024 ISP is released because they are advanced and are considered likely to meet one or more of the NER requirements by June 2024 (e.g. being enacted in legislation and/or having material funding allocated to the policy).
- The additional policies were considered relevant to include because they were expected to be included in the *Emissions Targets Statement* required to be published by the Australian Energy Market Commission (AEMC)[10] under the National Electricity Law, which must be considered by market institutions when having regard to the new emissions element of the National Electricity Objective (NEO). The Emissions Target Statement was published in September 2023 and includes the additional policies. AEMO may ultimately be required to consider the policies in the *Emissions Targets Statement* in preparing the ISP, regardless of whether the policies meet the NER requirements. In October 2023, the AEMC released its draft rule to harmonise the NER with the amended NEO. Should this draft rule be made as currently drafted, and come into effect in February 2024 as currently proposed, the NER will be updated to require AEMO to consider the policies in the *Emissions Targets Statement* when determining how the ISP would contribute to achieving the NEO.
- The legislation for the implementation of the amended NEO provides that, for processes already underway at 21 November 2023, AEMO has discretion as to whether to apply the amended NEO. In deciding whether to consider or apply the amended NEO, AEMO has had regard to the *AEMO transitional guidance about decisions under the amended national energy objectives*. In accordance with that guidance, AEMO has had regard to whether applying the amended NEO would make a material difference to AEMO's decision, and the ability for AEMO to conduct the appropriate analysis within required timeframes if the amended NEO were applied. AEMO has decided to apply the amended NEO in the preparation of the draft and final 2024 ISP. AEMO considers it can apply the amended NEO in preparing the draft and final 2024 ISP without materially altering AEMO's preparation, and the outcomes, of these documents, given the steps it has already taken to consider the policies in the *Emissions Target Statement*. AEMO considers that it can apply the amended NEO

[9] NER 5.22.3(b).

[10] AEMC. Targets statement for greenhouse gas emissions. September 2023, at https://www.aemc.gov.au/regulation/targets-statement-emissions.

to the preparation of the draft and final 2024 ISP by conducting analysis that it considers appropriate and proportionate for considering the emissions reduction element of the amended NEO at this stage of the implementation of the regulatory and policy frameworks, following the approach below.

If, by the release of the final 2024 ISP, the NER have not been amended to require AEMO to consider the additional policies in the *Emissions Targets Statement*, and the additional policies do not meet the NER requirements but are still advanced and/or continuing to progress, AEMO will exclude the additional policies from the ISP scenarios. However, in this case, AEMO will undertake sensitivity analysis to understand the impact of the additional policies because this analysis will be useful for stakeholders to understand the potential impacts of the additional policies on the ISP's Optimal Development Path (ODP), particularly if an additional policy remains likely to meet the NER requirements in the future and may constitute a material change to AEMO's choice of ODP.

3 Value of emissions reduction

AER Transparency Review

"AEMO states that the new emissions objective as part of the National Electricity Objective will be applied to the Draft ISP. Whilst we consider this may be appropriate, AEMO has not provided any further information in the report. We expect AEMO to explain any inputs and assumptions that are relevant to applying a value of emissions reduction."

AEMO's response

In the 2023 ISP Methodology, AEMO provided information on how a value of emissions reduction would be applied in the ISP if it were determined by an authoritative body, including for the purposes of having regard to the emissions reduction element in the amended NEO.

At present, a value is not available, and therefore has not been applied in the Draft 2024 ISP.

4 Social licence

AER Transparency Review

"AEMO states that it intends to include a sensitivity that explores the risks associated with 'social licence' (commonly referred to as community acceptance of a network project) such as alternative project options that reflect greater 'limitations' and higher costs to address social licence issues. We expect AEMO to explain any inputs and assumptions used to identify social licence considerations for the purposes of any sensitivity analysis."

AEMO's response

AEMO recognises that the process to build and maintain community acceptance takes time and effort, and a state of 'low social licence' for new projects could create development delays, increase costs and threaten the delivery of infrastructure that is vital for Australia's transition to net zero emissions by 2050.

AEMO has established an Advisory Council on Social Licence, which consists of experienced individuals representing a diverse range of community, social, cultural, and environmental perspectives. The Council helps AEMO understand social licence concerns in relation to the ISP, as well as broader community sentiment, execution challenges and possible opportunities presented by the construction of new energy infrastructure and the energy transition. These insights are further supplemented by the ISP Consumer Panel, which provides independent expert advice to AEMO during development of the ISP to ensure consumer needs and expectations are considered at each stage of the planning process.

For the first time this year, AEMO has conducted social licence-specific sensitivity analysis to explore some of the impacts and risks associated with low social licence for infrastructure options considered in the 2024 ISP. AEMO consulted on sensitivity principles and parameters with members of the Advisory Council on Social Licence and the ISP Consumer Panel.

After consultation, AEMO determined the goals for the sensitivity analysis, including to:

- Explore **generalised NEM impacts from low social licence**, rather than local or project-by-project impacts. This is considered appropriate because localised social licence information is not available for all project options across the ISP horizon.
- Incorporate **cost and delay impacts** from low social licence to reflect that project scopes may need to change to build and maintain social licence.
- Consider social licence impacts on **transmission projects as well as onshore wind and solar generation projects within renewable energy zones (REZs), and pumped hydro projects**. This approach acknowledges the deep inter-relationship between transmission, REZs and pumped hydro projects in the ISP modelling process, and the fact that social licence for new transmission projects as well as REZs and new pumped hydro is an emerging issue that merits consideration.
- **Not consider social licence impacts on utility-scale storage, gas-powered generation or offshore wind**. AEMO decided not to consider social licence for utility-scale storage and gas-powered generation because these projects are modelled with low locational detail in the ISP model. AEMO decided not to include social licence for offshore wind generators because there was insufficient data available due to the immaturity of the industry in Australia, and the ODP in the Draft 2024 ISP does not include offshore wind outside of that required to meet Victoria's offshore wind targets (that is, increasing the offshore wind costs in the sensitivity would not

have affected the ODP or its benefits). AEMO is open to undertaking further analysis as more information becomes available.

AEMO considered a number of modelling input parameters in the ISP that could be varied to reflect the impact of potentially adverse social licence outcomes, for example cost, delays, land resource limits, land-use penalty factors for transmission and generation investment. In the sensitivity analysis undertaken for the Draft 2024 ISP, AEMO decided to apply the following parameters to explore the impact of low social licence:

- Delays of up to two years for transmission projects.
  - This reflects delay impacts from low social licence for transmission. The delay does not include committed and anticipated projects, as these projects are already progressing and there is more certainty about their delivery dates. This parameter reflects the impact of low social licence on project lead times, for example times taken to obtain transmission easements and property rights.
- Increases in transmission and pumped hydro capital costs of up to 15%.
  - This adds a cost impost to transmission augmentations to reflect scope changes to routes and designs above the allowance that was costed in each estimate. The intent is for this cost to be additional to existing cost estimates that already include scope changes and risks. While future ISP projects were modelled with a 15% increase in cost, actionable projects included smaller bespoke adjustments, as they are progressed projects that have already undertaken some social licence measures. This same offset has also been applied to pumped hydro projects.
- Increases in REZ generation capital costs of between 5% and 60%.
  - This reflects the cost impost on solar and wind farms developments from low social licence for generation. This includes increased social licence costs within a REZ such as scope changes and additional community engagement and benefit sharing.
  - Generation costs were increased by approximately +5% to +60% based on private land parcel density within the REZ as shown in Table 1 and Figure 2. These cost uplifts were applied to specific REZ generation costs by generator technology type, using the existing generator cost values in the 2023 IASR. This is to capture higher social licence risks in more dense REZs that may have more stakeholders.
  - The intent is for this cost to be additional to existing cost estimates that already include community engagement and benefit sharing programs.
  - Full details about the social licence sensitivity, including outcomes, can be found in Appendix 8 (Social licence) of the Draft 2024 ISP.

Table 1 Social licence sensitivity – REZ generation cost increase based on private land parcel density

REZ	Private land parcel density[#] (parcels/km^2)	REZ cost multiplier[%]	Cost increase (%)	REZ	Private land parcel density[#] (parcels/km^2)	REZ cost multiplier[%]	Cost increase (%)
Q1	3.0	1.0	5%	**S1**	0.5	1.0	5%
Q2	0.0	1.0	5%	**S2**	0.7	1.0	5%
Q3	5.2	1.8	9%	**S3**	1.0	1.0	5%
Q4	1.1	1.0	5%	**S4**	1.0	1.0	5%
Q5	0.1	1.0	5%	**S5**	0.4	1.0	5%
Q6	4.5	1.6	8%	**S6**	0.0	1.0	5%
Q7	6.4	2.2	11%	**S7**	0.0	1.0	5%
Q8	4.7	1.6	8%	**S8**	0.2	1.0	5%
Q9	0.3	1.0	5%	**S9**	0.2	1.0	5%
N1	0.9	1.0	5%	**S10**	0	0	0%
N2	1.9	1.0	5%	**T1**	2.0	1.0	5%
N3	2.9	1.0	5%	**T2**	1.5	1.0	5%
N4	0.0	1.0	5%	**T3**	1.2	1.0	5%
N5	0.5	1.0	5%	**T4**	0	0	0%
N6	4.5	1.6	8%	**T5**	0	0	0%
N7	0.7	1.0	5%	**V1**	0.2	1.0	5%
N8	1.7	1.0	5%	**V2**	0.2	1.0	5%
N9	34.3	11.9	59%	**V3**	1.3	1.0	5%
N10	0	0	0%	**V4**	2.2	1.0	5%
N11	0	0	0%	**V5**	4.4	1.5	8%
N12	205.0	71.0	355%	**V6**	1.6	1.0	5%
-	-	-	-	**V7**	0	0	0%
-	-	-	-	**V8**	0	0	0%

[#] The estimated number of private land parcels within a REZ boundary divided by the REZ area (square kilometres), using land tenure data[11] and state cadastral data sets[12,13,14,15,16].

[%] Less dense REZs (<= 3.0 private land parcel density) have a minimum base increase of +5% applied.

[11] Commonwealth Government. *Land tenure of Australia*, at https://www.agriculture.gov.au/abares/aclump/land_tenure_2010-11_2015-16.

[12] Queensland Government. *Queensland Spatial Catalogue – Qspatial*, at https://qldspatial.information.qld.gov.au/catalogue/.

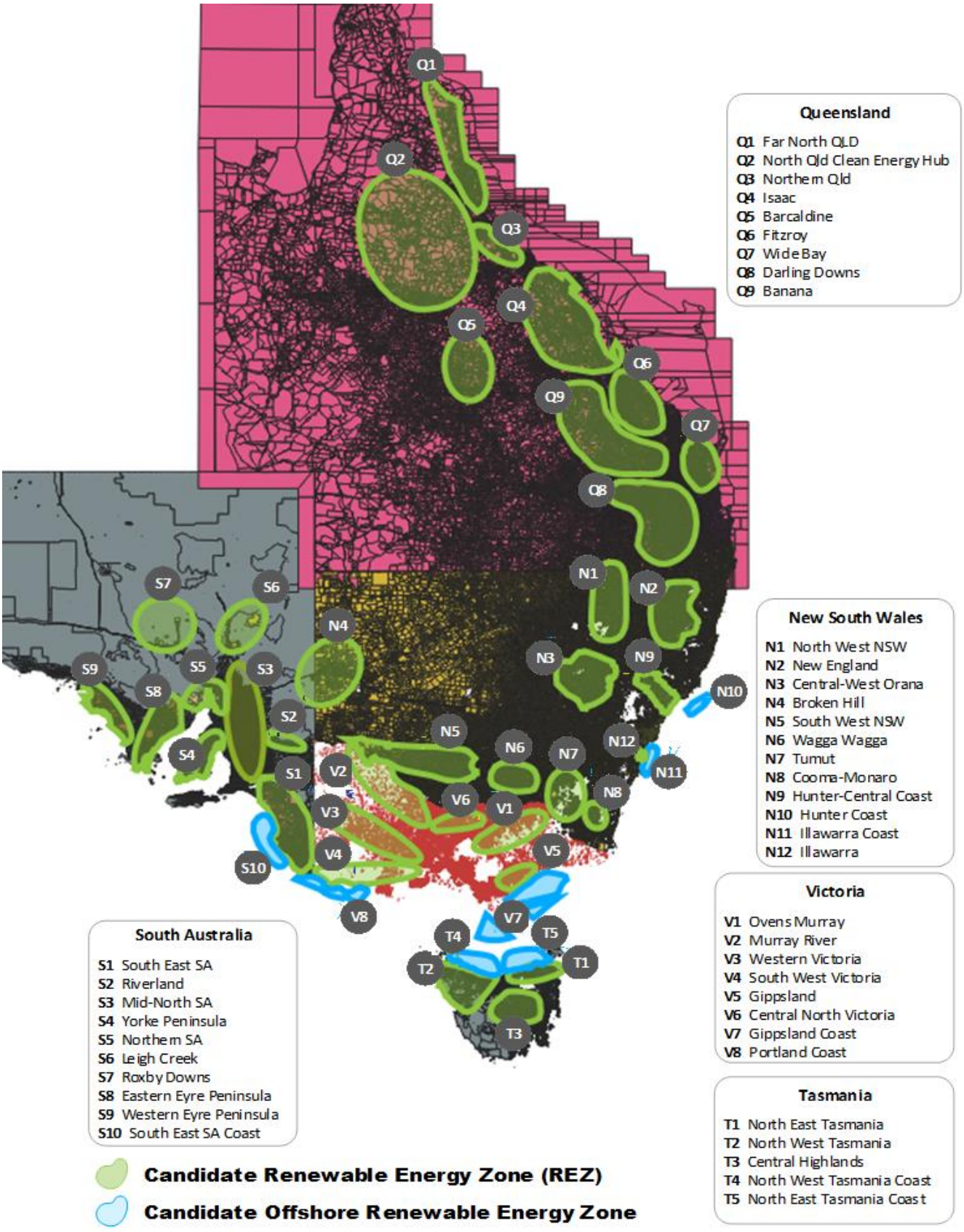
[13] New South Wales Government. *New South Wales Cadastre Web Service*, at https://data.nsw.gov.au/data/dataset/spatial-services-nsw-cadastre/resource/e7763410-113d-477e-b5d6-27e86c10f3d4.

[14] Tasmania Government. *List data Tasmania*, at https://listdata.thelist.tas.gov.au/opendata/.

[15] South Australia Government. *South Australia Land Use Generalised*, at https://data.sa.gov.au/data/dataset/land-use-generalised.

[16] Victoria Government. *Data Victoria*, at https://discover.data.vic.gov.au/dataset/vicmap-property-cadastral-area-boundary-line#.

Figure 2 REZ boundary map overlayed with cadastral land parcel data



5 Carbon budgets

AER Transparency Review

"The IASR has included assumed carbon budgets for each scenario to achieve net zero carbon emissions by 2050… The IASR provides carbon budgets for the NEM for the 2024-25 to 2029-30 period and 2024-25 to 2051-52 period. These carbon budgets have been derived from multi-sectoral modelling undertaken by the CSIRO and Climate Works.

CSIRO and Climate Works estimate carbon budgets for Australia (all sectors) for the period 2021-50. They do this by estimating global carbon budgets linked to different probabilities of various temperature outcomes, translate these budgets into a carbon dioxide-equivalent budget that includes other greenhouse gases, and derive Australia's share of these global budgets.

To arrive at carbon budgets for the NEM for the 2024-25 to 2051-52 periods based on the multisector modelling, AEMO must adjust for the different time periods and adjust the all-Australia budgets into NEM-only budgets. We consider that the IASR does not adequately explain how the NEM-only carbon budgets are derived.

We expect AEMO to provide further explanation of the assumptions used to derive the NEM-only carbon budgets."

AEMO's response

The NEM emissions budget came from assumptions around the global emissions allowed to occur to meet specific temperature rise targets for different scenarios as defined in the World Energy Outlook (WEO) and by the International Panel on Climate Change (IPCC) Assessment Report. To ensure the ISP narratives are aligned with global economic narratives and assumptions, the ISP scenarios are mapped to the WEO scenarios and IPCC frameworks. See Appendix B of CSIRO and Climate Works Australia's *Multi-sector energy modelling*[17] and Section 3.2 of AEMO's 2023 IASR[18] for more details.

With that mapping, the total global carbon dioxide equivalent (CO_2-e) budget to 2100 is used to identify an Australia-wide-only budget by calculating Australia's 'fair share' of that global budget. The chosen approach to determine Australia's 'fair share' of the global emissions budget aligns with that adopted by the Climate Change Authority which assumes it to be 0.97%. Appendix B of the *Multi-sector energy modelling*[12] discusses the derivation of this figure further.

Multi-sectoral modelling was then used to determine how to optimally allocate that Australia-wide-only budget across all domestic sectors – one of which is the electricity sector of which the NEM is part[12]. The long-term, temperature-linked NEM emissions budgets are then derived by aggregating emission trajectories for NEM-related activities resulting from the modelling.

An additional emissions budget to 2030, which relates to the *Climate Change Act 2022* emissions budget of 4,381 Mt CO_2-e (tonnes of carbon dioxide equivalent) from 2020-21 to 2029-30, is also incorporated in the latest IASR. This budget is calculated by 'scaling down' to the NEM level for the period 2024-25 to 2029-30 the economy-wide emission projection from the multi-sectoral modelling under the *Progressive Change* scenario,

[17] At aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2022/2023-inputs-assumptions-and-scenarios-consultation/supporting-materials-for-2023/csiro-climateworks-centre-2022-multisector-modelling-report.pdf.

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

which is just 77 Mt CO_2-e over and above the *Act*'s budget (4,458 Mt CO_2-e over the 2021-2030 period). The resulting NEM-wide emissions budget for the period 2024-25 to 2029-30, after adjusting for the 77 Mt CO_2-e difference, is 630 Mt CO_2-e.

The results for the economy-wide emissions budget for the *Progressive Change* scenario is chosen as the basis for the cumulative budget from 2025 to 2030 as it closely aligns with the intent of the *Act*, and the NEM share was derived using the latest data from the *Quarterly Update of Australia's National Greenhouse Gas Inventory*, March Quarter 2022 update[19].

The resulting NEM-only emissions budgets for period to 2050 and to 2030 are then used in the ISP.

[19] At https://www.dcceew.gov.au/climate-change/publications/national-greenhouse-gas-inventory-quarterly-update-march-2022.

6 Consumption and demand

AER Transparency Review

"When compared with 2021 IASR scenarios, AEMO has not clearly explained why there is less evidence of widespread electrification and therefore how this slower investment in electrification has been reflected in the updated forecasts. We observe that since the 2023 IASR was published that the Victorian Government has announced a ban on gas connections to new residential and government buildings from 1 January 2024 and expect the impact of this policy will be included in the Draft ISP."

AEMO's response

To develop electrification forecasts, AEMO drew on research underpinning the Australian Energy Transitions Initiative[20], which considered the electrification potential of key industrial processes and the uptake rate of electrically powered equipment. These translated into updated modelling constraints that were included in the multi-sector modelling conducted for the 2023 IASR. In addition, AEMO gleaned insights on electrification trends from analysis of electricity and gas meter data for industrial sites.

The Victorian Gas Substitution Roadmap has updated the Victorian Planning Provisions, making connection to reticulated gas supplies optional for new dwellings, apartment buildings and residential subdivisions. Additional policy details are expected to restrict gas connections for construction proposals requiring a planning permit starting 1 January 2024[21]. As there are several zoning types that allow the construction of new dwellings without requiring a planning permit, new gas connections will remain possible in these areas. A review of forecast method suitability for gas connection growth is ongoing for Victoria and other jurisdictions with similar proposed policies.

AER Transparency Review

"When modelling historical demand profiles, AEMO states that it samples AEMO meter data but does not specify if this data is based on basic meter data or interval meter data. We expect AEMO to clarify its data source and provide an explanation of how this is applied in jurisdictions with differing levels of interval meters."

AEMO's response

When developing historical consumption profiles for residential and commercial consumers, AEMO applies a process referred to as *Residential-business segmentation*. This segmentation approach is discussed in detail in the *Electricity Demand Forecasting Methodology*[22] and adopts one of two approaches depending on the interval meter penetration in a given region.

This process can be summarised as follows:

[20] For more information, see https://energytransitionsinitiative.org/.

[21] For more information, see https://www.planning.vic.gov.au/guides-and-resources/strategies-and-initiatives/victorias-gas-substitution-roadmap#:~:text=buildings%20by%202025.-,Phasing%20out%20new%20residential%20gas%20connections,Provisions%20and%20all%20planning%20schemes.

[22] For more information, see Appendix A6: https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2023/forecasting-approach_electricity-demand-forecasting-methodology_final.pdf.

- **Approach 1: AEMO sampling-derived estimate** is the preferred approach in regions with sufficient[23] penetration of interval meters. This approach includes selecting a representative[24] set of interval meters. Typically, the number of sampled interval meters totals approximately 30,000.
- **Approach 2: AER data-derived residential estimate** is a fallback approach for regions with insufficient penetration of interval meters. This involves scaling of metering data to align with information sourced from the AER's Economic Benchmarking Regulatory Information Notice (RIN)[25]. AEMO must perform some calibration of the RIN data to bring it into alignment with AEMO's definition of delivered energy.

AER Transparency Review

"AEMO discusses the impact that electrification has on daily and seasonal load shape, showing how electrification is likely to affect usage profiles on a winter or summer day. However, there is no example given for how electrification may affect shoulder periods including Autumn and Spring. We expect AEMO to explain why these periods do not need to be discussed."

AEMO's response

In the context of electrification, commercial and industrial electrical loads typically exhibit minimal seasonal variations, providing a consistent demand throughout the year. In contrast, residential electrical loads show marked seasonal fluctuations, primarily influenced by space heating requirements. During the winter months, residential electrical loads peak, driven by the heightened demand for space heating to maintain comfortable indoor temperatures. Conversely, the summer months demonstrate the least impact, with minimal or even no space heating needs.

These seasonal variations serve as illustrative examples to highlight the differential impacts of electrification across sectors. The shoulder seasons – spring and autumn – typically present load patterns that fall somewhere between the extremes observed in winter and summer. As such, these seasons in AEMO's view do not require significant narrative regarding the electrification impact, given the milder version of the insights provided by the summer and winter seasons.

AER Transparency Review

"AEMO forecasts growth in electricity connections, which is one of the main drivers of forecast electricity consumption. We consider that AEMO needs to explain the basis for the assumed growth in electricity connections. AEMO should further explain how population growth affects connection growth, as it appears that in some scenarios growth in connections is greater than population growth."

AEMO's response

The electricity connections forecast model is a function of:

- Actual number of residential connections;

[23] AEMO assesses the interval meter sufficiency on a case-by-case basis. It is necessary for there to be a large quantity of interval meters for both households with and without rooftop solar to adopt the sampling approach detailed in Approach 1.

[24] To be considered representative of the metering population, the sample set of interval meters should have a similar proportion of households with rooftop solar (as the population) as well as having matching average consumption.

[25] The AER issues annual RINs in order to collect information from regulated businesses. The AER publishes non-confidential information from the RIN responses on their website. For more information see https://www.aer.gov.au/industry/networks/performance.

- Actual dwelling numbers from the Australian Bureau of Statistics (ABS) latest census;
- The proportion of small area (residential dwelling) demolition approvals to new builds from ABS; and
- Actual and forecast new dwelling numbers provided by Oxford Economics Australia (OEA)[26].

The forecast comprises two steps:

- The **short-term model** is a trend forecast of residential connections, where the scenario spread is obtained by applying the average, low, and high regression coefficients to the central, low and high scenarios respectively. For extracting the low and high regression coefficients, a 95% confidence interval is applied.
- The **long-term model**, on the other hand, is based on the OEA dwelling forecast that impacts the scenario growth of the connections in the long-term horizon.

As a result, the scenario spreads in both short and long-term models are not purely a function of population.

[26] For more information see https://aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2023/forecasting-approach_electricity-demand-forecasting-methodology_final.pdf.

7 Consumer risk preferences

AER Transparency Review

"AEMO updated its ISP Methodology in June 2023 and included amendments providing that it may consider consumer risk preferences when using its professional judgment to select an optimal development path in the ISP. The updated ISP methodology discusses consumer risk preferences in relation to the following trade-off:

- *Defer capex but incur risk of capex cost increases; or*
- *Bring forward capex to remove risk of capex cost increases.*

AEMO has not explained from where it will source consumer risk preferences or provided further detail on how it will consider consumer risk preferences in selecting an ODP. We expect AEMO to provide further explanation regarding any assumptions relevant to consumer preferences."

AEMO's response

AEMO has sourced consumer risk preferences through a research project undertaken throughout 2023 by two consultancies engaged by AEMO, and in consultation with the 2024 ISP Consumer Panel. AEMO has directly engaged with residential consumers through two mediums: focus groups and an online survey. Participants were selected for both forms of engagement to ensure the demographic composition of the NEM's residential consumers was appropriately represented[27]. The data gathered, and outcomes, from these sessions are outlined below:

- **Seven in-person focus group sessions** (10-12 participants at each three-hour session, 82 in total). These sessions were conducted in: Brisbane, Sydney, Melbourne, Adelaide, Rockhampton, Goulburn, and Ballarat.

  In general, focus group participants preferred the concept of earlier investment in electricity infrastructure if it reduces their exposure to volatility (in their annual electricity bills) in the future. Quantitative results, supported by qualitative observations recorded during each focus group discussion, revealed that participants were generally willing to pay a small additional amount today to reduce volatility in the future. However, participants expressed a diverse range of amounts that they were willing to pay to mitigate volatility in their future bills.

- **Online survey** with 2,340 participants from across the NEM.

  In general, online survey participants also preferred the concept of earlier investment in electricity infrastructure if it reduces their future exposure to volatility– but less so than their focus group counterparts. Quantitative data from the online survey is broadly consistent with results from the focus group sessions but has been more challenging to interpret. As with the focus group participants, online survey participants expressed a diverse range of views regarding the extent to which they valued lower future volatility.

AEMO has elected to use the focus group data to develop an economic metric which can be used to estimate consumer risk preferences. This is due to better logical coherence in the focus group responses as participants were given an opportunity to learn about the NEM and risks considered as part of electricity infrastructure decision (reflecting an informed decision when answering the questionnaires). AEMO notes that this represents a small

[27] For a comprehensive outline, see Deloitte's report, at https://aemo.com.au/consultations/current-and-closed-consultations/draft-2024-isp-consultation.

sample size, but considers there to be broad consistency between the focus group and online survey data. A detailed discussion of AEMO's reasoning can be found in AEMO's *Summary of consumer risk preferences project*[28].

AEMO has not applied the recently developed consumer risk preference metric estimate to select an ODP for the Draft 2024 ISP. In future, if AEMO selects an ODP that is not risk neutral, AEMO might apply the estimated metric to evaluate how the ODP performs to reduce volatility in the cost of future electricity bills. This analysis would require AEMO to estimate annual residential electricity bills across the modelled period.

[28] At: https://aemo.com.au/consultations/current-and-closed-consultations/draft-2024-isp-consultation.

8 Victoria storage targets

AER Transparency Review

"The Victorian Government has pledged a target of 2.6 GW of renewable energy storage capacity by 2030, with an increased target of 6.3 GW of storage by 2035. The IASR has included the Victorian Government's intended storage targets in all scenarios.

The IASR makes clear that the storage target applies to both short-duration and long-duration energy storage systems, and the workbook published with the IASR shows that the modelled target will include eligible large-scale energy storage including "existing, anticipated, committed, and new entrant batteries of 1hr–8hr, as well as pumped hydro of 8hr–48hr". It is not clear whether or not aggregated embedded energy storages (referred to as Virtual Power Plants or VPPs) are assumed to contribute to the Victorian storage target. We expect AEMO to provide clarification on this issue."

AEMO's response

While the intended Victorian legislation and its eligibility criteria for the energy storage target are being settled, AEMO has applied an eligibility criteria that includes aggregated consumer energy resources (that is, VPPs), while non-aggregated consumer batteries are excluded.

AEMO will evaluate whether this assumption regarding eligibility continues to align with any legislative proposals and legislation arrangements once these have progressed further through the legislative process, which may inform the Final 2024 ISP if appropriate.

9 Concessional finance

AER Transparency Review

"The IASR notes that the Federal Government's Rewiring the Nation program is looking at a range of measures to support development of ISP projects and REZ developments, including $20 billion of concessional loans and equity to invest in transmission infrastructure projects. The AEMC is currently assessing a rule change request addressing how concessional financing provided by government funding bodies should be treated within the regulatory framework when some benefits may be intended to be shared with consumers.

The IASR provides that AEMO will not incorporate the impact of concessional finance in the draft or final 2024 ISP.

While this approach may be appropriate, we expect AEMO to provide further explanation in the draft 2024 ISP to make explicit the reasons for this assumption."

AEMO's response

The 2023 IASR outlined the Rewiring the Nation program, and stated that AEMO will not incorporate the impact of concessional finance in the draft or final 2024 ISP. AEMO engaged with the Clean Energy Finance Corporation (CEFC) and Federal Government before making this decision. The key reasons for AEMO's decision include:

1. **The allocation of concessional finance to specific transmission projects in the ISP is uncertain**. The Rewiring the Nation fund is intended to include transmission infrastructure, long-duration storage, electricity distribution network infrastructure and distributed energy resources across all of Australia. As such, AEMO is unable to predict how much finance will be allocated in future to specific transmission projects in the ISP.
2. **AEMO does not determine which projects will receive concessional finance**. AEMO considers that concessional finance agreements may be potentially subject to change until the point where a final investment decision is made. As such, AEMO is not able to predict which projects will receive concessional finance.
3. **The terms of concessional finance are likely to vary from project to project**. Projects have different financing requirements depending on individual circumstances. AEMO expects that terms such as the debt rate, the tenure, and the gearing ratio could vary from project to project.
4. **Any assumptions made by AEMO could potentially impact on future negotiations or expectations from proponents**. Because AEMO has a central role in planning the electricity sector, proponents may consider that assumptions made by AEMO have support from either the Federal Government or the CEFC. As such, assumptions made by AEMO may have an unintended influence on future negotiations between proponents and the CEFC.

For these reasons, AEMO is unable to incorporate the impact of concessional finance in the Draft or Final ISP. It is, however, possible that concessional finance terms are known at the time of the ISP Feedback Loop[29]. If the terms of concessional finance were firm at this time, AEMO might use these terms in the ISP Feedback Loop. This assessment might be limited to including the benefits of concessional finance that are passed on to consumers.

[29] Following completion of the Regulatory Investment Test for Transmission (RIT-T), a transmission network service provider (TNSP) may seek written confirmation from AEMO to confirm that the preferred option from the RIT-T remains aligned with the optimal development path in the most recent ISP. This process is referred to as the "feedback loop".

10 Fuel and renewables

AER Transparency Review

"The fuel and renewable assumptions provided by AEMO provide modelling around gas, coal, and renewable resources. For the 2023 IASR these assumptions have been updated with forecasts that consider recent government policy extending the existing gas cap of $12/GJ. We consider that as AEMO has assumed in other parts of the IASR that hydrogen is going to be a widely used fuel source, its price should be modelled in this section alongside other fuel sources. Additionally, it is unclear why gas prices in Hobart are forecast to be significantly higher than the rest of the NEM. We expect AEMO to provide clarification as this is a clear outlier in its current forecasting."

AEMO's response

AEMO published forecast renewable gas fuel prices, including hydrogen and biomethane, in the 2023 IASR Assumptions Workbook (see *"Gas, Liquid Fuel, H2 Price"* tab). These prices were developed by CSIRO and Climateworks Centre (CWC) alongside the multi-sector modelling analysis in 2022 reflecting a range of inputs, model settings, and outcomes that are internally consistent with the broad multi-sector modelling outcomes that are calculated for each scenario. These model outputs are subsequently considered and then used as inputs for a number of areas for ISP modelling. As outlined in the CSIRO/CWC multi-sector modelling companion report, hydrogen fuel costs are determined through optimisation of investment in hydrogen capacity and operation to deliver hydrogen to end-users at least cost, and is endogenously determined in the AusTIMES model for each modelled scenario. AEMO will consider broader discussion of hydrogen (and other renewable fuel) price forecasts in the body of future IASR publications.

Gas prices in Hobart are forecast to be approximately $2/gigajoule (GJ) higher than other east coast states. Prices in Melbourne and Hobart are higher as a result of weak southern supply development and reliance on more northern gas to meet demand. Prices are highest in Hobart because of the additional costs[30] to transport gas from the mainland to the Tasmanian network where there is no local gas production. ACIL Allen provides this explanation on page 22 of its report published alongside the 2023 IASR[31]. Although the explanation is provided with respect to residential and commercial gas prices, it also applies to prices for other customer types. This relative relationship between Hobart and Melbourne gas prices is broadly consistent with prior forecasts provided in previous IASRs.

AER Transparency Review

"AEMO has made certain assumptions regarding hydrogen usage by residential, commercial, and industrial users. Residential and commercial users are assumed to reach 8-10 per cent hydrogen in distribution pipelines by 2030, while industrial is forecast to reach 40-80 per cent. We observe it is not clear how industrial hydrogen will reach 40-80 per cent, and we consider this needs further explanation from AEMO."

[30] 2023 GSOO Supply Data reports prices at $2.55/GJ for transport via the Tasmanian Gas Pipeline (TGP); see https://aemo.com.au/-/media/files/gas/national_planning_and_forecasting/gsoo/2023/2023-gsoo-gas-statement-of-opportunities-supply-data.zip.

[31] See https://aemo.com.au/-/media/files/major-publications/isp/2023/iasr-supporting-material/acil-allen-natural-gas-price-forecasts.pdf

AEMO's response

It was assumed that residential, commercial and some industrial users would continue to be supplied by existing distribution pipelines which could handle a gas blend of up to a maximum of 10% hydrogen (by volume). However, the assumption for the majority of the industrial sector was that 100% hydrogen could be supplied directly if new supply infrastructure were established. The average for the industrial sector could therefore exceed 10% by volume depending on the relative proportion of supply from existing/new pipelines. The assumption is supported by the detailed results of the Multisector Modelling, which estimated an optimal industrial sector average in the range of 40-80%.

The new pipelines would be constructed from hydrogen-compatible materials, and therefore not subject to blending limitations. It was envisaged that infrastructure costs would be optimised through the use of hydrogen hubs, whereby users could be clustered close to the electrolysers, minimising the length of new pipelines that would be required.

11 Power system security

AER Transparency Review

"AEMO's power system security assumptions highlight changes in the various scenarios from new generation and transmission investments and how they change the scale and location of services needed for power system security.

The IASR details the unit commitment assumptions made by AEMO, with AEMO ultimately assuming that the requirement to maintain a minimum dispatch of coal-fired generation will end.

Currently for NSW, Queensland, and Victoria, AEMO applies a 'half-life' approach and assumes that the number of units required will halve in a certain number of years depending on the scenario. However, we consider this assumption has not been adequately explained given there is already a timeline for closure of several coal plants. We expect AEMO to explain the basis for the half-life approach.

Further, there is little detail discussing the assumptions regarding which power system security services will come online and when. Rather AEMO only states that they expect a mix of technologies to be delivered. We expect AEMO to explain the relevant mix of technologies that will be assumed to meet system security requirements."

AEMO's response

Synchronous generating unit commitment

There is uncertainty in regard to how unit commitment constraints will change into the planning timeframe. While network service providers (NSPs) are developing solutions for systems strength, inertia, and network support, the timeline and capability of solutions is currently uncertain. Removing unit commitment constraints in the ISP model from Year 1 would fail to represent a secure system, while holding them fixed into the horizon would fail to capture any improvements driven by NSP investment into replacement services. As such, AEMO must apply professional judgement to assume how unit commitment requirements could change over time.

To capture timing uncertainties, while balancing both factors realistically, AEMO has proposed a stepwise decreasing unit commitment requirement that halves every few years. This allows announced generator closures to proceed, while also reflecting current lead-time estimates for new system security assets (such as synchronous condensers). In addition, the approach recognises that operation with low or no synchronous units online will need to be carefully staged and only released once replacement assets or services are fully tested and commissioned.

For the purposes of the ISP modelling, AEMO implements this stepwise requirement as a constraint that keeps some synchronous units online, even out of merit order, but only if there would otherwise be insufficient system security services available. This constraint does not override publicly announced generator closures, and all units remain available for economic dispatch when not explicitly constrained-on for security purposes.

The constraint is initially set to AEMO's current operational requirements in each region, and then progressively relaxed as an increasingly diverse mix of system security services is delivered by the NSPs – including additional network assets, the retrofit of existing generation, and contracts with new technologies such as grid forming batteries.

Regulatory Investment Tests for Transmission (RIT-Ts) are already underway for each NEM jurisdiction to deliver the first round of these new security services, however, any new assets or technologies are subject to supply

chain risks and investment lead times. As a result, complete solutions are likely to be staggered over time, and synchronous generation is expected to remain to complement those services in the interim. The half-life approach also allows that some synchronous units may remain online under network support contracts with the NSP, should they prove to be the most cost-efficient providers.

System security technologies and timing

AEMO expects that a portfolio of system security solutions will likely prove efficient in each region, including synchronous condensers, the retrofit of existing generation, contracts for units to operate in synchronous condenser mode, minor network reconfigurations, and new grid-forming technologies.

The ISP modelling includes a $/kilowatt (kW) value associated with system security remediation for new inverter-based resources (IBR) and REZ investment, which in turn allows the ISP to consider the security cost and timing implications of the investments it outlines. These costs are based on those of synchronous condenser equipment in the latest Transmission Cost Database which were consulted on through the 2023 *Transmission Expansion Options Report*[32]. AEMO uses synchronous condenser costs as a proxy for system strength because it is a proven and mature technology. AEMO expects that alternative technologies, such as grid-forming inverters, are likely to provide system strength in future. The ISP itself does not attempt to optimise or identify system strength solutions, but rather ensure the costs are approximately captured.

Identifying and testing viable technologies for a given security need would require detailed power system analysis on a case-by-case basis to capture the necessary electrical characteristics and to assess the interactions between different technologies for a given network location. Such assessment is unlikely to have a material impact on the capacity or location of investment decisions made by the ISP when compared against the proxy $/kW cost approach.

The detailed power system analysis remains important in near-term planning activities and is most appropriately undertaken as an outworking of the ISP's results – through activities such as REZ Development Plans, or via the localised investment testing done through the system strength, inertia, and network planning frameworks.

AEMO has published the modelled quantity of system strength, inertia, and network support needs a part of the system security appendix to the Draft 2024 ISP.

[32] At https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-transmission-expansion-options-report.pdf.

12 Renewable energy zones

AER Transparency Review

"AEMO has included a new candidate offshore REZ in the vicinity of North-East Tasmania with limited explanation. We expect AEMO to explain the basis for the inclusion of this new zone."

AEMO's response

The 2023 IASR noted that the North-East Tasmania Coast offshore REZ has been included based on participant feedback. This feedback was from TasNetworks, the local transmission network service provider. TasNetworks confirmed this feedback in its submission in response to the Draft 2023 IASR[33], noting:

"*We support the addition of North East Tasmania Offshore Renewable Energy Zone (REZ). We have seen investor interest in offshore wind in both North West and North East Tasmania. The connection points for offshore wind are proposed as George Town area for North East Offshore REZ, and remains Burnie area for North West Offshore REZ*."

The Commonwealth Government has recently announced a consultation[34] for an offshore renewable energy infrastructure area which also broadly confirms this offshore location. AEMO will update its representation of offshore wind zone locations for Tasmania in due course following the finalisation of the Commonwealth Government's consultation.

[33] See https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2022/2023-inputs-assumptions-and-scenarios-consultation/submissions/tasnetworks.pdf.

[34] Australian Government. 'Offshore renewable energy infrastructure area proposal: Northern Tasmania, Bass Strait, Tasmania. Accessed 24 November 2023. At https://consult.dcceew.gov.au/oei-bass-strait.

13 Unknown risk factor for estimated transmission costs

AER Transparency Review

"The 2023 Transmission Expansion Options Report is an accompanying report to the IASR. In it, AEMO explains how its approach to cost estimation in the ISP deviates from the Association for Advancement of Cost Engineering (AACE) cost estimation framework. In particular, while the AACE framework adopts asymmetrical accuracy bands to reflect the greater upside risks that projects face, AEMO adds a contingency allowance to the cost estimate that results in estimates with symmetrical accuracy bands. AEMO explains why it has made this variation, but they do not adequately explain how it has derived the unknown risk factor. We expect AEMO to provide further explanation on this issue."

AEMO's response

AEMO acknowledges that its approach to applying cost estimation in the ISP may appear to deviate from the AACE framework – although AEMO considers any deviation to be superficial, as outlined in Section 2.1.1 of the 2023 Transmission Expansion Options Report[35].

The 'unknown risk' factor applied in AEMO's transmission project cost estimates was originally calculated by AEMO's consultant GHD when developing AEMO's Transmission Cost Database[36,37]. GHD took confidential cost estimates provided from recent projects delivered in the NEM to prepare the value. GHD found most cost predictions or estimates for infrastructure projects demonstrate some measure of asymmetrical distribution or skewness, usually to the high side where the probability of overrun is higher than the probability of underrun. Therefore, an appropriate unknown risk is usually a positive allowance added to cover the variability surrounding the base estimate.

The AACE note RP 96R-18 defines typical accuracy ranges expected in power transmission line infrastructure project estimates as they transition from Class 5 to Class 1, and is shown in Figure 9 of GHD's report. However, the AACE, an international body, recommended refining of the accuracy range, with the observation and inclusion of actual cost estimate changes from the jurisdiction the cost estimates are for (i.e. Australia), so GHD have used this information as a starting position and refined the information from recent Australian transmission infrastructure augmentation project cost estimate data.

GHD studied the progression of the total cost estimate of 22 recent major project network elements between the Project Assessment Draft Report and the Contingent Project Application stage for projects as they progressed through the RIT-T, focusing on the changing/increasing cost needed to correct the accuracy offset of early estimates compared to the later versions. The sample distribution allowed consideration of the estimate accuracy band. This consisted of 9 stations and 13 overhead line network elements. The results of that study are given in figures 10 and 11 in the GHD report.

[35] AEMO. 2023 *Transmission Expansion Options Report*, at https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-transmission-expansion-options-report.pdf.

[36] GHD. *Transmission Cost Database – GHD Report*. At https://aemo.com.au/en/consultations/current-and-closed-consultations/transmission-costs-for-the-2022-integrated-system-plan.

[37] The form to request the AEMO Transmission Cost Database is accessible under the 'references' drop down at https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation.

The GHD report found that:

- The accuracy range of the Australian TNSPs' early-stage cost estimate can be reasonably assumed to be ±30% for Class 5a estimates and ±50% for Class 5b estimates.
- On average the Australian TNSPs increased their early-stage Class 5b cost estimates by ~30%. The change from Class 5 cost estimates were driven by the different changes in all four unknown risk categories (scope and technology risks, productivity and labour cost risks, plant procurement risks, and project overhead risks). The highest variations were due to scope increases (i.e. scope and technology risks).

In AEMO's Transmission Cost Database, the unknown risk factor is applied differently for different network elements of the estimate. Network elements (like a substation or overhead line) are made up of building blocks in the database, which in turn are made up of components such as plant and materials, civil and structural works, and electrical works. Each component has an adjusted baseline cost (adjusted for certain project-specific attributes), and ultimately the percentage adjustments for unknown risk are applied to the adjusted baseline cost for individual components. There are three categories for unknown risk (substation, overhead line, and underground cables) and four sub-categories. Each combination of category and sub-category results in a specific set of adjustment factors for each of the nine components. Different risk values are applied for different categories and components.

Figure 3 shows where the calculation of unknown risk can be observed in the output of a sample cost estimate from AEMO's Transmission Cost Database. The application of the risk factors for all possible combinations can be observed in the Transmission Cost Database, which can be requested via AEMO's website[38].

The statement made in the 2023 Transmission Expansion Options Report that the unknown risk allowance is 'up to 30%' of the total network element cost being considered in the cost estimate was derived by aggregating the data from all published cost estimates for the 2023 Transmission Expansion Options Report and observing that the unknown risk allowance never exceeds 30% of the total network element cost for any cost estimate.

[38] The form to request the AEMO Transmission Cost Database is accessible at https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp/current-inputs-assumptions-and-scenarios/transmission-cost-database.

Figure 3 Output of Transmission Cost Database and calculation of unknown risk

9 'components' of each building block

	Category	Subcategory	Details	Nominal Voltage	Qty	UOM	Plant and Materials	Civil and Structural Works	Electrical Works	Secondary Systems	Design & Survey	Testing & Commissioning	Contractor Project Management & Overheads	Easement/ Property Costs	Environmental Offset Costs	Total Network Element costs	Percent of total
Building Blocks:	Station	AIS Switchbay	3CB Diameter 3CBs	500	3	lot	$ 9.47 M	$ 5.31 M	$ 1.95 M	$ 1.00 M	$ 1.63 M	$ 0.33 M	$ 2.02 M	$ 0.00 M	$ 0.00 M	$ 21.71 M	10%
	Station	Transformer	2 winding Tx (3 banks of 1ph) 1500MVA	500/330	3	ea.	$ 72.80 M	$ 10.72 M	$ 6.03 M	$ 0.33 M	$ 2.97 M	$ 0.75 M	$ 0.00 M	$ 0.00 M	$ 0.00 M	$ 93.61 M	42%
	Station	Property site work and building	AIS site infrastructure 25000 m2 footprint area and applicable control building	N/A	1	lot	$ 0.52 M	$ 15.81 M	$ 1.13 M	$ 2.33 M	$ 0.45 M	$ 0.45 M	$ 1.78 M	$ 0.09 M	$ 0.06 M	$ 22.62 M	10%
	Station	AIS Switchbay	3CB Diameter 3CBs	330	2	lot	$ 4.19 M	$ 2.22 M	$ 0.87 M	$ 0.67 M	$ 0.73 M	$ 0.15 M	$ 0.91 M	$ 0.00 M	$ 0.00 M	$ 9.74 M	4%
Adjusted Baseline							**$ 89.52 M**	**$ 40.18 M**	**$ 11.77 M**	**$ 5.07 M**	**$ 6.82 M**	**$ 1.99 M**	**$ 6.62 M**	**$ 0.09 M**	**$ 0.06 M**	**$ 162.11 M**	**73%**
Unknown Risks:	Station unknown risk	Plant procurement cost risks	Class 5b				8.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		
	Station unknown risk	Productivity and labour cost risks	Class 5b				0.00%	8.00%	8.00%	8.00%	8.00%	8.00%	0.00%	0.00%	0.00%		
	Station unknown risk	Project overhead risks	Class 5b				0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	8.00%	30.00%	30.00%		
	Station unknown risk	Scope and technology risks	Class 5b				24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	0.00%	24.00%	24.00%		
Total Unknown Risk Rate %							32.00%	32.00%	32.00%	32.00%	32.00%	32.00%	8.00%	54.00%	54.00%		
Total Unknown Risk Rate $							**$ 28.65 M**	**$ 12.86 M**	**$ 3.77 M**	**$ 1.62 M**	**$ 2.18 M**	**$ 0.64 M**	**$ 0.53 M**	**$ 0.05 M**	**$ 0.03 M**	**$ 50.32 M**	**23%**
Total Expected Network Element cost							**$ 122.82 M**	**$ 55.44 M**	**$ 16.24 M**	**$ 6.94 M**	**$ 9.35 M**	**$ 2.72 M**	**$ 7.48 M**	**$ 0.13 M**	**$ 0.15 M**	**$ 221.28 M**	**100%**

Unknown risk category

Unknown risk sub-category

Unknown Risk Allowance ($) is 32% of Adjusted Baseline

Different unknown risk allowance applied to each component

14 Employment factors

AER Transparency Review

"The IASR includes employment factors for transmission, generation and storage builds as an input to estimates for workforce requirements needed to implement the ISP. However, AEMO has not adequately explained how it has derived these factors. We expect AEMO to provide further explanation on this issue."

AEMO's response

AEMO sourced employment factors for generation, transmission and storage from "The Australian Electricity Workforce for the 2022 Integrated System Plan: Projections to 2050"[39], a renewable energy industry report prepared by the Institute for Sustainable Futures (ISF) for Reliable Affordable Clean Energy (RACE) for 2030.

Employment factors are derived from industry surveys of developers, installers and original equipment manufacturers conducted by the ISF. These surveys collect a breakdown of occupational data across sectors for construction, installation, operations and maintenance of recent actual projects and activities.

A detailed description of the methodology for deriving employment factors including the survey response data is described in:

- Rutovitz, J., Dominish, E. and Downes, J. (2015) "Calculating global energy sector jobs: 2015 methodology"[40], and
- Rutovitz, J., Briggs, C., Dominish, E., Nagrath, K. (2020) "Renewable Energy Employment in Australia: Methodology"[41].

[39] Race for 2030. *The Australian Electricity Workforce for the 2022 Integrated System Plan: Projections to 2050*, at https://www.uts.edu.au/sites/default/files/2022-11/ISP2022_Workforce_v1.pdf.

[40] At https://opus.lib.uts.edu.au/bitstream/10453/43718/1/Rutovitzetal2015Calculatingglobalenergysectorjobsmethodology.pdf.

[41] At https://www.uts.edu.au/sites/default/files/2020-06/RE-Employment-methodology-FINAL.pdf.

15 Growth in weather extremes

AER Transparency Review

"The IASR states that the 2024 ISP will explore adaptations to historical weather conditions to increase the frequency of weather extremes. Whilst this may be appropriate, AEMO has not explained what inputs these adaptations will be based on. We expect AEMO to explain the basis for any adjustments to historical weather conditions."

AEMO's response

As the climate might become much more erratic and severe in the future, AEMO has performed exploratory modelling to test the resilience of power system investments to various known and unknown risks, including more erratic and severe changes in weather patterns.

In the absence of appropriate weather modelling techniques being available to accurately predict the full range of potential future weather conditions, AEMO modelling applies algorithms to extend the duration of extreme weather conditions to simulate a more volatile future climate, while retaining the inherent internal consistency between supply, demand and transmission models by using historical weather.

To assess the NEM's resilience to more extreme variable renewable energy (VRE) drought events[42], AEMO has modelled a "what-if" sensitivity in which the most impactful three-day VRE low is extended to an eight-day event, with the most severe day (Thursday) lasting for five days longer. This is an exploratory exercise to demonstrate potential resilience, and while the time-series data repeats the trace development approach for demand, wind and solar generation that is deployed generally, in this instance the repeating day overrides the previous days to uplift the duration of the VRE low event. The purpose of the sensitivity is to demonstrate the resilience of the investment mix to extended low renewable conditions, as is appropriate for sensitivity analysis, and the choice of the duration of the extension to eight days has not been scientifically formulated.

[42] VRE droughts occur during dark and still weather conditions when periods of lower solar generation coincide with low wind generation.