Consultation Paper – Draft ISP Methodology

April 2021

Consultation Paper

For the Integrated System Plan (ISP)

Important notice

PURPOSE

AEMO publishes the Consultation Paper – Draft ISP Methodology pursuant to National Electricity Rules (NER) 5.22.8(d). This report includes key information and context for the methodology used in AEMO's ISP.

DISCLAIMER

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VERSION CONTROL

Version	Release date	Changes
1.0	30/4/2021	Initial Release

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1. Introduction

The *Integrated System Plan* (ISP) is a whole-of-system plan that provides an integrated roadmap for the efficient development of the National Electricity Market (NEM) over the next 20 years.

AEMO considers that 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 collaborative approach to developing the 2022 ISP.

AEMO has also addressed the requirements of the Australian Energy Regulator's (AER's) Forecasting Best Practice Guidelines and the Cost Benefit Analysis Guidelines (CBA Guidelines) in the development of the ISP Methodology. These requirements include:

- Providing a transparent process.
- Supporting and working with stakeholders in their understanding of AEMO's methodologies.
- Providing additional information to complement the formal documentation.

An initial Issues Paper was the first part of this process in February 2021. Following written submissions received, and a workshop/webinar hosted on 1 April, AEMO is publishing the *Draft ISP Methodology* (in addition to this document), marking the beginning of the second part of this two-stage process (see Figure 1 for more information).

Notice of Consultation: Invitation for written submissions on *Draft ISP Methodology*

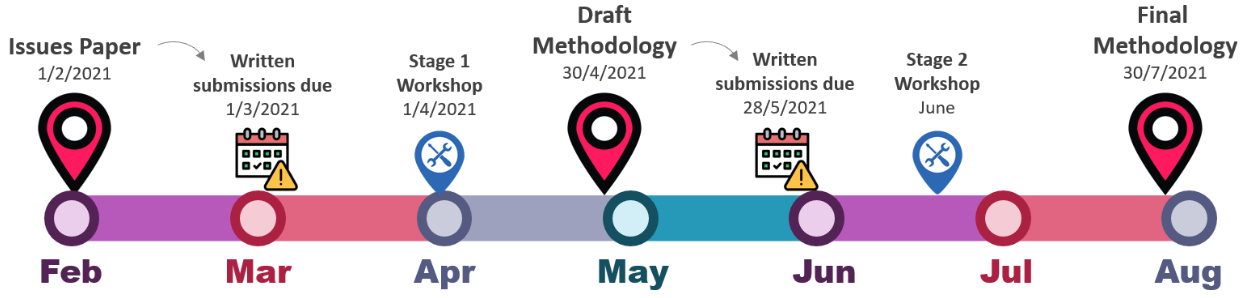
All stakeholders are invited to provide a written submission to any matters discussed within the *Draft ISP Methodology*. Submissions need not address all areas discussed.

Submissions should be sent via email to ISP@aemo.com.au and are required to be submitted by Friday 28 May 2021. All submissions should be provided in PDF format. Please identify any parts of your submission that you wish to remain confidential and explain why.

AEMO requests that, where possible, submissions should provide evidence and information to support any views or claims that are put forward.

The accompanying *Draft ISP Methodology* commences the second stage of the process in the development of the ISP methodology, shown in Figure 1 below. Subsequent stages are summarised as next steps, below the figure.

Figure 1 Timeline for ISP Methodology process



Next steps

AEMO will undertake a review of submissions received on the *Draft ISP Methodology* in June and July 2021, and will hold a workshop or webinar in June 2021 to provide further opportunity for stakeholders to provide views on the *Draft ISP Methodology*. Written submissions to the *Draft ISP Methodology* will inform the scope and approach to engagement in this workshop or webinar.

The *Final ISP Methodology* will be published on 30 July 2021 and will take into account views from all submissions received as part of the two-stage consultation process.

1.1 Purpose of consultation on *Draft ISP methodology*

The consultation process on the *Draft ISP Methodology* aims to provide stakeholders with a full and transparent explanation of the methodologies AEMO proposes to use in the 2022 ISP. By engaging on the proposed methodologies to be used, AEMO is ensuring stakeholders have the opportunity to provide their views on the proposed approach and help shape the final methodologies.

AEMO has published the *Draft ISP Methodology*, which accompanies this consultation paper and sets out the proposed methodologies for:

- **Modelling** – the proposed methodologies for the capacity outlook models, time-sequential model, gas supply model, and engineering assessment.
- **Cost benefit analysis** (CBA) – an overview of AEMO's proposed approach to applying the steps outlined in Section 3.3 of the AER's CBA Guidelines. This section also:
  - Differentiates between scenarios and sensitivities and outlines how each is treated differently in helping inform the determination of the Optimal Development Path (ODP).
  - Discusses the proposed approach to take-one-out-at-a-time (TOOT) analysis, which AEMO is considering to apply to form part of the approach to undertaking CBA.
  - Outlines how AEMO proposes to determine weights for scenarios

The combination of the processes described above leads to the determination of the ODP that optimises benefits to consumers and has a positive net benefit in the most likely scenario.

1.2 Broader ISP processes and consultation

2022 ISP publications to date

The *Draft ISP Methodology* is the fourth major publication in the process to develop the 2022 ISP. AEMO has previously published:

- The ***2022 ISP Timetable*** in October 2020, providing a high-level overview of the key milestones related to the 2022 ISP, and allowing stakeholders to understand and engage in the ISP consultation process.
- The ***Draft Inputs, Assumptions and Scenarios Report*** **(IASR)** in December 2020, proposing the scenarios to be used, as well as detailing current inputs and assumptions in relation to a variety of considerations for use in the 2022 ISP, including the approach for updating current assumptions for use in the proposed scenarios. Before the draft IASR was published, multiple stakeholder engagements had taken place to inform the content, including workshops and webinars. The publication of the draft IASR began a consultation process with stakeholders, which is currently in progress, on these scenarios and their inputs.
- The ***ISP Methodology Issues Paper*** in February 2021, which provided an overview of existing methodologies (used in the 2020 ISP), and information on where these are discussed elsewhere (if applicable), in addition to areas where AEMO is looking to enhance existing methodologies (used in the 2020 ISP) or introduce new methodologies to keep pace with emerging industry developments or align with the CBA.

The publication of the *Draft ISP Methodology* is the next phase of the formal consultation on modelling methods that utilise the inputs and assumptions being consulted in the draft IASR. These methods, and proposed refinements and improvements, are not reliant on individual assumptions or the scenario definitions.

2022 ISP ongoing consultations

Figure 2 below shows the status of the main ISP consultations. Before developing and consulting on the Draft 2022 ISP, AEMO is required to:

- **Consult on inputs, assumptions and scenarios** – AEMO received nearly 50 submissions to the Draft IASR. Following a submission webinar in March 2021, a series of Forecasting Reference Group (FRG) meetings, and a separate consultation on transmission costs, AEMO plans to release the 2021 IASR on 30 July 2021.
- **Consult on the ISP methodology** – after the *ISP Methodology Issues Paper* was published in February 2021, this report marks the second major milestone for the development of an ISP methodology. AEMO plans to release the *Final ISP Methodology* on 30 July 2021.

Figure 2 Parallel ISP consultations

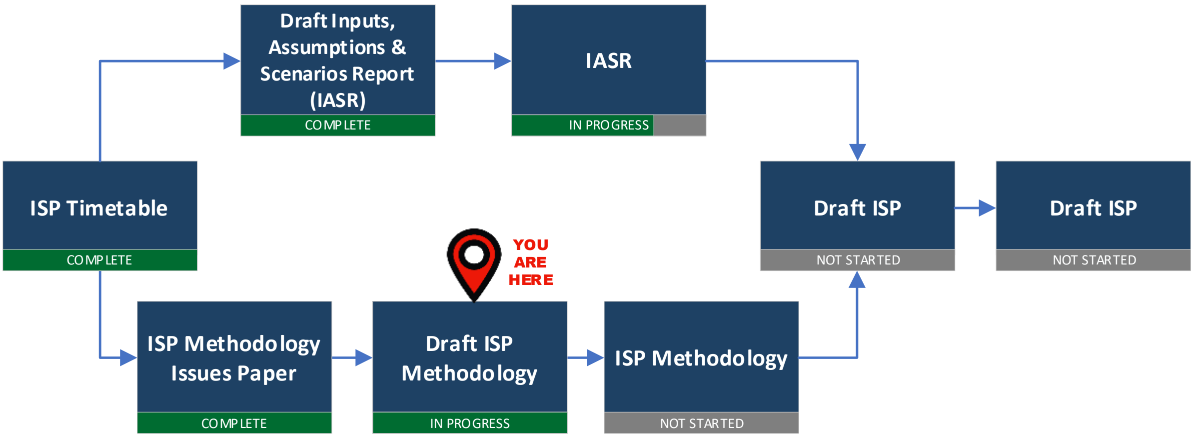
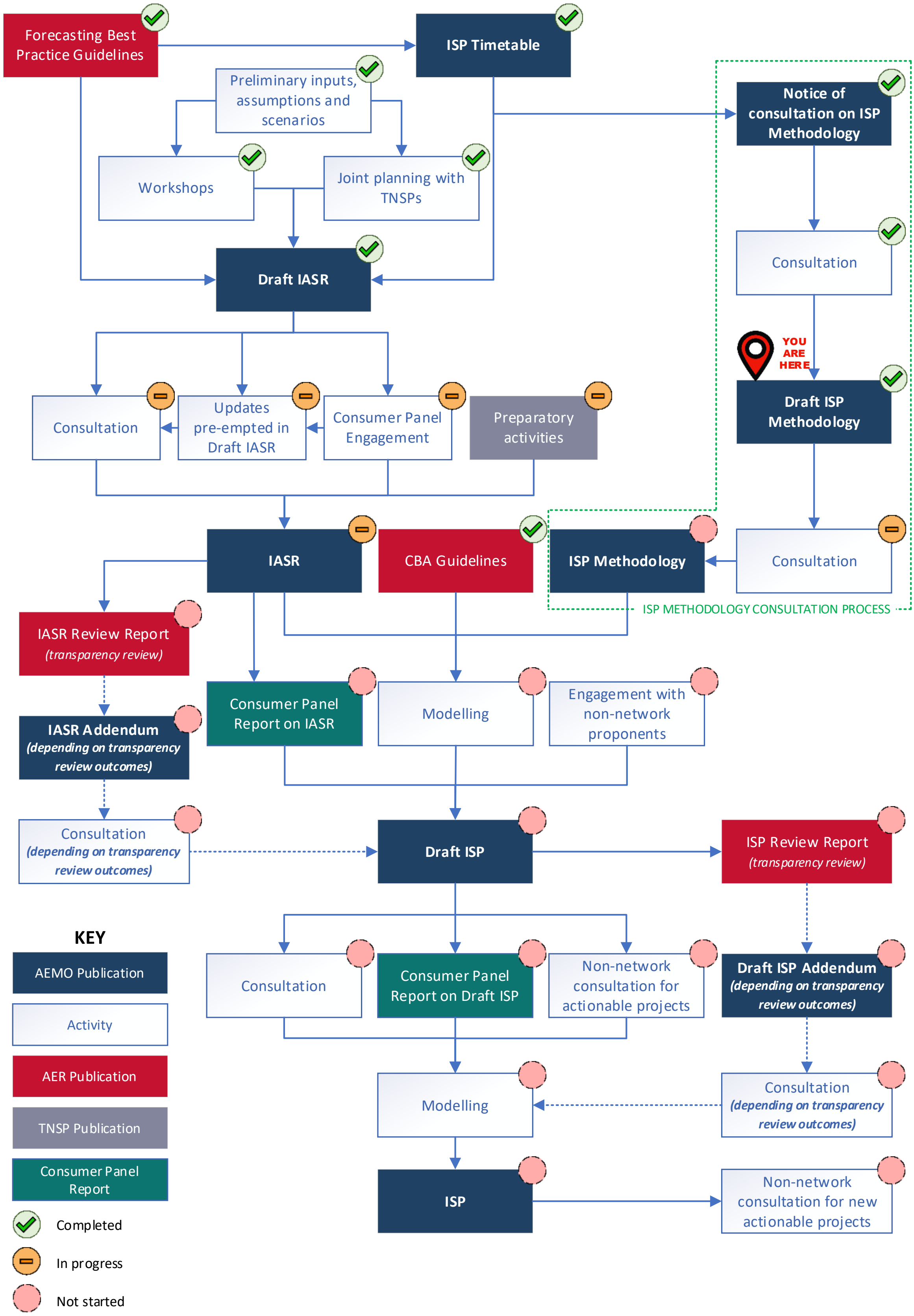


Figure 3 below shows the ISP process as a whole, noting current progress on all elements. The ISP Methodology consultation process is also highlighted within the overall process.

Figure 3 Navigating the ISP process



Supplementary materials

Table 1 below outlines related methodologies and information that will be used in preparing the 2022 ISP. Stakeholders are invited to refer to these documents for further background and context.

Table 1 Related methodologies and procedures

Document	Description	Location
2020-21 Planning and Forecasting Consultation on Inputs, Assumptions and Scenarios	AEMO is currently consulting on the scenarios, inputs and assumptions proposed for use in AEMO's 2021-22 forecasting and planning activities, including the 2022 ISP	https://aemo.com.au/consultations/current-and-closed-consultations/2021-planning-and-forecasting-consultation-on-inputs-assumptions-and-scenarios
Electricity Demand Forecasting Methodology Consultation	AEMO is currently consulting on its Electricity Demand Forecasting Methodology under section 2.1 of the AER's Forecasting Best Practice Guidelines. The Methodology forms part of AEMO's Forecasting Approach.	https://aemo.com.au/en/consultations/current-and-closed-consultations/electricity-demand-forecasting-methodology
2021 GSOO Gas Supply Adequacy Methodology	The *Gas Statement of Opportunities* (GSOO) provides AEMO's forecast of annual gas consumption and maximum gas demand, and reports on the adequacy of eastern and south-eastern Australian gas markets to supply forecast demand over a 20-year outlook period. This document describes the methodology and assumptions used to assess supply adequacy for the 2021 GSOO.	https://aemo.com.au/en/energy-systems/gas/gas-forecasting-and-planning/gas-statement-of-opportunities-gsoo
ESOO and Reliability Forecast Methodology Document	The *Electricity Statement of Opportunities* (ESOO) provides AEMO's forecast of electricity supply adequacy to meet the demands of an evolving consumer demand over a 10-year outlook period. This methodology explains the key supply inputs and methodologies involved in determining the expected unserved energy (USE) outcomes, for the ESOO and reliability forecast. It also explains how the forecast reliability gap and forecast reliability gap period are determined. This methodology provides relevant components that are shared with the ISP, outlined in the *Draft ISP Methodology*.	https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/nem-electricity-statement-of-opportunities-esoo
Engineering Framework	The *Engineering Framework* provides a map to help stakeholders stay informed of the changing technical needs of the power system, the work underway to meet these changing needs, how the different pieces fit together, and how they can engage on topics of interest.	https://aemo.com.au/en/initiatives/major-programs/engineering-framework

2. Summary of feedback

AEMO received feedback from 22 stakeholders during the consultation on the *ISP Methodology Issues Paper*; these stakeholders are listed in Table 2. The submissions are available on AEMO's website. AEMO also undertook a series of face-to-face and online engagements. A verbal feedback session was held with consumer advocates. which provided feedback that was considered by AEMO in the same way as all other written submissions. AEMO would like to thank all who provided feedback throughout this process.

Submissions covered a broad range of issues, providing AEMO with a valuable perspective on stakeholders' collective view of the issues raised in the *ISP Methodology Issues Paper*. While there was comprehensive coverage of issues, there were also common themes, as shown in Table 3 (in Section 2.1).

Table 2 List of stakeholders who provided formal feedback to the Draft ISP

Stakeholder	Form of submission
Australian Council of Social Service (ACOSS)	Consumer advocate feedback session
Canegrowers	Consumer advocate feedback session
Central Irrigation Trust	Consumer advocate feedback session
ElectraNet	Written submission
Energy Networks Australia (ENA)	Written submission
Energy Queensland (EQ)	Written submission
Energy Users Association of Australia (EUAA)	Consumer advocate feedback session
EnergyAustralia (EA)	Written submission
Etrog Consulting	Consumer advocate feedback session
GE Renewable Energy (GE)	Written submission
Havyatt Associates	Consumer advocate feedback session
Hydro Tasmania	Written submission
ISP Consumer Panel (CP)	Written submission
Major Energy Users Inc (MEU)	Written submission and consumer advocate feedback session
MM Technology (MMT)	Written submission
National Irrigators' Council	Consumer advocate feedback session
Origin	Written submission
Public Interest Advocacy Centre (PIAC)	Written submission and consumer advocate feedback session
Queensland Farmers' Federation	Consumer advocate feedback session

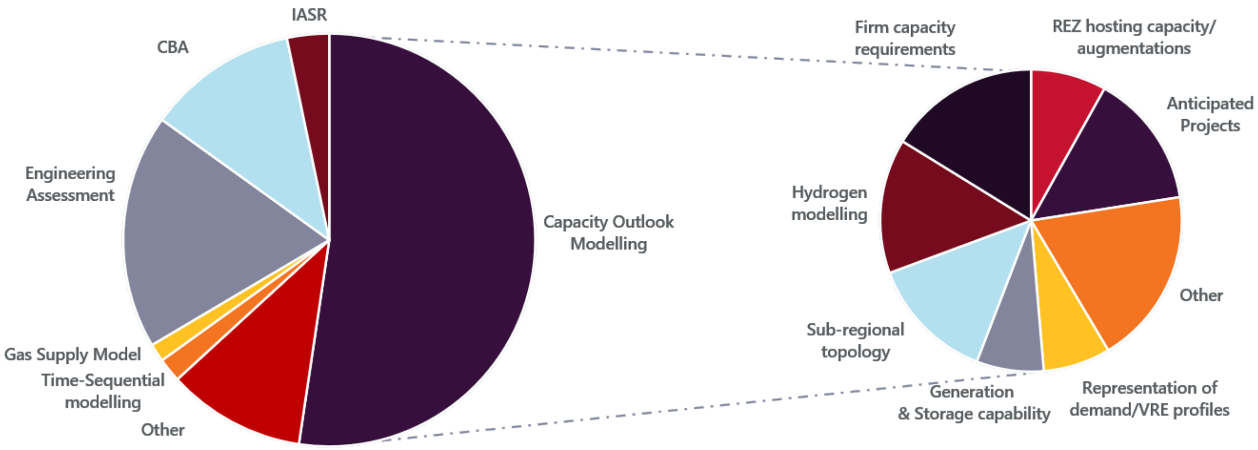
Stakeholder	Form of submission
Shell Energy (Shell)	Written submission
Snowy Hydro	Written submission
TasNetworks	Written submission

Topics of interest

AEMO received feedback from stakeholders on all key areas from the *ISP Methodology Issues Paper*.

Figure 4 shows the topics where stakeholders made comments and recommendations. On the left, the feedback is grouped into the different stages of modelling. The topic where most feedback was received was capacity outlook modelling – this feedback is further divided into subsections on the right, showing that feedback was evenly spread across sub-topics.

Figure 4 Topics of interest



2.1 Summary of key themes

Table 3 provides an overview of the themes that emerged from the written submissions, ordered by level of consensus and frequency of mentions. Detailed analysis is provided in Section 3.

Consensus was measured by analysing the various perspectives put forward by stakeholders under each theme. If over two-thirds of stakeholders generally agreed on the approach, idea or argument, then there is a high consensus. Conversely, if less than a third of stakeholders agreed on an approach, idea, or argument, and noted a variety of differing opinions, then consensus is considered low.

Table 3 Summary of key themes – modelling approach

Theme	Frequency	Consensus
Agreement to move towards a sub-regional approach for the capacity outlook model	6 stakeholders	High
Broad support for the TOOT analysis with some suggestions to expand the scope	5 stakeholders	High
Agreement to simplify the advanced and maturing categories for generation into a single anticipated project category	4 stakeholders	High

Theme	Frequency	Consensus
Economic and environmental factors should be considered when determining coal operation and retirements in the capacity outlook model	4 stakeholders	High
Agreement with the proposed approach to anticipated network projects	2 stakeholders	High
Agreement with the current approach to reserve modelling	2 stakeholders	High
Mixed views on moderating firm contribution factors to peak demand for variable renewable energy (VRE) and storage	7 stakeholders	Medium
Multiple considerations to be undertaken regarding the impact of hydrogen	7 stakeholders	Medium
Agreement to moving towards the use of "soft" land use penalty factors rather than hard limits	6 stakeholders	Medium
Some support for AEMO's decision to maintaining flexibility between the scenario-weighted and least-worst regrets (LWR) approaches	5 stakeholders	Medium
Differing views on whether interconnector losses in the capacity outlook model should be modelled on a regional or sub-regional basis	2 stakeholders	Low

Feedback with high consensus

Agreement to move towards a sub-regional approach for the capacity outlook model

There was broad agreement with the approach to move to a sub-regional approach (EA p.8, Origin p.1, GE p.2, Shell p.3, MEU p.3), with some providing caveats such as concern about potential inefficient investment if gas-powered generation (GPG) was to be restricted from certain locations due to a lack of current gas infrastructure (which was outlined in the *ISP Methodology Issues Paper* as a potential approach to limiting new entrant candidates), views around the sub-region locations requiring more thought, and the view that some end users will provide voluntary load shedding with high prices (MEU p.3).

With regards to concerns raised on the potential for inefficient investment if GPG were to be restricted due to a lack of infrastructure, AEMO applies constraints on new entrant technologies to avoid inefficient investment. For example, to improve model granularity AEMO uses iterative modelling (such as from single-year snapshots – see Section 2.4.4 of the *Draft ISP Methodology*) as much as practical to eliminate candidate development options that are not efficient in that scenario. By filtering out these options, increased model granularity is available to enable the most economically efficient solutions to be identified.

AEMO's proposed approach for determining the locations for sub-regions is based on ensuring, at a minimum, potential capacity options are available where they are likely to be most valuable, for example, in avoiding congestion issues. AEMO has provided additional detail in the *Draft ISP Methodology* on how sub-regional inputs are forecast (see Section 2.3).

The demand side participation (DSP) assumptions which are applied take into account voluntary load shedding.

Broad support for the TOOT analysis with some suggestions to expand the scope

Several submissions provided in principle support for TOOT analysis, with some suggesting it should be extended to include any relevant scenarios for actionable projects, rather than just the Central scenario. Further explanation on how the TOOT analysis would be undertaken was also requested – including whether it would assess alternative options in the counter-factual.

AEMO considers that the primary value of the TOOT analysis would not be served by substituting a next best alternative, but does appreciate the value that exists in sufficient transparency in comparing options. Rather than using TOOT analysis for this purpose, AEMO's CBA methodology will analyse alternative Candidate Development Paths (CDPs) for any major projects that are potentially actionable, with alternative CDPs having smaller and/or non-network alternatives included. Through comparison with the collection of CDPs, the CBA analysis will demonstrate the relative value (or not) of the potential actionable project. Section 5.10 of the *Draft ISP Methodology* provides further detail on how AEMO will provide transparency around the decision-making criteria and choice of the ODP.

Agreement to simplify the advanced and maturing categories for generation projects into a single anticipated project category

Some respondents suggested that the criteria of being defined as Anticipated could be tightened, such as increasing the number of criteria to be met, or some of the criteria being made compulsory.

AEMO proposes to retain the requirement that at least three criteria are met (instead of four criteria) because this is specified in the CBA Guidelines and the Regulatory Investment Test for Transmission (RIT-T). AEMO proposes to exclude projects from the Anticipated category that have not recently submitted a Generation Information survey in the most recent six months, and consider government-awarded funding when determining the commitment status.

Economic and environmental factors should be considered when determining coal operation and retirements in the capacity outlook model

Four submissions were received that relate to the approach to coal operation and retirements, with two stakeholders indicating that this approach should include the consideration of economic and environmental factors that could lead to retirements before the end of technical life. In addition, a separate stakeholder described a number of limitations in AEMO's approach, which they suggested could understate the need for dispatchable capacity in the modelling.

As outlined in the *Draft ISP Methodology* (Section 2.4.1), AEMO's approach to generator retirements does include economic considerations of early generator retirements. AEMO is seeking to take into account the potential for coal retirements based on market outcomes. Any retirement will naturally consider what may be required (and economic) as a replacement.

AEMO acknowledges that there are many complexities and interactions that affect the operation and development of generation in the NEM, such as detailed portfolio dynamics, alternative revenue streams, contract positions, settlement residues and other influences such as the retailer reliability obligation (RRO). However, it is not possible or feasible to include many of these impacts in ISP modelling due to their complexity, the availability of assumptions, or the ability to apply a systematic approach for their inclusion.

Agreement with the proposed approach to anticipated network projects

Two respondents stated they agreed with the proposed approach to determining anticipated projects[1], which would ensure an equivalent level of rigour for generator, network and storage projects.

AEMO agrees that dialogue between AEMO and the proponent is important to understand the status of the project, and AEMO intends to use the project commitment criteria and process described in the CBA Guidelines (and the RIT-T Instrument) to make decisions on whether a network project is highly likely to proceed.

Agreement with the current approach to reserve modelling

There was support for having the minimum capacity reserve levels generally set equal to the size of the largest generating unit and adjusted as needed to meet the reliability standard. Other responses included seeking clarity on how the peak demand duration events will be calculated, and clarity on the interactions between reserve modelling and the sub-regional model.

In response to this feedback, AEMO has clarified in the *Draft ISP Methodology* (Section 2.4.3) that peak demand events are calculated on a seasonal basis and informed by *Electricity Statement of Opportunities*

[1] See p.16 of the *ISP Methodology Issues Paper*, at https://aemo.com.au/-/media/files/stakeholder_consultation/consultations/nem-consultations/2021/isp-methodology/isp-methodology-issues-paper.pdf?la=en.

(ESOO) modelling which indicates the expected average duration of unserved energy (USE) events in a region that is nearly achieving the reliability standard. AEMO has further clarified in the *Draft ISP Methodology* (Section 2.4.3) that regional reserves are allocated to the sub-region that contains the regional reference node (RRN), with no reserve required in other sub-regions.

Feedback with some consensus

Mixed views on moderating firm contribution factors to peak demand for VRE and storage

In ensuring sufficient capacity exists to meet reliability requirements, some respondents expressed support for moderating firm contribution factors to peak demand for VRE, including the suggestion that this should also apply for behind-the-meter storage and virtual power plants (VPPs), while others disagreed with the proposed approach. Other considerations included concern over the use of the 85th percentile level of outputs as the relevant contribution to peak level.

AEMO has incorporated the suggestion to apply the proposed approach to behind-the-meter storage and Virtual Power Plants. With regards to VRE, as outlined in the *Draft ISP Methodology* (Section 2.4.3) AEMO is not proposing to continue with the 85th percentile approach.

Regarding storage, suggestions included incorporating uncertainties such as simulating with a longer and shorter foresight window to account for the impacts of sudden demand and VRE changes, as well as consideration of the role storage can play in providing predictable load.

AEMO acknowledges that its proposed approach is an imperfect solution, but does not currently consider that there is a better approach for the consideration of forecasting uncertainty within the least-cost optimisations. The role of storages in managing minimum load is considered in the optimisation which allows storage to charge during these periods.

Further, AEMO recognises that its time-sequential models incorporate some level of assumption of perfect foresight of future inputs such as demand and VRE output, at least for each day in the simulation, with more limited information provided about future days, depending on the model type. This means, for example, that storage operation and generator ramping and starts are correlated to system needs (such as need for additional energy/capacity for sudden drops in VRE production, or generator outages). From a reliability perspective, this means that the level of USE is minimised to the extent possible given the physical capabilities of generators and storages, and thus the solutions are optimised to the extent possible.

Multiple considerations to be undertaken regarding the impact of hydrogen

A variety of suggestions for amendments to the proposed approach to modelling hydrogen electrolyser uptake and operation were submitted, including suggestions such as locating hydrogen production facilities at retiring power station sites, and focusing on blue hydrogen production initially. Other respondents sought further clarification on the weighting to be given to the Export Superpower scenario.

The proposal to locate hydrogen production facilities at power stations sites has merit, and is something AEMO will consider for subsequent ISPs. AEMO's focus on green hydrogen is to maximise the value of the scenario by exploring the most impactful outcome, where hydrogen production requires complementary investments in generation, storage and/or transmission to produce hydrogen with the lowest carbon footprint. AEMO's proposed approach is detailed in (Section 2.5) of the *Draft ISP Methodology*.

AEMO is intending to consult on the scenario weighting later in 2021 as more information becomes available that could inform views on the relatively likelihood of scenarios.

Agreement to moving towards the use of "soft" land use penalty factors rather than hard limits

Feedback generally supported the penalty factor approach with soft land use limits, including the suggestion this should include the loss of productive output associated with the conversion of the land from its traditional use. Other responses included a recommendation to ensure an efficient level of network congestion and generation curtailment would be achieved by considering costs of additional network capacity and the impact of curtailed generation

AEMO proposes to include a soft limit and penalty factor for REZ resource limits, and to improve the approach to calculating network hosting capacity including a suitable level of curtailment and the wind and storage benefits associated with it. The *Draft ISP Methodology* provides more detail (Section 2.3.4).

Some support for AEMO's decision to maintaining flexibility between the scenario weighted approach and other alternatives (such as the least-worst regrets [LWR] approach)

Several submissions provided views on the relative merits of the two assessment methods for determining the optimal development plan that were proposed in the issues paper, and that were applied in the 2020 ISP.

AEMO is intending on using both approaches, including an expansion to the LWR approach, as outlined in Section 5 of the *Draft ISP Methodology*. The draft CBA methodology includes further analysis to identify an ODP that performs strongly across all assessments as a means of determining a robust ODP.

Feedback with low consensus

Differing views on whether interconnector losses in the capacity outlook model should be modelled on a regional or sub-regional basis

Respondents provided differing views on whether this should be calculated at a regional or sub-regional level.

AEMO proposes to maintain a regional approach to modelling losses because it provides a reasonable representation of losses in the transmission network, and sub-regional augmentations can still impact those loss equations, and modelling losses between existing regions is consistent with the published Forward-Looking Transmission Loss Factors methodology. See Section 2.3.6 of the *Draft ISP Methodology* for more information on AEMO's proposed approach.

2.2 Themes from the *Draft ISP Methodology* webinar

An open stakeholder webinar was held on 1 April regarding the *Draft ISP Methodology*. Attendance was above 80 throughout the event and peaked at 94 attendees. The recording of the webinar is available on AEMO's website[2].

The webinar was advertised to stakeholders as comprising:

- An overview of the common themes in written submissions received to the *ISP Methodology Issues Paper*, including some guidance about AEMO's current intentions and considerations in relation to each issue.
- An overview of the likely elements of the *Draft ISP Methodology*.

Each element included significant allowance for stakeholder comment and questions. Fourteen stakeholders made comments, through both web-based chat functionality and verbal discussion.

Attendees did not vocalise any issue with AEMO's characterisation of the range of feedback received in written submissions. The key areas of additional comment in the webinar were:

- The need for the *Draft ISP Methodology* to outline how the scenario weighting will be calculated.
- The expectation that the ISP seek to determine the lowest cost outcome to deliver electricity to consumers.
- Whether AEMO has considered the impact of the introduction of five-minute settlement of the wholesale electricity market on market dispatch outcomes.

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[2] At https://aemo.com.au/-/media/images/videos/2021/isp-methodology-webinar.mp4.

- A request for AEMO to consider the available offshore wind resources that exist in close proximity to coal-fired power stations (and where spare network capacity may exist once these stations close).
- The importance of additional transmission investment to allow the NEM to accommodate additional VRE.
- Whether the ISP's TOOT analysis will include a replacement or alternative lower cost option (see Section 3.5.8.

The majority of these comments replicate or support similar points made in written submissions, so it is not possible to readily identify changes to the methodology that are directly attributable to comments made in the webinar. However, the inclusion of a method in the *Draft ISP Methodology* (see Section 5.7.2) for how the scenario weighting will be determined addresses comments made in the webinar.

3. Discussion of submissions

This section presents material issues raised by stakeholders and AEMO's response to each issue.

3.1 Capacity outlook modelling

3.1.1 Anticipated generation projects

All respondents agreed with the proposal to simplify the advanced and maturing categories currently in the Generation Information publication into a single anticipated project category, as described in Section 2.2.2 of the *ISP Methodology Issues Paper* (EA p.4, MMT p.2, Shell p.2, ElectraNet p.1).

Some respondents suggested that the criteria of being defined as anticipated could be tightened (EA p.4, ElectraNet p.2):

- EA suggested four of the five criteria should be met, with the finance criteria being compulsory (EA p.4).
- ElectraNet suggested using a "progressing" threshold such that proponents must have participated in the generator information survey in the last six months to be classified as anticipated. In addition, they suggested further information be sought on steps taken for proponents to demonstrate their sufficient level of progression. (ElectraNet p.1)

Other comments suggested that government-awarded funding should be considered when determining the commitment status, but appropriate reservations on the influence this has on the project status should be made (EA p.4, MMT p.2).

AEMO's response

AEMO acknowledges the need to ensure the definition of anticipated projects is sufficiently stringent such that only projects likely to proceed are included. AEMO proposes to retain the requirement that at least three criteria are met (instead of four criteria), as specified in the CBA Guidelines and the RIT-T.

AEMO considers that evaluation of answers to qualitative questions (such as open-ended questions about what steps have been taken to demonstrate progress) would introduce some process ambiguity and be resource-intensive. AEMO agrees to exclude projects from the anticipated category that have not submitted a Generation Information survey in the previous six months, as an indicator of whether a project is actively progressing.

AEMO proposes to consider government-awarded funding when determining the commitment status (and in particular the achievement of progressing the 'finance' commitment category), having appropriate regard to the influence government-awarded funding has on the likelihood of the project proceeding.

3.1.2 Anticipated network projects

Two respondents stated they agreed with the proposed approach to determining anticipated projects, which would ensure an equivalent level of rigour with generator, network, or storage projects (ElectraNet p.2), but stressing the need for a two-way dialogue between AEMO and the proponent (MMT p.2).

Shell said the *Draft ISP Methodology* should define what is meant by "highly likely to proceed".

The Consumer Panel noted that the question outlined in the Issues Paper, "Do you agree with AEMO's approach to determining anticipated network projects for the ISP?", is difficult to answer without specific examples.

AEMO's response

AEMO agrees that dialogue between AEMO and the proponent is important to understand the status of the project.

AEMO intends to use the project commitment criteria and process described in the CBA Guidelines (and the RIT-T Instrument) to make decisions on whether a network project is highly likely to proceed.

The *Draft ISP Methodology* provides the detail regarding this approach, in Section 2.3.8.

3.1.3 Seasonal ratings

There were varied responses to the proposed approach to seasonal ratings (described in Section 2.2.2. of the *ISP Methodology Issues Paper*) which includes the application of a "typical" summer rating in addition to the 10% probability of exceedance (POE) summer and winter ratings. Some stakeholders supported the proposed approach (ENA p.3), whereas others suggested a need to consider capacity factors with renewables rather than just total available generator capacity (MMT p.3), and requested further transparency around the difference between the 10% POE summer derating and typical summer rating, as well as the temperature and demand thresholds are that switch between the ratings (EA p.7/8).

AEMO's response

AEMO agrees with MMT that total generating capacity alone is not sufficient to capture expected VRE generation, but the actual contribution of VRE is captured in half-hourly production traces

With regards to the additional clarity requested by EA, AEMO has provided further explanation in the *Draft ISP Methodology* (see Section 2.3.7), and notes the description of seasonal ratings and the temperature thresholds applied are consistent with the approach consulted on for reliability forecasting applied within the ESOO.

3.1.4 Reserve modelling

Responses to the proposed approach to reserve modelling included support for having the minimum capacity reserve levels generally set equal to the size of the largest generating unit and adjusting as needed to meet the reliability standard (Shell p.2,3), requesting clarity on how the peak demand duration events will be calculated (Shell p.4), consideration of generator forced outages (MEU p.2), and the role of DSP when assessing peak demand (MEU p.3)

Further clarity was also requested on the interactions between reserve modelling and the sub-regional model (Shell p.3).

AEMO's response

AEMO welcomes the comments provided and has taken steps to clarify processes to address these points.

AEMO has clarified in the *Draft ISP Methodology* (see Section 2.4.3) that the approach described by Shell is followed in AEMO's process. Peak demand events are calculated on a seasonal basis, and informed by ESOO modelling, which indicates the expected average duration of USE events in a region that is nearly achieving the reliability standard. The assumptions on forced outages are part of the IASR development process and will be consulted on in the June FRG, prior to publication of the Final IASR.

AEMO confirms that it considers the role of DSP in meeting peak demand, but as part of the IASR development process rather than the ISP Methodology consultation process. For more information on this, please refer to the IASR consultation[3].

AEMO has further clarified in the *Draft ISP Methodology* that regional reserves are allocated to the sub-region that contains the RRN, with no reserve required in other sub-regions (but with sub-regions contributing to their regional reserve requirement subject to intra-regional transmission capabilities). Reliability continues to be assessed at a regional level in time-sequential modelling.

3.1.5 Firm contribution factors for VRE and storage

Responses for this topic included support for moderating firm contribution factors to peak demand for VRE (EA p.10) and storage (EA p.10, Snowy Hydro p.2), and the view that this should also apply for behind-the-meter storage and VPPs (EA p.10). Submissions also provided some disagreement with the proposed approach, suggesting instead having a defined time period that is, in the new market, "time slot" bids have to be for both capacity and a time period of availability) (MMT p.3).

TasNetworks suggested reconsidering contribution factors once interconnectors are commissioned (TasNetworks p.2). Snowy Hydro discussed other factors such as predictability, capacity over time, location, and the ability of the resource to match load (Snowy Hydro p.2). Shell suggested matching historical traces for regional system demand and actual calculated VRE output (Shell p.3).

Origin posed the option of a monthly renewable capacity outlook or a derating on renewable capacity based on projections of delivered energy adjusted for longer commissioning times (Origin p.1). Shell and MEU noted concern over the use of the 85th percentile level of outputs (Shell p.3, MEU p.2).

Specifically on storage, TasNetworks suggested better incorporating uncertainties for storage devices. (TasNetworks p.2). Hydro Tasmania took a view that running scenarios with a longer and shorter foresight window to account for the impacts of sudden demand and VRE changes would be a positive development (Hydro Tasmania p.3). GE argued for further consideration of the role storage can play in providing predictable load (GE p.1,2). Snowy Hydro suggested further consideration of the New South Wales Infrastructure Roadmap and how it relates to storage (Snowy Hydro p.2).

EA and Shell sought further information on the operational limits used to reflect technical constraints in the models (EA p.7, Shell p.2).

AEMO's response

AEMO thanks EA for the suggestion to apply the proposed approach to behind-the-meter storage and VPPs and has incorporated this into the approach described in the *Draft ISP Methodology* (see Section 2.4.3).

AEMO's proposed approach is an attempt to reflect the contribution of storage during specified time slots. The modelling requires a single seasonal value as a proxy for a full reliability assessment, and it is unclear how a timeslot could be used for this approach. The actual capability and operation of storage is then considered in the full optimisation, which considers more than just the reserve requirements to satisfy reliability criteria. Further analysis of the role of storage in providing flexibility over different timeframes such as consecutive hot days is part of the full optimisation in the capacity outlook and time-sequential models.

AEMO acknowledges that the proposed methodology for applying assumptions regarding an assumed degree of foresight is an imperfect solution, but does not currently consider that there is a reasonable alternative approach for the consideration of forecasting uncertainty within the least-cost optimisations. The role of storages in managing minimum load is considered in the optimisation which allows storage to charge during these periods.

AEMO will seek to determine an optimised development of storage that meets the objective in the New South Wales Infrastructure Roadmap.

[3] At https://aemo.com.au/consultations/current-and-closed-consultations/2021-planning-and-forecasting-consultation-on-inputs-assumptions-and-scenarios.

Incorporating the impact of the contribution from VRE in other regions to reliability in a given region is challenging, however the approach does consider the potential to share excess reserves between regions. In essence, the method proposed uses an approach which matches demand and VRE output. However, this needs to be distilled into a single contribution as a percentage of capacity that can be applied in the firm capacity calculation. The development of VRE is an output of the model which is an annual decision within the model, and therefore assuming some form of commissioning profile beyond the applied build limits is not feasible. This development uncertainty is likely more important for short-term considerations such as in reliability forecasting.

As outlined in Section 2.4.3 of the *Draft ISP Methodology*, AEMO is not proposing to continue with the 85th percentile approach.

AEMO has provided further detail in the *Draft ISP Methodology* (see Section 2.4.7) to clarify the approach of operational limits.

3.1.6 Plant operation and retirements

Some respondents provided views on how the capacity outlook model should consider coal operation and retirements. These included consideration of economic and environmental factors (TasNetworks p.1, 2 and MEU p.2) that could lead to earlier than assumed retirements (MMT p.1).

EA noted multiple model limitations which understated the need for dispatchable capacity and placed a heavy reliance on pumped hydro energy storage (PHES), including limited consideration of externalities such as the RRO or contract markets, and a lack of consideration of ancillary service requirements and spot price outcomes (EA p.5, 6).

AEMO's response

AEMO's approach to generator retirements includes economic considerations to account for the potential for coal retirements based on revenue sufficiency outcomes. Any projected retirement will also consider what may be required as a replacement.

As noted in the previous section, AEMO acknowledges that there are many complexities and interactions that affect the operation and development of generation in the NEM, which include considerations such as contract markets. As a consequence, it is not possible to include all factors in ISP modelling at this time.

For example, the impact of financial considerations such as system restart ancillary services (SRAS), contract markets, and the interaction with the RRO, and the role of generation and storage within portfolios, are extremely complex and beyond the scope of what can be considered in this analysis. AEMO will endeavour to incorporate spot price outcomes in the determination of economic coal closures, but the other considerations are beyond what can currently be considered in the ISP.

AEMO also acknowledges that ancillary service requirements and potential revenue from new system services are a potential factor, but are not able to be incorporated at this time. Furthermore, the impact of the interim reliability measure is not required to be met in the ISP modelling, which remains focused on the reliability standard. The firmness of the interconnectors will be assessed on a physical basis rather than from a financial perspective.

3.1.7 Sub-regional topology

There was broad agreement with the proposal to move to a sub-regional capacity-outlook modelling approach (EA p.8, Origin p.1, GE p.2, Shell p.3, MEU p.3).

Feedback on the sub-regional structure generally included:

- Ensuring the appropriate balance between computational complexity and accuracy (EA p.8).
- Concern that the move to sub-regions might reduce the granularity in regions that have not changed (Hydro Tasmania p.3).

Feedback on the development of sub-regional inputs included:

- Confirmation of the reconciliation between sub-regional and regional demand forecasts (Shell p.3, Hydro Tasmania p.5) and loss factors (MEU p.3).
- Appropriate consideration of peak demand potential occurring at different times in the sub-regions (MEU p.3).
- Seeking further granularity on the approach for forecasting sub-regional inputs (Origin p.1).
- Considering the interaction with necessary changes to the load/VRE/distributed energy resources (DER) chronology assumptions (EA p.8).
- Views around the sub-region locations requiring more thought and the view that some end users will provide voluntary load shedding with high prices (MEU p.3).
- A proposal to consider quarters as an interval to improve the representation of network transfer limits at times of peak demand (EA p.8).
- More consideration in the *Draft ISP Methodology* of the potential for generator runback or tripping schemes, energy storage, or dynamic reactive support to enhance network transfer capability (Shell p.6).
- A recommendation for using monthly or seasonal day and night limits, and for summer applying 10% POE and typical summer temperature value similar to how thermal limits are applied (Shell p.4).

Additional stakeholder considerations included:

- Noting some concern about potential inefficient investment if GPG is restricted due to a lack of infrastructure (Shell p.4).
- Consideration of thermal and storage development and intra-regional transfer capacity (MEU p.3).
- The modelling should forecast and incorporate clamping events so as not to overestimate the benefits of increased interconnection (Origin p.1).

AEMO's response

Sub-regional structure

AEMO has proposed a sub-regional structure that maximises the value of increased granularity and model transparency on key sub-regional influences without needing to significantly reduce complexity or granularity in other areas. The topology reflects potential emerging intra-regional transmission limitations, and this may evolve over time as conditions change.

Sub-regional inputs

AEMO has provided additional detail in the *Draft ISP Methodology* (see Section 2.3.2) on how sub-regional inputs are forecast. AEMO can confirm that the sub-regional demand traces are based on the regional demand traces, and when aggregated, exactly match regional demand. The sub-regional demands are informed by connection point data but cannot be built entirely from connection point forecasts as AEMO's connection point forecasting approach does not extend for the entire ISP horizon. Any USE is calculated at a regional level. Reserves are also specified for each region, but take into account sub-regional transfer limits.

Sub-regional inputs will be detailed within AEMO's Final IASR. The *Draft ISP Methodology* provides clarity on how the inputs are included in the ISP modelling. AEMO's approach for sub-regional load accounts for the varying uptake of DER across different sub-regions, and this will be detailed in AEMO's Final IASR.

With regards to load shedding, the *Draft ISP Methodology* provides more detail on the DSP assumptions, which take into account the voluntary load shedding (see Section 2.3.7).

AEMO's objective in the specification of network limits is to best represent physical capabilities, particularly understanding how this might vary at times of extreme peak compared to more typical conditions. This is separate to any consideration of financial contracts.

AEMO ensures that an extensive set of network and non-network options are available in the ISP project list for selection, including high voltage direct current (HVDC), high voltage alternating current (HVAC), and virtual transmission lines. Each option is often a combination of several augmentations, including special protection schemes and appropriate dynamic reactive support. Furthermore, a level of runback schemes for generators is considered in each renewable energy zone (REZ) when developing REZ network expansion options.

It is important that transmission limits between sub-regions are representative of the network capability. AEMO has considered suggestions to determine network capacity seasonally, quarterly, based on time-of-day, and during peak or off-peak conditions. All these options are improvements on the previous static approach. Based on this feedback, and discussions with proponents, AEMO proposes to align the conditions used to assess network capacity with the conditions used to assess generation capacity (that is, summer peak, summer typical, and non-summer typical). Reference temperatures to be applied to these conditions are sourced from the *ESOO and Reliability Forecast Methodology*[4].

Other considerations

With regards to concerns raised on the potential for inefficient investment if GPG were to be restricted due to a lack of infrastructure, AEMO applies constraints on new entrant technologies to avoid inefficient investment. For example, to improve model granularity AEMO uses iterative modelling (such as from single-year snapshots – see Section 2.4.4 of the *Draft ISP Methodology*) as much as possible to eliminate candidate development options that are not efficient in that scenario. By filtering out these options, increased model granularity is available to enable the most economically efficient solutions to be identified.

In considering intra-regional limitations more directly within the capacity outlook model, the new approach allows for a more complete consideration of the interactions between the development of generation and/or storage development and intra-regional transmission capacity.

While AEMO's long-term models are not currently capable of considering clamping effects, if needed, AEMO will consider the potential for clamping as a qualitative assessment.

3.1.8 Interconnector losses

Stakeholder responses to the proposed approach regarding transmission losses stated interconnector losses should reflect the existing regional Forward-Looking Transmission Loss Factors (FLLF) methodology and be based on power system modelling of new transmission projects (EA p.8). Differing views were provided on whether this should be calculated a regional or sub-regional level (EA p.8, MEU p.3).

AEMO's response

AEMO proposes to maintain a regional approach to modelling losses (i.e. losses are calculated between regional reference nodes and generator MLFs are referenced to the RRN), for the following reasons:

- An inter-regional loss representation provides a reasonable representation of losses in the transmission network, and sub-regional augmentations can still influence those loss equations.
- Modelling losses between existing regions is consistent with the published FLLF methodology[5], so this approach is consistent with how losses are presently accounted for in the NEM.

3.1.9 Hydrogen methodologies

A variety of amendments to the proposed approach in the *ISP Methodology Issues Paper* were suggested by stakeholders, including use of a separate optimisation model to determine hydrogen demand and location (Origin p.1), locating hydrogen production facilities at retiring power station sites (MMT p.4), focusing firstly

[4] At https://www.aemo.com.au/-/media/files/electricity/nem/planning_and_forecasting/nem_esoo/2020/esoo-and-reliability-forecast-methodology-document.pdf?la=en.

[5] See AEMO, *Forward-Looking Transmission Loss Factors*, December 2020, at https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/loss_factors_and_regional_boundaries/forward-looking-loss-factor-methodology.pdf.

on hydrogen as a renewable storage medium and less so as an export, along with blue hydrogen which is cheaper to produce (MMT p.5), and modifying the capacity adequacy model to include hydrogen electrolyser capacity (Shell p.5).

Respondents also sought further clarification on areas such as the methodology used to determine the location and size of electrolyser plants, including suggestions that adding hydrogen to natural gas in blended pipelines may lead to pipeline embrittlement, a need for pressure reduction, and a reduction of transport capacity of the pipeline (TasNetworks p.2, Consumer Panel p.6, MEU p.3).

Some stakeholders noted that appropriate weighting should be given to the Export Superpower scenario (EA p.10, Shell p.6), cautioned against over-reliance on hydrogen demand as an exogenous input (TasNetworks p.2), and requested further information on how water and transport are considered in the modelling (CP p.6).

AEMO's response

AEMO's more detailed methodology regarding hydrogen's inclusion in the ISP is provided in the *Draft ISP Methodology* (see Section 2.5).

The proposed approach provides a balance in determining the scale and location of hydrogen production. The scale of demand is exogenous, and capacity of installed electrolysers is optimised. AEMO is considering placement of electrolysers next to ports or RRNs; this will require REZ and network developments that can appropriately service these new large electrical loads. The proposal to locate at power station sites has merit, and is something AEMO will consider for subsequent ISPs.

AEMO assumes that for storage via linepack, hydrogen could only be stored in distribution pipelines, which are low pressure.

A focus on green hydrogen production has been taken so the scenario is able to explore the most impactful outcome. In response to the comment on hydrogen as a renewable storage medium, this is captured to some degree through the way hydrogen demand is specified as flexible within monthly periods, as described in Section 2.5.2 of the *Draft ISP Methodology*.

AEMO is intending to consult on the scenario weightings later in 2021 (see Section 3.5.5) as more information becomes available that could inform views on the relatively likelihood of scenarios.

Water and transport locations are considered by limiting the number of possible hydrogen production locations to either the RRNs or the ports.

3.1.10 Other general comments on the capacity outlook model

Three respondents requested clarity/sought amendments to the interactions between the models. Specifically:

- EA requested clarity on the settings in the three variants of the capacity outlook model and what gets passed between them, and how they reconcile with the separate Integrated Model (IM) and Detailed Long-Term (DLT) model, as well as suggesting further exploration of the rolling reference years methodology, as EA considers this a potentially material influence. EA also sought clarity on the objective function for determining the most cost-effective trajectory for generation, storage, network investments, and retirement (EA p.7, 9).
- TasNetworks suggested combining the capacity outlook and time-sequential models when considering firm capacity requirements to better capture firm contribution between VRE generation, transmission requirements and the need for dispatchable capacity (TasNetworks p.2).
- Shell requested more detail on how the capacity outlook model operates, how approximations of time-sequential data are undertaken in the models, and how rounding from linearised build decisions for generation leads to a final decision on the selection of generation build. (Shell p.2).

More broadly, stakeholders sought further explanation on capacity expansion modelling. EA requested 'deep dive' sessions with stakeholders on a number of topics (EA p.7, 8):

- Further clarity on understanding load chronology assumptions (sampling versus fitted).
- VRE generation and DER participation profiles, chronology assumptions and how they represented and simplified, and whether any correlation to demand is maintained.
- Clarification on linearised transmission augmentations, how this is defined and reported on.
- Explanation of how the capacity expansion firm capacities for plant are adjusted for effective full forced outage rate).

Shell suggested that the linearised expansion model (REZ or other network expansion models) should factor considerations such as whether initial capacity of existing lines are considered for rebuilds, or whether the meshed network failing to deliver its nominal ratings is considered, and that it should be location-specific (Shell p.6).

AEMO's response

AEMO has provided further details in the *Draft ISP Methodology* on all the clarification requested here.

- The Single-Stage Long-Term (SSLT) model effectively replaces the IM that was used in the 2020 ISP (see Section 2.2 of the *Draft ISP Methodology*). AEMO continues to explore ways in which the capacity outlook modelling and time-sequential modelling can be better aligned, and combined where possible.
- AEMO has previously tested alternative rolling reference year starting points and found that they were not materially influencing outcomes. AEMO considers that not considering different weather patterns is not appropriate, and is therefore seeking feedback on any alternative approaches, or in understanding what approach could be taken if the choice of sequence is significant. AEMO will conduct further testing on this as part of the ISP, as detailed in Section 2.3.5 of the *Draft ISP Methodology*.
- The objective function used is to minimise the discounted total cost within each simulation, where the 'total system cost' includes capital expenditure for new generators, fixed operation and maintenance costs, variable operation and maintenance costs, rehabilitation costs due to generator retirements, fuel costs, costs of USE and DSP, and costs of network development (inter and intra-regional augmentations). Alternative transmission development paths are compared through comparing individual simulations, using the approach described in the CBA section of the *Draft ISP Methodology* (see Section 5).

AEMO will consider appropriate levels of stakeholder engagement on modelling approaches after the release of the *Draft ISP Methodology*, and will assess whether the methodology provides the improved clarity on the methods used and the approach to model interactions that EA has requested from the *ISP Methodology Issues Paper*.

AEMO has provided further detail on the load chronology assumptions in the *Draft ISP Methodology* (see Section 2.4.2). AEMO has clarified in the *Draft ISP Methodology* that the correlation of VRE and DER profiles is conserved through the methodology applied for load chronology. Additional clarification on the intergerisation of linearised decisions has been added in the *Draft ISP Methodology* (see Section 2.4.6).

AEMO has provided further explanation of the REZ expansion process, including detailing the intra-regional augmentation study and option methodology, which includes consideration of load chronology assumptions (sampling versus fitted), VRE generation and DER participation profiles and chronology assumptions, how they are represented and simplified, whether correlation to demand is maintained, how linearised transmission augmentations are defined and reported on, and how the capacity expansion firm capacities for plant are adjusted for effective full forced outage rate (see Section 2.3.4 of the *Draft ISP Methodology*). Further breakdown of the range of transmission projects and costs associated with REZ network expansion will also be provided as part of the Transmission Cost Report demonstrating how these aspects are considered as part of the REZ expansion augmentation options.

AEMO has clarified the approach to firm capacity in that the seasonal capacities are multiplied by one minus the effective forced outage rate (EFOR) (see Section 2.3.7 of the *Draft ISP Methodology*).

3.2 Time-sequential model

3.2.1 Deep dive sessions

EA suggested AEMO could undertake 'deep dives' of how AEMO's time-sequential modelling accommodates the decisions of plant owners in terms of short run marginal cost (SRMC) and other bidding approaches, unit commitments, intertemporal constraints, and other complex validations (EA p.12).

AEMO's response

AEMO will engage further on modelling approaches after the release of the *Draft ISP Methodology*, which seeks to provide greater clarity on the methods used and the approach to model interactions.

3.2.2 Changes in reserve margins

In the consumer advocacy forum, Havyatt Associates suggested investments should be tested through time-sequential market modelling, given changes in reserve margins depend on the reliability outcomes being pursued (CA, p5).

AEMO's response

AEMO has clarified in the *Draft ISP Methodology* how time-sequential modelling is used to refine the reserve margin assumptions (see *Draft ISP Methodology*, Section 2.4.3).

3.3 Gas Supply Model

The ISP Consumer Panel took the view that the model seems simplistic, and queried how the model assesses the costs of a transmission augmentation to supply a gas shortfall, and how a net present value (NPV) analysis could be completed without this cost information (CP p.11).

Shell took the view that co-optimisation between gas and electricity is required to appropriately assess the trade-off between the two (Shell p.4).

AEMO's response

AEMO understands that, ideally, electricity and gas systems would be co-optimised. However, the computational complexity added by a co-optimisation approach would require significant simplification to be made of both markets, which would impact the ability to appropriately model key elements in the electricity systems such as VRE variability and storage chronology.

Due to this, AEMO no longer includes the Gas Supply Model as a core component of the ISP Methodology. The methodology for the gas adequacy assessment performed for the *Gas Statement of Opportunities* (GSOO) is contained with the GSOO's supporting methodologies. The *Draft ISP Methodology* now reflects that the gas supply model may be deployed (using this GSOO methodology) to validate the assumptions and impact regarding adequacy of gas infrastructure using the outcomes of the capacity outlook and time-sequential models.

3.4 Engineering Assessment

3.4.1 REZ methodologies

On the methodologies proposed for REZs, there were multiple responses:

- GE and Shell supported the penalty factor approach with soft land use limits (GE p.3); Shell suggested this should include the loss of productive output associated with the conversion of the land from its traditional use (Shell p.5).

- PIAC recommended that the methodology aim to develop an efficient level of network congestion and generation curtailment through the consideration of costs of additional network capacity, the impact of curtailed generation, and the alternatives options to curtailment, when considering network limits (PIAC p.2).
- ElectraNet proposed a specific formula to capture the relationship between the depth of storage and its ability to contribute to network congestion. ElectraNet also proposed constraints that model the impact of wind and solar diversity and local storage on transmission requirements (ElectraNet p.2).
- Regarding resource limits, Hydro Tasmania argued precedence should be given to real identified projects over generic modelled generation development options and proposed threshold tests (Hydro Tasmania p.7).

MEU argued the costs of networks to serve REZs should increase with capacity to the power 0.7, rather than linearly (MEU p.7).

AEMO's response

Taking these suggestions into account, AEMO proposes making the following improvements for REZ methodology, detailed in the *Draft ISP Methodology*:

- The inclusion of the soft limit and penalty factor for REZ resource limits.
- Moving to representing each REZ's transmission limit, to which generation in the capacity outlook model can be dispatched. This will accurately capture the benefits from diversity of wind and solar and an economic valuation of curtailment. AEMO will no longer use the previous approach of approximating a REZ hosting capacity.

AEMO considers that the approach of linearising cost is more appropriate due to the iterative way the augmentation cost is developed; the linearised cost is derived from an appropriately sized network augmentation, which is specific to the REZ in question. To select the appropriately sized network augmentation, AEMO undertakes iterative modelling so the right REZ expansion cost is used (see *Draft ISP Methodology*, Section 2.4.6).

3.4.2 Power system security

Responses to matters for consideration relating to power system security costs included broad agreement with the proposed approaches (TasNetworks p.4), consideration of the economic benefits of network support and control ancillary services (NSCAS) delivered by an ISP project (TasNetworks p.4, Hydro Tasmania p.11)), and using fast-start capacity on a regional basis in addition to available frequency control ancillary services (FCAS) resources, which could be used for ramping (Shell p.6).

Specifically for system strength, respondents agreed with the proposed approach (MMT p.7, EA p.11), but argued a clear view of install requirements and costs across all scenarios is needed (EA p.11). Other points raised include the suggestion that consumers should bear the costs associated with system strength costs (MEU p.7), and a more proactive approach engaging with equipment manufactures and participants could lead to a more least-cost approach (Shell p.5).

With regards to ramping/operational reserves, Hydro Tasmania recommended a range where batteries are not discharged under 20% and above 80% when considering charge and discharge characteristics (Hydro Tasmania p.11).

Further clarity was sought on VRE ramp rates (Hydro Tasmania p.5, MEU p.7, EA p.12).

AEMO's response

AEMO proposes to model known NSCAS limitations/operational measures if triggers for using the NSCAS services are able to be calculated for use in market modelling, and where these could materially influence dispatch of generation with the energy market. Where augmentations remove the requirement for the NSCAS, then this will also be included. AEMO does not propose to undertake detailed NSCAS specific cost/benefit analysis; rather, any calculated benefits will be amalgamated into the overall benefits calculation, and would need to be on a case-by-case basis. AEMO considers benefits of reduced FCAS costs are better assessed as part of detailed studies during the regulatory investment stage.

AEMO proposes to expand on the system strength reporting to include install costs across all scenarios as part of the draft and final ISP.

Allocation of costs to different parties is not an aspect that the Rules or CBA Guidelines contemplate for development of the ODP outcome of the ISP. The ISP instead looks to ensure all costs are accounted for and minimised.

AEMO agrees that engagement with equipment manufacturers is vital in understanding the capabilities and costs of new equipment, and will continue to engage with manufacturers on an ongoing basis. Costs associated with system strength have been calculated on the basis of ensuring relevant costs (and potential benefits) are captured, and to allow proponents to assess if there are opportunities for the implementation of technologies other than proven ones. The system strength calculations and costs are necessarily high-level calculations only. The inclusion of some system strength costs to generator connection costs in locations with already low system strength means the model can take representative costs for system strength remediation into account when optimising the location of planting of generation.

AEMO has clarified that it will rely on results from ongoing studies to inform the need for any additional ramping limitations or headroom requirements as a result of high levels of VRE.

AEMO has clarified that the assumptions for battery storage is provided for the usable capacity, which does take into account some amount of unusable storage capacity.

AEMO is engaging with plant operators to explore the reasonableness of modelling assumptions used in the ISP.

3.4.3 Infrastructure delivery/costs

Multiple respondents provided views on the sequencing of projects to minimise costs where possible (ENA p.2, GE p.3, CP p.5, MEU p.7, CA p.5, EA p.11). Specifically:

- ENA suggested AEMO should consider sensible sequencing of projects and seek to smooth delivery costs, noting funding will be required if necessary to ensure this can be achieved (ENA p.2).
- GE stated they agree with the general principle of smoothing project delivery over a longer timeframe to alleviate potential capacity constraints and benefit from learning curve effects. (GE p.3).
- CP noted it encourages consideration of project staging and sequencing to smooth out the demand for new transmission infrastructure, to lower construction costs (CP p.11).
- MEU argued that multiple transmission projects occurring at the same time should be minimised, as concurrent projects will increase costs, and also that liaison with governments should be implemented to coordinate with other non-NEM infrastructure projects. (MEU p.7).
- The EUAA shared the view that appropriate sequencing of projects will potentially save consumers money by avoiding over-investment (CA p3). EUAA also suggested stronger requirements for accurate capital expenditure (capex) estimates would improve the ISP, and that the ISP should have an ongoing feedback mechanism to incorporate changing estimates (CA p.3).
- EA suggested AEMO should determine a form of 'industry effort index', to highlight the annual profile of connections needed to be processed over the various scenarios, to identify material and prolonged capacity release and hold points for both interconnector upgrades and generation projects (EA p.11). In addition, they suggested project timing could be informed by analysis conducted by AEMO that demonstrates how appropriately coordinated state investment targets can be aggregated and optimised across the NEM (EA p.12).

AEMO's response

AEMO agrees that the sequencing of projects to smooth project delivery is something that should be considered, however it is a complex problem. AEMO is collaborating with Infrastructure Australia and University of Technology Sydney to understand the labour and materials requirements of generation and transmission construction based on the 2020 ISP. While the coordination of project delivery is outside of AEMO's scope, AEMO will consider options to assess the implications of project smoothing on the ISP. This may be used to inform project planning by developers, governments, transmission network service providers (TNSPs), and market bodies.

AEMO agrees that more accurate capex estimates will improve the ISP, and to this end has established the Transmission Cost Database. AEMO is also developing the cost classification methodology to assess (and if necessary adjust) the TNSP estimates for more advanced projects, to ensure they are aligned with a consistent application of risk allowances. This has been discussed in the April Transmission Cost Workshop and will be outlined more fully in the *Draft Transmission Cost Report*.

3.4.4 Distribution network considerations

There were three broad responses to the subject of how AEMO should consider regarding the interplay between distribution and transmission networks:

- Future collaboration between AEMO and distribution network service providers (DNSPs) is required to enable co-optimisation of investment, meeting demand, and providing system security services, and should be further incorporated into the ISP modelling (ENA p.3, CP p.11, PIAC p.2).
- Care should be taken to ensure data requirements for DNSPs are not too onerous (ENA p.3, EQ p.1).
- DNSPs are best placed to understand the distribution network, therefore the ISP should not attempt overly complex distribution analysis (EQ p.2, TasNetworks p.4).

Other comments included a suggestion to include bottom-up scenario forecasts from DNSPs with key criteria clearly aligned to assist in overall integration of forecasting models and ensure all costs are considered (ENA p.3,4), and a request for AEMO to provide more clarity on how DER will be considered in the ISP (EQ p.2, MEU p.7, EA p.9).

AEMO's response

AEMO appreciates the ongoing engagement from DNSPs and the ENA. AEMO aims to explore how DNSP plans to accommodate high penetrations of DER can be leveraged to support power system operation and the development of the ISP. AEMO agrees that data requests to DNSPs should be proportionate and material to the primary ISP scope.

AEMO agrees that DNSPs are best placed to understand the distribution network, and does not intend to perform complex analysis of distribution networks or investment needs in the ISP. Instead, AEMO will rely on DNSPs continuing to plan their network and assisting AEMO in incorporating that information into the ISP.

3.5 Cost benefit analysis

3.5.1 Evaluation of costs and benefits

Two respondents provided views on AEMO's approaches to annuitising capital investments and terminal value:

- EA suggested the inclusion of a transmission costs terminal value and the ongoing benefits of those projects in the CBA, reflecting the need to recover costs from a potentially reducing customer base in some scenarios. Consideration should be given to how these treatments vary across scenarios (p. 12).
- The MEU did not support the annuity approach, instead arguing for generating an NPV for capital works, with a separate NPV for benefits (using two alternative discount rates). It stated that the NPV approach

effectively includes the terminal value (p. 5). The MEU also commented on the application of different discount rates more in the context of non-network versus network investments given their different risk profiles (p. 4).

AEMO also received verbal feedback from the ISP Consumer Panel that the approach to annuitising and terminal value would benefit from more clarity and detail.

AEMO's response

AEMO has provided more detail on the approach used for annuitising capital investments and the approach to terminal value in the *Draft ISP Methodology*.

With regards to the appropriate discount rate that should apply to the NPV component of the CBA analysis, AEMO has engaged external experts to inform this component of the IASR. Consultation opportunities for this work program will be detailed in the opportunities for engagement schedule[6].

With regards to the appropriateness of the annuitisation method versus other methods, the following section provides clarity on AEMO's approach.

Terminal value

The ISP modelling will include many capital investments with different economic lives, many of which will continue past the end of the ISP modelling horizon. Applying an equivalent annual annuity approach is a common approach in capital budgeting that enables simple comparisons of assets with non-equivalent lives.

AEMO's approach is to only consider the annualised costs of these capital investments (as well as other annual costs such as fuel costs) until the end of the modelling horizon. This means that when comparing two different development paths, any differences beyond 2050 are effectively ignored. In other approaches, such as when capturing the up-front cost of an asset, the terminal or residual value of the asset must be accounted for to avoid an inherent bias away from capital-intensive assets near to the end of the modelling horizon.

The annuitisation approach is effectively equivalent to the terminal value or residual value approach, in accounting for project costs. Figure 5 below demonstrates an example with three project investments across the modelling horizon – which in itself is a simplification of the capacity outlook model's required optimisation, considering the volume of project investments (actionable projects, future projects and ISP development opportunities). The annuitisation approach provides equivalence to a terminal value/residual value approach without the need for more complex computational steps.

This approach avoids making assumptions on the ongoing benefits of project investments beyond the modelling period. This is equivalent to assuming that costs and benefits are balanced beyond the modelling horizon.

Importantly, AEMO has found in previous assessments[7] that the annualisation approach tends to be more conservative on benefits outcomes. AEMO has observed that forecasts of market benefits in the later years of the horizon are generally higher, so the annualisation approach is more likely to under-estimate total benefits for consumers in most instances by ignoring the continued benefits. For example, across many figures in Appendix 2 of the 2020 ISP[8] (Figures 3, 4, 6, 7) it is evident that the annual net market benefits in the later years of the horizon were at or near to the highest values observed across the full horizon.

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[6] At https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp/opportunities-for-engagement.

[7] Including where development paths have been compared to counterfactuals, and in the TOOT analyses.

[8] At https://aemo.com.au/-/media/files/major-publications/isp/2020/appendix--2.pdf?la=en.

Figure 5 **Accounting for investments with differing project lives – annuitisation versus residual value (three project example) of the capital investment cost**

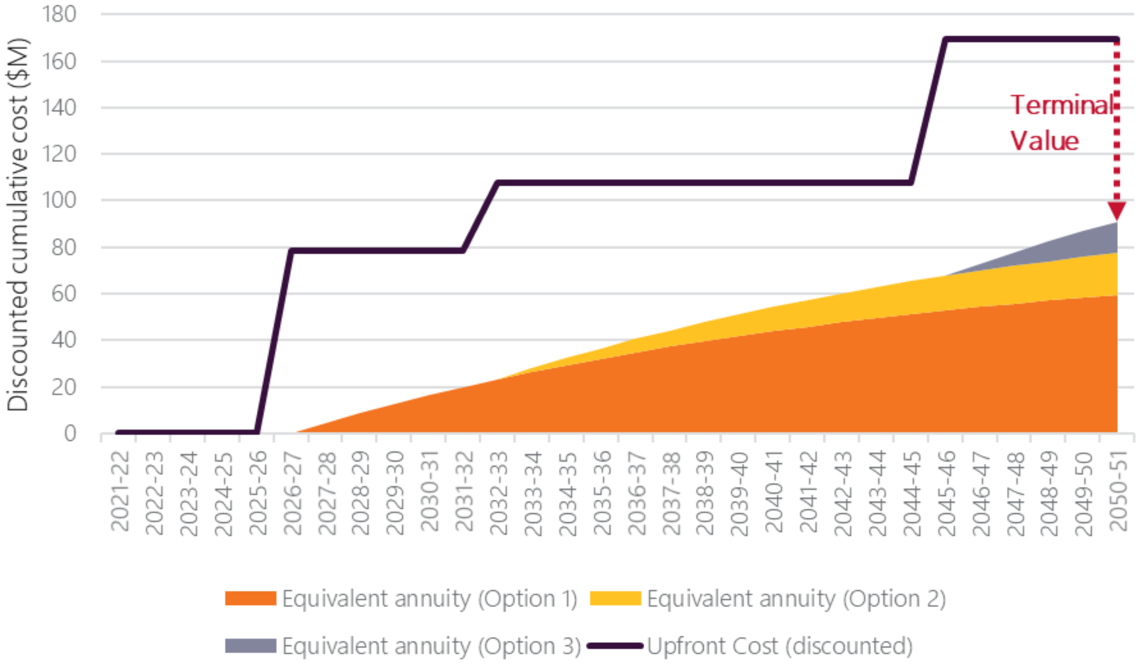
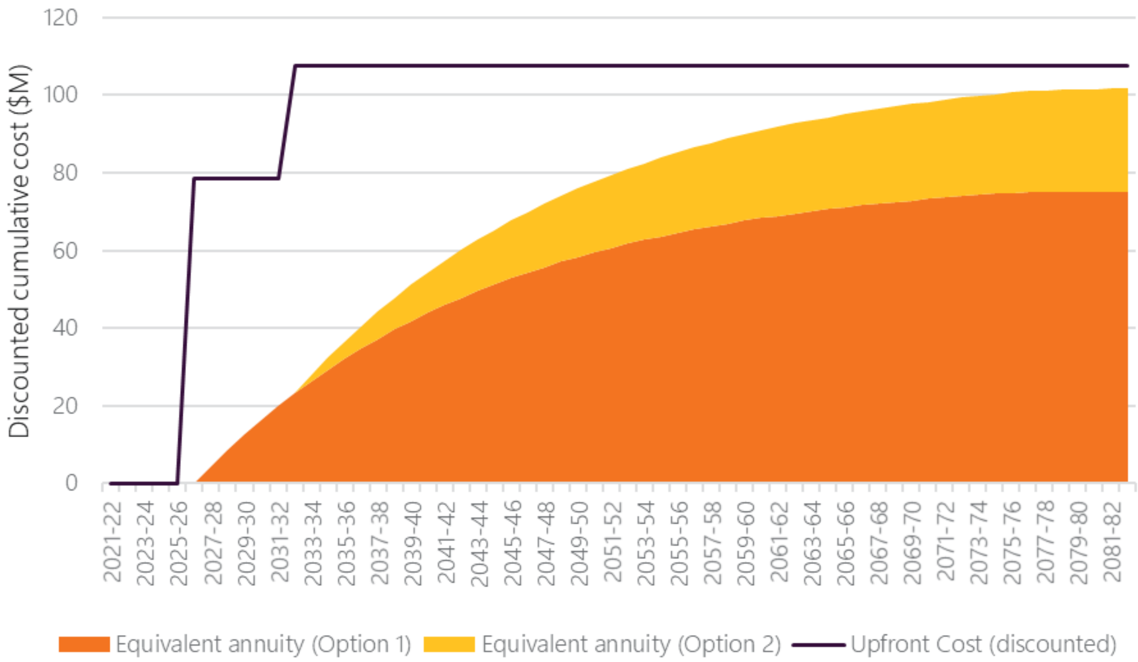


Figure 6 below demonstrates that for investments that are installed in early years, the discounted value of the period beyond the modelling horizon is typically low, considering the time value of money and an appropriate discount rate. In this example, applying a discount rate of 5%, after modelling half of the technical life of a project (25 of 50 years), means almost 80% of the discounted benefits are captured. With a higher discount rate (10%, for example), approximately 90% of the discounted benefits are captured in the same time period. Therefore, there is diminishing value of modelling the full horizon of each investment's technical life.

Figure 6 **Accounting for investments – technical life versus shortened modelling period**



An alternative approach would be to take the net benefits in the final year/s of the horizon and assume they would continue in perpetuity. This approach is also a common method for project assessments, and attempts to forecast continued benefits that were not modelled. A key risk in this approach is that the final year/s of the forecast horizon may not be representative of years beyond, however without forecasting a longer horizon, it is impossible to assess if this will be the case.

As stated above, based on previous analysis this would generally result in an assessment of higher net market benefits based on outcomes far into the future where uncertainty is highest. When considering futures with potentially hundreds of individual investments, the annuitisation approach is a reasonable alternative to full lifetime modelling, which would be infeasible and decreasingly material considering the time value of money.

AEMO does not consider that the cost recovery across a smaller customer base is directly relevant to the CBA analysis, which focuses on total costs, although this may be relevant to any presentation of distributional effects.

3.5.2 Counterfactual development path

ENA provided feedback on the counterfactual development path, saying that, given the likely level of activity outside of the ISP (such as state government VRE developments), there is a need to consider credible levels of both generation in REZs and transmission. Where funding arrangements for state-led transmission are in place, this needs to be part of the counterfactual and the Development Path (DP) options (p. 2).

AEMO's response

AEMO considers that generation and transmission development should only be fixed in the counterfactual development path if it can be classified as either committed or anticipated. Even in the case of government policy, the timing, size, and location of REZ generation and/or transmission development will in all likelihood not be specified to the level of detail required to meet these conditions, and would therefore not be included in the counterfactual.

Furthermore, if included in the counterfactual, it would reduce the ability to understand what value is provided by any network developments which are being considered in the development paths.

3.5.3 Determining the Optimal Development Path – alternative methods

Both Shell and the ISP Consumer Panel indicated that AEMO should explain what alternatives are available to the scenario-weighted average and LWR approaches, pointing specifically to the National Grid single-year regret analysis as an example (Shell p. 7-8, ISPCP p. 9).

Both submissions also suggested that more qualitative tools to assess key risks could be used, including their sensitivity to key inputs or the level of project risks. The submissions suggested that a DP that is optimal using a range of assessment methods would give stakeholders more confidence in its selection as the ODP (Shell p.7-8, ISPCP p. 9).

ENA proposed that the least probability-weighted average regret should be considered in tandem to improve alignment with the RIT-T (p. 2).

AEMO's response

In response to the feedback on alternative methods, AEMO has expanded the discussion in the CBA section in the *Draft ISP Methodology*.

AEMO agrees with the suggestion from the ISP Consumer Panel and Shell to take into account multiple assessment methods, including qualitative assessments informed by sensitivity analysis in selecting an ODP. The *Draft ISP Methodology* reflects this intended approach of using both methods, as well as sensitivities and the use of professional judgement, to select an ODP which performs strongly across a range of assessments.

AEMO's Draft ISP would provide a recommendation of the ODP informed by these assessments, provide detail on the rationale, and seek further consultation on the rationale.

Reflections on alternative methods

National Grid approach

Several submissions to the Issues Paper indicated that AEMO should be proposing other alternatives, with two submissions mentioning the "Single year least worst regrets" approach which is used by National Grid in the United Kingdom for its Network Options Assessment (NOA) report each year.

In this approach, and using equivalent AEMO terminology, least-cost development paths are determined for each of the scenarios, and projects are identified as potential actionable projects. This is equivalent to the AEMO methodology, as detailed in Section 5 of the *Draft ISP Methodology*.

Rather than building Candidate Development Paths (CDPs) based off the least-cost development paths, the National Grid approach builds CDPs by exploring all possible combinations of potential actionable augmentations. This would potentially result in more (or at least the same number of) combinations which then need to be explored.

Once the CDPs are developed, the National Grid approach then explores all combinations of delaying the set of potential actionable projects. This has influenced the equivalent step in AEMO's methodology which considers deferring projects in each CDP. The National Grid NOA cycle is annual, so the decision to delay is a "single year" impact, whereas the ISP is a biennial process, and a delay would effectively delay the project for two years.

When applying the CDPs to each scenario, the National Grid approach seems to not necessarily re-optimise project timings, as is the case in the AEMO approach. As the inclusion or exclusion of a project has a significant impact on the viability of other projects in AEMO's analysis, it is important that this impact is assessed. Again, this might be of lesser impact given the multitude of smaller augmentations being explored in National Grid's more meshed network.

The National Grid approach is otherwise equivalent to the AEMO approach when applying the standard LWR as the methodology for determining the ODP.

AEMO sees a strong alignment between the approach documented in the *Draft ISP Methodology* and the approach applied by National Grid in its entirety, allowing for some minor changes reflecting the different impact of augmentation projects in the Australian context.

Other alternatives

In its review for National Grid[9], the University of Melbourne reviewed a number of other alternative decision-making methodologies for transmission expansion planning. In addition to those described in this methodology, this review considered the following options:

- Min-max cost – aims to choose the options which minimises the maximum cost assessed across scenarios. This is considered a very conservative approach which might be undertaken by the most risk-averse decision-maker. AEMO has not considered the approach appropriate for the ISP, as it likely results in highly conservative decisions which increase the risk of over-investment.
- Min-min cost – aims to obtain the minimum cost in the lowest-cost scenario, and is therefore considered to be an approach used by a risk-seeking decision-maker who is willing to discount risks in other scenarios. This was also considered not appropriate, as it would overly focus on low-cost scenarios (for example, scenarios with decreasing load) and ignore risks of under-investment across the scenario collection.
- Real option analysis – aims to realistically capture the flexibility of decision-making under uncertainty. The University of Melbourne analysis concluded that the approach was not adequate for transmission expansion planning given the number of uncertainties and interactions between options, and was therefore not considered.

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9 See https://www.nationalgrideso.com/document/185821/download.

AEMO also considered the use of more subjective methods (as suggested by the ISP Consumer Panel). AEMO considers that the use of subjectivity falls into the category of the exercise of professional judgement which is provided for in the CBA Guidelines. AEMO's framework for the consideration of other factors, most significantly through sensitivity analysis, is detailed in the *Draft ISP Methodology*.

AEMO has also considered a more complete stochastic optimisation that would require the development of a scenario tree. Arguably such a method would deliver the most robust decision-making framework, which considers decision-making under uncertainty now, but also evolving uncertainty into the future. However, this would require a fundamental redesign in the approach to scenario development and significant advancements in computational techniques to be feasible. AEMO will continue to monitor developments in academic literature in this area.

AEMO has reviewed the National Grid approach and considers it is largely aligned with the development of CDPs and the LWR approach outlined by AEMO. Other alternatives are also reviewed but were not found to have significant merit compared to the assessment methods outlined.

AEMO has also reviewed further material prepared for National Grid by the University of Melbourne, and has reflected a proposed approach to consider least-worst weighted regrets (LWWR), which reduces the impact of less likely scenarios. This potentially addressed ENA's preference, athough AEMO notes that least probability-weighted *average* regret is equivalent to the scenario-weighted average net market benefits approach.

3.5.4 Determining the Optimal Development Path – scenario-weighted versus least-worst regret

Several submissions provided views on the relative merits of the two assessment methods proposed in the *ISP Methodology Issues Paper*. EA stated that it did not have any particular preference, and that consumer representatives may reflect preferences for a certain risk appetite during consultation on the ISP which could be a relevant consideration (p. 11).

Origin Energy was concerned about the application of LWR, as it was seen as having the potential to lead to overbuild in transmission (p. 1).

AEMO's response

While AEMO agrees that the consideration of consumer risk preferences is an important consideration in the assessment of the ODP, AEMO considers that there are risks of both over- and underinvestment which could drive potential regret costs, and that a LWR methodology will not always yield a result with more transmission investment.

However as outlined above, AEMO is intending on using both approaches, as well as further analysis, to identify an ODP that performs strongly across all assessments as a means of determining a robust ODP.

3.5.5 Scenario weightings

Both the ISP Consumer Panel and Shell expected more discussion in the ISP Methodology on the process for the development of, and consultation on, scenario weightings, including the identification of the most likely scenario (Shell p. 7, ISPCP p. 8). MEU also argued for the process for allocation of weightings to be included in the ISP methodology (p. 7).

Both the ISP Consumer Panel and Shell also suggested that the assignment of weightings when selecting the ODP should consider the linkages to the approach taken for RIT-Ts on actionable ISP projects (Shell p. 7, ISPCP p. 8).

EA argued that where probability weightings are used, AEMO should provide a clear and detailed explanation on their source, how they are tested and validated, and whether there are any threshold limits that unduly influence outcomes (p. 12).

AEMO's response

AEMO acknowledges the importance of scenario weightings in the RIT-T process, and that this will need to be carefully considered when assessing the ODP across the different assessment approaches.

AEMO is intending to consult on the scenario weightings later in 2021, as more information becomes available that could inform views on the relative likelihood of scenarios. AEMO has provided in the *Draft ISP Methodology* a description of the approach which is intended to be applied to determine scenario weightings through a consultation process.

3.5.6 Identified need

MEU suggested that a defined need must be specified and held constant such that a non-network option can be developed and fairly evaluated against that need (MEU p5). MEU highlighted that the ISP analysis program should lead to the least cost/regret solution and not the least cost/regret network solution (MEU p6).

AEMO's response

The AER's CBA Guidelines[10] describe the identified need as "the reason why an investment in the network is needed". AEMO is required to specify one identified need for each actionable ISP project. The identified need must be described as an objective to be achieved by investing in the network, and can be addressed by either network or non-network options (or a combination of the two).

AEMO agrees that an identified need should be evaluated and described such that non-network solutions can be developed and evaluated fairly. AEMO has drafted a new methodology for determining and describing the identified need for actionable ISP projects. The RIT-Ts for any actionable ISP projects must use the identified need determined by the ISP such that developers of non-network solutions can tailor their solutions.

3.5.7 Sensitivity analysis

As described above, the ISP Consumer Panel and Shell both indicated that more qualitative assessments, including sensitivity analysis, should be used in the determination of the ODP (Shell p. 8, ISPCP p. 9).

EA has also asked AEMO to consult on metrics of stakeholder interest in terms of key distributional impacts (p. 12).

AEMO's response

AEMO agrees with the suggestion from the ISP Consumer Panel and Shell to take into account sensitivity analysis in selecting an ODP.

The *Draft ISP Methodology* outlines AEMO's proposed approach to the presentation of distributional impacts.

3.5.8 TOOT analysis

Several submissions provided in principle support for the TOOT analysis. TasNetworks noted that the TOOT analysis would differ from the market benefits calculated in a RIT-T for an actionable project. TasNetworks also considered that the TOOT analysis should be extended to include any relevant scenarios, rather than just the Central scenario (p. 3-4).

Hydro Tasmania argued that TOOT analysis is good for illustrative purposes only, mainly because it is only tested on the Central scenario. It also argued for more clarity on how state-based policies and proposed developments would be recognised in the ODP, compared to the TOOT analysis (p. 4).

Shell suggested that the TOOT should use the upper bound on transmission cost in its assessment (p. 8).

Shell and the ISP Consumer Panel suggested that the TOOT analysis should compare the actionable project with a counterfactual that substitutes the project for a lower cost alternative, rather than comparing to a case where no alternative project is built (Shell p. 8, ISPCP p. 10-11).

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[10] At https://www.aer.gov.au/system/files/AER%20-%20Cost%20benefit%20analysis%20guidelines%20-%2025%20August%202020.pdf.

The MEU stated that TOOT assumptions need to be explained, and argued that an explanation is needed when doing a TOOT as to what happens if a project has a net negative benefit (p. 5).

The ISP Consumer Panel would appreciate more detail on the feedback loop process, on the cost that AEMO would use (either the Project Assessment Conclusions Report [PACR] or another figure), and on how individual project net market benefits would be assessed and whether that would differ from the net market benefit assessment under the previous AER 5.16.6 assessment (p. 11).

AEMO's response

AEMO engaged further with stakeholders on the approach for TOOT analysis in the webinar on 1 April 2021, in particular in relation to whether there should be any alternative or replacement project in the TOOT case. That discussion highlighted that the key outcome stakeholders seek is transparency on why an actionable project is preferred over an alternative, for example a smaller project, and also to provide a view on the magnitude of the difference.

AEMO considers that the primary value of the TOOT analysis would not be served by substituting a next best alternative, but embraces the value in the transparency when comparing options. As a result, rather than using TOOT analysis for this purpose, for any major projects that become actionable, AEMO will aim to provide results for alternative CDPs which have smaller and/or non-network alternatives included, and, through the comparison with the ODP, demonstrate the relative value of the actionable project.

AEMO does not consider that using an explicit upper bound on transmission costs is needed, but will use the net market benefits calculated through TOOT analysis to provide guidance on the sensitivity of a project's viability to transmission costs. The size of these incremental benefits is an indicator of the transmission cost threshold which, if exceeded, would lead to this project no longer remaining in the ODP, all other inputs remaining unchanged.

AEMO's intention is for the TOOT approach outlined to be comparable to the approach that would be used by TNSPs in performing subsequent RIT-Ts on actionable projects, as per the CBA guidelines.

AEMO has not provided details on the feedback loop in the *Draft ISP Methodology*, as feedback loops are not part of preparing a draft or final ISP.

Abbreviations

Term	Definition
ACOSS	Australian Council of Social Service
AER	Australian Energy Regulator
Capex	Capital expenditure
CBA	Cost benefit analysis
CDP	Candidate development path
CP	(ISP) Consumer Panel
DER	Distributed energy resources
DLT	Detailed long-term (model)
DNSP	Distribution network service provider
DP	Development path
DSP	Demand side participation
EA	EnergyAustralia
EFOR	Equivalent forced outage rate
ENA	Energy Networks Australia
EQ	Energy Queensland
ESOO	Electricity Statement of Opportunities
EUAA	Energy Users Association of Australia
FCAS	Frequency control ancillary services
FRG	Forecasting Reference Group
GE	GE Renewable Energy
GPG	Gas-powered generation
GSOO	Gas Statement of Opportunities
HVAC	High voltage alternating current
HVDC	High voltage direct current
IASR	Inputs, Assumptions and Scenarios Report

Term	Definition
IM	Integrated Model
ISP	Integrated System Plan
LWR	Least-worst regrets
LWWR	Least-worst weighted regrets
MEU	Major Energy Users Inc
MMT	MM Technology
NEM	National Electricity Market
NOA	Network Options Assessment
NPV	Net present value
NSP	Network service provider
NSCAS	Network Support and Control Ancillary Services
ODP	Optimal development path
PACR	Project Assessment Conclusions Report
PHES	Pumped hydro energy storage
PIAC	Public Interest Advocacy Centre
POE	Probability of exceedance
REZ	Renewable energy zone
RIT-T	Regulatory Investment Test for Transmission
RRN	Regional Reference Node
RRO	Retailer Reliability Obligation
Shell	Shell Energy
SRAS	System restart ancillary services
SRMC	Short Run Marginal Cost
SSLT	Single-stage long-term (model)
TNSP	Transmission network service provider
TOOT	Take-one-out-at-a-time (analysis)
USE	Unserved energy
VPP	Virtual power plant
VRE	Variable renewable energy