

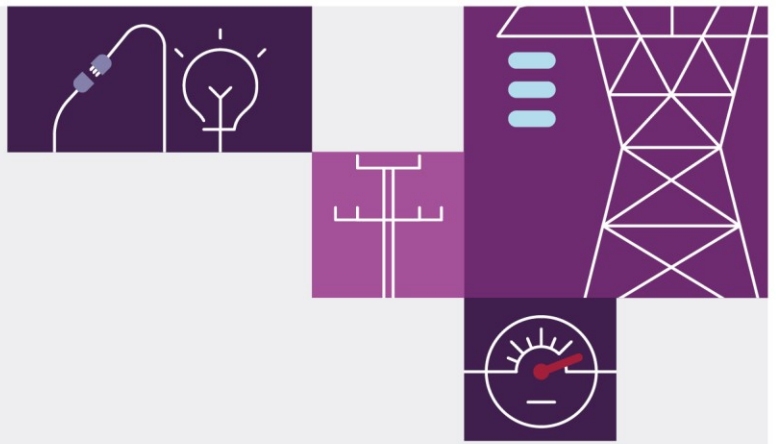
# 2023 Transmission Expansion Options – Consultation Summary Report

July 2023

Consultation summary report

For the Integrated System Plan (ISP) for the  
National Electricity Market





# Important notice

## Purpose

AEMO publishes this consultation summary report following its consultation on the Draft 2023 *Transmission Expansion Options Report* as part of an initiative to improve the accuracy and transparency of transmission expansion options used for the 2024 *Integrated System Plan*. The 2023 *Transmission Expansion Options Report* supplements the 2023 *Inputs, Assumptions and Scenarios Report (IASR)*.

This publication is generally based on information available to AEMO as at July 2023 unless otherwise indicated.

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# Executive summary

AEMO will soon begin the market modelling and power system analysis required to prepare and release the Draft 2024 *Integrated System Plan* (ISP). Transmission network expansion is a key part of the assessment, as it will increase the transfer capacity of renewable energy zones (REZs) and the backbone of the interconnected network, thereby delivering the transition at lower cost to consumers.

AEMO is now releasing a final 2023 *Transmission Expansion Options Report* for the 2024 ISP. This update follows consideration of stakeholder submissions received in response to the draft report published in May 2023. This consultation is made consistent with the National Electricity Rules (NER) and in accordance with the Australian Energy Regulator's (AER's) Forecasting Best Practice Guidelines.

## AEMO thanks stakeholders for their submissions

AEMO has considered all submissions on the Draft 2023 *Transmission Expansion Options Report*. Stakeholder engagement on this report included 20 public written submissions, two confidential submissions, a submission provided verbally by consumer advocates, several stakeholder meetings, and attendance by more than 100 people at a webinar. The material recommendations and AEMO's responses are outlined in the table below.

**Table 1 AEMO's response to material stakeholder feedback**

Stakeholder feedback	AEMO's response
Inflationary market pressures on transmission cost escalations returning to normal by 2026-27 is too optimistic and likely to persist further.	<b>Change made to draft position</b> – AEMO engaged with cost estimating teams in transmission network service providers (TNSPs), a specialist costing consultancy firm, Infrastructure Australia, and other stakeholders on this matter. There is general agreement about a risk of persisting market pressures, but no consensus on a timeframe. AEMO expects that the near-term pressure increasing transmission project costs will continue while the sector adapts to market pressures driven by the global race to net zero.  AEMO has changed the report to now include an expectation that costs will continue to rise initially before levelling out at a new normal from 2029-30 in the <i>Step Change</i> and <i>Green Energy Exports</i> scenarios, and 2026-27 for the <i>Progressive Change</i> scenario. The new normal also recognises that some elements of the cost of transmission projects will continue to increase beyond the rate of inflation.
Any transmission project lead time adjustments should be transparent, based on evidence, and ideally made through joint planning with TNSPs and relevant jurisdictional bodies.	<b>No change compared to draft position, with clarifications provided</b> – AEMO has a strong preference to only adjust project lead times through close joint planning and collaboration with the relevant TNSPs and/or jurisdictional bodies. AEMO has confidence in the joint planning processes. In addition, AEMO does consider it prudent to reserve the ability to apply adjustments to lead time based on transparent stakeholder feedback. Like all inputs for the ISP, lead times are subject to finalisation through public stakeholder consultation.
A call for better and more transparent incorporation of social licence into the planning process.	<b>Change made to draft position</b> – AEMO agrees with stakeholders about the importance of local community acceptance of new infrastructure development, as well as the importance of transparency and clear communication through the ISP process. In the final 2023 <i>Transmission Expansion Options Report</i> , AEMO has added a note that AEMO will include input and feedback from external stakeholders, including the Advisory Council on Social Licence and the ISP Consumer Panel, as part of the overall consideration of social licence matters in the ISP.
A suggestion to change cost estimate accuracy bands by adopting the Association for the Advancement of Cost Engineering's (AACE's) method exactly.	<b>Clarification regarding AEMOs application of the AACE method provided</b> – AEMO has clarified the way in which it implements the AACE cost estimation and has added a new section in the 2023 <i>Transmission Expansion Options Report</i> to outline any deviation from the AACE framework. Further, AEMO has noted that over time it intends to continue to enhance its cost estimation process as further evidence becomes available.
Better clarification of how biodiversity costs are treated now and in the future.	<b>Change made to draft position</b> – AEMO has clarified that biodiversity offset costs are initially estimated in the capital expenditure estimates for transmission augmentation projects using updated values in AEMO's Transmission Cost Database. In addition, AEMO will forecast biodiversity offset costs by holding the ratio of offset costs to total project cost constant over the ISP horizon.

## AEMO has made updates in three areas of the *Transmission Expansion Options Report*

Compared to the Draft 2023 *Transmission Expansion Options Report*, AEMO has changed three key areas.

### Forecasting transmission project cost estimates over time

In response to stakeholder feedback that the future cost of transmission projects had been underestimated, AEMO consulted further with transmission network service providers (TNSPs) and jurisdictional bodies, Infrastructure Australia, the ISP Consumer Panel and others. AEMO subsequently made the following revisions to its cost forecasts and forecasting approach:

- Property and land easement costs are assumed to increase in real terms throughout the study horizon. All other transmission component costs are assumed to increase initially and then remain constant from:
  - 2029-30 in the *Step Change* and *Green Energy Exports* scenarios – rather than the 2026-27 date proposed in the draft report.
  - 2026-27 in the *Progressive Change* scenario – consistent with the proposal in the draft report.
- Updates to forecasts for several of the baskets of goods and services identified by Mott MacDonald in its *Transmission Cost Database Update Final Report*.

AEMO has also clarified that biodiversity offset costs are categorised as capital expenditure, and are calculated using the Transmission Cost Database. AEMO has further clarified that biodiversity offset costs will be forecast by holding the ratio of offset costs to total project cost constant over the ISP horizon. AEMO considers this to be an appropriate approach to estimate future costs, given the known pressure on offset costs but in the absence of an appropriate economic model for deriving a dedicated escalation factor.

### Consideration of social licence

AEMO welcomes the feedback provided from a range of stakeholders about the consideration of social licence in the *Transmission Expansion Options Report* and in the ISP itself. Comments covered the importance of understanding the cost of social licence, a call for clearer communication about transmission augmentation options, and the need for meaningful consideration of undergrounding of transmission lines in option analysis.

Where feedback is better considered under the *Inputs, Assumptions and Scenarios Report* (IASR) or through the ISP process itself, AEMO has provided further information about those processes.

AEMO has updated the final *Transmission Expansion Options Report* to note that overall consideration of social licence in the ISP will have regard for input and feedback from external stakeholders including feedback from the Advisory Council on Social Licence and the ISP Consumer Panel.

### Transmission expansion options and generator connection costs

AEMO has updated the flow path and REZ augmentation options in the final 2023 *Transmission Expansion Options Report* to incorporate materials provided by TNSPs in preparatory activities reports for future ISP projects, as well as the latest project scope and cost estimate information where provided by project proponents.

AEMO has also updated cost estimate matters in response to feedback and final AEMO review, including changing all 500 kilovolts (kV) line conductors to quad conductor types across the project estimates, adjusting the treatment of modular power flow controller options, and updating generator connection cost assumptions.

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# 1 Introduction

Consultation and dialogue with all National Electricity Market (NEM) stakeholders is critical to AEMO's role as the National Transmission Planner for the NEM. This report outlines how AEMO has taken stakeholder feedback into account to prepare the 2023 *Transmission Expansion Options Report*, ahead of its application in the 2024 *Integrated System Plan* (ISP).

## 1.1 Stakeholder consultation process

AEMO consulted on the Draft 2023 *Transmission Expansion Options Report* to prepare transmission augmentation options for the 2024 ISP, including conceptual design, lead time, location and cost estimates. This consultation summary report is published as a supporting publication for the 2023 *Inputs, Assumptions and Scenarios Report* (IASR) and in accordance with the Australian Energy Regulator's (AER's) Forecasting Best Practice Guidelines<sup>1</sup>.

Note that this report uses terms defined in the National Electricity Rules (NER), which are intended to have the same meanings. There is a glossary of additional terms and abbreviations in Appendix A1.

AEMO's process and timeline for this consultation is outlined in Table 2.

**Table 2 Consultation process and timeline**

Consultation steps	Dates
Notice of consultation, and Draft 2023 <i>Transmission Expansion Options Report</i> including consultation questions published	2 May 2023
Pre-submissions webinar	18 May 2023
Consumer advocate information and verbal submission sessions	19 May 2023 and 31 May 2023
Submissions closed on Draft 2023 <i>Transmission Expansion Options Report</i> consultation	31 May 2023
Discussions with stakeholders to clarify submissions	June – July
2023 <i>Transmission Expansion Options Report</i> and <i>Consultation Summary Report</i> published	28 July 2023
Post publication webinar <sup>A</sup>	10 August 2023

A. Webinar registration and related content is available at <https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp/opportunities-for-engagement>.

Stakeholder engagement on the Draft 2023 *Transmission Expansion Options Report* included 22 written submissions (two of which were confidential) and one verbal submission, one public webinar, and two information and verbal submission sessions for consumer advocates. AEMO has published all written submissions and other consultation documents except for the confidential submission materials. AEMO also met with several stakeholders to discuss their submissions. Submissions and minutes from these discussions can be viewed on the consultation page<sup>2</sup>.

<sup>1</sup> AER. August 2020. *Forecasting Best Practice Guidelines*. At <https://www.aer.gov.au/system/files/AER%20-%20Forecasting%20best%20practice%20guidelines%20-%2025%20August%202020.pdf>.

<sup>2</sup> At <https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation>.

AEMO thanks all stakeholders for their feedback on the draft report, which has been considered in preparing this consultation summary report. A summary of material issues raised in submissions, and AEMO's response to each, is contained in Section 2 of this report.

## 1.2 Context for this consultation

This section outlines the purpose of the *Transmission Expansion Options Report*, before listing the updates AEMO has considered in completing this consultation, and how this consultation fits in to the 2024 ISP development process.

The ISP is a whole-of-system plan that provides an integrated roadmap for the efficient development of the NEM over at least the next 20 years.

Leveraging expertise from across the industry is pivotal to the development of a robust plan that supports the long-term interests of energy consumers. AEMO is committed to facilitating a stakeholder engagement process that ensures a consultative approach to developing the 2024 ISP.

AEMO has developed the final 2023 *Transmission Expansion Options Report* in accordance with the AER's Forecasting Best Practice Guidelines<sup>3</sup>. This includes providing a transparent process, supporting and working with stakeholders in their understanding of AEMO's processes and publications, and providing additional information to complement the formal documentation.

### 1.2.1 Purpose of the *Transmission Expansion Options Report*

Transmission expansion needs to be explored as part of ensuring that NEM consumers have efficient access to renewable energy and firming resources.

Transmission network expansion is a key part of the ISP assessment, as it will increase the transfer capacity of renewable energy zones (REZs) and the backbone of the interconnected network, thereby delivering the transition at lower cost to consumers.

The 2023 *Transmission Expansion Options Report* forms part of the 2023 IASR. It describes the engagement of independent experts and provision of industry and stakeholder advice, culminating in a report summarising the conceptual design, lead time, location and project cost estimates (including network augmentation costs, connection costs and system strength remediation costs) for candidate transmission projects to inform the development of the 2024 ISP.

### 1.2.2 2024 ISP development process

Figure 1 shows the status of the main ISP consultations. Figure 2 shows the ISP process, and current progress on all elements for the 2024 ISP<sup>4</sup>.

AEMO has now completed both consultations required before beginning the preparation of the Draft 2024 ISP:

- **Consult on inputs, assumptions and scenarios** – AEMO received submissions from 69 stakeholders on the Draft 2023 IASR (five of which were confidential). AEMO received 20 public written submissions, two

<sup>3</sup> AER. August 2020. *Forecasting Best Practice Guidelines*. At <https://www.aer.gov.au/system/files/AER%20-%20Forecasting%20best%20practice%20guidelines%20-%2025%20August%202020.pdf>.

<sup>4</sup> The 2024 ISP Timetable provides more information on the key milestones of the 2024 ISP development process, at <https://aemo.com.au/-/media/files/major-publications/isp/2022/2024-isp-timetable.pdf?la=en>



confidential submissions, and a verbal submission on the Draft 2023 *Transmission Expansion Options Report*. AEMO has now released the 2023 IASR and the 2023 *Transmission Expansion Options Report*.

- **Consult on the ISP Methodology** – AEMO received 25 stakeholder submissions on the *Draft 2023 ISP Methodology* that was published in March 2023. AEMO released the final ISP Methodology on 30 June 2023.

Figure 1 Parallel ISP consultations

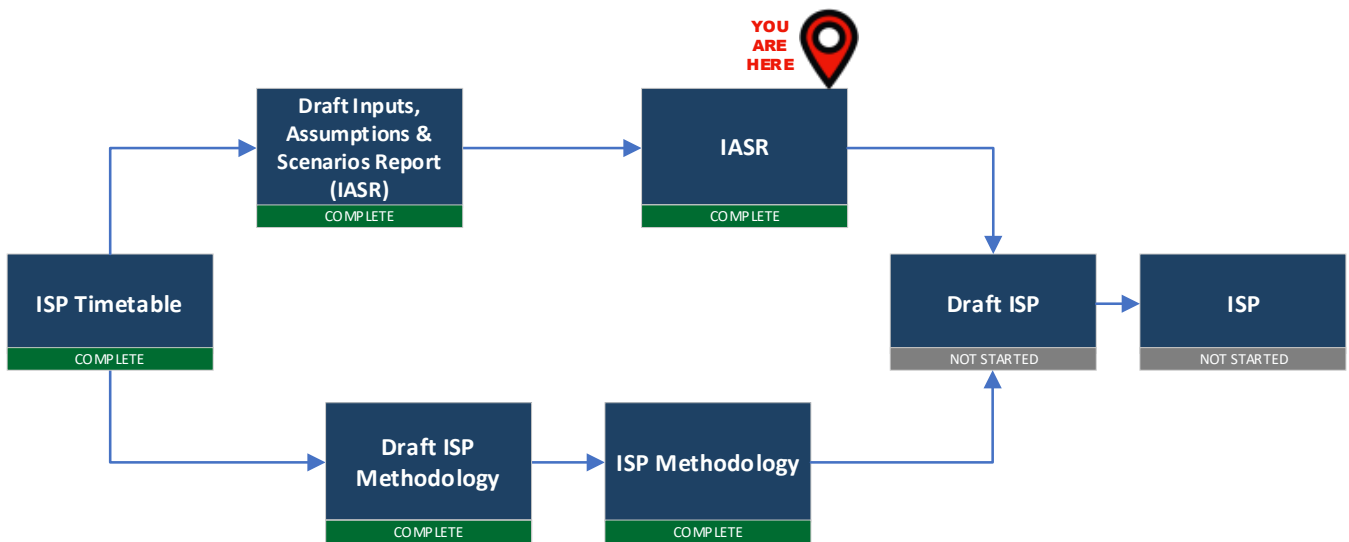
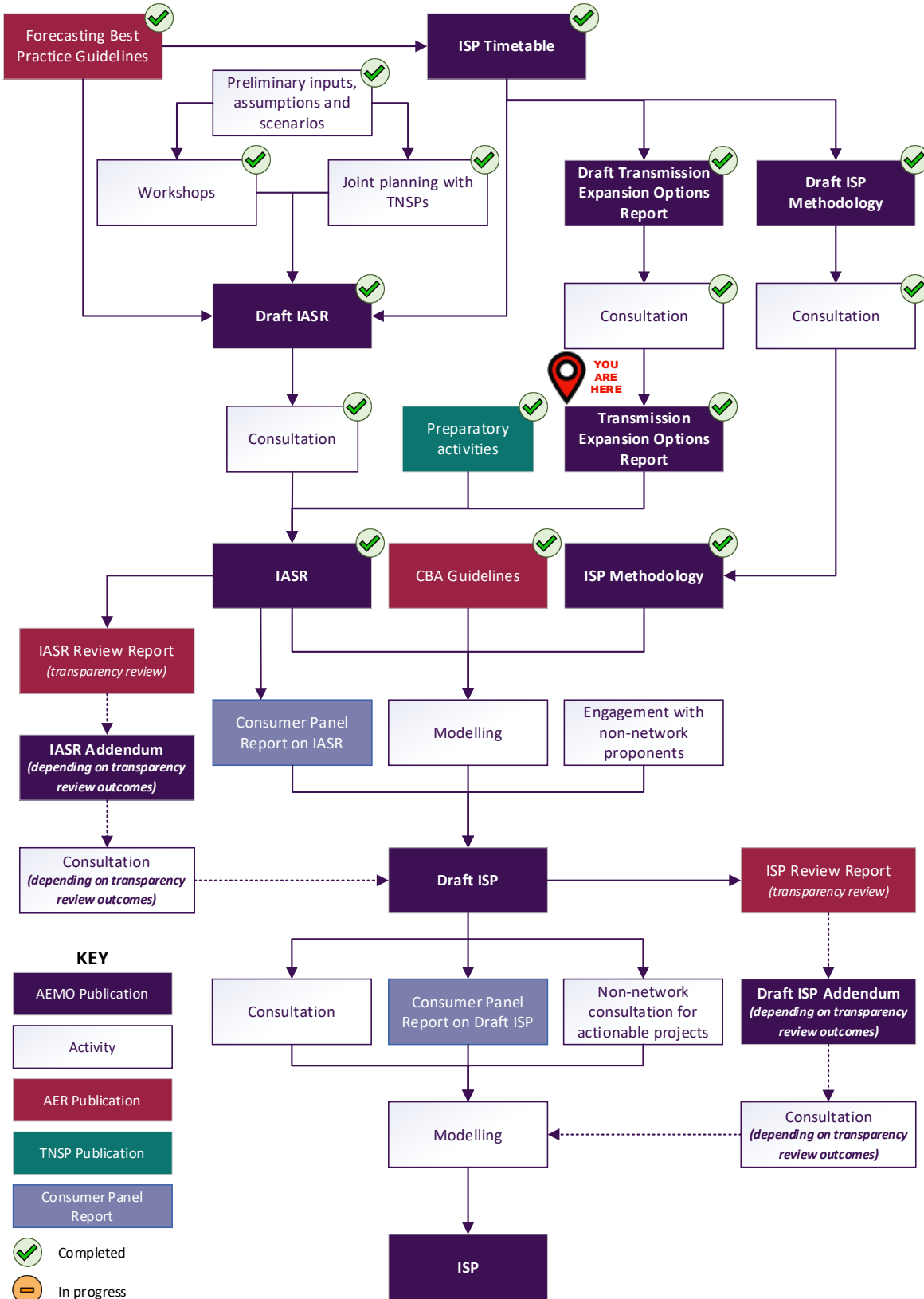


Figure 2 Navigating the ISP process



Note: The diagram above has been amended from the version published in the 2024 ISP timetable by adding a box containing "Draft Transmission Expansion Options Report" and "Transmission Expansion Options Report" with an additional "Consultation" box. The IASR will consider transmission development options and non-network alternatives.

### 1.2.3 Updates to the Draft 2023 Transmission Expansion Options Report considered in this consultation

AEMO is required to publish its ISP at least every two years. When developing, consulting on and publishing the inputs, assumptions and scenarios updated as part of the ISP development process, AEMO is required to complete a single stage consultation process (outlined in Appendix B of the AER's Forecasting Best Practice Guidelines).

All content in the Draft 2023 *Transmission Expansion Options Report* was subject to consultation, and several consultation questions were posed, broadly relating to:

- **Methodology** – how AEMO assesses conceptual design, project lead time, location, and cost estimates for transmission augmentation options that will be considered in the ISP.
- **Flow path augmentation options** – flow paths are the portion of the transmission network used to transport significant amounts of electricity across the backbone of the network to load centres.
- **REZ augmentation options** – REZs are areas where clusters of large-scale renewable energy can be developed using economies of scale.
- **Generator connection costs** – connection costs account for the network infrastructure required to connect a generator to the shared network (for example, to a nearby REZ or flow path).

This consultation summary report outlines AEMO's consideration of the feedback received in response to the draft report released in May 2023. As such, AEMO is releasing a final publication which includes the following updates:

- Changes to AEMO's approach to forecasting transmission project cost estimates over time.
- Clarification on AEMO's consideration of social licence.
- Changes to specific flow paths and REZ augmentation options, and generator connection costs.

In addition, AEMO has engaged in regular and extensive joint planning with transmission network service providers (TNSPs) and jurisdictional bodies since the release of the draft report to incorporate information needed to finalise the transmission augmentation options in the final report.

As part of collaboration with the TNSPs, AEMO received the preparatory activities for future ISP projects triggered in the 2022 ISP<sup>5</sup> to be completed by 30 June 2023. AEMO has incorporated the preparatory activities in the final 2023 *Transmission Expansion Options Report* and has published the following preparatory activities reports<sup>6</sup>:

- Darling Downs REZ Expansion (Stage 1) from Powerlink.
- Mid-North South Australia REZ Expansion from ElectraNet.
- Queensland – New South Wales Interconnector (QNI) Connect (500 kilovolts (kV) option) from Powerlink and Transgrid.
- QNI Connect (330 kV option – New South Wales scope) from Transgrid.
- Reinforcing Sydney, Newcastle and Wollongong Supply from Transgrid.

<sup>5</sup> In addition, Transgrid provided a report on the preparatory activities for reinforcing Sydney, Newcastle and Wollongong supply, which were requested in the 2020 ISP. AEMO has published the report for these preparatory activities on the consultation page for the 2023 *Transmission Expansion Options Report*, and has incorporated this preparatory activities information in the final report.

<sup>6</sup> The preparatory activities reports are available on the consultation page for the 2023 *Transmission Expansion Options Report*, at <https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation>.

- South East South Australia REZ Expansion from ElectraNet.
- South West Victoria REZ Expansion from AEMO Victorian Planning.

As part of preparing the final report, AEMO also commissioned some updates to the AEMO Transmission Cost Database from specialist consultancy Mott MacDonald. The updated database and an updated report from Mott MacDonald are published along with this report<sup>7</sup>.

## 1.3 Summary of submissions

This section provides an overview of the stakeholders who provided submissions to this consultation, and a summary of the material issues raised in their submissions.

### 1.3.1 List of stakeholders who provided submissions

Table 3 lists the stakeholders who provided submissions to this consultation.

**Table 3 Stakeholders who provided submissions<sup>A,B</sup>**

<b>Consumer Advocates</b> (verbal submission)	<b>Pacific Blue</b>	<b>Smart Wires</b>
<b>Engie</b>	Public Interest Advocacy Centre ( <b>PIAC</b> )	<b>Snowy Hydro</b>
<b>ISP Consumer Panel</b>	Queensland Conservation Council ( <b>QCC</b> )	<b>Star of the South</b>
<b>Lisa Gervasoni</b>	<b>RE-Alliance</b>	<b>TasNetworks</b>
<b>Lodestone Mines</b>	<b>Reach Solar Energy</b>	<b>Transgrid</b>
<b>Moyne Shire Council</b>	<b>Simon Bartlett</b>	<b>Windlab</b>
<b>Origin</b>	<b>Sligar and Associates</b>	<b>Zen Energy</b>

A. Some of the submissions noted in this table included confidential material. The confidential elements of those submissions are not referenced in this report and are not included in the published versions of those submissions. Two submissions were entirely confidential and so are not referred to in this report or on the consultation webpage.

B. **Shell** provided some commentary on transmission augmentation options in its submission in response to the Draft 2023 *Inputs, Assumptions and Scenarios Report*. AEMO provides its response to that commentary in Section 2.4 of this consultation summary report for the 2023 *Transmission Expansion Options Report*.

C. AEMO has established an **Advisory Council on Social Licence**. At its May 2023 meeting, the council discussed the Draft 2023 *Transmission Expansion Options Report*. AEMO has incorporated responses to that discussion in this consultation summary report. Minutes from that discussion are available at <https://aemo.com.au/consultations/industry-forums-and-working-groups/list-of-industry-forums-and-working-groups/social-licence-advisory-council>.

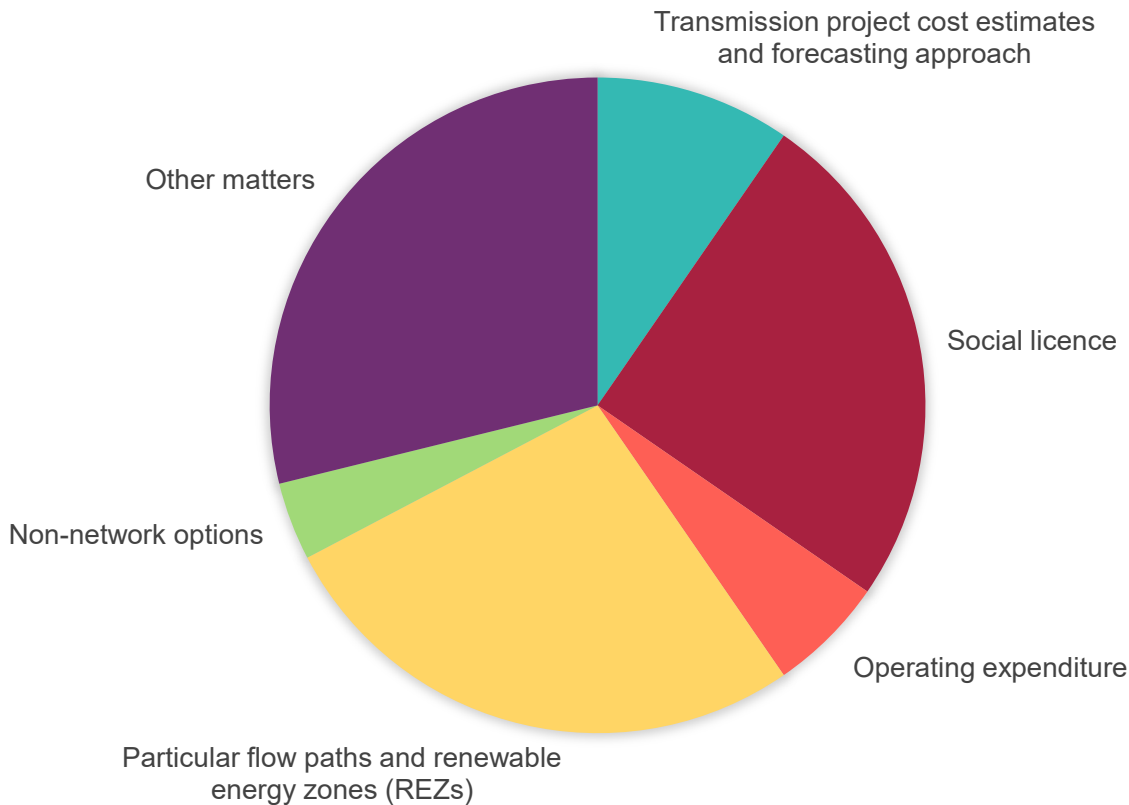
### 1.3.2 Summary of material issues

Figure 3 shows the proportion of stakeholders who commented on each of the material issues raised in response to the Draft 2023 *Transmission Expansion Options Report*.

Table 4 provides further detail on these material issues.

<sup>7</sup> At <https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation>.

**Figure 3** Proportion of submissions that addressed each material issue



**Table 4** Summary of feedback by topic

Theme	Description	Submitter(s)
<b>Transmission project cost estimates and forecasting approach</b>	<p>AEMO should engage with TNSPs and jurisdictional bodies prior to finalising the Transmission Cost Database for the 2024 ISP.</p> <p>AEMO should further justify why the forecasting methodology developed by Mott MacDonald is appropriate.</p> <p>AEMO should justify why it expects transmission project costs to cease increasing in real terms in 2026-27, and why transmission and generation project cost forecasts should be aligned.</p> <p>The use of cost estimate uncertainty bands does not reflect that project costs are often higher than initially estimated. AEMO should provide justification for the unknown risk adjustment factors for Class 5a and 5b estimates.</p> <p>AEMO should provide greater clarity as to whether biodiversity offset costs are treated as capital or operating expenditure, and further justify the method to calculating and forecasting these costs.</p> <p>AEMO should improve its description of the process of cross-checking cost estimates from TNSPs and jurisdictional bodies.</p>	<p>ISP Consumer Panel</p> <p>Reach Solar Energy</p> <p>Transgrid</p> <p>PIAC</p>
<b>Social licence</b>	<p>The explicit cost of social licence should be clearly stated by AEMO.</p> <p>There should be better granularity of data for feasibility studies.</p> <p>There needs to be clearer communication on the compatibility of augmentations, clear justifications of public good and emissions reduction of augmentation or investment.</p> <p>Earlier engagement with community and better tools to appropriately understand agricultural land use was recommended.</p> <p>There should be meaningful consideration of undergrounding of transmission lines in option analysis.</p>	<p>Lisa Gervasoni</p> <p>Moyne Shire Council</p> <p>Origin</p> <p>QCC</p> <p>RE-Alliance</p> <p>Star of the South</p> <p>Transgrid</p>

Theme	Description	Submitter(s)
<b>Operating expenditure</b>	<p>AEMO needs better justification of operating expenditure and maintenance estimates assumptions.</p> <p>Capital expenditure and depreciation costs associated with the full life-cycle cost should be considered in the ISP cost benefit analysis.</p> <p>An assumption that operational expenditure will be 1% of the capital cost per annum for transmission augmentation projects may not be appropriate for managing a more complex transmission network in the future.</p>	<p>ISP Consumer Panel</p> <p>Simon Bartlett</p> <p>Transgrid</p>
<b>Particular flow paths and REZs</b>	<p>Concern that REZ group constraint SWV1 options 1 and 2 look to be going through culturally and environmentally significant Budj Bim area.</p> <p>Recommendation for clearer communication of affects to the Moyne Shire of certain REZ group constraint SWV1 options.</p> <p>Alternative transmission options should be considered for Broken Hill REZ (N4).</p> <p>Various comments and questions were made regarding particular flow paths and REZs for the Draft 2023 <i>Transmission Expansion Options Report</i>.</p>	<p>Moyne Shire Council</p> <p>Transgrid</p> <p>Simon Bartlett</p>
<b>Non-network options</b>	<p>AEMO needs better processes for the inclusion of non-network options in ISP modelling.</p> <p>AEMO should consider an option for a virtual transmission line connection for the Victoria to South East South Australia flow path.</p> <p>AEMO and the TNSP should promote more market-led development of transmission options.</p>	<p>Origin</p> <p>Pacific Blue</p> <p>Engie</p>
<b>Other matters</b>	<p>The report should provide more information on how AEMO co-optimises REZ and flow path upgrades.</p> <p>The report should provide more information on how AEMO factors in consequences of project delay with relation to project lead time.</p> <p>AEMO's engagement process should allow stakeholders to provide their preferences for expansion, and more meaningful engagement processes with stakeholders were requested.</p> <p>AEMO should improve the level of detail in offshore REZ design.</p> <p>AEMO should provide a clearer explanation of how options presented in the report overlap with jurisdictional planning documents and strategies.</p> <p>AEMO should improve its ability to consider and build transmission for connection of future industrial loads.</p> <p>The report should provide a fairer, balanced approach to assessing viability of undergrounding compared to overhead transmission network equipment.</p> <p>AEMO should vary the assumed maximum transmission distance of cables with the voltage is selected in the AEMO Transmission Cost Database.</p> <p>The report should also advocate for transmission expansion to not just focus on large high voltage transmission projects.</p> <p>There was a request that AEMO or others expedite the approvals processes for transmission augmentation projects.</p> <p>Various comments and questions were made on the process and decisions applied in the Draft 2023 Transmission Expansion Options Report.</p> <p>AEMO needs to develop a clear, transparent and importantly accessible database of information used to inform decisions that go into the ISP or will be key to developing the ISP.</p> <p>AEMO should provide an update to the 100% renewables report.</p> <p>AEMO should understand the importance of the Sydney Southern Ring augmentation project, and that HumeLink will be limited if this southern ring is not built.</p>	<p>Origin</p> <p>PIAC</p> <p>Transgrid</p> <p>RE-Alliance</p> <p>Origin</p> <p>TasNetworks</p> <p>Lodestone Mines</p> <p>Star of the South</p> <p>Reach Solar Energy</p> <p>Simon Bartlett</p> <p>Sligar and Associates</p> <p>Snowy Hydro</p>

## 2 Submissions and AEMO responses

This section summarises the issues raised across stakeholder submissions, and AEMO's responses to the feedback received, as follows:

- Transmission project cost estimates and forecasting approach (Section 2.1).
- Social licence matters (Section 2.2).
- Operating expenditure (Section 2.3).
- Responses about particular flow paths and REZs (Section 2.4).
- Non-network options (Section 2.5).
- Other matters (Section 2.6).

### 2.1 Transmission project cost estimates and forecasting approach

#### Issue summary and submissions

In Section 3.7 of the Draft 2023 *Transmission Expansion Options Report*, AEMO presented a novel approach to forecasting cost changes for transmission network augmentation projects. AEMO also released an updated version of the Transmission Cost Database. The approaches to forecasting project component costs, and to updating the Transmission Cost Database, were developed through collaboration between AEMO and a specialist team of cost estimators and economists from consultancy Mott MacDonald. Mott MacDonald provided AEMO with forecast indices from 2022 to 2040. The work was informed by a series of industry consultations and was done to reflect the cost increases that TNSPs and jurisdictional bodies are facing in project delivery.

An outline of Mott MacDonald's methodology was provided for consultation as an attachment<sup>8</sup> to the Draft 2023 *Transmission Expansion Options Report*. The methodology that AEMO presented in the draft report was to accept the price changes forecasted by Mott MacDonald between 2021-22 and 2026-27, and then hold prices constant in real terms from 2026-27 to 2039-40. AEMO deviated from Mott MacDonald's forecasts beyond 2026-27 based on an AEMO view at the time that upward cost pressures for transmission and generation projects might be alleviated at approximately the same point in time. The choice of 2026-27 was informed by CSIRO's draft GenCost 2022-23 report<sup>9</sup>.

#### Context for AEMO's assessment

AEMO's view is that the observed cost escalation for transmission project inputs over the period from December 2020 to June 2022 has been driven largely by:

<sup>8</sup> Mott Macdonald. April 2023. *Transmission Cost Database Update Final Report*. Section 3, page 44. At [https://aemo.com.au/-/media/files/stakeholder\\_consultation/consultations/nem-consultations/2023/2023-teor/mott-macdonald-transmission-cost-database-update-final-report.pdf?la=en](https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2023-teor/mott-macdonald-transmission-cost-database-update-final-report.pdf?la=en).

<sup>9</sup> This view is representative of draft positions taken during the consultation period for the preparation of the GenCost report for 2022-23. Consultation materials for *GenCost 2022-23* are accessible at <https://www.csiro.au/en/research/technology-space/energy/energy-data-modelling/gencost>.

- Global, economy-wide shocks resulting from COVID-19 and Russia's invasion of Ukraine.
- An increase in transmission project investment, both domestically and internationally, to which supply chains have not had sufficient time to react.

By contrast, and barring the potential for future economic shocks, AEMO expects that future costs for transmission projects will be predominantly driven by:

- Costs of commodities required to produce items such as transmission lines, cables and transformers.
- A relatively high level of sustained investment in transmission network infrastructure, both domestically and globally.
- The general level of infrastructure construction activity in Australia.
- Capacity for the supply of inputs (labour, equipment, materials and plant) to increase.

This view has informed AEMO's approach to forecasting, and its choice regarding the extent to which it has incorporated the forecasts provided by Mott MacDonald.

### AEMO's assessment

AEMO thanks the **ISP Consumer Panel**, **PIAC**, **Reach Solar Energy** and **Transgrid** for their submissions, as well as TNSPs and jurisdictional bodies for advice provided through joint planning. AEMO appreciates the concerns raised and is conscious of the significant impact that transmission project cost estimates and forecasts will have on the outcomes of the 2024 ISP.

To address the concerns raised, AEMO has consulted extensively with TNSPs, jurisdictional bodies, and institutional bodies since the release of the *Draft 2023 Transmission Expansion Options Report*.

In previous iterations of the ISP, AEMO did not forecast a change in costs of delivering transmission network augmentation projects. Instead, costs were assumed to change only with economy-wide inflation. This meant that AEMO assumed no change in cost in real terms. In response to substantial increases in project costs experienced by project proponents in recent years above observed changes in CPI, and in recognition of the volume of transmission network build that was set out in the 2022 ISP, AEMO considered it valuable to develop forecasts.

AEMO's objective was to provide a reasonable methodology and basis on which future cost changes could be forecast. The developed approach is a NEM-first attempt to forecast future long-term costs for transmission network augmentation projects. AEMO recognises that there is some subjectivity in assessing both the factors that may impact the future, and the extent to which they may do so.

Table 5 provides the detailed feedback and AEMO's specific responses:



**Table 5 Detailed transmission cost estimate feedback and AEMO response**

Issue raised	AEMO's response												
<p><u>Testing the cost uplift in the AEMO Transmission Cost Database update</u></p> <p>The <b>ISP Consumer Panel</b> thought that the updated Transmission Cost Database had extended and improved upon the 2021 Transmission Cost Database in important ways.</p> <p><b>Transgrid</b> recommended that AEMO investigate through joint planning whether the uplift in project costs in the updated Transmission Cos Database is reflective of recently observed project cost increases.</p> <p><b>PIAC</b> supported the inclusion of risk allowances in baseline estimates of options. However, it argued risk allowances should be based on historical experiences of cost inflation between conceptual stages of planning and final costs. <b>PIAC</b> stated this would result in an average risk allowance in the vicinity of +100%. It believed that accuracy bands should be skewed to the positive (in keeping with the AACE framework). <b>PIAC</b> also stated that a uniform percentage across class of estimate should not be used, but rather the percentage should depend on the scale of the project, arguing that this reflects experience of larger projects seeing proportionally larger divergence.</p>	<p>AEMO agrees with the <b>ISP Consumer Panel</b> that the update to the Transmission Cost Database is an enhancement on the previous version.</p> <p>AEMO considers that the update to the Transmission Cost Database, conducted by Mott MacDonald, captures the increased costs of project delivery observed in recent projects in the NEM. For projects with identical scope, costs estimated using the updated Transmission Cost Database are up to approximately 30% higher than costs estimated using the 2021 version of the AEMO Transmission Cost Database. Consider the examples below:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Augmentation</th> <th style="text-align: center;">2022 ISP cost (real \$2023)</th> <th style="text-align: center;">2024 ISP cost (real \$2023)</th> <th style="text-align: center;">Real difference</th> </tr> </thead> <tbody> <tr> <td>REZ N8 Option 1</td> <td style="text-align: center;">\$160 million</td> <td style="text-align: center;">\$202 million</td> <td style="text-align: center;">26%</td> </tr> <tr> <td>Flow path CQ-SQ Option 2</td> <td style="text-align: center;">\$62 million</td> <td style="text-align: center;">\$77 million</td> <td style="text-align: center;">25%</td> </tr> </tbody> </table> <p>This update was informed by recent anonymised data from transmission network projects, webinars between AEMO, Mott MacDonald and industry participants, and AEMO's ongoing joint planning with TNSPs and jurisdictional bodies.</p> <p>Since the release of the Draft 2023 <i>Transmission Expansion Options Report</i>, AEMO has acted on <b>Transgrid's</b> suggestion and has tested the cost uplift in the updated database by seeking further verbal input from TNSPs and jurisdictional bodies on the update of the Transmission Cost Database. AEMO notes that these industry participants did not raise concerns with the cost escalation from December 2020 to June 2022 that is captured in the updated Transmission Cost Database.</p> <p>AEMO agrees with feedback that the Transmission Cost Database will require ongoing development. For future ISPs, AEMO will continue its collaboration with current and potential transmission project proponents to ensure that cost estimates in the database are aligned with market conditions.</p> <p>AEMO welcomes transmission cost information from stakeholders, noting that costs used to inform the Transmission Cost Database are aggregated to ensure confidentiality.</p>	Augmentation	2022 ISP cost (real \$2023)	2024 ISP cost (real \$2023)	Real difference	REZ N8 Option 1	\$160 million	\$202 million	26%	Flow path CQ-SQ Option 2	\$62 million	\$77 million	25%
Augmentation	2022 ISP cost (real \$2023)	2024 ISP cost (real \$2023)	Real difference										
REZ N8 Option 1	\$160 million	\$202 million	26%										
Flow path CQ-SQ Option 2	\$62 million	\$77 million	25%										
<p><u>Other matters relating to the updated Transmission Cost Database</u></p> <p>In the <b>Consumer Advocates</b> verbal submission, one participant suggested that the Transmission Cost Database should include the costs of bonds and other recycling and site rehabilitation costs after a project expires. The participant suggested that this is especially important if nuclear generations enter the energy mix. The participant also suggested that the final Mott MacDonald report should be published before the final 2023 <i>Transmission Expansion Options Report</i> to allow a further opportunity for feedback.</p>	<p>AEMO acknowledges the Consumer Advocates' view about the importance of including end of project costs in cost estimation processes, however generator end of project costs are not within scope for the Transmission Cost Database.</p> <p>AEMO appreciates the participant's suggestion to release an updated version of the Mott MacDonald report to allow for further consultation, but in this case considers that the initial release of the report for consultation alongside the Draft 2023 <i>Transmission Expansion Options Report</i> has provided sufficient opportunity for consultation and feedback.</p>												
<p><u>Overall approach to forecasting transmission costs</u></p> <p>The <b>ISP Consumer Panel</b> discussed the validity of using statistical relationships between variables that relied on historical data as a basis for forecasting future prices. In its view, the approach taken by Mott MacDonald underestimates the future impact of supply chain challenges. The <b>ISP Consumer Panel</b> specifically identified that its concerns with Mott MacDonald's methodology were that it:</p> <ul style="list-style-type: none"> <li>• Relied on historical data, and that historical data of construction activity "does not include any major network build".</li> <li>• Has not provided sufficient analysis to assure that the mix of skills required to deliver the projects represented in the Australian Bureau of Statistics'</li> </ul>	<p>AEMO agrees that using relationships between variables identified in historical data as a basis for forecasting a future state should be done cautiously. In this instance, using historical data specifically from historical transmission network projects offers little value, due to the small number of major transmission network projects that have been delivered in recent decades. This limitation was identified by Mott MacDonald. However, AEMO considers that Mott MacDonald's use of historically identified relationships is appropriate.</p> <p>Mott MacDonald identified relationships between the level of broader construction activity in Australia and several of the indices considered in the forecasting approach. These indices are subsequently correlated with the nine baskets of goods and services outlined in the <i>Transmission Cost Database Update Final Report April 2023</i><sup>10</sup>. For example, Mott MacDonald identified that the level of construction activity in Australia is correlated with the cost of construction, commissioning, and testing works.</p> <p>AEMO acknowledges that there are certain skills specifically required to construct transmission network projects. However, there are also many skillsets that are required by the broader construction industry as well as for transmission</p>												

<sup>10</sup> The indices correlated with the prices for each basket of goods and services have not changed between the *Transmission Cost Database Update Final Report April 2023* and the *Transmission Cost Database Update Final Report July 2023*.

Issue raised	AEMO's response
<p>database are representative of the skills required to deliver the proposed transmission project pipeline.</p> <p>The <b>ISP Consumer Panel</b> recommended that more reasoning be provided to justify why the use of relationships drawn from historical data is a valid approach to forecasting future prices.</p>	<p>network construction. Therefore, AEMO considers it reasonable to expect that the level of construction activity will continue to be a factor that is correlated with the cost of construction, commission and testing works, including for the transmission network industry. Similarly, Mott MacDonald identified a correlation in historical data between the level of construction activity and the cost of steel.</p> <p>In AEMO's view, it is reasonable to expect that the wider level of construction activity in Australia (as one of many other factors) will continue to be correlated with the cost of steel. More broadly, AEMO considers that Mott MacDonald has applied correlations with the level of construction activity where it is reasonable to expect that these correlations will persist into the future.</p> <p>The <b>ISP Consumer Panel</b> raised concern that if the skillsets represented by the historical labour force are different to the skillsets required for future project delivery, then correlations with historical labour data may not be a good basis for forecasting. AEMO acknowledges that shortfalls in the supply of labour and skills for the transmission network project delivery are currently expected. As a result, AEMO agrees that in the near term, there may be specific changes in the costs for skills uniquely required for transmission network project delivery. Consequently, the costs changes for these specific skills may not be captured if historical relationships between the costs of labour and other variables are used.</p> <p>AEMO notes that Mott MacDonald has assumed a long timeframe of adjustment in the supply of labour resources and has considered the impact of the costs for specialised services: "<i>The cost of other heavy and civil engineering construction continues to rise gradually but steadily due to the increasing costs of specialised labour</i>"<sup>11</sup>. This is related to the need for the labour force to acquire a different composition of skills. However, Mott MacDonald did not explicitly consider what these new skills will need to consist of. Therefore, Mott MacDonald's approach has considered historical labour data, and has also considered the time required for the labour force's skill composition to adjust.</p>
<p><u>Impact of scope change on cost forecasts</u></p> <p>The <b>ISP Consumer Panel</b> challenged AEMO's approach to evaluating cost increases for recent projects where the scope is changed, noting that AEMO removes the influence of scope change before analysing transmission cost trends.</p>	<p>AEMO agrees that project scope change can be impactful on project costs – and notes that scope change can also affect project benefits.</p> <p>Under the ISP regulatory framework, AEMO may action a transmission investment which could be somewhat conceptual in scope. The TNSP is then required to conduct a Regulatory Investment Test for Transmission (RIT-T), which could result in a different option being preferred. In the event that a new option has a greater capacity, it would likely have greater costs and greater benefits. AEMO is required to confirm that the TNSP's preferred solution remains aligned with the ISP by conducting an ISP Feedback Loop assessment.</p>
<p><u>The level of infrastructure construction activity</u></p> <p>There is a large pipeline of infrastructure projects in Australia. The <b>ISP Consumer Panel</b> pointed to <b>Infrastructure Australia's</b> forecast, in the 2022 Market Capacity Report<sup>12</sup> that demand for major public infrastructure will remain above the pre-COVID level out to 2026, and that the report flagged a significant rise in labour shortages.</p> <p>The <b>ISP Consumer Panel</b> argued that in the context of a tight labour market, there is limited capacity to increase the supply of labour or enhance productivity. In the <b>ISP Consumer Panel's</b> opinion, AEMO's price forecasts did not reflect a heightened level of construction activity or the existing labour and skills shortfalls identified by <b>Infrastructure Australia</b>.</p>	<p>AEMO agrees that the level of construction activity, beyond transmission network expansion, is a factor that will influence the cost of delivering transmission network projects.</p> <p>AEMO notes that the prices for several of the baskets of indices identified by Mott MacDonald<sup>13</sup> were identified to have a relationship with the level of construction activity. For example, Mott MacDonald identified that the cost of construction works, and the level of construction work done in historical data, were correlated. The identified correlation was used in conjunction with an assumed level of future construction activity to forecast future costs. In Section 3.2.4 of the <i>Transmission Cost Database Update Final Report April 2023</i><sup>14</sup>, Mott MacDonald stated an assumption "<i>that future construction activity (measured in real dollar values) will continue to increase at current levels until 2026 then remain steady in real terms until 2030, when it begins declining steadily</i>". This assumption has been maintained in <i>Transmission Cost Database Update Final Report July 2023</i>.</p> <p>In AEMO's view, Mott MacDonald's methodology has captured the extent to which the level of construction activity has been seen to influence cost for project inputs (such as construction works) in historical data. Further, Mott MacDonald's assumption of heightened construction activity out to 2030 appears somewhat aligned with the <b>ISP Consumer Panel's</b> view.</p>

<sup>11</sup> Mott MacDonald. July 2023. *Transmission Cost Database Update Final Report July 2023*. Page 48. At <https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation>.

<sup>12</sup> Infrastructure Australia. December 2022. *Infrastructure Market Capacity 2022*. At [https://www.infrastructureaustralia.gov.au/sites/default/files/2023-04/2022\\_IA\\_Market-Capacity-Report\\_2.0\\_HR.pdf](https://www.infrastructureaustralia.gov.au/sites/default/files/2023-04/2022_IA_Market-Capacity-Report_2.0_HR.pdf).

<sup>13</sup> Mott Macdonald. July 2023. *Transmission Cost Database Update Final Report July 2023*. Pages 14-15.

<sup>14</sup> Mott Macdonald. April 2023. *Transmission Cost Database Update Final Report April 2023*. Page 47. At <https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation>.

Issue raised	AEMO's response
<p><u><i>Competition for resources specific to delivering transmission network augmentation projects</i></u></p> <p>The <b>ISP Consumer Panel</b> and <b>PIAC</b> suggested that the concurrent delivery of multiple transmission network projects would result in increased demand for resources specific to the transmission network industry. <b>Reach Solar Energy's</b> submission provided the UK as comparison to Australia and cited that the UK government had concluded that its "current transmission build is not going to deliver its 2030 objectives".</p> <p>First, the <b>ISP Consumer Panel</b> reasoned that the concurrent delivery of multiple major domestic projects will exacerbate the imbalance between supply and demand for labour and skills that are uniquely required to deliver transmission network projects. The <b>ISP Consumer Panel</b> referenced a University of Technology Sydney report<sup>15</sup>, which forecast that the "energy workforce" would need to expand rapidly to implement the 2022 ISP's optimal development path (ODP). The <b>ISP Consumer Panel</b> acknowledged that state governments "are recognising the skill shortages" and are "seeking to address it".</p> <p>Second, the <b>ISP Consumer Panel</b> highlighted that the transmission network expansion set out in the 2022 ISP's ODP coincides with similarly significant network expansions that are planned in other nations. The <b>ISP Consumer Panel</b> noted that relative to 2019, substantial increases in procurement lead times have been observed for items such as circuit breakers and phase shifting transformers. The <b>ISP Consumer Panel</b> noted that transmission network project delivery in Australia relies substantially on imported materials and plant, and claimed that Australia's capacity to develop domestic supply chains is limited. It was argued that Australia is unable to exploit the economies of scale that are available to larger economies.</p> <p>Finally, the <b>ISP Consumer Panel</b> acknowledged that the Transmission Cost Database allows a risk factor to be selected which aims to account for heightened competition for labour and materials due to the concurrent delivery of large projects. However, the <b>ISP Consumer Panel</b> stated that it was not clear:</p> <ul style="list-style-type: none"> <li>• Whether the selection of this risk factor was optional.</li> <li>• How the decision to select this risk factor was made (if it is optional).</li> <li>• What impact selecting this risk factor would have on a project's cost estimate.</li> </ul> <p>Consequently, <b>ISP Consumer Panel</b> found the extent to which AEMO had considered the effects of simultaneous transmission project delivery unclear.</p>	<p>AEMO agrees that delivering the planned volume of transmission network projects set out in the 2022 ISP will increase demand for the plant, materials and labour that are required to deliver these projects. Further, AEMO recognises that several other nations are planning to undertake similarly significant transmission network expansions. Given that Australia imports a substantial amount of plant and materials, concurrent international transmission network expansion will place upward pressure on the costs for plant and materials.</p> <p>AEMO sees two risks that concurrent project delivery may pose and has reviewed its consideration of concurrent delivery against these aspects.</p> <ul style="list-style-type: none"> <li>• Increased project delivery costs due to an increase in demand for plant, material and/or labour.</li> <li>• The rate of transmission network construction (for example, kilometres of line per year) that can feasibly occur.</li> </ul> <p>AEMO agrees that it is important to consider the impact of a generally heightened level of transmission network construction on project costs and has reviewed its treatment of this factor. This review has included discussions with TNSPs and jurisdictional bodies to understand their views on this issue. These organisations generally agreed that competition for plant, materials and labour creates risks for project delivery. However, some commented that they are developing methods to mitigate these risks. For example, project staging and scheduling to better manage project delivery, or procuring plant for multiple projects at once to exploit economies of scale. Further, one industry participant observed that due to the length of Australia's transmission network, Australia can exploit certain economies of scale not afforded to other nations. Regarding supply, some industry participants independently commented that suppliers of plant are "aware" of the Australian market due to its large physical size. In AEMO's understanding, current and potential project proponents are developing solutions to mitigate the risks associated with heightened demand (and competition) for resources.</p> <p>AEMO does not think that the complete potential impact of delivering a high number of transmission projects concurrently should be embedded into the cost estimate of every project by default. AEMO notes that the Transmission Cost Database enables a "Market Activity" risk to be selected within the known risks. This factor enables AEMO to capture the impact on costs where a high number of projects are delivered concurrently, above the impact of a generally heightened level of transmission network expansion delivery. Depending on the level of risk selected, the costs of certain project components are adjusted by a multiplying factor. For example, setting this factor to "Tight" applies a 5% uplift to the costs of plant and materials, and labour.</p> <p>For the 2023 <i>Transmission Expansion Options Report</i>, AEMO has generally selected the 'Tight' market capacity for projects that have a short or medium project lead time, in recognition of the recent supply pressures observed by project proponents. AEMO sets this factor on a case-by-case basis and through joint planning with TNSPs and jurisdictional bodies.</p> <p>The <b>ISP Consumer Panel</b> raised concerns regarding the shortfalls in labour and skills for the energy transition that were forecast by the University of Technology Sydney<sup>15</sup> based on the 2022 ISP. AEMO recognises that there is a limit to the rate at which transmission network projects can be delivered, based on the quantity of a range of inputs. However, AEMO does not consider appropriate for the ISP to apply limits on the rate at which transmission network projects may be delivered by default. As part of its consultation on the update to the ISP Methodology<sup>16</sup>, AEMO amended the ISP Methodology so that if the generation or transmission build in the draft or final ISP is observed to be lumpy, a sensitivity analysis could be conducted to assess the impact of limiting infrastructure delivery based on supply chain constraints.</p> <p>In AEMO's view, its forecasts, ability to select a "Market Activity" risk factor, and the amendment to the ISP Methodology, allow for reasonable incorporation of increased competition for resources in the ISP process, particularly those uniquely required for transmission network projects.</p>

<sup>15</sup> University of Technology Sydney. *The Australian Electricity Workforce for 2022 Integrated System Plan: Projections to 2050*. January 2023. At <https://aemo.com.au/-/media/files/major-publications/isp/2022/supporting-materials/the-australian-electricity-workforce-for-the-2022-isp.pdf?la=en>.

<sup>16</sup> AEMO's *ISP Methodology* and the *Consultation Summary Report – Updates to the ISP Methodology* are at <https://aemo.com.au/consultations/current-and-closed-consultations/consultation-on-updates-to-the-isp-methodology>.

Issue raised	AEMO's response
<p><u>Availability of EPC contractors and contracting strategy</u></p> <p>The <b>ISP Consumer Panel</b> expressed a view that the availability of engineering, procurement and construction (EPC) contractors, and project management resources, will face “significant constraints”. It referred to Clough’s collapse and Downer’s announcement to shareholders that it will cease engaging in transmission infrastructure projects.</p> <p>The <b>ISP Consumer Panel</b> also noted that Mott MacDonald made no comment on the potential impact of a change in EPC contracting strategy to cost-plus, and questioned whether AEMO considers 30% or 15% unknown risk is consistent with a cost-plus EPC contracting strategy.</p>	<p>AEMO is aware that some EPC contracts have shifted recently from “fixed-price” to “cost-plus”, and that contracting strategies will continue to change over time. With a cost-plus contract, the contractor typically gets paid for all expenses of a project, including changes in scope and costs, plus an agreed profit margin. This contrasts against a fixed-price contract where the contractor manages a range of risks associated with the delivery of a project – with only changes in scope and cost outside of these elements able to be claimed as variations. In this sense the contractor prices the risk they are taking on, aiming to deliver the project below that price.</p> <p>Whether EPC contracts are primarily fixed-price or cost-plus is generally linked to the external environment. For example, cost-plus contracting is more likely to be adopted when there are high volumes of demand for services, high levels of volatility, highly uncertain scope or rapidly escalating input costs.</p> <p>Fixed-price contracts have the advantages of being predictable, with many of the risks priced into the contract and borne by the contractor. In a stable and low-volume contracting market, this kind of contract can be very competitive, and the purchaser will have a fairly predictable overall project cost.</p> <p>In a volatile and high-volume contracting market, the price a contractor would apply to include risks in a fixed-price contract is likely to be much higher than during a period of stability. In extreme cases, contractors may be simply unwilling to bear these risks. In effect, this shifts the risks to the purchaser who will need to manage these additional risks, generally through larger allowances being included outside of the contract cost. This can result in an increase to the ultimate cost of the project in this external environment.</p> <p>On balance, AEMO considers that:</p> <ul style="list-style-type: none"> <li>• Market competition will influence the cost of infrastructure, and that contracting strategies are an outcome of the contracting environment rather than reason for an increase in costs in themselves.</li> <li>• AEMO’s forecast of transmission costs, which incorporates market tightness and indices such as commodity prices (oil, aluminium, copper and steel) and land cost, broadly captures recent trends in market pressure and contracting strategies.</li> </ul>
<p><u>The impacts of other nations’ policies and funding</u></p> <p>The <b>ISP Consumer Panel</b> considered it an oversight that AEMO had not explicitly discussed the <i>Inflation Reduction Act 2022</i> (United States [US]) or the <i>Green Deal Industrial Plan 2022</i> (European Union [EU]). In their opinion, these policies will have an “enormous impact on the availability of capital and materials for ISP projects”. It was stated that these policies would absorb electricity infrastructure materials, and that countries without the ability to deliver equally substantial market interventions will experience longer procurement lead times and higher project costs.</p> <p>The <b>ISP Consumer Panel</b> reflected that the “Australian Government is providing a relatively limited range of subsidies” through Rewiring the Nation, and \$2 billion in funding for hydrogen projects. They questioned claims they have heard in industry that the Australia-US Climate, Critical Minerals, and Clean Energy Transformation Compact will mitigate the impacts they expect the <i>Inflation Reduction Act 2022</i> (US) to have.</p>	<p>AEMO acknowledges that the <i>Inflation Reduction Act 2022</i> (US) and the <i>Green Deal Industrial Plan 2022</i> (EU) were not explicitly considered in the forecasting approach. AEMO agrees that these policies will influence the international markets for generation and transmission plant and equipment. Further, AEMO recognises that the EU legislated the <i>Green Deal Industrial Plan 2022</i> (EU) to protect European businesses against the effects of the <i>Inflation Reduction Act 2022</i> (US).</p> <p>Since the Draft 2023 <i>Transmission Expansion Options Report</i>, AEMO has reviewed whether the forecasting approach should be adjusted to explicitly consider policies such as these. In AEMO’s view, the impacts of these policies are implicitly considered within the forecasting approach developed by Mott MacDonald. Further, AEMO does not currently consider that the impacts of these policies are certain and does not agree that they will necessarily be detrimental to domestic transmission project delivery. On this basis, AEMO has not adjusted its approach to explicitly consider the <i>Inflation Reduction Act 2022</i> (US) or other such policies.</p> <p>The forecasting methodology developed by Mott MacDonald draws upon commodity price forecasts presented in the December 2022 edition of <i>Resources and Energy Quarterly</i><sup>17</sup>. AEMO notes that this publication discusses the energy transition and the <i>Inflation Reduction Act 2022</i> (US). AEMO considers that the broad approach taken by Mott MacDonald (of using commodity price forecasts) enables an implicit treatment of policies such as the <i>Inflation Reduction Act 2022</i> (US).</p> <p>The <i>Inflation Reduction Act 2022</i> (US)<sup>18</sup> provides a substantial degree of funding for the US energy industry. A large proportion of this funding is associated with tax credits for manufacturers of solar and wind generator plant and equipment, and for solar and wind generation developers. In AEMO’s view, these tax credits will elevate both the supply and demand for solar and wind generation plant and equipment in the US. However, it is difficult to ascertain whether this will improve</p>

<sup>17</sup> Office of the Chief Economist and Department of Industry, Science and Resources. *Resources and Energy Quarterly: December 2022*. December 2022. At <https://www.industry.gov.au/sites/default/files/2022-12/resources-and-energy-quarterly-december-2022.pdf>.

<sup>18</sup> The White House. *Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act’s Investments in Clean Energy and Climate Action*. January 2023. At <https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf>.

Issue raised	AEMO's response
	<p>or worsen the balance of supply and demand for generation plant and equipment in the US or internationally. Further, it is not clear to AEMO that the incentives for generation plant and equipment will have a substantial impact on the costs of Australian transmission expansion. As a result of this uncertainty, AEMO does not consider it appropriate to explicitly consider these policies within its forecasts for transmission project costs.</p> <p>AEMO considers that there may be long term benefits from the <i>Inflation Reduction Act 2022</i> (US). First, some of the funding is allocated for research which may lead to solutions that alleviate cost pressures across the international transmission and generation industries. Second, the tax credits provided to suppliers may incentivise them to increase their supply capacity. Heightened supply capacity may benefit the international generation and transmission industries in the longer-term. However, AEMO views these potential possible outcomes as uncertain, and does not think that it is appropriate to account for them explicitly in its forecasts.</p> <p>The <i>Inflation Reduction Act 2022</i> (US) provides some funding specifically for transmission related projects. These funding programs cease by October 2031 regardless of whether expenditure limits are reached. The programs provide<sup>19</sup>:</p> <ul style="list-style-type: none"> <li>• US\$2 billion in loans to be designated by the US Department of Energy,</li> <li>• US\$760 million “in grants to facilitate the siting of interstate transmission lines”, and,</li> <li>• US\$100 million in direct Federal spending to conduct transmission planning, modelling and analysis for interregional transmission and transmission for offshore wind resources.</li> </ul> <p>In addition to the <i>Inflation Reduction Act 2022</i> (US), the <i>Bipartisan Infrastructure Law 2021</i> (US)<sup>20</sup> provides over US\$15 billion in grants, cooperative agreements and loan programs for transmission network developments and innovations. Therefore, between the <i>Inflation Reduction Act 2022</i> (US) and the <i>Bipartisan Infrastructure Law 2021</i> (US), the US Federal Government has committed to provide approximately US\$20 billion to the transmission industry, through various methods.</p> <p>AEMO also considers that the current Rewiring the Nation scheme is comparable with the <i>Inflation Reduction Act 2022</i> (US) when put into the Australian context. As outlined above, the <i>Inflation Reduction Act 2022</i> (US) and the <i>Bipartisan Infrastructure Law 2021</i> (US) provide approximately US\$20 billion in funding for transmission related projects (including some innovation programs). However, the US high-voltage network is nearly 256,000 km long<sup>21</sup>. Therefore, the level of funding represents approximately US\$0.08 million/km of existing transmission network. By contrast, Rewiring the Nation will provide US\$13.4 billion (AU\$20 billion, exchange rate on 4 July 2023) in low interest loans to transmission network developers. The existing NEM incorporates around 40,000 km of transmission lines. This equates to approximately US\$0.34 million/km of existing transmission network. AEMO recognises that the <i>Inflation Reduction Act 2022</i> (US) commits some of its transmission related funding in grants, and that these have more impact than loans of the same value. However, AEMO considers that Rewiring the Nation represents a substantial funding scheme for domestic transmission network projects relative to the <i>Inflation Reduction Act 2022</i> (US) and the <i>Bipartisan Infrastructure Law 2021</i> (US).</p> <p>AEMO appreciates that it is not currently clear how the Australia-US Climate, Critical Minerals, and Clean Energy Transformation Compact<sup>22</sup> will impact Australia's ability to procure supplies for the energy transition. The compact discusses a range of items including an intention to “use domestic financial instruments and incentives to foster greater integration of responsible clean energy supply chains and encourage investors to regard our two countries as leading destinations in which to build the future global clean energy industrial</p>

<sup>19</sup> The White House. *Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action*. January 2023. At <https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf>.

<sup>20</sup> The White House. *Build a Better America: A Guidebook to the Bipartisan Infrastructure Law for State, Local, Tribal and Territorial Governments and Other Partners*. May 2022. At <https://www.whitehouse.gov/wp-content/uploads/2022/05/BUILDING-A-BETTER-AMERICA-V2.pdf>.

<sup>21</sup> United States Environmental Protection Agency. *U.S. Electricity Grid & Markets*. April 2023. At <https://www.epa.gov/green-power-markets/us-electricity-grid-markets>.

<sup>22</sup> Prime Minister of Australia. *Australia-United States Climate, Critical Minerals, and Clean Energy Transformation Compact*. May 2023. At <https://www.pm.gov.au/media/australia-united-states-climate-critical-minerals-and-clean-energy-transformation-compact>.

Issue raised	AEMO's response
	<p><i>base</i>". While AEMO notes this discussion, AEMO does not consider that there is sufficient certainty about any policy influences relating to the Compact to warrant revision of the forecasting approach taken in the final 2023 <i>Transmission Expansion Options Report</i>.</p>
<p><u><i>The impact of state government policies</i></u></p> <p>The <b>ISP Consumer Panel</b> drew attention to the New South Wales Electricity Infrastructure Roadmap, the Queensland Energy and Jobs Plan, and the Queensland Government's recent update to the Buy Queensland policy.</p> <p>In AEMO's understanding, the <b>ISP Consumer Panel</b> was concerned that policies such as these may:</p> <ul style="list-style-type: none"> <li>• Result in limiting the capacity for project proponents to access labour and manufacturing resources located outside their state, thereby reducing the supply of resources available to project proponents.</li> <li>• More broadly result in increasing the costs of labour.</li> </ul> <p>The <b>ISP Consumer Panel</b> cited an Australian Financial Review article which reported that Queensland Health had advised entities bidding on the Capital Expansion Project to "allow for increases of up to 6 per cent a year under workplace guidelines". The <b>ISP Consumer Panel</b> was concerned that AEMO had not identified whether such policies had informed its cost forecasts.</p>	<p>AEMO understands that jurisdictional policies such as the New South Wales Electricity Infrastructure Roadmap, the Queensland Energy and Jobs Plan, and the Buy Queensland policy, include local content requirements that do and will apply to transmission infrastructure projects. However, AEMO does not agree that the existence of these policies necessitates a cost uplift to the project cost estimates applied for the ISP at this stage.</p> <p>The AEMO Transmission Cost Database is used to prepare a bottom-up cost estimate including an unknown risk factor. As individual projects are developed and as cost estimates from project proponents are further refined, AEMO considers that the impact of jurisdictional local content policies (and other policies) will be included in the results of contestable tendering outcomes and contracting arrangements based on up-to-date market and policy trends.</p> <p>AEMO considers that the Transmission Cost Database estimation process and the escalation factors applied under the new forecasting approach are reasonable for consideration of state government policies relating to local content at this stage.</p>
<p><u><i>Costs incurred to acquire social licence</i></u></p> <p>The <b>ISP Consumer Panel</b> commented that social licence factors are increasing the uncertainty of projects' costs and timelines. They observed that Mott MacDonald's report does not explicitly consider the impact of social licence acquisition on capital expenditure.</p>	<p>AEMO agrees there is a risk that additional costs and time may be incurred by potential transmission project proponents due to more in-depth community engagement processes. AEMO notes that certain social licence costs are to be captured by inclusion of announced landholder payment schemes in the ISP cost benefit analysis. However, the full extent of potential additional possible project costs is difficult to quantify.</p> <p>As discussed further in the <i>2023 Inputs, Assumptions and Scenarios Report – Consultation Summary Report</i><sup>23</sup>, AEMO will undertake sensitivity analysis in the 2024 ISP to explore impacts and risks relating to low social licence.</p>
<p><u><i>Assumptions about the future</i></u></p> <p><b>PIAC</b> disagreed with the expectation that input prices, particularly steel, will stabilise in the long-term. <b>PIAC</b> claimed that supply chain constraints, and competition for resources driven by large infrastructure projects, are expected to "<i>persist well into the 2030s</i>". In <b>PIAC's</b> opinion, a prudent approach would be to expect that future prices will remain at current levels or higher. It is AEMO's understanding that <b>PIAC</b> is referring to Mott MacDonald's assumption (as outlined in the version of their report published on 2 May 2023) that commodity prices will remain constant in real terms beyond June 2024<sup>24</sup>.</p> <p><b>Reach Solar Energy</b> stated that "Mott MacDonald's long-term outlook for costs appear reasonable to <b>Reach Solar Energy</b> but the near term is expected to be higher and face more constraints than indicated".</p> <p>The <b>ISP Consumer Panel</b> stated that Mott MacDonald's "<i>forecast for the next 10-15 years seems to assume that the ramp-up in the supply of resources to the energy sector will mean supply matches demand from 2025</i>". It further stated that "<i>this assumption is</i></p>	<p>AEMO considers it pertinent to highlight that international markets are generally recovering from some of the events that drove the significant cost increase observed in 2021 and 2022; COVID-19 and Russia's invasion of Ukraine. The March 2023<sup>25</sup> and June 2023<sup>26</sup> editions of Resources and Energy Quarterly present forecasts for commodity prices which sit well below price peaks during 2021 and 2022. For example, the presented forecasts from the March 2023 edition of Resources and Energy Quarterly include (all prices are in 2023 US dollars):</p> <ul style="list-style-type: none"> <li>• The price of iron ore falling from approximately US\$120 per tonne in 2022 to US\$63 per tonne by 2028.</li> <li>• The price of aluminium to fall by approximately 20% in real terms over the period from 2022 to 2028.</li> <li>• The price of oil falling from approximately US\$120 a barrel in 2022 to less than US\$80 a barrel by 2028.</li> </ul> <p>These commodities (along with others) are key inputs for transmission network construction. In AEMO's opinion, it is reasonable to expect that a decline in manufacturing input costs (in real terms) should place a downward pressure on the cost (in real terms) of manufactured plant and equipment.</p> <p>Considering that the reference year (2022) was a year in which international markets experienced elevated prices due to global economic shocks that they are forecast to recover from (notwithstanding risks of future economic shocks), it</p>

<sup>23</sup> At <https://aemo.com.au/en/consultations/current-and-closed-consultations/2023-inputs-assumptions-and-scenarios-consultation>.

<sup>24</sup> Mott MacDonald. *Transmission Cost Database Update Final Report July 2023*. July 2023. Page 47. Published as a supplementary material to this report.

<sup>25</sup> Office of the Chief Economist and Department of Industry, Science and Resources. *Resources and Energy Quarterly: March 2023*. May 2023. At <https://www.industry.gov.au/sites/default/files/2023-04/resources-and-energy-quarterly-march-2023.pdf>.

<sup>26</sup> Office of the Chief Economist and Department of Industry, Science and Resources. *Resources and Energy Quarterly: June 2023*. July 2023. At <https://www.industry.gov.au/sites/default/files/2023-07/resources-and-energy-quarterly-june-2023.pdf>.

Issue raised	AEMO's response
<p><i>difficult to accept given the large pipeline of projects outside of the energy sector that is competing for resources with the energy sector”.</i></p>	<p>is reasonable to assume that certain types of plant and raw materials may not undergo substantial cost increases from 2022 onwards and may even decrease in cost after 2022.</p> <p>AEMO agrees that its description in the Draft 2023 <i>Transmission Expansion Options Report</i> was unclear about which parts of the forecast presented were advised by Mott MacDonald, and which parts were the result of AEMO's choice to align transmission and generation cost escalation periods and treatment. AEMO has provided a clearer description of this in the final 2023 <i>Transmission Expansion Options Report</i>. AEMO has also amended its choices on some of these matters, as explained in the 'justification for a conclusion to real price increases' issue in the row below.</p>
<p><u><i>Justification for a conclusion to real price increases</i></u></p> <p>In Mott MacDonald's approach to forecasting, resources required for transmission projects were allocated into nine separate “baskets” of goods and services. Goods and services were grouped into a particular basket where the factors driving their costs were deemed to be similar. For example, civil and structural works, electrical works, and testing and commissioning were allocated to the same basket as the costs for these services were deemed to be driven by the same factors. Mott MacDonald then derived a separate forecast for each basket.</p> <p>In the Draft 2023 <i>Transmission Expansion Options Report</i>, AEMO assumed that the prices for all nine baskets identified by Mott MacDonald cease to change in real terms after 2027. Feedback on this assumption is discussed separately to the assumptions above. This is partly to highlight that this assumption was made by AEMO, independently of Mott MacDonald. It is also discussed separately because the assumption was applied due to AEMO's dual consideration of Mott MacDonald's forecasts for transmission projects, and the CSIRO's forecasts for generation projects.</p> <p>The <b>ISP Consumer Panel</b> noted that AEMO's only justification for holding costs constant in real terms beyond 2027 was that it would better align the cost changes that were forecast for transmission and generation. It recommended that AEMO provide better justification for:</p> <ul style="list-style-type: none"> <li>• The choice of 2027 as the date where transmission project costs cease increasing in real terms.</li> <li>• The real cost increases are expected to plateau across all categories of resources (hereby referred to as 'Baskets' consistent with Mott MacDonald) identified in Mott MacDonald's report at the same point in time. For example, why does AEMO expect the real cost of both design services and property to plateau in 2027.</li> <li>• Why AEMO considers it to be appropriate to align the forecasts of generation and transmission project costs.</li> </ul>	<p>AEMO's revised approach in the 2023 <i>Transmission Expansion Options Report</i> for treatment of real price increases is twofold.</p> <p><b>1. Apply Mott MacDonald's escalation factors until a 'new normal' date for each of the IASR scenarios: Progressive Change, Step Change and Green Energy Exports.</b></p> <p>AEMO expects that costs for transmission project resources will increase moderately in real terms for several years, above the increases driven by recent global economic shocks. The cost trajectory over this period reflects an expectation that demand for transmission project resources grows, and that there may be a material lag before there is a supply-side reaction to elevated prices. In addition, the cost trajectory reflects a view that global commodity markets are generally forecast to recover from recent global economic shocks, with prices falling substantially from their 2021-22 values. This view is supported by forecasts presented in recent editions of <i>Resources and Energy Quarterly</i>.</p> <p>The choice of 2029-30 in the Step Change and Green Energy Export scenarios, and of 2026-27 in the Progressive Change scenario is informed by consideration of how the required transmission build out rate will impact the costs of project delivery. The Step Change and Green Energy Export scenarios are likely to require a higher rate of transmission build in the period to 2030, to meet interim net-zero emissions targets. In AEMO's view, this may result in a greater growth in demand relative to supply. By contrast, AEMO expects that the growth in demand for transmission project resources will be less in the Progressive Change scenario, and therefore that supply may respond to increased demand over a shorter time frame. In particular, AEMO considers that the transmission build rate required the progressive change scenario will place less pressure on labour costs, which are largely influenced by domestic demand.</p> <p>This approach aligns with CSIRO's expectation, as outlined in GenCost 2022-23<sup>27</sup>, that capital expenditure for generation projects will take longer to return to a similar supply-demand balance to what was seen prior to recent economic shocks in the <i>Step Change</i> and <i>Green Energy Export</i> scenarios, than in the <i>Progressive Change</i> scenario. CSIRO has put forward that generation project capital expenditure will return to the pre-global economic shock supply-demand balance by 2026-27 in the <i>Progressive Change</i> scenario, and by 2029-30 in the Step Change and Green Energy Export scenarios.</p> <p><b>2. Beyond the 'new normal' date, hold costs constant in real terms except for easement and property costs.</b></p> <p>AEMO considers it reasonable to assume that at some point a 'new normal' may be achieved, at which transmission project costs cease increasing in real terms. To assume that costs persistently increase in real terms over the whole period to 2039-40 would imply an expectation that the demand for transmission project resources will persistently grow relative to supply, or that there is a substantial resource scarcity. AEMO does not expect that demand for transmission project resources will grow indefinitely, particularly after a period of high global transmission industry activity that would be required to achieve 2030 emissions targets. However, AEMO cannot see the case for assuming that transmission infrastructure costs would necessarily decline to return to the 'normal' observed prior to recent global events.</p> <p>As such, AEMO will assume that transmission project costs plateau in real terms, with the exception of property costs as noted below. This approach differs from the approach taken by CSIRO for the GenCost 2022-23 report. <b>CSIRO</b> has made a reasonable assumption that given the reasonable assumption that cost reductions due to learning rates can be applied for the newer types of electricity generation such as wind and solar.</p>

<sup>27</sup> At <https://www.csiro.au/en/research/technology-space/energy/energy-data-modelling/gencost>.

Issue raised	AEMO's response
	<p>This assumption will not be applied to property and easement costs, as the supply of land is finite, and there is no capacity for the market to adjust to accommodate higher demand. Instead, AEMO will assume that the costs for land will continue to escalate across the horizon to 2049-50. Mott MacDonald provided escalation factors for property and easement costs out to 2039-40. AEMO has extrapolated the escalation for property and easement costs provided by Mott MacDonald to achieve a forecast out to 2049-50. In its final GenCost 2022-23, CSIRO has adjusted its approach to take the same approach for property cost escalations as is outlined here for transmission. This ensures consistent treatment of property and easement cost forecasts between transmission and generation.</p>
<p><u>Cost estimate accuracy bands and the unknown risk allowance</u></p> <p>In Section 3.2.2 of the Draft 2023 Transmission Expansion Options Report, AEMO presented a cost classification system with symmetrical accuracy bands. This was displayed in Figure 6 of the draft report.</p> <p>In the <b>ISP Consumer Panel's</b> opinion, AEMO's analysis of cost estimate accuracy progression is "flawed":</p> <ul style="list-style-type: none"> <li>• First, it noted that AEMO's accuracy bands are narrower relative to the accuracy bands presented in the AACE's recommended practice for cost estimation.</li> <li>• Second, it questioned AEMO's application of symmetrical accuracy bands and observed that this does not align with the asymmetrical accuracy bands recommended by the AACE. The <b>ISP Consumer Panel</b> suggested that it is more commonly observed that estimated project costs are lower than actual project costs.</li> <li>• Third, it questioned the empirical basis upon which the unknown risk allowances (presented in Table 6 of the Draft 2023 <i>Transmission Expansion Options Report</i>) were based.</li> </ul> <p>Based on these points, the <b>Panel</b> reasoned that AEMO's choice to deviate from the AACE's recommended practice was not appropriate.</p> <p>In <b>PIAC's</b> view, the average risk allowance should be closer to 100% for early cost estimates. <b>PIAC</b> held that the percentage uncertainty should be larger for bigger projects, on the understanding that larger projects experience proportionally larger cost divergences than smaller projects. <b>PIAC</b> recommended that accuracy bands should be skewed towards the positive side of the estimate, in line with the AACE's recommended practice.</p>	<p>AEMO agrees with the point raised by the <b>ISP Consumer Panel</b> and <b>PIAC</b> that actual project costs are more commonly observed to be higher than they are initially estimated to be. AEMO acknowledges that its approach to applying cost estimation in the ISP may be considered to deviate from the AACE framework – although AEMO considers these deviations to be superficial, as outlined in Section 2.1.1 of the <i>2023 Transmission Expansion Options Report</i>.</p> <p>The ISP's cost benefit analysis includes the cost estimate reference point of each project, rather than the cost estimate with the accuracy band applied (though sensitivity analysis is conducted with elevated project costs). Due to this, AEMO considers that for the ISP, it is more appropriate to reflect that Class 5 project cost estimates are often lower than actual project costs, by actively accounting for unforeseen risks which may increase project costs.</p> <p>Section 3.2.2 of the Draft 2023 <i>Transmission Expansion Options Report</i><sup>28</sup> showed that an approximate 30% uplift was applied to Class 5b estimates to account for unknown risks. As a result of AEMO's approach, if a project's scope definition is determined to be at a Class 5b stage, then the cost estimate is comprised of: the baseline cost of components and adjustments for specific project attributes; multiplicative adjustments based on "known" risks; and up to 30% of the total network cost uplift to account for "unknown" risks.</p> <p>Therefore, without the up to 30% uplift factor, the estimate's accuracy band would be within the AACE's suggested accuracy band for Class 5 estimates (Downside risk: -20% to -50%, Upside risk +30% to +100%). However, if the up to 30% uplift were removed, the ISP's cost benefit analysis would simply see a total project cost estimate that is approximately 20% lower.</p> <p>Ultimately, AEMO considers that this approach closely aligns with an example in AACE documentation, although no guidance is provided by the AACE on how accuracy bands should be articulated following the addition of a contingency allowance.</p> <p>The up to 15% and 30% adjustments for unknown risk for Class 5a and 5b estimates were determined by <b>GHD</b> for the <i>2021 Transmission Cost Database</i><sup>29</sup>. <b>GHD</b> analysed the cost estimate progression of 22 recent (at the time) transmission network projects<sup>30</sup>. These included both overhead line and substation projects. For future ISPs, and as more information becomes available, AEMO will continue to review the extent to which these values reflect the typical divergence observed in the cost estimate progression of transmission projects.</p> <p>AEMO acknowledges <b>PIAC's</b> view that larger (and more complex) projects have greater potential for experiencing higher project costs. However, as discussed above, AEMO does not have an evidence base that would justify amending the risk uplift factor at this time. AEMO will enhance its cost estimation approach for future ISPs as more evidence becomes available.</p> <p>Based on feedback from the <b>ISP Consumer Panel</b> and <b>PIAC</b>, AEMO has included a new section in the final 2023 <i>Transmission Expansion Options Report</i> that outlines superficial deviations from the AACE cost estimation framework.</p>
<p><u>Environmental offset costs</u></p> <p>The <b>ISP Consumer Panel</b> recommended that AEMO provide clarity around the treatment of biodiversity offset costs (also referred to in this report and the</p>	<p>AEMO acknowledges that conflicting statements were made in the Draft 2023 <i>Transmission Expansion Options Report</i> about how biodiversity offset costs were treated. AEMO confirms here and in the final report that biodiversity offset costs are treated as capital expenditure in AEMO's cost estimation process.</p>

<sup>28</sup> At [https://aemo.com.au/-/media/files/stakeholder\\_consultation/consultations/nem-consultations/2023/2023-teor/draft-2023-transmission-expansion-options-report.pdf?la=en](https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2023/2023-teor/draft-2023-transmission-expansion-options-report.pdf?la=en).

<sup>29</sup> AEMO. 2021 *Transmission Cost Report*. August 2021. At <https://aemo.com.au/-/media/files/major-publications/isp/2021/transmission-cost-report.pdf?la=en>.

<sup>30</sup> GHD. ISP Transmission Cost Database. May 2021. At <https://aemo.com.au/-/media/files/major-publications/isp/2021/transmission-cost-database---ghd-report.pdf?la=en>.



Issue raised	AEMO's response
<p>Transmission Cost Database as environmental offset costs). The <b>ISP Consumer Panel</b> suggested that AEMO provide greater transparency around how the level of environmental risk can be determined when specific transmission line routes are not known. It further recommended that AEMO clarify whether AEMO's position is to treat biodiversity offset costs under capital expenditure or under operating expenditure, and to clarify how biodiversity costs are to be treated in the future.</p>	<p>These costs are shown as "Environmental Offset Costs" in each transmission expansion option's cost report.</p> <p>In the Transmission Cost Database, environmental offset costs are calculated for each network element within a transmission network expansion option. A baseline value is calculated as a proportion of the sum of all other known costs. Then, a known risk factor, "Environmental offset risks", is selected based on consideration of the project's location and the terrain it is likely to pass through. The level of environmental offset risk selected corresponds to a specific multiplicative factor.</p> <p>As noted in Mott MacDonald's report about the update of the Transmission Cost Database<sup>31</sup>, the amount of environmental offset costs allocated in the database was updated for the 2022 version of the database by applying the same ratio of environmental offset costs to total direct costs as the previous database and by providing updated risk classifications (and associated multiplicative factors). Mott MacDonald justifies this approach in Section 2.3 of its report.</p> <p>AEMO agrees that it is challenging to determine environmental offset costs in a reliable manner when the details of a prospective transmission line's route are highly uncertain. To compound this challenge, current or future governments may legislate new policies regarding environmental offsets that alter these costs, and outlooks for biodiversity offset markets are in flux. AEMO applies the environmental offset risk factors on a case-by-case basis for each project estimate, based on desktop studies of conceptual locations and routes, and through joint planning with TNSPs and jurisdictional bodies.</p> <p>AEMO acknowledges that there are pressures on biodiversity offset costs, and agrees with the ISP Consumer Panel that offsets ought to be escalated above inflation over the ISP horizon. AEMO has decided to forecast biodiversity offset costs by holding the proportion of offset costs to total project costs steady over the ISP horizon, at the same time that the overall project cost estimate is escalated in accordance with the transmission cost forecasting approach. AEMO considers this to be an appropriate treatment, given the known pressure on offset costs and in the absence of an appropriate economic model for deriving a dedicated escalation factor.</p>
<p><u><b>Use of the Transmission Cost Database to cross-check cost estimates</b></u></p> <p>In the Draft 2023 <i>Transmission Expansion Options Report</i>, AEMO said it would use the Transmission Cost Database to cross check project estimates provided by TNSPs and jurisdictional bodies, for example estimates provided as part of preparatory activities for future ISP projects or for actionable ISP projects.</p> <p>In relation to this, the <b>ISP Consumer Panel</b> specifically recommended that AEMO should:</p> <ul style="list-style-type: none"> <li>• Clarify whether the costs of committed and anticipated projects are re-assessed in the ISP process.</li> <li>• Outline how (or if) the Transmission Cost Database is used to cross-check cost estimates provided by TNSPs. The Panel expressed concern that AEMO may use its Transmission Cost Database, which produces Class 5 cost estimates, to cross-check TNSP cost estimates, which may be Class 3 or 4 estimates.</li> <li>• Outline which projects this cross-checking process will apply to.</li> </ul>	<p>AEMO confirms that the cost of committed and anticipated transmission augmentation projects are not reassessed as part of the draft or final ISP.</p> <p>AEMO notes that the Transmission Cost Database is used to perform a class 5 comparison of the costs provided by a TNSP for their projects. This approach is designed to:</p> <ul style="list-style-type: none"> <li>• Review the TNSP's cost estimates such that they are complete and consistent.</li> <li>• Validate that AEMO's transmission cost estimation process is reasonable.</li> </ul> <p>AEMO estimates the project and checks that the TNSP costs fall within the accuracy band of the Transmission Cost Database costs. Should the TNSP costs fall outside, AEMO will engage the TNSP to provide a further justification of their costs to ensure clarity and transparency of project costs going into the ISP. If the costs are justified appropriately, AEMO may use the information to refine the Transmission Cost Database with this latest information.</p> <p>This cross-checking is applied to preparatory activity cost estimates for future ISP projects, and to estimates for actionable ISP projects.</p>

<sup>31</sup> Mott Macdonald. *Transmission Cost Database Update Final Report*. July 2023. At <https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation>.

## AEMO's conclusion

### Cost forecasting

AEMO has adjusted aspects of the forecasts that were presented in the Draft 2023 *Transmission Expansion Options Report*. The forecasts for several baskets were re-examined by Mott MacDonald, and were adjusted due to improved specification of the equations used in the forecasting methodology. The following baskets were impacted by these updates:

- Underground cable.
- Overhead line.
- Design and survey, and contractor project management and overheads.
- Civil and structural works, electrical works, and commissioning and testing.

AEMO has also revised its expectation of when a 'new normal' may be reached, in which costs for transmission projects cease increasing in real terms. With the exception of property and easement costs, AEMO has elected to hold costs constant in real terms from 2029-30 in the *Step Change* and *Green Energy Exports* scenarios, and from 2026-27 in the *Progressive Change* scenario. In all scenarios, property and easement costs are forecast to continually increase across the horizon to 2049-50. AEMO has extrapolated from the property and easement escalation factors provided by Mott MacDonald up to 2039-40.

AEMO considers that its resulting forecasts reflect informed consideration of:

- Heightened demand for transmission project resources, both domestically and internationally.
- The broader level of domestic major infrastructure construction.
- The recovery of global markets from recent global economic shocks.
- The lead time required for a supply-side reaction to elevated prices for labour, materials, plant and equipment.

### Constraints on concurrent project delivery

AEMO acknowledges the forecasts of labour supply shortages, and other supply constraints, for the energy transition. The impact of a generally heightened level of transmission construction activity has been considered within the cost forecasting approach. Further, the Transmission Cost Database enables an adjustment for "Market Activity" risk, which can be set to "Tight" for projects that are expected to face additional competition for resources. However, AEMO will not apply build limit constraints due to potential workforce or plant and equipment shortages in the ISP by default. As outlined in the *Consultation Summary Report – ISP Methodology Update*<sup>32</sup>, AEMO may conduct a sensitivity if the transmission or generation build rates (for example kilometres of transmission line built per year) in candidate development paths are observed to vary significantly over the modelling period.

### Cost estimate accuracy bands and unknown risk factor

AEMO has maintained its use of symmetrical cost estimate accuracy bands for cost estimate classes. While AEMO agrees that cost estimates have an asymmetric risk profile, AEMO has chosen to apply an unknown risk factor to uplift its point cost estimates. While this does result in a symmetric accuracy band, it also allows the ISP

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<sup>32</sup> AEMO's consultation on updates to the ISP Methodology can be found at: [https://aemo.com.au/en/consultations/current-and-closed-consultations/consultation-on-updates-to-the-isp-methodology#:~:text=The%20Integrated%20System%20Plan%20\(ISP,least%20the%20next%20%20years.](https://aemo.com.au/en/consultations/current-and-closed-consultations/consultation-on-updates-to-the-isp-methodology#:~:text=The%20Integrated%20System%20Plan%20(ISP,least%20the%20next%20%20years.)

cost benefit analysis to consider a mid-point cost estimate that is inclusive of an unknown risk contingency. AEMO acknowledges that this approach may be considered to deviate from the Association for the Advancement of Cost Engineering (AACE) framework, but also notes that this approach appears to closely align with an example in AACE documentation.

AEMO has decided to retain its unknown risk treatment of up to 30% adjustment for unknown risk. This adjustment is based on GHD’s analysis of 22 transmission projects<sup>33</sup>. AEMO recognises that this is a limited data set, but notes that there is no new evidence to inform the selection of a different uplift factor for unknown risk. AEMO will review this approach for future ISPs as new information becomes available.

### Treatment of environmental offset costs

AEMO has clarified that environmental offset costs are treated under capital expenditure, not operating expenditure. AEMO has decided to forecast biodiversity offset costs by holding the proportion of offset costs to total project costs steady over the ISP horizon, at the same time that the overall project cost estimate is escalated in accordance with the transmission cost forecasting approach. AEMO considers this to be an appropriate treatment, given the known pressure on offset costs and in the absence of an appropriate economic model for deriving a dedicated escalation factor.

## 2.2 Social licence matters

There were many submissions that acknowledged the importance of building social licence for transmission infrastructure projects.

AEMO has established an Advisory Council on Social Licence to assist in understanding social licence issues facing the energy transition, for consideration in developing the ISP<sup>34</sup>. AEMO has incorporated social licence considerations in successive IASRs and ISPs through consultation with governments, TNSPs, consumer advocates and other stakeholders<sup>35</sup>.

Table 6 sets out AEMO’s responses to submissions about social licence.

**Table 6 Social licence feedback and AEMO response**

Issue raised	AEMO’s response
<p><u><i>Use of multi-criteria analysis, land use limits and specific cost components to consider social licence matters in the ISP</i></u></p> <p><b>RE-Alliance, Star of the South and Lisa Gervasoni</b> suggested that AEMO consider using multi-criteria analysis or new specific cost components to represent the impact of detailed social licence considerations, such as accounting for individual land-uses, the likelihood of generation being taken up by landholders, environmental factors, property density, water-way</p>	<p>AEMO agrees that multi-criteria analysis is a beneficial tool for appraising a broad set of project option variables in addition to cost impacts. AEMO is not, however, proposing to introduce a multi-criteria analysis stage in the preparation of the transmission augmentation option set for the ISP. AEMO considers that the information required for this type of analysis is better gathered by responsible TNSPs and jurisdictional bodies at the detailed project option development stage undertaken in the latter stages of regulatory approvals for transmission network projects.</p> <p>AEMO selects the transmission augmentation options included in the <i>Transmission Expansion Options Report</i> through collaboration and joint</p>

<sup>33</sup> GHD. ISP Transmission Cost Database. May 2021. At <https://aemo.com.au/-/media/files/major-publications/isp/2021/transmission-cost-database---ghd-report.pdf?la=en>.

<sup>34</sup> Further information about the Advisory Council on Social Licence is available at <https://aemo.com.au/consultations/industry-forums-and-working-groups/list-of-industry-forums-and-working-groups/social-licence-advisory-council>.

<sup>35</sup> For the most recent IASR consultation, see the Draft 2023 IASR at <https://aemo.com.au/consultations/current-and-closed-consultations/2023-inputs-assumptions-and-scenarios-consultation>. Social licence matters are considered on pages 25, 118, 121 and 122 of the Draft 2023 IASR. For the most recent ISP, see <https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp>. Social licence is considered throughout the 2022 ISP, including a dedicated section in Appendix 3: Renewable Energy Zones.

Issue raised	AEMO's response
<p>uses, and social, cultural, and heritage factors. components.</p> <p><b>Transgrid</b> submitted that AEMO should assess the social cost or benefit of different transmission expansions options with a clear and transparent methodology.</p> <p><b>Origin</b> submitted that it generally supported the social licence approach suggested. However, it suggested that the Draft 2024 ISP should set out any implicit or explicit social licence costs for its transmission augmentation for greater transparency.</p> <p>In the May 2023 meeting of the <b>Advisory Council on Social Licence</b>, it was noted that publishing 'limits' could signal that each REZ is at capacity, and that the 2023 <i>Transmission Expansion Options Report</i> should clearly explain what the opportunities are and that generation types within each REZ are not defined.</p> <p>In the May 2023 meeting of the <b>Advisory Council on Social Licence</b>, it was also noted that land-use limits applied by AEMO are derived from general government and stakeholder consultation but did not consult landholders. The data around land use limits and evidence to support land use limits was queried.</p>	<p>planning with TNSPs, jurisdictional bodies and other stakeholders. Where social licence matters are known at the conceptual project design stage, project proponents may include these in the joint planning process. This may include through provision of preparatory activities when requested by AEMO in an ISP.</p> <p>AEMO recognises the need for alternative assumptions to be explored in the 2024 ISP relating to social licence and will undertake tailored sensitivity analysis to explore the impacts and risks relating to low social licence.</p> <p>AEMO has endeavoured to set out its understanding of implicit or explicit social licence costs applied for transmission augmentation projects in the ISP process, in materials published between the 2023 <i>Transmission Expansion Options Report</i> and the 2023 IASR. AEMO welcomes feedback on specific matters that should be further discussed, considered or made transparent through the preparation and release of the Draft 2024 ISP.</p> <p>AEMO agrees that the use of the word 'limit' requires careful application so that it is not misunderstood in the context of the ISP modelling. AEMO has not identified generation opportunities within REZs in the 2023 <i>Transmission Expansion Options Report</i>, as it is focused on network options. However, AEMO will present REZ generation outlooks as part of the modelling results in the Draft 2024 ISP, for consultation.</p> <p>AEMO has provided detailed information about the assumed generation resource capacity in each REZ in successive IASRs and ISPs, and agrees with the <b>Advisory Council on Social Licence</b> comment that these are assumptions rather than fixed values.</p> <p>AEMO has sought any further evidence to support or amend the land use limits as part of the IASR consultation process. No further evidence has been provided to date, but AEMO welcomes additional data as it becomes available.</p>
<p><u><i>Selection of transmission augmentation options</i></u></p> <p><b>Moyné Shire Council</b> raised issues around the social licence of transmission projects specifically for the SWV1 group constraint (V4 Portland) and subsequently requested the consideration of undergrounding of transmission lines.</p> <p><b>Star of the South</b> noted that different transmission technologies such as overhead lines and underground cables have different advantages and disadvantages that need to be considered in a balanced way.</p> <p><b>Moyné Shire Council</b> raised concerns over SWV1 options 1 and 2, as they go through Budj Bim Cultural Landscape World Heritage Area.</p> <p><b>Lisa Gervasoni</b> raised concerns about the impact of the ISP process on the farming community in Australia. <b>Lisa Gervasoni</b> called for industry to undertake better engagement with local landholders and to minimise the impact of transmission infrastructure projects on individuals and food security. <b>Lisa Gervasoni</b> advocated for better tools to understand agricultural land use to avoid building in the wrong areas and ensure appropriate impact mitigation and compensation.</p>	<p>AEMO recognises that undergrounding of transmission lines is an important issue currently being explored in several jurisdictions, by TNSPs, and through the Energy Charter. AEMO will continue to work with relevant stakeholders to provide input, where appropriate.</p> <p>AEMO notes concerns raised by <b>Moyné Shire Council</b> about options 1 and 2 for the SWV1 group constraint in the draft 2023 <i>Transmission Expansion Options Report</i>. The preparatory activities prepared by AEMO Victorian Planning to consider the South West Victoria REZ (released as supplementary material to the final 2023 <i>Transmission Expansion Options Report</i>), has noted the potential close proximity of socially and culturally significant areas such as the UNESCO World Heritage Budj Bim Cultural Landscape.</p> <p>In the preparatory activities report, AEMO Victorian Planning has noted that <i>"the long-held social and environmental concerns about the burden of hosting even more renewable infrastructure in the south west is well known"</i> and that <i>"if in the event a future ISP nominates a transmission option in the SW REZ, a comprehensive engagement plan would be prepared that involves Traditional Owners, potential host landowners, neighbours, local communities, LGAs, consumer advocates, industry and interest groups and federal, state and local government authorities"</i>.</p> <p>AEMO acknowledges the landholder and community concerns raised by <b>Lisa Gervasoni</b>. AEMO agrees that it is critical that landholders be treated with respect and seen as stakeholders. AEMO has not identified any specific suggestions in the submission that can be addressed within the scope of the <i>Transmission Expansion Options Report</i>, but does note the specific suggestions raised for the broader uplift of the sector's treatment of social licence, and will seek to incorporate these where appropriate in AEMO's frameworks and processes.</p>
<p><u><i>Enhancement of communication about social licence</i></u></p> <p>In the May 2023 meeting of the <b>Advisory Council on Social Licence</b> it was noted that social licence requires building trust between landholders and the entire industry, that communication is crucial, and the responsibility falls on many stakeholders.</p> <p>A number of submissions expressed the view that AEMO could better communicate the inputs, assumptions, and modelling outcomes relating to social licence in the ISP. <b>RE-Alliance</b> provided specific examples including external engagement efforts and delivery of an interactive map.</p>	<p>AEMO agrees about the need to build and establish trust across the sector in relation to local community acceptance of new infrastructure development.</p> <p>AEMO supports recommendations to provide greater resources to the wider community to better understand and engage with future developments in a targeted and timely manner. However, while messaging and engagement can improve and while authoritative maps would be beneficial, AEMO notes that the options are currently conceptual only and cannot provide more accurate mapping.</p> <p>AEMO welcomes <b>RE-Alliance's</b> specific examples about opportunities to enhance AEMO's consideration and communication of social licence matters. AEMO notes that the transmission expansion options considered in the ISP are largely at conceptual design stage only, and so the ability to incorporate highly detailed mapping and engagement exercises for individual project options is not</p>

Issue raised	AEMO's response
<p><b>RE-Alliance</b> also recommended that AEMO:</p> <ul style="list-style-type: none"> <li>• “Further refine what you mean by social licence, informed by experts and guided by the AEMO Advisory Council on Social Licence. This could include engaging social scientists to inform and advise the [Advisory Council on Social Licence].</li> <li>• Include cultural, social, land-sector and environmental layers in options and routes presented in the ISP”.</li> </ul>	<p>envisaged for the ISP. However, AEMO acknowledges that there is room for enhancement and will continue to consider which of these examples could be incorporated in the 2024 ISP, and future ISPs.</p>
<p><u>Other specific feedback on social licence considerations</u></p> <p><b>QCC</b> considers that large environmental impacts are being observed from energy infrastructure sites in central and northern Queensland that would likely be classed as ‘scrub’ in AEMO’s Transmission Cost Database. <b>QCC</b> does not think that a ‘scrub’ classification would appropriately reflect the high prevalence of unprotected threatened species habitats in these areas.</p> <p><b>QCC</b> recommends a more granular assessment of land use types (and potential environmental impacts) at the early feasibility stage of option identification. <b>QCC</b> notes that relevant datasets are available.</p>	<p>AEMO agrees that a ‘scrub’ classification may not be the most appropriate land use classification for the type of land described by <b>QCC</b>, and acknowledges that ‘scrub’ is a very broad land use term. AEMO has not identified a ready method to make the land use classifications more granular in the Transmission Cost Database in the near term, and notes that the Transmission Cost Database has been prepared for conceptual design and location of options rather than more granular studies.</p> <p>AEMO intends to update its cost estimation process over time, but at this stage does not have plans to make the land use classifications more granular. AEMO undertakes extensive joint planning and collaboration with TNSPs and jurisdictional bodies, including seeking granular project feasibility assessment information where it is available.</p>

## 2.3 Operating expenditure

Table 7 sets out AEMO’s responses to submissions about operating expenditure.

**Table 7 AEMO’s response to submissions about operating expenditure**

Issue raised	AEMO's response
<p>The <b>ISP Consumer Panel</b> recommended that AEMO publish the evidence to support the case that operating expenditure can be estimated as 1% of capital expenditure per annum. The Panel cited that various project proponents have recently used values ranging from 0.5% to 3.8%.</p> <p><b>Transgrid</b> acknowledged that AEMO’s assumption of 1% may have been an appropriate figure in the past. However, in <b>Transgrid</b>’s view, continued use of 1% does not reflect the additional operational costs incurred by TNSPs who will be managing more complex transmission networks whilst maintaining a secure power system.</p> <p><b>Simon Bartlett</b> responded to the Draft 2023 IASR submitting that operating and maintenance costs are too low and should be higher (3.3%) and include both operating and capital expenditure and depreciation costs associated with the full life-cycle cost.</p>	<p>AEMO agrees that there appears to be variations in operating expenditure estimates, when expressed as an annual percentage of new capital expenditure within the NEM. AEMO acknowledges that the estimation of operating expenditure for assets with long lifecycles (exceeding 40 years) and assorted designs can be challenging, and many proponents adopt a ‘per cent of new capital expenditure’ rule of thumb in estimating operating and maintenance costs for RIT-Ts.</p> <p>In making its decision for the 2023 <i>Transmission Expansion Options Report</i>, AEMO considered the following as evidence:</p> <ul style="list-style-type: none"> <li>• Recent completed RIT-Ts and the estimates included in the associated Project Assessment Conclusion Reports (PACRs) (Victoria – New South Wales Interconnector West (VNI West) – 1% p.a, HumeLink – 0.5% p.a, Project EnergyConnect – 0.1% p.a).</li> <li>• Approved capital expenditure included in Contingent Project Applications (CPA) determinations for Project EnergyConnect (\$457.4 million and \$1,817.9 million \$2017-18) and Eyre Peninsula (\$280 million \$2017-18).</li> <li>• Recent regulatory determinations (2023-2028) for new transmission lines: Project EnergyConnect and Eyre Peninsula, with operating expenditure values ranging from 0.6% (<b>Transgrid</b>) to 0.9% (<b>ElectraNet</b>) p.a. These values are calculated by multiplying the Base Year operating expenditure (<b>Transgrid</b> - \$194.06 million, <b>ElectraNet</b> - \$108.66 million \$2022-23) and Forecast Rate of Change (<b>Transgrid</b> - 5.42%, <b>ElectraNet</b> 6.28%) due to new transmission lines, then dividing by the total capital cost from the relevant CPA as stated above.</li> <li>• Announced jurisdictional strategic benefit payments to landholders and neighbours.</li> </ul> <p>AEMO’s decision to maintain the 1% p.a value in the final 2023 <i>Transmission Expansion Options Report</i> is based on recent AER regulatory determinations. These values reflect the operating expenditures that regulated transmission networks are allowed to recover from consumers, in the initial years of operation following commissioning of these new transmission lines.</p>

Issue raised	AEMO's response
	<p>Both <b>ElectraNet</b> and <b>Transgrid</b>'s determinations yield approximately 1% of the total capital cost per annum but vary slightly by TNSP due to a range of jurisdictional factors (Customer Numbers, Circuit Length, Maximum Demand, Energy).</p> <p>AEMO maintains that a 1% p.a. value is an appropriate estimate for the <i>Transmission Expansion Options Report</i> and has clarified its evidence for this view, to the extent possible. AEMO will apply additional operating expenditure costs for projects where sufficient justification and evidence exists for each jurisdiction.</p> <p>AEMO agrees with <b>Transgrid</b>'s view that operating the future transmission network will be more complex. However, AEMO will continue to use the 1% value to estimate operating expenditure. AEMO notes that it has discussed the 1% value with a range of TNSPs and jurisdictional bodies, including <b>Transgrid</b>. In these meetings, there was no opposition to the 1% value, or suggestion that this value was inappropriate, particularly for projects which are mostly greenfield.</p> <p>AEMO disagrees with <b>Simon Bartlett</b>'s proposed treatment of capital costs, as this is inconsistent with the AER's cost-benefit analysis guidelines to make the ISP actionable<sup>36</sup>. Specifically, the AER's guidelines require that assets are depreciated in the analysis period, and undepreciated assets are modelled as a terminal value of the net present value (NPV).</p>

## 2.4 Responses about particular flow paths and REZs

Table 8 below sets out AEMO's responses to submissions about particular flow paths and REZs.

**Table 8 AEMO's responses to submissions about individual flow paths and REZs**

Issue raised	AEMO's response
<p><b>Moyne Shire Council</b> sought clarification on the impact of the Mortlake turn-in project on the timing of transmission expansion options for the SWV1 group constraint.</p>	<p>AEMO considers the Mortlake turn-in project to be a necessary pre-requisite to all SWV1 options, meaning that these options may only be built after the completion of the Mortlake turn-in project.</p>
<p><b>Moyne Shire Council</b> raised issues around the social licence of transmission projects for the SWV1 group constraint and subsequently requested a consideration of undergrounding of transmission lines. <b>Moyne Shire Council</b> argued that undergrounded transmission lines have lower maintenance costs than overhead lines, meaning that they may be more economically viable than appears when only considering capital expenditure.</p>	<p>Please refer to AEMO's response to this feedback in Section 2.2.</p>
<p><b>Transgrid</b> requested that alternative transmission options be considered for Broken Hill REZ (N4).</p>	<p>AEMO welcomes discussion of this issue as part of ongoing joint planning processes.</p>
<p><b>Windlab</b> argued that the capacity factors the AEMO uses for South-West New South Wales REZ (N5) are too low and should be increased to better capture the quality of the wind resource in N5.</p> <p><b>Windlab</b> expressed support for the inclusion of many transmission augmentation options in Queensland, and noted the importance of transmission options in facilitating efficient market outcomes in the NEM.</p>	<p>AEMO has responded to the capacity factor issues raised by <b>Windlab</b> in the 2023 IASR consultation summary report<sup>37</sup> and in the final ISP Methodology consultation summary report<sup>38</sup>.</p> <p>AEMO acknowledges <b>Windlab</b>'s support for the consideration of transmission network augmentation options.</p>
<p><b>Pacific Blue</b> suggested an additional transmission expansion options for consideration for the SWV1 group constraint: a 500 kV transmission line from Heywood to Mortlake to Bulgana.</p>	<p>AEMO Victoria Planning has provided preparatory activities advice for the South West Victoria REZ, including consideration of a broadly equivalent option to that proposed by <b>Pacific Blue</b>. AEMO has included the preparatory activities materials in the final 2023 <i>Transmission Expansion Options Report</i> and has published the preparatory activities report.</p>

<sup>36</sup> AER. Cost Benefit Analysis Guidelines, Guidelines to make the Integrated System Plan actionable, August 2020. At <https://www.aer.gov.au/system/files/AER%20-%20Cost%20benefit%20analysis%20guidelines%20-%202025%20August%202020.pdf>.

<sup>37</sup> At <https://aemo.com.au/en/consultations/current-and-closed-consultations/2023-inputs-assumptions-and-scenarios-consultation>.

<sup>38</sup> At <https://aemo.com.au/consultations/current-and-closed-consultations/consultation-on-updates-to-the-isp-methodology>.

Issue raised	AEMO's response
<p><b>Pacific Blue</b> suggested that a virtual transmission line should be considered connecting South East South Australia to South-West Victoria.</p>	<p>AEMO agrees that virtual transmission lines are a viable option that can be considered to meet transmission augmentation needs in some cases. AEMO welcomes specific non-network option submissions in response to IASR and ISP consultations. AEMO also notes the role of non-network option consideration by project proponents through regulatory approval processes.</p>
<p><b>Pacific Blue</b> advised AEMO that Central North Victoria REZ V6 Option 2 is more socially and economically viable than options 1 and 3.</p>	<p>AEMO notes this feedback, and anticipates that it would be considered by the local transmission network project proponent should any options in the Central North Victoria REZ be progressed.</p>
<p>For Murray River Victoria (V2) REZ, <b>Pacific Blue</b> suggested an additional transmission expansion option for Murray River Victoria (V2) REZ: a new 220 kV double circuit line between Bendigo and Kerang.</p>	<p>AEMO notes this suggestion, and considers that Option 2 for Central North Victoria (V2) REZ is conceptually aligned with this idea. The Victorian V2 and V6 REZs are in proximity to one another.</p>
<p><b>Engie</b> stated that it considers a combination of Option 1 and 4 for New South Wales Southwest REZ (N5) would facilitate the development of large amounts of renewable generation in the region. Additionally, it has stated that the cost of the option considering the amount of renewable generation unlocked is favourable compared to other options.</p> <p>Furthermore, <b>Engie</b> has suggested that Option 3 would not allow for the connection of new renewable resources at the same speed as Option 4, and therefore should not be favoured at present. <b>Engie</b> recommends that “<i>Option 3 should be considered as part of any possible future development states in the region</i>”.</p>	<p>AEMO welcomes <b>Engie's</b> feedback on the proposed New South Wales South West REZ options. AEMO notes that Transgrid and EnergyCo are continuing to develop transmission network planning in this region and for this REZ, and the three organisations will continue to consider this feedback as part of ongoing joint planning discussions.</p>
<p><b>Engie</b> recommended “<i>the northern section of VNI West be as closely aligned with [Project Energy Connect] as is possible</i>”. <b>Engie</b> has suggested that this would maximise connection opportunities. It has also suggested that this would be preferable to more greenfield routes as local concerns about greenfield routes have “potential to add significant delays and costs”.</p>	<p>AEMO recognises the need for facilitating a straightforward connection process as much as possible, to avoid needless congestion or curtailment of prospective generation. AEMO strives to remain consistent to the options developed with the TNSPs via joint planning processes. AEMO has not considered alternative options in the <i>Transmission Expansion Options Report</i> for VNI West due to the fact that the project is at an advanced stage in the RIT-T process. The ultimate design of transmission projects, including location selection, is not within AEMO's responsibility in its role as National Transmission Planner.</p>
<p><b>Smart Wires</b> suggested the use of modular power flow control options to provide benefits to the following projects/corridors:</p> <ul style="list-style-type: none"> <li>• VNI West.</li> <li>• HumeLink.</li> <li>• Woolooga to South Pine.</li> <li>• SQ – NNSW.</li> <li>• NNSW – CNSW.</li> <li>• REZs generally.</li> </ul>	<p>AEMO agrees with <b>Smart Wires</b> that modular power flow control solutions can be beneficial on the transmission network. AEMO has included modular power flow control options in Tasmanian REZ T3 options 1 and 2b, and Tasmanian REZ T5 option 1.</p> <p>AEMO notes that VNI West and HumeLink have both completed or are completing the RIT-T process, meaning that changes to their scope are no longer being consulted on. AEMO notes that the preferred option for VNI West includes a modular power flow control solution.</p> <p>AEMO acknowledges that modular power flow control solutions can be considered as viable solutions for some augmentation needs, and so has changed the 2023 <i>Transmission Expansion Options Report</i> to not refer to 'phase shifting transformers' in an option scope in cases where modular power flow control could also be a viable alternative. AEMO considers that this will provide more transparency about the variety of options available.</p> <p>Modular power flow control solutions may be considered for other options, including but not limited to those listed by <b>Smart Wires</b> when they progress to the detailed planning stage. These matters are considered in detail by project proponents during project design phases and through regulatory approval processes.</p>
<p><b>Simon Bartlett</b> made several comments to the responses AEMO gave to the 'pre-submitted' questions in the draft report webinar on 18 May 2023.</p>	<p><b>Simon Bartlett's</b> submission notes the CQ-NQ 500 kV option not having intermediate substations; it may be confusing, but 500 kV intermediate substations were modelled and costed, which is evident in the other building blocks of the cost estimate. AEMO has made the cost estimate clearer that there are intermediate substations. The submission asked the basis on which the CQ-NQ transmission lines should be cyclone rated. AEMO notes that it considers everything from CQ north to need cyclone-rated towers.</p> <p>The submission notes that twin conductor Olive 500 kV lines are not a good option to use and Powerlink has said it is only considering quad conductor 500 kV lines. AEMO is now assuming only quad conductor 500 kV lines.</p>

Issue raised	AEMO's response
	<p>The submission notes the discrepancy between the high voltage direct current (HVDC) voltages for the CQ-SQ option. AEMO notes this too and has corrected this. The submission notes the broader implications of not including appropriate HVDC options against high voltage alternating current (HVAC) options. This is a very valuable concern to raise and more appropriate HVDC options are being considered, however, in many cases there is a limit to how large HVDC transmission can be as they must connect into the existing network which becomes the capacity limitation. AEMO notes that while HVDC does have favourable qualities, HVAC allows for a simpler integration of renewables along the transmission corridor than HVDC does, which may have implications as the network evolves over time. Additionally, from a cost benefit point of view, HVDC options are often not appropriate for all transmission expansion options.</p> <p><b>Simon Bartlett's</b> submission queries why the Borumba connection is only \$60 million. AEMO notes that this was the cost of the 500 kV bays required to connect the existing Borumba substation (and associated generator infrastructure) to the transmission network. That existing infrastructure would fall under the generation and generation connection costs but as a whole of system plan, AEMO does not believe it is relevant to differentiate between what is paid by one entity versus another. AEMO understands that these details will be the subject of discussions between the local TNSP, jurisdictional bodies and other relevant stakeholders.</p> <p>The submission asked why a double circuit single tower line from Woolooga to South Pine is included for SQ1 option 2, taking new easements when there is an existing double width easement. The costing for this option details that due to this cost being a line rebuild, the easement is already partially acquired by Powerlink. Therefore, the cost of acquiring property and environment offset costs has been reduced by 30%. However, this is only a single width easement, so the existing line would have to be removed before a new double-circuit could be built. This work would incur significant market impact.</p> <p>The submission noted they are unable to locate the Queensland Energy and Jobs Plan's CQ-SQ option from Halys to Central Queensland. AEMO notes that the Plan actually has a 500 kV option from Halys to Woolooga and then to Central Queensland. AEMO has scoped this option as CQ-SQ Option 5 in both the draft and the final report.</p> <p>On other matters raised in the submission, AEMO provided a response during the 18 May 2023 webinar.</p>
<p><b>Shell Energy</b> noted concerns about 'splitting of projects' in the ISP if there is a risk that benefits could be claimed twice for different project segments. In particular <b>Shell Energy</b> considered that benefits of HumeLink and Southern Sydney 500 kV should not be considered in isolation.</p>	<p>AEMO agrees with <b>Shell Energy</b> that project benefits should not be overlapped or considered twice in the ISP. The ISP cost benefit analysis does not double-count benefits for individual projects – rather, the preparation of the ODP is a holistic assessment of benefits across the development pathway. For example, the benefits that would be considered cumulatively by HumeLink and Sydney Ring are considered across the ODP, and are not double-counted between the projects.</p>
<p><b>Shell Energy</b> noted the importance of considering smaller-scale transmission augmentation projects, in particular noting that potential projects could include:</p> <ul style="list-style-type: none"> <li>• Rebuild of one of the 132 kV lines from Wagga Wagga to Yass as a 330 kV line.</li> <li>• Strategic upgrades and network support of the 132 kV central New South Wales network to remove constraints in the Parkes, Orange and Forbes region.</li> <li>• Construction of an additional single or double circuit 220 kV transmission line between Bendigo and Shepparton.</li> <li>• Installation of energy flow control equipment on the Dederang – Wodonga – Jindera – Wagga, Murray to Lower Tumut, and Murray to Upper Tumut 330 kV transmission lines.</li> </ul>	<p>AEMO agrees that transmission network planning ought to include both large- and small- scale options where possible and where these suit the need. AEMO undertakes extensive joint planning with TNSPs and jurisdictional bodies accordingly. AEMO welcomes specific suggestions like those raised by <b>Shell Energy</b>.</p> <p>On the first and second projects, AEMO notes that options such as these may support some transmission network uplift, but that options included in the 2023 <i>Transmission Expansion Options Report</i> for these areas are generally designed to provide larger network capacity uplift. This is aligned with the need for the ISP model to have options for the significant uplift in supply through to the Sydney, Newcastle and Wollongong load centre in New South Wales over the ISP horizon.</p> <p>AEMO notes that the proposed new project for Bendigo and Shepparton (similar, although not the same) is conceptually covered in the Central North Victoria V6 REZ in the final 2023 <i>Transmission Expansion Options Report</i>.</p> <p>AEMO agrees that power flow control equipment can be beneficial in many instances. Some of the proposed options by <b>Shell Energy</b> have already been considered by Transgrid for the relevant transmission lines .</p>
<p><b>ZEN Energy</b> proposed a number of new transmission options in western Victoria:</p> <ul style="list-style-type: none"> <li>• Replace Ballarat–Bendigo–Shepparton single circuit with double circuit high capacity 220 kV.</li> </ul>	<p>AEMO notes that the first and second proposals are broadly incorporated in options in the 2023 <i>Transmission Expansion Options Report</i> Central North Victoria REZ V6. For the third proposal, a broadly analogous option is included in Western Victoria REZ V3 East Option 1.</p>



Issue raised	AEMO's response
<ul style="list-style-type: none"> <li>Replace Bendigo-Kerang single circuit with double circuit high capacity 220 kV.</li> <li>Replace Ballarat-Moorabool single circuit with double circuit high capacity 220 kV.</li> <li>Replace Moorabool-Terang single circuit with double circuit high capacity 220 kV.</li> <li>Duplicate Mortlake turn-in 500 kV circuit at Heywood.</li> </ul>	<p>For the final two proposals, AEMO notes the proposals and notes that further options may be considered by local project proponents on a case-by-case basis. AEMO notes that preparatory activities have been completed for the relevant REZ and are published as a supplementary material to the 2023 <i>Transmission Expansion Options Report</i>.</p> <p>In general, AEMO notes that replacing existing circuits with double-circuit towers can be more challenging and may be physically constrained by existing easements and available outage windows than greenfield options.</p>
<p><b>ZEN Energy</b> proposed a number of new transmission options for the CNSW-SNW (SNW Southern Loop) flow path:</p> <ul style="list-style-type: none"> <li>Replace Dapto to Sydney South lines from single circuit 330 kV to dual circuit 330 kV line.</li> <li>Replace existing 330 kV Bannaby to Sydney West line with 500 kV dual circuit.</li> </ul>	<p>For the New South Wales proposed options by <b>Zen Energy</b>, AEMO did not identify the Dapto to Sydney South 330 kV line being the limiting constraint from CNSW to SNW.</p> <p>AEMO considers that replacing the existing 330 kV Bannaby to Sydney West line with a 500 kV double-circuit would be similar to CNSW-SNW Option 2 (500 kV double-circuit from Bannaby to South Creek, rebuild South Creek – Sydney West as double-circuit 330 kV), as South Creek is relatively close to Sydney West substation. Options may be explored by the project proponent should this project be progressed.</p>
<p><b>ZEN Energy</b> also proposed a number of new transmission options for South Australia:</p> <ul style="list-style-type: none"> <li>Replace Davenport-Bungama-Para 275 kV circuit with high capacity double-circuit 275 kV.</li> <li>Replace Davenport-Brinkworth-Templers West-Para 275 kV line with high capacity double-circuit 275 kV.</li> </ul>	<p>AEMO notes that ElectraNet has provided a preparatory activities report for Mid-North South Australia REZ Expansion, which is released as a supplementary material for the 2023 <i>Transmission Expansion Options Report</i>. AEMO's final report incorporates the outcomes of the preparatory activities report.</p> <p>AEMO includes several options for expanding the Mid-North REZ in its report, based on ElectraNet's advice, which are higher capacity than the options proposed by <b>ZEN Energy</b>. AEMO will continue to joint plan with ElectraNet as options are considered should this REZ be developed.</p> <p>In general, AEMO notes that replacing existing circuits with double-circuit towers can be more challenging and may be physically constrained by existing easements and available outage windows than greenfield options.</p>
<p><b>ZEN Energy</b> also proposed a number of new transmission options for Queensland:</p> <ul style="list-style-type: none"> <li>Replacing Tarong and South Pine circuits with high capacity double-circuit 275 kV.</li> <li>New Calvale – Halys double circuits.</li> <li>An inland CQ-SQ and CQ-NQ SuperGrid route.</li> <li>Coupling circuits on the CQ-SQ eastern corridor.</li> </ul>	<p>AEMO engaged with Powerlink on these options. With Tarong-South Pine, easement issues are a constraint on this urban corridor. Additionally, Powerlink is completing several separate projects to uplift the limitations on power into South East Queensland.</p> <p>The Calvale – Halys new double circuit was previously studied but CQ-SQ Option 1 was determined to be the better option.</p> <p>AEMO notes <b>ZEN Energy's</b> suggestion regarding an inland SuperGrid route. Although AEMO understands there may be benefits to this approach, it is noted that an inland route may prevent the benefits of integrating the new 500 kV infrastructure with the existing 275 kV network. In addition, an inland route may not allow best access to the pumped hydro energy storage projects that are proposed by the Queensland government. AEMO will continue extensive joint planning with Powerlink as the SuperGrid plan is developed.</p> <p>Coupling the eastern CQ-SQ circuits has been shown to increase congestion on this flow path. In fact, Powerlink are aiming to install phase shifting transformers on this corridor to push power to other sections of network.</p> <p>In general, AEMO notes that replacing existing circuits with double-circuit towers can be more challenging and may be physically constrained by existing easements and available outage windows than greenfield options.</p>

## 2.5 Non-network options

Table 9 below sets out AEMO's responses to submissions about non-network options.

**Table 9 AEMO's responses to submissions about non-network options**

Issue raised	AEMO's response
<p><b>Origin</b> noted that the Draft 2023 <i>Transmission Expansion Options Report</i> did not include non-network solutions. While acknowledging that the Draft ISP will</p>	<p>After actionable projects are identified, AEMO is obligated to publish a notice in the Draft ISP requesting submissions for non-network options that are able to sufficiently meet the identified need that the actionable ISP project addresses<sup>39</sup>.</p>

<sup>39</sup> NER 5.22.12.

Issue raised	AEMO's response
<p>call for non-network options, <b>Origin</b> said that it would be more appropriate for potential non-network solutions to be identified in the final report. <b>Origin</b> suggested that the non-network solutions can then be included in the Draft ISP modelling alongside network options.</p>	<p>As per Section 3.4.3 of the AER's Cost Benefit Analysis Guidelines<sup>40</sup>, AEMO is also required to undertake early engagement with non-network proponents to gather information in relation to non-network options. As part of the consultation on the Draft 2023 IASR, AEMO requested information on specific non-network concepts and proposals. Through this consultation, as well as through joint planning with TNSPs, AEMO has included several virtual transmission line options in the 2023 <i>Transmission Expansion Options Report</i>.</p>
<p><b>Engie</b> noted that increasing costs can lead to some transmission projects being unable to meet the RIT-T criteria. <b>Engie</b> suggested that <i>"there could be value in AEMO or TNSPs market-testing with generation and storage proponents whether there are alternative market-led routes to develop some projects"</i>.</p> <p>As an example, <b>Engie</b> noted that New South Wales South-West REZ Option 4 is a good candidate for a market-led augmentation. <b>Engie</b> suggested that a market-led approach would <i>"obviate the need for a RIT-T and be an effective means to drive risk mitigation"</i>.</p>	<p>AEMO notes that the options in the <i>Transmission Expansion Options Report</i> are considered at a conceptual level. They do not incorporate consideration of the pathways (market-led or otherwise) for the development and construction of the network infrastructure. AEMO would encourage any market-led project proponents to engage with the relevant TNSP or jurisdictional body for the region of interest.</p> <p>Regarding the South West REZ in New South Wales, AEMO refers <b>Engie</b> to the New South Wales Government's framework for REZ development in New South Wales. In its role as the infrastructure planner, EnergyCo assesses and makes recommendations on the network operators who are authorised to undertake a REZ project. EnergyCo is taking a market-based approach for REZ development and is currently conducting a competitive tender for a network operator to design, build, finance and operate the Central West Orana REZ.</p>

## 2.6 Other matters

Table 10 sets out AEMO's responses to submissions about other matters not covered in the previous sections.

**Table 10 AEMO's responses to submissions about other matters**

Issue raised	AEMO's response
<p><b>Origin</b> stated that the <i>"model should aim to co-optimize REZ build with broader shared network flow path upgrades that are critical to implementing the zones"</i>. <b>Origin</b> noted that, without co-optimisation, the REZs may not be implemented correctly since they might face downstream congestion.</p>	<p>In its modelling, AEMO does consider REZ options in the context of the broader shared network, and upgrades required to this network. These considerations are captured in the form of pre-requisite flow path upgrades for REZs as well as relevant REZ group constraints.</p> <p>The flow paths and REZs are built into the model of the NEM in AEMO's market modelling, and optimised together in development of the ISP's ODP for the most efficient outcome.</p>
<p><b>Origin</b> suggested that AEMO should consider the staging of some of the REZ augmentation options. <b>Origin</b> noted that staging of transmission options would reduce the cost of the augmentation, while at the same time supporting earlier development of the REZs.</p>	<p>AEMO agrees that staging is an important consideration which can help reduce the risk of over-investment, and can support earlier development of REZs. Where appropriate, AEMO has included REZ augmentation staging options in the <i>Transmission Expansion Options Report</i> to efficiently build transmission as generation connects in the area.</p> <p>Additionally, in developing the ODP, the ISP considers sensitivities in project sequencing and supply chain limitations to improve the likelihood that projects are delivered on time and to budget. AEMO considers smoothed infrastructure sensitivity in the 2024 ISP to capture the costs and benefits of lower levels of volatility of employment demand.</p>
<p>While <b>Origin</b> stated that it supports incorporating uncertainty in transmission project lead time modelling, it requested more clarity on how the modelling will treat lead time delays. In cases where AEMO expects a project delay, <b>Origin</b> noted that it was unclear if AEMO would account for this delay by:</p> <ol style="list-style-type: none"> <li>recommending that the project be actioned in an earlier ISP in order to meet the modelled optimal in-service date; or</li> <li>adding the delay to the optimal in-service date, so that the upgrade occurs later than optimally modelled.</li> </ol>	<p>Impacts of changes in transmission project lead times are considered through sensitivity analysis in the ISP. When determining the final ODP, AEMO transparently compares candidate development paths on a range of factors including their sensitivity to project delays.</p>

<sup>40</sup> AER Cost Benefit Analysis Guidelines, at <https://www.aer.gov.au/system/files/AER%20-%20Cost%20benefit%20analysis%20guidelines%20-%202025%20August%202020.pdf>.

Issue raised	AEMO's response
<p><b>Origin</b> recommends that “if upgrades are delayed beyond what is optimal in the plan, the modelling should capture the implications of this, such as what it would mean for existing generation retirement and future build”.</p>	
<p><b>PIAC</b> argued that options reports should allow stakeholders to provide their preferences on the aims of expansion. It said engagement processes need to be accessible, timely, and focused on areas where stakeholders can have meaningful input, and engagement requires provision of adequate information to respondents to enable them to choose between clearly defined, meaningful alternatives and so communicate their values and preferences.</p> <p><b>PIAC</b> suggested that AEMO should produce a Generation and Storage Options Report and a Distributed Energy Resources Options Report.</p>	<p>AEMO agrees that ISP communication and engagement can always be improved and enhanced, and will take these suggestions into account. AEMO considers that the contents of the proposed two additional reports are arguably already covered through the IASR and through the CSIRO's production of the GenCost report each year. However, AEMO will consider these suggestions in the context of improved communication and engagement for the ISP.</p>
<p><b>TasNetworks</b> noted that development of new REZ infrastructure would have significant cost implications for customers due to the scale of the transmission build as well as the small customer base in Tasmania.</p> <p><b>TasNetworks</b> expressed concern with the potential requirement to apply RIT-T criteria for future network augmentation, and said that alternative models may be more appropriate. As an example, <b>TasNetworks</b> suggested that “radial connections could be delivered as designated network assets and be subject to special access regimes”, and these assets would be paid for by connecting parties rather than consumers.</p> <p><b>TasNetworks</b> suggested that AEMO should include commentary on asset classifications in the <i>Transmission Expansion Options Report</i>. <b>TasNetworks</b> stated that this would help communicate the cost implications of the options to customers and the commercial opportunities for prospective connecting parties.</p>	<p>AEMO agrees that the ISP should consider alternative investment frameworks, particularly where these are in the long-term interest of consumers. The update to the ISP Methodology, published 30 June 2023, recognises that “if the benefit to consumers of a REZ expansion is uncertain, AEMO may decide not to action that project, noting that it could still progress as a designated network asset – which is funded by connecting parties rather than consumers”.<sup>41</sup></p> <p>AEMO identifies actionable projects on the ODP by exercising professional judgement and balancing the risks of over- or under-investment. AEMO will work closely with <b>TasNetworks</b> via joint planning to assess these risks when considering whether some Tasmanian REZs are more appropriately progressed as actionable ISP projects or designated network assets and reflect this in the 2024 ISP.</p>
<p><b>Transgrid</b> provided several suggestions to improve the level of detail in offshore REZ design. This included considering different lengths of connection assets for different offshore REZs, the difference between floating and fixed offshore wind generation, and the impact of emerging technologies.</p>	<p>AEMO agrees that detailed offshore REZ design should take place, however this is outside the scope of the <i>Transmission Expansion Options Report</i>. These issues will be addressed as part of the next GenCost process to improve the process if possible. AEMO further notes that generation cost estimates are generally based on existing projects, with a learning cost reduction.</p>
<p><b>RE-Alliance</b> and <b>Origin</b> have suggested that the <i>Transmission Expansion Options Report</i> should clearly state how the options presented in the report overlap with jurisdictional planning documents and strategies.</p>	<p>AEMO works closely with TNSPs and jurisdictional planning bodies to identify the options for the <i>Transmission Expansion Options Report</i>. AEMO agrees with this feedback and has updated the final 2023 <i>Transmission Expansion Options Report</i> so alignment with jurisdictional transmission plans is clearer.</p>
<p><b>Snowy Hydro</b> suggested that the <i>Transmission Expansion Options Report</i> should focus on the development of the Sydney Southern Ring. In <b>Snowy Hydro's</b> view, the development of this option would “remove potential constraints on the existing 330 kV Line 39” which may arise when other projects (Project Energy Connect, VNI West, South West New South Wales REZ and Snowy 2.0) are completed. <b>Snowy Hydro</b> further noted that the benefits of Humelink are greatly reduced if Sydney Southern Ring is not developed. In <b>Snowy Hydro's</b> view, it is critical that AEMO takes appropriate action to ensure the project is delivered by 2027-28.</p>	<p>AEMO acknowledges <b>Snowy Hydro's</b> view that the Sydney Southern Ring is an important project for the NEM. AEMO will assess the net market benefits and optimal timing of the transmission expansion options considered in the ISP in a consistent manner (as set out in the ISP Methodology), and in accordance with the AER's Cost Benefit Analysis Guidelines.</p>
<p><b>Reach Solar Energy</b> put forward that delivering the energy transition is “not just about big transmission”. <b>Reach Solar Energy</b> noted that AEMO had included</p>	<p>AEMO notes <b>Reach Solar Energy's</b> comment that smaller transmission and distribution projects are also vital to the successful energy transition. AEMO</p>

<sup>41</sup> AEMO. *ISP Methodology*. At <https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2024-integrated-system-plan-isp/isp-methodology>.

Issue raised	AEMO's response
<p>South West New South Wales REZ Option 4 in the Draft 2023 <i>Transmission Expansion Options Report</i>, and that the AER has not accepted this option.</p>	<p>discusses a range of potential transmission augmentation options (large and small) with TNSPs and jurisdictional bodies through joint planning processes.</p>
<p><b>Reach Solar Energy</b> commented that while some states have enacted “<i>legislation to bypass the AER process</i>”, <b>Reach Solar Energy</b> considers that the RIT-T remains part of the New South Wales Roadmap. <b>Reach Solar Energy</b> put forward that “<i>the status of the South West RIT-T after just under 3 years of process and written assurance by Transgrid, sets a concerning precedent</i>”.</p>	<p>AEMO notes <b>Reach Solar Energy’s</b> concern but does not consider transmission regulatory reform within the scope of this consultation on the Draft 2023 <i>Transmission Expansion Options Report</i>.</p>
<p><b>Star of the South</b> suggested that a multi-criteria analysis incorporating costs as well as environmental, social, and land use considerations should be used to evaluate transmission options.</p>	<p>As noted in Section 2.2, AEMO agrees that multi-criteria analysis is a beneficial tool for appraising a broad set of project option variables in addition to cost impacts. AEMO is not, however, proposing to introduce a multi-criteria analysis stage in the preparation of the transmission augmentation option set for the ISP. AEMO considers that the information required for this type of analysis is better gathered at the detailed project option development stage undertaken in the latter stages of regulatory approvals for transmission network projects.</p>
<p>Figure 7 in the Draft 2023 <i>Transmission Expansion Options Report</i> provides an indicative cost multiplier between HVAC overhead lines and HVAC underground cables that <b>Star of the South</b> does not agree is an appropriate comparison in all instances.</p> <p><b>Star of the South</b> commented that these costs are highly site-specific and should be assessed on a case-by-case basis. <b>Star of the South</b> suggested that AEMO label or update Figure 7 to make it clearer that “<i>direct buried or installed in conduit transmission is most relevant for rural areas and tunnel installation is most relevant for urban areas or very specific situations</i>”.</p>	<p>AEMO agrees with this feedback and has updated the final 2023 <i>Transmission Expansion Options Report</i> accordingly.</p>
<p><b>Star of the South</b> said the statement in the Draft 2023 <i>Transmission Expansion Options Report</i> that HVAC underground cables are suitable for distances less than 50 km is not universally applicable to all transmission voltages. It suggested that AEMO should instead vary the assumed transmission distance cut-off with the voltage selected.</p>	<p>AEMO agrees with the proposed recommendation. AEMO has incorporated this feedback in the final 2023 <i>Transmission Expansion Options Report</i> to indicate potential transmission distance cut-offs for a range of voltages.</p>
<p><b>Star of the South</b> stated that Figure 7 in the Draft 2023 <i>Transmission Expansion Options Report</i> does not provide equal assessment of the overhead line and underground options as it does not take in to account the network operating constraints. <b>Star of the South</b> specifically noted the following points:</p> <ul style="list-style-type: none"> <li>• It suggested that double circuit lines are not favoured by AEMO operations for radially connected generation as they pose a risk during non-credible contingencies such as tower collapse. Two single circuits are instead preferred which would increase costs.</li> <li>• It suggested that if double circuit lines are used, the transfer capacity of lines is constrained below the thermal capacity.</li> </ul> <p>Additionally, <b>Star of the South</b> suggested that the comparison of 500 kV overhead lines to 500 kV underground cable is only appropriate for shorter distances. It noted that the cost comparison between 500 kV overhead lines and lower voltage underground cables (for example, 275 kV) would provide a more meaningful comparison.</p>	<p>AEMO notes that the 500 kV overhead line costs considered in Figure 7 were single circuit, not double circuit as stated by <b>Star of the South</b>.</p> <p>AEMO agrees that double circuit lines may not be favoured for radially connected generation and, in certain cases, the transfer capacity of double circuit lines will be constrained to below their rated thermal capacity. AEMO considers these and other network operating constraints when developing and evaluating each of the options.</p> <p>AEMO agrees with <b>Star of the South</b> that 500 kV cables are typically not used for long distances, and lower voltages are preferred.</p> <p>AEMO emphasises that Figure 7 is only an indicative figure to give a high-level summary of relative per unit costs differences between overhead lines and underground cables. Specific considerations such as network operating constraints, length of transmission and tower design vary on a case-by-case basis and are considered when costing individual options.</p>
<p><b>Sligar and Associates</b> commented that the report provides an excellent snapshot of the NEM's situation. The submission suggested that Jennifer Browne's comments from the webinar held 18 May 2023 may</p>	<p>AEMO agrees that a clear, transparent and importantly accessible database of information used to form decisions that go into the ISP will be support the energy transition. AEMO will take every step to make the publishable data as easy as possible to access and understand.</p>

Issue raised	AEMO's response
<p>necessitate some further consideration of how the Transmission Cost Database might be used.</p> <p><b>Sligar and Associates</b> asked that AEMO produce another 100% renewables publication.</p>	<p>AEMO appreciates <b>Sligar and Associates'</b> support for the 100% renewables information released as part of the 2022 system security reports<sup>42</sup> and the <i>AEMO Engineering Roadmap to 100% Renewables</i>. AEMO is continuing to deliver on the roadmap, and further information will be made available on AEMO's website<sup>43</sup>.</p>
<p><b>Lodestone Mines</b> strongly advocated for the expansion of South Australia's Mid-North REZ. It said AEMO should consider prospective industrial loads that want to expand but might not have the transmission infrastructure required or access to renewable energy to achieve sustainability targets.</p>	<p>AEMO agrees transmission expansion is often a vital part of ensuring that NEM consumers have efficient access to safe, reliable, affordable renewable energy for current and proposed electricity demand.</p> <p>AEMO's ISP modelling may incorporate transmission augmentation options to support increased demand forecasts, subject to the demand forecasts prepared through the annual IASR and <i>Electricity Statement of Opportunities</i> (ESOO) processes.</p>
<p><b>Star of the South</b> noted that the development timeframes for overhead line transmission corridors would differ to underground corridors. It noted that development timeframes should be differentiated for specific technology options.</p>	<p>AEMO agrees that different technology options may have different lead times, depending on the nature of the option and on supply chain matters. AEMO joint plans extensively with TNSPs and jurisdictional bodies to ensure that the project lead times included in the final 2023 <i>Transmission Expansion Options Report</i> are informed by the best information available at the time, and AEMO welcomed any comments in response to the draft report regarding any stakeholder advice about specific project lead time estimates.</p>

<sup>42</sup> At <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/system-security-planning>.

<sup>43</sup> At <https://aemo.com.au/en/initiatives/major-programs/engineering-framework>.

## 3 Summary of changes to the Transmission Expansion Options Report

This section summarises the key developments and changes to the 2023 *Transmission Expansion Options Report* since the draft report.

### Forecasting transmission project cost estimates over time

In response to stakeholder feedback that the future cost of transmission projects had been underestimated, AEMO consulted further with TNSPs and jurisdictional bodies, Infrastructure Australia, the ISP Consumer Panel and others. AEMO subsequently made the following revisions to its cost forecasts and forecasting approach:

- Property and land easement costs are assumed to increase in real terms throughout the study horizon. All other transmission component costs are assumed to increase initially and then remain constant from:
  - 2029-30 in the *Step Change* and *Green Energy Exports* scenarios – rather than the 2026-27 date proposed in the draft report.
  - 2026-27 in the *Progressive Change* scenario – consistent with the proposal in the draft report.
- Updates to forecasts for several of the baskets of goods and services identified by Mott MacDonald in its *Transmission Cost Database Update Final Report*.

AEMO has also clarified that biodiversity offset costs are categorised as capital expenditure, and are calculated using the Transmission Cost Database. AEMO has further clarified that biodiversity offset costs will be forecast by holding the ratio of offset costs to total project cost constant over the ISP horizon. AEMO considers this to be an appropriate approach to estimate future costs, given the known pressure on offset costs but in the absence of an appropriate economic model for deriving a dedicated escalation factor.

### Consideration of social licence

AEMO welcomes the feedback provided from a range of stakeholders about the consideration of social licence in the *Transmission Expansion Options Report* and in the ISP itself. Comments covered the importance of understanding the cost of social licence, a call for clearer communication about transmission augmentation options, and the need for meaningful consideration of undergrounding of transmission lines in option analysis.

Where feedback is better considered under the *Inputs, Assumptions and Scenarios Report (IASR)* or through the ISP process itself, AEMO has provided further information about those processes.

AEMO has updated the final *Transmission Expansion Options Report* to note that overall consideration of social licence in the ISP will have regard for input and feedback from external stakeholders including feedback from the Advisory Council on Social Licence and the ISP Consumer Panel.

### Transmission expansion options and generator connection costs

AEMO has updated the flow path and REZ augmentation options in the final 2023 *Transmission Expansion Options Report* to incorporate materials provided by TNSPs in preparatory activities reports for future ISP projects, as well as the latest project scope and cost estimate information where provided by project proponents.

As part of collaboration with the TNSPs, AEMO received the preparatory activities for future ISP projects triggered in the 2022 ISP<sup>44</sup> to be completed by 30 June 2023. AEMO has incorporated the preparatory activities in the final 2023 *Transmission Expansion Options Report* and has published the following preparatory activities reports<sup>45</sup>:

- QNI Connect (for both Queensland and New South Wales works)
- Darling Downs REZ expansion (Stage 1)
- Sydney Southern Ring
- Southwest Victoria transmission expansion
- Southeast South Australia transmission expansion
- Mid-North South Australia transmission expansion

In addition to incorporating outcomes of the preparatory activities, AEMO has made several changes to the *Transmission Expansion Options Report* based on submissions received through the consultation process as well as through extensive collaboration and joint planning with TNSPs and jurisdictional bodies. These included:

- All option costs were escalated to be shown in June 2023 dollars. The output of AEMO's Transmission Cost Database gives values in June 2022 dollars so these costs were escalated by the observed consumer price index between these years in the final report.
- Changing all 500 kV line conductors to quad conductor types. There was some inconsistency between 500 kV conductor assumptions in different regions in the draft report.
- The CopperString 500 kV project (Townsville area to Hughenden) is now considered an anticipated project<sup>46</sup>. This option has been removed from the list of potential options and is now just detailed for context.
- SQ-CQ Option 4 (a HVDC option) was changed based on stakeholder feedback. There was a discrepancy in the way the Transmission Cost Estimate was applying costs for this HVDC project. This issue was corrected and the new costs are reflected in the report.
- VNI West Option 5 has been updated to reflect VNI West Option 5A consistent with the VNI West PACR released by AEMO Victoria Planning and Transgrid on 27 May 2023.
- Introduction of new options to increase the transfer capacity from Gippsland to Melbourne (referenced in the report as SEVIC1 group constraint).
- AEMO will no longer refer specifically to the use of phase shifting transformers in project scope, the wording 'Power Flow Control' will be used to be technology agnostic. The high-level cost estimates will continue to assume the cost of a phase shifting transformer, but this is for estimation purposes only. AEMO anticipates that specific equipment options will be considered in detailed as augmentation projects are designed in detail.
- An updated cost estimate for HumeLink was provided by Transgrid in July 2023. AEMO has updated the final 2023 *Transmission Expansion Options Report* to consider this estimate in the AEMO cross-check undertaken

<sup>44</sup> In addition, Transgrid provided a report on the preparatory activities for reinforcing Sydney, Newcastle and Wollongong supply, which were requested in the 2020 ISP. AEMO has published the report for these preparatory activities on the consultation page for the 2023 *Transmission Expansion Options Report*, and has incorporated this preparatory activities information in the final report.

<sup>45</sup> The preparatory activities reports are available on the consultation page for the 2023 *Transmission Expansion Options Report*, at <https://aemo.com.au/consultations/current-and-closed-consultations/2023-transmission-expansion-options-report-consultation>.

<sup>46</sup> As noted in AEMO's July 2023 update to the transmission augmentation information page at <https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/transmission-augmentation-information>.

for estimates for preparatory activities and actionable ISP projects, and AEMO has included the updated cost estimate from Transgrid for the relevant HumeLink option for the uplift of the Southern New South Wales – Central New South Wales flow path for the ISP.

- Some adjustment factors for options have changed to ensure more consistency between regions or sub-regions where appropriate.
- Some small alterations have been made to cost estimates to ensure consistency of treatment across projects and between regions.

All consultation materials and supporting documentation for the 2023 *Transmission Expansion Options Report* are available on AEMO's website. AEMO thanks all stakeholders who have engaged in the consultation process for this report, and looks forward to continuing to consult with industry, consumers and other stakeholders throughout the delivery of the 2024 ISP.



# A1. Abbreviations

Acronym	Term
AACE	Association for the Advancement of Cost Engineering
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AU	Australia
EPC	engineering, procurement and construction
EU	European Union
HVAC	high voltage alternating current
HVDC	high voltage direct current
IASR	<i>Inputs, Assumptions and Scenarios Report</i>
ISP	<i>Integrated System Plan</i>
kV	kilovolt/s
NEM	National Electricity Market
NER	National Electricity Rules
NPV	net present value
ODP	optimal development path
PACR	Project Assessment Conclusions Report
PIAC	Public Interest Advocacy Centre
PST	Phase Shifting Transformer
QCC	Queensland Conservation Council
QNI	Queensland – New South Wales Interconnector
REZ	Renewable energy zone
ODP	Optimal development path
RIT-T	Regulatory Investment Test for Transmission
TNSP	Transmission network service provider
US	United States
VNI	Victoria – New South Wales Interconnector