Transparency Review Integrated System Plan 2022 Final Inputs, Assumptions and Scenarios Report

August 2021

AUSTRALIAN ENERGY REGULATOR

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Shortened forms

Shortened Form	Extended Form
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
CBA	cost benefit analysis
CBA guidelines	cost benefit analysis guidelines
CCGT	closed cycle gas turbine
CP	consumer panel
DER	distributed energy resources
DNSP	distribution network service provider
ESB	Energy Security Board
ESOO	Electricity Statement of Opportunities
FBPG	Forecasting best practice guidelines
FOR	Forced Outage Rates
FRG	Forecasting Reference Group
GSOO	Gas Statement of Opportunities
HILP	high impact low probability
IASR	inputs, assumptions and scenarios report
ISP	integrated system plan
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
OCGT	open cycle gas turbine
ODP	optimal development pathway
REZ	renewable energy zones
RIT–T	regulatory investment test for transmission

RRO	retailer reliability obligation
TNSP	transmission network service provider
TRET	Tasmanian Renewable Energy Target

1 Executive Summary

The Australian Energy Market Operator (AEMO) is responsible for publishing the Integrated System Plan (ISP) every two years and publishing an ISP methodology at least every four years. The ISP is a forward looking roadmap for eastern Australia's power system that seeks to optimise consumer benefits from future investment as the market transitions to a lower carbon environment.

The ISP identifies the transmission network (or equivalent non-network solutions) that are most likely to optimise net market benefits through the electricity system's transition to a lower carbon future. AEMO identifies the network investments that offer the highest net market benefits across future NEM development scenarios over the planning horizon as the optimal development path (ODP) for the NEM. The ODP includes 'actionable' ISP projects and future ISP projects, which can be progressed through the regulatory investment test for transmission (RIT-T) process. It also identifies future ISP development opportunities such as distribution assets, storage or demand side developments.

In 2019, the Energy Security Board (ESB) implemented rules requiring the Australian Energy Regulator to review the transparency of inputs and assumptions (also referred to as ISP parameters) determined by AEMO in developing the ISP to ensure greater stakeholder confidence in the ISP. Under the new ISP regulatory framework, we are responsible for undertaking transparency reviews at key stages in the ISP process, namely following AEMO's publication of its 2021-22 Inputs Assumptions and Scenarios Report (IASR) and draft ISP. In addition, we proactively monitor compliance and have set up a compliance issues register regarding AEMO's compliance with the National Electricity Rules (NER) and binding elements of the ISP guidelines.

This is our first Transparency Review report of AEMO's IASR. Our Transparency Review is not intended to assess the merits of AEMO decisions. Rather, our role through the transparency review process is to focus on the adequacy of AEMO's explanations of its inputs and assumption choices. Our Transparency Review report is an important step in ensuring that AEMO adequately explains the derivation of key inputs and assumptions in finalising its IASR as part of developing the 2022 ISP.

Key findings

We recognise that the ISP development process is a significant task, given AEMO is required to recommend a long term investment plan for the NEM that has now been given actionable status. This underscores the importance of developing robust, defensible and credible inputs to manage the risks of premature or overdue investment to consumers.

This is the first time that AEMO has been subject to the new Rules requirements as well as our Cost Benefit Analysis (CBA) and Forecasting Best Practice Guidelines (FBPG) in developing its latest ISP. To that effect, we had regard to the framework being applied the first time by AEMO in its development of 2022 ISP for the purposes of our Transparency Review report.

Overall we consider that AEMO has taken into account key uncertainties in the development of its scenario narratives and has undertaken a comprehensive assessment of the ISP parameters relevant to each scenario. Our review concludes that the majority of AEMO's inputs and assumptions have been adequately explained and AEMO has demonstrated that it has taken into account stakeholder feedback. However, in seeking to promote the transparency of the IASR, we have identified the following issues with the IASR parameters that require further explanation:

- The relationship between the multi-sectoral modelling used to inform the electricity sector's contribution to meeting net zero carbon emissions by 2050 and the separately derived inputs and assumptions related to distributed energy resources (DER), electric vehicles (EV) and energy efficiency.
- The adoption of an average of consultant projections for distributed PV and battery uptake for some scenarios and the adoption of projections from a single source for the remaining scenarios.
- The assumption that the Tasmanian Renewable Energy Target (TRET) will be included in the draft ISP, whereas at this stage of the ISP process, the budgeted policy initiative to develop six renewable energy zones in Victoria may not be included in the draft ISP.
- Whether any system security assumptions are driven by the minimum demand projections and if relevant, the basis for including these assumptions.
- The assumption that thermal coal plant is not flexible.
- The assumption applying an uplift factor of 50 per cent to the 2018 Entura estimates of capital costs for new entrant pumped hydro generators; and
- The projections of forced outages for coal and gas thermal power plant.

These issues with the ISP parameters are detailed in our report. AEMO must provide further explanations, in regards to the above parameters, as an addendum to the IASR, and consult on these issues in the draft ISP.

2 Introduction

2.1 What is the ISP?

AEMO is responsible for publishing the Integrated System Plan (ISP) every two years and publishing an ISP methodology at least every four years. The ISP is a forward looking roadmap for the eastern Australia's power system that seeks to optimise consumer benefits as the market transitions to a lower carbon environment. The ISP identifies the network projects (both network and non-network) that are most likely to optimise net market benefits through the electricity system's transition to a lower carbon future.

The projects that offer the highest net market benefits across scenarios over the modelling horizon are likely to represent the optimal development path (ODP) for the NEM. The ODP includes 'actionable' ISP projects and future ISP projects, which can be progressed through the RIT-T process. It also identifies future ISP development opportunities such as distribution assets, storage or demand side developments.

2.2 Our role in the ISP

The AER provides oversight of the ISP by ensuring that AEMO's processes are robust, credible and transparent. The requirements and considerations that the AER places on AEMO's forecasting processes are specified in our FBPG and our CBA guidelines[1].

The AER's forecasting guidelines require AEMO's forecasting practices and processes to have regard to the following principles:[2]

- forecasts should be as accurate as possible, based on comprehensive information and prepared in an unbiased manner
- the basic inputs, assumptions and methodology that underpin forecasts should be disclosed; and
- stakeholders should have as much opportunity to engage as is practicable, through effective consultation and access to documents and information.

In addition, AEMO is required to have regard to our CBA guidelines. Our CBA guidelines aim to ensure that AEMO identifies an optimal development path that promotes the efficient development of the power system based on a quantitative assessment of the costs and benefits of various options across a range of scenarios. In undertaking this assessment, the CBA guidelines requires AEMO to:[3]

- balance the risks of premature or overdue investment to consumers
- provide AEMO flexibility in its scenario development, modelling and the selection of the ODP

1 National Electricity Rules, cl. 5.16A.2
2 NER, cl. 4A.B.5
3 AER, Cost Benefit Analysis Guidelines, 25 August 2020, p.1

- require that the ODP provide a positive net market benefit in the most likely scenario
- have regard to the need for alignment between the ISP and RIT-T, for actionable ISP projects.

2.2.1 Transparency Review

In 2019, the ESB implemented rules requiring the AER to review the transparency of inputs and assumptions determined by AEMO in developing the ISP to ensure greater stakeholder confidence in the ISP.

Our Transparency Review is not intended to assess the merits of AEMO decisions. Rather, our role through the Transparency Review is to focus on the adequacy of AEMO's explanations of its inputs, assumptions and scenario design choices and AEMO's consideration of stakeholder engagement as it finalises these choices.

These changes were established in the context of reforms to the NER and the National Electricity Law (NEL) that converted AEMO's ISP into an actionable strategic plan. The actionable reforms strengthen the links between the ISP and the cost benefit analysis process that underpins the regulatory investment test for new transmission projects in the NEM.

The National Electricity Amendment (Integrated System Planning) Rule 2020 commenced on 1 July 2020, and the rules require the AER to publish a transparency review of the IASR and the Draft ISP. [4] The AER is required to publish these reviews one month after AEMO publishes the IASR and draft ISP. AEMO published its Final IASR on 30 July. The ISP process is outlined in Table 1.

Table 1: ISP 2022 process

	Date
AEMO 2022 ISP timetable published	30 October 2020
AEMO Draft IASR published	17 December 2020
AEMO Draft ISP methodology published	30 April 2021
AEMO Final IASR and ISP methodology published	30 July 2021
AER Transparency Review published	30 August 2021
AEMO Draft ISP published	10 December 2021
AER Transparency review of draft ISP published	Mid-January 2022
AEMO final ISP published	30 June 2022

4 NER cl. 5.22.9.

2.2.2 Monitoring and compliance

The AER also has a compliance monitoring function that is separate to our obligation to produce a Transparency Review. In particular, the AER is responsible for monitoring and enforcing compliance with the NER, including in relation to several guidelines associated with the ISP, and in relation to the RIT-T. The AER maintains and publishes a compliance issues register relating to compliance with these requirements by the AEMO and by transmission businesses (for actionable ISP projects).

These compliance functions require us to assess whether AEMO has satisfied the binding requirements specified in our FBPG and CBA guidelines.[5] These compliance functions are also complementary to our requirements to publish Transparency Review reports on the IASR and the draft ISP.

The FBPG also require the AER to publish and maintain a public issues register in circumstances where AEMO has either:[6]

- not complied with binding requirements in our guidelines or the NER
- not adequately addressed a concern raised with them by a stakeholder through their consultation process; or
- not been transparent in disclosing inputs, assumptions, scenario features, results or the drivers of those results (in the Draft and Final ISP reports).

The details of our compliance role and how stakeholders should engage with the AER on ISP compliance matters is provided on our website.[7]

AEMO is also required to provide a written compliance report outlining how it has complied with applicable requirements in the FBPG, had regard to considerations in the FBPG and resolved key issues raised by the AER through its issues register.

This compliance report is designed to help improve stakeholder confidence in the ISP and has allowed the AER to undertake an expeditious review of the Final IASR.[8]

2.2.3 Structure of the report

This report sets out our assessment of whether AEMO has adequately explained the key inputs and assumptions (ISP parameters).

This report is structured as follows:

- Section 3 sets out our assessment approach
- Section 4 sets out our assessment
- Section 5 sets out our findings.

5 AER, Compliance issues register: ISP & Actionable RIT-Ts, 6 June 2021. https://www.aer.gov.au/wholesale-markets/compliance-issues-register-isp-actionable-rit-ts

6 AER, Forecasting best practice guidelines, 25 August 2020, p. 7, 20

7 See https://www.aer.gov.au/wholesale-markets/compliance-issues-register-isp-actionable-rit-ts

8 AER, Forecasting Best Practice Guidelines, 25 August 2020, p.19

3 Our assessment approach

3.1 Rule requirements

The NER require the AER to report on the transparency of the Inputs, Assumptions and Scenarios Report, including whether:[9]

1. AEMO has adequately explained how it has derived key inputs and assumptions and how key inputs and assumptions have changed since the previous ISP; and
2. Key inputs and assumptions have been based on verifiable sources[10], or that AEMO has provided stakeholders with adequate opportunity to propose alternative inputs and assumptions where verifiable sources are not readily available.

One important aspect of transparency is the extent to which AEMO has consulted with relevant stakeholders on the contents of the report. Our review of whether AEMO has 'adequately explained' how it has derived key inputs and assumptions includes whether AEMO has adequately explained how it has used its judgment in coming to a view on a particular input, assumption or scenario design choice.

The NER also require AEMO to take the following actions to address the issues identified in this AER IASR report:[11]

1. as soon as practicable, provide further explanatory information in an addendum to the IASR; and
2. consult on these issues in the draft ISP.

3.2 AER engagement with AEMO

We have engaged with AEMO frequently throughout the IASR development process. In particular, we have taken a proactive approach to identifying matters that we consider relevant to our Transparency Review. This has provided AEMO with an opportunity to respond to issues we have raised over the course of IASR development.

This has involved AER staff:

1. Meeting with AEMO regularly during IASR development to provide our feedback on the development of specific inputs/assumptions and their general approach to stakeholder consultation.
2. Providing input to the development of various aspects of the IASR such as the design and use of the transmission cost database, and the approach to determining an appropriate discount rate.

9 NER, cl. 5.22.9

10 For the purposes of our Transparency Review we have interpreted a 'verifiable source' to be from a reputable and independent source consistent with our RIT-T application Guidelines.

11 NER, cl. 5.22.9

3. Attending Forecasting Reference Group (FRG) meetings to understand the scope of consultation processes, issues raised by stakeholders, and to seek clarification from AEMO and its consultants on the modelling approaches taken on specific issues.
4. Meeting with AEMO's ISP Consumer Panel to provide guidance on the scope of our oversight functions and any overlap between our respective functions over the course of IASR development.

4 Our assessment

4.1 IASR consultation

AEMO published its draft IASR on 17 December 2020. The FBPG require AEMO to adopt the single stage consultation process.[12] The single stage consultation process sets out the minimum consultation requirements that AEMO must follow in developing the IASR[13].

The 'single stage' consultation process requires AEMO to make reasonable efforts to hold discussions with stakeholders on matters that inform inputs, assumptions and scenario design choices and provide written feedback on the reasons and processes informing ISP parameter choices. AEMO gave stakeholders guidance on the key issues it would consult on in the draft IASR by stating that:[14]

> ……at the time of preparing this Draft 2021 IASR, many of the inputs and assumptions have not been finalised, due to key dependencies on other information (such as historical DER installations, operational demand data, policy or investment decisions, macro-economic forecasts, or other component forecasts) that are annually updated and made available closer to modelling commencing.
>
> To strike an appropriate balance between the principles of transparency, stakeholder engagement and accuracy, AEMO has presented indicative values for these inputs and assumptions in this Draft 2021 IASR, and outlined the update and consultation processes proposed to ensure the most relevant, and up-to-date information is used at the time forecasts are performed. This includes acknowledging which inputs will rely on consultant support to finalise, and the opportunities to engage on these consultant outputs.
>
> Where indicative or interim values have been used, they have been clearly identified; in most instances, they reflect the inputs and assumptions used for the 2020 ESOO and/or 2020 ISP. Stakeholder feedback on the reasonableness of these assumptions, or expectations as to how these should change in the current environment, will be valuable in informing the update process.

The draft IASR categorised the status of inputs and assumptions as:[15]

- **Interim** - an input that has not been updated since the 2020 IASR (released in August 2020) but is intended to be updated before the release of the final 2021 IASR. Where inputs are interim, and a forward plan indicated the planned timing and mechanism of consultation.
- **Draft** - an input that is considered final unless AEMO receives sufficient evidence to change as part of this Draft 2021 IASR consultation.
- **Current view** - an input or assumption which is regularly updated in a standardised process to reflect the most up-to-date observations.

12 AER, Forecasting Best Practice Guidelines 25 Aug 2020, Appendix B p. 22; FBPG, Requirement 2.2.
13 NER cl 5.22.8(b)
14 AEMO, Draft Inputs, Assumptions and Scenarios Report, 12 December 2020, p.15.
15 AEMO, Draft Inputs, Assumptions and Scenarios Report, 12 December 2020, p.36.

AEMO commenced consultation on inputs, assumptions and scenarios in October 2020 after publishing a high-level timetable outlining the ISP process on 30 October, before publishing the draft IASR. This consultation involved a series of industry workshops to canvass early views on scenario design.[16] AEMO initiated its scenario consultation early in the ISP development process. However, we consider that to further promote effective engagement, AEMO could have outlined:

- the process for iterating and finalising scenario design
- the scope of consultation on the parameters that would describe the scenarios; and
- when consultation on those parameters (inputs/assumptions) would start and end.

AEMO responded to this feedback by amending their engagement approach. Specifically, we observed that AEMO:

1. Set priorities for FRG engagements, commencing in January 2021[17] by outlining the scope and objectives of each of the subsequent webinars and FRG meetings before engagement commenced.
2. Clearly communicated AEMO's interpretation of feedback, and how it will respond to the feedback received in the following reports:
    - Draft IASR consultation feedback and the webinar[18]
    - Providing a record of all FRG discussions, including responses to issues raised[19]
    - ISP methodology consultation[20]
    - IASR Consultation Summary Report.[21]
3. Communicated the program of future consultations that it would undertake on the inputs and assumptions that align with the scenarios.
    - Calendar of future FRG consultation and the scope of each consultation. This often included the circulation of a meeting materials before the scheduled event to ensure stakeholders to consider the material before the meeting.

Importantly, we consider that AEMO's amended approach promoted more effective engagement as it provided stakeholders clarity on the scope of each consultation exercise and on the process that would govern AEMO's approach to finalising its views on a particular ISP parameter.

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16 NER, cl. 5.22.4(b)(1) requires AEMO to publish the ISP timetable and if AEMO expects to release an ISP update before finalising the ISP, AEMO's ISP timetable should include the ISP update. It should be noted that our Transparency Review does not apply to ISP updates.

17 AEMO, FRG - Reference Group Forward Plan, January 2021. https://aemo.com.au/en/consultations/industry-forums-and-working-groups/list-of-industry-forums-and-working-groups/forecasting-reference-group-frg.

18 AEMO, Draft 2021 Inputs, Assumptions and Scenarios Consultation Feedback, 3 March 2021 https://aemo.com.au/-/media/files/major-publications/isp/2022/iasr-consultation-feedback.pdf?la=en

19 AEMO. Forecasting reference group. https://aemo.com.au/en/consultations/industry-forums-and-working-groups/list-of-industry-forums-and-working-groups/forecasting-reference-group-frg (Last updated 26 May 2021)

20 AEMO, Consultation on the ISP methodology, 30 April 2021. https://aemo.com.au/en/consultations/current-and-closed-consultations/isp-methodology

21 AEMO, 2021 IASR Consultation Summary Report, July 2021.

4.1.1 Scenario development

The IASR has adopted scenarios that aim to reflect a plausible range of energy futures so that the ISP can inform the implications of those futures on the electricity market. The five scenarios that are proposed to be modelled are briefly described below:

- **Slow change** – market led change, with slow economic recovery from COVID 19, load closures, reflecting the slowest progress on decarbonisation
- **Steady progress** – reduces carbon intensity over time but does not achieve economy wide net zero emissions by 2050
- **Net zero by 2050** – technology led change, greater cross sectoral electrification and energy efficiency supports the entire economy towards net zero emissions in 2050, Consumers rely on electricity for heating and cooking
- **Step change** – economy wide emission reductions assumed to be achieved on or before 2050, rapidly falling cost of storage, distributed energy resource and other renewable technology and higher levels of electrification of other sectors; and
- **Hydrogen superpower** – economy wide emissions reductions are expected before 2050, significant hydrogen production for domestic demand and export, hydrogen replaces gas heating for residential consumers and higher levels of electrification and energy efficiency across sectors.

AEMO advised stakeholders that the following sensitivities would also inform its draft ISP analysis:[22]

- A low gas price sensitivity across scenarios
- High and low discount rates, with an additional high discount rate sensitivity
- High DER uptake rates, applying the step change scenario uptake forecasts to all other scenarios
- Strong electrification, where hydrogen uptake is limited and energy efficiency is more muted, where the majority of emissions reduction is achieved through electrification of the economy.

AEMO received feedback to its draft IASR consultation process that it should take a more sophisticated approach to estimating the electricity sector's share of the national carbon abatement burden than had been proposed.[23]

AEMO responded to this feedback by engaging CSIRO and ClimateWorks Australia to quantify how much abatement the electricity sector would deliver to meet national abatement goals. AEMO stated that the multi-sectoral modelling would be used in all scenarios, except

22 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021, pp. 25-26.
23 AEMO, IASR consultation feedback presentation, 3 March 2021

the, 'slow change' and 'steady progress' scenarios[24], to inform the following inputs and assumptions:[25]

- Consumption forecasts across the relevant scenarios by informing:
    - the impact on the longer term energy intensity of the business sector
    - new load growth across residential and business customers from electrification
    - The relativity of energy efficiency forecasts across the scenarios developed by bottom up forecasts.
- National and NEM emissions pathways for the scenarios that use carbon constraints; and
- Domestic hydrogen production as a substitute for other sources (relevant to the 'Hydrogen Superpower scenario').

However, AEMO had already commenced consultation on a number of demand parameters (listed below) that it noted would also be informed by the results of the multi-sectoral modelling exercise.[26]

- Rate at which energy efficiency would impact demand growth
- Rate of DER adoption (residential solar PV, non-scheduled solar PV and battery uptake)
- Rate of transport sector electrification (EV uptake); and
- Rate of fuel switching (e.g. from natural gas to electricity and hydrogen for heating and other business/industrial applications).

AEMO's concurrent engagement on the above parameters (see Appendix A) and the multi-sectoral modelling approach led to uncertainty on the specific modelling process that would inform these input choices, and the relationship, if any, between the multi-sectoral modelling and these separately derived parameters. The AER understands that the fuel switching assumptions (i.e. rate of switching from gas to electricity across consumer categories - residential, business and industrial) was the only parameter that was entirely attributable to the multi-sectoral modelling work.

We expect AEMO to provide further explanation, in its addendum to the IASR, on the relationship between the multi-sectoral modelling and projections of the rate of:

- energy efficiency technology uptake forecast by Strategy Policy Research and consulted on through the 28 April FRG process
- DER technology (both distributed solar PV and batteries) uptake rates forecast by GEM and CSIRO and consulted on over three FRG events (March to May).
- EV uptake rate forecast by CSIRO and consulted on through the FRG process in February and April.

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24 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021, p.42
25 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021, p.43
26 AEMO, FRG forward agenda 2020 IASR

Overall we encourage AEMO in future ISP processes to consider providing AEMO views on the ISP parameters that are likely to have the greatest impact on ISP outcomes, and seeking stakeholder views on how they wish to be consulted on these issues.

This may provide stakeholders with an opportunity to advise AEMO if there is any substantive issues that AEMO has not identified. This feedback may also inform AEMO's stakeholder engagement plan outlining the scope, timing and purpose of consultation activities over the course of IASR development.

4.2 Assessment of key inputs and assumptions

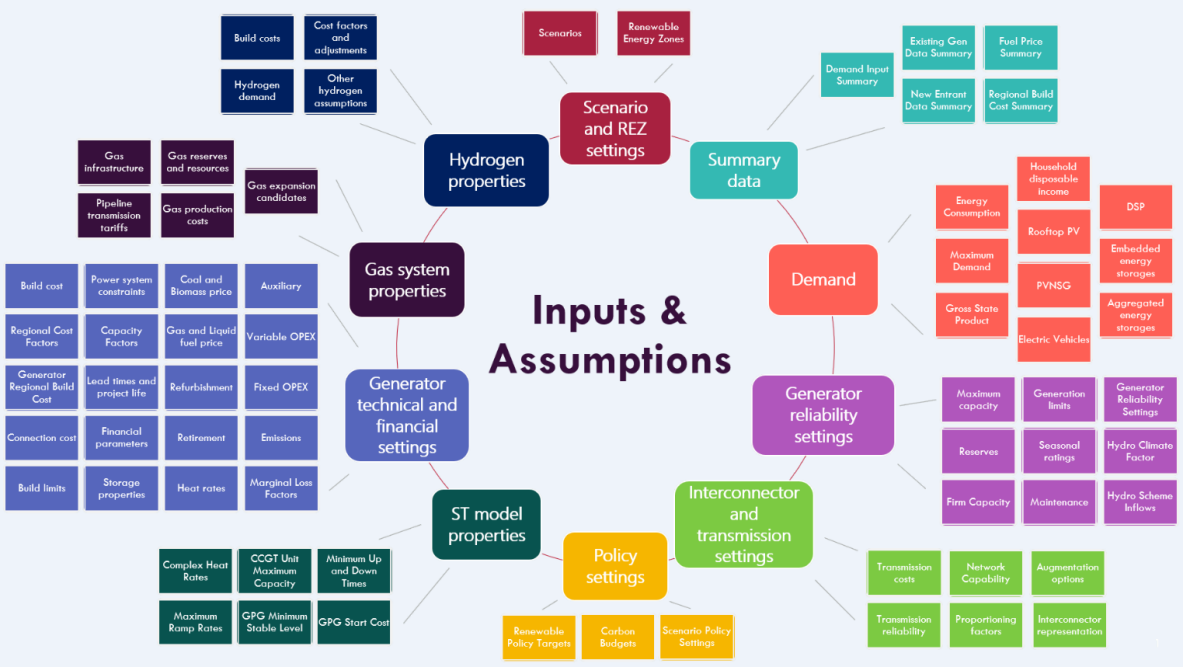
Our review has focused on those key inputs and assumptions categorised in the draft IASR as interim or draft[27], considering:

- Whether AEMO has adequately explained how it has derived key inputs and assumptions
- Whether AEMO has explained how key inputs and assumptions have changed since the previous ISP
- Whether AEMO has provided stakeholders an opportunity to propose alternative inputs and assumptions where verifiable sources are not available.

The final IASR includes a range of inputs and assumptions that are relevant to the draft and final 2022 ISP. The relationships between key inputs and assumptions is outlined in Figure 1.

27 AEMO, Draft Inputs, Assumptions and Scenarios Report, December 2020, p.36.

Figure 1: Inputs and assumptions relevant to this IASR review.



Source: AEMO

4.2.1 DER inputs and assumptions

The assumed DER technology adoption rate will affect forecast electricity consumption and maximum and minimum demand forecasts across regions. AEMO derived its projections for distributed PV, non-scheduled PV generation (i.e. 100 kW to 30 MW) and battery uptake by engaging GEM and CSIRO.

These inputs and assumptions are also be relevant for AEMO's Electricity Statement of Opportunities (ESOO) demand projections that are currently being progressed. AEMO stated in its draft IASR that:[28]

> AEMO will engage with consultants to develop DER forecasts that match the new scenarios and consult on these through FRG meetings. The Draft 2021-22 Inputs and Assumptions Workbook contains AEMO's latest DER forecasts provided by consultants in 2020. Any feedback received on these will be shared with consultants for consideration when developing new DER forecasts in the new year.

Explanation of relevant parameters

GEM and CSIRO consulted stakeholders on their respective methodologies and draft and final forecast uptake of DER through the Forecasting Reference Group forum. AEMO received two submissions to this process.[29]

We are broadly satisfied that AEMO's consultants have explained the model they have used to derive projections for the expected rate at which DER technologies will be adopted over

28 AEMO, Draft Transmission Cost Report, May 2021, p.60.

29 AEMO, FRG Consultation for 2021 IASR on DER – Meeting pack, May 2021.

the modelling horizon. However, as a general point, we consider AEMO should provide a high-level explanation of the drivers and methodology that underpins these critical assumptions in future IASRs. The 2021 IASR references high level reasoning from consultant's reports but does not provide AEMO's views on why they are accepting these projections.

AEMO also consulted on its approach for selecting either GEM or CSIRO's projections and assigning them to specific scenarios.[30] However, we consider that stakeholder understanding of the relative merits of CSIRO and GEM's respective approaches could have been supported by AEMO providing its views on the key differences between the modelling methodologies.[31] Providing an AEMO view may also have helped all stakeholders provide feedback on the application of these models used to derive these parameters. In particular, to apply:

- the CSIRO forecast to the 'Slow Change' scenario
- an average of the GEM and CSIRO forecasts for the 'Steady Progress' and 'Net Zero 2050' scenario
- the GEM forecasts for the 'Step Change' scenario
- the GEM forecasts for the 'Hydrogen Superpower' scenario.

AEMO also commented that:[32]

> In scenarios where the two forecasts are averaged, battery and PV are also averaged from their respective forecasts. Any strong discrepancy between the PV and battery projections that might be associated with increased V2G or EV subsidies will be carefully reviewed. AEMO consider the downside of averaging inputs is more than compensated for by the benefits of averaging the outputs to create a middle ground.

And:

> AEMO utilises two consultants' forecasts for PV and battery to explore the uncertainties in these important areas. Consistency within each scenario is ensured through the selection methodology described in the March FRG presentation[33], and will also be documented in the final IASR.
>
> GEM and CSIRO's final presentations at the April FRG will describe material changes since their 2020 report. Full details will be available in each consultant's 2021 report.

AEMO states in the IASR that it chose to average the CSIRO and GEM's "best" estimates for the 'Steady Progress' and 'Net Zero 2050' scenarios.[34] However, the minutes to the FRG meeting (see quote above) do not provide an adequate explanation of the costs and benefits of averaging the two consultants' projections. The final IASR also does not provide any additional guidance on why the two central scenarios are the consultants' "best" projections.[35]

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30 AEMO, FRG Consultation for 2021 IASR on DER, May 2021, p.8.
31 AEMO, Draft FRG Minutes - 31 March 2021, p.4. This was raised by a Consumer Panel member.
32 AEMO, FRG Consultation report, May 2021, p.
33 AEMO FRG consultation report - 2021 DER, p. 8.
34 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021 p. 51
35 AEMO Inputs, Assumptions and Scenarios Report, 30 July 2021 p. 51.

AEMO also states that it has adopted GEM and CSIRO in some scenarios on the basis that this provides a greater dispersion of forecasts across scenarios, commenting in the final IASR that:[36]

> AEMO includes both consultant forecasts based on stakeholder feedback and to explore a level of dispersion across the scenario collection to capture the long term uncertainty of DER uptake.

AEMO should also clarify why it has elected to apply GEM forecasts in some scenarios and CSIRO forecasts in others to support dispersion, given AEMO states it will be modelling a high DER sensitivity across all scenarios. More broadly, AEMO should also explain how the different application of the two consultants' projections will be consistent with the relevant scenario narratives, given the large differences in projections from the two consulting processes - especially for the 'Step Change' (19 per cent or ~11 GW by 2050) and 'Hydrogen Superpower' scenarios (19 per cent or ~13 GW by 2050).

We expect AEMO to further explain, in its addendum to the IASR, why its proposed approach to incorporating CSIRO and GEM forecasts to the IASR is appropriate. In particular, AEMO should consider the appropriateness of its choice of DER forecast for each scenario in light of the characteristics of that scenario.

Separately, AEMO's IASR also states that it has assumed that energy consumption is expected to rebound by 20 per cent of the energy generated by PV systems, as lower future energy bills may change consumption behaviour or trigger investments in equipment that use more electricity.[37] AEMO has advised that this assumption was consulted on in the draft IASR and through the electricity forecasting methodology consultation process.[38]

AEMO received one submission to the demand forecasting methodology consultation process, and referenced academic research supporting the 'rebound effect'. However, we consider that AEMO could have supported clarity on the need to engage on this issue in the draft IASR by explaining the materiality of this assumption (e.g. the impact of on total and peak demand forecasts). We provide this feedback to promote more effective engagement on this issue in future IASRs.

4.2.2 Government policy settings

Government policy is one of the most important assumptions in the ISP and can materially affect the planning results. In particular, if not applied correctly, these assumptions can drive inefficient planning outcomes by installing generation and accompanying transmission investments that do not support least cost development of the electricity system.

For these reasons, the NER specifies that AEMO may consider government environmental and energy policy in the ISP where that policy has been sufficiently developed to evaluate its impact on the power system; and one of the following is satisfied:[39]

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36 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021 p. 51.

37 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021 p. 52

38 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021 p. 50.
AEMO, Electricity demand forecasting methodology. Final Report and Determination, May 2021 pp. 23-24

39 NER cl. 5.22.3(b)aa

- a commitment has been made in international agreement to implement that policy
- the policy has been legislated; or
- there is material funding allocated to the policy in a budget of a participating jurisdiction.

AEMO stated that, for the purposes of the ISP, it will consider policy commitments as defined in the NER up until May 2021.[40] We understand that AEMO has adopted this approach to ensure that it will be able to undertake modelling to ensure the timely publication of the draft ISP in December 2021.

AEMO has assessed that the Victorian Government's recent policy announcement, budgeted, to establish six Renewable Energy Zones (REZs) in Victoria may not be included in the modelling for the ISP at this stage.[41] Conversely, the IASR states that the 2022 ISP will model other policy initiatives such as the Tasmanian Renewable Energy Target (TRET) on the basis that it has been legislated.[42]

The AER considers that AEMO should clarify the potential differential treatment of government policy initiatives; for example: TRET which is legislated and the Victorian Government's REZ policy in the ISP which has a material budget allocation. We expect AEMO to further explain, in its addendum to the IASR, how it determines whether a particular policy is sufficiently developed to inform its impacts on the power system. We also expect that should further details be provided by the Victorian Government during the ISP process that AEMO will provide a further update and outline the process for consulting with stakeholders in the draft ISP.

4.2.3 System security assumptions and minimum demand

AEMO has indicated that minimum demand (driven by the uptake of solar rooftop PV) is likely to affect the ability to operate the power system in a secure operating state.[43]

AEMO predicts minimum demand by applying the Electricity Demand Forecasting Methodology as part of its ESOO report. This methodology is not within the scope of this review. However, the key drivers of minimum demand, and its link with maintaining system security were identified as the purpose of the 'Slow Change' scenario in the IASR process.[44]

Explanation of relevant parameter

AEMO presented its maximum and minimum demand projections to stakeholders at the FRG meeting on 14 June 2021.[45] This presentation noted that rising PV uptake is likely to be a significant driver of rapid reductions to minimum demand over the next few years to a decade. In South Australia, minimum demand is expected to fall below zero in 2023 and is

40 AEMO, Draft Inputs, Assumptions and Scenarios Report, 12 December 2020, p. 6.
41 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021, p.25
42 AEMO, Draft Inputs, Assumptions and Scenarios Report, 12 December 2020 , p. 44
43 AEMO, NEM Engineering Framework Operational Conditions Summary, 2020, p. 17
44 AEMO, Draft Inputs, Assumptions and Scenarios Report, 12 December 2020 p. 25
45 AEMO, Forecasting Reference Group Meeting Pack – Draft Maximum and Minimum Demand Forecasts, June 2021

projected to range between -600 to -800 MW by 2030. In Victoria, minimum demand is expected to fall below zero by about 2027 and in NSW, minimum demand is forecast to halve by the end of the decade. These represent significant shifts in the projections from that modelled through the 2020 ESOO.

We acknowledge that the final results and drivers of the minimum demand projections will be detailed in the 2021 ESOO. However, given the significant downward shift between the 2020 ESOO projections and the 2021 draft ESOO projections[46], we would expect AEMO to outline the implications for maintaining power system security, if relevant. In particular, AEMO has previously raised system security concerns associated with minimum demand.[47] Further, we understand that any system security issues associated with minimum demand are currently being managed through operational practices and would expect AEMO to advise if this will continue to be the case.

We seek AEMO's clarification on whether any system security assumptions in the IASR are the result of minimum demand projections. If this is the case, we expect AEMO to explain, in its addendum to the IASR, the basis for these system security assumptions.

4.2.4 Generator operational assumptions

The way in which the technical capabilities of generators are modelled will have a material impact on ISP outcomes.

For several generator technical parameters (including complex heat rates, minimum stable levels, ramp rates for coal generators and minimum and maximum capacity factors), AEMO has relied on internal studies to inform the proposed values. We consider that AEMO would improve transparency by publishing these internal studies for stakeholder feedback.

The operating flexibility of thermal generators will also be critical under conditions of accelerated market transition arising from the continued influx of variable intermittent renewable generation.

AEMO has stated in the IASR that unit commitment for coal power plant will not be modelled in the ISP due to uncertainty over the ability of coal plant to operate flexibly.[48] However, AEMO has identified that coal generators will likely be required to operate more flexibly in the future, as the penetration of variable renewable energy resources in the NEM increases.[49]

We expect AEMO, in its addendum to the IASR, to provide further explanation of its approach to taking into account these operational strategies.

46 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021 p. 57
47 AEMO, NEM Engineering Framework Operational Conditions Summary, 2020 p. 17
48 AEMO, Inputs, Assumptions and Scenarios Report Consultation Summary Report, July 2021, p.68.
49 AEMO, Inputs, Assumptions and Scenarios Report Consultation Summary Report, July 2021, p.68.

4.2.5 Generator technology costs and storage assumptions

The build costs for new generators in the NEM are an important input given these costs effect the capital costs of existing and new generation and storage and therefore the estimated benefits of avoided or deferred generation and storage in the ISP.

Explanation of relevant parameter

AEMO has largely relied on Aurecon estimates of generator build costs (i.e. capital cost per MW) with the exception of pumped hydro build costs. Pumped hydro storage costs were sourced from an Entura 2018 report and an uplift factor of 50 per cent was applied to these costs.[50] AEMO states this uplift factor was applied to the Entura estimates to address stakeholder feedback to the 2020 ISP process.

However, AEMO should further explain the basis of its assumption regarding an additional uplift factor that has been applied to Entura's estimates of pumped hydro costs. AEMO should also explain its basis for assuming that Entura's analysis of pumped hydro cost contingencies was not appropriate and the basis for arriving at the 50 per cent uplift figure.[51,52,53]

We expect AEMO, in its addendum to the IASR, to provide further explanation of its approach to determining the uplift factor it has applied to pumped hydro costs and the reasoning for this assumption.

4.2.6 Forced generator outage assumptions

Forced outage rates (FORs) are a critical input for AEMO's reliability assessments and for modelling the capability of dispatchable generation capacity more generally. Forced outage of generators across the NEM can have significant implications for total system cost, as plant outages put upward pressure on the cost of providing energy from the assets already in place.

For ISP 2022 modelling purposes, AEMO collected information on historical outages, and (for selected participants) outage projections across the 10-year forecast period. The historical data was based on 11 years of outage data for coal, gas and hydro generating plants in the NEM. [54]AEMO's collection of historical FOR data and forward trajectories has significantly improved since 2020 ISP, where FORs were derived based on the most recent four years of data only[55].

50 AEMO, Final Inputs, Assumptions and Scenarios Report; p. 95
51 GE Hydro, Submission to draft IASR, 2021 p.2-3.
52 AEMO, Inputs, Assumptions and Scenarios Report Consultation Summary report, 30 July 2021 p. 73
53 The Entura capital costs include a contingency of 20% when compared to reported estimates of pumped hydro costs.
54 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021, p. 74.
55 AEMO, Forecasting and planning scenarios, inputs, and assumptions Report, August 2019, p. 43

AEMO also commissioned AEP Elical to provide the forward-looking outage values for coal-fired generators.[56] For a limited number of generators where a forward-looking projections were not provided or where outage projections were not sufficiently substantiated with explanations or evidence, AEMO has supplemented or replaced these forecasts with those provided by AEP Elical.

In response to stakeholder submissions, AEMO also provided information on new entrant generator outage assumptions. In particular, AEMO commissioned Aurecon to report on new entrant generation outage assumptions (such as wind and solar).[57]

Explanation of relevant parameter

In addition to stakeholder submissions to the draft IASR 2021, AEMO held a separate FRG in June 2021 to consult on its proposed approach on calculating FORs. The FRG presentation on forced generator outage assumptions also noted that these assumptions incorporated the implications of high impact, low probability (HILP) events. The ESOO Reliability and Forecasting methodology explains how FOR assumptions are adjusted to account for HILP events, but does not explain the conceptual basis for this adjustment.[58]

We sought clarification as to whether this assumption was required to ensure the ISP reasonably reflects the investments that will be necessary to meet the 0.002 per cent unserved energy standard. AEMO committed to provide a response to all FRG attendees. AEMO has subsequently removed discussion on HILP events in the final IASR 2021.

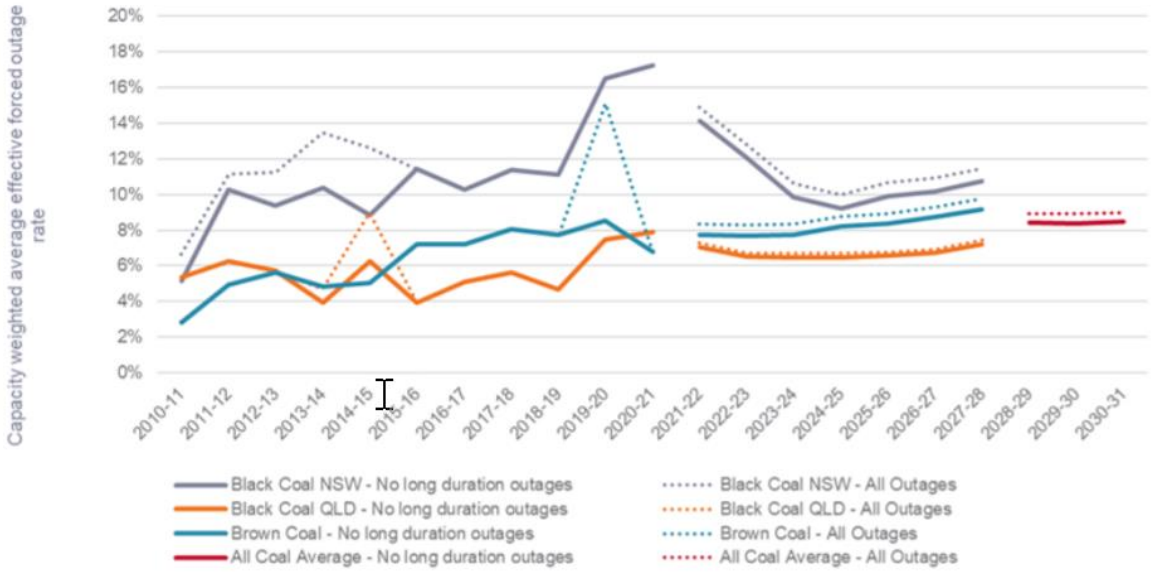
For the 2021 IASR, AEMO provided 10 year forward looking forced outage rate trajectories for both thermal generating plants and hydro plant. The 2021 IASR provides information on the process for collecting and calculating FOR data, and publishes:[59]

- FOR assumptions for new entrant generators; and
- Forward looking FOR trajectories.

Figures 1 and 2 from the 2021 IASR, show AEMO's 10-year projections for the effective full FORs of existing thermal and hydro technologies, with and without the effect of long duration outages.[60]

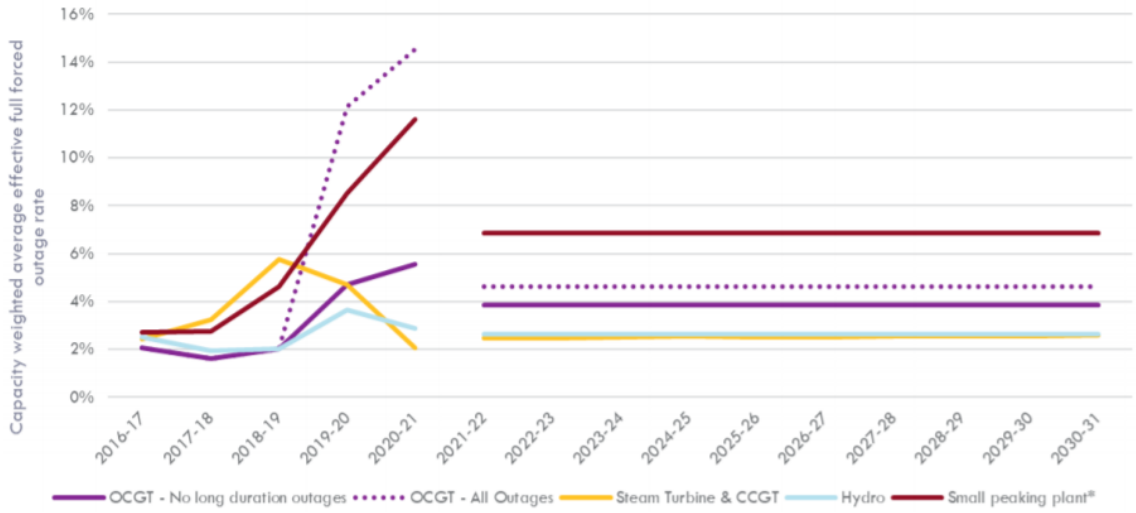
56 AEMO. Inputs, Assumptions and Scenarios Report, 30 July 2021, p.75
57 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021, p. 79
58 AEMO, FRG presentation - Forced outage rates, 30 June 2021 p. 5
AEMO, ESOO and Reliability Forecast Methodology Document, August 2020, pp. 9-10
59 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021, pp. 75-76
60 AEMO, Final Inputs, Assumptions and Scenarios Report, 30 July 2021, p 76

Figure 1: Final IASR 10-year projections for equivalent FORs of coal fired generation technologies[61]



Source: AEMO, IASR, 30 July 2021

Figure 2: Effective full forced outage rate projections for other generation technologies[62]



Source: AEMO, IASR, 30 July 2021

However, we consider the forced outage trajectories for existing thermal and hydro generating plants have not been adequately explained. Specifically, AEMO has not explained why:

61 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021 Figure 29, p. 78
62 AEMO, Inputs, Assumptions and Scenarios Report, 30 July 2021 Figure 30, p. 78

- the profiles for OCGT, CCGT, hydro and small peaking plants, presented in Figure 2, are held constant between 2021 and 2031.
- the profiles for coal, in contrast to other thermal plant between 2021 and 2031.

We expect AEMO to further explain the basis for these projections in its addendum to the IASR.

Separately, there appears to be some inconsistency between the different terminologies used in the FOR section of IASR 2021. In some instances AEMO uses the term `equivalent forced outage rate` while in others `effective forced outage rate` which is likely to confuse stakeholders. We expect AEMO to provide further explanation, in its addendum to the IASR, a clear definition of each term.

5 AER findings

AEMO must provide further explanation, in its addendum to the IASR, about how it has derived the ISP parameters set out below, and to consult on the following issues in the draft ISP.

Multi-sectoral modelling

- AEMO must provide further explanations on the relationship between the multi-sectoral modelling and the separately derived:
    - energy efficiency forecasts produced by Strategy Policy Research and consulted on through the 28 April FRG process.
    - rate of distributed energy resource (DER) uptake (both distributed solar PV and batteries) developed by GEM and CSIRO and consulted on over three FRG events (March to May).
    - rate of electric vehicle adoption developed by CSIRO and consulted on through the FRG process in February and April.

Distributed Energy Resource projections

- AEMO must provide further explanation as to why it proposes to adopt an average of consultant projections for distributed PV and battery uptake for some scenarios and a single source for the remaining scenarios.

Government policy assumptions

- AEMO must provide further explanation as to why the budgeted policy initiative to develop six renewable zones in Victoria is not sufficiently developed at this stage to determine its impact on the power system and may not be included in the draft ISP, whereas other policy initiatives which are legislated or budgeted will be included in the draft ISP.

Forced outage rate projections

- AEMO must provide further explanation supporting the assumed outage profiles for:
    - OCGT, CCGT, hydro and small peaking plants between 2021 and 2031.
    - Thermal coal power plant which are assumed to vary over the 10-year projection.
- AEMO must explain further the differences, if any, between the two terminologies 'equivalent forced outage rate' and 'effective forced outage rate' are similar or different in definition.

Other issues

- AEMO must provide further explanations of whether any system security assumptions are driven by the minimum demand projections and if relevant, the basis for these assumptions.

- AEMO must provide further explanations justifying the application of an uplift factor of 50 per cent to the 2018 Entura estimates of capital costs for new entrant pumped hydro generators.
- AEMO must provide further explanations justifying the assumption that thermal coal plant will not operate flexibly.

Appendix A

Table 1: FRG consultation on parameter choices that were informed by multi-sectoral modelling.[63]

FRG event	24 Feb 2021	1 March 2021	31 March 2021	28 April 2021	5 May 2021	30 June 2021
DER	-		Draft PV and battery Results projections (report)	PV and battery forecasts by CSIRO and GEM (presentation)	Consultation summary report on EV, PV and battery forecasts published.	
EV	EV forecasting methodology and assumptions (report)		Draft EV Results (report)	EV forecasts (presentation)		
Energy efficiency				Energy Efficiency forecasts (presentation)		
Multi-sectoral modelling (MSM)		AEMO engaged consultants to undertake MSM in its response to stakeholder submissions to draft IASR			MSM approach and methodology (presentation)	MSM results (Presentation) Incorporating MSM to IASR inputs (Presentation)
Industrial load surveys					Large industrial load forecasts (presentation)	
Appliance uptake					Draft appliance forecasts	

63 AEMO 2021. Forecasting Reference Group meeting packs distributed to mailing list.

Max and minimum demand	Draft Maximum and minimum demand forecasts (Presentation)