RELIABILITY PANEL AEMC

REVIEW

Reliability Panel AEMC

FINAL REPORT

2022 REVIEW OF THE RELIABILITY STANDARD AND SETTINGS

1 SEPTEMBER 2022

INQUIRIES

Reliability Panel
c/- Australian Energy Market Commission
GPO Box 2603
Sydney NSW 2000

E aemc@aemc.gov.au
T (02) 8296 7800

Reference: REL0082

CITATION

Reliability Panel, 2022 Review of the reliability standard and settings, Final report, 1 September 2022

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
Stephen Clark, Marinus Link Project Director, TasNetworks
Joel Gilmore, General Manager Energy Policy and Planning, Iberdrola Australia
Craig Memery, Director - Energy + Water Consumer's Advocacy Program, PIAC
Ken Harper, Group Manager Operational Support, AEMO
Keith Robertson, General Manager Regulatory Policy, Origin Energy
Ken Woolley, Executive Director Merchant Energy, Alinta Energy
Peter Price, Head of Corporate Strategy and Executive General Manager Asset Safety and Performance, Energy Queensland
Melissa Perrow, General Manager Energy, Brickworks Limited

EXECUTIVE SUMMARY

1 This final report has been prepared for the Reliability Panel's (Panel) 2022 Reliability standard and settings review (2022 RSS review). It sets out the Panel's final recommendations and considerations for the reliability standard and settings that should apply from 1 July 2025 to 30 June 2028. The Panel has provided this final report to the AEMC on 1 September 2022.[1]

2 The RSS review focuses on the reliability provided by power generation and interconnection assets (interconnectors) to meet customer demand and is 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 RSS reviews do not consider security-related incidents[2] The reliability and emergency reserve trader (RERT) and directions for reliability by AEMO are also not in scope.[3] The Panel notes and has considered the increasing relationship between security and reliability-related events in its consideration of the form of the reliability standard outlined in Chapter four.

3 The purpose of the 2022 RSS review was 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).[4]

4 The review was undertaken, and the final recommendations apply in the context of the existing energy-only market design. The ESB's work on considering a capacity mechanism design was out of scope for this review as with the interim reliability measure (IRM).[5] The Panel notes Energy Ministers Communiqué on 12 August 2022 that Senior Officials, rather than the ESB, would propose options for a framework that delivers adequate capacity, ensures orderly transition, and incentivises new investment in firm renewable energy to ensure the system can meet peak demand at all times.[6] The Panel acknowledges the overlap of these objectives with those of the RSSR. Investments incentivised by jurisdictional actions and interventions, such as the NSW Electricity Infrastructure Roadmap, were also out of scope. The Panel has provided commentary on both the interim reliability measure and the need for complementary measures/tools to the extent they are related to the Panel's considerations and recommendations on the reliability standard and settings.

5 The Panel has undertaken its 2022 RSS review in an unprecedented environment. The analysis, reasoning and recommendations presented in this final report reflect that the

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1 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.

2 "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.

3 Refer to Chapter one for discussion on scope of the review.

4 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).

5 The AEMC must conduct a review of the interim reliability measure by 1 July 2023.

6 https://www.energy.gov.au/government-priorities/energy-ministers/meetings-and-communiques, 12 August 2022.

review:

- was broader in scope than in the past, with the Panel considering both the form and level of the reliability standard and settings for the review period
- was undertaken against the backdrop of unprecedented and rapid change in the energy market and hence more uncertainty in future market conditions. In particular, the Panel notes the recent increase in fuel costs and administered price period between 12 June to 14 June and the market suspension from 15 June 2022, and
- considered future reliability outcomes in the context of a NEM power system that is undergoing a fundamental transition from being a capacity-limited thermal power system to a high variable renewable energy generation (VRE) more energy-limited power system.

6 Given this environment, the Panel has had regard to, and balanced, a range of different trade-offs to determine the need for change for the period of 1 July 2025 to 30 June 2028 as well as what may be needed outside the review period as the market transitions. The Panel considered each of these trade-offs in detail in its final recommendation rationales presented in Chapters four to Chapter eight and included:

- The trade-off between sufficient market revenue potential to support new entrant investment and minimising potential customer electricity bill cost impacts. The Panel, in coming to its final recommendations on market settings has particular regard to consumer concerns about changes to these settings and the related impact of any change on consumer electricity costs.
- The trade-off between regulatory predictability and the flexibility to adjust. The Panel has considered this trade off in addressing the gap the modelling revealed between the existing MPC and CPT and that required to incentivise the investment required to support reliability as the NEM transitions.
- The trade-off between providing sufficient scope for efficient market pricing outcomes and minimising the potential for systemic financial risk, and
- The trade-off between providing increased incentives to supporting investment and providing a gradual transition to maximise scope for market participants to prepare and respond to any material changes.

7 For the 2022 RSS review, Intelligent Energy Systems (IES) were engaged to undertake modelling to inform the Panel's considerations in this RSS review. Chapter three provides an introduction to the modelling approach, models used, and other modelling considerations. This final report should be read in conjunction with the IES 2022 Reliability Standards and Settings Review, Final Modelling Report published with this final report.[7]

Summary of Panel 2022 RSS review recommendation

8 The final report provides a summary of the Panel's recommendations for the 2022 RSS review in each of the scope areas including the form and level of the reliability standard and the associated market price settings (MPC, CPT, APC, MFP). The Panel's final recommendations

7 https://www.aemc.gov.au/market-reviews-advice/2022-reliability-standard-and-settings-review.

reflect the Panel's majority view.[8] In the interest of transparency for stakeholders, this report notes where any Panel members had a different view on final recommendations, specifically relating to the MPC/CPT and APC.

9 The Panel's final recommendations are:

- based on the issues for the review, the modelling that has been undertaken, and trade-offs the Panel made in coming to its decisions.
- informed by stakeholder feedback to the Panel's Issues Paper published in January 2022, the Panel's draft report published on 9 June 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 NER, the RSS review 2021 Guidelines, and AEMC terms of reference.[9]

10 The Panel will submit a rule change request to the AEMC to implement its recommended changes to the form or level of the reliability standard or settings, as set out below and in Chapter two. The Panel is required to submit rule changes to the AEMC given the existing standard and settings are set out in the National Electricity Rules (NER). Stakeholders will have the opportunity for further input on the changes recommended in this final report through the AEMC rule change consultation process.

Final recommendation on the form of the reliability standard

11 The Panel's final recommendation is to retain the current reliability standard form, which is expressed as a percentage of expected unserved energy, for the period 1 July 2025 to 30 June 2028.

12 The Panel however identifies a case for changing the form of the reliability standard by the next RSS review period, commencing on 1 July 2028. The Panel's final recommendation is that the form of the standard should be changed by 1 July 2028 to accommodate a "tail risk metric" in combination with an"expected value unserved energy standard" metric.

13 The Panel makes this final recommendation as:

- Reliability risk will need to be characterised differently in the transition from a primarily capacity-limited thermal power system to a more energy-limited VRE power system, with a commensurate shift in the distribution of unserved energy towards greater "tail risk". Tail risk represents low probability events that would have a high impact on reliability outcomes.
- A single "expected value unserved energy" metric provides insufficient information on the distribution of USE in a high VRE power system and may not effectively reflect changes in the NEM's reliability risk profile by 2028.[10]

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8 Clause 8.8.2(g) of the NER states that a decision of the Reliability Panel on any matter may be made by a majority of the members comprising the Reliability Panel. Where the members of the Reliability Panel are equally divided on any matter, the chairperson has a casting vote.

9 https://www.aemc.gov.au/market-reviews-advice/2022-reliability-standard-and-settings-review

10 The Panel's view is related to reliability-related tail risk rather than security-related tail risk. Reliability-related tail risk is associated with unserved energy occurring due to insufficient generation and inter-regional transmission in accordance with Clause 3.9.3C (b) of the NER which excludes loss load due to multiple and other non-credible contingency events.

- Loss of load probability (LOLP) and expectation (LOLE) based reliability standards do not sufficiently capture a changing reliability risk profile in an increasingly high VRE NEM.
- The Panel considers that there is likely to be a material benefit from amending the form of the reliability standard following 1 July 2028.
- A hybrid standard tail risk metric will provide the scope capture willingness to pay to address tail risk.

14 The Panel considers extensive analysis consultation will be required prior to implementing a specific change to the form of the standard. The Panel's final recommendation is therefore for a follow-up review assessing specific changes to the form and level of the standard, to commence following the conclusion of this RSS review.

Level of the reliability standard

15 The Panel's final recommendation is to retain the current level of the reliability standard at 0.002% expected USE in a region over a financial year for the review period from 1 July 2025 to 30 June 2028.

16 The Panel has decided not to recommend tightening the reliability standard to 0.0015%, or 0.001% expected USE over the review period as canvassed in its draft report. The reasons for the Panel's final recommendation on the level of the standard are based on that:

- The benefits of changing the level of the reliability standard from 0.002% USE to 0.0015% USE are not sufficiently material to justify a change.[11]
- Changing the form of the standard, rather than tightening the level of the standard, is the Panel's preferred approach to reflect the changing nature of reliability as the NEM transforms to a high VRE more energy-limited power system.
- The IES modelling considered base, low and high VCR sensitivity cases to provide information about the trade-off and cost of achieving potentially higher or lower levels of reliability.[12] The high VCR value sensitivity that identified a potential reliability standard level of 0.001% expected USE was not considered by the Panel to be a value that appropriately reflects customer willingness to pay for reliability and given the excessive MPCs required to achieve that level.
- The Panel notes the existing interim reliability measure and considers that this level of reliability does not reflect, customer willingness to pay for reliability, and
- In addition to considering the form of the reliability standard to account for tail risk, tighter levels of reliability may be better supported by other mechanisms or tools. Further discussion of other complementary measures is provided in Chapter six.

Market Price Cap and the Cumulative Price Threshold

17 The Panel's final recommendation is for a progressive adjustment in the level of

11 As outlined in the draft, 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). 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.

12 The base-case AER load-weighted jurisdictional VCRs are potentially conservatively high as they capture all load types including those excluded from rotational load-shedding on the basis of their VCR.

the MPC and CPT to achieve an MPC of $21,500/MWh and a CPT of $2,193,000 (corresponding to 8.5 hours of market prices at the recommended MPC) (in $2021) by the end of the review period. The Panel has recommended the progressive annual changes, presented in the table below, to achieve the recommended level by the end of the review period. The form of the MPC and CPT are recommended to be maintained for this review period.

Table 1: Recommended MPC/CPT transition pathway

2021 $	1 JULY 2025	1 JULY 2026	1 JULY 2027
MPC	$17,500/MWh	$19,500/MWh	$21,500/MWh
CPT	$1,575,000	$1,872,000	$2,193,000
CPT hours at MPC	7.5	8	8.5

18 The Panel's final recommendation adjusts the MPC and CPT over a three-year period from 1 July 2025 to 30 June 2028.

19 The final recommendation has been made on the basis that:

- material benefit will be achieved relative to outcomes under existing arrangements as indicated by the IES modelling undertaken for the review[13]
- the final recommendation aims to provide a gradual change in the MPC while also achieving levels identified by modelling as necessary to support reliability outcomes consistent with the standard
- the value of increasing demand response (DR) participation was taken into account to the extent possible[14]
- incentives for storage investment are incrementally improved
- contract markets impacts and systemic risk is minimised, and
- the impact on electricity costs is minimised to the level required to support reliability.

20 According to the Panel's modelling, this increase is the minimum level required to support investment in generation, storage and demand response needed to avoid exceeding the reliability standard in light of thermal generator retirements after 30 June 2028.[15]

21 The Panel has given particular consideration to consumer concerns regarding increases to the market settings and hence further increases in electricity costs. The final recommendation seeks to limit end-user bill impacts to the minimum level possible while still supporting future outcomes consistent with the reliability standard.

22 The modelling indicates consumer bill cost increases to be around 3 per cent from its final recommendation. This increase will be spread over a three-year period from 1 July 2025 to 30 June 2028. The Panel notes that end-user consumer costs are primarily driven by average

13 Refer to chapter two for Panel's assessment framework.

14 In the absence of certainty for the expansion of eligibility and baselining options for AEMO's Wholesale Demand Response Mechanism, it is difficult for the Panel to assume a material increase in the uptake of demand response under the current MPC.

15 Any potential delays in key investments such as delay in Snowy 2.0 will further increase near-term investment requirements.

price outcomes rather than peak prices influenced by the MPC. Recent cost increases have been driven by large increases in international fuel prices, which feed into average market prices, rather than peak market prices due to the level of the MPC. An increase in peak market prices however incentivise investment (and thereby competition) and are likely to produce lower future average prices than would have otherwise been the case.

23 The majority of the Panel considers the final recommendation was justified given the value of the benefit realised by consumers from enhanced future reliability outcomes as indicated by the detailed modelling performed for the review. The two Panel members representing consumers, however, do not consider an increase to the MPC or CPT is needed, on the basis that they considered the:

- reliability standard is unlikely to be exceeded during the review period
- financial impact and risk for some retailers and spot-exposed customers may be too high
- modelling assumes limited volumes of demand response are available under the existing price cap which does not reflect anticipated changes to the Wholesale Demand Response Mechanism,[16] and
- The modelling does not include revenue from jurisdictional schemes, such as the NSW Electricity Infrastructure Roadmap when calculating the MPC and CPT required to support marginal new entrants.

24 The Panel notes additional MPC/CPT increases in future review periods may be required to sufficiently incentivise investment consistent with the reliability standard in all NEM regions, and investment in the storage required to manage reliability risk in a high VRE power system.[17] The Panel's final recommendation for this review period, therefore, may represent a first step in a longer-term adjustment.

25 The Panel considers prospective future increases in MPC, beyond the level recommended in this report and in future reviews may warrant consideration of potential complementary measures. In particular, where complementary measures provide investment support necessary to support reliability in a high VRE power system while avoiding systemic risk challenges and MPC that approach the VCR. The Panel considers such mechanisms should enhance the scope and performance of the market rather than replace it and promote the long term interests of consumers.

Administered Price Cap

26 The Panel's final recommendation is to increase the level of the APC from $300/MWh to $500/MWh for the period of 1 July 2025 to 30 June 2028.

27 In coming to its decision the Panel considered its requirements for the review, the experience of the June APP and stakeholder submissions and feedback. It also had regard to the greater financial burden a higher APC would have on retailers and consumers. On balance, it considered that there was a material benefit to increasing the APC to minimise reliance on

16 https://aemo.com.au/en/initiatives/trials-and-initiatives/wholesale-demand-response-mechanism

17 Under the 2022 RSS review guidelines the MPC and CPT are indexed to movements in the Consumer Price Index (CPI): Reliability Panel, *Review of the reliability standard and settings guidelines,* final report, 1 July 2021, p.37, Sydney.

the compensation regime.

28 The final recommendation is based on that the proposed change:

- Provides for robust outcomes to possible future high fuel price periods. While the high fuel costs in the recent APP are not typical, the Panel considers that they may be less rare in the future and increasing the APC to $500/MWh should sufficiently cover the SRMC of most generators in a range of credible scenarios, noting that the APC will likely be rarely imposed and generally in times of unpredictable and extreme circumstances.
- Prevents undue reliance on compensation processes. In light of the recent APP where the AEMC has indicated that 24 registered participants have submitted claims, the Panel considers that the increased APC will reduce reliance on the compensation process to a limited number of very high-cost generators during periods of unusually high fuel costs.
- Improves incentives for storage to participate during an APP. During the recent APP, the Panel has heard reports that energy-limited units found the $300/MWh APC did not sufficiently provide incentives to charge and discharge as normal, which resulted in less than optimal utilisation without material intervention from AEMO, and
- Enables better management of APP-related consumer costs. Raising the APC reduces compensation costs that are passed through to consumers but may increase hedging costs. Reducing the reliance on compensation reduces cost uncertainty for both generators and consumers.

29 The Panel considered an increase to the level of the APC is justified to reduce undue reliance on the compensation scheme and reduce additional pass-through costs to consumers. However, the two Panel members representing consumers did not consider there is justification for an increase to the APC to the level of $500 at this time on the basis that they considered the cost to consumers of different settings under administered pricing is not yet known, and there may be other tools outside of the scope of this review, that may better promote the interests of consumers.

30 The view of these Panel members is that once compensation cost outcomes and generator behaviour of the recent APP become known, further analysis, consultation and consideration of alternative solutions could be the basis of a subsequent review to ensure that the recommendation remains appropriate.

31 The Panel noted that several stakeholders suggested changing the form of the APC from a fixed to a dynamic value in recognition of the links between gas and electricity prices. The Panel recommends this is further considered in the follow-up review that has been recommended by the Panel and includes consideration of links with the gas APC. This is to ensure it is addressed as the market continues to transition, and there is a sufficient adjustment period if it is determined the form will change.

Market Floor Price

32 The Panel's recommendation for the period of 1 July 2025 to 30 June 2028 is to retain the form and level of the MFP at -$1,000/MWh.

33 The Panel considers that the MFP should remain at-$1,000/MWh because:

- adjusting the level of the MFP is not warranted in the absence of a clearly identifiable benefit over the review period. The Panel notes the impact of 5-minute Settlement rule and Semi-scheduled Generator Dispatch rule changes appear to have reduced the incidence of MFP events,[18] and
- There are unacceptable risks associated with a more deeply negative MFP which may increase systemic risk and the potential for disorderly thermal generator retirement.

34 Implementing the MFP as an investment signal for demand response and storage is not warranted for this review period, though this may be considered by the Panel in future review periods.

18 https://www.aemc.gov.au/rule-changes/five-minute-settlement; https://www.aemc.gov.au/rule-changes/semi-scheduled-generator-dispatch-obligations.

CONTENTS

1 INTRODUCTION

This final report presents the Reliability Panel's (the Panel) recommendations and findings for the 2022 Reliability standard and settings review (2022 RSS review). The Panel's recommendations outline the reliability standard and settings required for the period of 1 July 2025 to 30 June 2028. The 2022 RSS review final report was to be provided to the AEMC by 1 September 2022.[19]

The Panel's recommendations and key findings for the 2022 RSS review were based on:

- the requirements in the NER and the RSS review 2021 Guidelines
- the suite of issues the Panel considered
- the modelling that was undertaken by the Panel. The modelling approach and key results for the 2022 RSS review are provided in Chapter three and discussed in each chapter as appropriate, and
- stakeholder feedback:
  - to the issues paper, published in January 2022,[20]
  - at the public forum held in March 2022, and
  - to the draft report, published in June 2022.[21]

This chapter provides a recap of the:

- purpose and scope of the 2022 RSS review
- requirements on the Panel and process for the 2022 RSS review, and
- stakeholder engagement and input over the course of the 2022 RSS review.

1.1 Purpose and scope of the 2022 RSS review

The 2022 RSS review was to consider the reliability standard and settings that should apply on and from 1 July 2025 to 30 June 2028.[22]

1.1.1 In scope for the 2022 RSS review

For the 2022 RRS review, the Panel was 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.

19 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.

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

21 Reliability Panel, 2022 *Reliability standard and settings review*, draft report, 9 June 2022, Sydney

22 The review 4-year cycle is expected to return for the next RSS review (expected to commence in 2026). More information about the reasoning for the three years for the 2022 review can be found here.

    - 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.[23] 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,[24]
        — Cumulative Price Threshold (CPT), which represents the limit of aggregate dispatch prices over a period of seven days (2,016 trading intervals)[25] that, when surpassed, triggers an Administered Price Period (APP),[26]
        — Market Floor Price (MFP), which places a lower limit on dispatch prices in the wholesale market,[27] 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.[28]

The 2022 RSS review was broader in scope than past reviews because both the form and the level of the standard and settings were considered.[29] The 2022 RSS review was also undertaken against the backdrop of unprecedented and rapid change in the energy market and hence more uncertainty in future market conditions. In particular, the Panel notes the recent increase in fuel costs and administered price period between 12 June to14 June and the market suspension from 15 June 2022.[30] The Panel also considered future reliability outcomes in the context of a NEM power system that is undergoing a fundamental transition from being a capacity-limited thermal power system to a high variable renewable energy generation (VRE) more energy-limited power system.

Given this environment, the Panel has had regard to, and balanced, a range of different trade-offs to determine the need for change for the period of 1 July 2025 to 30 June 2028 as

23 Clause 3.9.3C(a) of the NER.

24 Clause 3.9.4 of the NER.

25 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.

26 Clause 3.14.1 of the NER.

27 Clause 3.9.6 of the NER.

28 Clause 3.14.1 of the NER.

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

30 AEMO, *NEM market suspension and operational challenges in June 2022*, August 2022.

well as what may be needed outside the review period as the market transitions. As a result of the transition occurring in the NEM, its uncertainty and speed, the Panel has also needed to 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 has provided commentary on the nature and rationale for when such reforms, and when they may be required over time. These are discussed in the various chapters of this report, particularly the modelling in Chapter three and standard and settings in Chapter four to Chapter eight.

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.

The RSS reviews focus on the reliability provided by power generation and interconnection assets (interconnectors) to meet customer demand[31] and are limited to the key parameters that affect reliability in the market— the reliability standard and the four reliability settings.

The RSS reviews do not consider USE arising from security-related[32] 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.[33]

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 2021 Annual Market Performance (AMPR) Final Report, published on 28 April 2022. A copy of the 2021 AMPR Final Report can be found here.

Work on a capacity mechanism

In 2021, the ESB delivered its post-2025 market design advice to Ministers, including advice on 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) was out of scope for the 2022 review.

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

32 "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.

33 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 Panel and the ESB however collaborated during the 2022 RSS review to consider the interactions between the Panel's work and that of the ESB's work to consider a capacity mechanism design. In particular, the modelling was aimed to be an important piece of work that could help inform the ESB's work to the extent necessary.

The Panel notes the recent Energy Minister's Communique that t instructed Senior Officials, rather than the ESB, to propose options for a framework that delivers adequate capacity, ensures orderly transition, and incentivises new investment in firm renewable energy to ensure the system can meet peak demand at all times.[34] The Panel acknowledges the overlap of these objectives with those of the 2022 RSS review. Investments incentivised by jurisdictional actions and interventions, such as the NSW Electricity Infrastructure Roadmap, were also out of scope however the Panel considered the interactions of these and other aspects that sit outside the framework to the extent it was able to.[35] The Panel has made some commentary in this report, on the relevance of the work on the reliability standards and settings and consideration of complementary measures or tools to the extent it is relevant.

Interim Reliability Measure

The interim reliability measure is out of scope for the 2022 RSS review.[36] The Panel, in accordance with the AEMC terms of reference issued for the 2022 RSS review, has provided some commentary on the interim reliability measure in this report, which was relevant to the Panel's assessment of the reliability standard and 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[37] 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.[38] The AEMC must conduct a review of the interim reliability measure by 1 July 2023.[39]

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,[40]

34 https://www.energy.gov.au/government-priorities/energy-ministers/meetings-and-communiques 12 August 2022.
35 Refer to Chapter two for the Panel's assessment framework for the 2022 RSS review.
36 Reliability Panel, *2022 Reliability standard and settings review*, terms of reference, 27 January 2022, p.2, Sydney.
37 COAG Energy Council, *Interim Reliability Measures*, October 2020, available here.
38 Clause 3.9.3C(a1) of the NER.
39 Clauses 3.9.3A, 3.9.3B, 3.9.3C and 11.128.12(c) of the NER.
40 Clause 3.9.3A of the NER.

- the RSS review 2021 Guidelines,[41] and
- the Terms of Reference provided by the AEMC.[42]

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.[43]

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.[44] 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 was committed to wide-ranging stakeholder engagement during the course of the review.

The Panel received 16 submissions to the 2022 RSS review issues paper and also to the draft paper, with commentary on the form and the level of the reliability standard, and the level of the reliability settings. The Panel also held a 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 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.

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

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

1.4 Structure of this draft report

The structure for the remainder of this report is as follows [to be updated]:

- 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 Final 2022 RSS Review Modelling Report (separate report).
- Pierluigi Mancarella, University of Melbourne, 2022 RSS review, Final Advice, Form of the reliability standard, August 2022 (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.[45] 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: 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:[46]

> 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

45 These were outlined in the Panel's issue paper and draft report, and generally supported by stakeholders who provided submissions to these consultation documents.

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

c. 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 applied 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 needed 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 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 are 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

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.[47] These key interactions, issues and judgements that the Panel has had to make are discussed in the relevant chapter for the reliability standard and each setting.

The Panel considered the potential interactions between each of the reliability components and considered 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.[48] There are a range of issues and considerations that the Panel outlined in the issues paper and draft report.[49]

As outlined in Chapter one, a review of the interim reliability measure is outside the scope of the 2022 RSS review, as with the work that was carried out by the ESB on considering the design of capacity mechanism[50] However, in accordance with the Terms 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.

2.4 Panel approach: 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 stakeholders have the opportunity to understand and respond to any such change. The Panel considers that this process, in its totality, will ensure

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

48 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.

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

50 It is noted that Energy Ministers Communique agreed on 12 August 2022 that Senior Officials will now take up work related to options for a framework that delivers adequate capacity, ensures orderly transition, and incentivises new investment in firm renewable energy to ensure the system can meet peak demand at all times.

that the regulatory process remains predictable while balancing flexibility as the market evolves.

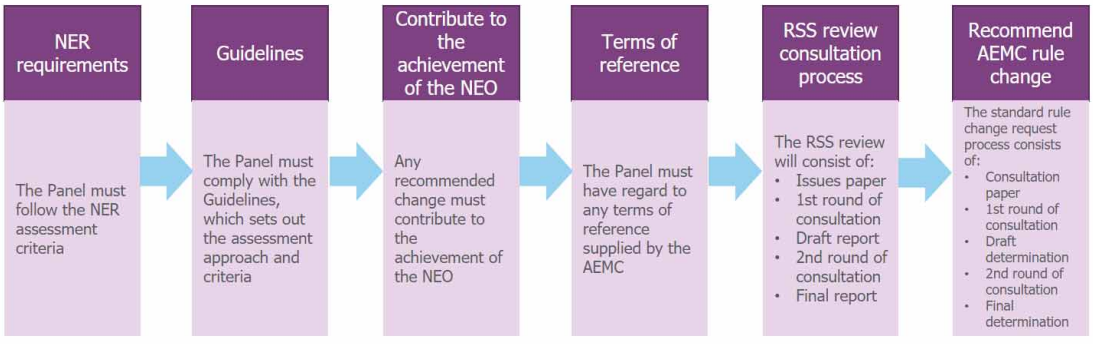
To allow for predictability and flexibility in this review and incorporate new information regarding market transition and changes, the Panel has only made a recommendation for change to the level or form of the reliability standard or settings where there would be a material benefit in doing so. As such, the first step of the review was for the Panel to 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 involved 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. Where there was sufficient evidence and clear rationale, quantitative analysis was 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.

As noted, where the Panel has recommended changes to the reliability standard or settings, the Panel will 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.

Figure 2.1 provides an overview of the Panel's approach as outlined in its issues paper and draft report.

Figure 2.1: Process and requirements for change



Source: AEMC

The Panel notes that generally stakeholders supported the approach and identification of key considerations for the 2022 RSS review, with an outline of the majority of stakeholder comments in the review draft report.[51]

51 Reliability Panel, *2022 Reliability standard and settings review*, draft report, June 2022.

The Panel considered a range of combinations and options based on the base case modelling, sensitivities and scenarios applied and also took into account the views of Panel consumer members about consumers concerns of increasing market settings and energy costs. The Panel also considered 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.

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 introduced before high-level unserved energy outcomes are presented.
- The modelling for the 2022 RSS review was undertaken by Intelligent Energy Systems (IES). 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, and
- 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. Additional information on modelling results, methods and assumptions are available in the IES modelling report published with this final 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 to inform the Panel's understanding on:[52]

- 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:[53]

- 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

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

53 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.[54] 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 five to eight of this report.

3.2 The modelling approach

The models implemented and the modelling approach used to inform the Panel's final 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.

3.2.1 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.[55] Review modelling leveraged AEMO's ESOO and ISP work, in particular, AEMO's published 2021 PLEXOS database.[56] The AEMO database was adjusted to reflect the requirements of the reliability work carried out for

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

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

56 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 and was, in particular, augmented to model commercial and policy-supported new entry, implement generator bidding,[57] and account for planned maintenance.[58]

The core PLEXOS model applied assumptions set out in AEMO's inputs, assumptions, and scenarios report (ISAR) to the extent possible.[59] The key AEMO data inputs include:

- 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, and
- 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.[60]

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.[61] 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.[62]

The core PLEXOS model uses a Monte-Carlo modelling approach, iteratively running many statistical simulations covering variations in forced outage profiles, weather-sensitive peak

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

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

59 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.

60 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 IES's modelling report.

61 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.

62 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.

demands, and demand shapes to identify the distribution of USE across a base case and a number of relevant scenarios and /or sensitivities.[63]

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.

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

3.2.2 IES optimisation model

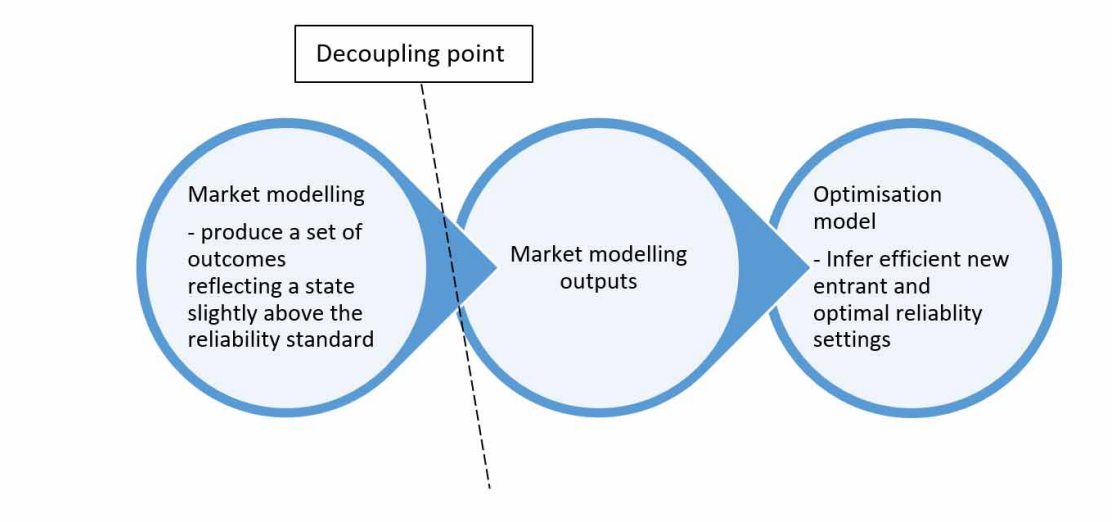
Large Monte-Carlo models, such as the core PLEXOS model, do not allow outcomes to be easily assessed for specific levels of USE. To address this limitation, IES developed a separate optimisation model to identify the marginal new entrant and associated market price settings required to achieve a target 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.[64]

63 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.

64 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.

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.[65]
- 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.

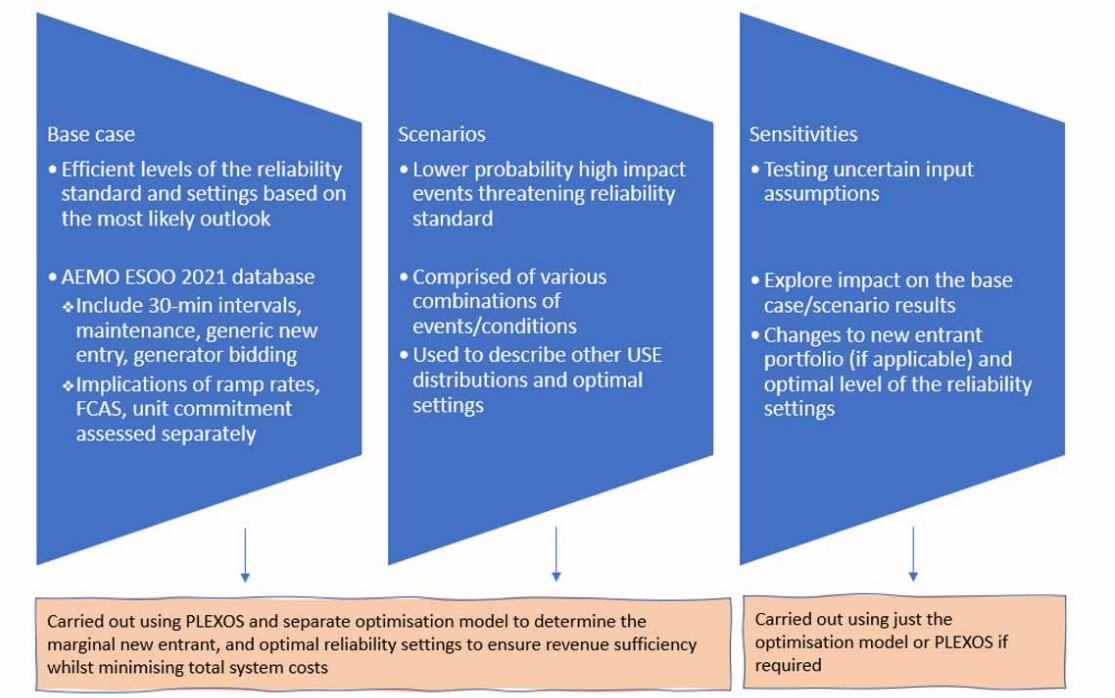
Additional details on IES's decoupled optimisation model are available in the accompanying IES modelling report.

3.2.3 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.

65 However, 100% fuel availability is assumed.

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 scenario

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 modelled a scenario, in addition to the base case, to assess the potential for changes in the distribution of USE over the review period associated with low variable renewable generation.[66]

- *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.

66 The Panel initially intended to model two additional scenarios. It was not able to model these two scenarios given the time available to the review. The Panel considers the next RSS review should investigate outcomes under the following scenarios: *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; and *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.

This scenario is 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.

The low VRE scenario is not designed to represent specific possible futures but instead to stress reliability outcomes to identify whether low VRE conditions may be a plausible reliability concern over the review period. As such, this scenario should be understood as a screening exercise to establish plausibility with no specific probability attached to its outcomes.

Sensitivities

While the low VRE scenario was designed to assess the impact of an emerging driver 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. Sensitivities were 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 six.

Modelling demand response (DR)

The Panel has elected to model DR in IES's optimisation model as a candidate new entrant which enters a portfolio with a supply-side resource. The Panel has utilised AEMO's step change ISP DR participation curves to estimate the volume of DR that would enter in response to an increase in the MPC for this purpose.

IES assessed the effect on the required MPC by modelling this new entrant DR as independent 'generators' that enter in a portfolio with the relevant supply side option for progressively higher MPCs. This approach simulates the effect of extending the step change DR participation curve on the required MPC. Further information on the approach to modelling DR is provided in Chapter six and the Final IES modelling report.

Stakeholders should note that AEMO's ISP ESOO demand response price quantity bid curves are also 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.

3.2.4 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 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.[67] The marginal new entrant, and associated market price settings, cannot be identified in the absence of a reliability gap.[68] A reliability gap must be synthesised for the purposes of the review modelling should the base case not show a reliability gap in one or more regions of the NEM.

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 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 is provided in IES's modelling report.

3.3 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.

67 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.

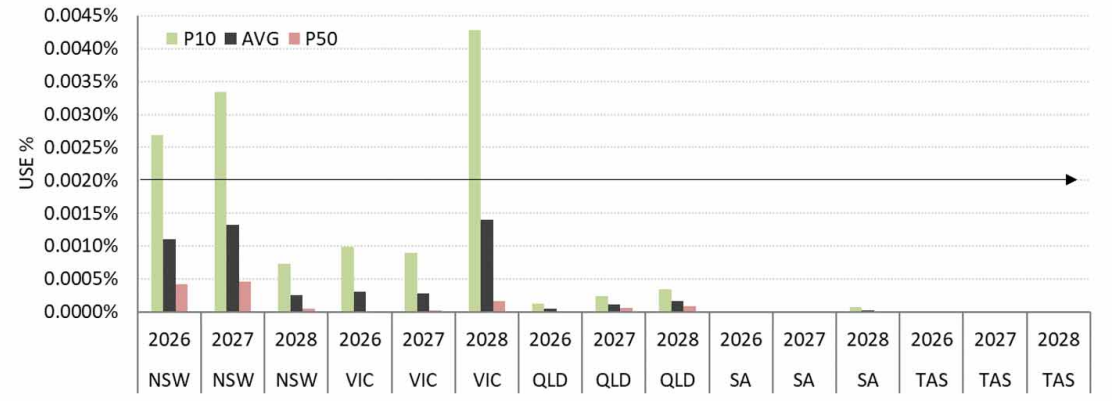
68 In the absence of a reliability gap, further investments will lead to higher total costs to consumers leading to inefficient outcomes (considering generating capital and investment costs + the cost of unnerved energy valued at VCR).

3.3.1 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.[69]

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:

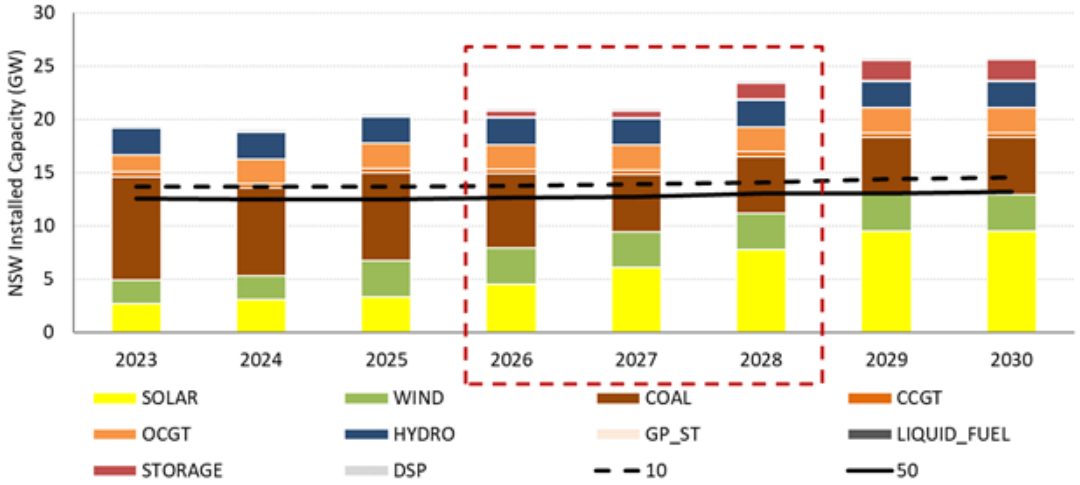
- There is no reliability gap in any jurisdiction, under the assumptions made here, even following the Eraring retirement. The NSW and VIC P10 cases both show USE levels that are in excess of the reliability standard, but the average remains below 0.002% once weightings have been applied.[70]
- NSW levels 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.

69 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.

70 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.

NSW USE is at its highest in 2027 before declining in 2028 due the 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 tighter in 2028, with expected USE of 0.0014%, however, still remains 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.

3.3.2 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.[71]

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

71 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.

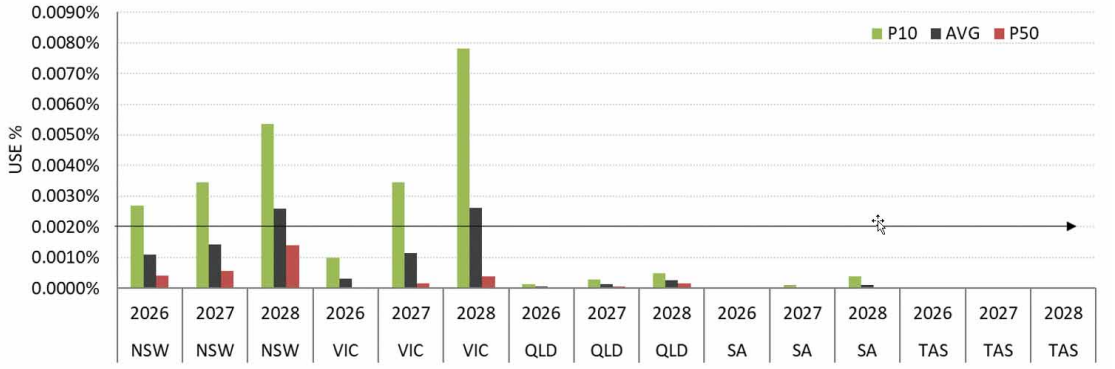
wide market price settings. For this reason, the Panel selected these two regions for the purpose of assessing the market price settings.

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 being:

- Vales Point power station in NSW from FY 2028,
- An additional Yallourn power station unit in VIC from FY 2028.[72]

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.[73]

Figure 3.5: Base case sensitivity USE



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

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.

72 The base-case sensitivity includes the retirement of a total of 3 Yallourn units in 2028. Two already announced and one removed to generate the reliability gap.

73 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

- 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.

3.3.3 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.[74] 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.[75]

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 maintained the correlation between wind and solar generation within the region and month, however, other implicit correlations were not considered.

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74 The base case was adjusted to remove 2 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.

75 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.

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.

3.4 USE distributions

This section summarises the Base case sensitivity and low VRE scenario USE distributions in 2028. 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 2: 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.

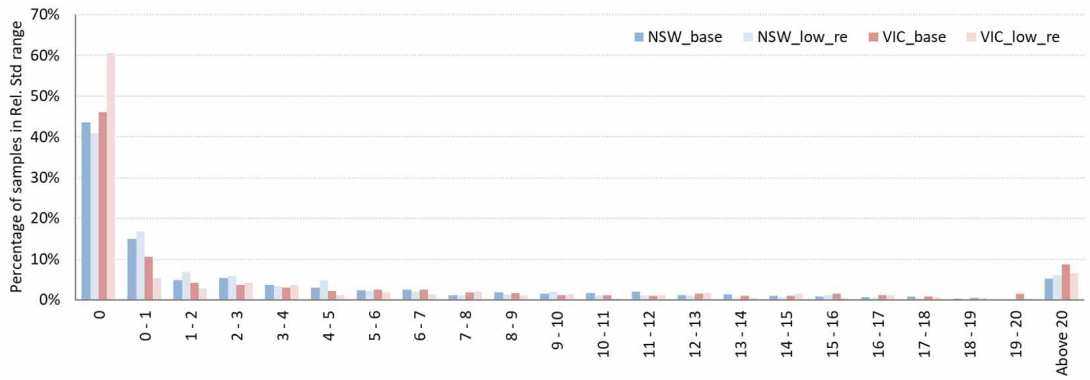
This level of reliability has been synthesised to allow the market price settings to be evaluated by adding the marginal new entrant.

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 3.7 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.

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 under a reliability standard expressed as 0.002% expected USE due to the averaging effect associated with a standard that is expressed as an 'expected value' and the low probability nature of these tail events.

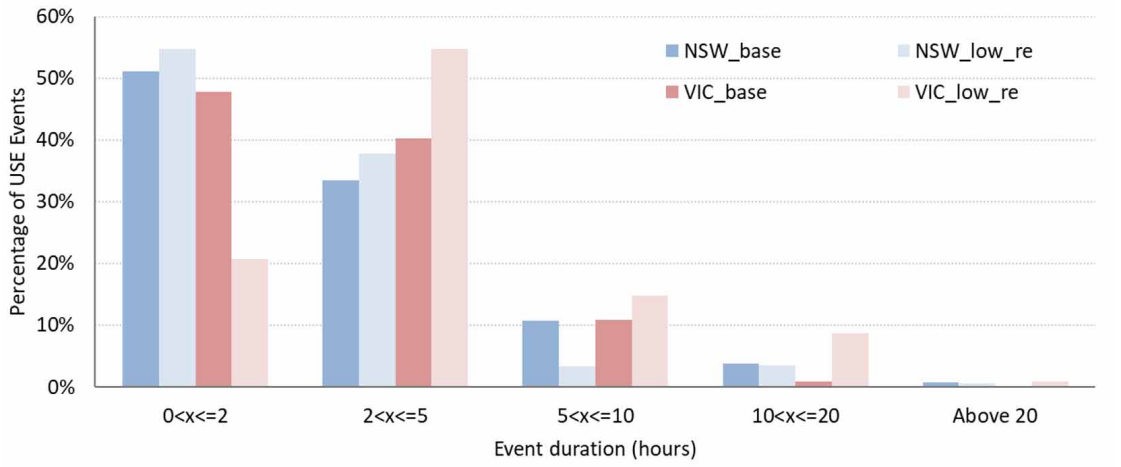
Further consideration of 'tail risk' and the form of the reliability standard is provided in Chapter four.

USE event duration and depth

Duration and depth are two key dimensions of USE events. 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.

Event duration is relevant given the inconvenience and cost associated with different length outages. Figure 3.7 to Figure 3.8 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

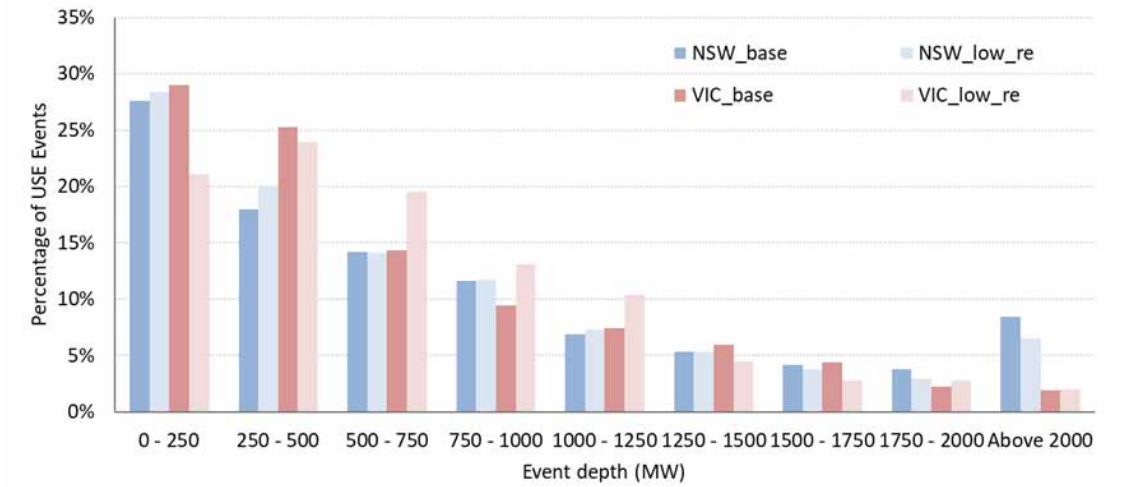


Source: IES, 2022 Reliability Standards and Settings Review - Modelling Report, Fig. 53.

These results show that despite the presence of a tail of greater than 5-hour events, modelled USE 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 to significantly shift relative to the base case distributions. 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. This is consistent with the increase in tail risk anticipated due to further thermal retirement and greater reliance on weather-dependent VRE generation.

Figure 3.8: USE event depth



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

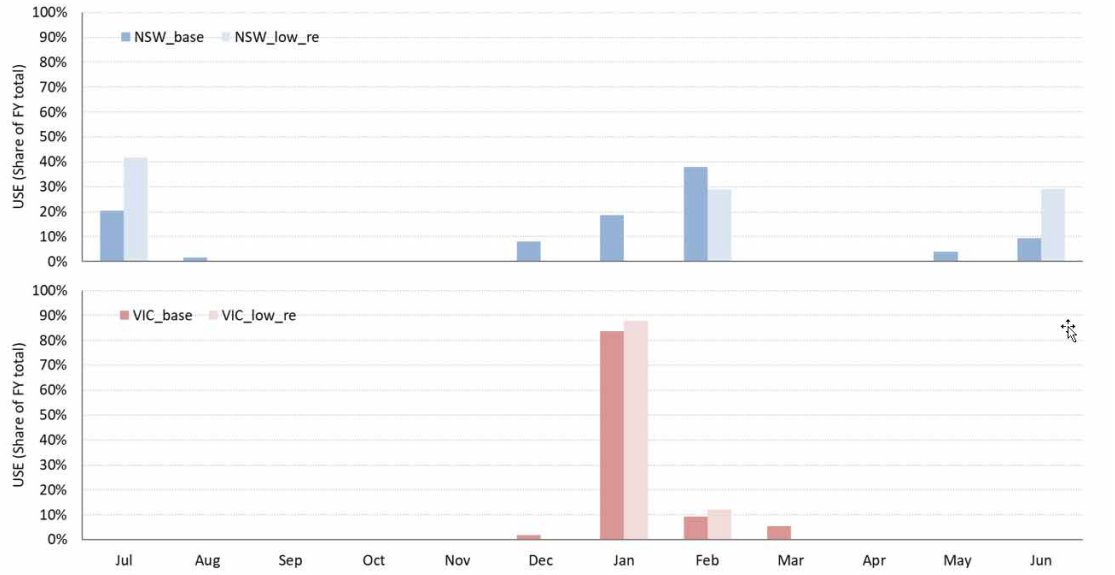
The distribution of maximum event depth shows a large share of events with a maximum depth of less than 250 MW and 500 MW with more than half of the events higher than 500 MW. This chart suggests significant new entrant capacity would be required to address long-tail events which have both high depth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

USE Event timing

Modelling identifies USE events as generally occurring around the evening peak load, and to a lesser extent in NSW also during morning peaks. 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.

3.4.1 Observations on low VRE scenario outcomes

From the results presented in section 3.3, and those contained in IES's modelling report, the Panel identifies VIC as a NEM region where low VRE generation periods could plausibly lead to a shift in the distribution of USE by 2028.

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 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.

4 PART A: FORM OF THE RELIABILITY STANDARD

BOX 3: FINAL RECOMMENDATION ON THE FORM OF THE RELIABILITY STANDARD

The Panel's final recommendation is to retain the current reliability standard form, which is expressed as a percentage of expected unserved energy, for the period 1 July 2025 to 30 June 2028.

The Panel however identifies a case for changing the form of the reliability standard by the next RSS review period, commencing on 1 July 2028. The Panel's final recommendation is that the form of the standard should be changed by 1 July 2028 to accommodate a "tail risk metric" in combination with an "expected value unserved energy standard" metric.

The Panel makes this final recommendation as:

- Reliability risk will need to be characterised differently in the transition from a primarily capacity-limited thermal power system to a more energy-limited VRE power system due to a shift in the distribution of unserved energy towards greater "tail risk". Tail risk represents low probability events that would have high impact on reliability outcomes.
- A single 'expected unserved energy' metric provides insufficient information on the distribution of USE in a high VRE power system and may not effectively reflect changes in the NEM's reliability risk profile by 2028.
- Loss of load probability (LOLP) and expectation (LOLE) based reliability standards do not sufficiently capture a changing reliability risk profile in an increasingly high VRE NEM.
- The Panel considers that there is likely to be a material benefit from amending the form of the reliability standard following 1 July 2028.
- A hybrid standard tail risk metric will provide the scope capture willingness to pay to address tail risk.

The Panel considers extensive analysis and consultation will be required prior to implementing a specific change to the form of the standard. The Panel's final recommendation is therefore for a follow-up review to assess specific changes to the form of the standard, to commence following the conclusion of this RSS review. To allow for an AEMC rule change process prior to the next RSS review, a rule change request recommending changes to the standard may be submitted by the Panel to the AEMC by the end of 2023.

The current form of the standard for the NEM is expressed in terms of the expected USE in a region for a given financial year. The Panel has considered whether this existing form is fit for purpose in a future NEM and has made a final recommendation on a direction for future change.

The Panel's considerations on the form of the standard have been significantly informed by advice received from Professor Pierluigi Mancarella of the University of Melbourne. Professor Mancarella's advice has been published alongside this final report.

This chapter:

- introduces the existing form of the reliability standard along with guidelines and NER requirements applying to Panel consideration on the form of the standard
- outlines the Panel's final recommendation on the form of the reliability standard
- outlines stakeholder submissions on the Panel's draft position
- provides the rationale for the Panel's final recommendation, and
- discusses modelling and analytical consideration relevant to implementing an adjusted reliability standard form.

4.1 Introduction

The RSS review 2021 guidelines (guidelines) describe the reliability standard (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.[76]

The standard in the NEM is an ex-ante standard that indicates the level of supply required 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 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 revenue potential from market price outcomes to support investment. The level of the standard is, therefore, important overarching support for efficient reliability outcomes delivered through market processes.

Further discussion on the level of the standard and associated market price settings is provided in Chapters five to Chapter eight.

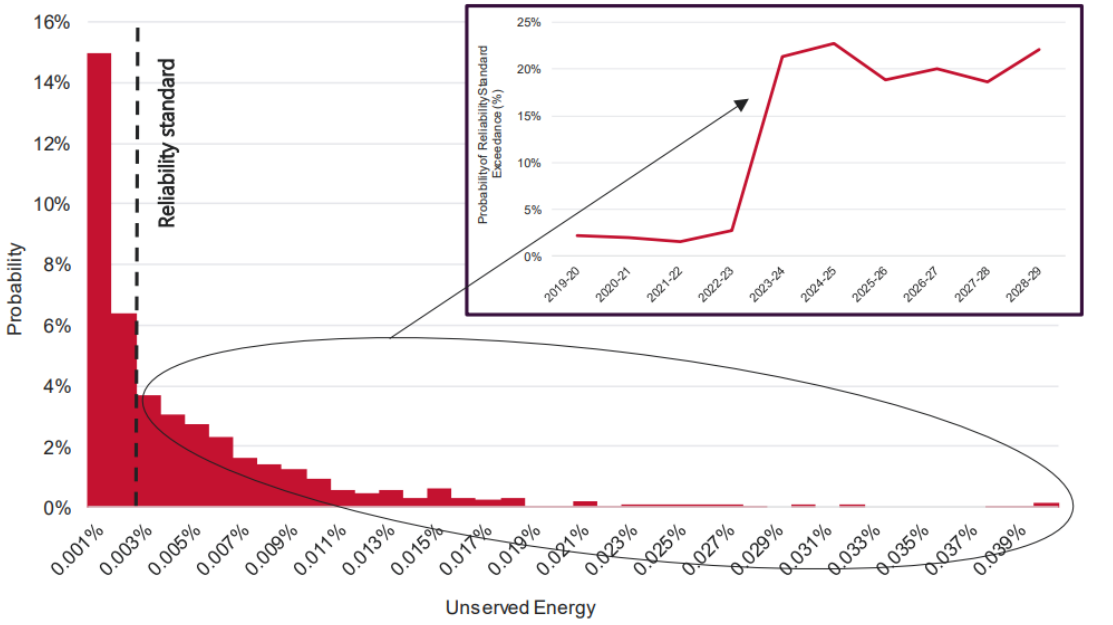
4.1.1 The form of the reliability standard in the NEM

The existing standard is expressed as 'expected' amount of USE. 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 financial year, 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 a reliability standard of 0.002% expected USE does not imply that there is no possibility of an actual outcome that is worse than 0.002% USE. Outcomes with levels of USE far higher than 0.002% are possible, although low probability and correspondingly discounted when assessing their impact against the reliability standard. These outcomes are referred to as 'tail risk'.

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

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.

Figure 4.1 illustrates 'tail risk' reliability outcomes modelled in AEMO's 2019 ESOO.[77] Figure 4.1 shows the modelled 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 USE outcomes significantly higher than the reliability standard even when the 'expected' amount of USE is lower than 0.002%.

In considering 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%.

Stakeholders should note that related to reliability-related tail risk, considered here, is distinct from system security-related tail risk. Reliability-related tail risk is associated with USE occurring due to insufficient generation and inter-regional transmission. This is in accordance with Clause 3.9.3C(b) of the NER which excludes loss load due to multiple and other non-credible contingency events.

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

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

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

- must have regard to any value of customer reliability (VCR) determined by the AER which the Panel considers to be relevant, and
- may take into account any other matters specified in the RSS review 2021 guidelines or which the Panel considers relevant.[78]

Requiring the Panel to have regard to 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 standard therefore fundamentally reflects an efficient level of reliability consistent with consumer willingness to pay.

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.

4.2 The Panel's final recommendation

The Panel's final recommendation does not include a change to the form of the reliability standard for the period 1 July 2025 to 30 June 2028.

The Panel however identifies a case for changing the form of the reliability standard by the next RSS review period, commencing on 1 July 2028. The Panel's final recommendation is that the form of the standard should be changed by 1 July 2028 to accommodate a "tail risk metric" in combination with the "expected value unserved energy standard" metric.

The Panel has made this final recommendation on the basis that:

- Reliability risk will need to be characterised differently in the transition from a primarily capacity-limited thermal power system to a more energy-limited VRE power system due to a shift in the distribution of unserved energy towards greater "tail risk".
- A single 'expected unserved energy' metric provides insufficient information on the distribution of USE in a high VRE power system and may not effectively reflect changes in the NEM's reliability risk profile by 2028.
- Loss of load probability (LOLP) and expectation (LOLE) based reliability standards do not sufficiently capture a changing reliability risk profile in an increasingly high VRE NEM.
- The Panel considers that there is likely to be a material benefit from amending the form of the reliability standard following 1 July 2028.
- A hybrid standard tail risk metric will provide the scope capture willingness to pay to address tail risk.

The Panel however considers a significant amount of additional analysis, consideration, and consultation will be required prior to making a specific recommendation on an adjusted form of the standard to be implemented. The Panel's final recommendation is for a follow-up

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

review, to commence following the completion of this RSS review, to investigate and recommend:

- the structure and definition of a possible "tail risk metric",
- any changes to the role of the expected value USE standard in combination with a possible tail risk metric,
- an approach to quantifying any risk aversion/insurance value represented by the tail risk metric,
- how to operationalise the tail risk metric in market settings and NEM processes, and
- a framework for robustly modelling future changes in tail risk.

The Panel's considerations on each of these points are discussed in section 4.4.

4.3 Summary of draft position and stakeholder views

On 9 June 2022, the Panel published a draft RSS review report which put forward a draft position on changes to the form of the reliability standard for stakeholder feedback. This section presents the Panel's draft position and stakeholder views expressed in submissions to the draft report. The Panel's consideration of stakeholder views is outlined in the Panel's rationale for its final recommendation presented in section 4.4.

4.3.1 The Panel's draft position

The Panel's draft position did not include a specific recommendation to change the form of the reliability standard. The Panel however identified a case for changing the form of the reliability standard as the NEM transitions from being 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 were:

- 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 an increasingly high VRE NEM and hence increasing tail risk,
- 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's draft position also put forward a 'straw person' tail risk metric option for stakeholder feedback. This option involved a conditional value at risk (CVaR) based 'risk aware' approach, to augment the existing standard as part of a multi-metric reliability

standard that included average and tail risk metrics. The 'straw person' approach was a combination of:

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

Further information on the 'straw person' multi-metric reliability standard is presented in section 4.4.5.

4.3.2 Stakeholder submissions

Stakeholder views were divided between those who agreed with the Panel's draft position on the need to change the form of the standard to account for tail risk and those who considered the existing form remained appropriate, at least for the review period.

One group of stakeholders supported including a complimentary tail-risk metric in the form of the standard,[79] though several stakeholders considered further research was needed prior to implementing a specific change.[80]

A range of comments were made on the additional work required to determine a specific change to the reliability standard. AEMO, EnergyAustralia, and AGL considered additional work was required on how any tail risk metric would be operationalised through the settings and other mechanisms.[81] Iberdrola suggested analysis to identify an acceptable distribution of outages from a reliability risk perspective was required.[82] Engie highlighted the challenge and risks associated with robustly estimating customer risk aversion.[83]

In contrast, other stakeholders considered that the current form of the reliability standard remained appropriate and did not support changing the form of the standard to include an additional metric accounting for tail risk.[84]

Energy Australia, AEC and EUAA were concerned that the inclusion of a tail risk metric would make the standard more stringent, in effect, tightening the standard.[85] The AEC considered concern about "tail risk" and limiting USE in extreme years had confused reliability and security-based load interruption as reliability interruption only occurs through controlled, rotational load shedding.[86] Origin did not consider there was clear evidence to suggest a change in the form or level of the standard is required at this time and PIAC noted that consumer and community groups support the current form of the standard.[87]

79 Submissions to the draft report: Energy Australia, p. 2; AEMO, p. 2; Hydro Tasmania, p. 6; Alinta, p. 2; AGL, p. 2; Origin, p. 1; CEC, p. 1; SA ETR, p. 2; Iberdrola, p. 2.

80 Submissions to the draft report: Energy Australia, p. 2; Alinta, p. 2; AGL, p. 2; Iberdrola, p. 2; Origin, p. 1; Shell, p. 2.

81 Submissions to the draft report: AEMO, p. 2; Energy Australia, p. 2; AGL, p. 2.

82 Iberdrola, submission to the draft report, p. 2.

83 Engie, submission to the draft report, p. 2.

84 Submissions to the draft report: AEC, p. 1; Energy Australia, p. 2; EUAA, p. 1; Snowy Hydro, p. 2; Shell, p. 2; PIAC, p. 2.

85 Submissions to the draft report: Energy Australia, p. 2; AEC, p. 1; EUAA, p. 1.

86 AEC, submission to the draft report, p. 1.

87 Submissions to the draft report: Origin, p. 1; PIAC, p. 2.

Only the SA Government Energy and Technical Regulation Division (SA ETR) noted support for deterministic planning metrics such as LOLP/LOLE.[88] A number of other stakeholders considered that LOLE/LOLP were inappropriate as substitute forms of the standard.[89]

4.4 Panel considerations in making its final recommendation

The Panel has made its final recommendation on the basis that:

- the Panel identifies a material benefit from amending the form of the reliability standard for the period commencing 1 July 2028
- reliability risk will be characterised differently in a high VRE NEM
- there is a shift in the distribution of USE towards greater tail risk, particularly towards 2028,
- a single 'expected value' standard provides insufficient information on the distribution of USE in a high VRE power system, and
- a hybrid standard tail risk metric will capture consumer risk aversion and willingness to pay to address tail risk.

4.4.1 The Panel identifies a material benefit from amending the form of the reliability standard

The Panel has recommended that the form of the standard should be changed by 1 July 2028 to accommodate a "tail risk metric" in combination with the "existing expected value standard" as it considers there is a material benefit likely relative to retaining existing arrangements. The Panel considers its final recommendation will contribute to the achievement of the NEO in a materially better way as a reliability standard that recognises tail risk will enhance the management of reliability risks in a transitioning NEM.

The form of the existing reliability standard was implemented when the NEM was an overwhelmingly capacity-limited thermal power system and is fit for purpose in such a power system. The NEM is transitioning to become a high VRE power system with reliability outcomes that are reliant on storage and other flexible resources. As discussed further in section 4.4.3, the existing expected value standard, on its own, will no longer provide sufficient information to adequately describe efficient reliability outcomes in a high VRE power system. These changes will require a future reliability standard made up of more than one metric to sufficiently describe an acceptable distribution of USE and corresponding reliability risk profile.

The Panel's final recommendation is for a multi-metric reliability standard that includes a "tail risk metric" in combination with the "existing expected value standard" to explicitly address the increase in tail risk expected in a high VRE more energy-limited power system where reliability is more reliant on storage and other flexible resources. A future NEM will face new reliability risks from energy storage limits and the potential for extended low VRE ('dunkelflaute') events. A significant investment challenge in a high VRE NEM will be signalling and coordinating investment in sufficiently long-duration storage resources required

88 SA Govt ETR, submission to the draft report, p. 2.

89 Submissions to the draft review: AEMO, p. 2; Engie, p. 2; EUAA, p. 1.

to limit USE from such events to efficient levels. A reliability standard that describes efficient levels of tail risk will provide a basis for mechanisms to support efficient levels of such investment in the long-term interest of consumers.

Conversely, a reliability standard that does not effectively reflect reliability risk may not signal efficient investment or effectively coordinate the different elements of the NEM's reliability framework in the long-term interests of consumers. This raises the risk of uncoordinated reform and policy intervention in response to increasing concern about tail risk remaining unaddressed by NER frameworks that are guided by the reliability standard. The potential for an appropriately amended reliability standard to coherently guide a coordinated set of NER frameworks to efficiently address tail risk is likely to result in material benefit relative to an alternative of uncoordinated reform and ad-hoc interventions. The following elements of the NEM's reliability framework are guided by the reliability standard and therefore notable in this regard:

- The level of the market price settings (MPC, CPT, APC, MFP)
- AEMO's market planning, operation, and information processes including (MT PASA, ST PASA, ESOO, ISP)
- AEMO interventions including RERT procurement and dispatch and directions for reliability, and
- Future complementary mechanisms to support reliability and storage in a high VRE power system.

An amended form of the standard will result in material benefit once the distribution of USE has materially shifted to higher levels of tail risk. The Panel's modelling, discussed in Chapter 3 and section 4.4.4, considers this likely to occur in response to further thermal generation closure expected post-2028. For this reason, the Panel's final recommendation includes a future work plan to deliver an amended and implemented form of the reliability standard by 1 July 2028[90].

4.4.2 Reliability risk will be characterised differently in a transitioned NEM

The NEM is transitioning from being a capacity-limited thermal power system to becoming a high VRE more energy-limited power system with reliability outcomes dependent on storage and other flexible resources. This shift will require a fundamental re-evaluation of our approach to assessing and understanding reliability risk and investment needs.

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 forced outage rates (FOR) is generally sufficient to characterise the distribution of USE and the resulting reliability risk profile. This was sufficient for the primary reliability planning task in a capacity-limited power system which was to ensure the capacity margin that would guarantee the installed capacity of available generation could meet demand at peak times.

90 The next RSS review needs to be completed by 30 April 2026 and the period considers 1 July 2028 to 30 June 3032

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).[91]
- 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.[92]
- 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.
- 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.

The above points contrast with the factors relevant to reliability in a high VRE, more energy-limited power system. 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 and the value of adjusting the form of the reliability standard to appropriately signal reliability risk and investment needs in this future power system.

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.

91 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.

92 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.

- The available reserve margin can no longer be represented in a Gaussian way, and may be heavily skewed. 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.

These changes signal a different, more diverse set of drivers for USE, and therefore reliability risk and investment needs, which are discussed in the next section.

4.4.3 A single 'expected value' standard provides insufficient information on the distribution of USE in a high VRE power system

One of the biggest limitations of the existing form of the reliability standard is that it only provides guidance on an acceptable level of reliability risk through a single average measure of risk across many thousands of potential outcomes. It does not provide sufficient information on the distribution of USE in a future power system.

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 noted in section 4.4.2, discrete generation forced outages will become less relevant and the distribution of USE will shift to reflect the impact of a wider set of drivers for USE in a future high VRE more energy-limited NEM. Drivers of USE will include:

- relatively short reliability events from insufficient flexible resources to meet ramping requirements

- thermal generation forced outage events
- 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
- increasing volatility in the supply and demand balance due to the anti-correlation of weather-dependent generation and demand, and
- increasing temporal linkages and greater weather-dependent correlation in supply-side resources.

These drivers will result in a shift in the distribution of USE such that the resulting reliability risk profile will no longer be easily understood from its expected value and forced outage rates. Instead, it will be a function of a range of complex and interacting factors. More information than the expected value will therefore be required to appropriately describe an acceptable distribution of USE and the resulting reliability risk profile.

The Panel's final recommendation will address this shortcoming by potentially including an additional metric to specifically address tail risk arising from sources including, but not limited to, those identified above.

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 involve 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.[93] 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. This issue also warrants further consideration in the follow-up review proposed in the Panel's final recommendation.

4.4.4 There is a shift in the distribution of unserved energy towards greater tail risk

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

The distribution of USE in a high VRE power system is likely to shift towards longer duration higher impact reliability events, particularly due to the risks from low VRE generation due to co-incident low solar and wind generation events. In contrast, short-duration events, which currently dominate the existing USE distribution will decline as incumbent thermal generation retires.

The change in the distribution of USE and reliability risk profile is illustrated in Figure 4.2 which was published by the Energy Systems Integration Group (ESIG) in their report on redefining resource adequacy for modern power systems.[94] Figure 4.2 shows a scatter plot of size, frequency, and duration of USE events for three power system scenarios each of which

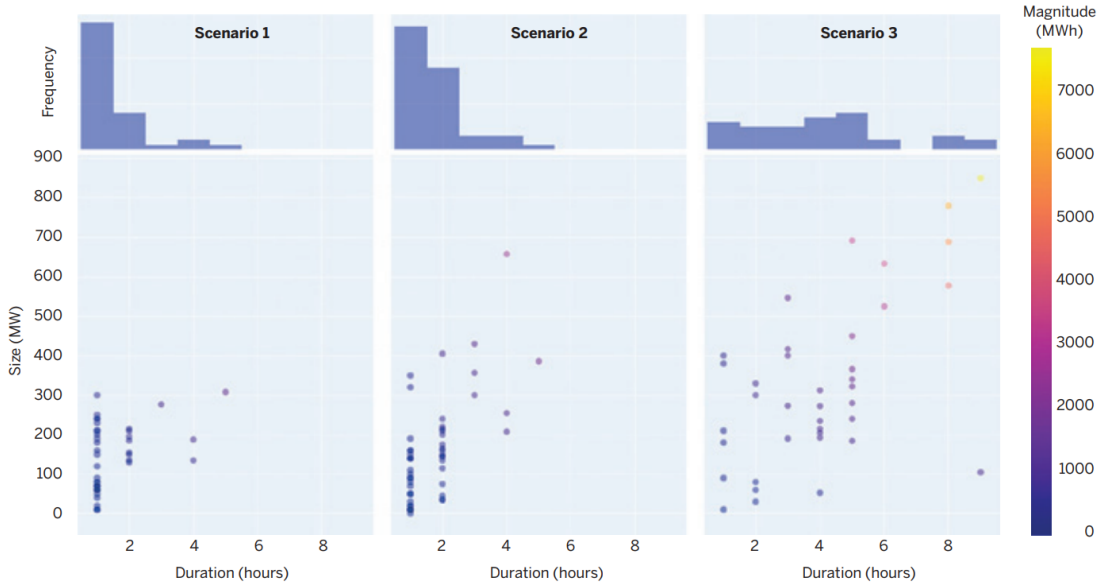
93 P. Joskow, "California's Blackouts, Near Blackouts, and Fires", MIT presentation, 5 October 2020.

94 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

progressively includes higher VRE penetration and reliance on storage. An important point is that each of these three scenarios has the same LOLP.

The difference in size, duration, and frequency of USE events in the high VRE and storage power system, scenario 3, is clear relative to the capacity-limited thermal power system in scenario 1. In particular, the increase in tail risk associated with scenario 3, despite no change in the system LOLP, illustrates both the shift in the distribution of USE in a high VRE power system and the shortcomings of a LOLP-based reliability standard in a high VRE power system.

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/

The ESIG goes on to identify the risk that an improperly planned high-renewables grid may experience much larger shortfall events than those we are used to planning for due to sustained periods of low renewable production. They observe this could cause longer and larger disruptions—even if the probability of these events occurring is lower than historical norms. Improved use of reliability standard metrics were identified as helping to avoid this challenge.[95]

The Panel's low VRE scenario, introduced in Chapter 3, considered the significance of plausible low VRE generation periods 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. This analysis supports the type of shift in reliability risk profile high in

95 ESIG, redefining resource adequacy for modern power systems, 2021, p. 13.

VRE conditions in a future NEM, particularly as further thermal generation capacity retires post-2028.

The Panel notes the AEC's submission to the draft report, which considered concern about "tail risk" had confused reliability and security-based load interruption.[96] While historically tail risk loss of load outcomes in the NEM has been associated with security events,[97] as previously noted, the Panel expects reliability-related tail risk to materially increase as further thermal generation retires post-2028 and is replaced by VRE firmed by storage and other flexible resources.

Conditional value at risk metric (CVaR) to target tail risk

The Panel's final recommendation is for a tail risk metric in combination with the existing expected value standard. This requires a metric that captures tail risk in a way that complements the existing expected value-based reliability standard form.

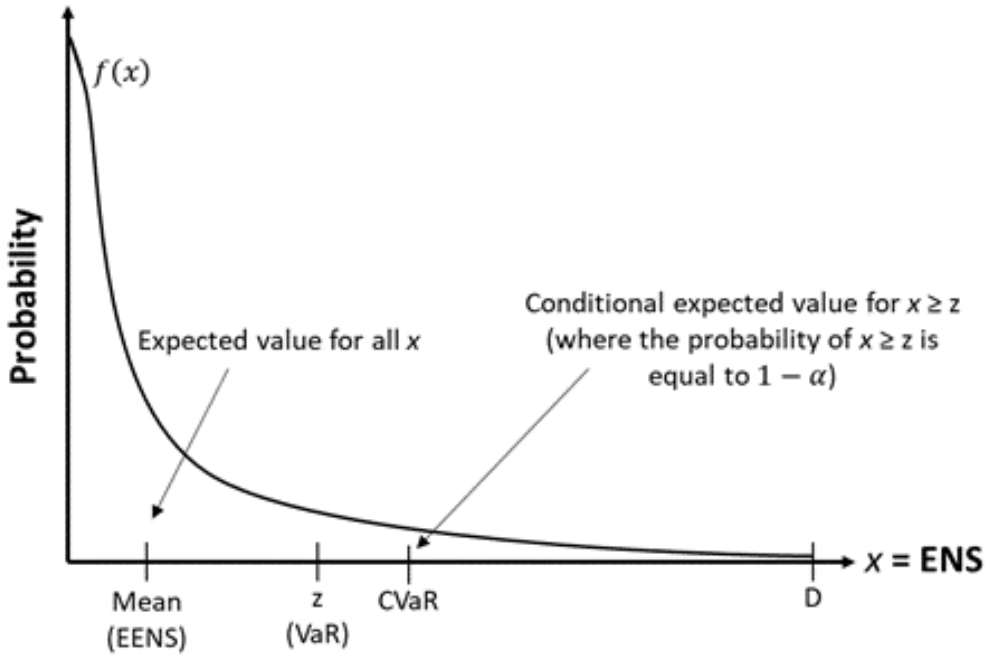
CVaR is a tail risk indicator that could be incorporated in a multi-metric reliability standard alongside an expected value metric. CVaR describes the fatness of the tail of reliability events defined as the mean value of the *α*% worst cases (the "tail") of a probability density function, in this case, USE.

Figure 4.3 illustrates the role of CVaR relative to the expected energy not served (EENS), or expected USE, for a hypothetical probability distribution. As illustrated, 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% of cases. The α CVaR value may be informed by the size and impact of the USE events which are considered sufficiently detrimental to justify additional investment to specifically address. Further discussion is provided in section 4.6 on modelling and analytical considerations for implementing a new standard form that includes a tail risk metric.

96 AEC, submission to the draft report, p. 1.

97 which fall outside the NER definition of USE for reliability purposes

Figure 4.3: Probability of USE, expected USE (EENS) & 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).

4.4.5 Willingness to pay to address tail risk may be addressed through a tail risk metric

The existing NEM 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 in depth or in duration. As an example, the current risk-neutral framework prefers a cheaper investment in 2-hour batteries to address the first part of every reliability event rather than a more expensive investment in longer duration storage which will provide more utility during low VRE generation 'dunkelflaute' periods.

While the existing reliability standard is risk neutral, consumers may be regarded as risk-averse to tail risk events which may also pose significant hedging costs on investors, possibly to the point of possibly limiting investment. Consumers purchase insurance against the impact of severe events paying a premium over the risk-neutral value of an insurance product. The viability of an insurance industry that charges an insurance premium may be viewed as a marker of community risk aversion. The Panel's final recommendation for a tail risk metric would provide scope for consumer risk aversion to severe reliability events to be explicitly recognised in the reliability framework.

Risk aversion can be implemented through the use of tail risk metrics such as, but not limited to, CVaR (discussed above).[98] A tail risk metric can be used to tune the level of risk aversion, to reflect the extent to which consumers are willing to pay for the insurance value of additional investment suitable to address tail risk outcomes that may not be fully valued under the existing risk-neutral framework.[99]

The Panel's draft report 'straw person' composite reliability standard

The Panel put forward a 'straw person' composite reliability standard in its draft report to facilitate stakeholder feedback on the issues and options identified in this chapter. The Panel received little detailed stakeholder feedback on its straw person option and therefore considers it should remain one option for consideration in the final recommendation's upcoming review.

The form of the reliability standard under the Panel's 'straw person' 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 4: 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.

This approach involves two ways to adjust the level of risk aversion in the composite standard corresponding to efficient levels that limit reliability risk to efficient levels that reflect consumer willingness to pay:

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;

98 Other options for implementing 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.

99 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.

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).

The selection of the *w,* and *α* parameters requires a significant level of additional modelling. The key elements in a high-level parametric trade-off analysis that could be conducted in the recommended follow-up review are discussed in section 4.6.1.

Alternatively, the average and tail risk elements of this reliability standard may be treated separately and explicitly set up to drive different elements of the reliability framework. The Panel's upcoming review will consider whether to combine the two metrics as indicated in the 'straw person' or whether to keep them separate.

4.5 Follow-up review and rule change process

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 available for this RSS review has not been sufficient to complete this process and further consideration and detailed modelling is required in a follow-up Panel review.

The Panel's final recommendation is therefore for a follow-up Panel review to recommend a specific future form of the standard including the:

- structure and definition of a possible "tail risk metric"
- role of the expected value USE standard in combination with a possible tail risk metric
- approach to quantifying any risk aversion/insurance value of a tail risk metric
- operationalising the tail risk metric in market settings and NEM processes, and
- framework for robustly modelling changes in tail risk.

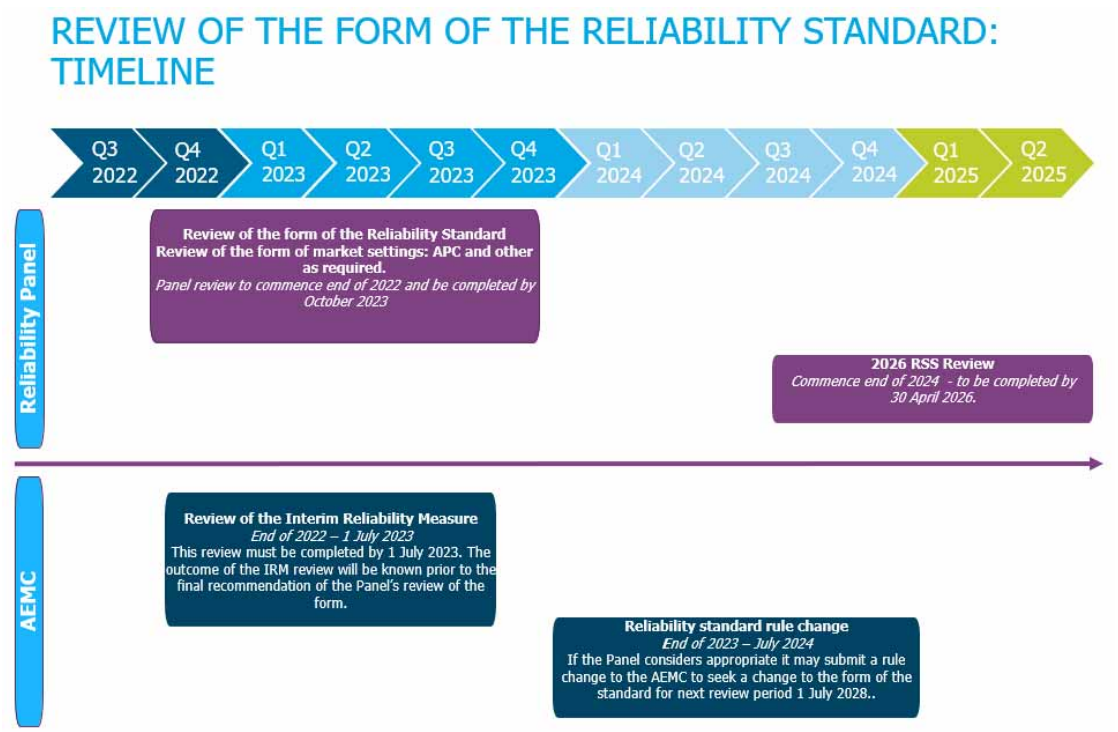
Modelling and analytical considerations relevant to the follow-up review are discussed further in section 4.6.

The Panel's final recommendation is for an amended reliability standard to be implemented prior to 1 July 2028. This is on the basis of its low VRE scenario outcome, presented in Chapter 3, which indicates a plausible shift in the distribution of USE may have commenced in Victoria by the end of the review period. Further, the amended standard form should be implemented by 1 July 2028 in preparation for the shift in reliability risk due to significant levels of thermal generator retirement anticipated in the next RSS review period.

Prior to a revised reliability standard form coming into effect, however, the AEMC must complete a rule change process to amend the NER in time for revised market settings to be identified in the next RSS review scheduled to commence in 2026. The Panel, therefore, considers the follow-up review should commence by the end of 2022 and be concluded by October 2023 to allow sufficient time for the subsequent processes, such as the AEMC rule change, to occur prior to the full implementation of a revised standard on 1 July 2028.

Figure 4.4 identifies a required timeline for the follow-up review, and subsequent processes required to fully implement a revised standard form by 1 July 2028.

Figure 4.4: Follow-up review timeline and new reliability standard implementation process



Source: Reliability Panel

4.6 Modelling and analytical considerations

This section summarises key modelling and analytical considerations for the follow-up review on the form of the standard. Further detail is provided in Professor Pierluigi Mancarella's advice to the Panel published alongside this report.

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

The Panel identifies a core consideration is how to develop a methodology to perform a cost-benefit analysis to determine the numerical values for the average and tail risk elements of an amended standard. This cost-benefit analysis should minimise costs, and account for the value of different technologies, while also reflecting consumer willingness to pay for average reliability outcomes given the insurance value of investment to address tail reliability outcomes.

In respect of the 'straw person' reliability standard, presented in section 4.4.5, this cost-benefit analysis informs the relative weighting between average and tail risk reliability metrics (w), as well as the *α-level* of the CVar for the composite reliability metric.

This section briefly summarises some key points from Professor Mancarella's advice in the following areas:

- Budget constraints associated with 'willingness to pay' for average and tail reliability
- Multi-objective optimisation of average and tail risk through Pareto efficient frontier, and
- Parametric studies to characterise efficient levels of overall risk.

Budget constraints and willingness to pay for average and tail reliability

Consumer willingness to pay for insurance against tail risk outcomes could be assessed and used to inform the relative weighting of the average and tail risk elements of an amended standard, corresponding to the selection of values of (w) and possibly (α).

This would involve identifying a total allowed reliability "budget", which is then broken down into budget to ensure the "base", the expected value level of reliability, as well as an incremental budget set aside to deal with tail risk. This incremental budget is, essentially, the "willingness to pay" for tail reliability and thus to create an insurance allowance against tail risk events whose probability is very difficult to estimate.

This incremental budget may be informed by studies on consumer willingness to pay through an expansion of existing processes such as the AER's process for undertaking the value of customer reliability. The Panel's follow-up review will consider a range of different approaches to characterising user willingness to pay, and the corresponding tail risk reliability investment 'budget'.

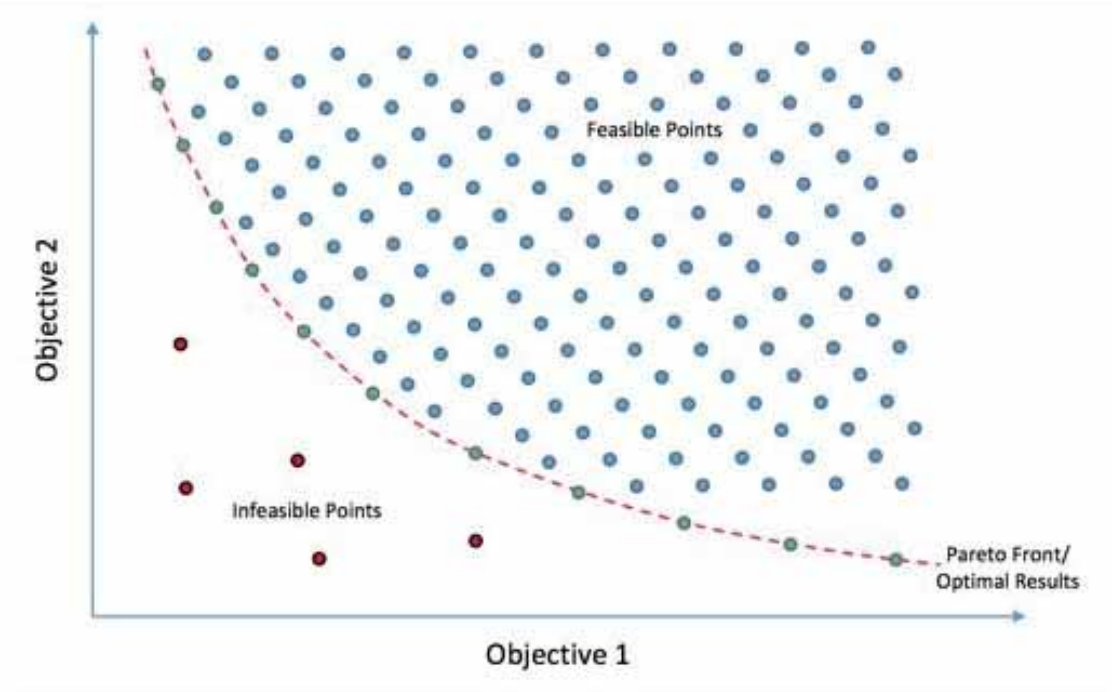
Multi-objective optimisation of average and tail risk through Pareto efficient frontier

Multi-objective optimisation is required to identify an efficient multi-metric reliability standard. A Pareto efficient frontier is a method allowing the multi-objective optimisation of cost and risk in a multi-metric reliability standard consisting of average and tail risk metrics.

Pareto-efficiency, in engineering analysis, can be applied to the selection of alternative design options where a set of options are each assessed under multiple criteria to identify the set of options where no single option outperforms the other members in the set.[100] Figure 4.5 illustrates a hypothetical Pareto efficient frontier describing the concept.

100 Note the use of 'Pareto efficient' in this context differs from its use in economics.

Figure 4.5: Hypothetical multi-objective optimisation using a Pareto efficient frontier



Source: [tbc]

A Pareto efficient frontier allows the relative weighting between average and tail risk reliability metrics (w) to be identified by describing how the lowest cost solution changes as a function of different end-user risk appetites and willingness to pay for insurance against tail risk outcomes. The decision maker could then make informed decisions based on the incremental economic and risk benefits/impacts across the two dimensions of average and tail risk by moving from one solution to another.

Parametric studies to characterise efficient levels of overall risk

A parametric study could be used to develop the Pareto efficient frontier. This would involve assessing boundary cases w=0 (tail value only, full risk aversion) and w=1 (expected value only, no risk consideration) as well as a number of (1-w) intermediate steps, and potentially intermediate steps in the CVaR *α-level* too. In practice, a set of Monte-Carlo studies would need to be performed for each value of (w) with a focus on the tail risk-related events and scenarios.

The Monte-Carlo studies would also provide insights into the value and role of different new entrant technologies to address average and tail reliability risk. This analysis could highlight whether specific technologies might be particularly suitable or unsuitable in dealing with extreme scenarios as well as contrasting their performance under extreme cases against their performance under expected cases. This could inform the incremental investment

requirements and set of marginal new entrants required to efficiently uplift the average reliability performance while also accounting for high impact low probability events.

4.6.2 Implementation considerations and approach

This section identifies considerations on how average and tail risk weights and values, identified through the above analysis, could inform the market price settings and potentially other complementary mechanisms.

How average and tail risk value could inform the market price settings

The analysis described above could produce insights relevant to changing the form of the market price settings to align investment incentives with average and tail reliability outcomes under a multi-part reliability standard.

While these are complex issues which require careful consideration in the follow-up review, AEMC rule change, and next RSS review, the level and form of the MPC and CPT could be informed by the average and tail risk shadow costs. In particular, the optimisation dual variables, that provide the shadow costs for the average and tail risk constraints, may yield different MPC/CPT solutions for average and tail risk which could inform a range of different market price settings.

How these different MPC/CPT solutions would be incorporated, or otherwise operationalised is beyond the scope of this particular review. A hypothetical example to illustrate one potential use of these findings however would be to inform a decision to change the CPT calculation period from one week to a different duration to address *dunkelflaulte* events relative to other risks.

Tail risk value assessment may inform reliability mechanisms complementing market revenue outcomes

While the analysis described above may inform changes to the form of the reliability settings, in practice, in order to recover investments aimed at hedging against rare but high impact tail events, very high market prices caps, close to the value of lost load and sustained for a relatively long period of time may be necessary. Such an outcome is likely to be challenging from a systemic risk perspective and therefore not be consistent with current NER requirements. This suggests scope for complementary mechanisms to further support investment to address tail reliability risk consistent with consumer willingness to pay.

Furthermore, in a market context, where decision-making is decentralised, an additional challenge lies in how different risk appetites from different stakeholders could be reconciled. Given the rarity of tail events, which in principle might not materialise in many years, market stakeholders may be inhibited from investing in technologies whose return would principally rely on very volatile low probability occurrences. In other words, if market stakeholders were to value their projects based on *expected*, risk-neutral returns, the resulting investment decisions might not align with signals emerging from a risk-averse methodology. This further suggests use of complementary mechanisms to supplement market revenue supporting investment to address tail risk.

Additional discussion on the potential role for complementary mechanisms given limits in the utility of scarcity pricing is discussed in Chapter 6.

4.6.3 Considerations in robustly modelling tail risk in a high VRE power system

From a techno-economic modelling perspective, several challenges are associated with the requirements for studies able to draw a full risk profile of future systems and inform on new reliability requirements, standards and settings.

First, care should be taken in determining the scenarios of interest, particularly to identify the drivers that concurrently could lead to the occurrence of high-impact tail risk reliability events. This calls for the integration of more detailed weather models, for both the supply and demand sides and relevant technologies, into reliability studies.

Extensive probabilistic studies, based on extensive Monte Carlo simulations, will be required. Suitable modelling approaches would need to be devised to adequately sample tail events via a Monte-Carlo framework while also being computationally efficient thereby allowing an adequate number of studies to be run. It will be essential that the underlying random variables are extracted from the probability distributions produced from these studies that are adequately designed to include rare events.

Modelling should capture the potential for ramping and operational flexibility requirements to act as a future driver of USE. These have not been traditionally considered in reliability studies for resource adequacy, given the computational resources associated with the modelling resolution required.

It will be essential for studies to capture and realistically simulate the behaviour of energy-limited resources, particularly longer-duration resources, as it may not be straightforward to identify their opportunity cost, and therefore their market-driven behaviour, in the presence of extreme operational (price- and weather-driven) events and uncertainty.

5 PART B - LEVEL OF THE RELIABILITY STANDARD

BOX 5: FINAL RECOMMENDATION - LEVEL OF THE RELIABILITY STANDARD

The Panel's final recommendation is to retain the current level of the reliability standard at 0.002% expected USE, in a region over a financial year, for the review period from 1 July 2025 to 30 June 2028.

The Panel has decided not to recommend tightening the reliability standard to 0.0015%, or 0.001% expected USE over the review period as canvassed in its draft report. The reasons for the Panel's final recommendation on the level of the standard are based on:

- The benefits of changing the level of the reliability standard from 0.002% USE to 0.0015% USE are not sufficiently material to justify a change,
- Changing the form of the standard, rather than tightening the level of the standard, is the Panel's preferred approach to reflect the changing nature of reliability as the NEM transforms to a high VRE more energy-limited power system.
- The IES modelling considered base, 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 high VCR value sensitivity that identified a potential reliability standard level of 0.001% expected USE was not considered by the Panel to be a value that appropriately reflects customer willingness to pay for reliability and given the excessive MPCs required to achieve that level.
- The Panel notes the existing interim reliability measure and considers that this level of reliability does not reflect, customer willingness to pay for reliability.
- In addition to considering the form of the reliability standard to account for tail risk, tighter levels of reliability may be better supported by other reliability mechanisms or tools.

The Panel has considered stakeholder submissions to its draft report in developing its final recommendation. Stakeholder views on the Panel's draft report are presented in section 5.3.2 with the Panel's detailed rationale and considerations presented in section 5.4.

The reliability standard (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 standard is currently set at a level where expected unserved energy (USE) must not exceed 0.002% of total energy demand in a NEM region for a given financial year.[101]

This chapter sets out details of the Panel's final recommendation and supporting rationale on the level of the reliability standard for the period 1 July 2025 to 30 June 2028. Specifically, it:

101 Clause 3.9.3C(a) of the NER.

- introduces the existing reliability standard in the NEM, and NER and guideline requirements applying to the Panel's final recommendation
- details of the Panel's final recommendation on the level of the standard for the period 1 July 2025 to 30 June 2028
- stakeholder submissions on the Panel's draft position, and
- detailed consideration and rationale supporting the Panel's final decision.

5.1 Panel requirements: level of the reliability standard

This section introduces the standard and key Guideline requirements the Panel is required to consider when making its final recommendation.

5.1.1 Overview of the level of the reliability standard

The standard defines an efficient level of reliability, expressed as an expected amount USE. The standard then informs the different elements of the NEM's energy-only market reliability framework including:

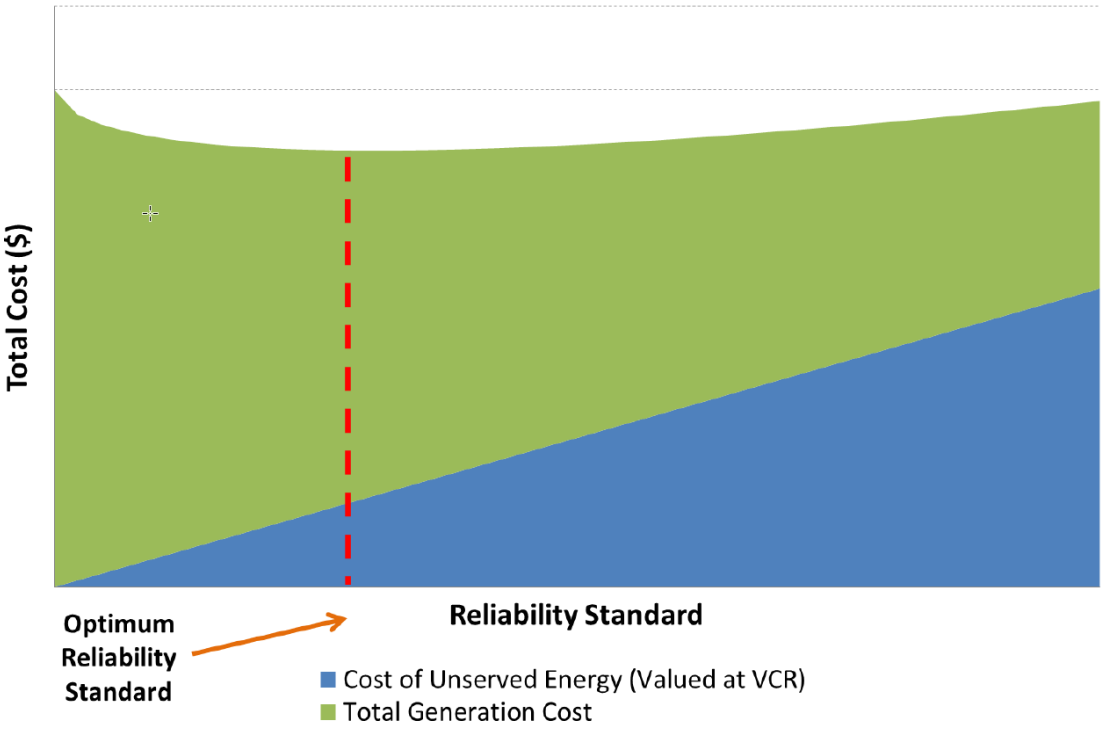
- The market price settings (MPC, CPT, APC, MFP) that determine the energy market revenue potential supporting investment and operational outcomes
- AEMO's information provision, forecasting, and operational processes, and
- AEMO interventions as a last resort for maintaining reliability.

The standard represents an economic trade-off between reliability and affordability, based on what customers value. The efficient level of reliability, therefore, trades off 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 efficient level of the standard, which balances the economic trade-off between reliability and affordability, is the level of USE 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

In addition to the standard, the interim reliability measure (IRM) was put in place by Energy Ministers (formally COAG Energy Council) following advice from the ESB to improve the short term reliability (resource adequacy) of the electricity system.

The IRM stands apart from the standard and associated market price settings, and is required to be reviewed by the AEMC by 1 July 2023.[102] Under the NER, the IRM will cease in March 2025. [103]

5.1.2 NER and 2021 RSS Review Guideline Requirements

The Panel is to apply the following NER requirements in its assessment of the level and form of the standard. These criteria state the Panel, among other things:[104]

- must have regard to any value of customer reliability (VCR) determined by the AER which the Reliability Panel considers to be relevant, and
- may take into account any other matters specified in the Guidelines or which the Panel considers relevant.

The Panel will also consider factors including, but not limited to:

102 Clauses 3.9.3C and 11.128.12(c) of the NER.

103 Unless extended by the AEMC following its review of the interim reliability measure by 1 July 2023.

104 Reliability Panel, Final guidelines, *review of the reliability standard and settings guidelines*, 1 July 2021.

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

The key requirement for the Panel when recommending the level of the 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.[105]

The 2021 RSS review guidelines (guidelines) also require the Panel to only consider a change to the level of the standard where there is a material benefit in doing so. A material benefit arises when the change will or is likely to, contribute to the achievement of the NEO and meet the assessment criteria set out in the guidelines in a materially better way.[106]

5.1.3 VCR sensitivities and analysis

The Panel has considered the VCRs published by the AER in the modelling informing its final decision on the level of the standard for the period 1 July 2025 to 30 June 2028.[107]

The Panel accounted for the uncertainty that exists within the VCR as there is no single value that accurately captures all consumer values placed on reliability. In order to assess the efficient level of reliability, the Panel's final recommendation considered a sensitivity analysis of a base case, low case, and high case VCR. The AER's 2019 load-weighted regional VCRs were adopted as the base case with high and low sensitivity cases as set out in Table 5.1.

This approach has accounted for different customer types and classes, rotational load shedding practices, and outage duration. Details on the construction of the VCR sensitivities used in the modelling informing the Panel's final recommendation are provided in Appendix A1.[108]

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	97,267

Source: AER VCR final report, re-weighted by Panel RSS review project team. Details on the re-weighting approach are provided in Appendix A1.

105 Clause 3.9.3A(e)(4) of the NER

106 The Panel must also have regard to any terms of reference provided by the AEMC, stakeholder consultation and responses, modelling, and any other factors the Panel considers relevant.

107 The Panel notes that the AER's next review of the VCR is due by 31 December 2024.

108 The Panel notes that rotational load shedding practices in NEM regions focus on lower VCR residential and light commercial and industrial customers. Critical loads and other very high VCR customers are generally excluded from rotational load shedding. Rotational load shedding is therefore likely to produce actual VCR outcomes that are lower than the base case AER jurisdictional load weighted VCR set.

5.2 The Panel's final recommendation

The Panel's final recommendation is to retain the current level of the standard at 0.002% expected USE in a region over a financial year for the review period from 1 July 2025 to 30 June 2028.

The Panel has decided not to recommend tightening the reliability standard to 0.0015%, or 0.001% expected USE over the review period as canvassed in its draft report. The reasons for the Panel's final recommendation on the level of the standard are based on:

- The benefits of changing the level of the reliability standard from 0.002% USE to 0.0015% USE are not sufficiently material to justify a change,
- Changing the form of the standard, rather than tightening the level of the standard, is the Panel's preferred approach to reflect the changing nature of reliability as the NEM transforms to a high VRE more energy-limited power system.
- The IES modelling considered base, low, and high VCR sensitivity cases to provide information about the trade-off and cost of achieving potentially higher or lower levels of reliability.13 The high VCR value sensitivity that identified a potential reliability standard level of 0.001% expected USE was not considered by the Panel to be a value that appropriately reflects customer willingness to pay for reliability and given the excessive MPCs required to achieve that level.
- The Panel notes the existing interim reliability measure and considers that this level of reliability does not reflect, customer willingness to pay for reliability.
- In addition to considering the form of the reliability standard to account for tail risk, tighter levels of reliability may be better supported by other reliability mechanisms or tools.

The Panel has considered stakeholder submissions to its draft report in developing its final recommendation. Stakeholder views on the Panel's draft report are presented in section 5.3 with the Panel's detailed rationale and considerations presented in section 5.4.

5.3 Summary of draft position and stakeholder views

On 9 June 2022, the Panel published a draft review report which put forward a draft position on the level of the standard for stakeholder feedback.[109] This section presents the Panel's draft position and stakeholder views expressed in submissions to the draft report. The Panel's consideration of stakeholder views is provided in the Panel's rationale for its final recommendation presented in section 5.4.

5.3.1 The Panel's draft position

The Panel did not make an explicit draft recommendation on the level of the standard given its ongoing considerations on the form of the standard. The Panel noted that the IES modelling identified the most efficient base case level of reliability, over the period 1 July

109 Further information may be found at:https://www.aemc.gov.au/market-reviews-advice/2022-reliability-standard-and-settings-review#:~:text=The%20purpose%20of%20the%202022,2025%20to%2030%20June%202028.

2025 to 30 June 2028, which corresponded to 0.0015% expected USE. This modelling did not however reveal a significant benefit from changing the level of the standard from 0.002% to 0.015% expected USE.[110]

The high VCR sensitivity case identified an efficient level of reliability close to 0.001% expected USE however utilised a VCR of close to $100k in each region. The Panel sought stakeholder views on whether this sensitivity realistically reflected consumer willingness to pay for reliability.

The Panel made the following general observations in its draft report:

- Increasing uncertainty associated with a more weather-dependent power system is driving concerns on the level of the standard. In particular, concerns regarding increasing reliability tail risks as the power system transitions.
- The Panel acknowledged these concerns but did not consider tightening the level of the reliability standard beyond efficient levels to be a preferable means of addressing these risks. The Panel considered future amendments to the form of the standard, to specifically speak to tail risk, to be the most appropriate approach to addressing the NEM's changing reliability risk profile.
- The IRM of 0.0006% USE involves significantly higher costs than the efficient level when assessed using the base case customer average weighted VCR. The high VCR case however indicates a potentially efficient level of reliability which is close to 0.001%.

5.3.2 Stakeholder views on the Panel's draft position

Stakeholders overwhelmingly supported maintaining the current level of the standard. These stakeholders did not consider there was a material benefit to changing the level of the standard from 0.002% expected USE.[111] In expressing this view, several stakeholders noted that the AER's VCR values had not increased materially since 2014 and considered this evidence that the value consumers place on reliability has not changed in the period.[112] There was no stakeholder support for a higher reliability standard.

No stakeholders who commented in their submissions supported the Panel utilising the high VCR 0.001% sensitivity as the reliability standard. AEC, Iberdrola, and AGL did not consider the high VCR sensitivity indicated consumer willingness to pay for reliability.[113] AGL noted that VCR values of this magnitude are underpinned by the notion that consumers would prefer long-duration reliability events rather than a short event which they considered to be untrue in practice.[114]

110 IES's modelling for the draft report indicated an 0.2% reduction in total system cost, or approximately $10 million a year would be achieved by shifting from 0.002% to 0.0015% expected USE. Further discussion is provided in section 4.4.1.

111 Submissions to the draft report: AEC, p. 2; Energy Australia, p. 1; EUAA, p. 3; Snowy Hydro, p. 2; Alinta, p. 1; Iberdrola, p. 2; Origin, p. 1; PIAC, p. 1; AGL, p. 2; Shell, p. 2.

112 Submissions to the draft report: PIAC, p. 1; Shell, p. 2.

113 Submissions to the draft report: AEC, p. 2; Iberdrola, p. 2; AGL, p. 2.

114 AGL, submission to the draft report, p. 2.

Two submissions supported tightening the standard as a means of addressing tail risk prior to a reformed form of the standard being implemented.[115] AEMO considered the Panel should incorporate tail risk in the standard in some way, even if this is simply lowering the allowable USE standard from 0.002% as an interim measure.[116] In contrast, Origin and Iberdrola considered it is better to account for potential future changes in the NEM through changes to the form of the reliability standard, rather than tightening beyond what is the most efficient reliability level.[117]

5.4 Panel considerations supporting its final recommendation

Consistent with the NER, Guidelines, and Assessment Framework, this section sets out the following detailed considerations supporting the Panel's final recommendation:

- The benefits of tightening the level of the reliability standard are insufficiently material to justify the change.
- The high-VCR scenario does not reasonably reflect consumer willingness to pay, and
- Addressing tail risk is more appropriately achieved by changing the form of the standard post-2028.

5.4.1 The benefits of tightening the level of the reliability standard are insufficiently material to justify the change

The Panel does not consider a material benefit would be achieved by adjusting the level of the standard, expressed as a percentage of expected USE, from its current level to the lowest cost level of 0.0015% identified in the modelling performed by IES for the review.

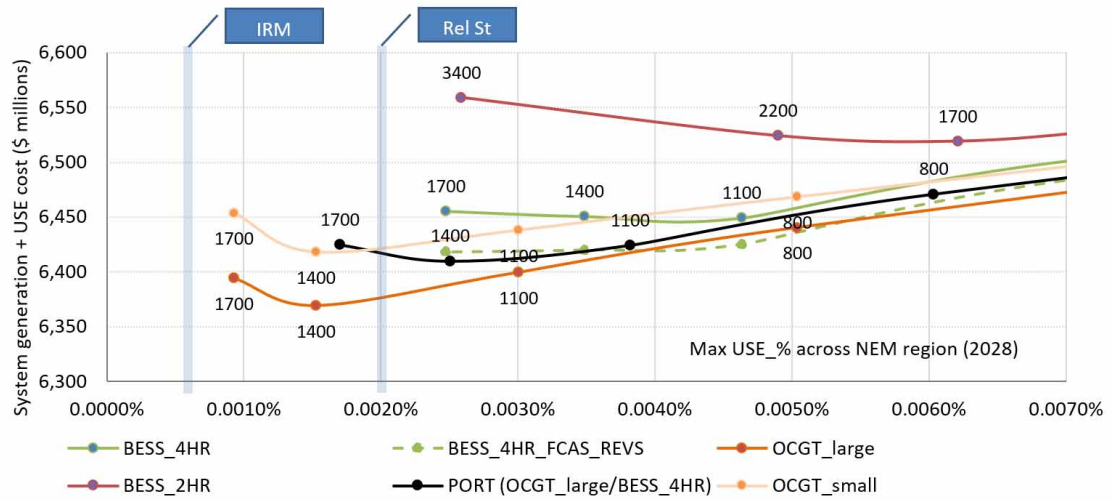
In order for there to be a material benefit, the Panel would need to consider existing arrangements are clearly misaligned with consumer willingness to pay for reliability. The Panel does not consider existing arrangements are sufficiently misaligned for a change in the level of the standard to 0.0015% to advance the NEO in a materially better way.

The Panel notes that the difference between 0.002% and 0.0015% expected USE on the lowest cost OCGT new entrant line in Figure 5.2, represents less than a 0.2% reduction in total system cost. This roughly indicates a $10 million a year benefit from adjusting the level of the reliability standard to 0.0015% expected USE.

The Panel considers this benefit 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. This is consistent with the Panel's RSS review guideline requirement to provide regulatory stability and flexibility.

115 Submissions to the draft report: AEMO, p. 2; Hydro Tasmania, p. 6.
116 AEMO, submission to the draft report, p. 2.
117 Submissions to the draft report: Iberdrola, p. 2; Origin, p. 1.

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.

5.4.2 The high-VCR scenario does not reasonably reflect consumer willingness to pay for reliability

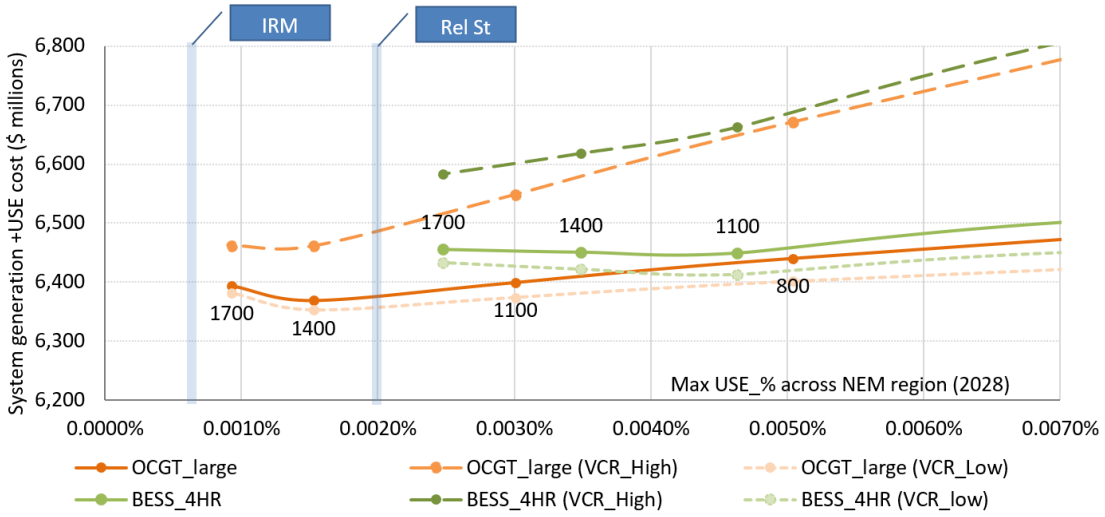
The Panel's high VCR case identified 0.001% expected USE as the most efficient level of reliability. This outcome was achieved under a high case VCR of around $100k/MWh in each jurisdiction of the NEM. The Panel's final recommendation is that this does not reasonably reflect consumer willingness to pay for reliability.[118]

As outlined above, the Panel notes no stakeholders who provided submissions supported the Panel utilising the high VCR 0.001% reliability sensitivity as the reliability standard.[119]

118 The modelling indicates that achieving an IRM level of reliability, relative to 0.002% evaluated using the base case VCR is likely to be in the order of $100 million a year.

119 Submissions to the draft report: AEC, p. 2; Iberdrola, p. 2; AGL, p. 2.

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 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 Panel understands there is no single VCR that accurately captures all consumer values placed on reliability. Different actual VCR values exist for residential versus business customers, and for different climate zones where these are linked to volumetric energy consumption.[120] The Panel considers that while there are likely to be some end users who have a VCR of $100k/MWh, this figure doesn't represent a reasonable mean population value appropriate for determining a single standard that applies to all customers.[121]

The Panel has considered whether there have been changes in how customers value a reliable supply of electricity since the last RSS review in 2018. In particular due to issues including:

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

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

121 The Panel 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 duration. This is because the VCR is a per energy value rather than a per outage value. Further information on the re-weighting of customer VCR to produce the high and low VCR sensitivities is provided in Appendix A.1.

- 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.

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 not consider there to be sufficient information available on the impact of issues, such as those listed above, to robustly incorporate in an assessment of the efficient level of the standard in advance of assessment in the AER's next round VCR update.

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 and that a 100k VCR does not represent a reasonable measure of customer population willingness to pay. The Panel notes that the practice of rotational load shedding in the NEM, which excludes critical loads and central business districts, focuses reliability-related outages on residential and light commercial/industrial customers. As these customers have a generally lower VCR, the base-case AER load-weighted jurisdictional VCRs are potentially conservatively high as they capture all load types including those excluded from rotational load-shedding on the basis of their VCR.

The interim reliability measure is not a suitable NEM reliability standard

The Panel's analysis indicates the IRM, at 0.0006% expected USE, is significantly tighter than a level of reliability consistent with consumer willingness to pay for reliability. The Panel, therefore, does not consider the IRM is a suitable level for the NEM reliability standard. The Panel has formed this view as:

- The Panel does not consider a $100k VCR to be a reasonable measure of customer willingness to pay for reliability. The 0.001% standard indicated by the $100k VCR is still significantly looser than a 0.0006% standard.
- As further discussed in Section 4.4.3, a reliability standard set at 0.0006% expected USE would require a significantly higher MPC. The MPC required for a 0.0006% expected USE standard is likely to be above a reasonable estimate of customer VCR and inconsistent with maintaining an appropriate level of systemic financial risk in the NEM. Levels of reliability tighter than 0.002% may be better supported by other reliability mechanisms/tools than through the market price settings.
- As discussed in Chapter 4, changing the form of the standard to reflect the changing reliability risk profile is a more preferable way to manage tail risk rather than tightening the standard.

5.4.3 Changing the form of the standard is a preferable solution to manage tail risk.

As outlined above, the Panel prefers amending the form of the reliability standard to address the changing power system reliability risk profile given market transition, and greater tail risk.

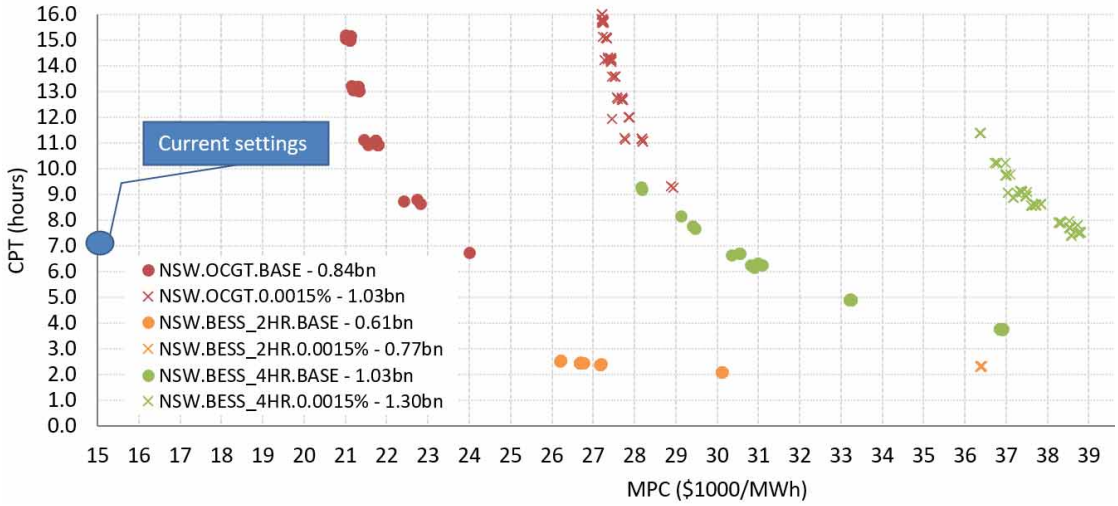
The Panel has not tightened the standard in the interim to address any tail risk concerns. The Panel has elected not to amend the standard in this way, preferring to retain the existing standard level of 0.002% expected USE for this review period.

The Panel's reasoning is because:

- Its low VRE case, presented in Chapter 3, indicates that reliability-related tail risk concerns are unlikely to become material until the additional thermal generation is replaced with VRE post-2028.
- Tightening the reliability standard as a means of managing tail risk may be less efficient.
- Significantly higher MPCs are likely required to achieve a tighter standard.

Tightening the general reliability standard as a means of addressing tail risk would require market price settings to be determined on the basis of a tighter standard. The MPC is sensitive to higher levels of reliability as a progressively shorter duration of USE is targeted by a higher level of the standard. Figure 5.4 presents IES's assessment of MPC/CPT that would be required to achieve reliability outcomes consistent with a reliability standard of 0.0015% expected USE. It can be seen that the efficient frontiers for NSW OCGT and two and four-hour batteries indicate an MPC would be required that is approximately $7,000 higher than under the existing standard.

Figure 5.4: MPC/CPT implications of a tighter reliability standard



Source: IES

The Panel also questions whether achieving higher levels of reliability through the market price settings is practical given the progressively higher risk and uncertainty involved. As discussed in Chapter 6, any increase in reliability beyond 0.002%, may need to be supported by complementary reliability mechanisms and tools.

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

BOX 6: FINAL RECOMMENDATION ON THE MARKET PRICE CAP (MPC) AND CUMULATIVE PRICE THRESHOLD (CPT)

The Panel's final recommendation is for a progressive adjustment in the level of the MPC and CPT to achieve an MPC of $21,500/MWh and a CPT of $2,193,000 (corresponding to 8.5 hours of market prices at the recommended MPC) (in $2021) by the end of the review period. The Panel has recommended the progressive annual changes, to achieve the recommended level by the end of the review period.

The final recommendation has been made on the basis that:

- material benefit will be achieved relative to outcomes under existing arrangements as indicated by the IES modelling outcomes for this review
- the final recommendation aims to provide as gradual a change in the MPC while also achieving levels identified by modelling as necessary to support reliability outcomes consistent with the standard,
- the value of increasing demand response (DR) participation was taken into account to the extent possible.
- incentives for storage investment are incrementally improved
- contract markets impacts and systemic risk is minimised, and
- the impact on electricity costs is minimised to the level required to support reliability.

According to the Panel's modelling, this increase is the minimum level required to support investment in generation, storage and demand response needed to avoid exceeding the reliability standard in light of thermal generator retirements after 30 June 2028.

The Panel has given particular consideration to consumer concerns about increasing MPC/CPT and also increasing electricity costs. The final recommendation seeks to limit end-user bill impacts to the minimum level possible while still supporting future outcomes consistent with the reliability standard. Modelling indicates consumer bill cost increases to be around 3% from its final recommendation. This increase will be spread over a three-year period from 1 July 2025 to 30 June 2028.

The majority of the Panel considers the final recommendation was justified given the value of the benefit realised by consumers from enhanced future reliability outcomes as indicated by the detailed modelling performed for the review. The two Panel members representing consumers, however, do not consider an increase to the MPC or CPT is needed, on the basis that they considered the:

- reliability standard is unlikely to be exceeded during the review period
- financial impact and risk for some retailers and spot-exposed customers may be too high
- modelling assumes limited volumes of demand response are available under the existing price cap which does not reflect anticipated changes to the Wholesale Demand Response Mechanism, and
- The modelling does not include revenue from jurisdictional schemes, such as the NSW Electricity Infrastructure Roadmap when calculating the MPC and CPT required to support marginal new entrants.

The Panel notes additional MPC/CPT increases in future review periods may be required to sufficiently incentivise investment consistent with the reliability standard in all NEM regions, and investment in the storage required to manage reliability risk in a high VRE power system. The Panel's final recommendation for this review period, therefore, may represents a first step in a longer-term adjustment.

The Panel considers prospective future increases in MPC, beyond the level recommended in this report and in future reviews may warrant consideration of potential complementary measures. In particular, where complementary measures provide investment support necessary to support reliability in a high VRE power system while avoiding systemic risk challenges and MPC that approach the VCR. The Panel considers such mechanisms should enhance the scope and performance of the market rather than replace it and promote the long term interests of consumers.

The MPC and CPT share a common purpose. They protect the long-term integrity of the market by limiting financial exposure to unbounded high prices. Their impact on new investment in capacity is also connected as the MPC and CPT together determine the market revenue potential available to support new entrant investment. The Panel has therefore considered them together when assessing the trade-off between incentivising efficient operation and investment and managing overall market exposure to price risk.

This chapter presents the Panel's final recommendation on the level of the MPC and CPT. The Panel's rationale for its final recommendation is also presented. This chapter specifically:

- introduces the guideline and NER requirements applying to the Panel's final recommendation
- presents the Panel's final recommendation with a summary of reasons
- presents stakeholder submissions on the Panel's draft report and positions
- sets out the rationale for the Panel's final recommendation
- outlines transitional arrangements, and
- provides observations on the use of complementary reliability tools and mechanisms.

6.1 Introduction

This section introduces the MPC and CPT's objectives and role in supporting reliability outcomes consistent with the standard. NER, and guideline requirements applying to the Panel's consideration of both are also presented.

6.1.1 Role of the MPC and CPT

The MPC and CPT are set at levels that are sufficiently high to support the investment required to achieve reliability outcomes consistent with the standard, but not too high to create systemic financial risks that may compromise the stability of the market.

The MPC places an upper limit on wholesale market prices that can be reached in any trading interval. It serves as a limit on customer bids, preventing them from paying more than a set amount for energy in any dispatch interval. The value of the MPC is specified in the NER and is currently set at $15,500/MWh.[122] The MPC serves two functions which are:[123]

- 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 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 $1,398,100 for the period 1 July 2022 to 30 June 2023.[124] This value represents the cumulative financial impact of 7.5 hours of market prices at the existing MPC. [125]

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

- 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 Relationship between the CPT and MPC

The level of the CPT and MPC are related from an investment perspective. They together determine the extent to which market revenue is sufficient to financially incentivise new entrant investment consistent with achieving the standard.

A higher MPC without a corresponding increase in the CPT requires fewer MPC periods prior to the CPT being breached and administered pricing applied. This means fewer high price periods from which peaking / low capacity generators can recover their revenue requirements. Previous RSS reviews have managed this relationship by maintaining the ratio

122 Australian Energy Market Commission, *Schedule of reliability settings*, 24 February 2022, p.1, Sydney.

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

124 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.

125 Australian Energy Market Commission, *Schedule of reliability settings*, 24 February 2022, p.1, Sydney.

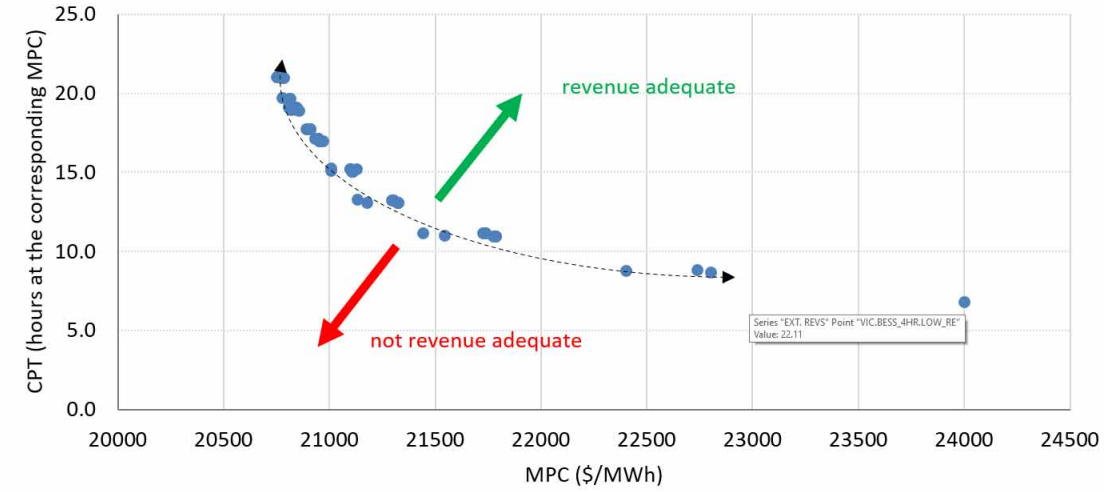
between the MPC and CPT at a constant level where the CPT represents 7.5 hours of market prices at the MPC.

The Panel has explicitly considered the relationship between the CPT and MPC in its modelling. IES's modelling for the review (discussed further in Chapter three) co-optimised the level of the MPC and CPT when identifying the combinations that provide new entrant revenue sufficiency while also minimise total market costs.[126]

IES's co-optimised modelling allowed an efficient frontier of MPC/CPT combinations to be identified. This efficient frontier describes the set of MPC/CPT combinations that just cover marginal new entrant capital and operating costs given the distribution of USE and patterns of generator dispatch.[127]

Figure 6.1 illustrates this concept by showing the efficient frontier of MPC/CPT combinations for a NSW OCGT marginal new entrant. MPC/CPT combinations that lie above the frontier provide revenue that exceeds the amount required for the new entrant technology (in this case OCGT) to recover its costs. Conversely, settings that lie below this frontier do not provide sufficient market revenue potential to support investment in the new entrant technology. The efficient MPC and CPT combination, therefore, lies on, or close to, this line.

Figure 6.1: Example efficient frontier showing the relationship between the 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

126 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 level of the standard efficiency question (productive efficiency) as it is directly assessing the impact of the market price settings.

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

whether a specific MPC/CPT combination provides sufficient market revenue potential to support one or more marginal new entrant 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 technologies. The key marginal new entrant technologies were OCGT and 2 and 4-hour battery for NSW and VIC.[128] Further details on the Panel's use of the efficient frontiers in making its final recommendation are provided in Section 6.4. Additional details on the modelling approach is provided in Chapter 3 and IES's supporting final report.

6.1.3 Requirements in setting the MPC and CPT

The NER and 2021 RSS review guidelines ('guidelines') set out a number of requirements that the Panel must consider when recommending a level for the MPC and CPT.

The NER states that the Panel can only recommend an MPC and CPT that the Panel considers will, among other things:[129]

- allow the 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 standard to be satisfied without the use of AEMO's powers to intervene prevents the Panel from placing any reliance on RERT, or AEMO directions for reliability, to achieve outcomes consistent with the standard.

In addition, the guidelines provide that, when assessing the level of the MPC, the Panel will also consider the following principles:[130]

- 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, and
- 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 guidelines require the Panel to consider the following principles. The CPT should:[131]

- 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
- not impede the ability of the market to determine price signals for efficient operation and investment in energy services, and

128 IES modelled OCGT costs using AEMO's ISP large OCGT option.

129 NER clause 3.9.3A(f).

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

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

- be determined by giving consideration to the level of the MPC.

The Panel's consideration of these factors in coming to its final recommendation set out in Section 1.2.

6.2 Final recommendation

The Panel's final recommendation is for a progressive adjustment in the level of the MPC and CPT to achieve an **MPC of $21,500/MWh** and a **CPT of $2,193,000** (corresponding to 8.5 hours of market prices at the recommended MPC) (in $2021) by the final year of the review period.

The Panel considers this recommendation will enable the market to achieve and send efficient price signals, and support the efficient operation of, and investment in electricity services over the long run, while also limiting market participant exposure to price risk.

The Panel's final recommendation is for three annual changes to transition from the current MPC and CPT to the recommended level by FY 2028. The recommended annual changes are as set out in Table 6.1 below.

Table 6.1: Recommended MPC/CPT transition pathway

	1 JULY 2025	1 JULY 2026	1 JULY 2027
MPC	$17,500/MWh	$19,500/MWh	$21,500/MWh
CPT	$1,575,000	$1,872,000	$2,193,000
CPT hours at MPC	7.5	8	8.5

Source: Note all figures are in 2021 dollars.

The Panel's final recommendation is made in the context of a power system in transition, in particular the magnitude of thermal generator retirements possible in the next review period, and the likelihood of a material reliability gap, in making this recommendation. The incumbent thermal generation fleet is retiring and being replaced with variable renewable generation complemented by storage and other flexible resources. The Panel's final recommendation, in respect of the review period 1 July 2025 to 30 June 2028, should be interpreted as the first step in a longer-term adjustment in the market prices settings to achieve MPC/CPT that are sufficient to incentivise:

- investment consistent with the reliability standard in all NEM regions, and
- investment in the storage required to manage reliability risk in a high VRE power system.

The Panel's final recommendation provides an incremental step toward these goals which will require an additional change in future RSS review periods. The Panel has minimised the magnitude of the recommended change in this review period with the intent of providing as gradual a transition as possible while also achieving the levels necessary to support reliability outcomes consistent with reliability. [132]

132 Refer to IES final report published with this report.

According to the Panel's modelling, the proposed increase is the minimum level required to support investment in generation, storage and demand response needed to avoid exceeding the reliability standard in light of thermal generator retirements after 30 June 2028.[133]

In forming its recommendation, the Panel has given particular consideration to consumer concerns about increases in electricity costs. The Panel has sought to minimise the extent of change in this review period and the modelling indicates that consumer bill increases to be around 3 per cent from its final recommendation.[134] This increase will be spread over a three-year period from 1 July 2025 to 30 June 2028. The Panel notes that end-user consumer costs are primarily driven by average price outcomes rather than peak prices influenced by the MPC. Recent cost increases have been driven by large increases in international fuel prices, which feed into average market prices, rather than peak market prices due to the level of the MPC. Peak market prices however incentivise investment (and thereby increases competition) are likely to produce lower future average prices than would have otherwise been the case.

The majority of the Panel considers the increase in the MPC/CPT was justified given the value of the benefit realised by consumers from enhanced future reliability outcomes as indicated by the detailed modelling performed for the review. The two Panel members representing consumers, however, do not consider an increase to the MPC or CPT is needed, on the basis that they considered the:

- reliability standard is unlikely to be exceeded during the review period
- financial impact and risk for some retailers and spot-exposed customers may be too high
- modelling assumes limited volumes of demand response are available under the existing price cap which does not reflect anticipated changes to the Wholesale Demand Response Mechanism[135], and
- The modelling does not include revenue from jurisdictional schemes, such as the NSW Electricity Infrastructure Roadmap when calculating the MPC and CPT required to support marginal new entrants.

The final recommendation is based on that:

- a material benefit will be achieved relative to outcomes under existing arrangements as indicated by the IES modelling outcomes
- the final recommendation aims to provide as gradual a change in the MPC while also achieving levels identified by modelling as necessary to support reliability outcomes consistent with the standard, according to the Panel's modelling
- the value of increasing demand response (DR) participation was taken into account to the extent possible.[136]

133 Any potential delays in key investments such as delay in Snowy 2.0 will further increase near-term investment requirements.

134 This was calculated based on a representative retail bill as determined in the AEMC 2021 retail competition review. Commercial and Industrial customers are likely to experience a different bill impact given their characteristic load shapes.

135 https://aemo.com.au/en/initiatives/trials-and-initiatives/wholesale-demand-response-mechanism

136 In the absence of certainty for the expansion of eligibility and baselining options for AEMO's Wholesale Demand Response Mechanism, it is difficult for the Panel to assume a material increase in the uptake of demand response under the current MPC.

- incentives for storage investment are incrementally improved
- contract markets impacts and systemic risk is minimised, and
- the impact on electricity costs is minimised to the level required to support reliability.

Further detail on the Panel's rationale in each of these areas is provided in Section 6.4.

6.3 Summary of draft position and stakeholder views

On 9 June 2022, the Panel published a draft review report which put forward a draft position on the level of the MPC and CPT for stakeholder feedback.[137] This section presents the Panel's draft position and stakeholder views expressed in submissions to the draft report. The Panel's consideration of stakeholder views is outlined in the Panel's rationale for its final recommendation presented in Section 6.4.

6.3.1 Panel's draft position

The Panel did not make a recommendation in its draft report on a specific level for the MPC and CPT but instead identified ranges for stakeholder feedback within which it intended to make its final recommendation.

The Panel's draft position however noted that IES's modelling identified a materially significant misalignment between the existing MPC/CPT and the MPC/CPT IES considered was required to provide investment consistent with the standard over the period 1 July 2025 to 30 June 2028.

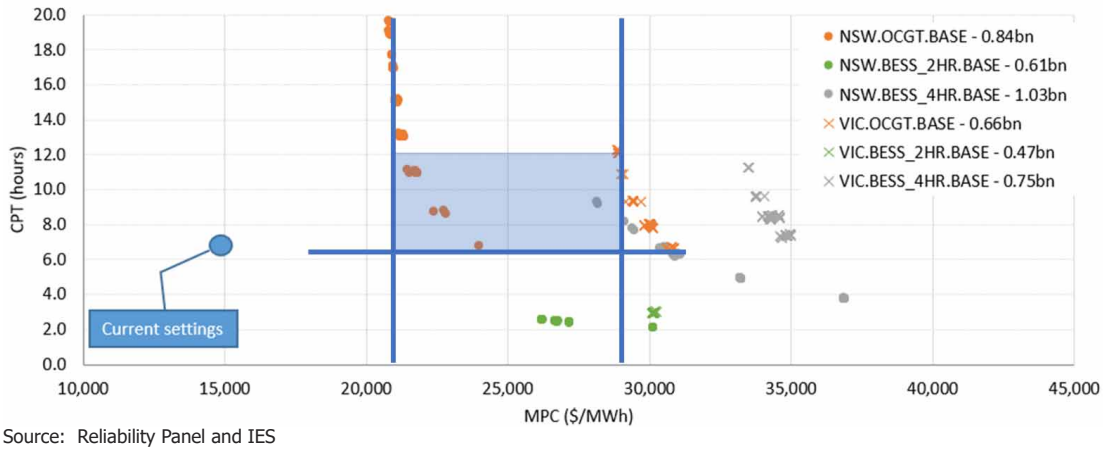
The MPC and CPT ranges identified in the Panel's draft report were.

- **MPC** (2021$)**:** $21,000/MWh to $29,000/MWh
- **CPT** (2021$): $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's draft CPT and MPC ranges, are indicated in Figure 6.2 along with the NSW and VIC new entrant OCGT and battery storage efficient frontiers.

137 Further information may be found at:https://www.aemc.gov.au/market-reviews-advice/2022-reliability-standard-and-settings-review#:~:text=The%20purpose%20of%20the%202022,2025%20to%2030%20June%202028.

Figure 6.2: Panel's draft position MPC and CPT ranges



Source: Reliability Panel and IES

6.3.2 Stakeholder submissions

The following stakeholder submissions were received on the Panel's draft position. All stakeholder submissions are available on the RSS review project page at: https://www.aemc.gov.au/market-reviews-advice/2022-reliability-standard-and-settings-review

Stakeholders generally supported an increase in the level of the MPC to increase financial support for new entrant investment.[138] Of the stakeholders who supported an increase in the MPC, a number explicitly supported a final recommendation within the range proposed by the Panel although AEMO considered the Panel's range appeared on the high side.[139] Snowy Hydro's submission considered an MPC of $22,500/MWh was sufficient to incentivise additional investment in dispatchable capacity.[140]

A number of stakeholders however considered the Panel should recommend an MPC at the lower end of the range identified in the Panel's draft report.[141]

A number of stakeholders noted the increased level of financial risk from the potential magnitude of MPC increase suggested in the draft report.[142] While Energy Australia and Origin both supported an increase to the MPC, they both questioned whether a large increase in the MPC would increase investment sufficiently to justify the corresponding increase in financial risk.[143]

138 Stakeholder submissions to the draft report: AEMO, p. 10; AEC p. 2; Energy Australia, p. 3; Snowy Hydro, p. 1; Alinta, p. 2; Iberdrola, p. 3; Hydro Tasmania, p. 4; CEC, p. 3; Engie, p. 2; AGL, p. 3.

139 Stakeholder submissions to the draft report: AEMO, p. 10; AEC, p. 2; Engie, p. 2; Snowy Hydro, p. 1; Iberdrola, p. 3.

140 Snowy Hydro, submission to the draft report, p. 1.

141 Submissions to the draft report: Iberdrola, p. 3; Energy Australia, p. 5; CEC, p. 3; Snowy Hydro, p. 1.

142 Submissions to the draft report: Shell Energy, p. 3; Energy Australia, p. 5; Origin Energy, p. 1.

143 Submissions to the draft report: Energy Australia, p. 4; Origin Energy, p.1.

Stakeholders indicated a willingness to increase the CPT with a number suggesting a higher CPT as a means of minimising any increase in the MPC.[144] The CEC questioned whether a much higher CPT allowed the existing MPC to be retained.[145] There was no stakeholder support for decreasing the CPT from its current level. Several stakeholders commented that, at a minimum, its historic 7.5-hour relationship with MPC should be maintained[146] with others suggesting an increase in the CPT, to the top of the Panel's range at 12 hours, subject to not creating unacceptable levels of systemic risk.[147]

Several considered the Panel should recommend an MPC/CPT that is sufficient to incentivise multiple new entrant technologies.[148] The CEC and AEC in particular considered the MPC should be increased to a level sufficient to incentivise investment in storage.[149] PIAC and AEMO both suggested the Panel explicitly include the value of DR in its analysis of the required MPC/CPT.[150]

Two stakeholders commented on the form of the CPT and its relationship to the MPC. Engie considering the CPT should be decoupled from the MPC and set solely at a level that manages systemic risk.[151] CSR and AEC supported the Panel's draft proposal that the design of the CPT is reviewed in detail.[152] The AEC particularly considered any future review of the CPT should be undertaken in the near future.[153]

Two stakeholder submissions opposed any increase in the MPC/CPT. The EUAA considered the MPC shouldn't be raised given the potential for a capacity market to be introduced.[154] CSR did not consider there to be compelling evidence to support increasing the MPC given the jurisdictional support programs in place and the capacity market design process underway.[155]

Several stakeholders commented on transitional arrangements.[156] The CEC encouraged the Panel to carefully consider the rate of any increases in the level of the MPC and CPT noting a rapid increase could exacerbate financial risks for participants. The CEC and Hydro Tasmania however cautioned the Panel to consider the urgency of the need for new investment in considering the speed of transition.[157]

144 Submissions to the draft report: AEMO, p. 10; CEC, p. 3; Iberdrola, p. 3; Snowy Hydro, p. 2.
145 CEC, submission to the draft report, p. 3.
146 Submissions to the draft report: Alinta, p. 4; AEMO, p. 10; Engie, p. 2; Snowy Hydro, p. 2.
147 Submissions to the draft report: AEC, p. 2; Snowy Hydro, p. 2.
148 Submissions to the draft report: AEC, p. 2; Hydro Tasmania, p. 5; CEC, p. 3.
149 Submissions to the draft report: CEC, p. 3; AEC, p. 2.
150 Submissions to the draft report: AEMO, p. 9; PIAC, p. 2.
151 Engie, submission to draft report, p. 3.
152 Submissions to the draft report: AEC, p. 2; CSR, p. 2.
153 AEC, submission to the draft report, p. 2.
154 EUAA, submission to the draft report, p. 2.
155 CSR, submission to the draft report, pp. 1-2.
156 Submissions to the draft report: Energy Australia, p. 3; CEC, p. 4; Hydro Tasmania, p. 4.
157 Ibid

6.4 Panel considerations in making its final recommendation

Consistent with the Assessment Framework, NER, and Guidelines, this section sets out the Panel's rationale for its final recommendation on the basis that:

- material benefit is achieved relative to outcomes under existing arrangements as indicated by the IES modelling outcomes for this review.
- the final recommendation provides as gradual a change in the MPC as possible while also achieving levels necessary to support reliability outcomes consistent with the standard, according to the Panel's modelling
- the value of increasing demand response participation was taken into account to the extent possible
- incentives for storage investment are incrementally improved
- contract markets impacts and systemic risk is minimised, and
- the impact on electricity costs is minimised to the level required to support reliability.

6.4.1 Material benefit from increasing the MPC/CPT in this review period

Consistent with the guidelines, the Panel has recommended a change to the level of the MPC and CPT as it considers there is a material benefit achieved relative to retaining existing arrangements as indicated by the IES modelling. Modelling for the review shows that a significantly higher MPC is necessary to support the investment to achieve the economic level of reliability. The Panel considers its final recommendation will contribute to the achievement of the NEO in a materially better way as its proposed MPC/CPT are likely to significantly improve the alignment of incentives for investment with those needed to achieve the standard.

The modelling performed for the review identified a misalignment between the current MPC/CPT and that required to support investment consistent with achieving the standard. Modelling indicates existing market price settings do not currently provide revenue sufficiency for any marginal new entrant technology in NSW or VIC (as the two regions with reliability outcomes closest to the level of the reliability standard) over the review period. The magnitude of the identified misalignment exceeds the level of uncertainty inherent in the modelling and indicates existing arrangements are inconsistent with achieving the standard.

The Panel's final recommendation is for a progressive increase to achieve the required level by the end of this review period, in anticipation of significant reliability challenges in the next review period. While the review's base case modelling, presented in Chapter three, did not reveal a reliability gap in this review period,[158] the magnitude of possible thermal retirement post-2028 however requires an adjustment in the MPC/CPT. 3,470 MW of thermal coal-fired retirement has already been announced for the next review period with the potential retirement of 6,469 MW under AEMO's ISP step change scenario.[159] An increase in the

158 The Panel notes stakeholder views that consider the likelihood of a reliability gap is larger than that indicated by the Panel's modelling. Hydro Tasmania in particular shared information from their internal modelling which sees a greater risk of USE exceeding the reliability standard than indicated in IES's base case due to higher forced coal outage rates, heightened risk of coal closure, and gas availability assumptions.

159 AEMO, 2022 Integrated system plan, June 2022, Fig 19.

MPC/CPT is therefore required avoid the detrimental impact on electricity consumers of inefficiently high levels of USE in the next review period.

The Panel has noted the weight of stakeholder views recommending an increase in the combined level of the MPC/CPT to sufficiently incentivise new entrant investment in its consideration of the materiality of benefits.[160]

The Panel particularly notes Hydro Tasmania's submission which identified that maintaining the status quo could result in a range of undesirable outcomes, including insufficient incentives for efficient investment in flexible and dispatchable generation and storage assets; a heightened risk of market interventions (including RERT activation, generator directions and market suspensions); and ultimately, a heightened risk of reliability shortfalls across the review period.[161]

The Panel has considered CSR's view that it did not consider the case for a higher MPC/CPT to have been made, and EUAA's view that no increase in the MPC/CPT is required as a capacity market is likely to be implemented. The Panel's terms of reference however require it to recommend market price settings for the current energy-only market design.[162] The Panel was therefore unable to consider any future reliability mechanisms, such as a capacity mechanism, in its final recommendation.[163]

6.4.2 The Panel has minimised the extent of change in this review period

The Panel has carefully considered the modelling, and the trade-off between achieving the most efficient level of the MPC/CPT and its impact on participants in coming to the view that its final recommendation. It considered the increase should be at the lowest end of the range identified in its draft report while still achieving outcomes consistent with the standard. This approach maximises the scope for market participants to adjust to the recommended change and also minimises systemic risk and end-user cost impacts, which are further discussed in sections 6.4.4 and 6.4.5.

The Panel has minimised the extent of change in this review period by:

- Recognising the value of DR participation on the MPC/CPT required to achieve outcomes consistent with the standard
- Providing for a gradual multi-review period transition to levels sufficient to incentivise storage and Victorian new entrants, and
- Providing a progressive adjustment over the review period.

Recognising the value of DR participation on the MPC/CPT required to achieve outcomes consistent with the standard

160 The following stakeholder submissions to the draft report supported increasing the MPC: AEMO, p. 10; AEC p. 2; Energy Australia, p. 3; Snowy Hydro, p. 1; Alinta, p. 2; Iberdrola, p. 3; Hydro Tasmania, p. 4; CEC, p. 3; Engie, p. 2; AGL, p. 3.

161 Hydro Tasmania, submission to the draft report, p. 4.

162 AEMC, Terms of Reference for the Reliability Panel 2022 Reliability standard and settings review, p. 6.

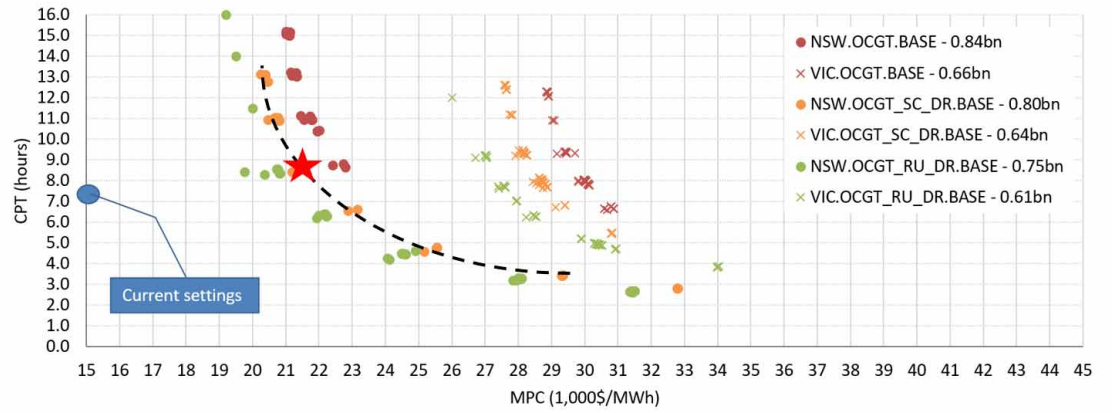
163 Energy Ministers may elect to adjust the market price settings, including the MPC and CPT, as part of any future decision on a capacity market mechanism.

The Panel's final recommendation has had regard to the value of DR. New entrant DR limits the investment that is required to address a reliability gap and can therefore reduce the required MPC from what it would have otherwise been in the absence of any DR. The Panel has particularly noted PIAC and AEMO's submissions to the draft report, both of which suggested the Panel explicitly include DR in its analysis of the required MPC/CPT, in making its final recommendation.[164]

IES modelled the influence of new entrant DR that enters as part of a portfolio with OCGT to identify a composite DR-OCGT efficient frontier. The Panel has adopted the composite DR-OCGT frontier that corresponds to DR volumes consistent with AEMO's ISP step change scenario in making its final recommendation on the level of the MPC/CPT.[165] [166]

Figure X6.3 presents the modelled composite DR-OCGT frontiers along with the baseline OCGT case presented in the Panel's draft report. Two DR-OCGT curves are presented. One accounts for volumes consistent with ISP step change participation curves (orange) with the other representing a high DR uptake case which assumes double ISP step change volumes (green). The Panel's final recommendation is placed on the ISP step change volume DR-OCGT curve and is identified by the red star.

Figure 6.3: Final recommendation on the DR-OCGT efficient frontier



Source: Reliability Panel and IES
Note: The CPT is a dollar value that is expressed in hours at MPC

The MPC is observed to be approximately $1000/MWh less on the step change DR-OCGT frontier relative to the OCGT new entrant frontier. The final recommendation for a $21,500/MWh and CPT at 8.5 hours of MPC, would roughly correspond to a $22,500/MWh and CPT at approximately 9.5-10 hours of MPC on the NSW OCGT curve.

164 Submissions to the draft report: AEMO, p. 9; PIAC, p. 2.

165 AEMO's ISP step change DR participation curves were used to estimate the seasonal volume of DR that would enter given progressively higher MPCs. The MPC required is then reduced to the extent to which this volume of DR reduces the capital and operating costs of marginal new entrant resources.

166 IES's final modelling report provides further details on the participation curves and methods used to model the value of DR in reducing the MPC.

While the costs and characteristics of new entrant DR are uncertain, the Panel considers the entry of low fixed cost DR volumes, consistent with the ISP step change scenario, to represent an appropriately conservative view to include in its final recommendation. The Panel also expects that future market reform, such as two-sided market implementation, and the development of the wholesale demand response mechanism may act to significantly increase DR participation in the NEM. Details of the DR volumes used are provided in the accompanying IES report.

Providing for a gradual multi-review period transition

The Panel's final recommendation for the period 1 July 2025 to 30 June 2028 represents the smallest adjustment possible while still supporting new entrant investment by the end of the review period. The Panel considers this change is a first incremental step in a longer-term adjustment in the market price settings to provide:

- investment consistent with the standard in all NEM regions, and
- sufficient market revenue incentive to support a wider portfolio of new entrant technologies including storage (further discussed in section 6.4.4).

The Panel, in making its final recommendation, considered an excessively rapid change in the MPC would be required to reach the level needed to incentivise Victorian new entrants in this review period. To set the MPC at a level consistent with new entrant OCGT in VIC would require an MPC of approximately $29,000/MWh in which is an increase of $13,500/MWh from current levels and is $7,500/MWh higher than the level required for NSW.[167]

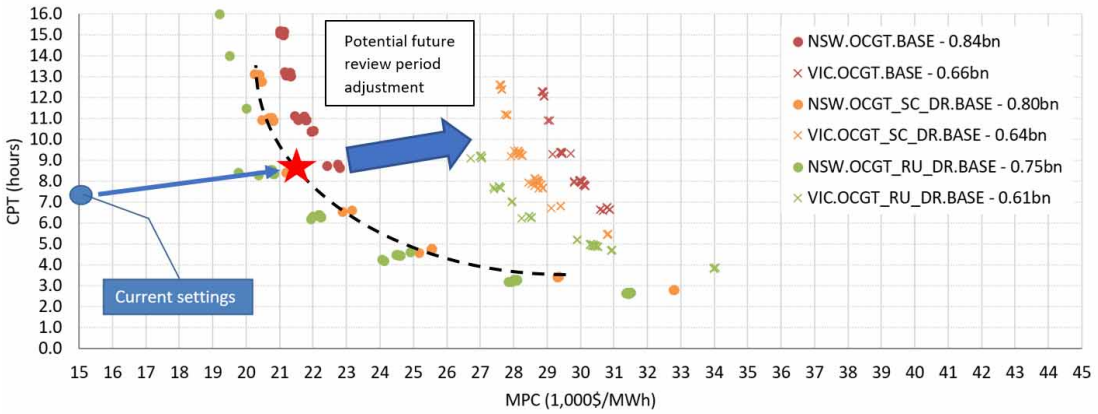
An excessively rapid change in a single review period would not appropriately balance predictability and flexibility and may lead to an increase in potential systemic financial risk (further discussed in Section 6.4.5). The Panel, therefore, considers any further increase in the MPC to achieve levels necessary for Victorian new entrants should occur in a future review period. The extent of change required would be confirmed at the next RSS review commencing in 2026[168].

Figure 6.4 provides context on the recommendation made for this review period and the longer-term adjustment necessary to achieve the levels required for Victoria.

167 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.

168 The next RSS review is to consider the period of 1 July 2028 to 30 June 3032

Figure 6.4: Part 1 and part 2 of the Panel's final recommendation



Source: Reliability Panel and IES
Note: The CPT is a dollar value that is expressed in hours at MPC

A progressive transition pathway over the review period

The Panel's final recommendation provides for as gradual a change as possible by recommending three progressive annual increases in the MPC/CPT. As the base case modelled by IES does not identify a reliability gap in the review period itself, the Panel's final recommendation is to progressively adjust over the three years of the review period to the minimum level required by 2028 in anticipation of the reliability challenges and gap arising in the next review period. This approach will maximise the time available for market participants to adjust.

The Panel notes stakeholder submissions to the issues paper and draft report supported incremental changes to support regulatory certainty and predictability.[169]

The Panel agrees with stakeholders 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 over a period. While recognising that the MPC remains below the level required to support efficient investment for most of the review period, the practical impact of this will be minimal given the absence of a base case reliability gap as expected USE over the review period.[170]

Table 6.2: Recommended transition pathway

	1 JULY 2025	1 JULY 2026	1 JULY 2027
MPC	$17,500/MWh	$19,500/MWh	$21,500/MWh
CPT	$1,575,000	$1,872,000	$2,193,000

169 Submissions to the draft report: Energy Australia, p. 3; CEC, p. 4; Hydro Tasmania, p. 4.

170 The Panel's base case reliability projection, presented in Chapter three, indicates that expected USE in NSW and VIC remains below 0.002% over the review period.

	1 JULY 2025	1 JULY 2026	1 JULY 2027
CPT hours at MPC	7.5	8	8.5

Source: Note all figures are in 2021 dollars.

6.4.3 Incentives for storage investment are incrementally improved

The Panel's final recommendation incrementally improves energy market incentives for storage investment and is a step toward an MPC and CPT that sufficiently incentivises storage investments.

In developing its final recommendation, the Panel has considered stakeholder views that recommended an MPC/CPT that is sufficient to incentivise multiple new entrant technologies in particular storage.[171]

The Panel considers market price settings should adjust over time to a level sufficient to incentivise storage investment of appropriate duration. It considers this particularly important as the NEM transitions from being a capacity-limited thermal power system to high VRE penetrations with reliability supported in part by storage of sufficient duration.[172]

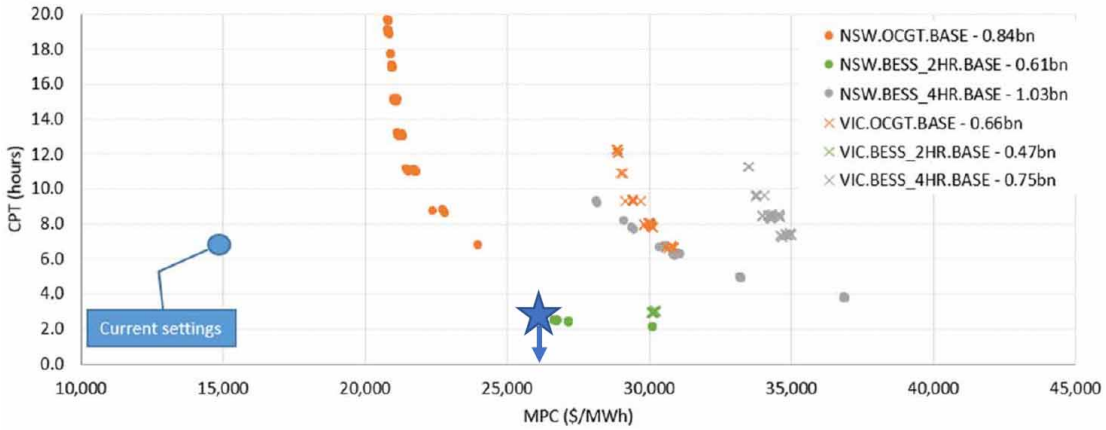
The Panel has however elected to minimise the extent of change over this review period to balance regulatory predictability and flexibility in the interest of achieving a gradual transition over the longer term. Further increases to sufficiently incentivise storage investment from market revenues will be considered in a future RSS review.

IES's modelling indicated an MPC of approximately $26,000/MWh would be required to provide sufficient energy market revenue to support 2-hour battery investment as the most competitive new entrant storage technology. The Panel however did not consider the reliability benefits provided by 2-hour storage to justify an increase in the MPC from current levels to $26,000/MWh over a single review period.

171 Submissions to the draft report: AEC, p. 2; Hydro Tasmania, p. 5; CEC, p. 3.

172 Incrementally improved incentives for longer duration storage may assist investment that limits undue reliance on gas investment in some regions given any possible future gas availability issues.

Figure 6.5: MPC required to incentivise 2-hour storage investment



Source: Reliability Panel and IES
Note: The CPT is a dollar value that is expressed in hours at MPC

The Panel's final recommendation does however take a step towards incentivising additional supply side resources including longer duration storage. The final recommendation is for an increase in the CPT (from 7.5 to 8.5 hours of market prices at MPC) to incrementally assist the investment case for longer duration storage. The Panel considers this increase to incrementally support longer duration storage investments required to manage emerging reliability risks from low VRE events.

The Panel does not consider its final recommendation MPC/CPT will act as a barrier to the entry of additional storage resources in the NEM. The Panel notes that battery storage investments are heavily supported by FCAS revenues and likely to be above the conservative assumptions used in the review's modelling.[173] The Panel also notes that there is a significant level of jurisdictional support for larger-scale storage investments, through schemes such as the NSW Roadmap. Small end-user storage investments, which participate in the market via a VPP, are also often justified for reasons other than energy market revenue potential.

6.4.4 Contract market outcomes and systemic risk 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."[174] The Panel has made its final recommendation on the basis that contract market outcomes are likely to be improved and systemic risk will not threaten the overall integrity of the market.

Contract market impacts

173 Review modelling assumed historic FCAS revenues 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. This is a conservative assumption that may significantly underestimate actual FCAS revenues.

174 Clause 3.9.3A(f)(2) of the NER.

The Panel considers its final recommendation will enhance contract market outcomes supporting reliability and the efficient management of risk in the NEM.

Appropriately priced, liquid contract markets are necessary to provide market participants with the opportunity to efficiently share risk between counter-parties. They also provide a steadier stream of revenue, relevant to merchant exposure, that supports investment and reduces risks to parties financing investment.[175]

The Panel notes Hydro Tasmania's submission to the draft report which 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.[176]

The Panel expects its final recommendation will see higher contract prices thereby enhancing contract market support for new investment. The recommended increase in the MPC and CPT is likely to incentivise buyers of caps and other market customers to hedge more of their retail load than would have otherwise been the case. This will increase demand for risk management products. Conversely, the final recommendation may make sellers more conservative in the number of caps they sell to manage increased financial risk from unplanned outages. The intersection of supply and demand is expected to see contract market prices shift over the long term towards new entrant levels.

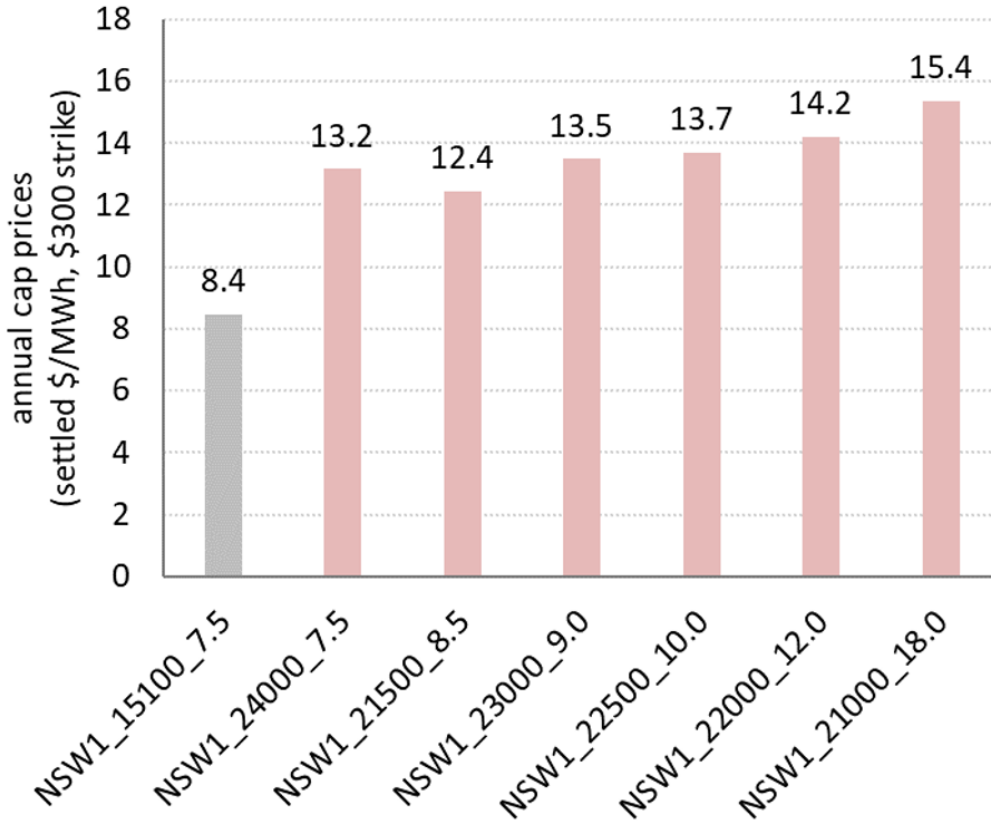
IES modelled the impact on cap settlement prices for a number of different points on the NSW OCGT efficient frontier. These are presented in Figure 6.6 and illustrate an expected increase in cap prices from $8.4/MWh for a $300 cap under current arrangements to $12.4/MWh under the Panel's final recommendation. This increase brings expected cap prices into the range of the 'new entrant price' which is noted in Snowy Hydro's submission to the review's issues paper as being around $13.50/MWh in $2021.[177]

175 This lowers the overall cost of capital relative to merchant exposure thereby facilitating efficient investment and risk sharing.

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

177 Snowy Hydro, submission to the issues paper, p. 4.

Figure 6.6: Annual settlement prices for a $300 strike price cap in NSW



Source: IES, note all figures are in 2021 dollars.

Systemic risk considerations

The Panel considers its final recommendation will not create risks that threaten the overall integrity of the market. The Panel notes some stakeholders who supported a higher MPC/CPT were concerned about the potential for increased volatility and systemic price risk should the MPC/CPT be revised substantially higher.[178] The Panel has considered these views in making its final recommendation and does not consider there is likely to be an inherent increase in systemic risk solely from its final recommendation for a higher MPC/CPT.

Any increase in financial risk from a higher MPC/CPT can still be symmetrically shared between generation and customers through physical and financial hedging as generation and load are natural counterparties in an energy-only market. An increase in financial risk, therefore, does not inherently threaten the integrity of the market if incentives are for market participants to remain appropriately hedged.

178 Submissions to the draft report: Shell Energy, p. 3; Energy Australia, p. 5; Origin Energy, p. 1.

As noted above, the Panel's final recommendation increases the incentives for market participants to manage risk through contracting or self-generation. Improved incentives for contracting may discourage some retailers from maximising short-term returns by remaining unhedged and risking failure under adverse conditions. Counter-intuitively, increasing the level of financial risk via a higher MPC/CPT may improve the NEM's systemic risk if it reduces the number of retailers who are materially under or un-hedged and therefore financially vulnerable to a physical or financial shock.

The failure of a single participant doesn't in and of itself give rise to systemic financial risk. Systemic risk and market integrity issues arise when adverse conditions lead to an uncontrolled cascading or industry-wide financial collapse. The Panel has identified three possible sources of increased systemic risk arising from its final recommendation. These are:

- a CPT which is set so high that industry-wide financial losses become unmanageable during extremely adverse conditions
- potential financial stress from an overly rapid increase in MPC/CPT. The market may be systemically more vulnerable to a financial or physical shock that occurs when all market participants are financially adjusting to higher MPC/CPT, and
- the existing systemic risk vulnerabilities associated with the ROLR scheme as identified in the AEMC's NEM financial resilience review may be exacerbated by an increase in the MPC/CPT.[179]

The Panel's final recommendation manages and minimises the potential for systemic risk from these sources by:

- retaining the Panel's historical approach to minimising systemic risk which is to limit the MPC/CPT to the level required to provide for the lowest cost marginal new entrant option.
- limiting the increase in the CPT in this review period. The Panel has balanced its intentions to incentivise storage duration with the potential increase in financial risk faced by retailers in particular.[180]The Panel considers its final recommendation CPT of $2,193,000 (corresponding to 8.5 hours of market prices at the recommended MPC) balances these considerations, and
- the progressive annual increase in the CPT/MPC over the review period will maximise the scope market participants have to progressively adjust and prevent any potential for financial impact from a single large jump.

In regard to the longstanding systemic risk vulnerabilities associated with the ROLR scheme in its current form, the Panel notes the outcome of the Energy Minister's meeting on 12 August 2022 which agreed to reform the ROLR regime in response to the Australian Energy Market Commission's updated review of the regime and market resilience, and to progress

179 A threat to financial stability in the NEM would arise if a large retailer experienced financial distress and triggered the application of the ROLR scheme in its current form. This is because of the additional financial obligations that would be placed on a ROLR if it acquires a large number of customers, which would need to be met in a very short timeframe. If these obligations cannot be met by the ROLR, further failures may occur thereby risking a cascading financial failure. AEMC, NEM Financial Resilience Review, final report, 6 March 2016, p. 7.

180 Retailer views were informally sought to test the Panel's view that its final recommendation CPT would not lead to an undue increase in systemic risk.

the associated legislative amendments.[181] The Panel is therefore confident that the systemic risk vulnerabilities associated with the ROLR scheme will be addressed prior to 1 July 2025.

6.4.5 The impact on electricity costs is minimised to the level required to support reliability

The RSS review guidelines 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.[182]

The Panel has given particular consideration to consumer concerns regarding their concerns about increases to market settings and the impact on customer electricity costs. The Panel recognises the pressure recent electricity cost increases have placed on end customers and has made a final recommendation that seeks to minimise the extent of change in this review period to limit end-user bill impacts as much as possible while still supporting outcomes consistent with the reliability standard.

The Panel has considered the potential increase in electricity purchase costs from its final recommendation increase in the MPC/CPT. IES has performed an analysis that indicates a 3% increase in consumer bill costs from the Panel's final recommendation relative to expected outcomes under the existing MPC/CPT.[183] [184] The majority of the Panel considers the final recommendation is justified given the value of the benefit realised by consumers from enhanced future reliability outcomes assess through the detailed modelling. This increase will also be spread over a three-year period from 1 July 2025 to 30 June 2028.

The Panel notes that recent electricity cost increases are largely due to increases in *average* market prices from elevated international fuel costs due to the Ukraine war rather than peak market prices which would be influenced by the proposed increase in the MPC/CPT. Increasing potential peak market prices supports investment, but has a more limited impact on the short-term average prices which determine consumer electricity costs given they apply for short periods of time.

In this regard, the impact of average and peak market pricing on the level of end-user bill costs is illustrated in Snowy Hydro's submission to the review's issues paper which cited ACCC 2018 Retail Electricity Pricing Inquiry findings that the cost of capacity, influenced by peak market prices, was 2% of wholesale electricity costs in NSW[185]

An increase in the MPC over multiple review periods, as proposed in the Panel's final recommendation, seeks to minimise average electricity prices, and therefore consumer costs in the longer term. Over time, *average* prices, and therefore consumer bill impacts, will be driven towards the level reflecting the least cost-mix of resources that can achieve the

181 Further information is available at: https://www.energy.gov.au/government-priorities/energy-ministers/meetings-and-communiques

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

183 Further information on IES electricity purchase cost assessment can be found in the IES modelling report.

184 The AEMC retail competition review bill structure was used to identify the residential consumer bill impact and incorporated network, green scheme and other bill element, AEMC, 2020 AEMC retail competition review, final report, p. 72. The Panel notes that the impact on commercial and industrial customers is likely to be different given the relative magnitude of the different bill components, and the different commercial and industrial load profiles

185 Snowy Hydro, submission to the issues paper, p. 1.

reliability standard. An increase in the MPC to incentivise a wider portfolio of 'marginal' new entrants, including storage and DR, aims to facilitate investment in the least cost mix of resources and therefore minimise long-term *average* prices and end consumer electricity costs.[186]

As outlined, the majority of the Panel considers the final recommendation for the MPC/CPT was justified given the value of the benefit realised by consumers from enhanced future reliability outcomes assessed through modelling outcomes. The two Panel members representing consumers, however, do not consider an increase to the MPC or CPT is needed, on the basis that they considered the:

- reliability standard is unlikely to be exceeded during the review period
- financial impact and risk for some retailers and spot-exposed customers may be too high
- modelling assumes limited volumes of demand response are available under the existing price cap which does not reflect anticipated changes to the Wholesale Demand Response Mechanism, and
- the modelling does not include revenue from jurisdictional schemes, such as the NSW Electricity Infrastructure Roadmap when calculating the MPC and CPT required to support marginal new entrants.

6.5 Observations on the use of complementary reliability tools/mechanisms

The Panel has conducted this review, and made its final recommendation, in line with its terms of reference which require it to recommend the reliability standard and settings in the context of existing energy-only market arrangements. As a result, the Panel did not consider the work to design a capacity mechanism in the NEM as part of its review.[187]

The Panel has however had some opportunity to reflect on the role of an energy-only market and the use of scarcity pricing as a mechanism for providing an acceptable level of reliability given the investments required to manage reliability in an evolving power system with an evolving risk profile.

The Panel considers the energy-only market framework involves very beneficial incentives for generation fleet performance and DR participation. High levels of price volatility and financial risk are features of an energy-only market and competition in an unconstrained spot market should deliver the least-cost mix of resources to meet the reliability standard. Scarcity pricing creates incentives for investment through periods where peak prices exceed market prices by a very large margin. The financial risk associated with these peak prices then creates an

186 Greater price volatility, provided by an increase in the MPC, sends an investment signal for batteries, hydro, peaking gas and demand-side participation which profit from this volatility and are required to provide reliability in a high VRE power system which will have reduced exposure to international fuel price movements and therefore lower average market prices and consumer cost impacts.

187 The Panel notes the recent changes to ESB's role in the capacity market development project as announced by Energy Ministers in the communique of 12 August 2022. In particular that "Ministers agreed to instruct Senior Officials to propose options for a framework that delivers adequate capacity, ensures orderly transition, and incentives new investment in firm renewable energy to ensure the system can meet peak demand at all times."

incentive for physical investment either directly through physical hedging, or indirectly via financial contracting with other capacity providers.

The Panel is also aware of a number of possible limitations on the use of scarcity pricing to support the investment required to support the investment needed to support reliability in a high VRE power system. In particular issues such as whether:

- market price settings are an appropriate mechanism for signalling risk aversion and management of tail risk under an amended reliability standard (as discussed in Chapter 4)
- the increase in annual revenue variability for a reliable new entrant, given increasing weather dependency, may make investment cases excessively challenging
- a very high CPT, required to incentivise long-duration storage, would not be bankable given it relies on revenues from extremely low probability events, and
- the structure and competition in Australia's contract markets are appropriate and sufficient for market participants to appropriately manage further increases in financial risk from higher scarcity pricing.

The Panel has minimised the magnitude of the recommended change in this review period with the intent of providing as gradual a transition as possible in recognition of end-user and market participant impacts. The Panel's final recommendation provides an incremental step towards an MPC/CPT which provides investment consistent with the reliability standard in all NEM regions, as well as investment in the storage required to manage reliability risk in a high VRE power system. Additional increases in coming review periods will be required to achieve these objectives.

The review's modelling indicates an MPC of above $35,000/MWh may be required to fully incentivise 4-hour storage investments in Victoria.[188] While not explicitly modelled, a significantly higher CPT, in combination with a higher MPC is likely required to incentivise longer duration storage from spot market revenues. The Panel also notes the potential for these future increases may approach the level of the VCR and the limits of consumer willingness to pay.[189]

Stakeholders have questioned whether the very high MPC/CPT settings and associated levels of financial risk necessary to support investments such as long-duration storage are beyond what will be delivered through the energy-only market in the NEM. The Panel has noted Energy Australia and Origin Energy's submission to the draft report who both questioned whether a large increase in the MPC would increase investment sufficiently to justify the corresponding increase in risk in this regard.[190]

The Panel has considered the potential for complementary reliability tools and mechanisms to limit the extent to which future MPC/CPT increases are needed to address investment needs

188 The very high MPCs required for these more capital-intensive investments arise from targeting very short-duration high-priced periods as a key means of recovering their costs.

189 The current AER weighted average regional VCRs are (in $2021: NSW - $43,526/MWh; VIC - $42,586/MWh; QLD - $41,366; SA - $41,366; TAS - $41,366.

190 Submissions to the draft report: Energy Australia, p. 4; Origin Energy, p.1.

in a transitioning power system. The Panel considers a market with very strong scarcity price signals can also include other complementary measures to provide a higher degree of certainty in supporting investments that are critical for maintaining reliability in a transitioning power system. In particular, when those complementary measures are needed to support investment while also avoiding MPCs which create systemic risk challenges and approach the VCR.

The Panel notes, however, that any complementary mechanisms should be efficiently coordinated with market operation and price signals. The presence of such mechanisms should and ideally would enhance the scope and performance of a market rather than replace it and promote the long term interests of consumers.

7 RELIABILITY SETTINGS: ADMINISTERED PRICE CAP

BOX 7: ADMINISTERED PRICE CAP RECOMMENDATION

The final recommendation is to increase the level of the APC from $300/MWh to $500/MWh for the period of 1 July 2025 to 30 June 2028.

The final recommendation was informed by the Panel's requirements, analysis of issues made apparent by the recent administered price period in June 2022, and stakeholder feedback. In its analysis, the Panel also had regard to the greater financial burden a higher APC may have on retailers and consumers and consumers concerns about any increases to settings for the period. On balance, it considered that there was a material benefit to increasing the APC to reduce undue reliance on the compensation regime.

The final recommendation is based on that the proposed change:

- Provides for robust outcomes to possible future high fuel price periods - while the high fuel costs in the recent APP are not typical, the Panel considers that they may be less rare in the future and increasing the APC to $500/MWh should recover the SRMC of most generators in a range of credible scenarios, noting that the APC will likely be rarely imposed and generally in times of unpredictable and extreme circumstances. Additionally, based on actual and forecasts inflation, by July 2025 the APC would be $643/MWh after adjusting it for the Consumer Price Index (CPI).
- Prevents undue reliance on compensation processes - in light of the recent APP where the AEMC has indicated that 24 registered participants have submitted claims, the Panel considers that the increased APC will reduce reliance on the compensation process to a limited number of very high-cost generators during periods of unusually high fuel costs.
- Improves incentives for storage to participate during an APP - during the recent APP, the Panel has heard reports that energy-limited units found the $300/MWh APC did not sufficiently provide incentives to charge and discharge as normal, which resulted in less than optimal utilisation without material intervention from AEMO.
- Enables better management of APP-related consumer costs - raising the APC shifts reduces compensation costs that are passed through to consumers but may increase hedging costs. Minimising the reliance on compensation reduces cost uncertainty for both generators and consumers.

The Panel considered an increase to the level of the APC is justified to reduce undue reliance on the compensation scheme and reduce additional pass-through costs to consumers. However, the two Panel members representing consumers did not consider there is justification for an increase to the APC to the level of $500 at this time on the basis that they considered the cost to consumers of different settings under administered pricing is not yet known, and there may be other tools outside of the scope of this review, that may better promote the interests of consumers.

The view of these Panel members is that once compensation cost outcomes and generator behaviour of the recent APP becomes known, further analysis, consultation and consideration of alternative solutions could be the basis of a subsequent review to ensure that the recommendation remains appropriate.

The Panel noted that several stakeholders suggested changing the form of the APC from a fixed to a dynamic value in recognition of the links between gas and electricity prices. The Panel has recommended not to change the form of the APC for the review period, however, recommends that this be reconsidered in the Panel's follow-up review with consideration of links with the gas APC. This is to ensure it is addressed as the market continues to transition, and there is a sufficient adjustment period if the form does change.

7.1 Introduction and key requirements

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

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

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 SRMC of generators in the NEM
- any compensation claims since the last review
- implications for the contracts market.

Setting the APC requires the Panel to make a trade-off in balancing mitigating the risk of 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 highly desirable that the APC is sufficiently high to minimise the likelihood of triggering significant compensation claims,[191] yet not so high as to contribute to the financial distress of energy purchasers and risk contributing to financial instability in the market during extreme market events.[192]

191 See clause 3.14.6 of the NER.

192 Reliability Panel, *2022 Reliability standard and settings review,* issues paper, 27 January 2022, p.71, Sydney.

In determining whether a material benefit would be realised by changing the level or the form of the APC in this review, the Panel considered 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 APC for the period from 1 July 2025 to 30 June 2028 would clearly outweigh the benefits.

The RSS Review 2021 Guidelines stipulate that, in making its decision, the Panel must 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.[193]

This chapter sets out:

- overview of the recent APP event and current AEMC APC rule change
- the Panel's final recommendation
- key issues and stakeholder views relating to the APC
- the Panel's rationale for the Panel's final recommendation
- implementation.

7.1.1 Overview of the recent APP event

In the APP that occurred between 12 - 14 June 2022, many generators withdrew capacity and AEMO suspended the market on 15 June 2022 after determining it had become impossible to operate. Further detail on the APP event is provided below, and has been used as a primary case study in the Panel's consideration of the level of the APC.

Over the last 12 months, the cost of gas, coal, and liquid fuel prices have increased significantly as a result of geopolitical conflict and local fuel shortages. Reduced available capacity has also driven higher wholesale costs due to higher demand during winter, lower than average wind and solar output, and a large volume of planned and unplanned outages from thermal generators.

These challenging market conditions resulted in a breach of the CPT in QLD on 12 June 2022, and NSW, SA and VIC on 13 June 2022 when the the APC was applied in these NEM regions. The $300/MWh APC was below the marginal cost of many peaking generators in the NEM, which did not incentivise them to make their generation available. Other participants, whose marginal costs may have been lower than the APC also bid unavailable. AEMO considers this may have been because after peaking generators withdrew their capacity, dispatch was then imposed on these units in a cascading effect as most capacity withdrawn was gas fired, and before AEMO can direct, it must dispatch other available resources.[194]

193 Reliability Panel, *Review of the reliability standard and settings guidelines*, final report, 1 July 2021, p.16, Sydney.

194 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: AEMO, p.10.

The increased demand on gas use for power generation at a time of extremely high gas prices was another contributing factor to the challenging market conditions experienced during the APP in June 2022.

Given that many generators withdrew capacity under the APP, AEMO issued manual directions to ensure there was enough supply to meet demand. However, on 15 June 2022, AEMO determined that the spot market had become impossible to operate and suspended the market under its powers in the NER.[195]

Many participants incurred a loss during the APP where their direct and opportunity costs were in excess of $300/MWh. These losses can be recovered through the compensation framework administered by the AEMC.[196] An eligible party may apply for compensation provided that they incurred total costs during the APP that exceed the total revenue they received from the spot market. The AEMC has indicated that 38 cost compensation claims from 23 registered participants have been received, and it has not yet determined the total amount of compensation that will be issued. A significant portion of those compensation claims passed through to retailers will be passed onto their customers, a cost that creates an unhedgeable financial burden (see section 7.4.6).

7.1.2 AEMC rule change on increasing the APC temporarily

In light of the recent APP, on 1 July 2022, Alinta Energy submitted a rule change request to the AEMC seeking to amend the APC to mitigate ongoing threats to the reliable operation of the NEM. The rule change request proposes to increase the APC from $300/MWh to $600/MWh in every NEM region, with a sunset period of 12 months or a suitable period as determined by the AEMC.

The proposed amendment to the APC seeks to ensure normal market operation and settlement during an APP, where prices are reflective of the SRMC of coal and gas generators buying fuels under today's market conditions and dispatch is based on least cost.

Alinta requested that the AEMC consider the proposal as a request for an urgent rule under section 96(1) of the National Electricity Law (NEL) and the AEMC has determined that the proposed rule meets the definition of an urgent rule under section 87 of the NEL. Alinta considers the rule change to be urgent as the current energy challenge on the east coast of Australia has threatened:

- the effective operation and administration of the wholesale electricity market
- the security and reliability of the interconnected system.

The AEMC published a consultation paper on 4 August 2022 and the final determination will be published on 29 September 2022 in line with the expedited timeframe for an urgent rule (pending the outcomes of objections to the use of the expedited process).[197] The

195 See clause 3.14.3(a)(3) of the NER and AEMO's incident report: AEMO, *NEM market suspension and operational challenges in June 2022*, August 2022..

196 There is a separate compensation process for participants affected by directions issued by AEMO which is administered by AEMO in accordance with clause 3.12.2 of the NER.

197 AEMC, *Amending the administered price cap*, consultation paper, 4 August 2022.

implementation of the Panel's final APC recommendation is for 1 July 2025, which follows any potential temporary increase of the APC.

7.2 The Panel's final recommendation

The final recommendation differs from the draft recommendation, which was to retain the existing level of the APC. The final recommendation is to increase the level of the APC to $500/MWh for the period of 1 July 2025 to 30 June 2028. This change was informed by the Panel's requirements, analysis of issues made apparent by the recent administered price period in June 2022[198], and stakeholder feedback.

The majority of the Panel consider the increase to the level of the APC is justified to minimise undue reliance on the compensation scheme and minimise additional pass-through costs to consumers. However, the two Panel members representing consumers do not consider there is justification for an increase to the APC to the level of $500/MWh at this time on the basis that they consider the cost to consumers of different settings under administered pricing is not yet known, and there may be other tools outside of the scope of this review, that may better promote the interests of consumers. The view of these Panel members is that once compensation cost outcomes and generator behaviour of the recent APP becomes known, further analysis, consultation and consideration of alternative solutions could be the basis of a subsequent review to ensure that the recommendation remains appropriate.

More detail on the rationale for the final recommendation is laid out in section 7.4. The final recommendation is for the full increase in the APC to apply over the entire review period.

The Panel has recommended not to change the form of the APC for the review period, however, recommends a floating, or otherwise flexible APC, be considered in the Panel's follow-up review with consideration of links with the gas APC. This is to ensure it is addressed as the market continues to transition, and there is a sufficient adjustment period if the form does change (see section 7.5).

7.3 Stakeholder submissions on the Panel's draft recommendation and positions

The Panel's draft position was that the current level and form of the APC, at $300/MWh, may remain appropriate for the period 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 APC compensation process is available for generators to cover any shortfall in market revenue during an APP and had, so far, been sufficient to recover generators' costs, and
- issues arising from limited incentives for storage or energy-limited resources were considered insufficiently material for the period FY2026 - FY2028 to justify a change.

198 During the APP in June 2022, many peaking generators were not incentivised to make their generation available as their marginal costs exceeded the $300/MWh APC, and AEMO suspended the market as it determined it had become impossible to operate.

Noting the above, the Panel's draft position also signalled its intention 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's draft position was published on 9 June 2022, prior to the APP between 12 - 14 June 2022. Stakeholder submissions on the APC were largely framed in terms of the experience of this APP.

7.3.1 Summary of stakeholder views on the level of the APC

Informed by recent events, most stakeholder submissions did not support the draft position and supported increasing the level of the APC. Reasons included:

- Many stakeholders commented that recent experience demonstrated the current APC was not able to function effectively during the APP as it was lower than the SRMC of generation from OCGTs and resulted in many generators withdrawing capacity.[199] As a result of this experience, Alinta submitted its urgent rule change request to the AEMC.[200]
- Many stakeholders recommended increasing the APC to a level where compensation claims would be minimised and unlikely,[201] to avoid the current situation where the AEMC has indicated that 38 claims from 23 registered participants have been received for the recent APP. AEC noted that at gas prices of $40/GJ, an OCGT would likely be paying approximately $440/MWh just for fuel if sourcing gas from the spot market.[202]
- In response to the Panel's observation in the draft report that current high fuel costs are unlikely to constitute a structural change in fuel prices, Engie noted that the APC is likely to be applied in extreme cases so the structural level of expected future fuel costs is not the benchmark.[203]
- AEC noted that the level of the APC is well below its real value when it was decided in the mid-1990s, and based on actual and forecast inflation, by July 2025 the escalated APC would be $643/MWh after adjusting it for the Consumer Price Index (CPI).[204]
- Some stakeholders highlighted that during the recent APP, the APC did not effectively signal to energy-constrained resources such as batteries, hydro, and some coal plants when their energy would be most valuable, and did not allow the spot market to signal energy storage or load shifting to help meet peak demand.[205]

EUAA recommended no change to the level or form of the APC, with the view that compensation processes sufficiently enable recovery of SRMC, and thermal generators with long-term fuel supply contracts should not earn windfall gains from an increase in the APC.[206]

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199 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: AEC p.2; Alinta p.4; AEMO p.10; Engie p.4; Snowy Hydro p.2; CEC p.5; AGL p.3; Origin p.4; Shell p.3; Iberdrola p.4.

200 AEMC, *Amending the administered price cap*, consultation paper, 4 August 2022.

201 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: AEC, p.3; AGL p.3; Alinta p.4; Origin p.4; SA Department for Energy and Mining p.3.

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

203 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: Engie p.4.

204 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: AEC p.2.

205 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: Engie p.4; Iberdrola p.4.

206 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: EUAA p.2.

7.3.2 Summary of stakeholder views on the form of the APC

Most stakeholders that recommended increasing the value of the APC also recommended the Panel consider changing its form from a fixed to dynamic value. Suggestions included:

- Indexing the APC to the cost of fuel, e.g. the price of diesel and gas.[207] CEC suggested indexation to gas hub prices on a weekly or more frequent basis, with automatic resets every year by the Panel.[208]
- Origin suggested setting based on the SRMC of a representative (benchmark) OCGT plant with assumed fuel costs equivalent to the APC in the STTM and DWGM.[209] Alinta suggested calculating a base APC using a formulaic approach for a benchmark facility where the level would be indexed at intervals against a fuel input price series, i.e. ACCC LNG netback price series.[210]
- Snowy Hydro suggested multiplying the gas APC by a deemed heat rate for OCGT of 12GJ/MWh = $480/MWh, or the average spot price for the previous 12 months multiplied by five, i.e. at present approximately $630/MWh.[211]
- Iberdrola proposed a mechanism whereby the APC is increased if the marginal unit required to meet demand has an SRMC above $300/MWh, rather than a permanent increase.[212]

7.4 Panel considerations in making its final recommendation

This section goes through the Panel's considerations in making its final recommendation to increase the APC, which are in keeping with the assessment principles outlined in section 2.1. The Panel:

- has identified a material benefit from increasing the APC as indicated by modelling for the review
- considers the new, higher APC:
  - improves financial incentives for generation during an APP with high fuel prices
  - minimises undue reliance on compensation during an APP, and
  - increases incentives for storage.
- considered the relationship between gas and electricity APC, and
- enables better management of APP-related consumer costs.

7.4.1 Material benefit from increasing the APC

Consistent with the 2021 Guidelines, the Panel has recommended a change to the level of the APC that it considers will provide a material benefit relative to retaining existing arrangements and as assessed by the modelling. The Panel considers its final

207 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: AEC p.2.
208 Reliability Panel, *2022 Reliability standard and settings review,* draft paper submissions: CEC p.5.
209 Reliability Panel, 2022 Reliability standard and settings review, draft paper submissions: Origin p.4.
210 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: Alinta p.3.
211 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: Snowy p.2.
212 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: Iberdrola p.4.

recommendation will contribute to the achievement of the NEO for the reasons outlined below.

The Panel is of the view that, while it is mindful of the burden it represents to retailers and consumers, the existing APC does not promote efficient investment in, and efficient operation and use of, electricity services for the long-term interests of consumers. This is largely because it presents an unacceptable risk that undue reliance is placed on compensation, which would ultimately be paid for by consumers in higher levels of unserved energy and through their retailers who are unable to hedge against compensation claims. Large and frequent compensation claims represent a reduction in the reliability that would otherwise be provided by the market via hedging and investment decisions.

The Panel identifies the existing APC at $300/MWh is fundamentally misaligned with the level required to recover the fuel costs of some thermal generators under high gas, and other fuel, price conditions. The events and outcomes during the recent APP demonstrate the degree of misalignment. In particular, the level of generation withdrawn and the consequent market suspension by AEMO when its reliance on directions and compensation caused it to determine that it had become impossible to operate the spot market.[213]

The $300/MWh APC was implemented at a time when Australia's domestic gas market was insulated from international events with little volatility and prices generally set by long-term bilateral gas supply agreements. Australia's gas markets have been linked to international markets since the development of the LNG export industry and are now subject to increased price volatility, driven by international events. Similarly, coal export volumes have dramatically increased, effectively linking domestic coal prices to international markets.[214]

Consequently, the Panel notes that gas supply shortfalls, with consequentially higher price events, may occur in the future and therefore have been considered in its deliberations about the level of the APC. The Australian Competition and Consumer Commission (ACCC) has identified that supply conditions in the east coast market are expected to deteriorate significantly in 2023, with a shortfall of 56 PJ expected.[215] This is equivalent to around 10% of domestic demand and is the largest projected supply shortfall forecasted since the ACCC's Inquiry commenced in 2017. However, the Panel notes that this projected supply shortfall assumes no gas reservation scheme is introduced in eastern Australia.

While geopolitical circumstances have driven the most recent increases in fuel prices, possible domestic supply constraints and other sources of risk may lead to future high fuel prices such that the APC could be set at a level that is sufficiently robust to greater fuel price volatility than has historically been the case.

213 See clause 3.14.3(a)(3) of the NER.

214 Export coal prices from Newcastle have increased to over $400 USD/t in recent months, from historical levels closer to $100 USD/t. This has impacted coal availability to domestic power generators. Extreme rain events in the eastern states have also reduced coal availability to domestic power generators, compounding domestic coal supply issues.

215 ACCC, *Gas supply inquiry 2017 - 2025 interim report,* July 2022, p.8.

7.4.2 Improved financial incentives for generation during an APP with high fuel prices

In reviewing the APC, the Panel is specifically required to consider any significant changes in the typical SRMC of generators in the NEM[216]. The SRMC for thermal generators is a function of fuel costs, which have increased significantly in 2022. The level of the APC needs only to cover the marginal cost faced by the generator in order for the generator to be left financially viable and willing to generate.

Extreme market conditions trigger a CPT and the implementation of an APP involving the application of the APC. The Panel has observed that extreme events in the NEM can be coincident with abnormally high fuel, especially gas, prices. The Panel notes that current high fuel costs are not typical and not necessarily indicative of future costs (as outlined in the draft recommendation). However, the 2021 Guidelines specify that the Panel must consider significant changes in the SRMC of generators, and it is, therefore, necessary to account for the possibility of future APPs coinciding with high fuel costs in determining the level of the APC.

While a $300/MWh APC may provide sufficient incentives for generation when gas prices reflect AEMO annual average gas forecasts, the existing APC does not provide sufficient incentives in a period of tight supply and high thermal fuel prices. The Panel considers that the APC should be set at a level that will recover a reasonable share of fuel costs when fuel costs are unusually high.

During the recent APP in June 2022, spot prices for thermal coal were over $400/MT and spot prices for gas were around $40/GJ.[217] For an OCGT gas-fired plant with a heat rate of around 14 GJ/MWh (HHV), this results in a generation fuel cost of around $560/MWh. The high price of gas coupled with a relatively lower APC was a key driver in many peaking generators withdrawing their capacity.

Results from modelling conducted to inform the RSS review and APC rule change process are presented in Figure 7.1. It shows the capacity of thermal generation with fuel costs and opportunity costs that would exceed the APC at different levels. These results have been modelled using assumed coal costs of $400/MT and gas costs of $40/GJ, which is the current STTM and DWGM APC. These costs represent the fuel costs that prevailed in the recent APP event, and while these costs are not common, the Panel must take into account the possibility of high prices occurring again during future periods of stress which may trigger the CPT and application of the APC.

Figure 7.1 shows that for an APC of $300/MWh, there is 7,000 MW of de-rated thermal capacity that exceeds the APC and therefore requires compensation. As the APC increases, there is a lower level of thermal generation with fuel costs above the APC. At an APC of $800/MWh, all thermal generation have fuel costs and opportunity costs below the APC and there is no need for compensation.

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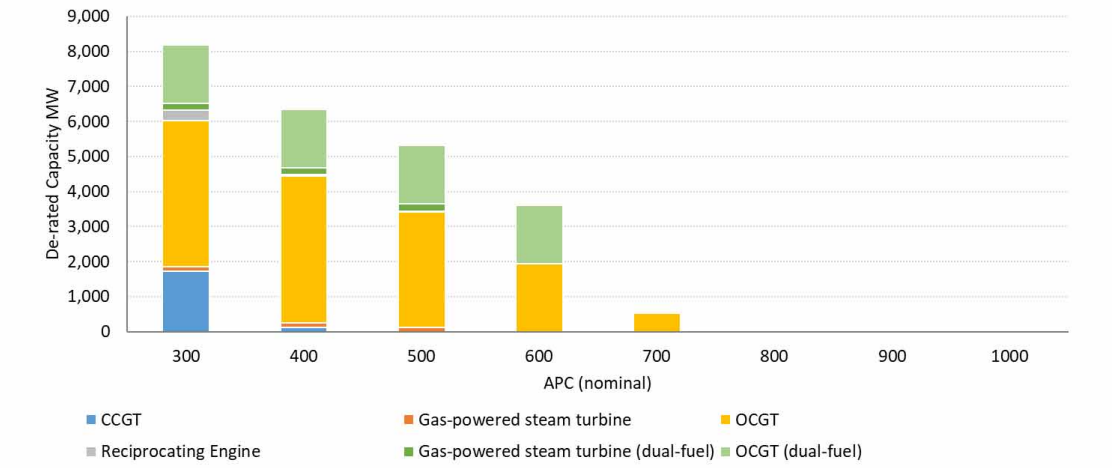
216 In accordance with the NER and review 2021 Guidelines

217 Note that during this period Victorian gas prices had been capped at the wholesale gas APC of $40/GJ and that the underlying gas prices were much higher. It is also worth noting that the Victorian gas APC had been lowered from $80/GJ to $40/GJ in 1 June 2008.

The Panel considers the APC should be set at a level that does not require undue reliance on compensation during an APP in a range of scenarios, including those where extremely high fuel costs apply.[218] At the recommended APC of $500/MWh, there is about 5,000 MW of de-rated thermal capacity that exceeds the APC and requires compensation in a high price scenario.

Figure 7.1: Thermal capacity with fuel costs exceeding APC at different levels



Source: IES

Note: High cost scenario, assuming coal costs $400/MT and gas costs $40/GJ (current STTM and DWGM APC). Total generating capacity of 27,991 MW.

7.4.3 Avoiding undue reliance on compensation during an APP

The Panel recommends an APC of $500/MWh as it reduces reliance on the compensation process to a limited number of high-cost generators during periods of unusually high fuel costs.

Generators can claim compensation for extra costs they incur from generating electricity during an APP if they are higher than the APC. Previous RSS reviews have set the level of the APC to cover the fuel costs of all but a small number of generators that operate in the NEM. The objective has been to prevent *undue* reliance on the compensation regime.

When the draft report was published, there had only been one occasion of a claim for compensation since the start of the NEM, which resulted in $130,486.94 being paid to Synergen Power. Since then, the Panel considers that the recent APP has demonstrated an undue reliance on the compensation process which may result in substantial financial pressure placed on retailers and costs paid by consumers (see section 7.4.6).

The Panel considers that some reliance on compensation is appropriate, however, it is not intended to be used by a large number of participants during an APP and should be called

218 If it is assumed that generators cannot access gas due to supply shortages and must instead run on diesel, then an APC of $900/MWh rather than $800/MWh would be required to cover the fuel costs of all thermal generators with no need for compensation.

upon very rarely. As shown in Figure 7.1, the Panel has identified its final recommended APC of $500/MWh would have limited the proportion of thermal generation fleet that required compensation to about 20% (at gas prices of $40/GJ).

Consideration of improvements to compensation arrangements

In the recent APP, concerns were expressed regarding uncertainty as to how costs would be assessed (particularly opportunity costs). While the Panel considers that increasing the APC to $500/MWh will reduce undue reliance on compensation, it also recognises the need for other improvements to the compensation process that might mitigate participant concerns. This may include:

- greater clarity in the NER and guidelines on the interactions between the APC compensation framework and other compensation mechanisms with some opportunities for streamlining to achieve more consistency and clarity on their various applications and administration.
- increased transparency on the methodology used to define and assess opportunity costs with clear direction on evidentiary requirements.
- greater certainty about the timing of compensation and consideration of the harmonisation of compensation and the NEM prudential framework to avoid cash flow issues.

7.4.4 Increasing incentives for storage

The Panel has heard reports that, during the recent APP, some energy-limited units found it more challenging to schedule their intentions as they normally would, and instead reverted to withholding capacity as an optimal outcome.

Prior to the APP in June 2022, thermal fuel prices had been low enough to ensure that average prices during an APP would have been much lower than the existing APC of $300/MWh. This price spread would have provided sufficient incentives for energy-limited resources to submit bids both in and out of merit order, and operate normally without withholding capacity.

However, during the recent APP, very high thermal fuel prices coupled with the relatively low APC may have made it more difficult for energy-limited resources to operate normally. The Panel considers that increasing the APC to $500/MWh will increase the likelihood that normal bidding of energy-limited resources can continue even if an APP occurs when thermal prices are high.

The Panel also notes that increasing the APC to $500/MWh will result in decreasing the APC floor from -$300/MWh to -$500/MWh, which it considers will not introduce material risks during an APP as it increases the range of prices available to operate energy-limited units.

7.4.5 The relationship between gas and electricity APC

Many stakeholders raised the misalignment between the electricity and gas APC as a contributing factor to the recent market suspension.[219]

The STTM APC is defined as $40/GJ in rule 364 of the NGR. In accordance with rule 492 of the NGR, AEMO must review the STTM APC no later than six months after the completion of an RSS review and recommend a value that should apply to commence two years after the review is completed. The DWGM APC is also currently set at $40/GJ in AEMO's Wholesale Market APC Procedures (Victoria).

Determining the STTM APC via the NGR and DWGM APC via AEMO Procedures is outside of the Panel's remit. However, the Panel recognises that in the future there may be benefit in AEMO reviewing the STTM APC prior to a future RSS review, rather than within six months of its completion.

EUAA recommended that the Panel consider having the responsibility to advise on STTM price settings.[220] AEMO noted that while providing it with the power to increase the APC during an APP may perversely encourage some generators to bid unavailable, it seems odd that it has the power to suspend the market yet no power to adjust the APC.[221]

Additionally, the higher MPC being recommended for the next review period may increase the alignment between gas and electricity price caps, and thereby contribute to reducing market distortions.

7.4.6 Risks to the contract market, retailers and consumers

Some stakeholders noted that changes to the APC will require consideration of the consequential impacts on the contracts markets, retailer risk, and consumer costs.

Stakeholders raised concerns over any increase to the APC and the possibility that a higher APC would impose a greater financial burden on retailers and higher costs for consumers[222]. As noted in the previous chapter, the Panel recognises the substantial financial strain being experienced by residential, commercial and industrial consumers from rising energy costs, and considers that consumer costs and financial instability are likely to be exacerbated by significant cost recovery through the compensation process as opposed to a higher APC. The Panel must also consider the other cause of financial risk and pain to consumers from the potential for higher levels of unserved energy, which could occur if the reliability settings are insufficient to encourage new investment in generation needed to meet the reliability standard.

Unlike spot prices, retailers cannot hedge compensation associated with an APP as the contracts that cover spot price risk (e.g. caps and swaps) do not protect retailers against the

219 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: AGL p.3; EUAA; AEMO; CEC p.5; Origin p.4; CSR p.2.

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

221 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: AEMO p.10.

222 Reliability Panel, *2022 Reliability standard and settings review*, draft paper submissions: EUAA and PIAC.

pass-through of compensation costs. Perhaps counter-intuitively, a lower APC may raise the potential risk for consumers through the recovery of unhedged compensation costs.

Undue reliance on compensation places risks on retailers and consumers who have no control over the amount that must be paid and cannot protect themselves against the risk. This risk is increased with the threat of a large, unpredicted compensation bill. In particular, this may place significant financial pressure on some retailers who are already facing substantial risks with five retailer failures since May 2022 having triggered retailer of last resort (RoLR) events.[223]

While the total amount payable through the recent APC compensation process has not yet been determined, on balance, the majority of the Panel considers consumers' long-term interests are better served if the APC is raised to reduce the likelihood there is undue reliance on the compensation process. As noted, two Panel members representing consumers do not consider there is justification for an increase to the APC to $500/MWh at this time on the basis that they consider the cost to consumers of different settings under administering pricing is not yet known, and there may be other tools outside of the scope of this review, that may better promote the interests of consumers.

The view of these Panel members is that once compensation cost outcomes and generator behaviour of the recent APP becomes known, further analysis, consultation and consideration of alternative solutions could be the basis of a subsequent review to ensure that the recommendation remains appropriate.

The Panel recognises that the origins of the $300/MWh cap contracts commonly traded in the NEM came from the VicPool electricity market's coinsurance scheme dating back to 1994, and were not originally related to the APC. However, the Panel acknowledges that increasing the APC to $500/MWh will impact any existing listed over-the-counter $300/MWh cap contract offers that extend into the FY2026 to FY20208 period.

After consulting with energy contract traders, the Panel considers the impact on futures contracts is not material enough to outweigh the benefits from increasing the APC. While the Panel acknowledges the time it takes for the contracts market to adjust (i.e. around one year for the ASX to develop 5-minute cap contracts), the notice provided by this report and the subsequent rule change should minimise any adverse consequences.

7.5 Implementation

The Panel recommends implementing an APC value of $500/MWh for the period from 1 July 2025 to 30 June 2028. The Panel recognises the impact this may have on the contracts market and retailers, however, does not anticipate significant implementation issues given the value is recommended to stay as a fixed value.

The Panel recognises that increasing the APC to $500/MWh alone does not guarantee there will not be a repeat of the challenges faced in June 2022 if thermal fuel prices are sufficiently

223 Pooled Energy, Weston Energy, Enova Energy, Power Club and Mojo Power East.

high. Therefore, it suggests the form of the APC is considered in the Panel's follow-up review, including consideration of these three approaches:

- indexing the APC to another price, e.g. ACCC LNG netback price series or the gas APC in the Victorian DWGM
- defining the CPT in a way that ensures it activates only when it can achieve its objective and does not activate in market conditions where it could do more harm than good, and
- increasing the APC temporarily in specified circumstances as opposed to a permanent increase.

8 RELIABILITY SETTINGS: MARKET FLOOR PRICE

BOX 8: FINAL RECOMMENDATION ON THE MARKET FLOOR PRICE (MFP)

The Panel's recommendation for the period of 1 July 2025 to 30 June 2028 is to retain the form and level of the MFP at -$1,000/MWh.

The Panel considers that the MFP should remain at-$1,000/MWh because:

- adjusting the level of the MFP is not warranted in the absence of a clearly identifiable benefit over the review period. The Panel notes the impact of Five-Minute Settlement Rule 2017 and Semi-Scheduled Generator Dispatch Obligations Rule 2021 changes appear to have reduced the incidence of MFP events.
- There are unacceptable risks associated with a more deeply negative MFP which may increase systemic risk and the potential for disorderly thermal generator retirement.

Implementing the MFP as an investment signal for demand response and storage is not warranted for this review period, though this may be considered by the Panel in future review periods.

8.1 Introduction and key Panel requirements

The MFP sets a lower limit on wholesale market prices that can be reached in any trading interval measured in $/MWh. The level of the MFP is specified in the NER and is currently set at -$1,000/MWh.[224]

The purpose of the MFP is to allow the market to clear during low demand periods, while preventing market instability by imposing a negative limit on the total potential volatility of market prices.[225]

The MFP is currently set to provide an operational signal that reflects the willingness of inflexible generation to stay dispatched during excess generation periods. Less flexible generators subject to high start-up costs and technical unit commitment constraints, such as minimum up-time requirements, place significant value on remaining dispatched at their minimum load level event in the event of negative prices. In contrast, highly flexible generation, which can start or cease generation easily and at a low cost, will reduce generation and de-commit if necessary in response to negative pricing.

The Panel is required to consider key requirements outlined in the NER and the RSS review guidelines. Relating to the form and level of the MFP, the NER provides that the Panel may only recommend an MFP that it considers will:[226]

224 NER clause 3.9.6(b).

225 Reliability Panel, *Review of the reliability standard and settings guidelines,* final report, 1 July 2021, p.12, Sydney.

226 NER clause 3.9.3A(h).

- allow the market to clear in most circumstances, and
- not create substantial risks which threaten the overall stability and integrity of the market.

The RSS Review guidelines further state that the Panel will consider the following principles in its review of the MFP:[227]

- 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.

Under the guidelines, the Panel is to be guided by the principle of providing a predictable and flexible regulatory framework.[228] The Panel is to exercise its judgement to achieve predictable outcomes, while reflecting significant changes in market conditions, to support efficient investment and operational decisions by participants.

This chapter sets out the:

- the Panel's final recommendation
- stakeholder submissions on the Panel's draft position
- rationale for the Panel's final recommendation
- implementation and next steps.

8.2 The Panel's final recommendation

The Panel's final recommendation is to retain the current level and form of the **MFP as -$1000/MWh** for the period 1 July 2025 to 30 June 2028. This final recommendation is the same as the Panel's draft recommendation.

The key reasons for the Panel's final decision are that:

- recent market outcomes indicate that the current level of the MFP is sufficient in allowing the market to clear in most circumstances
- a change to the philosophy of the MFP to become an investment signal is not warranted for the review period 1 July 2025 to 30 June 2028 as it may lead to substantial risks which threaten the overall stability of the market
- maintaining the current level and form of the MFP promotes a stable and flexible regulatory environment.

The Panel does not consider adjusting the level of the MPC to be warranted in the absence of a clearly identifiable benefit over the review period. The Panel notes the impact of 5-minute

227 Reliability Panel, *Review of the reliability standard and settings guidelines,* final guidelines, 1 July 2021, p.12, Sydney.
228 Reliability Panel, *Review of the reliability standard and settings guidelines,* final guidelines, 1 July 2021, p.2.

settlement rule and semi-scheduled generator dispatch rule changes appear to have reduced the incidence of MFP events.[229] [230]

While the Panel does not recommend a change in the level and form of the MFP in this review period, the Panel's final recommendation is for the role and philosophy of the MFP to be further considered in the next RSS review.

8.3 Summary of draft recommendation and stakeholder views

The Panel's draft report recommendation was to retain the current form and level of the MFP for the review period from 1 July 2025 to 30 June 2028.

In making its draft recommendation, the Panel considered changing the MFP from solely being an operational signal, to a more deeply negative level to also act as an investment signal for demand response and storage. The Panel's draft decision was not to proceed with this option for the period 1 July 2025 to 30 June 2028 given:

- the lack of a clearly identifiable benefit given the reduction in the frequency of MFP events following the introduction of 5-minute settlement and the semi-scheduled generator dispatch rule changes
- the potential systemic risks arising from the possible impact on the thermal generation fleet and the absence of tools to effectively manage financial risks from more deeply negative prices.

Stakeholder submissions to the draft report

The majority of the eight stakeholders that commented on the MFP supported the Panel's draft position to maintain the level at -$1000/MWh.[231] Engie was the only stakeholder who identified an alternate preference on the level of the MFP for this RSS review period. Engie requested the Panel lift the level of the MFP closer to zero as they considered generation and contracting trends are reducing the volume of plant that might bid the price down towards the floor.[232]

No stakeholders that provided a submission requested a more negative MFP be implemented for the period 1 July 2025 to 30 June 2028.

Stakeholder submissions also supported the Panel's position that in the MFP should continue to be treated as an operational signal in the current market rather than being adjusted to become an investment signal for demand response and storage.[233] Several stakeholders suggested that the MFP should continue to be monitored to assess any future merit to changing the MFP's role to act as an investment signal.[234]

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229 Further information on the National Electricity Amendment (Semi-scheduled Generator Dispatch Obligations) Rule 2021 can be found at - https://www.aemc.gov.au/rule-changes/semi-scheduled-generator-dispatch-obligations

230 Further information on the National Electricity Amendment (Five Minute Settlement) Rule 2017 can be found at - https://www.aemc.gov.au/rule-changes/five-minute-settlement; https://www.aemc.gov.au/rule-changes/semi-scheduled-generator-dispatch-obligations

231 Reliability Panel, 2022 Reliability standard and settings review, draft report submissions: Australian Energy Council, p. 3; Energy Users Association Australia, p. 3; Alinta Energy, p. 5; Origin, p. 4; Iberdrola, p. 4; Shell, p. 4.

232 Reliability Panel, 2022 Reliability standard and settings review, draft report submissions: Engie p.3.

233 Reliability Panel, 2022 Reliability standard and settings review, draft report, 9 June 2022, p. 99.

8.4 Panel considerations in making its final recommendation

Consistent with the review's Assessment Framework, NER and Guideline requirements, this section sets out the Panel's rationale for its final recommendation on the basis that:

- the benefits of change over the period 1 July 2025 to 30 June 2028 are not sufficiently material, and
- there are unacceptable risks associated with a more deeply negative 'investment signal' MFP over the review period.

8.4.1 The benefits of change are not sufficiently material

The Panel does not consider adjusting the level of the MFP to be warranted in the absence of a clearly identifiable benefit over the review period. The Panel notes the impact of 5-minute settlement and semi-scheduled generator dispatch rule changes appear to have reduced the incidence of MFP events and any benefits that would result from a more negative MFP.

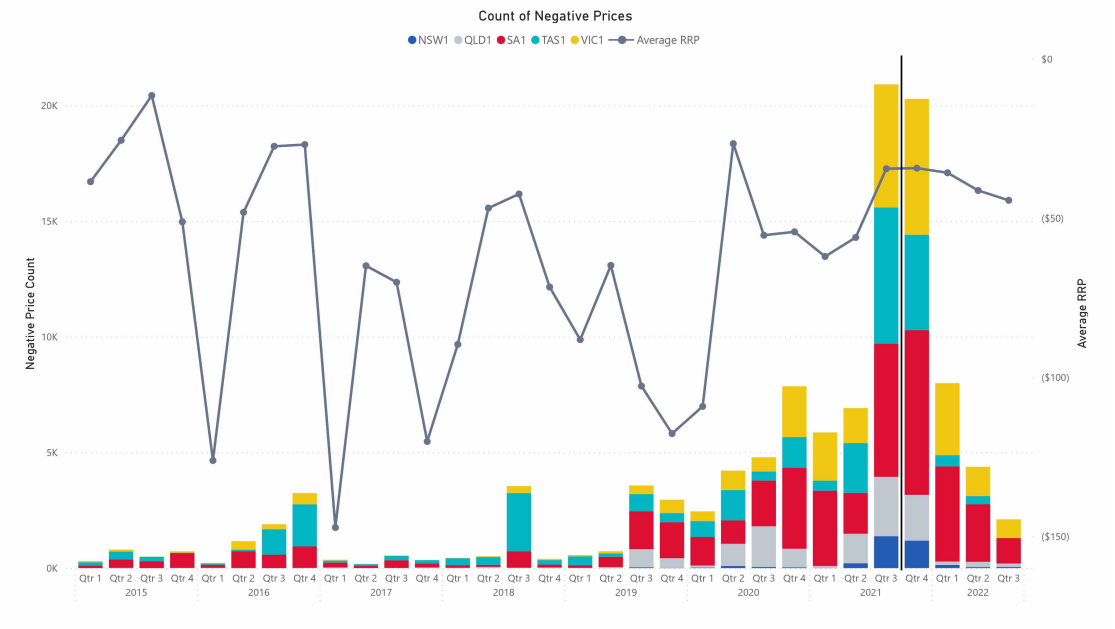
The implementation of the five-minute settlement and the semi-scheduled generator dispatch rule changes, which came into effect in October 2021, have changed the obligations and financial incentives in the NEM relevant to the frequency of negative and MFP events. There is initial evidence that these changes have materially shifted the likelihood of MFP events and alleviated the need to further decrease the MFP to allow the market to clear at efficient levels.

Figure 8.1 shows the changes in the frequency of MFP events in Q1, Q2, and Q3 of 2022 following the implementation of 5-minute settlement and the semi-scheduled generator dispatch rule changes. It shows a progressive increase in negative pricing and MFP events following Q3 of 2019 with a large in the negative prices in Q4 2021. The quantity of MFP events in those quarters equates to around three times the amount of events experienced in the previous highest quarters.

While the data is limited, the experience since 5-minute settlement and semi-scheduled rule change implementation suggests that negative prices are more likely to be closer to zero than they have been in the past with a consequential reduction in the frequency of MFP events.

234 Reliability Panel, 2022 Reliability standard and settings review, draft report submissions: Origin, p. 4; Iberdrola, p. 4; Alinta Energy, p. 5.

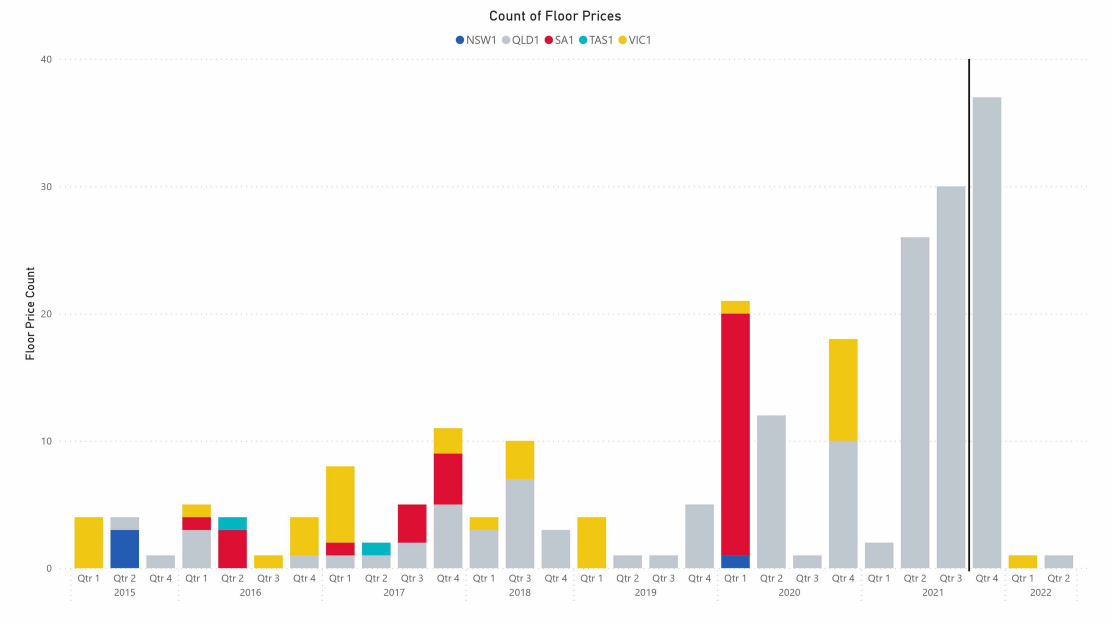
Figure 8.1: Count of negative prices



Source: AEMC, taken from AEMO data.
Note: Shows the number of negative prices experienced in each region of the NEM and the average of those negative prices.
Note: Q3 2022 data is incomplete. Outcomes to mid-August 2022 are included.

Figure 8.2 shows the total number of market floor price events experienced from Q1 2015 to Q2 of 2022 showing a reduction in MFP events in Q1 and Q2 of 2022.

Figure 8.2: Total number of market price floor events



Source: Analysis of AEMO data.
Note: Q3 2022 data is incomplete. Outcomes to mid-August 2022 are included.

The Panel considers the observed reduction in the degree of negative pricing supports that the current level of the MFP is sufficient in allowing the market to clear in most circumstances and therefore no change is needed to the level of the MFP for the period 1 July 2025 to 30 June 2028.

With present levels of uncertainty in the market, providing stability to market participants in relation to the MFP may support efficient investment and operational decisions by participants. For this reason, the Panel considers retaining the existing MFP for the review period will support regulatory certainty in the long-term interest of consumers.

8.4.2 There are unacceptable risks associated with a more deeply negative MFP at this time

The MFP has historically been set to act as an operational signal to manage generator commitment under excess generation conditions rather than as an investment signal for reliability purposes. The 'philosophy' of the MFP has therefore been to set the MFP at a sufficiently negative level to account for cycling 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 and the MFP could be implemented at a more deeply negative level to enhance demand response and storage investment. The Panel considers future power system reliability will involve a greater reliance on demand response and storage and considers that 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, may be warranted at some point in the future.

The Panel, however, retains its draft recommendation view that this shift is not appropriate for the period 1 July 2025 to 30 June 2028. There are significant financial implications for less flexible thermal generation from a more deeply negative MFP, implemented as an investment signal for demand response and storage. More deeply negative pricing could lead to a disorderly exit of less flexible thermal generation from the NEM.

A disorderly exit of thermal generation in the face of deeply negative prices in this review period is unlikely to be in the long-term interests of consumers as it may lead to:

- significant negative impacts on reliability, particularly if it occurs in advance of the investment occurring to replace retiring thermal generation capacity, and
- an increase in systemic risks from a reduction in contract market products for risk management. A rapid reduction in dispatchable thermal capacity will reduce the availability of cap contracts thereby impacting contract market pricing and liquidity with consequential impacts on the ability of customers to manage their financial market risk.

The Panel also identifies a lack of risk management frameworks and tools for market participants to manage deeply negative price risk. Arrangements such as a negative CPT are likely required to limit market participants' exposure to prolonged negative prices which could threaten their financial viability. The transition from existing MFP arrangements to an 'investment signal' MFP would need to be very carefully considered and communicated to the market in order for negative price risk management hedging products to be developed.

For these reasons, the Panel considers a move to 'investment signal' negative pricing in this review period may lead to an unacceptable increase in systemic risk.

The Panel, however, agrees that there is likely a benefit to implementing the MFP as an investment signal in a future high VRE and storage power system once incumbent thermal generation assets have significantly retired. The Panel considers a significant degree of additional consultation and modelling is required prior to any such change. The Panel, therefore, recommends that the future role of the MFP be further considered in the Panel's next RSS review.

8.5 Implementation and next steps

As the Panel's final recommendation is for the role and philosophy of the MFP to be further considered, the Panel identifies the following issues that should be considered in the next RSS review:

- Whether there is any evidence that a more deeply negative MFP is required to achieve efficient levels of storage and DR uptake consistent with achieving the reliability standard
- How a more deeply negative MFP would affect supply side investment risk and the corresponding levels for the MPC and CPT

- The availability and development of negative price risk management tools, and the degree of systemic risk arising from the impact on less flexible thermal generator finances.

In considering these specific issues, the Panel, for the next RSS review should identify the timing, conditions, and supporting policy and risk management infrastructure required to implement a more deeply negative MPF as an investment signal.

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.[235] 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.[236]

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.[237] 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

235 AEMO, 2021 Inputs, Assumptions and Scenarios Report, July 2021, p. 105-106, available here.
236 AER, *Values of Customer Reliability: Final report on VCR values*, December 2019, p. 74, available here.
237 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.[238]

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.

238 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