RELIABILITY PANEL AEMC

REVIEW

Reliability Panel AEMC

DRAFT REPORT

2022 REVIEW OF THE RELIABILITY STANDARD AND SETTINGS

9 JUNE 2022

INQUIRIES

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ABOUT THE RELIABILITY PANEL

The Panel is a specialist body established by the Australian Energy Market Commission (AEMC) in accordance with section 38 of the National Electricity Law and the National Electricity Rules. The Panel comprises industry and consumer representatives. It is responsible for monitoring, reviewing and reporting on reliability, security and safety on the national electricity system, and advising the AEMC in respect of such matters.

RELIABILITY PANEL MEMBERS

Charles Popple (Chairperson), AEMC Commissioner
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EXECUTIVE SUMMARY

1 This draft report has been prepared for the Reliability Panel's (Panel) 2022 Reliability standard and settings review (2022 RSS review). The purpose of the 2022 RSS review is to consider whether the existing form and level of the reliability standard and settings remain appropriate for the expected market conditions from 1 July 2025 to 30 June 2028 (FY2026 - FY 2028).[1]

2 The RSS reviews focus on the reliability provided by power generation and interconnection assets (interconnectors) to meet customer demand and are limited to the key parameters that affect reliability in the market— reliability standard and the four reliability settings, being the Market Price Cap (MPC), Cumulative Price Threshold (CPT), Administered Price Cap (APC) and the Market Floor Price (MFP). The standard and settings aim to encourage sufficient investment in generation or demand response capacity to meet consumer demand for energy, while protecting market participants from potential financial risks that threaten the overall stability and integrity of the market.

3 The draft report provides a range of Panel positions and observations informed by the analysis undertaken at this stage of the review, rather than a set of specific recommendations. It recognises that there is a suite of considerations and modelling outcomes that the Panel still needs to have regard to. Further, the Panel is of the view that it is important to obtain stakeholder input and feedback on modelling outcomes before making any final recommendations. The Panel must provide its final report to the AEMC by 1 September 2022.[2]

Panel decision-making considerations

4 The 2022 RSS review is bound by a specific framework in the NER and the RSS review 2021 Guidelines. This includes a set of specific assessment principles that the Panel must apply when determining the final recommendations for the reliability standard and settings that include:

- allowing efficient price signals while managing price risk,
- delivering a level of reliability consistent with the value placed on that reliability by consumers, and
- providing a predictable and flexible regulatory framework.

5 The Panel needs to apply these considerations in its decision-making, but notes, that for this review and the final report, the Panel will need to make more judgements than in the past for the standard and settings for the period of 1 July 2025 to 30 June 2028. This is because the review is:

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1 The change to a three-year period is a result of the National Electricity Amendment (Extension of time and reduction in scope of the 2022 reliability standard and settings review) Rule 2022 No. 2, which excluded 2024 from the review period because the 2022 RSS review final report date was delayed to September 2022. The review 4-year cycle is expected to return for the next RSS review (expected to commence in 2026).

2 Australian Energy Market Commission, *Extension of time and reduction in scope of the 2022 reliability standard and settings review*, final determination, 2 December 2021, Sydney.

- being undertaken against the backdrop of unprecedented and rapid change in the energy market and hence more uncertainty in future market conditions. The Panel has aimed to deal with this future uncertainty in its approach to the modelling for the review, in particular looking at a larger range of sensitivities and scenarios based on the issues identified by the Panel and stakeholders.
- broader in scope than in the past, with the Panel considering both the appropriateness of the form and level of the reliability standard and settings for the required period.
- considering the reliability standard and settings in the context of a NEM experiencing a changing reliability risk profile. The Panel considers the NEM's ongoing transition from a capacity limited thermal power system to a high variable renewable energy generation (VRE) more energy-limited power system will change the drivers of unserved energy (USE) and the resulting risk profile.

6 The review has been undertaken in the context of the existing energy-only market design. The Panel notes and recognises the interaction of the review and the work of the Energy Security Board (ESB) to design a capacity mechanism (and any required market price settings in that context) as directed by National Cabinet.[3]

7 The Panel is working with the ESB so that the 2022 RSS review outcomes, in particular, the modelling result set can provide useful input and inform the ESB's work. To date, the Panel and ESB have had a number of meetings that have covered opportunities for collaboration, input into the Panel's modelling approach and how that work can be used as a platform for the ESB to build upon and use as necessary in particular, in their base case analysis. The Panel and the ESB will continue to meet during the final stages of the review and consider how the Panel's work can be used where needed. The Panel may make some commentary on this collaboration to the extent it is relevant in the final report.

Summary of draft Panel positions

8 The Panel provides the following draft position summary in regard to the form and level of the reliability standard and settings for the review period. These positions are:

- based on the issues under consideration and the modelling that has been undertaken to date for the review
- informed by stakeholder feedback to the Panel's Issues Paper published in January 2022 and ongoing consultation, including from the RSS review Public Forum held in March 2022, and
- provided in accordance with the requirements of the Panel under the National Electricity Rules (NER), the RSS review 2021 Guidelines and AEMC terms of reference.

Modelling for the 2022 RSS Review

9 Intelligent Energy Systems (IES) have been engaged to undertake modelling to inform the Panel's considerations in this RSS review. Chapter three provides an introduction to the

3 Refer to https://www.energy.gov.au/sites/default/files/2021-12/Capacity%20mechanism%20initiation%20paper%20-%20December%202021a.pdf

modelling approach, models used, and other modelling considerations. This draft report should be read in conjunction with the IES 2022 Reliability Standards and Settings Review - Modelling Report which has been published concurrently.

10 The modelling undertaken by IES for the review involved detailed time-sequential modelling of the NEM,[4] to evaluate the efficient level of reliability and associated market price settings for a set of candidate new entrants considered on a technology-neutral basis.[5] These included generation options, storage, and demand response.[6]

11 A set of sensitives and scenarios were modelled to capture the uncertainty in relevant circumstances over the review period. Modelled uncertainty includes operational uncertainty in respect of weather-dependent generation and demand patterns and the potential for generation and transmission outages, as well as understanding whether there are emerging drivers for USE in a power system that is transitioning towards high levels of weather-dependent VRE.

12 The IES modelling outcomes are reflected in terms of a central base case, scenarios and sensitivities and reveal that:

- the central base case does not indicate a reliability gap in any NEM region between FY2026 - FY2028.[7]
- a reliability gap was synthesised in New South Wales (NSW) and Victoria (VIC) for the purposes of solving the efficient market settings. This gap was achieved by removing existing thermal generation in NSW and VIC as the two regions with reliability outcomes that were the closest to the level of the reliability standard.
- the distribution of USE associated with reliability performance at 0.002% USE over FY2026 - FY2028 is dominated by short-duration events. Low probability long-duration events, however, are still possible and contribute to expected USE outcomes.[8]
- A shift in the distribution of USE towards long-duration USE events in VIC is observed under the low VRE scenario in the outer years of the review period. No material change in the distribution of USE was observed in New South Wales under the low VRE scenario.

Form of the reliability standard

13 The Panel is still considering whether the existing form of the reliability standard - expressed as USE - remains appropriate and fit for purpose going forward, particularly in the context of a changing market and hence reliability risk profile.[9]

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4 This modelling included the effect of solar PV, demand response, and electric vehicle uptake.

5 Candidate new entrants include the generation and demand response technology options that are assessed as potential lowest cost marginal new entrant for the purpose of identifying market price settings.

6 The impact of DR as a marginal new entrant is considered as a sensitivity case for comparison with base case outcomes. Marginal new entrant DR is taken to be that which is not currently economic but would become economic with an increase in the MPC/CPT.

7 The Panel notes that there could be future changes where this base case outcome may change, for example, but not limited to, if there are additional closures, higher or updated forced outage rates or transmission developments planned do not meet their expected timeframes.

8 Short duration events can be considered as less than 2 - 5 hours in duration while long-duration events are in excess of 5 hours.

9 The current form of the reliability standard for the NEM is expressed in terms of the expected USE in a region and the existing level of the standard is set at a maximum of 0.002% of the total energy demand in that region for a given financial year.

14 The Panel, however, identifies a case for changing the form of the reliability standard as the NEM transitions from a primarily capacity limited thermal power system to a more energy limited high VRE power system. For this draft report, the Panel is not making a specific recommendation on the form of the reliability standard, but rather seeks stakeholder feedback on its approach to and considerations for reform. The Panel's draft directions on the form of the reliability standard are, however:

- USE is a more suitable metric for the form of the reliability standard rather than loss of load expectation (LOLE) and loss of load probability (LOLP). LOLE and LOLP are not considered to sufficiently capture a changing reliability risk profile in the NEM due to its transition from a capacity limited thermal power system to a more energy limited high variable renewable power system.
- A set of more than one metric may be required in order to capture features of both expected and more extreme events, particularly given higher expected levels of inter-annual and intra-annual renewable energy output variability.
- The form of the reliability standard should provide additional information to describe acceptable USE, for instance via augmenting expected value measures with "tail" indicators.
- The form of the reliability standard could also include risk-aware approaches that could incorporate consumer and investor risk aversion associated with long-duration high impact tail risk related reliability events.[10]

15 The draft report presents a 'straw person' risk-aware option for reform of the reliability standard for stakeholder feedback. Further detail on the Panel's considerations for the form of the reliability standard is presented in Chapter four.

Level of the reliability standard

16 Given the Panel's ongoing considerations of the form, it has not made a draft recommendation at this stage on a specific level for the reliability standard to apply over the period FY2026 -FY2028. The Panel is seeking stakeholder views on the IES modelling outcomes as they relate to the level of the standard. A detailed discussion of the Panel's considerations and IES modelling outcomes for the level of the reliability standard are set out in Chapter five.

17 The standard is set at a level that balances delivering reliable electricity supplies and maintaining reasonable costs for customers. It represents an economic trade-off between reliability and affordability, based on what customers value. The Panel considers the efficient level of the reliability standard, which balances the economic trade-off between reliability and affordability, to be the level of reliability that minimises total system costs including the costs to consumers from USE.

18 The Panel is aware that increasing uncertainty associated with a more weather dependent power system is driving concerns on the level of the standard. The Panel acknowledges these concerns however considers that future amendments to the form of the standard may be the

10 'Risk-aware' approaches include specific elements of the reliability standard and techniques that provide for consumer and societal risk aversion to be embedded within the reliability framework. Further details are provided in Chapter 4.

most appropriate approach to addressing a changing reliability risk profile.

19 The IES modelling does not reveal a material benefit by changing the level of the reliability standard when expressed as a percentage of USE and when assessed using the base case values of customer reliability (VCR).[11]

- The minimum system generation and USE cost occurs with OCGT as the marginal new entrant and occurs at a level of USE of approximately 0.0015%.[12]
- The difference between 0.002% and 0.0015% reliability outcomes with the OCGT as the marginal new entrant represents less than a 0.2% difference in total cost. This roughly indicates around a $10 million dollar a year benefit from adjusting the current level of the reliability standard to 0.0015%.

20 The IES modelling considered low and high VCR sensitivity cases to provide information about the trade-off and cost of achieving potentially higher or lower levels of reliability. The Panel notes the IES modelling indicates that the efficient level of reliability does not shift materially from the base case level under the low VCR sensitivity.[13] In contrast, the efficient level associated with the high VCR case[14] is noted to decrease significantly and is around 0.001%. The Panel seeks stakeholder feedback on the outcomes under the base, low, and high VCR cases.

Market Price Cap and the Cumulative Price Threshold

21 The Panel is not making any specific recommendations on the level of the MPC[15] and CPT in this draft report.[16] It does however present the IES modelling outcomes that identify a range of possible candidate MPC/CPT combinations for stakeholder consideration and seeks views on the Panels' approach to identify a NEM wide MPC/CPT recommendation in its final report.

22 The MPC and CPT should together be sufficient to support investment outcomes consistent with the reliability standard while also limiting potential systemic financial risks. For this reason, the level of the MPC and CPT are considered together in this draft report. The Panel notes that the IES modelling reveals:

- a materially significant misalignment between *existing* MPC and CPT with the MPC/CPT which is required to provide investment consistent with the reliability standard over the period 1 July 2025 to 30 June 2028, and
- the IES modelling indicates, taking account of a number of considerations, a range for the MPC of around $21,000/MWh to $29,000/MWh and a corresponding CPT of

11 The NER requires the Panel to have regard to any VCR determined by the AER and any changes that may be applicable to that VCR.

12 The OCGT used to identify this level of efficiency corresponds to the AEMO ISAR 'large' OCGT investment option.

13 The low VCR sensitive ranges were $26,685 - $38,338 in $/MWh.

14 The high case VCR, calculated as a VCR of around $100k/MWh in each jurisdiction of the NEM, consistent with the Panel's understanding of the VCR used by ACIL Allen in its modelling informing the ESB's decision on its interim reliability measure.

15 The MPC places an upper limit on wholesale market prices that can be reached in any trading interval. It serves as a limit on the bids of customers without demand-side response, preventing them from paying more than a set amount of energy in any dispatch interval. The value of the MPC is specified in the NER and is currently set at $15,100/MWh.

16 The CPT is a threshold on the cumulative price for energy and frequency control ancillary services (FCAS) over a period of seven days beyond which an administered price period (APP) commences and the APC is applied to market prices. The current level of CPT is $1,359,100 for the period 1 October 2021 to 30 June 2022.

$1,359,100 (corresponding to 7.5 hours at the existing MPC) and $4,176,000 (corresponding to 12 hours at a maximum MPC of $29,000/MWh).[17]

23 The Panel has identified a set of principles or guidelines to inform its final report recommendations on the MPC and CPT. These include among other things, reconciling the New South Wales and Victorian MPC/CPT result sets, and maintaining a level of predictability by considering potential transitional arrangements. These are outlined in Chapter six for stakeholder feedback.

24 The Panel is not considering any changes to the form of the CPT in this review, however, the Panel considers future reviews should consider specific changes to the form of the CPT. To facilitate detailed consideration to the extent possible, the Panel intends to identify and give qualitative consideration to alternate forms for the CPT in its final review report.

Administered Price Cap

25 The APC is the maximum market price paid to participants that can be reached in any dispatch interval and any trading interval, during an Administered Price Period (APP). The APC, combined with the CPT, is a mechanism to minimise financial stability risks to the market arising from an extended period of supply scarcity and corresponding high prices. It is set at a level sufficiently high to incentivise generation to make itself available during an APP.

26 The Panel's initial view is that the level and form of the APC at $300/MWh may remain appropriate for the period 1 July 2025 to 30 June 2028. The Panel is seeking stakeholder feedback to inform further consideration of the APC given recent increases in fuel costs. That is, the Panel intends to give additional consideration between the draft and final reports on how the APC can provide for a robust outcome given future fuel cost increases.

27 The Panel's draft position is that an APC at $300/MWh may remain broadly appropriate for the period of 1 July 2025 to 30 June 2028 because:

- AEMO's 2021 ESOO forecasts that fuel costs for most generation types are expected to decrease or remain the same from 2022 to 2040. The Panel is aware that unprecedented increases in fuel costs are driving stakeholder concern on whether the existing APC remains sufficient to cover generator variable costs during an APP. At this stage, the Panel considers these fuel cost increases are attributable to a set of geopolitical circumstances that do not reflect a structural change likely to remain applicable between FY2026 - FY2028.
- The APC compensation process is available for generators to cover any shortfall in market revenue during an administered pricing period (APP) and has, so far, been sufficient to recover generators' costs.
- Issues arising from limited incentives for storage or energy-limited resources are insufficiently material for the period FY2026 - FY2028 to justify a change.

28 The Panel draft position is based on a number of key considerations relating to the APC that include:

17 It is important to note that a higher MPC may not necessarily equate to higher consumer costs because the revenue associated with high price periods is still very small when compared to revenues across the rest of the year.

- Trade-off between mitigating the risk of a systemic financial risk and incentivising market participants to supply electricity during administered price events,
- Effectiveness of the compensation process, and
- Potential impact on the contract markets.

29 Further discussion of the Panel's position on the form and level of the APC is provided in Chapter seven.

Market Floor Price

30 The Panel proposes to retain the existing form and level of MFP at -$1,000/MWh for the review period from 1 July 2025 to 30 June 2028. The MFP sets a lower limit on wholesale market prices that can be reached in any trading interval and is set to reflect the amount that inflexible generators are willing to pay to remain dispatched.

31 The Panel's position is based on a number of considerations, including the trade-off between allowing the market to clear and not creating substantial risks to retail competition, the philosophy behind or objective of the MFP and costs and benefits of a shift in that philosophy or objective. The Panel notes that there have been relatively few MFP periods since five-minute settlement and the semi-scheduled dispatch rule change have both come into effect.[18] This suggests the market is clearing at an efficient level, and at this stage, there is not sufficient evidence to suggest that the MFP at its current level inhibits the efficient entry of storage or demand response in the NEM.

32 The Panel, therefore, considers implementing the MFP as an investment signal for demand response and storage is not warranted for this review and review period. The Panel's considerations for the MFP are outlined in Chapter eight.

Panel considerations for the final report and next steps

33 In addition to the Panel requirements described above, the review's scope does not consider USE arising from security-related incidents, [19] such as non-credible or multiple contingency events.[20] The review also does not account for the impact of other processes that impact system reliability as seen by the consumer, such as the powers of the Australian Energy Market Operator (AEMO) to intervene in the operation of the market through the reliability and emergency reserve trader (RERT) or directions for reliability.[21] The Panel notes, and is considering the increasing relationship between security and reliability related events in its consideration of the form of the reliability standard in Chapter four.

34 As noted the design of a capacity mechanism by the ESB is out of scope for the review. The Interim Reliability Measure (IRM) that was introduced with the purpose to improve the

18 Chapter eight discusses that five-minute settlement reforms and the semi-scheduled generator dispatch rule change appear to have reduced, through improvement in bidding incentives, the trigger of MFP events.

19 Clause 3.9.3 (b)

20 "Security" relates to operating the power system within defined technical limits even if there is an incident, such as the loss of a major transmission line or large generator. USE under NER reliability frameworks is limited to that associated with insufficient generating and inter-regional transmission capacity given the set of credible contingencies that may occur.

21 AEMO provides information to participants on projections and forecasts relevant to reliability outcomes and also has tools that it can use to intervene, when needed, to maintain reliability.

reliability (resource adequacy) of the electricity system in the short term is also out of scope for the 2022 RSS review.[22] The Panel may however provide commentary on the IRM in its final report to the extent that this is relevant to the Panel's assessment of the reliability standard and/or settings.[23]

35 The Panel has noted that it will only consider and recommend a change when there is a reasonable possibility that these recommended changes will, or are likely to, contribute to the achievement of the National Electricity Objective (NEO) in a materially better way. Further discussion of the Panel's considerations of materiality is outlined in Chapter two.

36 For changes the Panel considered necessary over the power system transition, but not immediately required in respect of the period FY2026 - FY2028, the Panel intends to provide commentary on when such reforms may be required over time.

37 The Panel is to set out its conclusions and recommendations as part of a final report to the AEMC.[24] Where the Panel recommends any changes to the form or level of the reliability standard or settings, the Panel is required to submit rule changes to the AEMC given the existing standard and settings are set out in the NER. The AEMC will then go through its rule change process for any change to the existing standard and settings.

Stakeholder input and submissions

38 The Panel is committed to seeking stakeholder feedback on its draft report and providing opportunities for engagement. The Panel therefore welcomes stakeholders to engage with the Panel in the final stages of the review. Chapter one sets out the remaining timeframes for the review.

39 The Panel invites submissions from interested parties in response to this draft report by Thursday, **7 July 2022**. Submissions will generally be published in full on the AEMC's website.

40 Electronic submissions must be lodged online through the AEMC's website www.aemc.gov.au using the link entitled "lodge a submission" and reference code "REL0082". Our treatment of the content of your submission, including agreed confidential information, is also explained on that page. The submission must be on letterhead (if submitted on behalf of an organisation), signed and dated.

22 Refer to COAG Energy Council, Interim Reliability Measure, October 2020.

23 AEMC Terms of Reference to the Reliability Panel for the 2022 Reliability Standard and settings review, January 2022.

24 Clause 3.9.3B of the NER.

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

This Draft Report has been prepared for the Reliability Panel's (the Panel) 2022 Reliability standard and settings review (2022 RSS review). It sets out the Panel's current considerations for the reliability standard and settings required for the period of 1 July 2025 to 30 June 2028. The Draft Report outlines the Panel's positions or directions where it is appropriate to do so at this stage of the review. The Panel must provide its 2022 RSS review Final Report to the AEMC by 1 September 2022.[25]

The Panel's current considerations and positions in this Draft Report are based on the outcomes of:

- the NER and RSS review 2021 Guidelines requirements for the Panel
- the suite of issues the Panel is considering
- the modelling that has been undertaken by the Panel to date. The modelling approach and key results for the 2022 RSS review are provided in Chapter three and discussed in each chapter as appropriate.
- stakeholder feedback:
  - to the issues paper, published in January 2022,[26]
  - at the public forum held in March 2022, and
  - from ongoing consultations with the Panel held to date.

This chapter provides a recap as per the Panel's issues paper, of the:

- purpose and scope of the 2022 RSS review
- Panel requirements and process for the 2022 RSS review, and
- stakeholder engagement and input into the Draft Report and the 2022 RSS review.

1.1 Purpose and scope of the 2022 RSS review

The 2022 RSS review is to consider the reliability standard and settings that will apply on and from 1 July 2025 to 30 June 2028 for the existing energy-only market. The change to a three-year period is a result of the National Electricity Amendment (Extension of time and reduction in scope of the 2022 reliability standard and settings review) Rule 2022 No. 2, which excluded 2024 from the review period because the 2022 RSS review final report date was delayed to September 2022. The review 4-year cycle is expected to return for the next RSS review (expected to commence in 2026). More information about the rule change can be found here.

25 The extension of time for the review final report was a result of the AEMC's final rule and determination on the Extension of time and reduction in the scope of the 2022 reliability standard and settings review rule change. Australian Energy Market Commission, *Extension of time and reduction in scope of the 2022 reliability standard and settings review*, final determination, 2 December 2021, Sydney.

26 Reliability Panel, *2022 Reliability standard and settings review*, issues paper, 27 January 2022, Sydney.

1.1.1 In scope for the 2022 RSS review

For the Panel's 2022 RRS review, the Panel is to consider whether both the existing form and level of the:

- reliability standard remains appropriate for the expected market conditions from 1 July 2025 to 30 June 2028, and if not, recommend a revised form and or level of the standard.
    - The current reliability standard is expressed in terms of the expected unserved energy (USE) in a region and is set at a maximum expected unserved energy of 0.002% of the total energy demand in that region for a given financial year[27] It is an ex-ante standard used to indicate to the market the required level of supply to meet demand on a regional basis. The standard is operationalised by AEMO, including informing the market that the standard is not being met.
- reliability settings remain appropriate for the market conditions expected from 1 July 2025 to 30 June 2028, and if not, recommend a revised form and or level of the settings.
    - The reliability settings are price mechanisms designed to incentivise investment in sufficient generation capacity and demand-side response to deliver the standard while providing limits that protect market participants from periods of very high or very low prices, both temporary and on a sustained basis. The settings consist of the:
        — Market Price Cap (MPC), which places an upper limit on dispatch prices in the wholesale market,[28]
        — Cumulative Price Threshold (CPT), which represents the limit of aggregate dispatch prices over a period of seven days (2,016 trading intervals)[29] that, when surpassed, triggers an Administered Price Period (APP),[30]
        — Market Floor Price (MFP), which places a lower limit on dispatch prices in the wholesale market,[31] and
        — Administered Price Cap (APC), which is the prevailing dispatch price that applies during an APP after a set of sustained high dispatch prices exceed the cumulative price threshold.[32]

The 2022 RSS review is a broader review than in the past, as both the form and the level of the standard and settings are being considered.[33] The Panel is also undertaking the review against the backdrop of unprecedented change in the energy market, and at a rapid pace. It is also further challenged by the time frames by which the Panel needs to complete the 2022 RSS review.

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27 Clause 3.9.3C(a) of the NER.

28 Clause 3.9.4 of the NER.

29 This was changed from 336 trading intervals to 2,016 five minute trading intervals with the introduction of five-minute settlement on 1 October 2021. See Australian Energy Market Commission, *Schedule of reliability settings*, 25 February 2021 and National Electricity Amendment (Five Minute Settlement) Rule 2017 No. 15, cl 3.14.2.

30 Clause 3.14.1 of the NER.

31 Clause 3.9.6 of the NER.

32 Clause 3.14.1 of the NER.

33 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, Sydney.

Given this, the Panel will need to make judgements on a wider range of modelling outcomes than was required in previous reviews. These judgements will be around the requirements for the Panel, the issues that it is considering, and the outcomes of the modelling and scenarios it has undertaken. These are discussed in the various chapters of this report, particularly the modelling in Chapter three and standard and settings in Chapters six to eight.

Given the transition occurring in the NEM, its uncertainty and speed, the Panel will also make some decisions around the changes that are required in this review for the period relative to those changes that could be made in future reviews. For changes that are identified as emerging given the power system transition, but not immediately required, the Panel intends to provide commentary on the nature and rationale for when such reforms, and when they may be required over time.

1.1.2 Out of scope for the 2022 RSS review

The reliability of the power system is a complex issue. There are many factors that affect the system's overall reliability as well as the level of reliability a particular customer may experience.

As outlined in the Panel's issues paper, the 2022 RSS review focuses on the reliability provided by power generation and interconnection assets (interconnectors) to meet customer demand[34] and is limited to the key parameters that affect reliability in the market— reliability standard and the four reliability settings.

The 2022 RSS review is not considering USE arising from security-related[35] incidents, nor considering other factors and processes that impact on actual system reliability outcomes as seen by consumers, such as the powers of the Australian Energy Market Operator (AEMO) to intervene in the operation of the market. An example of a security-related event that is excluded from consideration is an incident such as a storm that brings down multiple major transmission lines, making it difficult for the power system to operate within its defined technical limits.[36]

Stakeholders should also note that disruptions to, or outages in the transmission and distribution "poles and wires" within a region, leading to loss of supply to homes and/or businesses are also excluded from consideration.

A comprehensive overview of reliability and security-related events and Panel insights on this is provided in the Panel's recently 2021 Annual Market Performance (AMPR) Final Report, published on 28 April 2022. A copy of the 2021 AMPR Final Report can be found here.

ESB work to design a capacity mechanism

In 2021, the ESB delivered its post-2025 market design advice to Ministers, with the implementation of the package currently underway, including its work to provide advice on

34 Reliability Panel, *2022 Reliability standard and settings review*, issues paper, 27 January 2022, p.5, Sydney.

35 "Security" relates to operating the power system within defined technical limits even if there is an incident, such as the loss of a major transmission line or large generator.

36 Clause 3.9.3C(b)(2) excludes unserved energy associated with non-credible or multiple contingency events from consideration when assessing performance against the reliability standard.

the design of a capacity mechanism. The ESB's work to design and provide advice to National Cabinet on a capacity mechanism (and any required reliability market settings in that context) is out of scope for the 2022 review as it is being developed by the ESB.[37]

The Panel and the ESB are however collaborating to consider the interactions between the Panel's work and that of the ESB's capacity mechanism design work. In particular, the modelling is an important piece of work that can provide a good foundation and help inform the ESB's work to the extent necessary.

The Panel and the ESB have had a number of meetings to discuss opportunities for collaboration, input into the Panel's modelling approach and how that work can be used as a platform for the ESB to build upon and use as necessary. The Panel and the ESB will continue to meet during the review and consider how the Panel's work can be used to inform the design of a capacity mechanism. The Panel may make some commentary on this collaboration and the relevance of the work on the reliability standards and settings to the development of a capacity mechanism to the extent it is relevant in the final report.

Interim Reliability Measure

The interim reliability measure is out of scope for the 2021 RSS review.[38] The Panel may, in accordance with the AEMC terms of reference issued for the 2022 RSS review comment on the interim reliability measure in the final report, to the extent that this is relevant to the Panel's assessment of the reliability standard and/or settings.

The interim reliability measure was put in place by the Energy Ministers Meeting (formerly COAG Energy Council) following advice from the ESB to improve the reliability (resource adequacy) of the electricity system in the short term[39] and is relevant for contracting interim reliability reserves and for the Retailer Reliability Obligation. The interim reliability measure for generation and inter-regional transmission elements in the NEM is a maximum expected USE in a region of 0.0006% of the total energy demand in that region for a given financial year.[40] The AEMC must conduct a review of the interim reliability measure by 1 July 2023.[41]

1.2 Panel requirements for the 2022 RSS review

There are a number of requirements that the Panel must comply with or take into account when undertaking its RSS reviews. These were outlined in the Panel's consultation paper and are outlined below and in Chapter two for stakeholder reference.

The key requirements that the Panel must comply with or take into account when undertaking its RSS reviews include:

- the requirements in the NER,[42]

37 Australian Energy Market Commission, *Extension of time and reduction in scope of the 2022 reliability standard and settings review*, final determination, 2 December 2021, Sydney.

38 Reliability Panel, *2022 Reliability standard and settings review*, terms of reference, 27 January 2022, p.2, Sydney.

39 COAG Energy Council, *Interim Reliability Measures*, October 2020, available here.

40 Clause 3.9.3C(a1) of the NER.

41 Clauses 3.9.3A, 3.9.3B, 3.9.3C and 11.128.12(c) of the NER.

42 Clause 3.9.3A of the NER.

- the RSS review 2021 Guidelines,[43] and
- the Terms of Reference provided by the AEMC.[44]

It is important to note that, for any recommended changes that the Panel may make in this review, the Panel would need to consider if those recommendations and changes will, or are likely to, contribute to the achievement of the NEO, and meet the requirements in the NER and the RSS review 2021 Guidelines. The Panel must also have regard to the terms of reference provided by the AEMC, stakeholder consultation and responses, modelling outcomes and any other factors the Panel considers relevant. When the Panel undertakes an assessment of the standard and settings in a review, the Panel must set out its conclusions and recommendations as part of its final report, which is provided to the AEMC.[45]

The Panel must submit to the AEMC any rule change proposal that results from a review as soon as practicable after the review itself is completed.[46] Any change to the form and level of the standard and settings would then be made through an AEMC rule change process.

1.3 Stakeholder consultation and engagement

The Panel is committed to wide-ranging stakeholder engagement and the Panel intends to continue the dialogue during the course of the review.

The Panel received 16 submissions to the 2022 RSS review issues paper, with commentary on the form and the level of the reliability standard, and the level of the reliability settings. The Panel also held its first public forum for the review in March 2022, which was attended by approximately 60 stakeholders.

In addition to these formal consultation processes, the Panel and review team have held a number of bilateral consultations on issues or considerations for the review. The Panel has welcomed these discussions and the valuable feedback it has received to date.

Table 1.1 provides the consultation timetable for the review.

Table 1.1: Timetable for the review

DELIVERABLE	KEY DATES
Issues paper published	27 January 2022
Public Forum	30 March 2022
Draft Report and supporting documents published	9 June 2022
Stakeholder submissions due	7 July 2022
Stakeholder engagement and consultation	July - August 2022
Final Report and supporting documents	1 September 2022

43 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, Sydney.
44 Reliability Panel, 2022 Reliability standard and settings review, terms of reference, 27 January, Sydney.
45 Clause 3.9.3B of the NER.
46 Clause 3.9.3A(i) of the NER.

The Panel invites stakeholder submissions and comments to this Draft Report. Submissions are due by 7 July 2022.

Submissions will generally be published in full on the AEMC's website. Electronic submissions must be lodged online through the AEMC's website www.aemc.gov.auusing the link entitled "lodge a submission" and reference code "REL0082". Our treatment of the content of your submission, including agreed confidential information, is also explained on that page. The submission must be on letterhead (if submitted on behalf of an organisation), signed and dated.

If choosing to make submissions by mail, the submission must be on letterhead (if submitted on behalf of an organisation), signed and dated, and posted to:

Reliability Panel

c/- Australian Energy Market Commission

PO Box A2449

SYDNEY SOUTH NSW 1235

1.4 Structure of this draft report

The structure for the remainder of this report is as follows:

- Chapter 2: Assessment Principles and Approach
- Chapter 3: Review Modelling - Approach, Considerations and Key Modelling Results
- Chapter 4: Part A: Form of the Reliability Standard
- Chapter 5: Part B: Level of the Reliability Standard
- Chapter 6: Reliability Settings: Market Price Cap and the Cumulative Price Threshold
- Chapter 7: Reliability Settings: Administered Price Cap
- Chapter 8: Reliability Settings: Market Floor Price
- Appendix A1: Approach to VCR sensitivity analysis
- Appendix A2: Reliability standard and reliability settings - past key determinations, recommendations and amendments
- IES Draft 2022 RSS Review Modelling Report (separate report).

2 ASSESSMENT PRINCIPLES AND APPROACH

This Chapter provides an overview of the Panel's assessment principles and approach for the 2022 RSS review. These were outlined in the issues paper published in January 2022 and generally supported by stakeholder submissions to that issues paper. Discussion of the Panel's specific requirements relevant to the reliability standard and each of the settings is provided in the relevant chapters, and stakeholder commentary on the assessment approach is provided in section 2.4 of this chapter.

The Panel is required to comply with the requirements in the NER and the RSS review 2021 Guidelines. These cover the following:

- assessment principles, as outlined in the RSS review 2021 Guidelines,
- specific criteria and considerations outlined in both the NER and RSS review 2021 Guidelines for the standard and/or settings, and
- the Panel's approach for any recommendations for change to the reliability standard and/or settings.

The RSS review 2021 Guidelines set out the general approach to and principles for the modelling that is undertaken. The modelling approach and principles are discussed in Chapter three.

2.1 Assessment principles in the 2021 RSS review Guidelines

The RSS review 2021 Guidelines state that when undertaking a review of the reliability standard and settings, the Panel will be guided by the NEO and the assessment principles set out below.

The NEO is:[47]

> To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to:
>
> (a) price, quality, safety, reliability and security of supply of electricity; and
>
> (b) the reliability, safety and security of the national electricity system.

The Assessment Principles set out in the RSS review 2021 Guidelines are:

1. **Allowing efficient price signals while managing price risk.** The Panel will exercise its judgement to balance, allowing for efficient price signals against managing wholesale price risk for participants. The settings should:
   a. allow sufficient scope for competition between buyers and sellers in the market to set efficient prices to achieve the standard, over the long run,
   b. be designed to provide a sufficient range to promote this behaviour in the market, and

47 National Electricity Law, s.8 as contained in National Electricity (South Australia) Act 1996 (SA).

c. also, provide protection from uncapped prices in any given trading interval and sustained high prices over a defined period, such that wholesale market outcomes do not result in inefficient over-investment, overly high financing costs, or excessive price risk for all participants.

2. **Delivering a level of reliability consistent with the value placed on that reliability by customers.** The Reliability Panel will have regard to estimates of the value placed on reliability by customers when exercising its judgement as to the level of the standard. The settings should be sufficient to support the level of investment necessary to deliver the reliability standard over the long run.
3. **Providing a predictable and flexible regulatory framework.** The Panel will exercise its judgement to achieve predictable outcomes recognising the importance stability creates for market participants in terms of investment while taking into account changing market conditions to support efficient investment and operational decisions by participants.

The assessment principles with the assessment criteria and requirements inform the materiality assessment that the Panel will apply in its consideration of the form and level of reliability standard and settings. For any recommended changes to the reliability standard and settings, the Panel would need to be satisfied that such changes will, or are likely to, contribute to the achievement of the NEO and meet the requirements in the RSS review 2021 Guidelines and the NER. As noted, if the Panel recommends a change to the standard and/or settings, this would need to be progressed through an AEMC rule change process.

2.2 Assessment criteria and considerations

As noted, there are a number of requirements in the NER that relate to the assessment of the standard and each of the settings. Other NER requirements relate only to the standard or a specific setting. This section outlines the overarching relevant criteria and requirements. The following sections in this chapter outline the other Panel considerations and the Panel's approach to any recommendations for change.

2.2.1 General assessment criteria in the NER that applies to both the reliability standard and settings

When undertaking each review, there are a number of requirements in the NER that the Panel must follow. These include:

- complying with the RSS review 2021 Guidelines,
- having regard to any terms of reference provided by the AEMC,
- having regard to the potential impact of any proposed change to a reliability setting on:
  - spot prices
  - investment in the National Electricity Market (NEM)
  - the reliability of the power system, and
  - market Participants.

- having regard to any value of customer reliability determined by the AER, which the Panel considers relevant, and
- any other matters specified in the RSS review 2021 Guidelines or which the Panel considers relevant.

As noted, there is a range of specific NER requirements that apply to the reliability standard and each of the settings. These are outlined in the RSS review 2021 Guidelines and also for stakeholder reference in the reliability standard and each of the reliability settings chapters.

2.3 Other considerations that the Panel may take into account

The Panel is also able to take into account other considerations in the 2022 RSS Review.

There is a range of interactions in setting the standard and each of the settings. Overall, the value of each market setting will affect the achievement of the standard. Within the settings, there are further interactions where changing the value of one setting will affect the optimal value of the other settings. There are also aspects of the framework that sit outside these elements that will affect their operation and the achievement of the reliability standard, for example, the RRO, RERT, and government policies.[48] These key interactions, issues and the judgements that the Panel will need to make are discussed in the relevant chapter for the reliability standard and each setting.

The Panel will consider the potential interactions between each of the reliability components, and it will consider the aspects that sit outside the framework to the extent the Panel is able to. There is an interaction with the reliability framework going forward. These include, where appropriate, the suite of jurisdictional policies that have been announced or are underway.[49] There are a range of issues and considerations that the Panel outlined in the issues paper and have been provided in this draft report.[50] These are important for the Panel when considering any changes required to the reliability standard and settings.

As outlined in Chapter one, the review of the interim reliability measure will be out of scope for the 2021 RSS review, along with the work underway by the ESB to design a capacity mechanism. However, in accordance with the Term of Reference, the Panel may provide commentary on the interim reliability measure to the AEMC in its final report to the extent that such commentary is relevant to the Panel's assessment of the reliability standard and/or settings. As indicated, the Panel is collaborating with the ESB so that aspects of the Panel's work can be utilised and built upon where necessary in the considerations for the design of a capacity mechanism.

2.4 Panel approach for any recommendations for change

There are a number of equally important steps that must take place for a change to the standard or settings, which ensure that stakeholders have the opportunity to understand and

48 While RERT and the RRO are relevant to actual levels of USE, their operation is outside the scope of this review.

49 An outline of the existing jurisdictional policies and programs as outlined in the January issues paper can be found here. Since that time, it is noted that there has been a range of other measures announced. The Panel will, to the extent it is possible, will consider those in this review. Refer to Chapter three on the modelling approach for more detail.

50 Reliability Panel, *2022 Review of the reliability standard and settings*, issues paper, 27 January 2022, pp.22-42, Sydney.

respond to any such change. The Panel considers that this process, in its totality, will ensure that the regulatory process remains predictable while balancing flexibility as the market evolves.

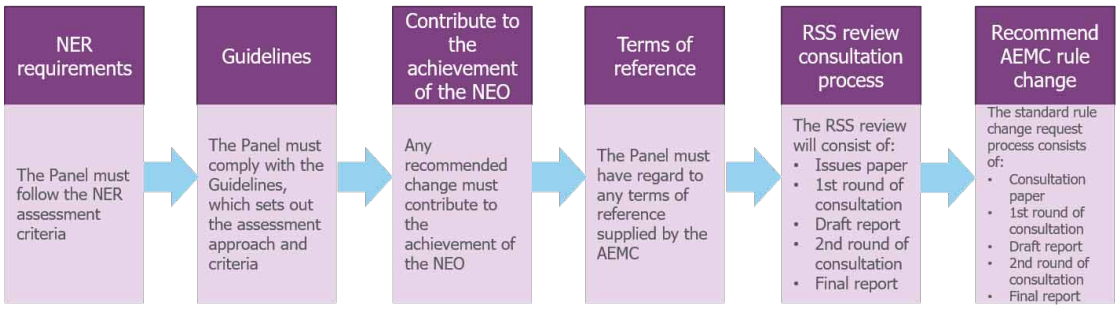
Further, to allow for predictability and flexibility in this review and incorporate new information regarding market transition and changes, the Panel will only change the level or form of the reliability standard or settings where there would be a material benefit in doing so. As such, as the first step of this review, the Panel will determine whether there is a reasonable possibility that a change in the form and/or level of the reliability standard or settings will, or is likely to, contribute to the achievement of the NEO and meet the assessment criteria above.

This will involve undertaking a qualitative assessment to determine whether there is sufficient evidence and a clear rationale that a change would result in a material benefit, which will take into account changes in the market and stakeholder feedback during the review. If there is sufficient evidence and clear rationale, a quantitative study would be undertaken to understand whether a material benefit may arise resulting from a change relative to the status quo and whether the material benefit is robust to a range of scenarios and sensitivities considered in the Panel's modelling exercise.

If the Panel recommends that the current standard or settings should change, as noted, it would need to submit a rule change request to the AEMC in order to implement these changes. The AEMC would consider any proposed changes through the usual rule change process, allowing further opportunities for stakeholder input and consultation.

As per the Panel's January issues paper, Figure 2.1 provides an overview of the Panel's approach.

Figure 2.1: Process and requirements for change



Source: AEMC

The Panel notes that generally stakeholder submissions supported the approach and identification of key considerations for the 2022 Review.[51] Commentary included and focused on:

51 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: EUAA, p.3; Origin p.1; Alinta, pp.4-5; Australian Aluminium Council, p.4.

- the 'materiality' test for any change. That is, any change the Panel may propose would have to go through the rigour of a rule change process.[52]
- the proposed assessment approach, whereby the case for changing the standards or settings should be dependent on the delivery of material benefits across a broad range of scenarios. A key area of focus for the Panel should be to evaluate the likely effectiveness of changes to the settings in incentivising investment in the resources needed to balance the system.[53]
- Importance of the Panel weighing reliability challenges against costs from any changes, undertaking analysis to account for decarbonisation and delivering regulatory reforms in a staged manner. This includes the need to explore incremental adjustments before designing new frameworks and ensure that the Panel assesses the benefits of incremental changes before ESB's new capacity market mechanism.[54]
- A qualitative assessment may be an unnecessary impediment, as outlined in the Issues Paper, to modelling the impact of a change in reliability settings.[55]
- The trade-off between energy 'reliability' and price is as much technical as it is a political-economic decision. The Panel should not be distracted by the broader political landscape[56]and the increased concern about reliability outcomes is likely based on an incomplete assessment of the available data.[57]
- The Panel should leave to the ESB's capacity mechanism work any question of achieving levels of reliability beyond the standard. [58]

The Panel will consider a range of combinations and options based on the base case modelling, sensitivities and scenarios applied. Further, the Panel may need to also consider the changes that are required in this review for the period relative to those changes that could be made in future reviews. For changes that are identified as necessary given the power system transition, but not immediately required, the Panel provides commentary on when such reforms may be required over time. This is outlined in more detail in Chapter three and for each relevant chapter for the reliability standard and settings.

52 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: EUAA, p.3; and Australian Aluminium Council, p.4.

53 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Origin p. 1.

54 Reliability Panel, 2022 Reliability standard and settings review, issues paper submission: CEC p.1.

55 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Snowy Hydro, p.3.

56 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Engie p.1.

57 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Shell p.1.

58 Reliability Panel, 2022 Reliability standard and settings review, issues paper submission: Australian Energy Council p.2.

3 REVIEW MODELLING - APPROACH, CONSIDERATIONS, AND KEY MODELLING RESULTS

BOX 1: KEY OBSERVATIONS AND MODELLING RESULTS

- The modelling performed to inform the Panel's considerations on the standard and setting is initially introduced before high-level unserved energy outcomes are presented.
- The modelling for the 2022 RSS review is being undertaken by Intelligent Energy Systems (IES). The IES modelling outcomes are reflected in the context of a central base case, scenarios and sensitivities. Scenarios and sensitivities were modelled to account for uncertainty given the transition of the power system to higher penetrations of variable renewable generation.
- IES base case modelling, which represents the Panel's best estimate of likely outcomes, does not indicate a reliability gap in any NEM region between FY2026 - FY2028 under the approach and assumptions used.
- A reliability gap was synthesised in New South Wales (NSW) and Victoria (VIC) for the purpose of identifying efficient market price settings. This gap was achieved by removing existing thermal generation in NSW and VIC as the two regions base case with reliability outcomes that were the closest to the level of the reliability standard.
- Modelling shows the distribution of unserved energy associated with reliability performance at 0.002% USE over FY2026 - FY2028 is dominated by short-duration events. Low probability long-duration events, however, may still occur and contribute to expected unserved energy outcomes.
- A shift in the distribution of unserved energy towards long-duration events is observed in VIC under the low variable renewable generation scenario towards the end of the review period. No material change in the distribution of unserved energy was observed in New South Wales over the review period.

Detailed modelling of the electricity market informs each RSS review. Modelling provides a quantitative basis for the Panel to identify efficient levels for the standard and market price settings.

This chapter summarises the Panel's modelling task and the approach taken by its consultant Intelligent Energy Systems (IES). Key high-level results are then provided as context supporting detailed consideration of the reliability standard and settings in the following chapters. Specifically, this chapter:

- summarises the modelling task and approach used to inform the Panel's consideration of the standard and settings
- presents key high-level results relevant to the Panel's considerations. These include:

- base case results showing the Panel's best estimate of unserved (USE) energy outcomes applying over the period relevant to the review,
- the distribution of USE energy events under modelled 0.002% USE level of reliability,
- high-level observations on the distributions of USE energy modelled under the base case and low variable renewable generation scenarios.

This chapter provides a high-level introduction to the general modelling approach. Further details on modelling relevant to the level or form of the standard and settings are provided in the relevant chapter. Additional information on modelling results, methods and assumptions are available in the IES modelling report published with this Draft Report.

3.1 The modelling task

The modelling task is to quantitatively support Panel decision-making on an efficient reliability standard and its associated market price settings, appropriately accounting for uncertainty in conditions applying during the period relevant to the review being 1 July 2025 to 30 June 2028 (FY2026 - FY2028).

The RSS review 2021 Guidelines require the RSS review modelling needs to inform the Panel's understanding on:[59]

- an efficient reliability standard consistent with delivering a level of reliability consistent with the value placed on that reliability by customers, and
- market price settings that provide sufficient financial incentives to support investment in the lowest cost marginal new entrant power system resource required to achieve reliability outcomes consistent with the efficient level of reliability.

In conducting the RSS review, the NER requires the Panel to have regard to the potential impact of any change to the reliability settings on the following.[60]

- spot prices,
- investment in the NEM,
- the reliability of the power system, and
- market participants.

The modelling performed for the review is specifically designed to address each of these requirements by modelling investment outcomes and price-dispatch dynamics in the NEM over the period relevant to the review. Modelling investment, price and dispatch outcomes in the NEM allows the costs of different investment options as well as the revenues accruing to those options to be identified.

Review modelling also captures uncertainty in relevant circumstances over the review period. Uncertainty in this regard includes operational uncertainty in respect of weather-dependent generation and demand patterns and the potential for generation and transmission outages, as well as understanding whether there are emerging drivers for USE in a power system that

59 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, p.37, Sydney.

60 Clause 3.9.3A(e)(3) of the NER.

is transitioning towards high levels of weather-dependent variable renewable generation (VRE).

The Panel has given significant consideration to the detailed assumptions in the modelling related to the treatment of uncertainty. This involved identifying and modelling scenarios and sensitivities to understand the impacts of changes in the power system over the review period.[61] The range of outcomes arising from the investigated scenarios and sensitivities then inform the Panel's conclusions on an appropriate level of the standard and market price settings described in Chapters 5 to 8 of this report.

3.2 Submissions to the issues paper

Stakeholder submissions to the review's issues paper generally supported the Panel's proposed approach to modelling to inform the Panel's considerations on the standard and market price settings.[62] In particular:

- Shell Energy supported the modelling approach and principles proposed by the Panel. Shell agreed that detailed, time-sequential modelling is crucial to assessing reliability as energy storage and VRE make up an increasing proportion of the supply assets.[63]
- EnergyAustralia (EA) considered the Panel's issues paper, and comments made by its secretariat in recent stakeholder meetings, indicate it has a solid grasp of its modelling task, particularly in designing scenarios and sensitivities to explore reliability drivers.[64]

Several stakeholders noted the importance of the Panel modelling utilising a set of assumptions and inputs that are common to those used in AEMO's reliability work:[65]

- Shell Energy considered assessment of the standard and settings should continue to be based on ensuring the ongoing supply to consumers based on forecasts of consumer demand and supply-side resources which are currently provided to the Panel by AEMO.[66]
- While CS Energy acknowledged the different objectives, as outlined in the issues paper, of NEM planning documents, such as the Electricity Statement of Opportunities (ESOO) and the Integrated System Plan (ISP), CS Energy considered it important for participants that there is a level of consistency between these documents and the input assumptions.[67]
- EA and the AEC both supported the use of AEMO's 11 reference year renewable generation traces as a means of accounting for variation in renewable generation levels including extended and widespread renewable energy droughts.[68]

61 These changes include accounting for new technologies including batteries and demand response as reliability providers.

62 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: CS Energy p.10; AEC p.6; Origin Energy p.7; Shell Energy p.7; EnergyAustralia p.4)

63 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Shell Energy p.7.

64 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: EnergyAustralia p.4.

65 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Shell Energy p.4; CS Energy p.1.

66 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Shell Energy p.4.

67 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: CS Energy p.1.

68 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: EnergyAustralia p.4; AEC p.6.

However, stakeholders also identified a number of challenges associated with modelling using the Panel's proposed approach.[69]

- AEMO considered that there is uncertainty in judging the economic level of the standard using a 'central planning' modelling approach which is highly sensitive to estimates of resource costs and consumers' willingness to pay.[70]
- EA questioned whether the Panel's modelling and assessment approach will primarily relate to achieving reliable outcomes out to 30 June 2028. EA considered a longer modelling time horizon was required to identify settings and a standard that provided for stable and predictable outcomes to support efficient investment over the longer-term power system transition.[71]
- Shell Energy, EA, and Engie further identified the potential for the perfect foresight assumption used in optimisation based electricity market modelling software to lead to overly optimistic results, particularly for storage assets.[72] Shell particularly considered imperfect foresight should be explicitly modelled when considering storage dynamics.[73]
- AEC and Engie both considered outcomes are likely to be sensitive to the use of portfolio-wide optimisation behaviour in the modelling. The AEC advised the Panel to take a conservative view with respect to portfolio optimisation, by applying bidding structures consistent with atomistic ownership.[74]

Stakeholders appreciated the Panel's challenge of modelling reliability outcomes in the context of high levels of uncertainty associated with a power system in transition.[75] Stakeholders generally supported the Panel's proposed approach of addressing uncertainty through scenarios and sensitivities. A number of relevant observations were made including:

- EA supported running more aggressive coal retirement sensitivities in addition to relying on endogenous economic retirements.[76]
- Shell Energy and the AEC noted the need for scenarios to address correlated, multi-region low renewable generation events. Shell Energy considered that to acknowledge the nature of these events it will be necessary to appropriately weight these scenarios, which may mean over-weighting since these periods will increasingly be the focus of investment for reliability.[77]

The issues raised in stakeholder submissions are addressed in the Panel's considerations on its draft position.

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69 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEMO p.2; EnergyAustralia p.2;

70 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AEMO p.2.

71 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: EnergyAustralia p.2.

72 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Shell p.7; EA p.4; Engie p.5.

73 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Shell Energy p.7.

74 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEC p.2; Engie p.5.

75 Reliability Panel, 2022 Reliability standard and settings review, issues paper submissions: EnergyAustralia pp.3-4; AEC p.6; Shell Energy p.7; Origin Energy p.8.

76 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: EnergyAustralia p.4.

77 Reliability Panel, 2022 Reliability standard and settings review, issues paper submissions: Shell Energy p.7; AEC p.1.

3.3 The modelling approach

The models implemented and the modelling approach used to inform the Panel's draft recommendations are introduced in this section. This is a summary that is intended to provide a contextual understanding of the modelling performed for the review. Further details on model specifications, inputs, and assumptions are provided in the accompanying IES modelling report published with this draft report.

The Panel's consultant, IES, developed two models to perform the quantitative market modelling necessary to inform the Panel's decisions. These models are the:

- **Core PLEXOS model** - an investment and operating model of the NEM that replicates the behaviour of the national electricity market dispatch engine (NEMDE). Detailed time-sequential modelling was performed using this model to identify the distribution of USE and revenues and costs accruing to each power system resource option over the relevant time horizon.
- **IES optimisation model** - a model to co-optimise the market price settings that minimise total system costs consistent with providing revenue sufficiency for the marginal new entrant investment required to achieve the reliability standard. Marginal entrants were evaluated on a technology-neutral basis, with a range of candidate technologies assessed. These included generation options, storage, and demand response.

Further details on the core PLEXOS model, the IES decoupled optimisation model, and their relationship are provided below.

3.3.1 Core PLEXOS model

IES used PLEXOS for Power Systems, developed by Energy Exemplar, to conduct time-sequential price-dispatch and investment modelling of the NEM.[78] Review modelling leveraged AEMO's ESOO and ISP work, in particular, AEMO's published 2021 PLEXOS database.[79] The AEMO database was adjusted to reflect the requirements of the reliability work carried out for the Panel ans was, in particular, augmented to model commercial and policy supported commercial new entry and retirement, implement generator bidding,[80] and account for planned maintenance.[81]

The core PLEXOS model applied assumptions set out in AEMO's inputs, assumptions, and scenarios report (ISAR) to the extent possible.[82] The key AEMO data inputs include:

78 Further information on PLEXOS for Power Systems can be found at: https://www.energyexemplar.com/plexos.

79 The Panel is unable to use the 2022 ESOO PLEXOS model given its August publication date and the timelines available for the review. The Panel understands that AEMO will make a number of changes to the 2022 ESOO model relative to the 2021 ESOO model. The Panel understands that the 2022 ESOO will no longer model forced outages on the Dederang-South Morang and Upper/Lower Tumut Dederang lines in Victoria. The Panel has also received stakeholder feedback that suggests modelling forced outages on these lines may increase USE in VIC relative to that likely in the 2022 ESOO.

80 This entailed allocation of the large generators to regional portfolios and calibrating the PLEXOS revenue recovery mechanisms to reflect 2021 generator bidding.

81 IES, Reliability *Standard and Settings Review modelling*, Modelling Report, June 2022 p. 39.

82 AEMO, 2020-21 Planning and Forecasting Consultation on Inputs, Assumptions and Scenarios, for more information see: https://aemo.com.au/consultations/current-and-closed-consultations/2021-planning-and-forecasting-consultation-on-inputs-assumptions-and-scenarios.

- the cost and technical characteristics of the candidate set of generation options modelled as new entrant resources
- VRE traces over the review time horizon. These included 11 weather reference year solar and wind generation traces.
- 50%, and 10% probability of exceedance (POE) demand traces incorporating peak demand and energy forecasts as well as electric vehicle charging loads
- Residential solar PV generation traces and price-sensitive demand response price-quantity bid curves.
- Forced outage rates and seasonal de-ratings for the NEM generation fleet and key transmission elements
- information relating to other factors that influence the generation mix over the assessment time horizon, including jurisdictional reliability and renewable energy schemes, end of life generator retirements and committed and anticipated ISP transmission development projects.

The core PLEXOS was used to model supply and demand dynamics in each of the five NEM regions on a 30-minute resolution, considering regional demands and transmission with intra-regional network constraints, seasonal generator ratings, generator bidding response and variable generation from solar and wind plants. It does not include ramp rates, unit commitment parameters, and the frequency control ancillary services markets.[83]

Investment under jurisdictional schemes was accounted for in PLEXOS modelling. Jurisdictional policies were included if they meet the NER criteria as being legislated or sufficiently committed.[84] This set of policies is consistent with that used by AEMO in its ISP and includes the QRET, VRET, TRET and NSW Electricity Infrastructure Roadmap.[85]

The core PLEXOS model uses a Monte-Carlo modelling approach, iteratively running many statistical simulations covering variations in forced outage profiles, weather-sensitive peak demands, and demand shapes to identify the distribution of USE across a base case and a number of relevant scenarios and /or sensitivities.[86]

The price-dispatch result set from the base case and scenario modelling was then used with the IES 'decoupled' optimisation model, described in the next section, to determine the marginal new entrant generator and associated market price settings (MPC and CPT in particular) in each region with a 'reliability gap' over the review time horizon.

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83 Modelling was conducted on an energy-only basis with FCAS revenues accruing to certain technologies estimated from historical outcomes and applied as outcome sensitivities. Further details on the approach to considering FCAS revenues are provided in section 3.3.4 and IES's modelling report.

84 Clause 5.22.3(b) of the NER defines a set of criteria AEMO must apply when considering whether to include jurisdictional environmental or energy policies in the ISP. These include meeting at least one of the following: 1) a commitment has been made in an international agreement to implement that policy; 2) that policy has been enacted in legislation; 3) there is a regulatory obligation in relation to that policy; 4) there is material funding allocated to that policy in a budget of the relevant participating jurisdiction; or 4) the MCE has advised AEMO to incorporate the policy.

85 While jurisdictional schemes are included in the generating mix, which is modelled, it should, however, be noted that revenue from jurisdictional schemes is excluded when identifying the efficient level of reliability and associated market price settings.

86 IES ran 3,300 simulations for the base case and 1,550 for each scenario. IES identified the required number of simulations necessary for convergence in the distribution of USE.

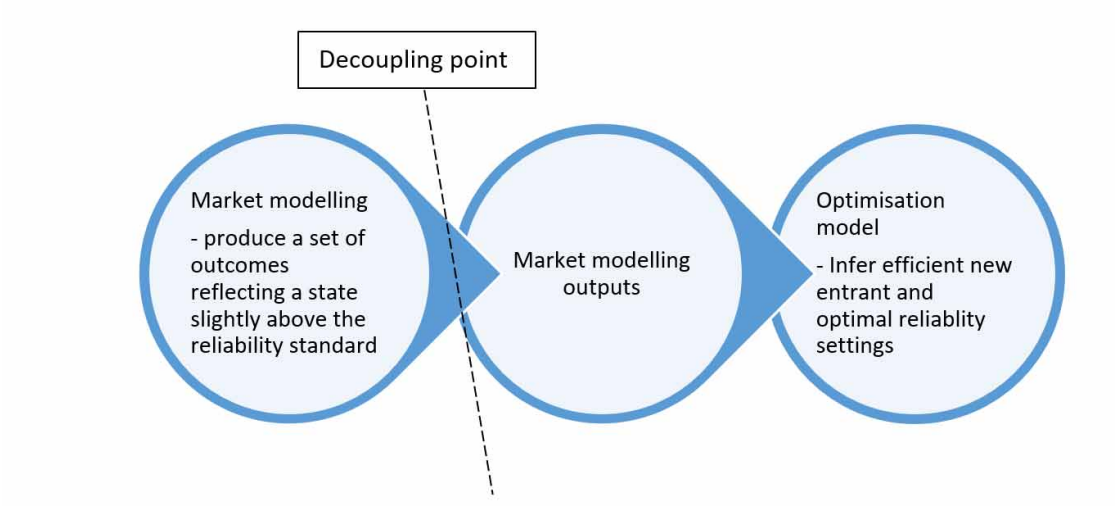
More complete details on PLEXOS model specifications are available in the accompanying IES modelling report.

3.3.2 IES optimisation model

Large Monte-Carlo models, such as the core PLEXOS model, do not allow outcomes to be easily assessed for specific levels of USE. To address this limitation, IES developed a separate optimisation model to identify the marginal new entrant and associated market price settings required to achieve a target level of USE such as that corresponding to the level of the reliability standard.

This optimisation model takes information from the core PLEXOS model on all relevant periods of USE to focus on the investment required to address the final element of USE required to achieve the target level of reliability. PLEXOS is first used to model price-dispatch outcomes for a level of reliability that is sufficiently close to the target level to allow the marginal new entrant to be modelled as a price taker which does not impact existing generator dispatch and pricing outcomes. The relationship between the core PLEXOS model and the IES optimisation model is illustrated in Figure 3.1.[87]

Figure 3.1: Core PLEXOS and IES optimisation model relationship



Source: IES, Reliability Standard and Settings Review - modelling report, Fig. 1.

IES's optimisation model retains the dynamics and technical limitations associated with each candidate new entrant generation types, including:

- OCGT and CCGT - Actual availability is de-rated for forced and planned outage assumptions based on AEMO IASR assumptions.[88]

87 The marginal plant also earns revenues in line with average revenues for the same generation type in the same region outside of the periods assessed in the optimisation.

88 However, 100% fuel availability is assumed.

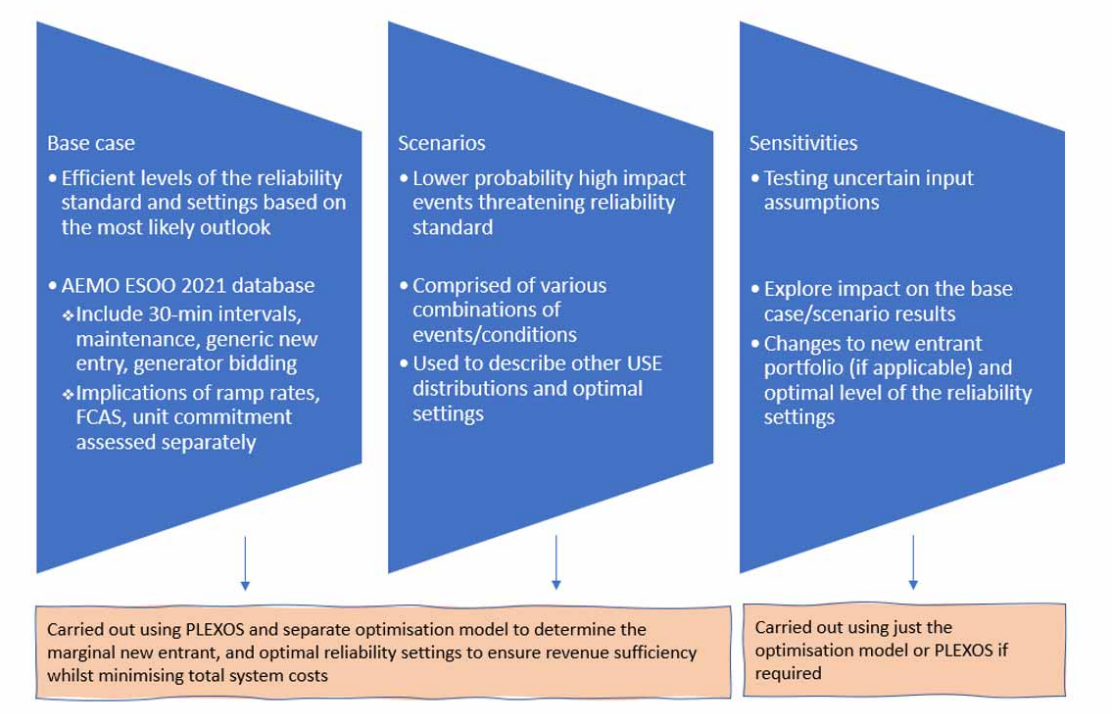
- Storage - The chronology of the USE events and periods leading up to them are maintained so that CPT and storage charging behaviour can be adequately captured. FCAS revenues are also considered in the revenue condition.
- Wind and solar - actual input traces and curtailment levels were used to account for actual solar and wind contribution during USE periods.

Additional details on IES's decoupled optimisation model are available in the accompanying IES modelling report.

3.3.3 Base case, scenarios and sensitivities

A set of scenarios and sensitivities were defined around a central base case to account for uncertainty in the circumstances applying over the period relevant to the review. Figure 3.2 illustrates the role of the base case, scenarios and sensitivities in the analysis with further explanation below.

Figure 3.2: Modelling base case, scenarios, and sensitivities



Source: IES, 2022 Reliability Standards and Settings Review - Modelling Report, June 2022, Fig. 2.

Base case and scenarios

The 'base case' represents the Panel's best estimate of reliability outcomes between FY2026 - FY2028. It directly leverages AEMO's 2021 ESOO central case assumptions updated to include the announced Eraring power station closure in Aug 2025.

IES models an efficient reliability standard and settings that reflect market conditions seven years into the future in the context of a rapidly changing power system. The Panel has addressed this challenge by including a limited set of scenarios to investigate the impact of emerging drivers of USE associated with the NEM's transition to high levels of VRE.

The Panel has identified the following scenarios, in addition to the base case, to be modelled over the course of the review:

- *Low RE yield:* Likely low energy availability associated with periods of low co-incident low solar and wind generation when the system is likely to be highly dependent on VRE.
- *Extreme weather:* to explore the impact of extreme weather conditions, i.e., low likelihood but high impact. This includes drought limiting the role of hydro combined with high demand and low wind yield.
- *Diversity of supply*: to explore how reliant the system is on particular NEM regions and the importance of interconnectivity to facilitate a diversity of supply.

These scenarios are intended to explore changes in the distribution of USE outcomes (shape, depth, frequency, duration, location) associated with non-traditional drivers of USE relative to the base case.

Scenarios for the review are not designed to represent specific possible futures but instead to stress reliability outcomes to identify whether an emerging driver may be a plausible reliability concern over the review period, FY2026 - FY2028. As such, scenarios should be understood as a screening exercise to establish plausibility with no specific probability attached to outcomes under these scenarios.

The Panel has focused on the base case and low RE yield scenarios in this draft report due to the limited time available for modelling prior to publication.

Sensitivities

While scenarios are designed to assess the impact of emerging drivers of USE, sensitivities are intended to address parameter uncertainty in identifying the marginal new entrant and associated market price settings.

IES's optimisation model provides a high level of flexibility to investigate the impact of a range of sensitivities on the marginal new entrant and resulting market price settings. This flexibility was utilised to account for uncertainty when establishing the MPC/CPT ranges put forward in the Panel's draft position presented in Chapter Six. Sensitivities are considered that allow the Panel to understand the impact of factors including:

- The impact of imperfect foresight in battery and OCGT market participation.
- Different capital costs
- Marginal new entrant operating limitations and dynamics.

Specific details of the scenarios investigated are presented in Chapter 6.

3.3.4 Other modelling considerations

This section presents the Panel's consideration of the following issues in its modelling:

- modelling on five-minute vs 30-minute time scales,
- approach to including FCAS revenues, and
- modelling demand response as a new entrant reliability resource.
- **Modelling on five-minute vs 30-minute time scales** - The Panel initially intended to model the NEM on a five-minute basis consistent with a five-minute settlement. The Panel has instead elected to model the NEM on a 30-minute basis. This decision was informed by the additional computational time and costs associated with five-minute modelling as well as the available renewable energy trace data which was limited to 30-minute resolution. 30-minute modelling does not provide for a detailed assessment of USE from ramping limits in the NEM. Due to time and resource limits ramping related USE has not been investigated in the modelling for this draft report. The Panel may consider the effect of ramp rate limitations between draft and final.
- **Approach to including FCAS revenues** - In its issues paper, the Panel considered co-optimised modelling of energy and FCAS markets. After considering the computational time, cost, and complexity involved in such modelling, the Panel has elected to perform time-sequential modelling on an energy-only basis and estimate FCAS revenues accruing to marginal new investment options from historic outcomes. The Panel identified that energy-FCAS co-optimisation involved complexity and computational requirements which didn't justify the additional insight that would be obtained from co-optimised modelling of these markets.[89] This information is then applied in IES's optimisation model to understand the potential impact of FCAS revenues on the marginal new entrant and associated price settings.
- **Modelling demand response as a new entrant reliability resource** - The Panel has elected to model demand response in IES's optimisation model as a candidate new entrant using a conservative approach informed by costs provided on a confidential basis by a demand response market participant. Marginal new entrant demand response is taken to be that which is not currently economic but would become economic with an increase in the MPC/CPT.[90] The impact of demand response as a marginal new entrant is considered as a sensitivity case for comparison with base case outcomes. Stakeholders should note that AEMO's ESOO demand response price quantity bid curves are applied in the core-PLEXOS modelling. This means demand response is fully accounted for in the price-dispatch and USE modelling then used by IES's optimisation model to identify the marginal new entrant and associated market price settings.

89 Historic FCAS revenues have been de-rated to account for an anticipated reduction in FCAS market prices and revenues from historically high recent levels. FCAS revenues are based on estimated FCAS revenues of $30,000/MW/year in 2022 reduced at 5% per annum.

90 $50,000/MW/year CAPEX and $5,000/MWh variable costs with a 2 hour daily response limit was assumed for candidate marginal new entrant demand response.

BOX 2: ONGOING CONSIDERATION OF DEMAND RESPONSE AS A MARGINAL NEW ENTRANT RELIABILITY PROVIDER.

The Panel has taken a conservative approach to incorporating demand response in the modelling in recognition of the high degree of uncertainty relating to marginal new entrant demand response costs and technical characteristics.

The Panel appreciates stakeholder interest and considers demand response an important future power system resource. The Panel looks forward to engaging with stakeholders on further consideration of demand response as a marginal new entrant resource in the modelling performed to inform recommendations in its final report.

3.3.5 Modelling process

A number of key steps make up the process used to model the base case and scenarios. A core element of this process is identifying whether there is a 'reliability gap' associated with the base case, or scenario.

A 'reliability gap' occurs when levels of USE in a region of the NEM exceed the level of the standard (or alternate target reliability level). A reliability gap is needed to identify the lowest cost new entrant resource in a region required to limit USE to the level of the standard.[91] The marginal new entrant, and associated market price settings, cannot be identified in the absence of a reliability gap.[92] Should the base case not show a reliability gap in one or more regions of the NEM, a reliability gap must be synthesised for the purposes of the review modelling.

The following four-step modelling process was used to identify efficient market price settings from a reliability gap in one or more NEM regions.

- **Step 1 - Determine if there is a reliability gap and establish the distribution of USE**: Utilise the core PLEXOS model, and establish whether there is a reliability gap accounting for policy-based new entrants and retirements.
- **Step 2 - Address most of the reliability gap:** Using PLEXOS, determine the lowest cost set of commercial new entrants bringing the level of USE very close to the reliability standard.
- **Step 3 - Synthesise a reliability gap (if necessary):** Remove capacity by retiring/removing generation to achieve USE just exceeding the target thereby allowing settings/standard levels to be determined.
- **Step 4 - Determine the marginal new entrant and optimal reliability settings:** 'Decouple' from PLEXOS and solve for the marginal new entrant and associated market

91 The characteristic shape of the distribution of unserved energy events that make up this reliability gap allows IES to determine, using its optimisation model, the lowest cost new entrant and associated market price settings considering generating capital and fixed operating and maintenance costs.

92 In the absence of a reliability gap, further investments will lead to higher total costs to consumers leading to inefficient outcomes (considering generating capital and investment costs + the cost of unnerved energy valued at VCR).

price settings in the IES optimisation model once levels of USE are sufficiently close to the target level that pricing and dispatch outcomes can be assumed to be unchanged by the marginal new entrant resource required to just achieve the target level of reliability.

The modelling process described above is used to identify market price settings. Additional information on the modelling approach utilised to identify the efficient level of reliability, and resulting reliability standard, are addressed in Chapter Five and IES's modelling report.

3.4 USE outcomes

This section presents high-level results on the level and distribution of USE modelled using the core-PLEXOS model. Base case, base case sensitivity, and low VRE scenario USE volumes are presented.

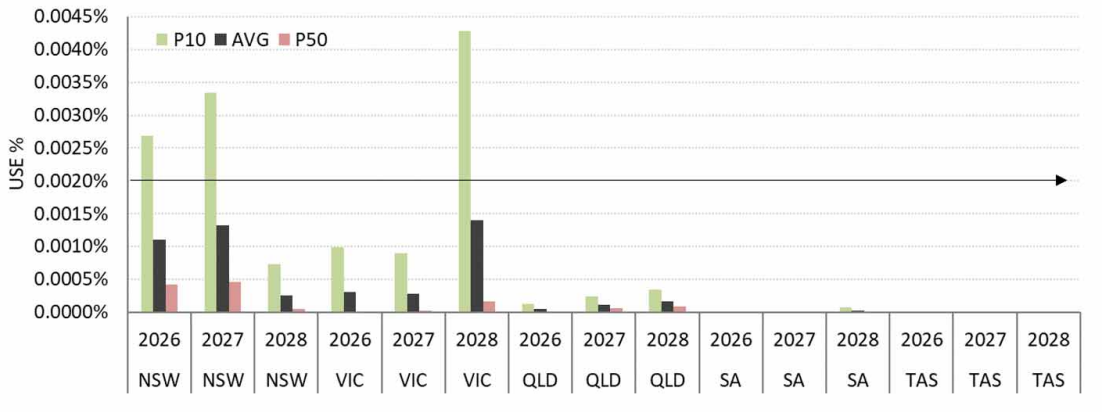
These results illustrate the application of the first three steps in the modelling process set out above and provide context to the results presented in the following chapters.

3.4.1 Base case USE

The base case was modelled to identify USE outcomes associated with the AEMO P50 and P10 demand traces. These USE outcomes were then statistically weighted to identify whether a reliability gap exists on an average basis in respect of one or more regions in the NEM.[93]

Base case USE outcomes are presented for each region of the NEM over the review period in Figure 3.3. NSW and VIC are identified as the two regions with USE outcomes closest to the level of the reliability standard. Other regions show little or no USE over the review period.

Figure 3.3: 2022 RSS review base case outcomes



Source: IES, 2022 Reliability Standards and Settings Review - Modelling Report, Fig. 22.
Note: The average is the 10% and 50% POE peak demand outlooks (weighted 30% and 70% respectively)

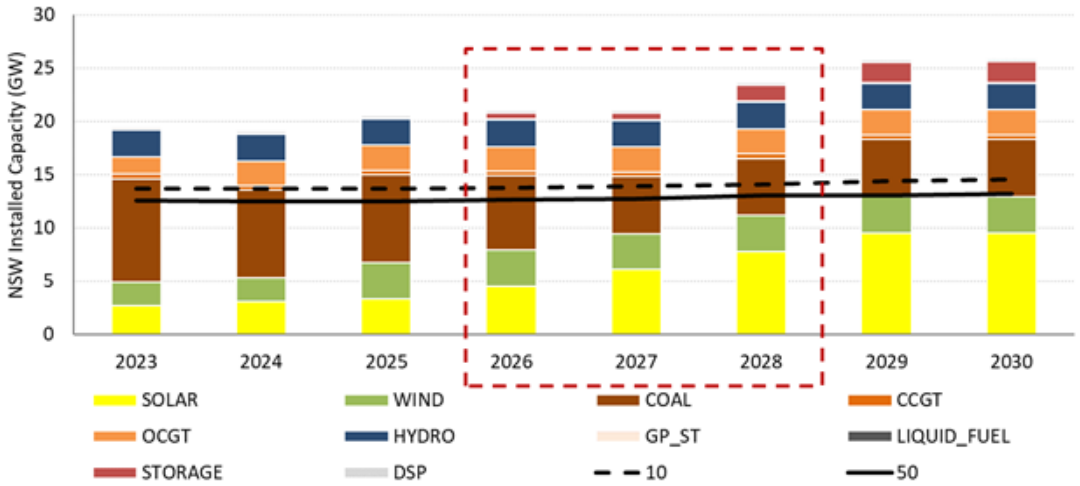
Observations on base case outcomes are:

93 The P10 result was weighted at 30% with the P50 result weighted at 70%. No USE is assumed to occur under the P90 result. Further details on the weightings can be found in the IES modelling report.

- There is no reliability gap in any jurisdiction, under the assumptions made here, even following the Eraring retirement. The NSW and VIC P10 cases both show USE levels that are in excess of the reliability standard, but the average remains below 0.002% once weightings have been applied.[94]
- NSW levels of USE are impacted by the early closure of Eraring but addressed by investment under the NSW Electricity Infrastructure roadmap (subject to ramp up, which is assumed to be linear).
- Supply and demand in VIC are tighter in FY2028 following two economic retirements at the Yallourn power station, however, no reliability gap is identified.
- No economic retirements are identified on top of Eraring and two units at Yallourn power station over the review period. The remaining thermal generators are revenue positive given the impact of Eraring and Yallourn retirements on revenue outcomes for other thermal generators.

NSW USE is at its highest in 2027 before declining in 2028 due entry of investments under the NSW Electricity Infrastructure Roadmap. The following figure shows the significant policy supported solar PV and wind investment that enters under the NSW Roadmap to replace the lost capacity following Eraring's closure.

Figure 3.4: NSW installed capacity over the review horizon



Source: IES, 2022 Reliability Standards and Settings Review - Modelling Report, Fig. 23.

The VIC outlook is relatively stable over the review horizon. The impact of Yallourn's retirement is compensated by increasing interconnector flows enabled by additional generation investment in other regions in particular that are incentivised under the NSW Electricity Infrastructure Roadmap and the Tasmanian RET. VIC reliability outcomes are

94 While the base case is the Panel's central view of likely reliability outcomes over the review period, stakeholders should note that a reliability gap may occur should actual circumstances not reflect the assumption and inputs used by IES in its modelling.

tighter in 2028, with expected USE of 0.0014%, however, still remaining below the 0.002% reliability standard.

The Panel notes these base case outcomes are largely consistent with AEMO's ESOO when 'anticipated' but yet to be fully committed new entrants arising from the NSW Roadmap are included.

3.4.2 Base case sensitivity USE

As no reliability gap was identified in any region under the base case, a reliability gap was synthesised to allow market price settings and/or the efficient level of the reliability to be identified in one or more regions.[95]

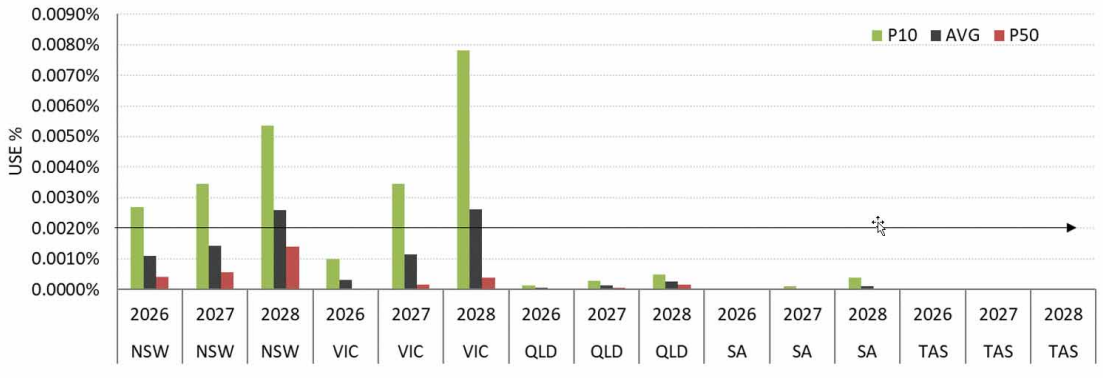
A reliability gap for the purpose of identifying market price settings was synthesised in NSW and VIC by removing capacity associated with the next scheduled thermal generator retirement. NSW and VIC were the two regions with a base case reliability outcome closest to the level of the reliability standard. Given this, they are also the two regions where commercial new entrants are likely required and are therefore most relevant to consider when identifying NEM wide market price settings.

A reliability gap was synthesised for NSW and VIC by removing:

- Vales Point power station in NSW from FY 2028
- Three Yallourn power station units in VIC from FY 2028.

Both Vales Point and Yallourn power stations are taken to retire roughly one year ahead of their currently announced retirement dates, as listed on the AEMO generation information page, and therefore represent a minimalist departure from the base case.[96]

Figure 3.5: Base case sensitivity USE



Source: IES, 2022 Reliability Standards and Settings Review - Modelling Report, Fig. 25.

95 The discussion of the reliability gap in this section is specific to the reliability gap created to determine the market price settings, in particular the MPC and CPT. The approach to identifying the efficient level of reliability is different and described in Chapter Five.

96 AEMO Generation Information Page, accessed 6 May 2022. For further information see: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information

Following the synthetic retirement of Vales Point and Yallourn power stations, a reliability gap is observed in both NSW and VIC in 2028. This reliability gap involves a level of USE that is just above the reliability standard thereby allowing market price settings to be determined for both regions.

Drivers of USE under the base case sensitivity

A combination of supply and demand factors were identified as drivers leading to USE under the base case sensitivity in NSW and VIC. USE was generally not attributable to any single variable. The following general observations can be made.

Modelled NSW USE is driven by:

- high loads, USE is generally observed for load within 15% of the annual peak.
- high forced outages at, mainly, coal plants. Planned and forced outages leading to up to 1/3 of the coal fleet being out of service are modelled.
- reduced VNI import limits from the south
- solar variation is not a driver of USE which tends to occur across evening peaks when solar is low, and
- low wind contribution (below 20%).

Modelled VIC USE is driven by:

- high loads, within 10% of the annual peak. Peak load conditions are more relevant for USE in VIC than in NSW.
- high forced outages, forced and planned outages of 30% of the coal fleet occur in modelling consistent with NSW.
- low wind occurring at the same time as significantly reduced interconnector import limits.

Additional analysis on the drivers of USE under the base case is provided in IES's modelling report.

3.4.3 Low VRE scenario

The low VRE scenario was constructed to assess whether low periods of solar and wind generation represented a plausible reliability risk during the period FY2026-FY2028. The scenario was developed as a screening exercise to stress NEM reliability rather than as a predictive exercise. IES consider the weather conditions modelled under the low VRE scenario to be possible but statistically improbable.

The low VRE scenario was constructed using a modified set of base case assumptions combined with two weather traces modelling lower monthly VRE generation, and lower peak demand VRE contribution than under the base case.[97] These traces were developed to specifically test outcomes that are outside the weather variation seen in the 11 reference years modelled in the base case.[98]

97 The base case was adjusted to remove 1 unit of Vales Point and 1 Yallourn unit in the system, which, combined with the low VRE traces, lead to a reliability gap with a total amount of unserved energy of 0.0025%. The unserved energy outcomes achieved from the low VRE scenario were identified as being sufficiently close to the reliability standard for use in IES's decoupled optimisation model.

As an example, in NSW the total monthly yield in the low VRE trace is 10% lower than the average of the 11 reference years, with up to a 25% difference in some months. The minimum peak demand contribution trace is on average 32% lower with deviations of up to 70% against the average of the 11 reference years. The RE generation in VIC is much more variable such that the low VRE yield traces are 22% lower than the average of the 11 reference years and low peak demand contribution traces are 51% lower than the average.

Given the time available for the review, IES was not able to develop low VRE traces that retained all correlations. The traces generated to maintain the correlation between wind and solar generation within the region and month, however, other implicit correlations were not considered.

The impact of the low VRE scenario on the distribution on USE is summarised in the following section alongside base case distributions. Full details of the method used to create the low VRE traces are available in IES's modelling report.

3.5 USE distributions

The following section summarises the USE distributions in 2028 for the Base case-sensitivity and low VRE scenario. These distributions correspond to USE slightly above the 0.002% USE reliability standard and are used to develop the market price settings in chapters six to eight.

BOX 3: INTERPRETING THE USE DISTRIBUTIONS

Stakeholders should note that the results here are associated with a level of reliability that is just outside the level of the reliability standard.

This level of reliability has been synthesised to allow the market price settings to be evaluated by adding the marginal new entrant.

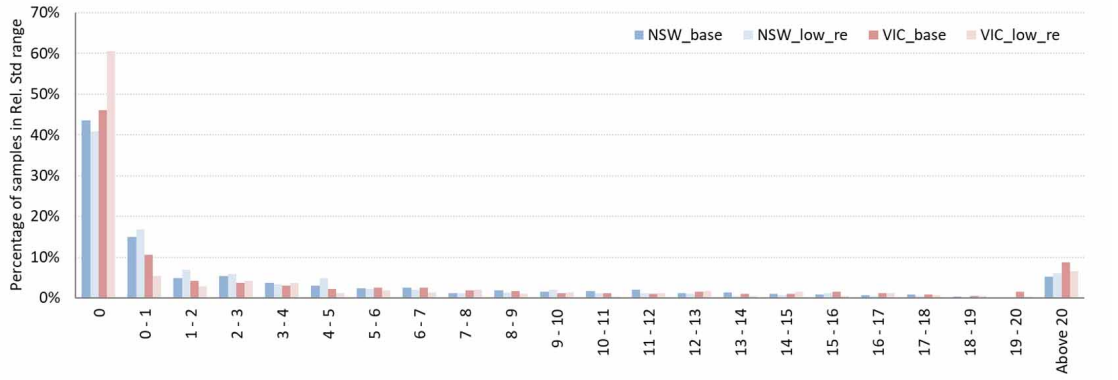
These are different to the Panel's best 'base case' estimate of reliability outcomes between FY2026-and FY2028 (which is below 0.002%) and also the consumer experience of wholesale market-related reliability given AEMO's use of non-market mechanisms such as directions and the RERT to limit load shedding.

Distribution of USE by sample

Figure 3.6 presents the amount of USE associated with each individual modelling sample for multiples of the level of the current reliability standard. IES ran 3,300 samples in its base case sensitivity and 1,550 in its low VRE scenario modelling. A sample is defined as a single iteration of the model and comprises variations in demand shapes, peak demands, outage profiles and renewable energy generation traces.

98 IES combined a single reference year (for demands, inflows, line limits) with two synthetically generated weather traces. The existing traces from the 11 reference years were then blended to form a complete trace.

Figure 3.6: Distribution of USE by sample for the base case and low VRE scenario



Source: IES, 2022 Reliability Standards and Settings Review - Modelling Report, Fig. 52.
Note: The x-axis represents multiples of 0.002% USE

The distribution of USE by samples shows a large percentage of samples (40%) with no USE and a long tail with more than 10% of all samples experiencing more than 10 times the reliability standard. VIC under the low VRE scenario has significantly more samples with no USE at 60% which is consistent with the shift in the distribution of USE for VIC under the low VRE scenario discussed further below.

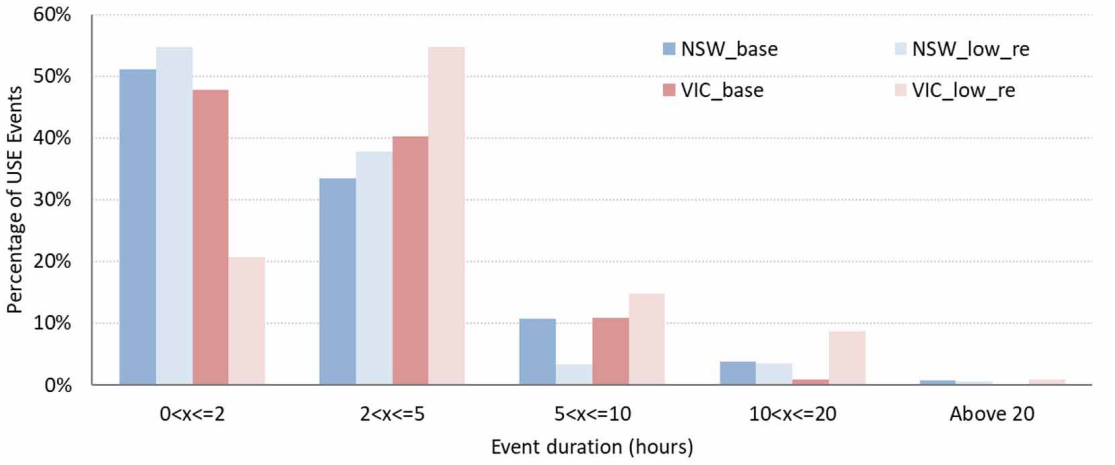
These distributions all correspond to an average level of expected USE close to the reliability standard level of 0.002%. Stakeholders should note that low probability long-duration tail risk events can still occur consistent with the level of the reliability standard due to the averaging effect associated with a standard that is expressed as an 'expected value' and given their low probability. Further consideration of 'tail risk' and the form of the reliability standard is provided in Chapter 4.

USE event duration and depth

Two key dimensions to the USE outcomes are duration and depth. Duration is defined as the total number of hours of USE during an event and maximum depth refers to the highest level of USE within an event. Depth is relevant as stakeholders may have a different cost of inconvenience associated with different event durations, indicated by a growing concern for long-tailed events or tail risk. Distribution of depth is important as it indicates the level of new entrant build to address duration.

Figure 3.7 to Figure 3.9 present the distributions of USE event duration for the base case sensitivity and low VRE scenario in NSW and VIC.

Figure 3.7: USE event duration

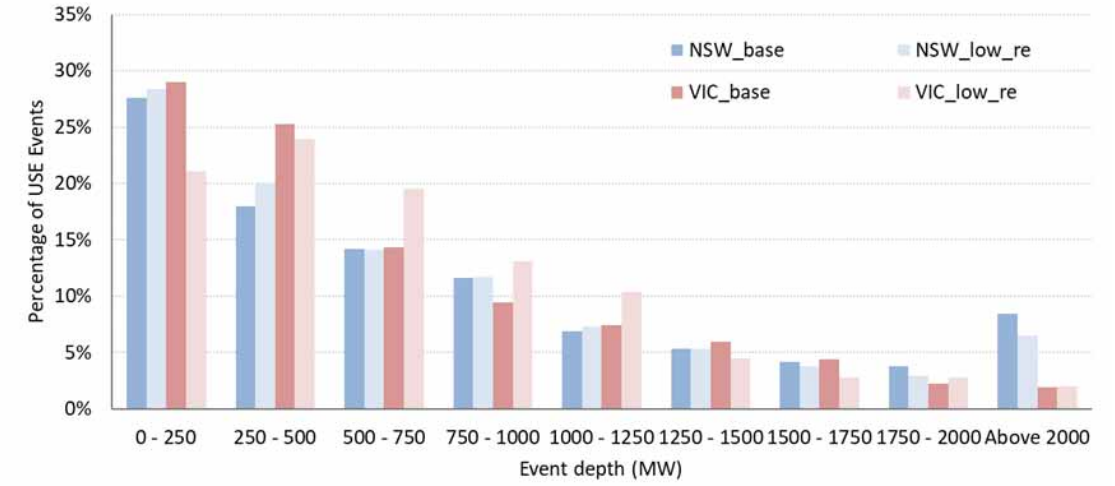


Source: IES, 2022 Reliability Standards and Settings Review - Modelling Report, Fig. 53.

These results show that despite the presence of a tail of greater than 5 hour events, modelled unserved energy event duration in NSW and VIC are mainly 0-2 and 2-5 hour periods. 2 hour events represent approximately 50% and between 2 – 5 hours approximately 35% of all USE events.

The distribution of USE event duration under the VIC low VRE scenario is however noted as significantly shifted relative to the base case distributions in each state. The NSW low VRE USE distribution shows a re-distribution of 5 to 10-hour events but no clear change in distribution bias. In contrast, VIC is observed to have a material shift in distribution bias with fewer short duration events but longer duration events.

Figure 3.8: USE event depth



Source: IES, 2022 Reliability Standards and Settings Review - Modelling Report, Fig. 54.

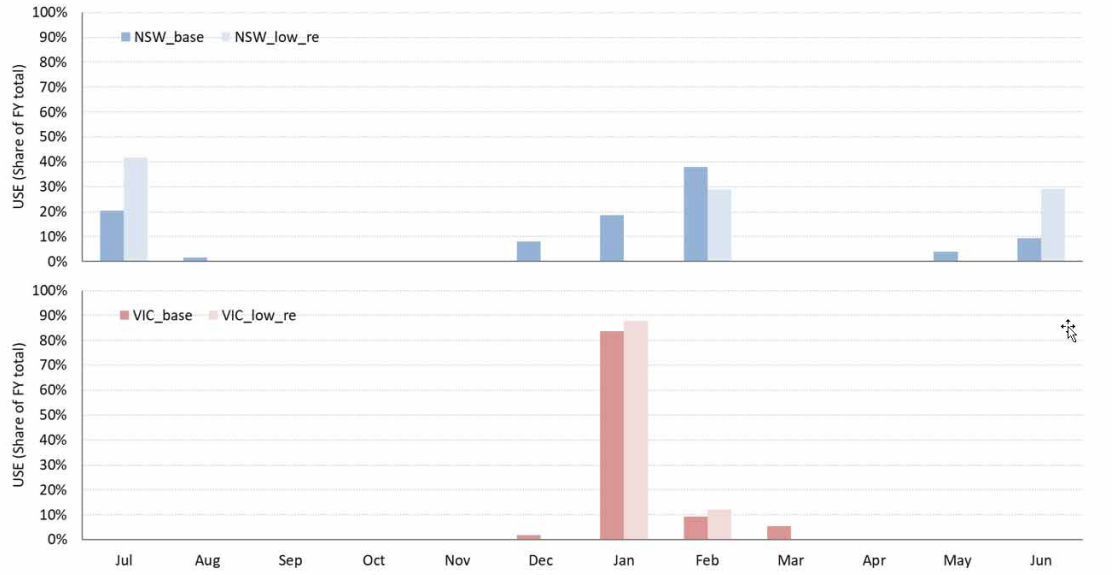
The distribution of maximum event depth shows a large share of events with a maximum depth less than 250 MW and 500 MW with more than half of the events higher than 500 MW. This chart suggests significant new entrant capacity would be required to address long-tail events which have both high depth and long duration.

USE Event timing

Modelling identifies USE events generally occurring around the evening peak, and also during morning peaks to a lesser extent in NSW. As event duration increases, the window in which USE is observed expands around the evening peak but is still focused on the peak load times.

Modelled USE under the base case sensitivity is identified as occurring exclusively in summer in VIC and both summer and winter in NSW.

Figure 3.9: USE outcomes - base case, base case sensitivity, and low VRE scenario



Source: IES, 2022 Reliability Standards and Settings Review - Modelling Report, Fig. 51.

3.5.1 Observations on the low VRE scenario outcomes

From the results presented in section 3.4, and those contained in IES's modelling report, the Panel identifies VIC as a NEM region where low VRE considerations could lead to a shift in the distribution of USE during the period relevant to the modelling.

IES developed the input traces for the low VRE sensitivity case to stress test outcomes rather than act as a predictive exercise. The results in VIC, however, are sufficiently clear to:

- require consideration of the effect on the marginal new entrant and impact on associated market price settings presented in Chapter 6.
- inform consideration of the need to, and justify adjusting the reliability standard to speak effectively to increasing tail risk.

Further consideration of these issues is provided in Chapter four in the form of the standard and chapters on the market price settings.

4 PART A - FORM OF THE RELIABILITY STANDARD

BOX 4: FORM OF THE RELIABILITY STANDARD

The Panel's draft position does not include a specific recommendation to change the form of the reliability standard. The Panel however identifies a case for changing the form of the reliability standard over the course of the NEM's transition from a primarily capacity limited thermal power system to a more energy limited high VRE power system.

The Panel's draft positions on the form of the standard are:

- USE is a more suitable metric for the form of the reliability standard rather than loss of load expectation (LOLE) or loss of load probability (LOLP). LOLE and LOLP do not sufficiently capture a changing reliability risk profile in the NEM given its transition from a capacity limited thermal power system to a more energy limited high variable renewable power system,
- A set of more than one metric may be essential in order to capture features of both expected and more extreme events, particularly given higher expected levels of inter-annual and intra-annual renewable energy output variability,
- The form of the reliability standard should provide sufficient information on the full probability distribution of the metrics selected to describe the system performance, for instance via augmenting expected value measures with "tail" indicators, and
- The form of the reliability standard could also include risk-aware approaches that could account for the risk attitude of the decision-maker.

The Panel presents a 'straw person' risk-aware option for reliability standard reform for stakeholder feedback.

The reliability standard (the standard) is an ex-ante standard used to indicate to the market the level of supply and inter-regional transmission capacity required to limit the risk associated with events leading to unserved energy (USE).

The current form of the standard for the NEM is expressed in terms of the expected USE in a region and the existing level of the standard is set at a maximum of 0.002% of the total energy demand in that region for a given financial year.

This chapter sets out the Panel's draft position on the standard's form in addition to its considerations and understanding of related issues. This chapter:

- introduces the existing form of the reliability standard,
- describes issues associated with a changing NEM reliability risk profile,
- presents stakeholder comments on the form of the standard,
- discusses Panel considerations on reform options, and
- identifies the Panel's draft position.

The Panel has included a high level 'straw person' proposal for reform as part of its draft position to inform stakeholder feedback.

4.1 The existing form of the reliability standard

This section introduces:

- The reliability standard and its role in the NEM,
- The probabilistic nature of the existing form of the standard which is expressed as an expected value of USE, and
- Requirements that apply to the Panel's consideration of the reliability standard's form.

4.1.1 Introduction to the reliability standard in the NEM

The RSS review 2021 Guidelines describe the standard as a measure applied to generation and inter-regional transmission elements in the NEM, the purpose of which is to define the maximum expected amount of energy that is at risk of not being served in a region in a given financial year.[99]

In the NEM, the standard is an ex-ante standard to indicate to the market the required level of supply to meet demand on a regional basis. It is not a regulatory or performance standard that is "enforced". The standard is intended to provide a clear, actionable expression of the economically efficient level of generation and inter-regional transmission capacity sought for the NEM for the purposes of informing the market and AEMO processes.

The provision of information on the market's performance against the reliability standard is an important part of the existing reliability framework and helps guide and inform market participants' expectations of the future, enabling more efficient investment and operational decisions. AEMO is required by the NER to publish various materials which provide information to market participants – and any other interested parties – on matters pertaining to the reliability standard; that is, over and above the information contained in contract and spot prices.[100]

The purpose of this information is to inform the market of prevailing and forecast conditions against the level of the reliability standard, particularly when reserves may be running low, in order to elicit a market response. For example, the electricity statement of opportunities (ESOO) identifies potential shortages of generation over a 10-year forecast time horizon to prompt the market to make new investments to alleviate any forecast reliability problems. AEMO also publishes relevant information through its Projected Assessment of System Adequacy (PASA) and pre-dispatch processes.[101] In operational timescales, AEMO issues lack of reserve (LOR) notices to inform the market when supply scarcity conditions apply.[102]

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99 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, p.5, Sydney.

100 Under clause 3.9.3D of the National Electricity Rules (NER), AEMO is required to develop and publish Reliability Standard Implementation Guidelines (RSIG) that set out how AEMO will implement the reliability standard.

101 Clauses 3.7.2(f)(6), 3.7.3(h)(5) of the NER.

102 Clause 4.8.4 of the NER - Additional information is available in AEMO's reserve level declaration guidelines: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Reserve-Level-Declaration-Guidelines.pdf; AEMO also has a range of intervention powers that relate the performance against the standard. These include RERT and directions for reliability which are further described in section 2.2.2 of the review issues paper.

The level of the standard is based on an economic trade-off made on behalf of consumers as to the appropriate level of reliability and is a key input to the various market settings, that is, the MPC, MFP, CPT, and APC that define the price envelope that applied to spot market outcomes. Further discussion on the level of the standard and associated market price settings is provided in Chapters 6 to 8.

4.1.2 The existing reliability standard is an 'expected value'

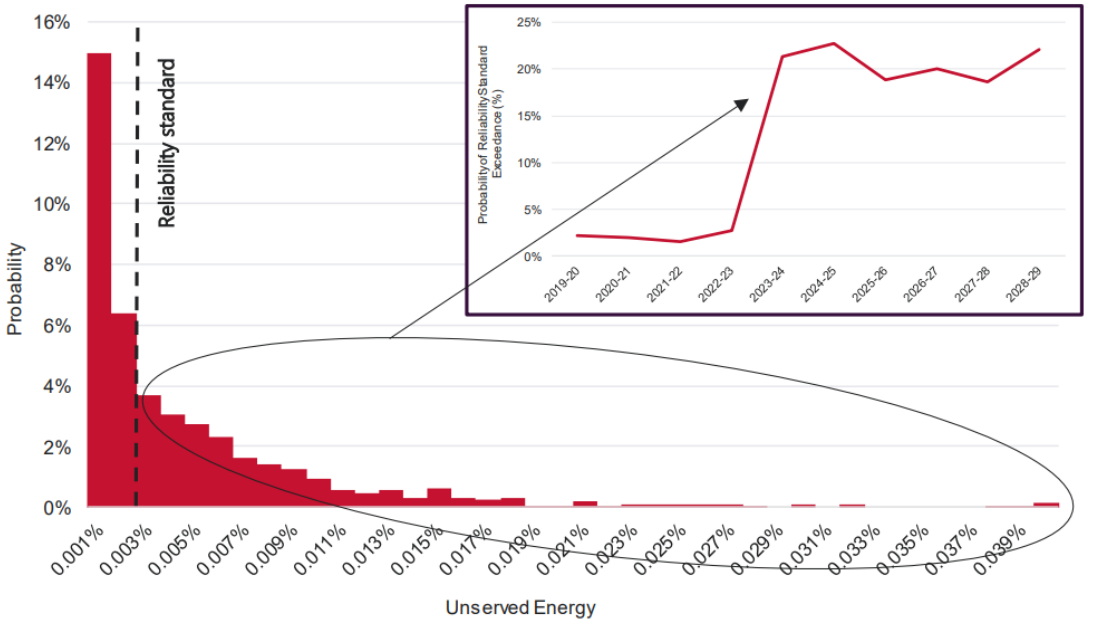
The existing form of the standard is expressed as 'expected' amount of USE. This expression indicates the statistical nature of the current reliability standard in relation to the USE probability distribution.

An 'expected value' statistically represents a weighted average of all possible outcomes in a probability distribution. The reliability standard of 0.002% USE in a region in a 12 month period, therefore, represents the average of the probability distribution of all possible USE outcomes where each outcome is weighted by its probability of occurrence. Stakeholders should note the reliability standard does not imply that there is no possibility of an outcome worse than 0.002% USE. Outcomes with levels of USE far higher than 0.002% are possible, although low probability and correspondingly discounted when assessed against the reliability standard.

The Panel is considering whether the existing form of the standard is fit for purpose given a changing reliability risk profile. The concept of a probability distribution, given its relationship to a 'risk profile',[103] is therefore at the centre of the Panel's consideration with respect to the form of the standard.

103 Risk involves the probability of a set of events considered together with their consequences.

Figure 4.1: The reliability standard as an average of the unserved energy distribution



Source: AEMO, 2019 Electricity Statement of Opportunities, August 2019, p. 13
Note: Samples with zero USE have been omitted from the chart.

The distribution of USE includes what can be described as 'tail risk'. Tail risk involves low probability but potentially high impact reliability events. Figure 4.1 illustrates 'tail risk' by showing AEMO's 2019 ESOO modelling of the probability of different levels of USE in NSW in 2023-24 relative to the reliability standard level of 0.002%. AEMO included this chart in its 2019 ESOO to explicitly illustrate tail risk and the potential for significant USE outcomes even when the 'expected' amount is lower than 0.002%.

In its discussion of these results, AEMO specifically noted that while 'expected' USE is 0.00174% in this case, which is within the current standard, they identified a significant risk that actual USE may be significantly higher than 0.002%. Their analysis indicated a 21% probability that USE in NSW will exceed 0.002% in 2023-24.[104]

4.1.3 Requirements for the Panel in determining the form of the reliability standard

As noted, the Panel is required to consider key requirements outlined in the NER and the RSS review 2021 Guidelines. Relating to the form and level of the reliability standard, the NER requires that the Panel:

- must have regard to any value of customer reliability (VCR) determined by the AER which the Panel considers to be relevant, and

104 AEMO, *2019 Electricity Statement of Opportunities,* August 2019, p. 13.

- may take into account any other matters specified in the RSS review 2021 Guidelines or which the Panel considers relevant.[105]

Requiring the Panel to have consideration for the VCR determined by the AER ensures that the standard is set to strike a balance between having enough generation and demand response to meet customer demand in the majority of circumstances, and keeping costs as low as possible for customers.

The RSS Review 2021 Guidelines further state that the Panel will also consider other factors including but not limited to:[106]

- any changes made to AER's value of customer reliability measure, and
- any marked changes in the way consumers use electricity, particularly through the use of new technology, suggest a large number of consumers may place a lower value on a reliable supply of electricity from the NEM.

The RSS review 2021 Guidelines specify a set of requirements that apply to both the level and form of the reliability standard. The requirements above primarily relate to the economic trade-off that is used to determine the efficient level of the reliability and therefore have limited applicability to the Panel's considerations on the form of the standard.

The primary requirement applying to the Panel's consideration of the form of the standard is for the Panel to only consider a change to the form of the reliability standard where there is a material benefit in doing so and a reasonable possibility that these recommended changes will, or are likely to, contribute to the achievement of meeting the NEO in a materially better way.

The Panel considers a reform will contribute to meeting the NEO in a materially better way if it is materially better than the existing form at reflecting and describing an efficient and acceptable level of reliability given changing reliability risk profile in the NEM. A form of the standard that is materially better at describing an acceptable level of reliability given these changes will advance the long term interests of consumers by improving the accuracy and quality of information available to market participants thereby informing efficient investment and operating decisions via the market price settings and AEMO's operational and information processes.

4.2 A changing reliability risk profile

The Panel is considering whether the reliability standard's form should be adjusted to appropriately reflect, and describe, an appropriate level of reliability, given the NEM's changing reliability risk profile.

This section describes the Panel's understanding of the factors driving this change to inform its further considerations on adjusting the form of the standard. In particular, it contrasts the conventional approach to understanding reliability in capacity-limited thermal power systems,

105 NER clauses 3.9.3A(e)(4) and (5).

106 Reliability Panel, *Review of the reliability standard and settings guidelines*, Final guidelines, 1 July 2021 p. 5.

as the NEM has historically been, with changes occurring due to increasing penetrations of variable renewable energy (VRE) and energy limited resources in the NEM.

4.2.1 The historic approach to understanding reliability in the NEM

The historical focus of reliability planning in a capacity limited thermal power system has been on ensuring that the installed capacity of available generation could meet demand at peak times. Hence the task has traditionally been to identify the right amount of capacity or reserve margin that would guarantee the reliability standard.[107]

The following dot points broadly characterise a historic approach to understanding reliability in a capacity limited thermal power system. These are presented to contrast with the factors relevant to reliability in a high VRE, more energy-limited power system (as the NEM is becoming). This comparison informs the Panel's understanding of the nature of change in the NEM's reliability risk profile over the course of its transition.

In a capacity limited thermal power system:

- Forced thermal generation and key transmission outages occur largely independently of each other and can be modelled by an understanding of the probability each generator will fail, also known as its forced outage rate (FOR).[108]
- There is usually one typical provider of 'marginal' capacity which does not change with time or as a function of the state of the system, given generation levels or demand conditions.
- Annual peak power demand drives reliability requirements, which may be translated into the availability of generation/network capacity at peak times. Off-season and off-peak times can be generally ignored.
- The relationship between installed capacity and expected peak demand could be easily translated into a reserve margin of generation capacity which would remain available during peak times and therefore available to cover the loss of generation from a 'credible' forced outage occurring at peak demand.
- Supply power availability and power demand requirements at peak times could at first approximation be statistically represented as "normally" distributed based on independent Gaussian probabilities.[109]
- An "average" USE event is a reasonable representation of "all" events under typical conditions (e.g., driven by generator or transmission forced outage, not too high, representing a limited source of uncertainty in peak demand forecast)
- Energy-limited resources, such as hydro, would generally be modelled in terms of their expected available power at peak times and are not major contributors to overall reliability outcomes.

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107 Reserve margin is defined as installed conventional generation capacity minus expected peak demand.

108 AEMO characterises the forced outage rates of all major generators and transmission lines in the NEM which are key inputs into the Monte-Carlo assessments of reliability.

109 Strictly speaking, the distribution describing available capacity from conventional generation based on their FOR is binomial, which under conditions that broadly apply to traditional power systems can be approximated as Gaussian.

- Supply power availability at peak times is not significantly influenced by the past operational history and by any specific control strategy, and forecast uncertainty of system and market conditions would only play a minor role.

In a capacity limited thermal power system, the expected value of the USE distribution (as described by the current form of the reliability standard), combined with a knowledge of generator and key network element FOR is generally sufficient to characterise the distribution of USE and the resulting reliability risk profile.

4.2.2 Reliability in a high VRE and more energy-limited future NEM

The Panel considers that the reliability risk profile in a high VRE more energy-limited power system (such as the NEM is becoming) can no longer be sufficiently characterised from an understanding of the thermal unit, and key network element FOR at peak demand. The reliability risk profile can therefore no longer be characterised from independent distributions, that are at first approximation Gaussian, as reliability outcomes are likely to become more uncertain, with higher levels of volatility arising from a wider range of drivers of USE.

In future power systems, especially for planning purposes, the reference to historical discrete generation forced outages will become less relevant and the shift will be towards identifying and forecasting weather patterns and "disturbances" relevant to reliability outcomes. These will include disturbances at different timescales, including:

- relatively short reliability events such as ramping timescales of a few hours, and
- longer events, such as co-incident low solar and wind generation levels (known as dark-depressions or 'dunkelflaute') on timescales, in the order of one to a few weeks.

In a high VRE more energy-limited power system:

- Because weather-driven supply and demand may have very different seasonal patterns, reliability issues are no longer limited to peak times and occur on a seasonal level, for which maintenance periods of conventional generators and key network elements might become an important additional consideration.
- The available reserve margin can no longer be represented in a Gaussian way, and may be heavily skewed. Fat tails are a characteristic of renewable generation systems. For example, wind output is often described as a Gamma or Weibull distribution, both characterised by heavy tails.
- There is no longer a clear link between installed capacity and available power output at peak times, with traditional capacity margins becoming completely inadequate to describe system reliability risk.
- Supply sources are no longer independent as weather may create highly correlated rapid changes in output. This means the diversity effect that characterises the independent uncorrelated failures of conventional generators, no longer applies.
- Available supply output from weather-based resources and weather-dependent demand levels become more anti-correlated which means that supply and demand may move in different directions under certain circumstances compounding the resulting impact on reliability. This includes a high likelihood of potentially higher demand due to extremely

hot/cold weather and potentially lower supply due to weather-driven loss of efficiency, capacity, outages, etc.

- Supply-side ability to contribute to system adequacy is no longer independent of time, with more and critical dependence on the weather characteristics. Time dependence and time-coupling are accentuated by the presence of different types of centralised and demand-side storage and other energy limited resources including demand response.

From this, the Panel appreciates that the reliability risk profile in a high VRE power system, where storage is a material reliability provider, is likely to involve increased tail risk, with much higher volatility stemming from a range of sources and different drivers of USE. As a consequence, all failure events and probability distributions of reliability metrics are no longer as easy to identify and assess, as they do not stem anymore from fundamentally Gaussian supply and demand relationships.

These observations have important implications for the form of the reliability standard and whether a single expected USE metric, as is currently the case, remains sufficient to appropriately describe the reliability risk profile in a high VRE and more energy limited future NEM.

4.2.3 The impact of increasing energy storage and demand response on the reliability risk profile

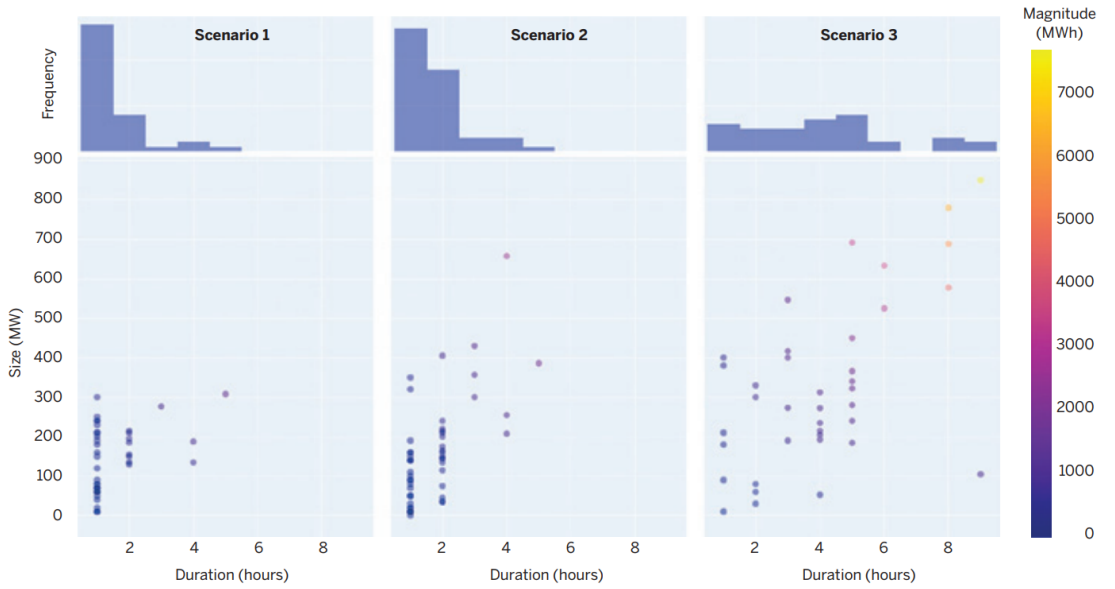
The Panel considers the distribution of USE shifts towards longer duration higher impact reliability events in a high VRE power system with storage as a material reliability provider. In contrast, short-duration events, which currently dominate the existing USE distribution are reduced/eliminated with long duration events, associated with energy limits, dominating.

The shift in the reliability risk profile in high VRE and storage power systems, relative to capacity-limited thermal power systems is illustrated in Figure 4.2 which shows a scatter plot of size, frequency, and duration of USE events for three scenarios progressively involving higher VRE and storage. The size, duration, and frequency of USE events in a high VRE and storage power system can be observed in scenario 3 which shows a lower frequency of short-duration events and increasing tail risk of more long duration, high MWh events relative to scenario 1. An important observation is that each of these three scenarios has the same LOLP. Section 4.4.1 will consider the significance of this observation further.

Figure 4.2 was published by the Energy Systems Integration Group (ESIG) in their report on redefining resource adequacy for modern power systems.[110]

110 ESIG, *Redefining resource adequacy for modern power systems*, 2021. Available at: https://www.esig.energy/wp-content/uploads/2021/08/ESIG-Redefining-Resource-Adequacy-2021.pdf

Figure 4.2: Scatter Plot of Size, Frequency, and Duration of Shortfall Events with Energy-limited Reliance on Energy Limited Resources



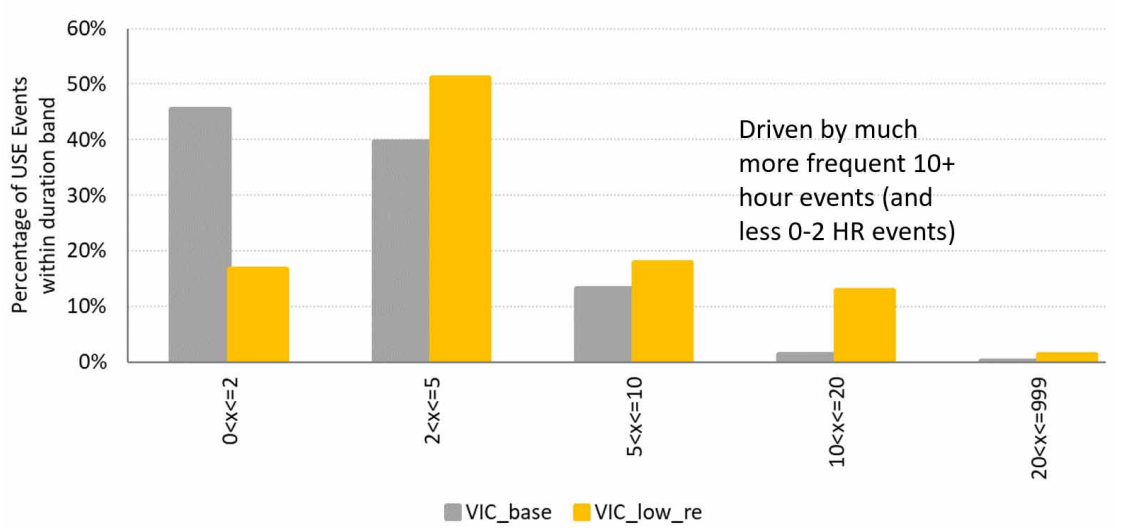
Source: Redefining Resource Adequacy Task Force. 2021. Redefining Resource Adequacy for Modern Power Systems. Reston, VA: Energy Systems Integration Group, Fig. 8.
Note: For further information see: https://www.esig.energy/resource-adequacy-for-modern-power-systems/

A key task to ensure reliability in a high penetration VRE and energy-limited power system will be incorporating the reliability risks associated with the likelihood and features of dunkelfaute (low VRE generation due to co-incident low solar and wind generation) events.

The existing framework may not address the challenges that dunkelflaute events will bring in a future power system, especially in a system with large shares of energy-limited resources. These risks arise from insufficient storage capacity and duration to maintain supply during extended low VRE generation periods. This raises the question of whether reform is needed to the type and features captured in the form of the reliability standard to address this risk.

The Panel's low VRE scenario, modelled for the review, and introduced in Chapter 3, considered the possible significance of dunkelflaute events in the Australian context for the period FY2026-FY2028. A plausible shift in the distribution of USE was identified in VIC in 2028 (Figure 4.3) if the low VRE scenario occurred. While this shift was not yet pronounced in most of the NEM during the review period, this analysis shows low VRE conditions could produce a different distribution to that historically experienced in the NEM.

Figure 4.3: A shifting unserved energy distribution in VIC for 2028



Source: IES
Note: Base case and low VRE scenario Victorian event duration distribution for 2028.

The Panel understands that demand response may also change the dynamics of reliability in a future NEM.

Under supply scarcity conditions, flexible demand will reduce their consumption depending on their willingness to pay and storage assets might start discharging based on their assessment of the value of their stored energy. This behaviour will act to minimise the potential for USE in response to a shortage of supply-side generation capacity. Hence, this demand-side flexibility might mean that no interruptions would occur, but supply scarcity will still manifest itself through ongoing high prices and price volatility.

While from a purely economic perspective such price outcomes may be regarded as a sign the market is working, it may limit the value of a purely USE focused reliability standard for capturing the reliability risk profile. A future power system where there is high levels of demand reponse may require a reliability standard that is wider in scope. An increase in scope of the reliability standard in this regard could include additional components describing non-USE related reliability metrics, potentially such as LOR related outcomes.

The Panel is at an early stage in its understanding of these issues but will give further consideration to demand reponse related reliability dynamics over the course of the review.

4.3 Stakeholder views

This section presents stakeholder views on the suitability of the current form of the reliability standard given the potential shift in the reliability risk profile introduced in the issues paper and discussed above.

Stakeholders noted that the issues discussed in the Issues Paper were appropriate and generally submission responses could be grouped into two key areas of consideration:

- Stakeholders that considered USE remains the optimal form of the reliability standard:
  - Origin stated that USE remains appropriate as it captures high-impact, low probability events.[111]
  - The AEC commented that deterministic approaches are inaccurate and unworkable in a power system characterised by stochastic generation and energy limits. While USE is a straightforward economic valuation that cannot be done for LOLE and LOLP.[112]
  - Both Alinta and Shell support USE and do not think alternative forms of the standard should be applied.[113]
  - Engie acknowledged that no single metric captures all dimensions of reliability, however, USE is well-established and noted that the standard should remain a probabilistic measure.[114]
  - AEMO stated that the form of the standard is appropriate so long as the level of the standard recognises tail risk.[115]
  - CS Energy considered that USE remains the appropriate measure for the reliability standard, however, they may be value in presenting USE as a probability as it may provide additional clarity.[116]
  - The EUAA stated that the current form is appropriate and supported a probabilistic rather than deterministic form. However the EUAA note there may be a need to refine the current USE definition to take into account different frequency, duration and size of interruptions.[117]
- Stakeholders that considered additional or alternative forms of the standard should be investigated:
  - The government of South Australia Department for Energy and Mining suggested that the existing form of the standard may mask the frequency, duration, and depth of reliability events. Therefore one or more alternate forms should be considered.[118]
  - EA noted that the Panel should consider additional outage metrics, however, there would likely be insufficient time in this review to evaluate how these can be accommodated to changes in the form of the standard.[119]
  - Hydro Tasmania highlighted that any alternative metric to define reliability must have the confidence of Federal, State and Territory energy ministers.[120]

111 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Origin Energy, p.1.
112 Reliability Panel, *2022 Reliability standard and settings review,* issues paper submissions: Australian Energy Council, p.3.
113 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Alinta Energy, p. 5; Shell, p.1.
114 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Engie, p.2.
115 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Australian Energy Market Operator, p. 4.
116 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: CS Energy, p.5.
117 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: EUAA, p.3.
118 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: South Australia Department for Energy & Mining, p.3.
119 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: EnergyAustralia, p.8.
120 Reliability Panel, 2022 Reliability standard and settings review, issues paper submissions: Hydro Tasmania, p.3.

Issues raised by stakeholders are considered in Panel considerations set out in this chapter. The Panel will however respond to specific stakeholder views when making its final recommendation. This is because the Panel is still considering a range of issues that will inform its final recommendation.

4.4 Panel considerations

The Panel understands the reliability risk profile of the future NEM will be fundamentally different to that observed historically. This shift has major implications for the form of the reliability standard required to appropriately describe an efficient and acceptable reliability risk profile for the NEM.

This section sets out the following specific considerations that inform the Panel's draft position on the form of the reliability standard. Specifically on:

- Changing the standard from USE to LOLP / LOLE
- Multiple metrics in a hybrid standard to address tail risk
- Reliability risk aversion and risk-aware reliability standards

4.4.1 Changing the standard from USE to LOLP / LOLE

This section considers whether a reliability standard expressed as a LOLE or LOLP is likely to better reflect the reliability risk profile in a future NEM than the current reliability standard expressed as an expected % of USE.

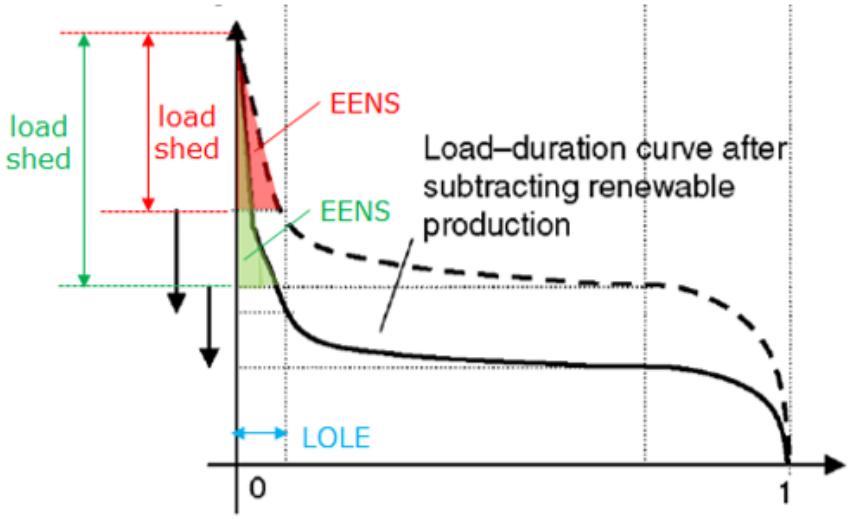
LOLE is the expected amount of time (days or hours per year) in which available generating capacity is insufficient to serve demand. LOLP indicates the frequency (LOLE divided by the number of hours in a year expressed as a percentage) of supply interruptions and not their duration (hours), depth (MW) or energy (MWh). LOLE and LOLP provide no information about the volume of energy lost due to interruptions and only provide an estimate on the likelihood of an interruption occurring or its total duration. [121]

LOLP and LOLE have historically been used internationally given their practical application in defining capacity margins. As noted in section 4.2.2, however, there is no longer a clear link between installed capacity and available power output at peak times in high VRE more energy limited power systems. The available margin therefore can no longer be represented in a relatively simple way and the resulting distribution of operational capacity may be heavily skewed. This factor, along with increasing tail risk (as discussed in the next section) are reasons why likelihood-based standard forms may not appropriately reflect reliability risk in the future NEM.

Figure 4.4 is a qualitative demonstration of this limitation with reference to a generation system designed with a LOLE reliability standard. This figure demonstrates that a LOLE based standard could lead to a wide range of different levels of USE due to the volatility introduced into the load duration curve by VRE. The same LOLE can be seen, as a single metric, to insufficiently describe the reliability risk profile as seen by consumers.

121 A more complete discussion on alternate reliability standard forms is provided in the review's issues paper.

Figure 4.4: LOLE based reliability standard in a system with and without VRE



Source: Pierluigi Mancarella, elaborated from "Darryl R. Biggar, Mohammad Reza Hesamzadeh, *The Economics of Electricity Markets*, Wiley-IEEE Press, September 2014"

Figure 4.2 in section 4.2.3 compared the size, frequency, and duration of USE events for three power systems, each with the same LOLP but increasing penetrations of VRE and reliance on energy limited storage. The wide range of reliability outcomes, and significant level of tail risk, despite all systems having the same LOLP, also indicates the limits of LOLP as a reliability standard form that sufficiently captures reliability risk in the future NEM.

While the existing form has its limitations the current USE standard in the NEM is an energy standard for an energy-only market that is suited to valuing cumulative, long-term energy shortfalls and thus rewarding additional energy generation or consumer responses to reduce that shortfall.[122] USE speaks directly to energy adequacy, rather than capacity adequacy, which also makes it more suitable for describing the reliability requirements of a high VRE more energy-limited power system. This will become more important in future NEM given the potential impact of low VRE generation ('dunkelflaute') events.

For these reasons the Panel does not consider replacing the existing USE based standard with LOLP or LOLE would achieve the NEO in a materially better way.

4.4.2 Multiple metrics in a hybrid standard to address tail risk

The current single metric reliability standard has historically provided sufficient information to signal reliability risk and expectations in a capacity limited NEM. As the NEM's resource mix and reliability risk profile changes, however, USE as a single metric may no longer sufficiently

122 What the current USE standard cannot capture, is the difference in the actual experiences of consumers in different regions. For example, in a region where the demand profile is very peaky (e.g. air-conditioning use increases dramatically on occasional very hot days), the entire allowance of USE (the whole 0.002%) could be used up in a single hot day. Alternatively, in a region where the demand profile is quite flat (e.g. airconditioning use is minimal or fairly constant because temperatures are consistently high), shortfalls in supply are likely to be less severe but more frequent.

describe an acceptable reliability risk profile. This section presents the Panel's consideration of whether a reliability standard consisting of multiple metrics would better represent reliability risk in a future NEM.

The existing form of the reliability standard is a single metric 'expected value' which represents a probability-weighted average across the entire USE distribution. This single metric doesn't however specifically capture or limit tail risk to an acceptable level.

A single reliability standard metric (either LOLP/LOLE/or USE) is likely to be most appropriate in a power system with USE events that share similar characteristics. As previously discussed, the main driver of reliability events and USE in a capacity limited thermal power system was unplanned outages under peak load conditions. These events could be modelled as independent events statistically represented as "normally" distributed based on Gaussian probabilities with an "average" event that was a reasonable representation of "all" events under typical conditions. The expected value, combined with a knowledge of forced outage rates and peak demand conditions thereby allowed the entire distribution of USE to be sufficiently characterised.

As discussed in section 4.2.2 greater volatility in reliability outcomes, and higher levels of tail risk, are expected in a high VRE and more energy limited NEM. The USE distribution and resulting reliability risk profile will no longer be easily understood from its expected value and forced outage rates as a range of additional drivers of USE will also apply. More information than the expected value may therefore be required to appropriately describe an acceptable distribution of USE and the resulting risk profile. This may include information on the frequency, duration, and depth of potential supply shortfalls as well as metrics specifically addressing tail risk.[123]

For these reasons, the Panel's draft position is that more than one reliability standard metric may be required to describe the distribution of USE sufficient to describe an acceptable reliability risk profile in a future NEM.

Conditional value at risk (CVaR) to target tail risk

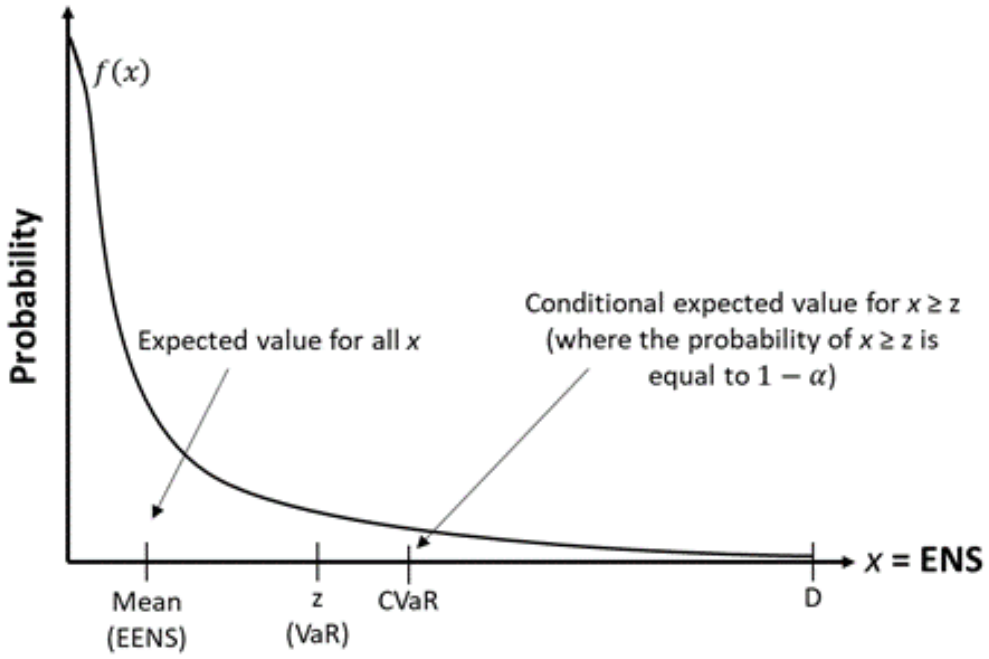
The Panel is interested in additional metrics to describe acceptable levels of tail risk given the changes expected in the distribution of USE in the NEM. The Panel is particularly considering the application of metrics that can capture tail risk in a way that complements the existing expected value standard.[124]

CVaR is an indicator that could be used to better assess the fatness of the tail of reliability events defined as the mean value of the α% worst cases (the "tail") of a probability density function, in this case, USE. Figure 4.5 illustrates the role of VaR and CVaR relative to the expected energy not served (EENS) for a hypothetical probability distribution. The 'straw person' option for reliability standard reform presented in section 4.5.1 utilises CVaR along with expected USE in a composite reliability standard that describes both average USE outcomes and lower probability 'tail risk' related USE.

123 Energy Systems Integration Group, *Redefining resources adequacy in a modern power system,* August 2021, p. 10.

124 As an example, a tail risk metric may define the expected USE in the worst 10% of periods (corresponding to a 1 in 10 year worst USE case).

Figure 4.5: Probability of USE, expected USE & CVaR



Source: R. Moreno et al., "From Reliability to Resilience: Planning the Grid Against the Extremes", IEEE Power and Energy Magazine, July-August 2020.

Note: Probability distribution of energy not supplied (USE), highlighting the "mean" metric (expected USE) and "tail" metric (CVaR):1-α indicates the size of the considered set of worst cases, VaR (or z) is Value at Risk, CVaR is Conditional Value at Risk, D is maximum demand, x is Energy Not Supplied (ENS), and the Mean value is Expected Energy Not Supplied (EENS).

As illustrated in Figure 4.5 a α%-CVaR essentially represents the expected USE in the higher (1-α)% cases. A 99%-CVaR would thus correspond to the expected energy not supplied in the worst 1% cases.

Flexibility needs and short duration USE events

While tail risk is a particular focus for the review, the Panel is also aware that high penetrations of VRE may also lead to ramping requirements that lead to short-duration USE events due to a shortfall in system flexibility. The Panel notes the experience in the California rolling blackout event of August 2020 where USE occurred due to flexibility limits and other operating constraints.[125] When considering multiple metrics for a future reliability standard, the Panel also notes the need to consider increased system need for flexibility and the related risk of possibly frequency short duration USE events. The Panel intends to consider this issue further in its final report.

4.4.3 Risk aversion and risk-aware reliability standards

The existing reliability standard is risk-neutral. Risk neutrality values every unit of USE in the probability distribution as equal in weight, whether it is the first or last MW of a severe event

125 P. Joskow, "California's Blackouts, Near Blackouts, and Fires", MIT presentation, 5 October 2020.

in MW or in time. For example, the existing standard considers the expected (average) USE across all possible outcomes. However, a more risk-averse standard might consider what worst-case outcomes look like. Given the increasing significance of tail risk, the Panel is considering whether a risk-neutral standard remains appropriate or whether risk aversion and risk-aware options would better reflect the reliability risk profile in the future NEM.

Consumers may be regarded as risk-averse to tail risk events which can also pose significant hedging costs on investors too, to the point of possibly limiting investment. This is likely to be particularly important in a power system dominated by VRE and storage given the higher expected levels of general volatility and tail risk.

Risk aversion can be implemented through use of tail risk metrics such as CVaR (discussed above). A complementary metric, such as CVaR can be used to tune the level of risk aversion. Further discussion of issues relevant to implementing a CVaR approach is provided in the Panel's draft 'straw person' option for stakeholder feedback.

The Panel also notes that risk aversion may not be limited to the tail of the USE distribution. In principle, risk-aversion might be applied to both cases of rare but extreme events, and also frequent and smaller events including the short duration flexibility related USE discussed above.

The options for implementing risk-aware reliability standards are not limited to CVaR. Other options to implement risk aversion within the reliability standard include adopting methods such as robust optimisation, or min-max regret that specifically hedge against the occurrence of worst-case scenarios. The Panel will give consideration to these additional approaches in its final report.

4.5 Draft position and 'straw person' option

The Panel's draft position does not include a specific recommendation to change the form of the reliability standard. The Panel however identifies a case for changing the form of the reliability standard over the course of the NEM's transition from a primarily capacity limited thermal power system to a high VRE more energy limited power system.

While its considerations on the form of the standard remain underway, the Panel makes a set of interim observations relevant to the case for changing the form of the reliability standard in the NEM. These interim observations are set out below for stakeholder feedback:

- There will be a fundamental shift in the NEM's reliability risk profile over the coming decade. The main underlying parameters affecting reliability risk will increasingly be no longer at first approximation be normally distributed, temporally uncoupled, and independent. A wider range of drivers of USE will exist with greater volatility in reliability outcomes and increasing tail risk.
- Expected USE is a more suitable metric for the form of the reliability standard rather than LOLE and LOLP, which remain inappropriate for the NEM which is undergoing a transition to relying on a high level of VRE.

- More than one metric may be essential in order to capture features of both expected and more extreme events, particularly given higher expected levels of inter and intra-annual renewable energy output variability,
- The form of the reliability standard should provide information on the full probability distributions of the metrics selected to describe the system performance, for instance via augmenting expected value measures with "tail" indicators such as CVaR, and
- The form of the reliability standard could also include risk-aware approaches that could account for a modulated risk attitude of the decision-maker.

The Panel identifies a large amount of analysis, consideration, and consultation will be required prior to making a specific recommendation on an adjusted form of the standard. The time and resources available for this RSS review may not be sufficient to complete this process. Should this be the case, the Panel's approach will be to advance thinking to inform further consideration in future processes.

The Panel's approach to advancing thinking and informing future consideration involves its final review report identifying:

- the issues justifying the need for change
- a set of criteria and guidelines for identifying specific reform options for further evaluation
- additional 'straw person' reform options
- a path forward towards a specific recommendation for change, and
- the likely time frame for when a change may be necessary

This chapter's discussion, and the Panel's draft position, are a step toward achieving these above points. The following section presents a 'straw person' reform option to illustrate the Panel's considerations and relevant considerations on next steps for stakeholder feedback.

4.5.1 Risk-aware 'straw person' option for reliability standard reform

This 'straw person' option for reform is presented to facilitate stakeholder feedback on the issues and options identified in this chapter. This option does not represent a Panel recommendation at this time.

A CVaR based 'risk aware' approach, implemented as part of a multi-metric reliability standard, could augment the existing standard to address increased tail risk while also incorporating appropriate levels of risk aversion. The form of the reliability standard under this approach could be described as a weighted combination of:

- average – and therefore risk-neutral – probabilistic measures, such as the expected value of the USE probability distribution function, and
- tail – and therefore risk-averse – probabilistic measures, such as the CVaR of the USE probability distribution function.

An example of a general form composite reliability metric R_{USE} for USE could be set up as illustrated in the following box, which uses a linear combination of expected and tail metrics to make trade off decisions between "average" and "extreme" events.

BOX 5: EXAMPLE GENERAL FORM COMPOSITE RISK-AWARE RELIABILITY STANDARD.

$R_{USE} = w \cdot \text{expectedUSE} + (1- w) \cdot 95\%\text{-CVaR}_{USE}$

Note: The *w* parameter reflects the weighting applying to the level of risk aversion. This should not be confused with *α* which describes the extent of the tail captured by CVaR.

The Panel understands there are two ways to model and control the risk attitude of the decision-maker in the proposed formulation:

1. risk-aversion could be controlled by changing the relative weights assigned to the expected value and CVaR components, moving from a fully risk-neutral approach (w=1) – as is currently the case – to a fully risk-averse one (w=0), thus truly capturing the whole spectrum of risk-aware decision-making options;
2. the degree of risk aversion to be considered could be further controlled by changing the value of the parameter *α* defining the CVaR, setting it for example equal to 95% (capturing the worst 5% cases) or 99% (capturing the worst 99% cases).

This representation is thus also extremely flexible, and the parameters of the model, namely, *α* and *w*, could be changed in response to evolving conditions without having to change the form of the standard.

The Panel seeks stakeholder views on this and other possible approaches to developing composite risk-aware reliability standards.

Cost-benefit analysis to determine risk-aware reliability standards and their settings

The Panel notes that if risk-aversion needs to be considered in reliability standards to inform market developments, a core consideration is how to develop a methodology to perform an appropriate cost-benefit analysis to determine the numerical values of each reliability standard component given any decision to incorporate risk aversion.

A methodology utilising appropriate risk-averse models and in line with the above considerations is required. For example, instead of determining the optimal energy not supplied level as a tradeoff between the cost of interruptions (VCR), assessed based on the USE (a risk-neutral measure), and investment into the marginal new entrant, the CVaR (e.g., at 95% level) of the distribution of the energy not supplied could be used to augment the USE, as illustrated in the equation above.[126] Alternatively, a (weighted) *regret analysis* could replace the more traditional cost-benefit analysis utilised in this review and described in chapter 3, which would again lead to incorporating in the decision making different risk-aware perspectives.[127][128]

126 Simple examples of application of cost-benefit analysis with expected and tail metrics can be found in: R. Moreno et al., "From Reliability to Resilience: Planning the Grid Against the Extremes", IEEE Power and Energy Magazine, July-August 2020

127 Simple examples of applications for transmission planning in Great Britain can be found in: P. Mancarella, et al., "Study of advanced modelling for network planning under uncertainty", prepared for National Grid Electricity System Operator," 2020.

128 The Panel intends to follow the outcomes of a Melbourne University project supported by CSIRO and in the context of the international Global Power System Transformation (GPST) consortium where we will study the "equivalence" between modelling

The Panel identifies the process used to determine the parameters used in a composite reliability standard to be a challenge and is particularly interested in stakeholder insights into how the weighting (*w*) between the average and CVaR components of the straw person reliability standard above could be determined in a robust, transparent, and defensible manner.

risk awareness via Expected value + CVaR and via LWWR for power system planning.

5 PART B - LEVEL OF THE RELIABILITY STANDARD

BOX 6: LEVEL OF THE RELIABILITY STANDARD

- The Panel has yet to form a view on the level of the reliability standard given its ongoing considerations on the form of the standard.
- The Panel notes that the IES modelling does not reveal a material benefit from changing the level of the reliability standard, when expressed as a percentage of USE, and when assessed using the base case value of customer reliability (VCR).
- The IES modelling reveals that the efficient level of reliability corresponds to 0.0015% USE which is associated with an OCGT as the marginal new entrant. An o.2% decrease in costs is achieved from shifting from 0.002% to 0.0015% expected USE
- The efficient level of reliability is a function of the VCR used. The IES modelling considered, in addition to the base case, a low and high VCR sensitivity. The Panel notes the IES modelling indicates that the efficient level of reliability does not shift materially from the base case level under the low VCR sensitivity. The high VCR sensitivity reveals a tighter standard of around 0.001% may be applicable.
- The Panel seeks stakeholder feedback on reconciling outcomes under the base and high VCR cases.
- The Panel is aware that increasing uncertainty associated with a more weather dependent power system is driving concerns on the level of the standard. The Panel acknowledges these concerns however considers that future amendments to the form of the standard may be the most appropriate approach to addressing a changing reliability risk profile.

The standard is a measure applied to generation and inter-regional transmission elements in the NEM, the purpose of which is to define the maximum expected amount of energy that is at risk of not being served in a region in a given financial year.

The reliability standard is currently set at a level where expected USE must not exceed 0.002% of total energy demand in a NEM region for a given financial year.[129]

This chapter sets out the Panel's draft considerations and position on the level of the reliability standard. Specifically, it addresses:

- Requirements for the Panel in determining the level of the reliability standard
- Key issues and stakeholder views relating to the level of the reliability standard
- Panel considerations and decision-making approach, and
- Draft Panel position.

129 Clause 3.9.3C(a) of the NER.

5.1 Requirements for the level of the reliability standard

The key requirement for the Panel when recommending the level of the reliability standard is to have regard to any VCR determined by the AER which the Panel considers to be relevant when balancing the trade-off between the value that customers place on the reliable supply of electricity with the costs required to deliver this level of reliability.[130]

Other requirements for the Panel applying to identifying an appropriate level of the standard are outlined in Chapter four on the form of the reliability standard. The same requirements apply to both the form and the level of the reliability standard.

5.2 Stakeholder views on the level of the reliability standard

Stakeholders make a number of observations on the level of the reliability standard in their submissions to the review's issues paper published on 27 January 2022.[131]

Stakeholders did not generally consider a material benefit would arise from changing the level of the reliability standard from its current level of 0.002%.[132]

Specific stakeholder views were:

- The AEC noted that 0.002% is the only economically defensible USE target when compared to the VCR.[133]
- The EUAA did not see any material benefit in a move away from the current form and level of the probabilistic standard of 0.002% USE.[134]
- Origin did not consider there was any evidence to suggest a change in the level of the standard is required. [135]
- Alinta considered the current standard of 0.002% USE appropriately balances the trade-off between the cost of USE to various consumer cohorts and the cost of additional capacity to meet the standard.[136]

In contrast, several stakeholders considered the existing level of the standard to be insufficiently tight. Both the government of South Australia Department for Energy and Mining and AEMO raised questions on the appropriateness of the current level of the standard.[137]

130 Clause 3.9.3A(e)(4) of the NER.

131 Reliability Panel, 2022 Reliability standard and settings review, issues paper, 27 January 2022, p.50, Sydney.

132 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Alinta Energy, p. 5; Shell, pp. 1-5; Energy Users Association (EUAA), p. 2; Australian Energy Council (AEC), pp. 2-3; Origin Energy, p.1.

133 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEC, p. 3.

134 Reliability Panel, 2022 Reliability standard and settings review, issues paper submissions: EUAA, p. 2.

135 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Origin Energy, p. 1.

136 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Alinta Energy, p. 5.

137 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: South Australia Department for Energy and Mining, p. 2; AEMO, p. 2.

- The South Australian Department for Energy and Mining noted that energy ministers agreeing to the interim reliability measure casts questions over whether the current level is appropriate.[138]
- AEMO considered the existing standard to be insufficient. AEMO's submission considered the interim reliability measure of 0.0006% is justified given the potential for demand response under a future two-sided markets.[139]

While issues raised by stakeholders are considered in the Panel considerations set out in this chapter, the Panel will respond to specific stakeholder views when making its final recommendation. This is because the Panel is still considering a range of issues that will inform its final recommendation.

5.3 Panel considerations

This section presents the Panel's considerations in making its draft recommendation in relation to the:

- materiality of benefits required to justify a change in the level of the reliability standard
- value of customer reliability used to balance the value that consumers place on a reliable supply of electricity with the costs required to deliver that reliability, and
- approach to considering changes in consumer use of electricity.

The considerations in this section address the NER requirements identified in section 5.1.

5.3.1 Considerations in respect of materiality

The RSS review 2021 Guidelines require the Panel to apply a materiality assessment in determining whether to recommend a change to the level of the reliability standard or settings, which can only be made if the Panel considers there is a material benefit in doing so.[140] This section presents the Panel's considerations on the factors it intends to apply in assessing the materiality of benefits justifying a change to the level of the reliability standard.

As noted in Chapter Two, the materiality assessment requires the Panel to form a view that any recommended change to the level of the reliability standard will, or is likely to, contribute to the achievement of the NEO in a materially better way. This requirement supports predictable outcomes for the market recognising the importance stability creates for market participants in terms of investment, while taking into account changing market conditions, to support efficient investment and operational decisions by participants.[141]

The Panel considers a material benefit to occur if review modelling identifies the existing level of the reliability standard is fundamentally misaligned with an efficient level of reliability. A fundamental misalignment would lead to inefficient reliability outcomes that no longer reflect consumers' willingness to pay for reliability. A fundamental misalignment may arise if the

138 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: South Australia Department for Energy and Mining, p. 2.

139 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEMO, p. 2.

140 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, p.4, Sydney.

141 Ibid, p. 2.

marginal new entrant technology, technology costs, and/or the VCR has changed relative to one another since the last RSS reviews.

The Panel's materiality assessment will also consider any financial benefit associated with a reduction in total costs, including costs of USE, arising from a shift from 0.002% to another level. In this regard, a material benefit may be one where the financial benefit is clearly greater than:

- any uncertainty associated with the modelling which includes:
  - accounting for realistic variation in the VCR, and
  - the range of new entrant resources to be implemented in the NEM over the period FY2026 - FY2028.
- any regulatory or implementation costs which may arise from a change in the level of the standard.

Section 5.5 outlines the Panel's position at this stage of the review

5.3.2 The VCR used to assess benefits

The VCR describes consumers' willingness to pay for reliability and is, therefore, a critical parameter in the Panel's assessment. The VCR ensures that the level of the standard is set to strike a balance between having enough generation and demand response to meet customer demand in the majority of circumstances, and keeping costs as low as possible for customers.

The NER requires the Panel to have regard to any VCR determined by the AER and may take into account any other matters specified in the RSS review 2021 Guidelines or which the Panel considered relevant.[142] This section sets out the Panel's use of VCR figures published by the AER in the context of the factors it considers relevant.

Stakeholder submissions to the review's issues paper supported the Panel using the VCR published by the AER.[143] The AEC, in particular, considered the AER's process to be the world's most robust quantitative determination of VCR.[144] No stakeholders argued against the Panel using AER VCR figures in determining its recommended level for the reliability standard.

However, some stakeholders noted the difficulty of applying a single point estimate of VCR given the range of different customer classes and types each with its own specific VCRs.[145] The EUAA cautioned the Panel to perform sensitivity testing as a comprehensive answer to gaps in VCR values, given that the AER's VCR estimates were never intended to reflect the values for all consumer classes.[146]

142 Clauses 3.9.3C(e)(4-5) of the NER.

143 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEC, p. 3; Shell, p. 4.

144 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEC, p. 3.

145 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AGL, p. 4; EUAA, p. 3.

146 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: EUAA, p. 3.

The Panel agrees there is no single VCR that accurately captures all consumer values placed on reliability. Different VCR values exist for residential versus business customers, and for different climate zones where these are linked to volumetric energy consumption.[147] Even this still does not capture all the variation in the value customers place on reliability, including differences between individuals, or the value consumers may place on reliability on a very hot day compared to a mild day.

The Panel has accounted for this inherent uncertainty in the VCR through sensitivity analysis. This analysis is intended to reveal a range of possible efficient levels of reliability for Panel consideration. The Panel has:

- Used the AER jurisdictional customer load-weighted VCR as its base case. These values reflect the customer composition of the network as per the guidance provided in the AER's final report.[148] The Panel considers that, while the customer load weighted VCRs are a single point estimate, they still represent the best estimate of the VCR as a base case for the purposes of assessing the level of the reliability standard.
- The Panel has conducted a sensitivity analysis using the following low and high case VCRs, to capture the impact of this uncertainty on the efficient level of reliability, accounting for different customer types and classes, rotational load shedding practices, and outage duration.
    - The low case VCR - The Panel has re-weighted the AER's customer load weighted VCR to exclude large commercial and industrial loads. The low case reflects the Panel's understanding of the likely composition of customers subject to rotational load shedding in NSW and VIC. The low case substantially represents the VCR of residential customers and small and medium commercial and industrial customers who are subject to load shedding by DNSPs.
    - The high case VCR - the Panel has re-weighted the one-hour duration VCR values for all residential and business customer segments. The one-hour duration VCR values in $/kWh the AER has determined are in general higher than the values for average customer load-weighted VCRs for outages of all durations. This approach addressed the general duration of rotational load-shedding which usually only impacts individual customers for up to one hour and also accounts for the potential higher VCR given changes to consumer use of electricity discussed in the next section.[149]

The specific VCRs corresponding to these sensitivity cases are set out in Table 5.1 below with additional details on their composition provided in Appendix A1.

147 Reliability Panel, *Reliability standard and settings review,* issues paper, 27 January 2022, p. 54.

148 Australian Energy Regulator, *Annual update - VCR review final decision,* Appendices A-E, December 2021, found here.

149 This is because the VCR is a per energy value rather than per outage value, meaning that if a customer loses energy for one hour it will have a higher impact than losing energy for two hours because the impact relative to the energy lost is not as high.

Table 5.1: **Value of customer reliability base case, low and high sensitivity cases**

VCR ($/MWH)	NSW & ACT	VIC	QLD	SA	TAS
Base case	43,526	42,586	41,366	44,673	33,234
Low case	34, 202	30, 581	32, 617	38, 338	26, 685
High case	100,626	99,056	101,229	94,383	97,627

Source: AER VCR final report, re-weighted by Panel staff

Note: Separate values for ACT and NSW could not be derived by the AER using the Department of the Environment and Energy as ACT consumption data is not separated out from NSW.

5.3.3 Consideration of changes in consumer use of electricity

The RSS review 2021 Guidelines also require the Panel to consider any marked or forecast changes in the way consumers use electricity in its recommendation on the level of the reliability standard. The RSS review 2021 Guidelines specifically require the Panel to consider the impacts of the use of new technology, which suggests a large number of consumers may place a lower or higher value on a reliable supply of electricity from the NEM.[150]

Stakeholders that commented on the matter in submissions to the issues paper and did not consider there was a strong case for adjusting the level of the reliability standard to account for changes in consumer use of electricity, either since the last review or since the AER published its VCR determination in 2019.[151]

- AGL's submission noted that AER VCR has not materially changed in recent years and there is no clear evidence to suggest consumers are willing to pay for higher levels of reliability.[152]
- The AEC considered any changes to VCR associated with the pandemic would be second-order and temporary. The AEC, therefore, cautioned against adjusting the official level based on some anecdotal views.[153]
- Shell noted that the absolute levels of VCR for the different customer classes remained static or in some cases decreased since they were assessed by AEMO in 2014.[154]

The Panel considers that, while there have been changes to how consumers may value a reliable supply of electricity, the materiality of these changes is difficult to establish. The Panel does, however, consider there is a range of factors that suggest the value consumers place on a reliable supply of electricity may be changing, and, in particular, increasing relative to the AER's VCR published in 2019. These include:

- Increased distributed energy resources (DER) impacting how consumers may value reliability,

150 Reliability Panel, *Review of the reliability standard settings guidelines - final guidelines*, 1 July 2021, p. 6.

151 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AGL, p. 4; AEC, p. 3; Shell, p. 4.

152 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AGL, p. 4.

153 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEC, p. 3.

154 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Shell, p. 4.

- Impact of COVID-19 on electricity use patterns including due to the increase in working from home, and
- Changing end-user consumer technologies including the electrification of transport.

While quantifying the effect of these specific factors is beyond the scope of this review, as discussed above, the Panel intends to define a high VCR sensitivity case that provides a band of consideration sufficient to account for any changes to actual consumer VCR associated with the factors listed above.

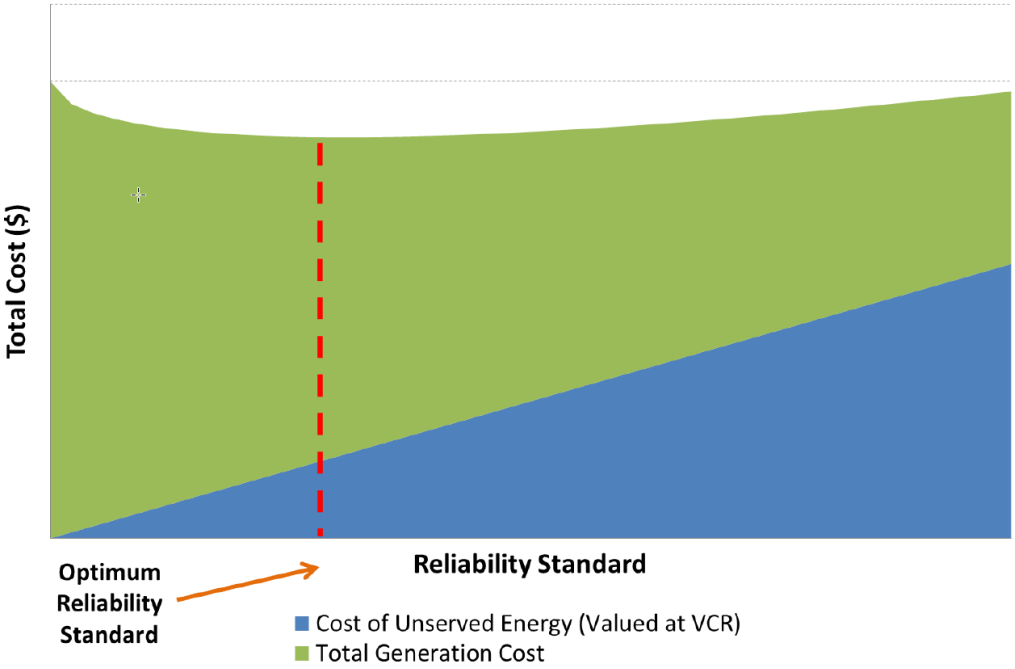
5.4 Modelling informing the efficient level of the reliability standard

The standard is set at a level that balances delivering reliable electricity supplies and maintaining reasonable costs for customers. It represents an economic trade-off between reliability and affordability, based on what customers value. Modelling to inform whether the reliability standard continues to reflect this level, therefore, requires an assessment of the costs:

- to consumers from USE arising from a range of different reliability events, and
- of procuring additional power system resources to address this USE.

The Panel considers the efficient level of the reliability standard, which balances the economic trade-off between reliability and affordability, to be the level of reliability that minimises total costs. This efficient level is conceptually illustrated in Figure 5.1 below.

Figure 5.1: Conceptual representation of the optimal level for the reliability standard



Source: ROAM, Reliability Standard and Settings Review, Final report, 21 May 2014.

5.4.1 IES modelling approach

IES employed the core PLEXOS model, introduced in Chapter three, along with the VCR scenarios described in section 5.3.2 to establish points on the total cost curve conceptually illustrated above.

Technology specific cost curves were established for each key marginal new entrant technology option identified for the purposes of setting the MPC and CPT in Chapter six (OCGT, 2 and 4-hour batteries as marginal new entrants have been assessed).

Modelling informing the efficient level of reliability associated with each key candidate new entrant technology was performed by:

- removing policy-based new entrants to reveal USE associated with their absence
- back-filling with new entrant generation of each candidate new entrant type to systematically reduce the level of USE
- Running the core PLEXOS model to establish the total cost of generation for each assessed level of USE, and
- calculating total costs as the sum of generation related costs (new entrant CAPEX and OPEX) and the cost to customers associated with USE valued at the relevant VCR.

The impact of new investment supported by Jurisdictional schemes was excluded when modelling the efficient level of reliability. Jurisdictionally supported new entrants were excluded to identify the efficient level of reliability on a purely commercial basis. Total system costs were therefore assessed based exclusively on commercial new entrants and the back filled capacity of marginal new entrant technology under investigation.[155]

Efficiency was addressed on a NEM-wide basis considering per region reliability. This involved the incremental new entrant capacity being added to the state with the highest USE as a percentage of total region demand. These results were obtained from capacity being added into NSW only. This is because NSW was the region with a material USE in the absence of policy new entrants.

Demand response was accounted for in the AEMO ESOO price-quantity bid curves utilised in the core-PLEXOS model. Demand response wasn't however modelled as a marginal new entrant technology for the purposes of identifying the efficient level of reliability. The Panel intends to consider options for modelling the impact of marginal new entrant demand response on the efficient level of reliability in its final report.

Further details on the specific modelling performed to inform the Panel's draft position on the level of the reliability standard can be found in IES's accompanying modelling report.

5.4.2 Draft results on the efficient level of reliability

The IES modelling result set informing the Panel's considerations on the level of the standard is presented in Figure 5.2 and Figure 5.3.

155 The efficient level of reliability is therefore assessed using a different power system to that used to identify the market price settings. The reliability gap, described in chapter three, was created by removing thermal generation which is scheduled to retire by 2030. The efficient level of reliability was established by removing policy-based new entries to create the reliability gap that was backfilled with the candidate marginal new entrant technologies.

Figure 5.2 identifies the total annualised system generating and USE cost associated with a range of different new entrant OCGT, two-hour, and four-hour battery capacity evaluated using the base case VCR.

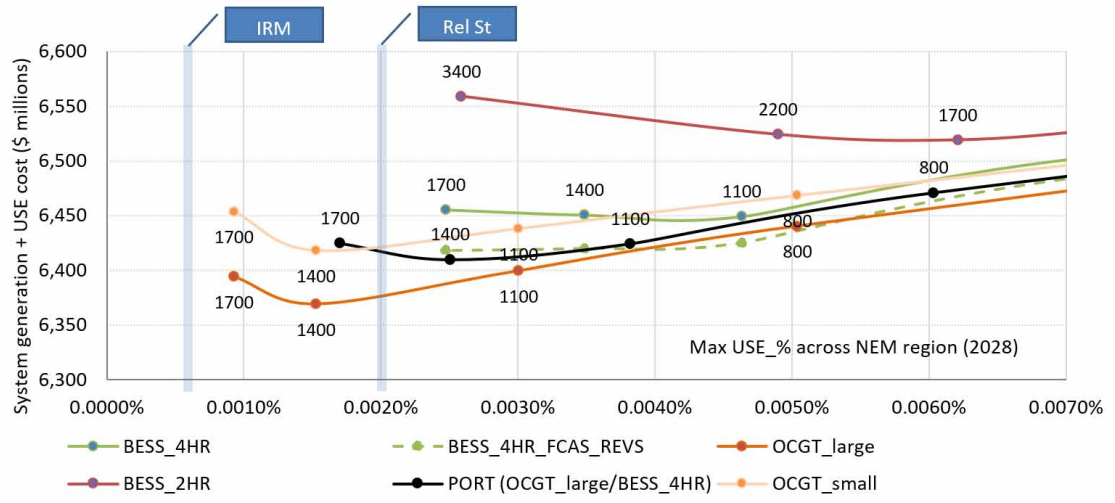
Figure 5.3 indicates that the minimum system generation and USE cost occurs with OCGT as the marginal new entrant and occurs at a level of USE of approximately 0.0015%.[156]

The efficiency trade-off is different for each technology. Two- and four-hour batteries lead to a higher efficient level of USE because of the higher capacity and CAPEX that is required to address an equivalent level of USE as the OCGT. Efficient reliability levels associated with battery new entry under the base case are noted to exist between 0.004% and 0.005% and involve significantly higher costs than that of an OCGT.

The Panel notes that the difference between 0.002% and 0.0015% reliability points on the OCGT line represents less than a 0.2% difference in total cost. This roughly indicates around a $10 million dollar a year benefit from adjusting the current level of the reliability standard to 0.0015%.

The black line in Figure 5.2 evaluates the efficient level of reliability for a hypothetical portfolio consisting of a 50% split between large OCGTs and four-hour batteries. This curve was modelled to identify the efficient level given a mix of new entrant technology reflecting a possible technology split in actual investment in the NEM over the period relevant to the review. The Panel notes the efficient level of reliability under this portfolio case sits just above the current level of the reliability standard at 0.0025%, involving higher costs of up to $50 million per year relative to the entry of OCGTs alone.

Figure 5.2: Technology specific efficient reliability level curves



Source: IES, 2022 Reliability Standard and Settings Review - Modelling Report, Fig. 17.
Note: IES The Y-axis is based on total NEM-wide generation cost + USE cost (based on state-based VCRs), and the X-axis reflects NSW reliability as the state with the highest USE levels in the absence of policy-based new entry.
Note: Stakeholders should note the Y-axis is truncated and commences at 6,300 million.

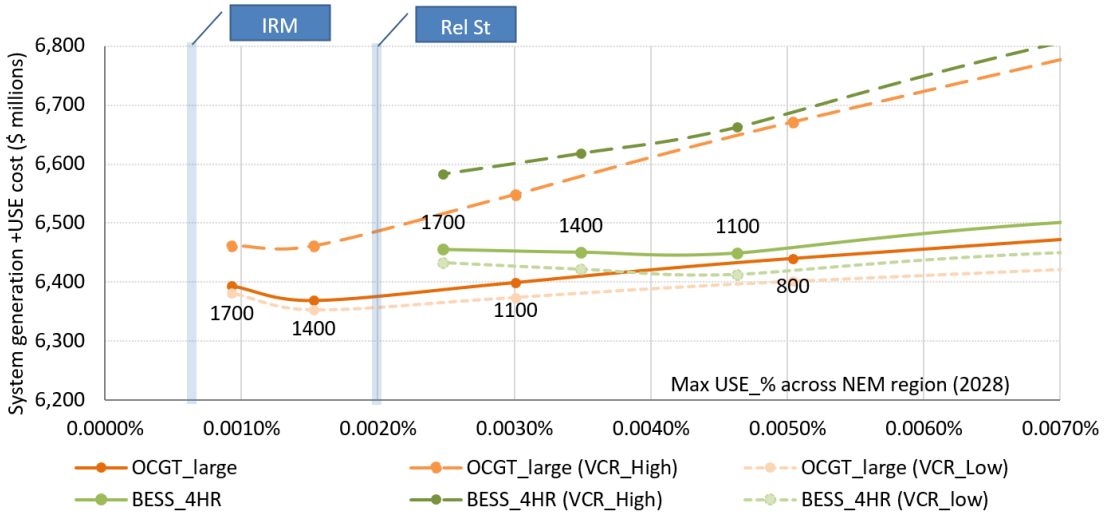
156 The OCGT used to identify this level of efficiency corresponds to the AEMO ISAR 'large' OCGT investment option.

The uncertainty associated with the level of VCR has been captured in Figure 5.3. The total cost curves for the low and high VCR cases are provided for the OCGT and four-hour battery VCR base case.

The Panel notes the efficient level of reliability does not shift materially from the base case level under the low VCR sensitivity. In contrast, the efficient level associated with the high VCR case is noted to decrease significantly.

The large OCGT under the high VCR case has a minimum that is estimated at 0.0012% although the exact minimum is difficult to establish without further modelling around this specific point. The sensitivity of the efficient level of reliability to the high VCR case relative to the low VCR case is attributable to the magnitude of difference between the two cases and the base case.

Figure 5.3: Impact of high and low VCR cases on the efficient level of reliability



Source: IES, 2022 Reliability Standard and Settings Review - Modelling Report, Fig. 20.

Note: IES The Y-axis is based on total NEM-wide generation cost + USE cost (based on state-based VCRs), and the X-axis reflects NSW reliability as the state with the highest USE levels in the absence of policy-based new entry.

Note: Stakeholders should note the Y-axis is truncated and commences at 6,300 million.

The Panel notes the high VCR sensitivity cases utilised a VCR case comparable with that used to determine the IRM.[157] The efficient level of USE of approximately 0.001% is identified which is closer to the IRM level of 0.0006%. The additional costs associated with achieving the 0.0006% cannot be determined accurately from the draft modelling results as the efficiency curves do not extend to that level of reliability. The Panel estimates the additional annual system cost associated with achieving an IRM level of reliability, relative to 0.002% USE evaluated using the base case VCR is in the order of $100 million dollars a year.

Level for different forms of the standard

157 ACIL Allen Consulting, *Report to Energy Security Board: Reliability standard, economic analysis to support review*, 6 March 2020, p. 16.

The Panel's final recommendation on the level of the reliability standard will depend on whether the Panel recommends a change in the expression of the standard from USE to another form. The Panel is not, at this stage, making a specific recommendation on the level of the standard given its ongoing consideration of alternate forms.

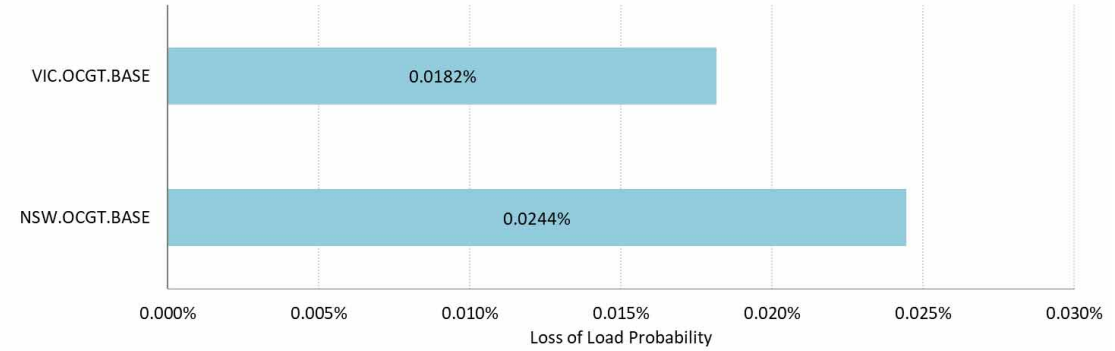
While the Panel's preferred option at this stage is not to substitute a USE-based standard for one expressed as a LOLP/LOLE, the Panel considers that any alternate form for the reliability standard should however be as close to a translation of the efficient level of reliability, identified in terms of USE, as possible.

The LOLP and LOLE outcomes corresponded to 0.002% for the lowest cost marginal new entrant (being OCGT) in NSW and VIC are presented in Figure 5.4 and Figure 5.5 as context. The main observation is an expectation of experiencing on average between 1.6 and 2.15 hours of supply interruption each year. This loss of load expectation is a weighted average of many samples with no supply interruptions and a smaller but more high impact number of samples with a significantly higher loss of load hours. The difference between NSW and VIC is also evident with a high loss of load hours in NSW approximately 20% higher than VIC, driven by the higher base USE implied by the 0.002% reliability standard.

Figure 5.4: Loss of Load Expectation (LOLE) outcomes at 0.002% expected USE

Source: IES
Note: LOLE – loss of load expectation is expected hours over year with unmet load.

Figure 5.5: Loss of Load Probability (LOLP) outcomes at 0.002% expected USE



Source: IES

Note: LOLP is LOLE expressed as a percentage of time over a year. Note it is expressed as a percentage rather than a proportion of the year.

5.5 Draft Panel positions

The Panel has not made a specific recommendation on the level of the reliability standard for the period of 1 July 2025 to 30 June 2028 at this stage of the review. The Panel intends to make a specific recommendation once it has further considered the form of the standard.

The Panel however makes the following general observations:

- The Panel is aware that increasing uncertainty associated with a more weather dependent power system is driving concerns on the level of the standard. The Panel acknowledges these concerns however considers that future amendments to the form of the standard may be the most appropriate approach to addressing a changing reliability risk profile.
- The Panel notes AEMO's view that a tighter standard, consistent with the IRM is necessary to address increasing tail risks. The Panel agrees with AEMO that tail risks are likely to increase as the power system transitions, the Panel does not however consider tightening the level of the reliability standard beyond efficient levels to be a preferable means of addressing these risks. As noted above, amending the form of the standard to specifically speak to tail risk is likely to be a more appropriate approach.
- The interim reliability measure of 0.0006% USE involves higher costs than the efficient level when assessed using the base case customer average weighted VCR. The high VCR case however indicates an efficient level of reliability which is close to 0.001% and potentially consistent with the interim reliability measure.

Materiality of benefits

As noted, the Panel is required to only consider a change to the level of the reliability standard where there is a material benefit in doing so. and considers a material benefit is likely to occur if the Panel identifies existing arrangements are fundamentally misaligned with consumer willingness to pay for reliability. The IES base case modelling results presented in

Figure 5.2 do not indicate a material benefit is likely to arise from an adjustment in the level of the reliability standard from 0.002% to 0.015% of USE.

Under this case, the financial benefit associated with such a shift is approximately a 0.2% reduction in costs, which the Panel considers smaller than inherent modelling uncertainty and therefore immaterial. In addition, the Panel does not consider this magnitude of benefits to justify the additional regulatory uncertainty and costs associated with a corresponding change to the level of the standard.

While the Panel does not identify that there is likely a material benefit associated with adjusting the level of the reliability standard, when evaluated using the base case VCR, the high VCR case may indicate a more efficient level for the reliability standard exists below 0.001%.[158] This outcome was achieved under a high case VCR, which calculated a VCR of around $100k/MWh in each jurisdiction of the NEM, consistent with the Panel's understanding of the VCR used by ACIL Allen in its modelling informing the ESB's decision on its interim reliability measure.[159]

The Panel seeks stakeholder feedback on its approach to weighting outcomes under the high case VCR, relative to the base case.

158 The modelling informing the Panel's draft position was not able to identify the specific efficient level of reliability under the high VCR case as no points under 0.001% USE were evaluated.

159 https://www.energy.gov.au/government-priorities/energy-ministers/priorities/national-electricity-market-reforms/post-2025-market-design/interim-reliability-measures

6 RELIABILITY SETTINGS: MARKET PRICE CAP AND THE CUMULATIVE PRICE THRESHOLD

BOX 7: DRAFT PANEL POSITION - MARKET PRICE CAP (MPC) AND CUMULATIVE PRICE THRESHOLD (CPT)

The Panel notes that the IES modelling identifies a materially significant misalignment between *existing* MPC and CPT and that IES identify as required to provide investment consistent with the reliability standard over the period 1 July 2025 to 30 June 2028.

These modelling results suggest that maintaining existing levels of the MPC/CPT may, in the absence of additional jurisdictional or AEMO intervention, lead to an increase in USE and uncertainty for consumers associated with insufficient investment outcomes.

The Panel has not identified a specific recommendation in this draft report but has instead identified a range of possible candidate MPC/CPT combinations within which it may make a specific recommendation in the final RSS review report. These ranges are:

- **MPC:** $21,000/MWh to $29,000/MWh
- **CPT:** $1,359,100 (corresponding to 7.5 hours at the existing MPC) and $4,176,000 (corresponding to 12 hours at a maximum MPC of 29,000/MWh)

The Panel will identify its final recommendation considering the balance between providing efficient investment signals with systemic market risk. The Panel puts forward a set of decision-making guidelines it is considering using to identify a specific recommendation in its final report for stakeholder feedback.

Panel considerations on transitional arrangements, reconciling NSW and VIC specific result sets, and differences between 2018 and 2022 review outcomes are also presented for stakeholder comment.

Stakeholders should clearly note that a significant increase in the MPC and CPT doesn't automatically cause a material increase in consumer bills as the costs associated with high price periods are still small when compared to the costs across the rest of the year.

The MPC and CPT, share a common purpose. They protect the long term integrity of the market by limiting exposure to high prices. Their impact on new investment in capacity is also connected. The Panel is therefore required to consider them together when assessing the trade-off between incentivising efficient operation and investment in the long run and managing participants' and the overall market exposure to price risk.

A complex set of factors are involved in coming to a recommendation on the combined level of the MPC and CPT. The Panel has not recommended specific changes to the MPC and CPT in this draft report. Instead, the Panel seeks stakeholder feedback on modelling results and directions in its thinking, along with considerations it intends to apply when making a specific recommendation in the review's final report.

This chapter:

- introduces the objectives of, and the relationship between, the CPT and MPC
- summarises stakeholder views on the CPT and MPC
- outlines the Panel's considerations informing its draft position
- presents modelling outcomes informing the Panel's assessment of possible options for the level of the MPC and CPT, and
- presents the Panel's draft position on possible ranges for the CPT and MPC for stakeholder feedback.

6.1 CPT, MPC, their relationship and requirements

This section set out:

- the objectives of the MPC and CPT in supporting reliability outcomes consistent with the reliability standard
- NER and guideline requirements applying to the Panel's consideration of both, and
- the relationship between the two settings.

6.1.1 CPT and MPC objectives

The MPC places an upper limit on wholesale market prices that can be reached in any trading interval. It serves as a limit on the bids of customers without demand-side response, preventing them from paying more than a set amount of energy in any dispatch interval. The value of the MPC is specified in the NER and is currently set at $15,100/MWh.[160] The MPC services two functions which are:[161]

- to enable the market to achieve and send efficient price signals, to support the efficient operation of, and investment in electricity services over the long run, and
- to limit market participant exposure to price risk.

The MPC is therefore set at a level that is sufficiently high to support the investment required to achieve the reliability standard but not too high to create systemic financial risks that may compromise the stability of the market.

The CPT is a threshold on the cumulative price for energy and frequency control ancillary services (FCAS) over a period of seven days beyond which an administered price period (APP) commences and the APC is applied to market prices. The current level of CPT is $1,359,100 for the period 1 October 2021 to 30 June 2022.[162] This value represents 7.5 hours of the existing MPC. [163]

The CPT has two purposes that are closely related to the MPC. The CPT aims to:

160 Australian Energy Market Commission, *Schedule of reliability settings*, 25 February 2021, p.1, Sydney.

161 Reliability Panel, Review of the reliability standard and settings guidelines, final report, 1 July 2021, p.29, Sydney.

162 The CPT is increased by indexation each year. The movement to a five-minute settlement in October 2021 means the value of the CPT has been multiplied by six to match the movement of settlement from a 30-minute to a five-minute basis. As such, the value of the CPT is $1,359,100 from 1 October 2021 to 30 June 2022.

163 Australian Energy Market Commission, *Schedule of reliability settings*, 25 February 2021, p.1, Sydney.

- cap the total price risk to which market participants are exposed over a given time period, and
- maintain the effectiveness of the MPC, by not hindering the market price signals for efficient operational decisions and efficient investment in generation capacity and/or demand-side response.

6.1.2 Requirements in setting the MPC and CPT

The NER and the RSS review 2021 Guidelines state that the Panel can only recommend an MPC and CPT that the Panel considers will, among other things:[164]

- allow the reliability standard to be satisfied without the use of AEMO's powers to intervene, and
- not create risks that threaten the overall integrity of the market.

The requirement to set the MPC and CPT at a level that allows the reliability standard to be satisfied without the use of AEMO's powers prevents the Panel from placing any reliance on RERT, or AEMO directions for reliability, to maintain the level of USE at the level of the reliability standard.

In addition, the RSS review Guidelines provide that, when assessing the level of the MPC, the Panel will consider the following principles:[165]

- The MPC should not be used to actively steer the market into a short-run equilibrium position or to actively drive disinvestment decisions.
- While the MPC may move either up or down over time, these movements should be gradual. These movements should occur over a period of several review periods.
- When setting the MPC, the Panel should give secondary consideration to the MPC's effect on the financial burden faced by participants from high market prices, including price volatility and impacts on retailers.

When assessing the level of the CPT, the RSS review 2021 Guidelines require the Panel will consider the following principles:[166]

- The CPT should protect all market participants from prolonged periods of high market prices, with particular consideration to impacts on investment costs and the promotion of market stability.
- The CPT should not impede the ability of the market to determine price signals for efficient operation and investment in energy services.
- The CPT should be determined by giving consideration to the level of the MPC.

The Panel's consideration of these factors in coming to its draft position is set out in section 6.5.1 to section 6.5.4.

164 NER clause 3.9.3A(f).

165 Reliability Panel, R*eview of reliability standard and settings guidelines,* final report, July 2021, p.30, Sydney.

166 Reliability Panel, *Review of the reliability standard and settings,* final report, 1 July 2021, p.7, Sydney.

6.1.3 Relationship between the CPT and MPC

The level of the CPT and MPC are related. They together determine the extent to which market revenue is sufficient to financially incentivise new entrant investment consistent with the reliability standard. The extent to which one cap is sufficient to incentivise new investment depends in part on the level of the other price cap.

A higher MPC without an increase in the CPT requires fewer MPC periods prior to the CPT being breached and administered pricing at $300/MWh is applied. This means fewer high price periods from which peaking / low capacity generators can recover revenue. Previous RSS reviews have maintained the ratio between the MPC and CPT at a constant level corresponding to a CPT which represents 7.5 hours at the MPC to manage this relationship.

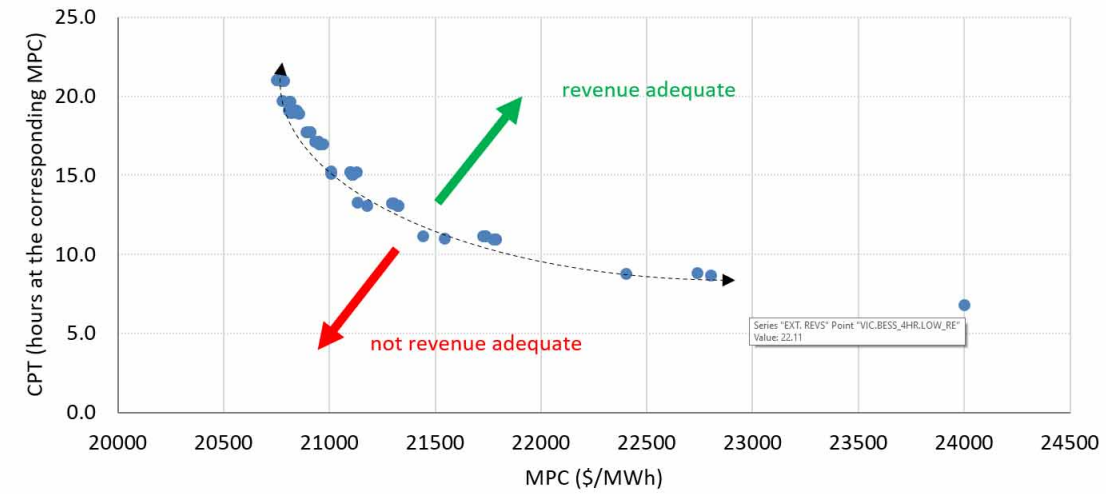
The Panel has explicitly considered the relationship between the CPT and MPC in its modelling. The modelling performed by IES for the review (discussed further in Chapter three and the following section) co-optimised the level of the MPC and CPT that provides revenue sufficiency while also minimising total market costs.[167]

Modelling allows an efficient frontier of MPC/CPT combinations to be identified that just cover the capital and operating costs of marginal new entrant generation options given the distribution of USE and patterns of dispatch.[168] Figure 6.1 illustrates this efficient frontier of MPC/CPT combinations. Combinations that lie above this frontier are revenue adequate but not efficient as the new entrant technology would over-recover its costs. Conversely, settings that lie below this frontier do not provide sufficient revenue to recover costs and are therefore insufficient to support investment in the new entrant technology consistent with achieving the reliability standard. The efficient MPC and CPT, therefore, lie on, or close to, this line.

167 Total market costs are defined as spot price times served demand and USE priced at VCR. The system cost definition is different to the one used for addressing the efficiency question (productive efficiency) as it is directly assessing the impact of the market price settings.

168 The boundary is defined as all MPC/CPT points that are within a 5% threshold of the lowest cost combination.

Figure 6.1: Example efficient frontier showing the trade-off between MPC and CPT



Source: IES, 2022 Reliability Standard and Settings Review - Modelling Report, Fig. 65.
Note: The points that define the efficient frontier have a total region cost within 5 per cent of the minimum total region cost point.

Efficient frontiers can be established for each candidate marginal new entrant technology. The relative positions of each efficient frontier then informs the Panel's understanding of whether a specific MPC/CPT combination provides sufficient revenue to support one or more technologies.

The Panel considered the relative position of frontiers for a subset of key marginal new entrant technologies from within the set of all candidate new entrant technologies. The key marginal new entrant technologies were OCGT and 2 and 4-hour battery for NSW and VIC. Further details are presented in section 6.4 below.

6.2 Stakeholder submissions to the issues paper

The Panel has considered stakeholder views in identifying its draft position on the level of the MPC/CPT. This section focuses on stakeholder submissions on the level of the MPC and CPT. Other relevant stakeholder feedback is considered alongside the Panel considerations set out in section 6.2.1 and section 6.2.2.

While issues raised by stakeholders are considered in Panel considerations, the Panel will respond to specific stakeholder views when making its final recommendation. This is because the Panel is still considering a range of issues that will inform its final recommendation.

6.2.1 Stakeholder submissions on the MPC

A significant number of stakeholders recommended the Panel consider increasing the MPC.[169] Of these:

169 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEC p.4; Engie p.3; Snowy Hydro p.7; Hydro Tasmania p.2.

- The AEC considered that the overall trends in the power system imply an increase in the real MPC in order to retain USE within the standard.[170]
- ENGIE considered key reliability settings such as the MPC and CPT have been set too low and that market trends indicate a higher rather than lower MPC is likely to be most appropriate.[171]
- Snowy Hydro considered the growing risk of extreme events in the NEM supports the need for an increase in reliability settings, particularly the MPC. Snowy Hydro further suggested the Panel analyse outcomes for MPC between $20,000/MWh and $30,000/MWh in identifying a sufficient increase.[172]
- Hydro Tasmania considered an increase in the MPC is needed to more accurately reflect the real value of reliability in the energy-only market.[173]

A further group of stakeholders considered a change in the level of the MPC was likely warranted but didn't explicitly suggest an increase. [174]

The Australian Aluminium Council, requested consideration be given to a lower MPC particularly given the potential introduction of a capacity mechanism.[175]

Stakeholders generally supported the Panel's proposed approach to determining the MPC.[176]

- Shell Energy supported the current approach to determining the level of the MPC in particular setting the MPC at the lowest level below the value of customer reliability that will result in the reliability standard being met.[177]
- EA however considered the Panel should consider whether it would be prudent to defer the closure of the thermal plant rather than fund the marginal new entrant in determining the level of the MPC. [178]

A number of stakeholders specifically commented on the importance of including demand response and storage as candidate new entrant resources when setting the MPC and CPT:[179]

- The AEC considered the vanilla new entrant seems likely to be a large-scale lithium-ion battery and modelling should evolve from meeting the last increment of load with a peaking gas turbine as it has done previously across to storage.[180]
- CS Energy considered that the MPC may provide investment signals for shallow storage, yet not for deep storage requirements in the event of low probability, high impact

170 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AEC p. 3.

171 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Engie p.2.

172 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Snowy Hydro p.4.

173 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Hydro Tasmania p. 2.

174 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: SA Government Department of Energy and Minerals, p. 3; AEMO, p. 2; Shell, p. 5; Alinta, p. 1.

175 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Australian Aluminium Council p. 4.

176 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Shell p.5; EnergyAustralia p.7; EUAA p. 4.

177 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Shell p. 5.

178 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: EA p.7.

179 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Engie p. 5; CEC p. 3; AEC p. 1; Shell p. 1; EA p. 4; Origin p. 8; CS Energy p.6.

180 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AEC p.1.

weather events, and suggested the Panel consider how different duration of storage is provided timely investment signals.[181]

- Shell Energy considered that demand response is an important provider of reliability services in the NEM. However, they also noted the difficulties in assessing it as a new entrant due to its uncertainty.[182]
- CS Energy identified concerns around modelling demand response including the high degree of uncertainty regarding the costs and technical performance of demand response as a reliability provider.[183]

6.2.2 Stakeholder submission on the CPT

A number of stakeholders considered there may be merit in increasing the CPT.[184]Stakeholders particularly noted the existing CPT level limited incentives for long-duration storage and incentives to contract for risk management. Stakeholder views included:

- Snowy Hydro considered that the current level of CPT is too low, and poses a major problem for peaking assets, that is a CPT (and MPC) are set too low which encourages customers to take on risk by leaving their positions unhinged in the spot market [185]
- Hydro Tasmania considered that there is a risk the CPT, together with the MPC, will mute the investment signals for longer duration capacity in favour of shorter-term capacity that will benefit from the protection offered by the artificially capped MPC, CPT and APP. [186]
- AGL requested the Panel consider whether there is merit in increasing the CPT to provide appropriate investment incentives in a changing power system. [187]
- The AEC noted that the current level of the CPT effectively removes the investment case to build storage with greater than about 5-6 hours of energy depth. The AEC considered this insufficient with an increase in the CPT required.[188]
- CS energy considered the current period of 7.5 hours may not be sufficient to provide market signals to deep storage. CS recommended the Panel consider the role of a higher CPT but also noted a higher CPT may not result in achieving a least-cost outcome for consumers.[189]
- The CEC identified a higher CPT would support new capacity investment by reducing the frequency with which the CPT binds by creating new contracting incentives and reducing investment risk.[190]

181 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: CS Energy p.7.
182 Reliability Panel, 2022 Reliability standard and settings review, issues paper submission: Shell Energy p.7.
183 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: CS Energy p.6.
184 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AGL p.1; Hydro Tasmania pp.2-3; Snowy Hydro p. 14; AEC p. 3; CS Energy pp. 7-9; CEC p.2.
185 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Snowy Hydro p.14.
186 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Hydro Tasmania p.2.
187 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AGL, p.1.
188 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AEC p.3.
189 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: CS Energy p.7.
190 Reliability Panel, *2022 Reliability standard and settings* review, issues paper submission: CEC p.2.

AEMO and Shell were neutral in their views and considered the existing level of the CPT to be largely appropriate[191]

In contrast, the AER's submission noted that participants have been exposed to periods of very high prices without the CPT thresholds being breached. The Panel further notes the AER has provided submissions to previous RSS reviews on the level of the CPT which argued against an increase in the CPT on the basis of its impact on consumers and retailers.[192]

Stakeholders generally considered the form of the CPT to be appropriate[193] The AEC however encouraged the Panel to consider the form of the CPT and provided two objectives to assess the current form of the CPT:[194]

- not interfering with the investment signals to build dispatchable capacity to keep the power system within the standard in a future energy-limited system, and
- limiting financial risks in the aftermath of a force-majeure network event to a level that is unlikely to cause a systemic financial contagion.

Stakeholder comments didn't support the implementation of a negative CPT. Stakeholder views on a negative CPT are considered further in Chapter Seven on the level of the market floor price.

6.3 Panel considerations

This section discusses the Panel's key considerations in coming to its draft recommendation on the MPC/CPT. Key considerations include:

- contract market impacts and market integrity considerations
- materiality of benefits justifying a change
- considerations on regulatory certainty and flexibility, and
- whether historic market outcomes support a case for change.

6.3.1 Contract market impacts and market integrity considerations

The NER provides that the Panel may only recommend an MPC and CPT that "will, in conjunction with other provisions of the Rules, not create risks which threaten the overall integrity of the market.[195] The RSS review 2021 Guidelines further require, that when setting the MPC, the Panel should give consideration to the MPC's effect on the financial burden faced by participants from high market prices, including price volatility and impacts on retailers.[196]

Appropriately priced, liquid contract markets are necessary to provide market participants with the opportunity to efficiently share risk between counter-parties. The Panel, therefore,

191 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEMO p.6; Shell Energy p.6.
192 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AER p.1.
193 Reliability Panel, 2022 Reliability standard and settings review, issues paper submissions: Origin p.8; Shell Energy p.1.
194 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AEC p.4.
195 Clause 3.9.3A(f)(2) of the NER.
196 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, p.7, Sydney.

considers market integrity to be facilitated by an appropriately priced and liquid contracts market given the importance of contracting for managing financial risk and providing the stable cash flows needed to underpin financing of high capital cost, long life, and generation assets.[197]

The MPC and the CPT influence the optimal contracting position of a generator, retailer, or customer through their impacts on price risk exposure, and thereby contract market liquidity. The Panel, therefore, considers impacts on contract market liquidity to be at the centre of the question of market integrity impacts arising from potential changes to the MPC and CPT.

The Panel notes stakeholder comments on contract market impacts received in submissions to the review's issues paper. In particular, stakeholder views that an increase in MPC and CPT was required to improve contract market liquidity and pricing to efficient levels:[198]

- Hydro Tasmania considered an increase in the MPC would sharpen signals to invest in new capacity by creating a greater demand for financial derivatives in order to manage price risk and accurately reflect the real value of reliability in the energy-only market.[199]
- Snowy Hydro considered cap prices under existing settings were below the level required to effectively incentive new entrant investment, particularly in VIC, and that the current level of the CPT created a moral hazard by capping contract prices which encouraged market customers to take on risk, unhedged exposure to the spot market -safe in the knowledge that once administered pricing is triggered, those risks will be borne by generators.[200]

These views were however balanced by other stakeholders who were concerned about the potential for increased volatility and systemic price risk should the MPC/CPT be revised substantially higher.[201] Origin Energy particularly noted that increasing the MPC/CPT would heighten market participants' financial exposure to sustained high prices while not necessarily improving the level of investment given the levels of investment uncertainty.[202]

In developing its recommendations in this review, the Panel has identified the following key considerations in respect of market integrity and contract market impacts:

- The Panel considers the approach taken in previous reviews which set the MPC at the lowest level reasonably practicable, consistent with providing revenue sufficiency for the marginal new entrant, remains an appropriate approach to balancing market efficiency while also minimising any impact on market integrity.
- Contract market outcomes will be best achieved when market price settings (the MPC and CPT in particular) are sufficient to support efficient new entry investment. Market price

197 Contracts provide generators with a steadier stream of revenue than the spot market. A steadier stream of revenue reduces the risks to parties providing funding to generators, such as debt and equity holders. This lowers the overall cost of capital required to finance the project and lowers the cost of the new generation capacity.

198 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Hydro Tasmania p.2; Snowy Hydro p.5.

199 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Hydro Tasmania p.2.

200 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Snowy Hydro p.5.

201 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Origin Energy p.6; EnergyAustralia p.5.

202 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Origin Energy p.6

settings that are insufficient will not create incentives leading to appropriately priced and efficient contract market outcomes appropriately supporting market integrity.

- The Panel however notes negative transitional impacts on contract market liquidity and market integrity could arise from a step-change in the level of the MPC/CPT. The Panel is concerned that an excessively large, sudden increase in the MPC/CPT could:
  - Increase prudential requirements requiring increased cash or security from market participants. Such a change would affect both new entrants and existing market participants, potentially impacting market integrity associated with the financial impact on small market participants.
  - Decrease short term contract market liquidity by limiting trading position sizes due to 'value as risk' limits on market trading positions.[203]

The Panel proposes transitional arrangements in section 6.5.3 to minimise any negative transitional impact from a material adjustment in the MPC/CPT.

The Panel seeks stakeholder feedback on its considerations in respect of market integrity and contract market impacts to inform its final recommendation.

6.3.2 Materiality of benefits justifying a change

The RSS review 2021 Guidelines require the Panel to recommend a change to the level of the market price settings only be made if the Panel considers there is a material benefit in doing so.[204] This section presents the Panel's draft set of factors it intends to consider in assessing whether the materiality of benefits justifies a change to the combined level of the MPC/CPT.

The Panel notes the weight of stakeholder views recommending an increase in the combined level of the MPC/CPT to sufficiently incentivise new entrant investment required to achieve reliability outcomes consistent with the level of the reliability standard.[205]

Shell Energy, however, noted the tension between the impact of a lower market price cap reducing the value of existing assets, and the material increase in risk associated with a higher MPC. Shell urged caution on the part of the Panel in carefully adjusting the level.[206]

Consistent with RSS review 2021 Guidelines requirements, the Panel considers a material benefit to arise from a change that contributes to the achievement of the NEO in a materially better way than existing arrangements. The Panel considers a change in the MPC/CPT will contribute to achieving the NEO in a materially better way if it leads to a significant improvement in the alignment of investment outcomes with an efficient level of reliability. MPC/CPT that are fundamentally misaligned will lead to inefficient outcomes either in respect of additional costs borne by consumers in respect of generation over-investment, or an inefficiently high level of USE.

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203 In the contracts market, risk measures such as value at risk (VaR) and stress limit exposure are used to determine the amount and the number of contracts to trade.

204 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, p.4, Sydney.

205 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: AEC p.4; Engie p.3; Snowy Hydro p.7; Hydro Tasmania p.2.

206 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Shell Energy p.5

In identifying whether any identified misalignment is likely to provide material benefits, the Panel intends to consider whether the:

- identified misalignment clearly exceeds the level of uncertainty inherent in the modelling
- impact of any change to the MPC/CPT on existing assets and market participants, and
- implementation costs associated with a change.

The Panel seeks stakeholder feedback on its considerations in respect of the materiality of benefits justifying a change to the level of the CPT/MPC.

6.3.3 Considerations on regulatory certainty and flexibility

The RSS review 2021 Guidelines require the Panel to exercise its judgement to achieve predictable outcomes recognising the importance stability creates for market participants in terms of investment, while taking into account changing market conditions, to support efficient investment and operational decisions.[207]

The Reliability Panel's approach to reviewing the standard and settings is therefore designed to balance predictability and flexibility in the development of the regulatory frameworks for reliability.

The Panel notes stakeholder submissions to the issues paper on the importance of predictability, in particular:

- EA suggested the Panel could make smaller 'directional' changes for the 2024-28 period, otherwise, it could provide guidance for its 2028 reviews and its ongoing monitoring functions. EA considered having decision-makers articulate such 'signposts' or thresholds for changes to regulatory settings are useful in a rapidly changing National Electricity Market (NEM) and can help reduce investment uncertainty. [208]
- the AEC considered that an increase in the MPC should involve well-telegraphed progressive increases that would be manageable by the industry. [209]

Hydro Tasmania however noted the tension between making gradual movements over time and not being so gradual as to fail to adequately incentivise investment.[210] Engie further considered the Panel should be sure to avoid being caught behind the curve if modelling indicates upward pressure on the equilibrium MPC.[211]

As the level of the MPC/CPT informs decisions to invest in long term assets, the Panel identified value in maintaining predictability in the level and form of components wherever appropriate. Predictability of outcomes supports market confidence and reduces perceived regulatory risk, helping to support efficient investment.[212]

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207 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, p.2, Sydney.

208 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: EA p.4.

209 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AEC p.3.

210 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Hydro Tasmania p.2.

211 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Engie p.3.

212 The Panel recognises the impact that rapid technological change and policy uncertainty is having on consumers, market participants and the broader investment community. Policy uncertainty, in particular regarding the integration of emissions reduction and energy policy, is to some degree constraining the investment environment, and potentially raising risk premiums and costs to consumers.

The Panel considers that predictability and certainty, consistent with the long term interest of consumers, are best achieved through transitional arrangements that clearly signal a realignment in MPC/CPT to efficient levels over a period of time. The Panel's view in this regard is consistent with the guidance provided in the RSS review 2021 Guidelines that while the MPC may move either up or down over time, these movements should be gradual. Any such movements should occur over a period of several review periods.[213]

While the Panel considers predictability should be pursued to the extent reasonably practicable, transitional arrangements providing predictability also need to allow for a re-alignment necessary to provide for reliable outcomes in line with the reliability standard. The Panel's draft position notes a tension on this point is evident in this review and section 6.5 discusses initial options further for stakeholder feedback.

6.3.4 Historic outcomes informing a need for a change

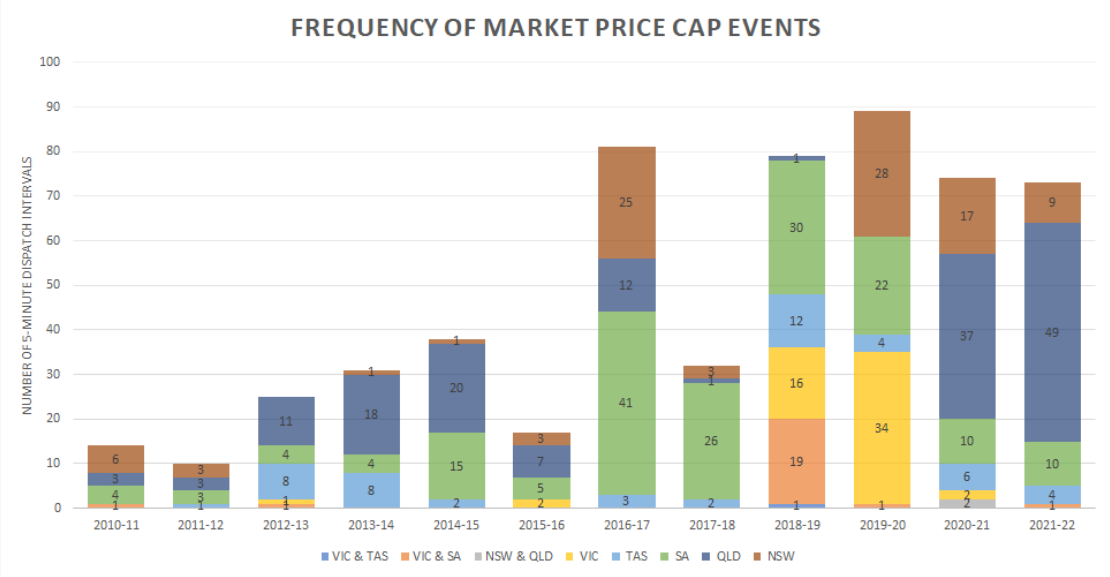
The Panel is considering whether historic market price outcomes inform the case for change. In particular, whether MPC and/or CPT events in the NEM indicate a need to adjust existing levels by binding more frequently.

The Panel presented information in its issues paper on trends that indicate the MPC is binding increasingly frequently. Figure 6.2 shows the increase in MPC events in the NEM over the last 10 years and shows the MPC is binding increasingly frequently. The Panel notes this trend may indicate the MPC is becoming less aligned with efficient outcomes.

Figure 6.2 shows the increase in MPC intervals showing that, except 2016, 2018 and 2020 financial years, there is a general trend of an increasing number of dispatch intervals where the MPC has been reached. In the 2020 financial year, the largest number of MPC events occurred in VIC.

213 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, pp.6-7, Sydney.

Figure 6.2: MPC outcomes



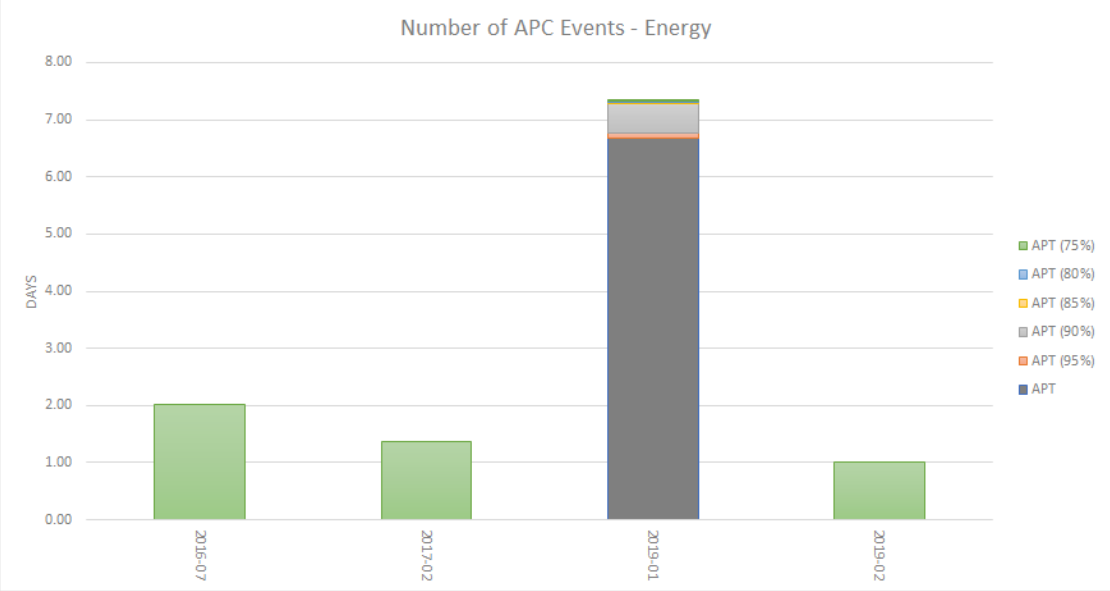
Source: Analysis of AEMO data

Historic outcomes in respect of the CPT are less informative on the need for change as there are few circumstances where the CPT historically has been triggered in the NEM. Although the Panel is aware that energy price outcomes are coming close to exceeding the CPT as it writes this report.

Figure 6.3 shows the CPT for the energy market was breached only once in recent history and the APP triggered following this CPT breach was limited to a maximum of 2 days per event.[214]

214 The 2021 AMPR final report indicated that for the period 2020-2021, CPT was not breached for energy, so the APC was not triggered. The CPT was breached for frequency control ancillary services (FCAS) on 5 June 2021 in the fast contingency raise service in Queensland. The APC was consequently applied until 10 June 2021.

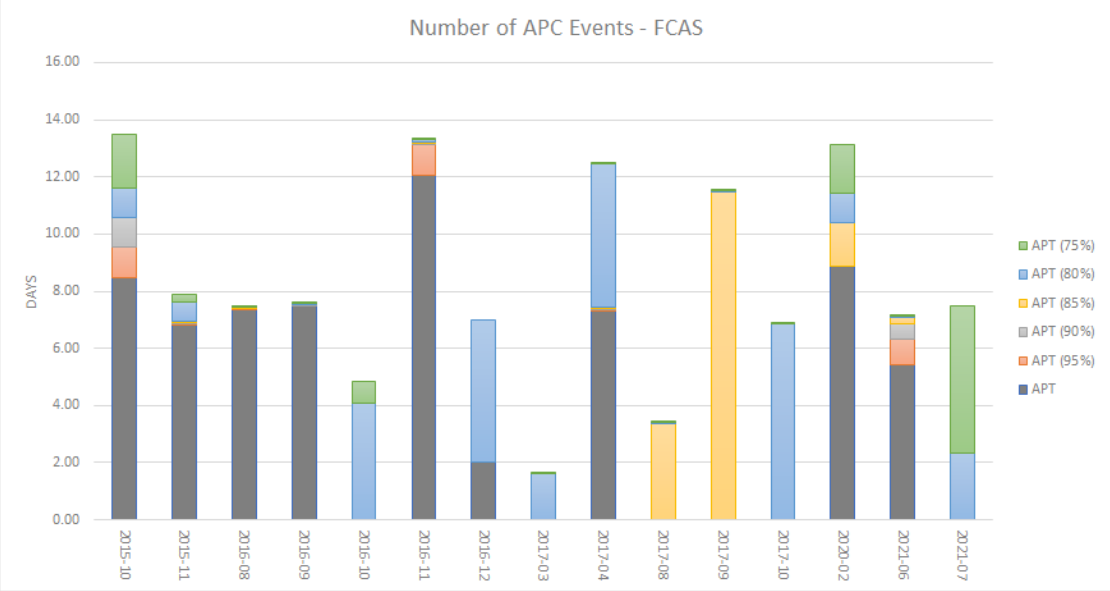
Figure 6.3: Number of APC Events - Energy



Source: Panel Analysis of AEMO data

Even if a hypothetical 75 per cent of the CPT was applied, there were a limited number of circumstances to inform as to the level of the CPT. The same analysis was conducted on the FCAS market, shown in Figure 6.4. It shows the CPT for the FCAS market has been exceeded nine times in the recent history and the most the APP applied was below nine days. These results do not suggest the level of the CPT as it currently stands represents an inappropriate barrier to efficient market operation.

Figure 6.4: Number of APC Events - FCAS



Source: Panel Analysis of AEMO data

6.4 Modelling - approach and key results

This section expands on the introduction to IES's modelling provided in Chapter three. It introduces key elements of IES's modelling that specifically relate to modelling the MPC/CPT. The CPT/MPC result set informing the Panel's draft position set out in section 6.4.3 is then presented.

6.4.1 IES optimisation model

IES used an optimisation model specifically developed for the 2022 RSS review to:

- evaluate marginal new entrant options,
- co-optimise the MPC and CPT that minimise market costs while also providing revenue adequacy for the marginal new entrant, and
- identify the efficient frontier of MPC/CPT combinations for each candidate marginal new entrant technology.

The optimisation model utilises price and dispatch outcomes from the core PLEXOS model, introduced in Chapter three, for each region for which a reliability gap was modelled. IES modelled a reliability gap in PLEXOS for NSW and VIC, which are the two regions with base case reliability outcomes closest to the level of the reliability standard.[215]

215 The marginal new entrant was modelled as the last increment of investment that is required to achieve the reliability standard. For NSW and VIC, PLEXOS was used to model price and dispatch outcomes associated with a level of reliability that is sufficiently close to the reliability standard such that the marginal new entrant can be modelled as a price taken that doesn't affect dispatch and revenue outcomes for other generators.

The optimisation model then solves for the lowest cost marginal new entrant and associated settings in each region separately that minimise total region costs given constraints describing revenue sufficiency of the marginal new entrant generator.[216][217]

The optimisation model uses chronological price-dispatch outcomes for periods leading up to and immediately following any USE to identify the marginal new entrant build, and costs required to just achieve the level of the reliability standard[218]so that storage sizing and charging can be modelled as a function of available surplus energy prior to the USE event.[219] Generator specific constraints are included such as battery minimum state of charge are included to adequately consider the dynamics and technical limitations associated with each new candidate generator type.

Comprehensive information on IES's modelling is available in the accompanying IES modelling report.

BOX 8: ONGOING CONSIDERATION OF DEMAND RESPONSE AS A MARGINAL NEW ENTRANT RELIABILITY PROVIDER.

The Panel has elected to model demand response in IES's optimisation model as a candidate new entrant using a conservative approach based on costs provided on a confidential basis by a demand response market participant. Marginal new entrant demand response is taken to be that which is not currently economic but would become economic with an increase in the MPC/CPT. The impact of demand response as a marginal new entrant is considered as a sensitivity case for comparison with base case outcomes.

The Panel's approach to incorporating demand response in the modelling has been conservative in recognition of the high degree of uncertainty relating to demand response as a marginal new entrant reliability resource.

The Panel appreciates stakeholder interest in demand response and considers demand response an important future power system resource. The Panel looks forward to engaging with stakeholders on approaches to further considering the contribution of demand response in modelling performed to inform recommendations in its final report.

Note: Marginal new entrant demand response was taken to involve $50,000/MW/year capital and $5,000/MWh variable costs and have a 2-hour daily response limit.

216 The marginal new entrant is taken to earn revenue in reliability periods as well as revenues in line with averages for the same generation type in the region outside periods assessed in the optimisation model. The optimisation model used cost and generator technical performance assumptions consistent with those applied in the PLEXOS model.

217 Total region costs are calculated from wholesale energy and USE costs. This is different to the total system costs minimised in the results presented in Chapter 5 which are based on production rather than market costs.

218 The optimisation model will extract all relevant periods of USE, periods pertaining to the reliability settings, e.g., the period after significant USE events which may trigger CPT and solve for the marginal new entrant plant to address the remaining reliability gap and optimal level of the settings.

219 Surplus energy is based on curtailed energy from solar and wind plants, and surplus capacity at non-energy limited plants. Input wind and solar traces and curtailment levels from the actual modelling will be used to determine actual solar and wind contributions toward the USE periods.

6.4.2 Sensitivities investigated

A key challenge for the review is to reasonably capture uncertainty. The Panel's recommendations on settings apply up to 7 years in the future in the context of a power system experiencing a rapid technological transition. IES's modelling utilised sensitivities as a means of addressing parameter and plant performance related uncertainty impacting candidate MPC/CPT combinations.

IES's optimisation model approach provides a high degree of flexibility to consider a range of sensitivities and their impact on the lowest cost marginal new entrant and associated settings. The set of sensitivities used to inform the Panel's draft recommendation is set out in Table 6.1.

Detailed sensitivity specifications are provided in the IES modelling report published with this draft report.

Table 6.1: Sensitivities used and considered in IES modelling

SENSITIVITY	DESCRIPTION
Imperfect foresight and operational constraints	The underlying modelling assumes perfect foresight which may understate actual risks across the marginal new entrants. Imperfect foresight was approximated by running sensitivities applying additional operational constraints.
FCAS revenue assumption	FCAS revenues used to reduce the capex cost base for the energy-only modelling are based on forward-looking estimates. Historic revenue outcomes were adjusted to reflect conservative possible revenue outcomes given forward looking FCAS market supply and demand.
Higher WACC	The WACC in the base case may not adequately investment risks or reflect cost of capital applying in FY2026-FY 2028. Model increased risks through a higher WACC applied uniformly across all new entrant candidates.
Higher gas prices	Gas prices are expected to drive the competitiveness of peaking gas plants relative to other new entrant options. The gas price sensitivity modelled the impact of significantly higher gas prices on new entrant outcomes.

6.4.3 Modelled MPC/CPT combinations in NSW and VIC

A result set of candidate MPC/CPT combinations for key new entrant technologies in NSW and VIC is presented in this section. These results outline the general characteristics of the result set informing the Panel's draft position put forward in section 6.5.

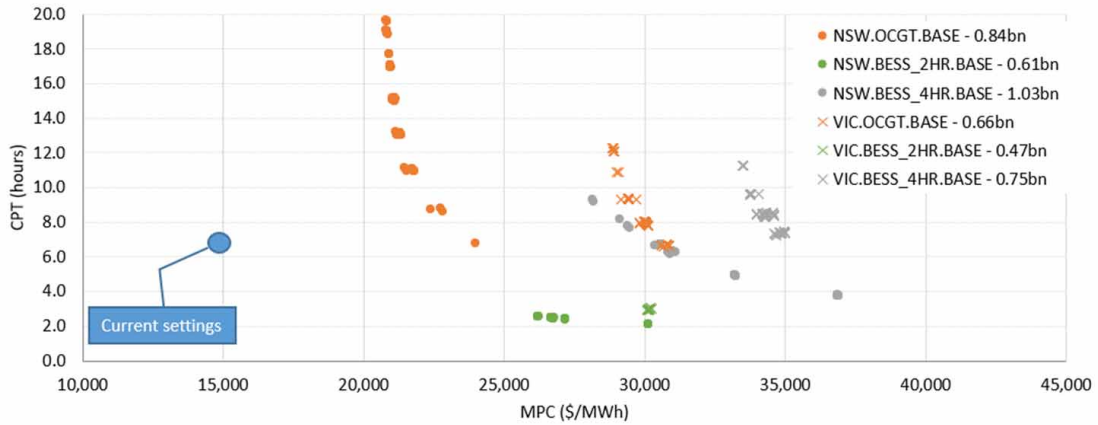
The base case identifies the lowest cost marginal new entrant to be an OCGT in NSW which requires a minimum MPC of $21,000 to achieve revenue neutrality. The minimum MPCs required to incentivise 2-hour and 4-hour batteries in NSW are observed to be $27,000/MWh and $29,000/MWh respectively. The CPTs that correspond to these MPC points are discussed in the section below.

The Panel notes all of these options are materially above the current MPC of $15,100/MWh. This finding will be significant to the Panel's draft position set out in section 6.5. Additional details on each of these results are presented in IES's modelling report published with this draft.

As introduced in section 6.1.3, an efficient frontier of MPC/CPT combinations exists for each candidate new entrant technology which describes a locus of combinations describing the tradeoff between the level of the MPC and CPT. Figure 6.5 presents efficient MPC/CPT frontiers for the key marginal new entrant technologies being OCGT, 4-hour and 2-hour batteries.[220]

Figure 6.5 shows the parabolic relationship between the MPC and CPT for base case outcomes.[221] The CPT can be significantly reduced from high levels with only a slight increase in the MPC from minimum levels because revenues associated with long-duration events are less significant for total new entrant revenues given the distribution of USE event duration described in Chapter four.[222]

Figure 6.5: Efficient MPC/CPT frontiers for NSW and VIC



Source: IES, 2022 Reliability Standard and Settings Review - Modelling Report, Fig. 69.

220 Candidate MPC/CPT outcomes that define this boundary is identified by considering all MPC/CPT combinations that have total market costs within 5% of the minimum.

221 The impact of sensitivities is illustrated in the section below.

222 It should be noted that a higher degree of uncertainty is associated with long-duration events which are low probability events.

The lowest potential MPC is achieved by an OCGT in NSW with a CPT corresponding to approximately 16 hours and an MPC of $21,000. Minimising the MPC however requires reliance on revenue realised from lower probability longer duration USE events. Reliance on revenues from low probability events may impact investment associated with the bankability of revenue from such events. An MPC of $23,500/MWh would be required should the Panel consider limiting the CPT to the existing ratio of CPT to MPC of 7.5 hours.

Two and four-hour batteries in NSW require a minimum MPC of $26,000/MWh and $28,000/MWh to achieve revenue sufficiency. Batteries require higher MPCs but lower CPTs than new entrant OCGT. This outcome is due to batteries being sized and dispatched to make a reduction in USE that is significantly limited to their energy discharge duration.[223]

Victorian marginal new entrant OCGT and batteries are observed to have significantly higher MPC requirements than in NSW with the minimum OCGT MPC of $29,000/MWh required for revenue sufficiency for a 12-hour CPT. This difference is attributable to the lower level of USE in VIC that occurs for a 0.002% level of reliability relative to NSW.

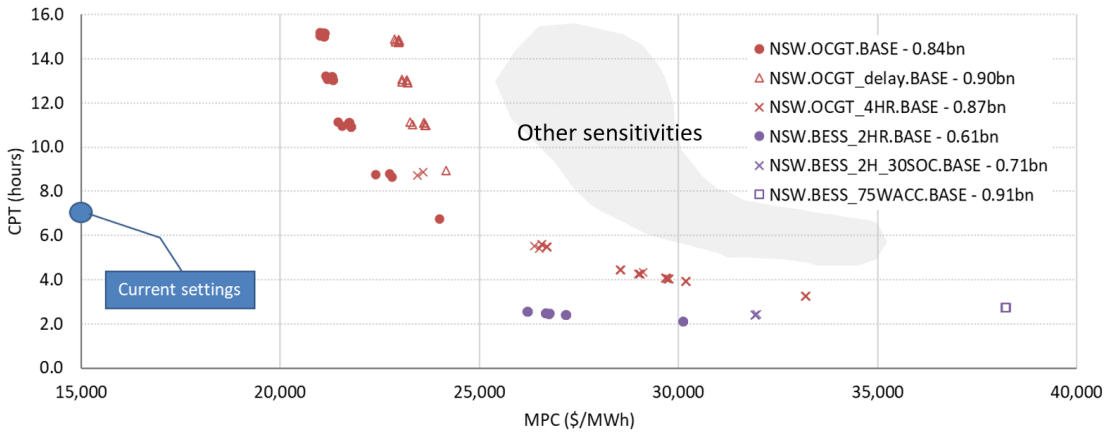
Additional information is available in the IES modelling report published alongside this draft report.

Effect of sensitivities on efficient frontiers

The effect of the sensitivity cases is to generally apply additional constraints/costs that shift the associated MPC/CPT efficient frontiers upwards and to the right of the base case frontier. The effect of the sensitivity cases is illustrated in Figure 6.6.

Results from key sensitivity cases, therefore, define a band of outcomes that the Panel can consider when accounting for uncertainty in its recommendations.

Figure 6.6: The effect of sensitivity cases on efficient frontiers



Source: IES, 2022 Reliability Standard and Settings Review - Modelling Report, Fig. 76.

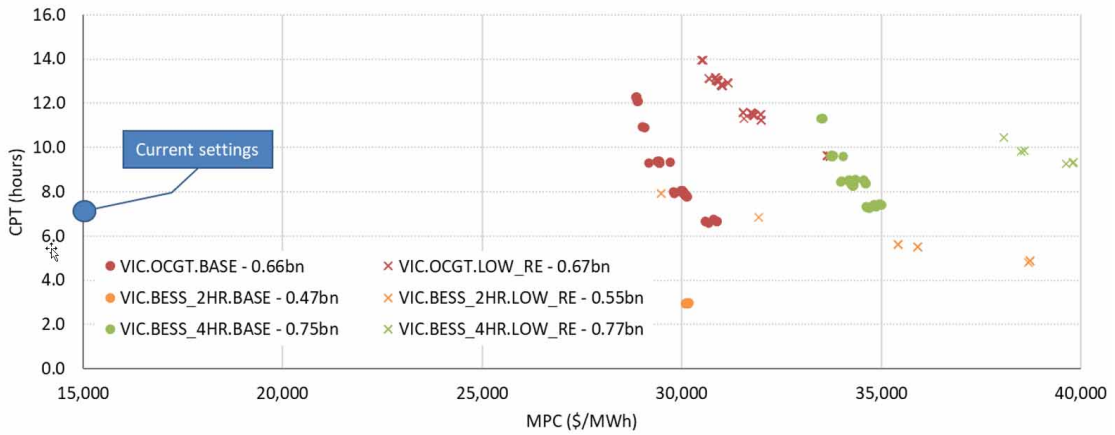
223 High CPTs that are significantly above the duration of the battery generally increase total market costs without contributing to new entrant revenue sufficiency and therefore not identified as points on the efficient frontier.

Low VRE scenario impact on efficient frontiers

Low VRE scenario results are provided with the base case sensitivities for NSW and VIC separately in Figure 6.7 and Figure 6.8. Due to very similar USE distributions across the NSW scenarios, the low VRE scenario is not observed to shift the position of the frontiers significantly. The main difference is a slight shift to the left for the OCGT which is likely due to the lower number of zero USE samples for the NSW Low VRE scenario.

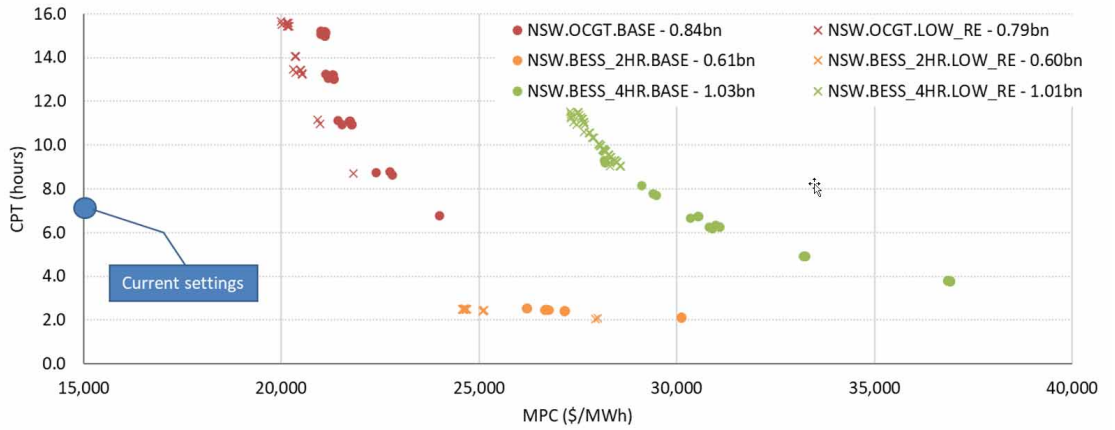
There are larger differences across the VIC scenarios consistent with the observed shift in the distribution of USE towards lower probability longer duration events. This increases costs and shifts the frontier to the right, however, the increase in duration significantly increases the cost of the battery storage options due to energy limitations. The points for the battery storage options, therefore, shift further to the right than for the OCGT which is not subject to the same energy limits.

Figure 6.7: VIC Efficient frontiers for the low VRE scenario



Source: IES, 2022 Reliability Standard and Settings Review - Modelling Report, Fig. 78.

Figure 6.8: NSW Efficient frontiers for the low VRE scenario



Source: IES, 2022 Reliability Standard and Settings Review - Modelling Report, Fig. 79.

6.5 Draft Panel position

The Panel notes that the IES modelling reveals a materially significant misalignment between *existing* MPC and CPT and the MPC/CPT which IES consider is required to provide investment consistent with the reliability standard over the period FY2026-FY2028.

These modelling results suggest that maintaining existing levels of the MPC/CPT may, in the absence of additional jurisdictional or AEMO intervention, lead to an increase in USE and uncertainty for consumers inconsistent with their long term interests and achievement of the NEO.

The Panel has not identified a specific recommendation in this draft report but notes that, as outlined above, the modelling identified range of possible candidate MPC/CPT combinations for the Panel to consider in making its final recommendation. The Panel intends to use these results, along with stakeholder feedback to inform a specific recommendation in its final review report. The Panel is particularly considering making its final recommendation within the following range of MPC and CPT outcomes:

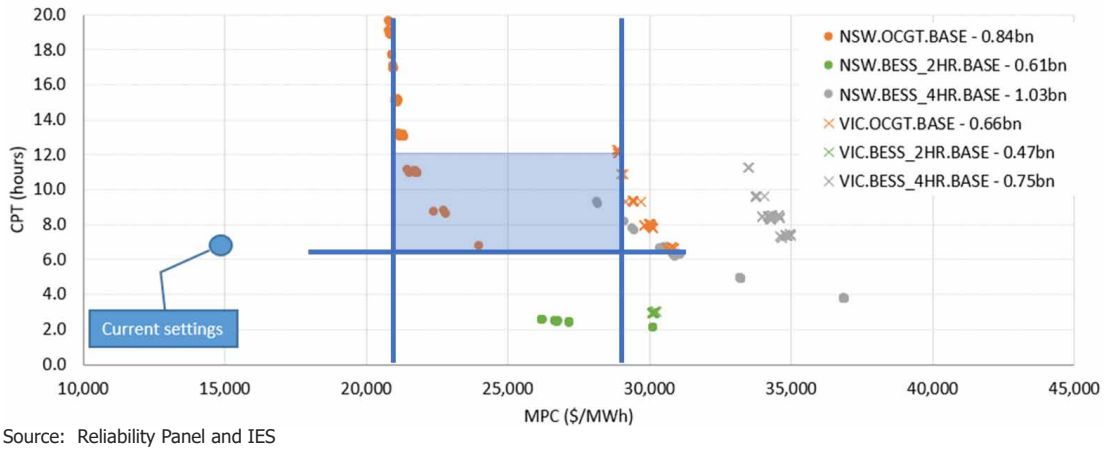
- **MPC:** $21,000/MWh to $29,000/MWh
- **CPT:** $1,359,100 (corresponding to 7.5 hours at the existing MPC) and $4,176,000 (corresponding to 12 hours at a maximum MPC of 29,000/MWh)

The Panel seeks stakeholder feedback on these ranges, the approach to identifying them, and other considerations that could be used by the Panel to come to a specific recommendation in its final review report.

6.5.1 MPC CPT ranges and guidelines for identifying a final recommendation

The Panel's draft CPT and MPC ranges, identified from the IES's modelling results presented in section 6.4, are indicatively indicated in Figure 6.9.

Figure 6.9: Indicative MPC/CPT ranges identified from Fig 6.5 NSW and VIC results set



Source: Reliability Panel and IES

The Panel proposes the following guidelines be utilised to identify a specific recommendation in its final report for stakeholder comment. The Panel proposes:

- the recommended MPC be clearly lower than the VCR accounting for the composition of customers shed during rotational load-shedding. The Panel has adopted a low range VCR sensitivity case that has been constructed to reflect the likely composition of end-use load types subject to rotational load shedding. The Panel proposes its low range VCR case be used as an absolute upper limit to any recommended MPC.[224]
- an MPC is recommended at the lowest level reasonably practicable, consistent with providing revenue sufficiency for the marginal new entrant and accounting for uncertainty. This approach minimises systemic risk and market integrity issues.
- the effect of uncertainty is captured by using the middle of the band of MPC/CPT outcomes for each candidate new entrant technology, defined by the sensitivities modelled. Utilising the middle of the MPC/CPT band may provide for an appropriately robust outcome.
- the CPT should not be reduced below its current level of $1,359,100 (corresponding to 7.5 hours at the existing MPC). While the Panel notes that the CPT has historically been set according to a fixed ratio of 7.5 hours at MPC, the Panel considers the monetary value of the CPT to be the primary consideration in identifying a floor for consideration rather than the ratio of hours at MPC.
- That the recommended MPC/CPT should not be clearly inappropriate for any single region and be revenue adequate for at least one candidate marginal technology in both NSW and VIC. This is a challenge given the higher settings required to achieve 0.002% reliability in VIC relative to NSW.

224 The Panel's low range VCR case is presented in Chapter five.

6.5.2 Reconciling NSW and VIC MPC/CPT result sets

The Panel considers a single NEM wide recommendation should not be clearly inappropriate for any single region. The Panel considers it desirable for a NEM wide MPC/CPT that balances reliability needs within all regions.

Modelling results indicate a higher MPC is required to support investment in VIC than in NSW. The higher MPC/CPT outcomes for VIC relative to NSW are a direct consequence of the reliability framework, specifically the percentage-based 0.002% standard. The difference is USE volume associated with 0.002% in VIC, relative to NSW, along with differences in the distribution of USE (Victorian USE events are 'peakier' than in NSW) increases the amount of capacity that is required to address the last increment of USE to achieve the level of the reliability standard, and provides less MWh for a candidate marginal new entrant to recover their costs.

To set the MPC at a level consistent with new entrant OCGT in VIC would require a greater than $14,000/MWh increase in the MPC from current levels and greater than $6,000 increase from the level required in NSW. The magnitude of this difference makes it challenging for the Panel to identify a single MPC/CPT recommendation that reconciles results in both regions while also meeting the other decision-making guidelines proposed in section 6.1.2.

Consistent with the reliability standard, IES has solved for MPC and CPT in each region individually without consideration of the possible benefits of reserve sharing between NSW and VIC. IES's investigation has identified that the potential for lower MPC in VIC by solving for VIC and NSW together in the optimisation model would be immaterial given the highly constrained interconnectors between regions during USE events.

The Panel seeks stakeholder views on approaches to identifying a single NEM wide recommendation in its final report that balances the different levels required in NSW and VIC.

6.5.3 Transitional arrangements

The CPT and MPC ranges identified position for this draft report represent a significant increase from current levels. The Panel is sensitive to the likely impact on market participants associated with a single step-change in level and its NER requirements regarding the need to consider incremental changes.

Section 6.5.3 outlined the Panel's draft position that predictability and certainty, consistent with the long term interest of consumers, are best achieved through transitional arrangements that clearly signal a realignment in MPC/CPT to efficient levels over a period of time. While the Panel considers a gradual transition should be pursued to the extent reasonably practicable, transitional arrangements also need to allow for an effective re-alignment due to the materiality of the misalignment which has been identified. Given this, a transitional period extending across multiple review cycles may not be appropriate.

To inform the Panel's final recommendation, feedback is sought on stakeholder impacts arising from a realignment that progressively adjusts the level of the MPC and CPT in each year between FY2026 - FY2028 to achieve the minimum recommended level at the end of the review period in 2028.

6.5.4 Draft position on changing the form of the MPC/CPT

The Panel's issues paper considered whether the Panel should recommend a different form for either the MPC or CPT.

The Panel is aware of a number of different approaches to the form of the CPT that may be implemented to limit the systemic risk associated with extended periods of high market prices. The Panel particularly notes the AEC's submission in this regard that encouraged the Panel to consider the form of the CPT and proposed two objectives to assess the current form of the CPT.[225]

Given the scope of the review and time available, the Panel has elected to focus its time and resources on identifying the level of the MPC and CPT given the material misalignment identified in modelling.

The Panel however considers future reviews should consider specific changes to the form of the CPT. To facilitate detailed consideration to the extent possible, the Panel intends to identify and give qualitative consideration to alternate forms for the CPT in its final review report.

6.5.5 Observations on differences between MPC/CPT range in 2022 vs 2018 RSS review modelling

The range of MPC and CPT combinations identified by IES's modelling for the 2022 RSS review is significantly higher than the MPC/CPT recommended in the Panel's 2018 RSS review.

It should be noted that the Panel's 2018 RSS review occurred at a much earlier stage in the NEM's transition with reliability concerns of a different nature than those that are in play for the period FY2026 - FY2028. The 2022 review is taking place in the context of a power system that has experienced significant change relative to that which is being considered in the 2018 reivew. The modelling performed for this review includes more extensive consideration of weather-related risks and uncertainties and consideration of the role of storage applicable to the power system to apply in FY2026 - FY2028. The difference between the 2018 Panel recommendation and MPC/CPT range being considered in this review can be significantly attributed to this different power system context.

In 2018, the modelling performed by Ernst and Young (EY) also identified a range of possible MPC outcomes between $1,500 and $37,000/MWh.[226] This wide range illustrates the sensitivity of MPC outcomes to a range of factors including, assumptions around portfolio-based bidding and other factors. IES's modelling report includes a breakdown of specific modelling factors that are likely to have led to the difference between the information considered by the Panel when making its 2018 recommendation and the range of MPC/CPT outcomes identified in this chapter. [227]

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225 Reliability Panel, 2022 Reliability standard and settings review, issues paper submission, AEC p.4.

226 Ernst and Young, 2018 RSS review modelling report, Table 14.

227 The modelling methods used by Ernst and Young in 2018 were different to those used by IES for this review. IES utilised a core-PLEXOS model, aligned with AEMO's ESOO, along with a specific optimisation model which provided a very high degree of resolution on outcomes at 0.002% USE.

In coming to its recommendation in 2018, the Panel applied the same qualitative considerations also relevant to this review including regulatory stability. Given these qualitative considerations and the wide range of possible outcomes identified in modelling, the Panel considered that limited change was appropriate when making its 2018 recommendation.

7 RELIABILITY SETTINGS: ADMINISTERED PRICE CAP

BOX 9: ADMINISTERED PRICE CAP DRAFT POSITION

The Panel considers the level and form of the APC, at $300/MWh, may remain appropriate for the period 1 July 2025 to 30 June 2028. The Panel however seeks stakeholder feedback to inform further consideration on this issue between the draft and final report given recent increases in fuel costs.

The Panel's draft position is that an APC at $300/MWh may remain broadly appropriate for the period of 1 July 2025 to 30 June 2028 because:

- AEMO's 2021 ESOO forecasts that fuel costs for most generation types are expected to decrease or remain the same from 2022 to 2040. The Panel is aware that unprecedented increases in fuel costs are driving stakeholder concern on whether the existing APC remains sufficient to cover generator variable costs during an APP. The Panel considers these fuel cost increases are attributable to a set of geopolitical circumstances that do not reflect a structural change likely to remain applicable between FY2026 - FY2028.
- the APC compensation process is available for generators to cover any shortfall in market revenue during an administered pricing period (APP) and has, so far, been sufficient to recover generators' costs, and
- issues arising from limited incentives for storage or energy-limited resources are insufficiently material for the period FY2026 - FY2028 to justify a change.

Noting the above, the Panel intends to give additional consideration between the draft and final reports on how the APC can provide for a robust outcome given future fuel cost increases. The Panel particularly values stakeholder feedback on this issue.

The APC is the maximum market price paid to participants, measured as a $/MWh value, that can be reached in any dispatch interval and any trading interval, during an administered price period (APP).

The APC is the prevailing dispatch price that applies during an APP after a set of sustained high dispatch prices exceed the cumulative price threshold. The value of the APC is specified in the NER and is currently set at $300/MWh.[228]

The APC, combined with the CPT, is a mechanism to minimise financial stability risks to the market arising from an extended period of supply scarcity and corresponding high prices. It is however set at a level sufficiently high to incentivise generation to make itself available during an APP.

228 Reliability Panel, *Review of the reliability standard and settings guidelines,* final report, 1 July 2021, p.34, Sydney.

The 2021 RSS review Guideline specifies that the APC is not subject to indexation.[229] The Panel notes that the RSS review 2021 Guidelines note that the indexation of APC should not be reopened for this review and is therefore out of scope.[230]

This chapter sets out:

- requirements for the Panel in determining the APC
- key issues and stakeholder views relating to the APC, and
- the Panel's draft positions.

7.1 Requirements for the Panel in determining the APC

In reviewing the APC, the Panel is specifically required, in accordance with the NER and RSS review 2021 Guidelines to consider:

- significant changes in the typical short-run marginal costs (SRMC) of generators in the NEM
- any compensation claims since the last review, and
- implications for the contract market.

Setting the APC requires the Panel to make a trade-off, balancing mitigating the risk of a systemic financial risks for the electricity industry during extreme market events and incentivising market participants to supply electricity during administered price events.

The Panel considers it is highly desirable that the APC is sufficiently high to minimise the likelihood of triggering a compensation claim,[231] yet not so high as to contribute to the financial distress of energy purchasers and risk contributing to financial instability in the market in resource to extreme market events.[232]

The Panel noted in the Issues Paper for the review that there are a number of other factors that are also important to consider, such as the impacts on the contract market[233] The Panel noted that the value of the APC can affect the contract market by either decreasing or increasing expected future prices and residual risk and potentially decreasing or increasing the incentive for, and ability to finance new investment.[234]

The Panel noted in the Issues Paper that the imposition of the APC on the market price has been seen to have consequences, such as triggering the switching-on of large amounts of demand in response to the lower market price. Some level of sophistication about how the APC is applied, how it is determined, and whether it varies over time, could potentially involve changing its form.[235]

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229 Therefore, its real value declines over time. The NER also does not prescribe indexation for the APC and retains their nominal values. - Reliability Panel, *Review of the reliability standard and settings guidelines,* final report, 1 July 2021, p.35, Sydney.

230 Reliability Panel, 2016 *Reliability standard and settings guidelines*, p. 9: 'It is confirmed in these guidelines that MPC and CPT are subject to annual indexation and the MFP and APC are not subject to indexation. This will not be opened for reconsideration in future reviews.'

231 NER clause 3.14.6.

232 Reliability Panel, *2022 Reliability standard and settings review,* issues paper, 27 January 2022, p.71, Sydney.

233 Reliability Panel, *2022 Reliability standard and settings review*, terms of reference, 27 January 2022, p.6, Sydney.

234 Reliability Panel, *2022 Reliability standard and settings review,* issues paper, 27 January 2022, p.72, Sydney.

235 Reliability Panel, *2022 Reliability standard and settings review,* issues paper, 27 January 2022, p.72, Sydney.

The Panel has noted that for any recommended changes to the reliability standard and settings, the Panel will need to consider if there is a material benefit in making the change, including if those changes will, or are likely to, contribute to the achievement of the NEO, and meet the NER and requirements in the RSS review 2021 Guidelines.[236]

In determining whether a material benefit would be realised by changing the level or the form of the MFP in this review, the Panel will need to consider whether:

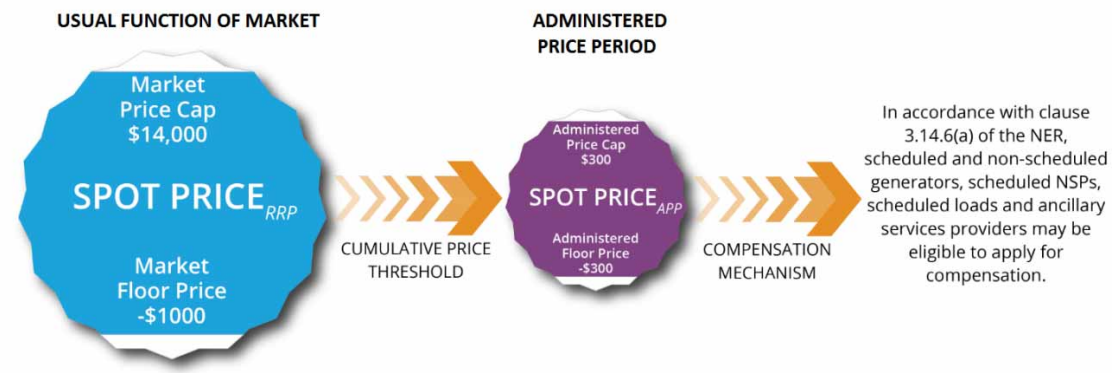
- there is evidence of a problem with existing arrangements that are likely to apply from 1 July 2025 to 30 June 2028.
- the risks associated with any change of the MFP for the period from 1 July 2025 to 30 June 2028 clearly outweigh the benefits.

Finally, the RSS review 2021 Guidelines stipulate that, in making its decision, the Panel is to be guided by the principle of providing a predictable and flexible regulatory framework that is sufficiently flexible to respond to a changing market and power system, while still maintaining stability which is important to promote investment.[237] With present levels of uncertainty in the market, providing stability to market participants may support efficient investment and operational decisions by participants.

7.2 An introduction to the APC compensation process

The application of the APC may cause some participants to incur a loss, where the participant's direct or opportunity costs are in excess of $300 per MWh. This may create a disincentive to supply energy during an APP, particularly if opportunity costs are high. Accordingly, the APC compensation process allows these participants to claim compensation for direct and opportunity costs incurred due to the application of an APP.[238] The APC compensation process is illustrated in Figure 7.1.

Figure 7.1: APC compensation arrangements



Source: AEMC

236 Reliability Panel, *2022 Reliability standard and settings review*, issues paper, 27 January 2022, p.iii, Sydney.
237 Reliability Panel, Review of the reliability standard and settings guidelines, final report, 1 July 2021, p.16, Sydney.
238 Clause 3.14.6 of the NER.

Under the APC compensation process, an eligible party may apply for compensation provided that they have incurred total costs during the eligibility period that exceed the total revenue it received from the spot market during that period. Compensation can be claimed in respect of both direct costs and opportunity costs.[239] Direct costs include fuel costs, wear and tear, and operating and maintenance costs. Opportunity cost is defined as the value of the best alternative opportunity for eligible participants during the application of a price limit event or at a later point in time.[240]

The AEMC publishes compensation guidelines that set out the details of calculating compensation claims under the APC compensation process. Further information can be obtained here: https://www.aemc.gov.au/markets-reviews-advice/review-of-compensation-guidelines

7.3 Key issues and stakeholder views

The Panel outlined a number of key issues relevant to the assessment of the APC in considering whether the current level of $300/MWh for the APC remains appropriate. [241] These include whether the:

- Current level appropriately balances the competing objectives of minimising financial stress in the market during an administered price period (APP) with providing sufficient incentive for generators to make themselves available during an APP.
- The compensation process is sufficient to recover the generators' costs associated with generation during an APP.
- Current level provides appropriate incentives for storage and other energy-limited resources to beneficially contribute to reliability during an APP. The APC seeks to provide both sufficient incentives for investment in different technologies and incentives to operate them efficiently to meet demand during APP periods. The Issues Paper outlined that there may be a need to consider setting the APC with regard to an estimate of the opportunity cost of storage, particularly longer-term storage.

The Panel notes that there are also a number of issues that are relevant to consider related to the form of the APC. This includes whether the current form provides an appropriate set of incentives in a power system that is reliant on energy-limited storage and demand response for reliability outcomes. For example:

- Energy limited storage is incentivised by price volatility to contribute to reliability during an APP by charging and discharging when appropriate. A fixed APC limits price volatility and therefore the financial incentive for energy-limited storage to effectively contribute to reliability during APP periods.
- The APC limits financial risk by imposing a cap on the sum of the energy market and FCAS prices over the last 7 days. This approach is not particularly aligned with the quarterly tenor of financial instruments that limit risk to individual participants. There is a

239 Other adjustments can also be made to cover financing costs.

240 AEMC, Final Amended Compensation Guidelines, 8 September 2016, p. 16.

241 Reliability Panel, *2022 Reliability standard and settings review*, issues paper, 27 January 2022, p.72, Sydney.

question of whether defining the APC in line with the period of financial market instruments may achieve a more efficient outcome.

Most stakeholder submissions noted that the above issues were appropriate to consider and generally raised three main areas or issues for the Panel to consider in regard to the level and form of the APC. These are outlined below.

Justification for increasing the APC.

- Three stakeholders recommended that the Panel consider increasing the APC.[242]
- The AEC considered that now the APC has about half of its original value without indexation. The AEC considered that as the compensation arrangements are only available for scheduled generators, the demand-side has no incentive to assist, and there are challenges in compensating for the fair value of stored energy.
- Engie suggested that the Panel consider both a one-off increase and ongoing indexation of the APC. Engie considered that gas prices have become higher on average and more volatile, and the current APC level is unlikely to reflect the marginal cost of new generation at times of supply scarcity.[243]

A reason to change the form of the APC.

- Both AGL and Alinta recommended the Panel consider changing the form and level of the APC. AGL considered that the Panel should consider what form and level of APC will ensure dispatchable generation will remain in the market during an APC event, and the Panel should consider whether there is merit in increasing either the CPT, the APC, or shortening the duration of the APC event, or a combination thereof.[244]
- Alinta considered that the increasing penetration of storage combined with the continued role of peak gas and distillate turbines with very low-capacity factors to supply the market during APC events may warrant a change in this setting and/or a more sophisticated form of APC.[245]
- The AEC suggested an alternative form, i.e., declining APC but did not offer substantial reasoning for the change.[246]

The Panel has yet to determine a specific recommendation on the APC in this draft report and is still considering a range of issues that will inform its final recommendation. While issues raised by stakeholders are considered in Panel considerations, the Panel will respond to specific material stakeholder views when making its final recommendation.

242 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Australian Energy Council (AEC) p.6; Engie p.5; AGL p.2.

243 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Engie p.5.

244 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AGL p.2.

245 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Alinta p.8.

246 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AEC p.5.

7.4 Draft options and positions

This section sets out the Panel's views on the options for consideration for the level and form of the APC and the Panel's positions, having regard to the issues and stakeholder views at this stage of the review.

7.4.1 Draft options for consideration

The Panel considered a number of options, including:

- Keeping the current form and level of the APC (i.e. status quo)
- Increasing the level of the APC

  As noted a number of stakeholders highlighted concern that the current level of the APC does not reflect the marginal cost of the generation at times of supply scarcity and therefore no longer provides sufficient financial incentives for generators to make themselves available during an APP without requiring compensation after the event. In considering this option, the Panel has had regard to assessing the fuel costs of generators in the NEM and any compensation claims since the last review. The Panel also makes observations on the factors that are driving current high fuel prices.
- Amending the form of the APC by including a declining APC

  Energy-limited storage is incentivised by price volatility to contribute to reliability during an APP by charging and discharging when appropriate. The Panel considered this approach because a fixed APC may limit the price volatility and therefore financial incentive for energy-limited storage to effectively contribute to reliability during APP periods. The Panel considered gradual decline/or stepped decline in the APC during an APP because this approach might potentially balance the tension between limiting financial risk during an APP while also providing sufficient incentives to make generation available.

7.4.2 Panel draft positions

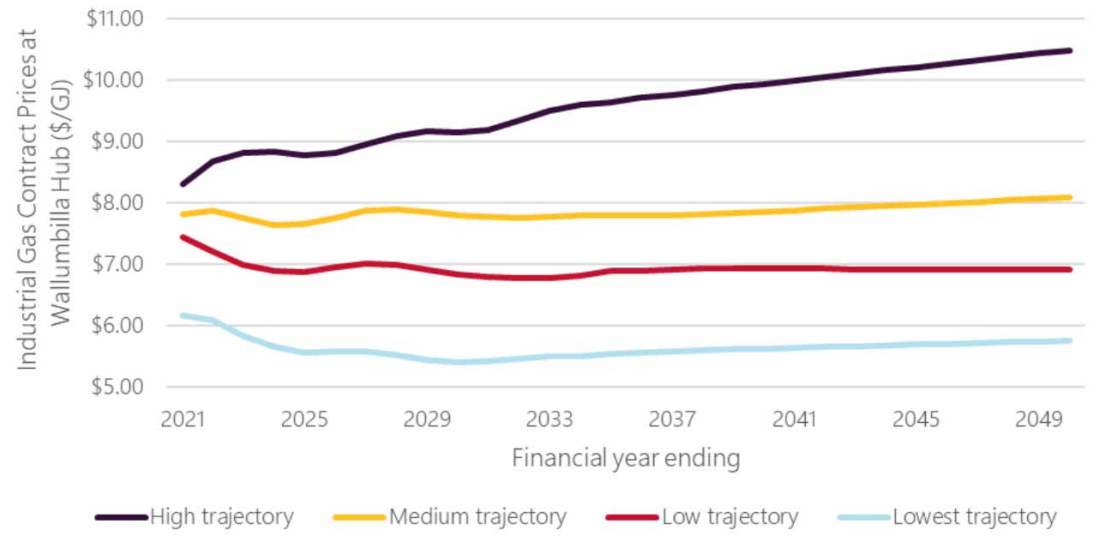
Following consideration of stakeholder submissions, the Panel's draft position for the 2022 RSS review is to retain the current form and level of the APC for the review period 1 July 2025 to 30 June 2028. The Panel's reasons are set out below. The Panel intends to further consider the robustness of the current APC to fuel price uncertainty over the review period between the draft and final report. The Panel welcomes stakeholder views on this matter.

Fuel costs

Considering changes in the fuel costs of generators in the NEM is fundamental to evaluating whether a change in the APC may yield material benefit. The level of the APC needs only cover the marginal cost faced by the generator in order for the generator to be left financially viable and willing to generate. An increase in the level of the APC may be warranted if there is sufficient evidence of a significant increase in the number of generators that have to apply for out-of-pocket expenses from generating electricity during an APP. This situation may occur if there is a substantial rise in fuel costs that is identified as likely to occur over the review period.

Figure 7.2 shows the forecast of gas prices from the financial year 2022 to 2050 by generation types, according to AEMO's 2021 ESOO and ISP input assumptions and scenarios report. It shows that fuel costs for most generation types are expected to decrease or remain much the same over the period relevant to the review. While AEMO's gas price forecasts are of average annual contract prices and don't necessarily reflect the prices that will occur in extreme conditions that could have triggered the CPT event, extreme prices are likely to be rare, and so should be balanced against the cost to consumers of a higher APC.

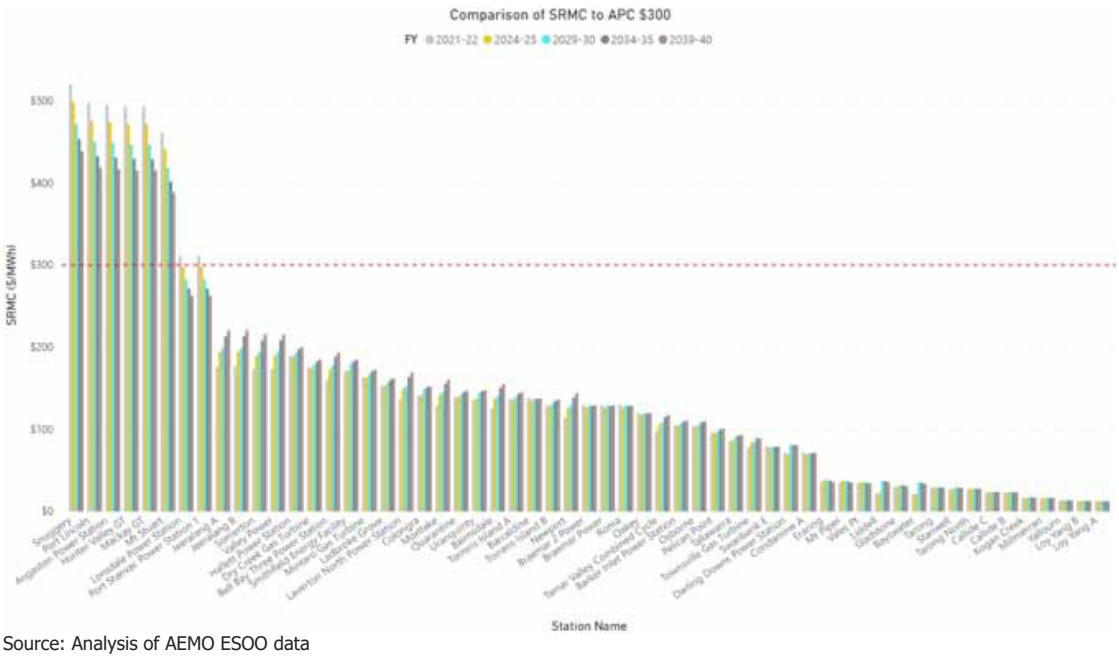
Figure 7.2: AEMO 2021 ISAR gas price forecast - Average industrial gas price forecast at Wallumbilla



Source: AEMO, 2021 Input Assumptions and Scenarios Report, Fig. 39.

Figure 7.3 compares NEM generator SRMCs, calculated from AEMO's central trajectory fuel price forecast, with the current APC at $300/MWh. NEM generator SRMCs are projected to increase over time but are within the range of $150/MWh and $200/MWh, below the current level of the APC at $300/MWh. Notwithstanding current events causing an unprecedented rise in fuel prices, it is highly uncertain if present conditions will lead to a substantial and permanent increase in the fuel costs of generators in the NEM over the period concerned.

Figure 7.3: Comparison of forecast fuel costs to the APC



Source: Analysis of AEMO ESOO data

Note: The forecast costs are based on fuel prices in AEMO's 2021 ESOO report, assuming variable operating and maintenance costs do not change over time.

The Panel identifies the unprecedented recent rise in fuel costs as attributable to geopolitical factors including Russia's current military action against Ukraine. These geopolitical factors, however, may not reflect a structural or enduring shift that will remain relevant over the period FY2026 - FY2028. On this basis, the Panel's central base case view is that AEMO's fuel price projections remain relevant.

While the factors driving current fuel cost increases may not be structural or enduring, the Panel notes that a different range of factors, not currently evident, may act to increase fuel costs and therefore generators' variable costs over the period FY2026 to FY2028. The Panel intends to give additional consideration between its draft and final on whether the existing APC provides for a sufficiently robust outcome given fuel price uncertainty arising from a range of sources.

Compensation arrangements are available to cover any shortfall in generator revenue during an APP

The APC serves only as a default; generators can claim compensation for extra costs they incur from generating electricity if they are higher than the APC.

From Figure 7.3 the Panel identifies six generators that are estimated to have a short-run marginal cost (SRMC) that exceeds the present APC setting over the period FY2026 - FY2028 when assessed using AEMO's price forecasts.

While the Panel does not consider it desirable to rely on compensation processes, it notes this compensation is limited to a small number of generators with compensation only payable in respect of the shortfall between market revenue and SRMC. The likely quantum of compensation will therefore be far smaller than the additional market costs associated with a permanently higher APC which will be borne by all customers.

The Panel's draft position is therefore that existing compensation arrangements are sufficient for generators to recoup losses, and the costs to consumers should overall be minimised by retaining the existing level of the APC at $300/MWh in combination with compensation processes.

In deciding whether there may be a material benefit in reassessing the APC, as outlined above, the Panel must also consider compensation claims since the last review. There has only been one occasion of a claim for compensation since the start of the NEM. The AEMC[247] for that claim decided that compensation is payable by AEMO to Synergen Power with respect to its claim and that the amount of compensation payable was $130,486.94, assuming a settlement date of 1 October 2010.[248]

Issues arising from limited incentives for storage or energy-limited resources are insufficiently material to justify a change.

As previously noted, energy-limited storage is incentivised by price volatility to contribute to reliability during an APP by charging and discharging when appropriate. The Panel notes AEC's suggestion of a gradual or stepped APC in this regard. The Panel is aware that a fixed APC may limit the price volatility and therefore financial incentive for energy-limited storage to effectively contribute to reliability during APP periods.

The Panel has decided not to consider a gradual or stepped APC to support issues arising from the APC's effect on storage or energy-limited resources. Apart from the AEC's suggestion, the Panel didn't receive additional feedback or information sufficient to make consideration of a gradual or stepped decline in the APP was required as a priority reform for the period FY2026 - FY2028. The Panel has therefore prioritised other considerations in this review given the scope of the review and time available.[249]

The Panel does however consider a change in the structure of the current APC, including implementing stepped or declining APCs may be part of future reforms as the NEM transitions to high penetrations of VRE and storage. While the Panel has not made a specific recommendation on alternate forms and structures for the APC in this draft report, it may provide further consideration in its final report.

Impact of changing the APC on the contract market is not material

As noted in the issues paper, the value of the APC can impact the contract market through changing expected future prices and residual risk. After consulting with the energy contracts

247 A three-member panel comprising Geoff Swier, Sibylle Krieger and Bob Graham was engaged to assess and advise the AEMC on the compensation claim and provided its final report on 18 August 2010.

248 Australia Energy Market Commission, *Compensation claim from Synergen Power*, 8 September 2010, Sydney.

249 The greatest impact of creating additional APC price steps would be to increase the effect of the CPT, which is equivalent to reducing CPT. The Panel has set out its considerations on the value of the CPT in conjunction with the MPC in previous chapters.

traders, the Panel considers that the APC has less impact than MPC and CPT on contract market outcomes.

8 RELIABILITY SETTINGS: MARKET FLOOR PRICE

BOX 10: MARKET FLOOR PRICE DRAFT POSITION

The Panel's draft position is to retain the form and level of MFP at -$1,000/MWh for the review period from 1 July 2025 to 30 June 2028.

The Panel considers that the MFP should remain at-$1,000/MWh because:

- There are relatively few periods where the MFP binds, particularly following the introduction of five minute settlement and the semi-scheduled generator dispatch rule change. This indicates the market is clearing at an efficient level which is above -$1000/MWh.
- There is no evidence that the MFP at its current level inhibits the efficient entry of storage or demand response in the NEM.
- Implementing the MFP as an investment signal for demand response and storage is not warranted for this review.

Stakeholder views are sought on the draft panel positions for the MFP.

The MFP sets a lower limit on wholesale market prices that can be reached in any trading interval measured in $/MWh. The value of the MFP is specified in the NER and is currently set at -$1,000/MWh.[250]

The purpose of the MFP is to allow the market to clear during low demand periods, while preventing retail market instability by imposing a negative limit on the total potential volatility of market prices.[251]

The 2021 RSS review Guideline specifies that the MFP is not subject to indexation.[252] Therefore, its real value declines over time. The NER also does not prescribe indexation for the MFP, which retain their nominal values.[253] The Panel notes that the RSS review 2021 Guidelines note that the indexation of MFP should not be reopened for this review.[254]

This chapter sets out:

- requirements for the Panel in determining the MFP,
- key issues and stakeholder views relating to the MFP, and
- draft options and the Panel positions.

250 NER clause 3.9.6(b).

251 Reliability Panel, *Review of the reliability standard and settings guidelines,* final report, 1 July 2021, p.12, Sydney.

252 Reliability Panel, *Review of the reliability standard and settings guidelines,* final report, 1 July 2021, p.33, Sydney.

253 Reliability Panel, *Review of the reliability standard and settings guidelines,* final report, 1 July 2021, p.36, Sydney.

254 Reliability Panel, 2016 *Reliability standard and settings guidelines*, p. 9: 'It is confirmed in these guidelines that MPC and CPT are subject to annual indexation and the MFP and APC are not subject to indexation. This will not be opened for reconsideration in future reviews.'

8.1 Requirement for the Panel in determining the MFP

The specific criteria for the Panel relating to the MFP include that:

- The Panel may only recommend an MFP that it considers will:
  - Allow the market to clear in most circumstances, and
  - Not create substantial risks which threaten the overall stability and integrity of the market.[255]
- The RSS Review 2021 Guidelines further state that the Panel will consider the following principles in its review of the MFP:
  - The number and frequency of trading intervals where the market price has been or has approached, the level of the MFP, and
  - Whether there have been significant changes in the generation fleet, such that average generator cycling costs have changed significantly.

The Panel has noted that for any recommended changes to the reliability standard and settings, the Panel will need to consider if there is a material benefit in making the change, including if those changes will, or are likely to, contribute to the achievement of the NEO, and meet the requirements in the NER and the RSS review 2021 Guidelines.[256]

In determining whether a material benefit would be realised by changing the level or the form of the MFP in this review, the Panel will need to consider whether:

- there is evidence of a problem with existing arrangements that are likely to apply from 1 July 2025 to 30 June 2028, and
- the risks associated with any change of the MFP for the period 1 July 2025 to 30 June 2028 clearly outweigh the benefits.

Finally, the RSS review 2021 Guidelines stipulate that, in making its decision, the Panel is to be guided by the principle of providing a predictable and flexible regulatory framework that is sufficiently flexible to respond to a changing market and power system, while still maintaining stability which is important to promote investment.[257] With present levels of uncertainty in the market, providing stability to market participants may support efficient investment and operational decisions by participants.

8.2 Key issues and stakeholder views relating to the MFP

In setting the MFP, the Panel is making a trade-off on behalf of consumers and participants. This involves a trade-off between allowing the market to clear in most circumstances and not creating substantial risks which threaten the overall stability and integrity of the market.[258]

255 NER clause 3.9.3A(h).

256 Reliability Panel, *2022 Reliability standard and settings review*, issues paper, 27 January 2022, p.iii, Sydney.

257 Reliability Panel, *Review of the reliability standard and settings guidelines,* final report, 1 July 2021, p.16, Sydney.

258 Reliability Panel, *2022 Reliability standard and settings review,* issues paper, 27 January 2022, p.65, Sydney.

If the MFP were not at a sufficiently low level to allow the market to clear, that is, allow less flexible generators with different cycling costs to differentiate themselves through their negative bids:[259]

- A lower MFP would, in theory, reduce distortion and enable the market to clear efficiently a larger proportion of the time.
- A higher MFP could affect the operation of generators that have cycling costs higher than the costs incurred by being dispatched at the MFP. This could lead to inefficient rationing of overabundant, less flexible generation and higher wholesale prices.

However, an extremely low MFP may create risks that expose less flexible thermal generators to increased negative price risk, given their unit commitment constraints. This would increase the cost of inflexibility and affect the financial viability of these generators.

Changes to the MFP (increasing or decreasing it) would also have implications for the contract market.

There were three main issues raised in stakeholder submissions regarding the level and form of the MFP. Stakeholders also expressed their views on a negative CPT. They are outlined below.

Justification for increasing/decreasing the MFP

- Engie recommended that the Panel consider increasing the MFP.[260] Engie considered that minimum demand events are security rather than a reliability issue, and they are caused by price-insensitive rooftop solar. So, the MPF is not a solution to these events. The Panel should consider increasing the level of the MPF (i.e., to a less negative figure). The market will still typically clear, but the absence of very low negative prices may assist the transition.
- AEMO considered a much lower price floor may incentivise more DSP / utility-scale batteries but in doing so may make the management of commitment/decommitment of thermal plants more expensive and difficult. [261] In CS Energy's view, there may be benefits in reducing the MFP over time, given the changing system requirements and the original intent of the MFP.[262]

MFP is considered an operational or investment signal

- CS Energy suggests the MFP is primarily an operational rather than an investment signal and considered that the Panel should ensure that appropriate operational signals, the original intent of the MFP, remain.[263]

Justification for not introducing a negative CPT

259 Reliability Panel, *2022 Reliability standard and settings review,* issues paper, 27 January 2022, p.65, Sydney.
260 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: Engie p.4.
261 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: AEMO p.2.
262 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: CS Energy p.8.
263 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submission: CS Energy p.8.

- A number of stakeholders[264] considered that there is no material justification for introducing a negative CPT. Origin suggested that the Panel considers whether the increasing prevalence of negative pricing may impact the effectiveness of the CPT as a risk management tool. Origin suggested that one option to address this would be to exclude negative prices from the CPT calculation.

8.3 Panel considerations and draft position

Following consideration of stakeholder submissions, the Panel's draft position is to retain the current form and level of the MFP for the review period from 1 July 2025 to 30 June 2028.

The Panel considered the following two options regarding a change to the MFP, in identifying this draft recommendation:

- Keeping the current form and level of the MFP (i.e. status quo), and
- Implementing the MFP as an investment signal for demand response and storage.

Changing the form of the MFP may be considered if there is evidence that a materially lower MFP might be required.

The Panel notes that the increased level of demand-side participation and storage plants potentially allows the wholesale price to be more responsive to changing market conditions over time and should help to clear the market during periods of high variable generation, leading to fewer MFP events.

8.3.1 The Panel has decided to keep the current form and level of the MFP

The principal reason for the Panel's draft decision to retain the current level and form of the MFP is that recent data indicates the MFP is not so high that it is materially affecting the market from clearing at an efficient level. The Panel also notes that additional information will be required on the impact of recent changes to market arrangements, namely the five-minute settlement and the semi-scheduled generator dispatch obligations rule change prior to being able to judge whether there is a material benefit in changing the level of the MFP.

The implementation of the five-minute settlement[265]and the semi-scheduled generator dispatch rule changes[266], which came into effect in October 2021, have changed the obligations and financial incentives in the NEM. There is initial evidence that these changes have materially shifted the likelihood of MFP events and reduced the value of lowering the MFP.

The Panel looked at recent data to consider trends and to see what, if any, impact five-minute settlement and the semi-scheduled generator dispatch obligations rule changes have had on the frequency of MFP events since they came into effect.

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264 Reliability Panel, *2022 Reliability standard and settings review*, issues paper submissions: Origin pp.6-7; AEC p.3; CS Energy p.8; Shell pp. 1,5.

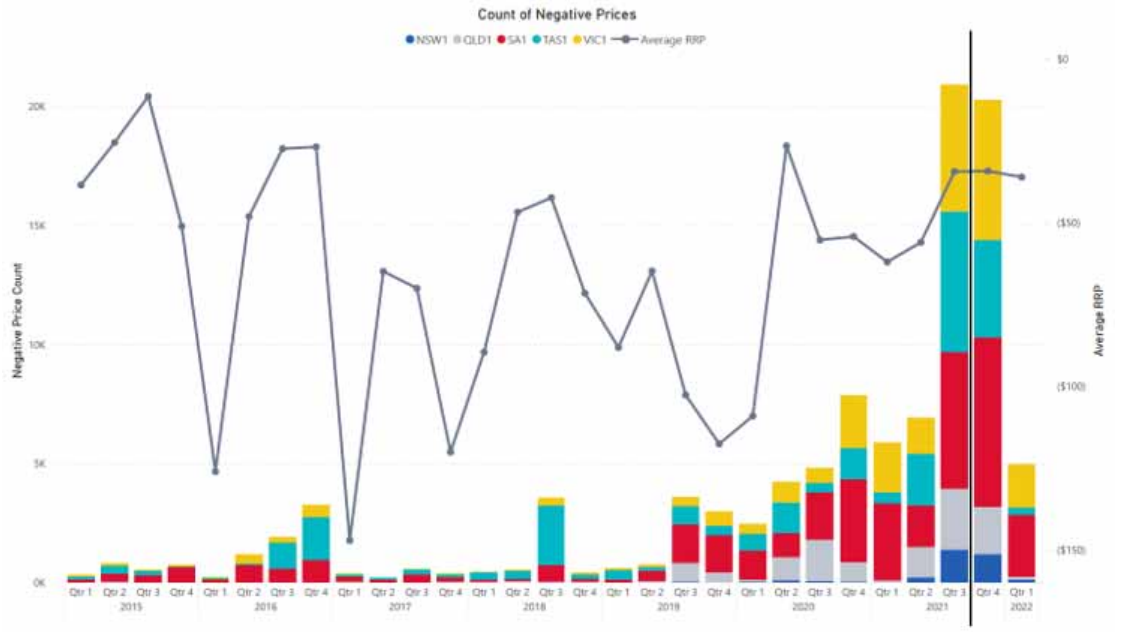
265 Australian Energy Market Commission, *Schedule of reliability settings*, 25 February 2021, Sydney.

266 Australian Energy Market Commission, Semi-scheduled generator dispatch obligations, 11 March 2021, Sydney.

Figure 8.1 (below) shows the number of negative prices experienced in each region of the NEM and the average of those negative prices across the NEM. It shows a large spike in the number of negative prices in Q4 2021 and Q1 2022, quantities in those quarters amounting to about three times the previous highest number in any quarter in the period.

On the other hand, the average of those negative prices in the last three quarters was relatively high (~$-30/MWh) compared with most other quarters in the period. This includes a nadir of ~$-100/MWh in Q1 of 2016, which was accrued over very few periods of negative prices. While the data is limited, the experience in the last three quarters suggests that negative prices are more likely to be closer to zero than they have been in the past.

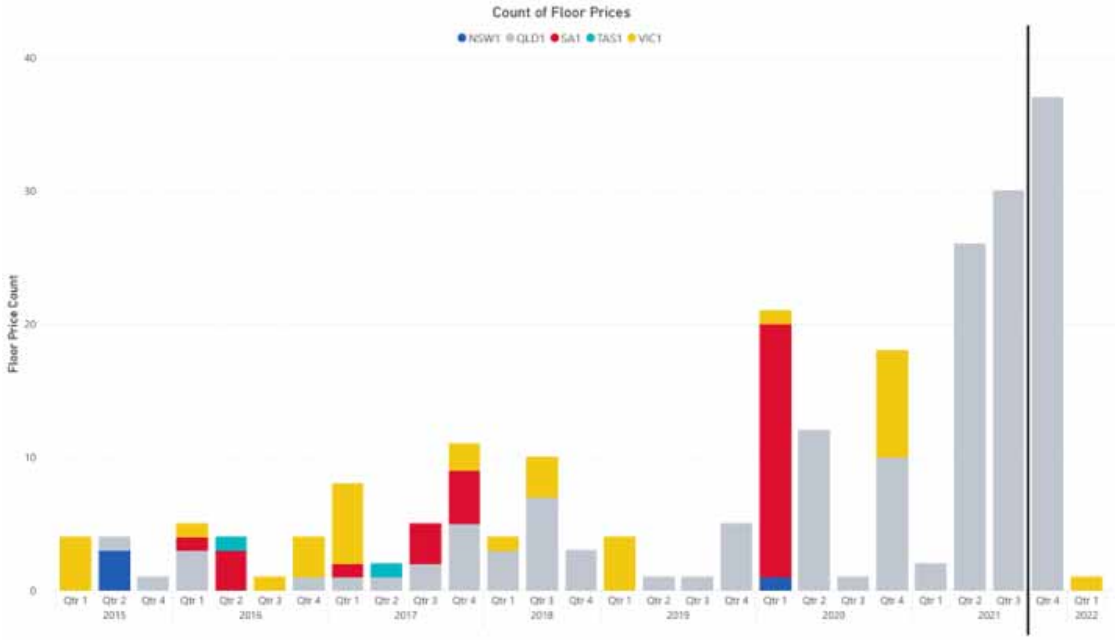
Figure 8.1: Count of negative prices



Source: AEMC, taken from AEMO data

Figure 8.2 shows the number of market floor prices experienced from Q1 2015 to Q1 of 2022. Only Queensland experienced a significant number market floor prices in 2021 and Victoria recorded only a few market floor prices in Q1 of 2022.

Figure 8.2: Count of market floor prices



Source: Analysis of AEMO data

8.3.2 The Panel has decided not to implement the MFP as an investment signal for demand response and storage

The philosophy behind or objective of the MFP

The MFP has been set to act as an operational signal rather than as a signal for investment for reliability purposes. The 'philosophy' of the MFP has therefore been to include accounting and opportunity costs of the inflexible thermal plants that wish to remain dispatched despite an abundance of low or zero cost generation.

Negative prices also provide a financial incentive for demand response and storage. Future power system reliability will likely involve a greater reliance on demand response and storage. Some proponents of these resources argue that future power system needs may therefore require a shift in the 'philosophy' of the MFP to act as an investment signal for new entrant demand response and storage, in combination with the MPC and CPT.

Changes in the philosophy of the MFP may involve changes in both the form and its level and also the implementation of any supporting arrangements that may be required. As the frequency of MFP and low price events is increasing, there may be a need to consider whether it would be appropriate to introduce an equivalent of the CPT for negative prices. As with the existing CPT, a negative CPT would seek to limit market participants' exposure to prolonged negative prices which could threaten their financial viability.

A change in the philosophy of the MFP to provide for deeper negative prices to provide an incentive for storage and load would likely involve a set of complementary changes, such as a

negative CPT, that would be complex to implement and require modelling and consultation beyond what the time and resources available to this review allow.

Costs and benefits of a shift in the philosophy of the MFP

The benefit of shifting the philosophy of the MFP involves any material reduction in consumer costs due to USE associated with improved reliability outcomes over both the period relevant to the review and the longer-term energy transition.

Any reduction in the costs of USE achieved by a shift in the MFP should be considered against the risks associated with such a change. These risks may include whether a lower MFP is likely to:

- accelerate the retirement of inflexible thermal generating leading to inefficient levels of USE over the period FY2026 - FY2028 and longer-term transition,
- create un-manageable system security risks associated with de-commitment or early retirement of synchronous generation in the NEM, and
- lead to systemic financial risks that cannot be effectively managed by market participants.

During a period where there is excess generation and prices are negative, storage technologies such as batteries or pumped hydro can consume electricity to increase their stores of energy and discretionary demand can switch on, both of which increase the headroom for inflexible generation to ride through those periods. The availability and operation of these resources increase demand as they take advantage of low or negative prices, which pushes up the price at which the market clears during low demand/high renewable generation periods. It follows that the setting of the MFP is relevant to the availability, cost, and financial viability of storage and discretionary demand.

The Panel notes that it is not the level of the MFP but the spread of prices that encourage arbitrage by battery and pumped hydro storage facilities. Also, both types of resources would only benefit from a lower MFP if doing so would lead to even lower prices. However, as the data in the figures show, it is not apparent that reducing the MFP would reduce negative prices to a degree that would support investment in more discretionary demand or storage technologies.

The Panel considers a future set of arrangements in a high VRE and storage NEM may include a materially lower MFP. The Panel however does not consider there to be sufficient evidence that the current MFP will prevent the market from clearing or inhibit the uptake of storage and demand response over the period FY2026 - FY2028 to justify a change in this review.

ABBREVIATIONS

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
Commission	See AEMC
MCE	Ministerial Council on Energy
NEL	National Electricity Law
NEO	National electricity objective
NERL	National Energy Retail Law
NERO	National energy retail objective
NGL	National Gas Law
NGO	National gas objective

A APPENDIX

A.1 Approach to VCR sensitivity analysis

This section outlines in more detail the Panel's approach to the VCR sensitivity analysis discussed in Chapter five.

A.1.1 Base Case VCR

The Panel has used the AER's customer load-weighted state VCR averages as its base case. These values are also used in AEMO's 2021 Inputs, Assumptions and Scenario's report.[267] Customer load-weighted state VCR averages have been determined as the most suitable base case as they reflect the customer composition on the network as per the guidance provided in AER's VCR report.

The AER calculated these state-based VCR values by weighting the remoteness and climate zone groupings using a combination of population and consumption data.[268]

A.1.2 Low case VCR sensitivity

As the state customer load-weighted VCR's likely have higher VCR values than the customers who would be rotationally load shed, the Panel has conducted a low case VCR sensitivity to calculate VCR values for consumer load that is most likely to be rotationally load shed.

The Panel considers that, in most instances of rotational load shedding during a reliability event, residential load is likely shed first, prior to large commercial, large industrial and agricultural loads. This assumption has been informed by conversations the Panel has had with each NEM jurisdiction on their rotational load shedding practices.

Given this, the Panel has conducted a re-weighting of the AER's state based load weighted VCR values, which comprise of a transmission-connected VCR and distribution-connected VCR. The transmission-connected VCR is the load-weighted average of the transmission-connected respondents to the AER's 2019 direct cost survey.[269] The distribution connected VCR value is the load-weighted average of the different segment VCRs derived from the AER's main survey, being:

- Residential VCR - 34.3% of distribution load,
- Agricultural VCR - 0.7% of distribution load,
- Commercial VCR - 25.5% of distribution load, and
- Industrial VCR - 39.5% of distribution load.

Within these load distributions, the AER also specifies the load weightings that small and medium industrial and commercial loads account for compared to large industrial and commercial loads. For example, small and medium industrial load accounts for 6% of the total industrial distribution load while large industrial accounts for 94%. Additionally, small

267 AEMO, 2021 Inputs, Assumptions and Scenarios Report, July 2021, p. 105-106, available here.
268 AER, *Values of Customer Reliability: Final report on VCR values*, December 2019, p. 74, available here.
269 AER, *Values of Customer Reliability: Final report on VCR values*, December 2019, p. 75.

and medium commercial accounts for 16% of the total distribution load while large commercial accounts for 84%.

The Panel conducted a re-weighting where the percentage of load and the associated VCR values for agriculture, large industrial and large commercial were excluded. This process determined the low case sensitivity VCR values found in table 5.1 of chapter 5.

A.1.3 High case VCR sensitivity

For the high case, the Panel's intent is to consider other credible ways in which VCR values may be higher than those established under the base case. This provides the Panel an indication of how sensitive the reliability standard is to the VCR chosen.

Through conversations with the NEM jurisdictions on their individual approaches to rotational load shedding, the Panel understands that load that is rotationally load shed is mostly likely switched off for a period 45 minutes to one hour at a time. Given this, the Panel has re-weighted customer load-weighted VCR values taking only one-hour duration VCR values. For each of its varying customer segments, the AER provides a range of VCR values depending on the length of the event and the time of year which the event occurs.[270]

The outages with a duration of zero to one hour, in general, have higher VCR values. This is because the VCR is a per energy value, rather than a per outage value. This means that if a customer loses energy for one hour it will have a higher impact than losing energy for two hours because the impact relative to the energy lost is not as high.

The Panel used the same transmission and distribution load weightings noted above. The high case VCR values shown in table 5.1 in chapter 5 were determined by calculating a weighted average of the zero to one-hour duration outages for all customer load types, including large commercial, large industrial and agriculture the high case VCR values. Note that, in contrast with the low case, the Panel has included all load types in this scenario to cover extreme cases in reliability events where large commercial and large industrial loads may be rotationally load shed.

270 The AER has determined VCR values based on outage durations of 0 to 1 hours, 1 to 3 hours, 3 to 6 hours and 6 to 12 hours. The VCR values are also based on different peak and off-peak periods throughout t the year, including weekday winter, weekend winter, weekday summer and weekend summer.

A.2 Reliability standard and reliability settings - past key determinations, recommendations and amendments

The table below sets out the key reviews and rule changes relating to the NEM reliability standard and reliability settings undertaken by: the National Electricity Code Administrator (NECA) Reliability Panel and the ACCC up until 2006; and the AEMC Reliability Panel and AEMC from 2006 onwards.

Table A.1: Reliability parameter amendments since NEM start

YEAR	WORK	TITLE	OUTCOME	ADDITIONAL COMMENTS ON THE RELIABILITY STANDARD
1997	**Code change authorisation** ACCC	*National Electricity Code*	Conditions of authorisation (as relevant to the market price cap and market floor price): • The Reliability Panel must conduct yearly reviews of the value of lost load (VoLL) and any changes to the value of VoLL must take effect six months after notification. • Zero dispatch pricing during an excess generation period will apply for only one year from the commencement of the NEM.	
1998	**Review** NECA	*Power system reliability standards and guidelines for market intervention*	Determination: • Set reliability standards for the wholesale market at a maximum of 0.002 percent of unserved energy in any region over the long term (standards establish a uniform approach across the market while	Reasons for setting the reliability standard at 0.02% USE: • USE was considered the most relevant metric to the NEM. More sophisticated measures not warranted for the generalised, market-based environment of the NEM.

YEAR	WORK	TITLE	OUTCOME	ADDITIONAL COMMENTS ON THE RELIABILITY STANDARD
			ensuring consistency with past jurisdictional standards).	• Considered that forms alternate to USE were more focused on overall operation rather than individual customer reliability. • 0.002% USE chosen as the appropriate level as it was equivalent to 1GWh, or 0.002% of total supply.
1999	**Review** NECA	*Review of VoLL 1999*	Recommendations: • Increase VoLL in two steps: to $10,000/MWh in September 2001 and to $20,000/MWh in April 2002. • Introduce a rolling three-year schedule of VoLL, extended by one year in each annual review. • Introduce risk arrangements such that if spot price in the preceding week (336 trading intervals) exceed the cumulative price threshold (CPT) of $300,000, reduce VoLL to administered price cap, which was proposed to be set at $300/MWh in peak periods and $50/MWh in off-peak periods.	
2000	**Code change authorisation**	*VoLL, Capacity Mechanisms and Price Floor*	Code amendments: •	

YEAR	WORK	TITLE	OUTCOME	ADDITIONAL COMMENTS ON THE RELIABILITY STANDARD
	ACCC		• Increase VoLL to $10,000/MWh from April 2002. • Introduce risk arrangements such that if spot price in the preceding week (336 trading intervals) exceeds the cumulative price threshold (CPT) of $150,000, reduce VoLL to administered price cap (APC). • Remove the zero price floor and introduce a negative price floor set at -$1,000/MWh.	
2002	Review NECA Reliability Panel	*Review of VoLL 2002*	No changes recommended.	
2003	Review NECA Reliability Panel	*Review of VoLL and cumulative price threshold 2003*	No changes recommended.	
2005	Review NECA Reliability Panel	*Review of VoLL and cumulative price threshold 2005*	No changes recommended.	
2006	Review AEMC Reliability Panel	*VoLL 2006 Review*	No changes recommended. (Comprehensive Reliability Review in progress)	
2007	Review AEMC Reliability Panel	*VoLL 2007 Review*	No changes recommended. (Comprehensive Reliability Review in	

YEAR	WORK	TITLE	OUTCOME	ADDITIONAL COMMENTS ON THE RELIABILITY STANDARD
			progress)	
2007	Review AEMC Reliability Panel	*Comprehensive Reliability Review*	Recommendations: • Increase in VoLL from $10,000/MWh to $12,500/MWh, effective from 1 July 2010. • Define CPT in rules as 15 times VoLL. • Term value of lost load (VoLL) be changed to market price limit (MPL). • Current annual review of VoLL be replaced with a reliability standard and settings review to take place every two years, with two years' notice of any change. • The current form of USE and level of 0.002% USE should be retained. • A hybrid form should not be adopted, but forecasts of frequency, duration and depth of possible shortfalls that make up the 0.002% USE should be prepared by NEMMCO on a regular basis to provide stakeholders with a gauge as to the possible nature of USE events. •	The reliability standard was unchanged as it: • Reflects the economic impact on typical consumers, • Is relatively easy to measure, • Applies equally to each of the NEM regions, and • Has been used since the NEM commenced. The form remained the same as: • It was considered a hybrid form should not be adopted as it would introduce "conflicting objectives" that could not be incorporated into the market design. E.g. introducing parameters to limit the frequency or depth of individual events could affect the cumulative long-term energy shortfall. • "Hybrid standards, in effect, are as restrictive as their most restrictive element, whether that is long term USE, annual shortfall, or shortfall from an individual event."

YEAR	WORK	TITLE	OUTCOME	ADDITIONAL COMMENTS ON THE RELIABILITY STANDARD
			• The reliability standard should be considered retrospectively over a long-term period of looking back at least 10 years. • Reduced the scope of the standard to exclude USE associated with 'acts of God' or resulting from industrial action.	• Hybrid forms remove the simplicity offered by a single form & have the potential to distort investment signals. The level was also left unchanged because: • Reliability events are responsible for a very small proportion of actual or forecast interruptions and any tightening of the level would likely have substantial costs in terms of required new investment.
2008	Review AEMC Reliability Panel	*VoLL 2008 Review*	No changes recommended (Comprehensive Reliability Review recently completed).	
2008	Review AEMC	*Determination of Schedule for the Administered Price Cap*	The schedule for the APC was amended and set at $300/MWh for all regions in the NEM, for all time periods.	
2009	Review AEMC Reliability Panel	*VoLL 2009 Review*	No change recommended (Comprehensive Reliability Review rule change in progress).	
2009	Rule change AEMC	*NEM Reliability Setting: VoLL, CPT and Future Reliability Review*	NER amendments: • Increase in VoLL from $10,000/MWh to $12,500/MWh, effective from 1 July 2010.	

YEAR	WORK	TITLE	OUTCOME	ADDITIONAL COMMENTS ON THE RELIABILITY STANDARD
			• Set CPT at an absolute level of $187,500. • Term "value of lost load (VoLL)" be changed to "market price cap (MPC)". Current annual review of VoLL be replaced with a reliability standard and settings review to take place every two years, with two years' notice of any change.	
2010	Review AEMC Reliability Panel	*Review of the Reliability Standard and Settings*	Determination: • No change to reliability standard. Recommendations: • No change to the market floor price. • Adjust MPC and the CPT in line with changes in the Producer Price Index (Stage 2 PPI) on an annual basis with effect from 1 July 2012. The Panel to conduct an annual review to consider whether PPI remains appropriate, whether higher increases in the MPC or CPT are necessary, and whether reliability standard remains appropriate (intended to replace Panel's biennial review process).	Specific recommendations relating to the form of the reliability standard include: • No change being recommended as it was considered, similarly to 2007, that adding other dimensions to the form of standard would add to the complexity of its implementation without adding sufficient value to participants. • The Panel saw value in AEMO calculating and publishing the expected distribution of reliability outcomes on a regional basis, which could be determined from the Monte Carlo simulations used to determine the Minimum Reserve Levels (MRLs). • The Panel noted that LOLE & LOLP could be calculated from AEMO's

YEAR	WORK	TITLE	OUTCOME	ADDITIONAL COMMENTS ON THE RELIABILITY STANDARD
				statistics providing a fuller appreciation of the possible market outcomes of a given reliability event. • That measuring the effectiveness of the reliability standard would not be meaningful. This is because it is not appropriate to assign significant meaning to individual historical outcomes or to the average of a number of outcomes over a long period of time. Relating to the level of the standard the Panel noted: • Given the limitations of the approach to estimating the change in generation capacity (and hence the cost saving from relaxing the Reliability Standard), the costs of meeting the Reliability Standard and the benefits to customers appear to be broadly balanced at the current level.
2011	Rule change AEMC	*Reliability Settings from 1 July 2012*	NER amendments: • Adjust MPC and the CPT in line with changes in the Consumer Price Index (CPI) on an annual basis with effect	

YEAR	WORK	TITLE	OUTCOME	ADDITIONAL COMMENTS ON THE RELIABILITY STANDARD
			from 1 July 2012. • Panel to undertake a four-yearly comprehensive review of the reliability standard and reliability settings, including indexation (to replace the Panel's biennial review process).	

2014	Review
	AEMC Reliability Panel
		Reliability Standards and Settings Review 2014	Determination:
			• No change to the reliability standard.
			Recommendations:
			• No change to the MPC, MFP, CPT and APC,
			• No change to the measure of indexing the MPC and CPT.
			• AEMC or Panel (as appropriate) to carry out the following work ahead of the next reliability standard and settings review:
			  • review of the form of the CPT mechanism,
			  • review of the measure of indexation of the MPC and CPT,
			  • develop a methodology to derive an appropriate estimate of VCR for use in determining the efficient
				Specifically on the reliability standard the Panel noted that:
				• In past reviews, the Panel had not identified any overall benefits to the market, or market participants and consumers, from amending the form of the reliability standard.
				• Considered no material changes to the market to warrant changing the form of the standard.
				• There was no case for changing the level of the standard.

YEAR	WORK	TITLE	OUTCOME	ADDITIONAL COMMENTS ON THE RELIABILITY STANDARD
			reliability standard, and • develop a methodology for undertaking future reliability standard and reliability settings reviews.	
2018	Review AEMC Reliability Panel	*Reliability Standards and Settings Review 2018*	Determination: • No change to the reliability standard. Recommendations: • No change to the MPC, MFP, CPT or APC, and • No change to the measure of indexing the MPC and CPT.	The reliability standard was not reassessed in this review as there was not sufficient evidence that the materiality threshold in the 2016 RSS review guidelines for its reassessment was met. The reliability standard thus remained a maximum expected unserved energy in a region of 0.002 per cent of the total energy demanded in that region for a given financial year.

Source: AEMC