RELIABILITY PANEL AEMC

REVIEW

Reliability Panel AEMC

ISSUES PAPER

2022 RELIABILITY STANDARD AND SETTINGS REVIEW

27 JANUARY 2022

INQUIRIES

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ABOUT THE RELIABILITY PANEL

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

RELIABILITY PANEL MEMBERS

SUMMARY

BOX 1: AEMC RULE CHANGE - EXTENSION OF TIME AND REDUCTION IN SCOPE OF THE 2022 RELIABILITY STANDARD AND SETTINGS REVIEW RULE CHANGE

The Commission is currently considering a rule change request from Dr. Kerry Schott AO, former Chair of the Energy Security Board (ESB) to extend the time and reduce the scope of the 2022 Reliability Standard and Settings review (RSS review). The rule change request proposes to remove the need for the Panel to include the reliability settings in the RSS review, and hence only review and report on the reliability standard (standard). The rule change request has been put forward as a one off change applying to 2022 RSS review and not future RSS reviews.

The AEMC draft determination for the extension of time and reduction in scope of the 2022 reliability standard and settings rule change was published on the 23 December 2021. *The draft d*etermination proposes a more preferable rule that sets out the Panel will retain the function of reviewing the reliability settings in the RSS review. The more preferable rule however would make changes to the Panel's responsibilities by:

- Extending the timing for the 2022 RSS review and final report to the AEMC from 30 April to 30 August 2022.
- To accommodate the move to 30 August 2022, removing financial year 2024 from consideration in the review. The standards and settings review would therefore be for the period 1 July 2025 to 30 June 2028.

This RSS review would not consider the design of a capacity mechanism rather the Panel would undertake its review in the context of the current energy only market. The merits and design of a capacity market, along with any associated settings is not in scope for the rule change request.

Note: For further information on the AEMC rule change see: https://www.aemc.gov.au/rule-changes/extension-time-and-reduction-scope-2022-reliability-standard-and-settings-review

1 This Issues Paper has been prepared for the Reliability Panel's (Panel) 2022 Reliability standard and settings review (2022 RSS review). The purpose of this paper is to set out the Panel's approach and initial set of issues that will be considered in this RSS review for stakeholder feedback. It is the first step in the extensive consultation process that will be undertaken over the course of the RSS review.

2 The Panel also notes that there is the work by the ESB to design a capacity mechanism based on a direction from National Cabinet.[1] The Panel is collaborating with the ESB so that both processes can be appropriately aligned and dovetail where necessary.

3 Under the NER, the Panel is required to conduct a review of the reliability standard

1 For further information see: https://www.energy.gov.au/government-priorities/energy-ministers/priorities/national-electricity-market-reforms/post-2025-market-design

(standard) and reliability settings (settings) every four years. The Panel's 2022 RSS review will consider whether the existing form and level of the standard and settings remain appropriate for expected market conditions from 1 July 2024 to 30 June 2028.[2]

Reliability in the NEM

4 A reliable power system has an adequate amount of capacity (generation, demand response, interconnector, and energy storage capacity) to meet consumer needs. This requires adequate investment, including sufficient investment to cover generator retirements, as well as an appropriate operational framework so that supply and demand can be maintained in balance at any particular point in time.

5 The core objective of the existing reliability framework in the NEM is to deliver efficient reliability outcomes through market mechanisms to the largest extent possible.[3] These mechanisms provide strong financial incentives for participants (generators, retailers, aggregators and customers) to make investment, retirement and operational decisions that support reliability. In addition, AEMO provides information to participants on projections and forecasts relevant to reliability outcomes and also has tools that it can use to intervene, when needed, to maintain reliability.[4]

6 The standard and settings are key components of the NEM's reliability framework. These elements aim to encourage sufficient investment in generation or demand response capacity to meet consumer demand for energy, while protecting market participants from potential financial risks that threaten the overall stability and integrity of the market.

- The standard defines an efficient level of reliability, expressed as the level of unserved energy (USE) that represents an efficient economic trade-off between reliability and affordability based on what consumers value.
- The market price settings are set to achieve market outcomes consistent with the standard by defining a price envelope that provides sufficient revenue to support investment while also limiting the potential for high, low, and cumulative price impacts:
  - Market Price Cap (MPC)
  - Market Floor Price (MFP)
  - Cumulative Price Threshold (CPT)
  - Administered Price Cap (APC)

Reliability in a NEM in Transition

7 The physical power system is undergoing a period of significant adjustment with continuing and rapid change in the generation mix through the exit of ageing thermal generators, entry of large and small-scale variable renewable generation, and increasing uptake of distributed

2 The AEMC rule change on extension of time and reduction of scope is considering changing the period relevant to the standard and settings determined in the 2022 RSS review. On 23 December 2021 the AEMC published a draft determination to change the period over which the standard and settings determined in the 2022 RSS review would apply to 1 July 2025 to 30 June 2028.

3 Reliability Panel, *Information Paper: The reliability standard, current considerations*, 12 March 2020, Sydney.

4 While the reliability standard and settings may influence decisions to invest and consumer electricity generated by behind the meter distributed generation, the reliability standard and settings focus on the reliable supply of electricity from the NEM transmission and generation system.

energy resources and demand response. These changes are in turn altering market dynamics and price distributions with increasing intra day price variability and incidences of high and low wholesale prices.

8 Retiring thermal generation is being replaced by storage combined with weather dependent variable generation. The entry of large scale and small scale storage, combined with high penetrations of weather dependent generation may see a shift in the profile of risks to reliability seen in the NEM as this transition occurs.[5]

9 While the NEM continues to provide high levels of reliability, there is some evidence to suggest that reliability pressures are increasing and operational reliability is becoming more challenging for AEMO to manage. Reliability issues have mostly arisen only on very hot days, as hot weather can affect both consumer usage patterns and the power system's ability to provide supply. More recently however, reliability issues have begun to emerge during 'shoulder' and 'winter' periods in addition to the summer peak. The Panel will consider the standard and settings in light of a transitioning NEM and these emerging reliability pressures.

Assessment approach

10 The Panel is required to apply a specific framework when reviewing the standard and settings, which is outlined in the NER and 2021 guidelines.[6] The 2021 guidelines require the Panel determine the standard and settings that:[7]

- allow efficient price signals while managing price risk
- deliver a level of reliability consistent with the value placed on that reliability by customers, and
- provide a predictable and flexible regulatory framework.

11 For any recommended changes to the reliability standard and settings, the Panel would need to be satisfied that such changes will, or are likely to, contribute to the achievement of the NEO and meet the requirements in the 2021 guidelines and the NER. If the Panel recommends a change, this would need to be progressed through an AEMC rule change process.

12 Consistent with the 2021 guidelines, the Panel will only consider a change to the form or level of the reliability standard or settings where there is a material benefit in doing so. As such, the Panel will only recommend a change to either the form or level of the standard when there is a reasonable possibility that these recommended changes will, or are likely to, contribute to the achievement of meet the NEO in a materially better way.

Level and form of the reliability standard

13 Under the 2021 guidelines for the 2022 RSS review, the Panel will consider both the level and form of the standard.

14 In assessing an efficient level for the standard, the Panel is required to consider the VCR

5 AEMO, draft 2022 ISP, p. 9 - 10.

6 In addition to the considerations and requirements from the NER and guidelines, outlined above, the Panel is also able to take into account other considerations in the 2022 RSS review.

7 Reliability Panel, R*eview of the reliability standard and settings guidelines,* final guidelines, 1 July 2021, Sydney, available here.

determined by the AER to ensure that the standard strikes a balance between having enough generation and demand response to meet consumer demand in the majority of circumstances, and keeping overall costs for consumers as low as possible.

15 The current reliability standard is expressed in terms of outputs. It expresses the maximum expected amount of energy demand that can be unmet in each NEM region in a year (It is expressed as a proportion — 0.002 per cent of the total energy demanded in a region in a financial year).[8]

16 The Panel also notes that there is the interim reliability measure in operation until the 31 of March 2025. The interim reliability measure for generation and inter-regional transmission elements in the NEM is a maximum expected unserved energy in a region of 0.0006% of the total energy demanded in that region for a given financial year. The interim reliability measure is not within the scope of the Panel's review.[9]

17 The Panel will consider whether the existing form of the reliability standard remains appropriate or sufficient to effectively signal reliability risk to the market given the increasing penetrations of variable renewable generation, coupled with storage, and frequency of extreme weather events.

18 A single metric has historically provided sufficient information to signal reliability risk. However, this may not be the case in the future when reliability is significantly influenced by energy constrained resources, rather than capacity limited thermal generation. A number of different and supplementary reliability standard forms could be adopted to express the reliability standard. Given the changing power system reliability risk profile, and increasingly diverse sources of reliability risk, the Panel may consider whether another, or more than one form and metric may be required to appropriately signal reliability outcomes and risk given an evolving NEM.

Market price settings

19 The 2022 RSS review is to consider the form and level of the market prices settings (MPC, MFP, CPT, APC) required to achieve a level of reliability consistent with the standard. The Panel is required to consider the trade off between settings that allow for efficient market prices, allow the market to clear at most times, while also not creating risks that threaten the overall integrity of the market.

20 The role and key objectives of each of the price settings are:

- The MPC sets the maximum price that can be reached in the wholesale market for energy and FCAS. The MPC is set, together with the CPT, at a level to provide financial incentives for investment and operational decision-making that are sufficient to achieve the reliability standard.
- The MFP sets a lower limit on wholesale market prices that can be reached in any trading interval. The NER states that the Panel may only recommended an MFP it considers will

8 Clause 3.9.3C(a) of the NER.

9 Under clause 11.128.12(c) of the NER the AEMC must complete a review of the interim reliability measure by 1 July 2023.

allow the market to clear in most circumstances. The MFP should be set to reflect the amount that inflexible generators are willing to pay to remain dispatched.

- The CPT is the maximum cumulative energy and FCAS price that can be reached over a period of seven days, before an administered price period (APP) commences and the APC, is applied to market prices. The CPT acts to cap risk to market participants while maintaining the effectiveness of the MPC.
- The APC is the maximum market price paid to participants that can be reached in any dispatch interval and any trading interval, during an APP. The APC, combined with the cumulative price threshold (CPT), is a mechanism to minimise financial stability risks to the market arising from an extended period of supply scarcity and corresponding high prices. It is set at a level sufficiently high to incentivise generation to make itself available during an APP.

21 The Panel identifies a range of considerations to be applied in identifying efficient levels for each of the market price settings in this RSS review for stakeholder feedback.

Modelling for the review

22 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 Issues Paper introduces the modelling task required to inform the Panel's determination on the standard and settings, proposes a set of principles describing the Panel's high level approach to modelling for the RSS review, and identifies a set of specific issues in relation to modelling reliability in a changing NEM for stakeholder feedback.

23 Modelling informing the 2022 RSS review is proposed to include:

- detailed time sequential modelling of price and dispatch outcomes in the markets for energy and FCAS will be conducted,
- modelling will be technology-neutral and assess the standard and settings on the basis of the cheapest available, marginal new entrant technology options, including storage,
- participant decision-making on time-scales from investment decision-making to dispatch will be modelled,
- scenarios will be developed to address the range of possible reliability outcomes and risks to reliability, and
- sensitivity analysis will be applied on assumptions where there exists material uncertainty on the true or forecast value.

24 In addition to this high level approach, the Panel also identifies a range of additional considerations for stakeholder feedback including: modelling on five minute vs 30 minute timescales, approach to including FCAS, modelling uncertain sources of generation, load, and demand response, scenario selection and the management of uncertainty.

25 This paper identifies and discusses issues at a high level to inform stakeholder engagement with the review. In addition, the Panel will publish the details that underpin the modelling throughout the course of this RSS review.

Submissions

26 The Panel anticipates that, given the significance of this review, as well as the interest to date from stakeholders, there will be multiple opportunities for stakeholders to engage and participate in the process, including through bilateral meetings, public forums and formal submissions. Chapter one sets out the relevant milestones for this review.

27 The Panel invites comments from interested parties in response to this Issues Paper by COB Thursday 3 March 2022. Submissions will generally be published in full on the AEMC's website.

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

CONTENTS

APPENDICES

TABLES

FIGURES

1 INTRODUCTION

This Issues Paper has been prepared for the Reliability Panel's (the Panel) 2022 Reliability standard and settings review (2022 RSS review). The publication of this paper [along with the accompanying terms of reference issued to the Panel from the AEMC] formally commence the Panel's review of the reliability standard and settings.

The RSS review, in accordance with the NER, must be completed by 30 April 2022.[10] The AEMC is currently considering a rule change request submitted by Kerry Schott AO that seeks to extend the time the Panel has to undertake the review, and hence provide the final report for the 2022 RSS review.

The rule change request also seeks to reduce the scope of the review, that is the Panel would only need to consider the reliability standard and not the settings.

The rule change request was proposed as a one off, transitional arrangement for only the 2022 RSS review.

A draft determination was published on 23 December 2021 and a final determination is due by the end of March 2022. The AEMC's draft determination is to make a more preferable draft rule that requires the Panel, for the 2022 RSS review to:[11]

- provide its final report to the Australian Energy Market Commission, with any recommendations for change to the reliability standard and settings by 30 August 2022, and
- consider the reliability standard and settings of an energy-only market that it recommends should apply for 1 July 2025 to 30 June 2028.

The Panel also notes the work by the ESB to design a capacity mechanism based on a direction from National Cabinet.[12] The Panel is collaborating with the ESB so that both processes can be appropriately aligned and dovetail where necessary.

The purpose of this paper is to set out the Panel's approach for the review and initial set of issues that will be considered. It is also the first step in the extensive consultation process that will be undertaken, with a focus on obtaining views on the issues outlined.

This chapter outlines the:

- Panel's requirements under the National Electricity Rules (NER) for the RSS reviews
- purpose and scope of the 2022 RSS review
- process for the 2022 RSS review, and
- opportunities for stakeholder comment and input.

10 Clause 3.9.3A(d) of the NER.

11 AEMC, Extension of time and reduction in scope of the 2022 Reliability Standard and Settings Review, Draft rule determination, 23 December 2021, p. i.

12 For further information see: https://www.energy.gov.au/government-priorities/energy-ministers/priorities/national-electricity-market-reforms/post-2025-market-design

1.1 The RSS review requirements

Under the NER, the Panel is required to conduct a review of the reliability standard (standard) and reliability settings (settings) every four years. The 2022 RSS review must be completed by 30 April 2022.[13] This four yearly review allows the Panel to assess and consider whether the current form and level of the reliability standard and reliability settings remain suitable for expected and evolving market conditions, or whether the Panel recommends that changes should be made to ensure these mechanisms continue to meet their intended purpose as well as the requirements of the market, market participants and consumers.

1.1.1 Panel's requirements for conducting RSS reviews

There are a number of factors that the Panel must apply or take into account when undertaking its RSS reviews, these include the:

- requirements in the NER[14]
- Reliability Standard and Settings Guidelines (2021 guidelines)[15], and
- any Terms of Reference provided by the AEMC.[16]

As noted, the Panel is required to undertake its assessment of the standard and settings in accordance with the 2021 guidelines.[17] These guidelines set out the principles, assessment approach and assumptions that the Panel must apply for its RSS reviews. More detail on the requirements embedded in the guidelines is provided in Chapter four of this paper which sets out the Panel's assessment approach for this review.

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 2021 guidelines. The Panel must also have regard to any 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 subsequently provided to the AEMC.[18]

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.[19] Any change to the form and level of the standard and settings would then be made through an AEMC rule change process.

13 Clause 3.9.3A(d) of the NER. Note the existing rule change as outlined above has proposed in its draft determination to amend the 30 April 2022 deadline. Timelines for the 2022 Review will be updated when the final determination for the rule change is published. This final determination is expected in early March 2022

14 Clause 3.9.3A. of the NER.

15 Reliability Panel, R*eview of the reliability standard and settings guidelines,* final guidelines, 1 July 2021, Sydney.

16 [insert TOR once issued]

17 Reliability Panel, R*eview of the reliability standard and settings guidelines,* final guidelines, 1 July 2021, Sydney, details available here.

18 Clause 3.9.3B of the NER.

19 Clause 3.9.3A(i) of the NER.

1.2 Purpose and scope of this review

1.2.1 Purpose of this review

The 2022 RSS review is to consider the standard and settings that will apply on and from 1 July 2024 to 30 June 2028.[20]

The purpose of the RRS review is to:

- Consider whether the existing form and level of the standard remains appropriate for the expected market conditions from 1 July 2024 to 30 June 2028, specifically:
  - Consider whether or not the existing form of the standard is appropriate for the expected market conditions, and if not, recommend a revised form of the standard.
  - Consider whether or not the current level of the standard is appropriate for the expected market conditions, and if not, recommend a revised level of the standard.
- Consider whether the existing form and levels of the settings remain appropriate for the market conditions expected from 1 July 2024 to 30 June 2028, specifically:
  - Consider whether or not the existing form of the settings is appropriate for the expected market conditions, and if not, recommend a revised form of the settings.
  - Consider whether or not the existing level of the settings is appropriate for the expected market conditions, and if not, recommend a revised level of the settings.
- Recommend changes required to the NER in its final report for the review and submit a rule change request to the AEMC.

The standard and settings are key components of the NEM's reliability framework. These elements aim to encourage sufficient investment in generation or demand response capacity to meet customer demand for energy, while protecting market participants from potential substantial risks that threaten the overall stability and integrity of the market.

Reliability standard

The standard is an ex-ante standard used to indicate to the market the required level of supply to meet demand on a regional basis. AEMO operates the system to meet the standard. The standard is operationalised by AEMO, including informing the market that the standard is not being met.

The form and level of the standard is specified in the NER.[21] The current standard for the NEM is expressed in terms of the expected unserved energy (USE) in a region and is set at a maximum of 0.002% of the total energy demanded in that region for a given financial year.

The reliability standard in the NEM applies to USE due to insufficient customer generation and inter-regional transmission capacity. Customer interruptions due to outages in the distribution network, e.g. when a tree falls across distribution network elements are not included as USE for the purpose of assessing the reliability standard. Further detail about the purpose and function of the standard is provided in Chapters two and five of this paper.

20 Stakeholders should note the AEMC's draft determination to amend the period relevant to the standard and settings determined in the 2022 RSS review to commence from 1 July 2025 rather than 1 July 2024. .

21 Clause 3.9.3C(a) of the NER.

As noted, there is the interim reliability measure that is in place until the 31 of March 2025.[22] The interim reliability measure for generation and inter-regional transmission elements in the NEM is a maximum expected unserved energy in a region of 0.0006% of the total energy demanded in that region for a given financial year.[23] Additional information on the interim reliability measure is provided in section 2.2.3. Consideration of the interim reliability measure is out of scope for this review.

Reliability settings

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

Table 1.1 lists the current reliability standard and reliability settings levels as at 1 October 2021.[29] Further discussion of the reliability standard and settings is provided in Chapter six to Chapter ten.

Table 1.1: The current reliability standard and reliability settings 1 October 2021 to 30 June 2022

Reliability Standard	The reliability standard for generation and inter-regional transmission elements in the national electricity market (NEM) is a maximum expected unserved energy in a

22 Clause 11.128.1 of the NER.

23 Clause 3.9.3C(a1) of the NER.

24 Clause 3.9.4 of the NER.

25 Clause 3.9.6 of the NER.

26 This was changed from 336 trading intervals to 2,016 five minute trading intervals with the introduction of 5 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.

27 Clause 3.14.1 of the NER.

28 Clause 3.14.1 of the NER.

29 Under clauses 3.9.4 and 3.14.1 of the NER, the Commission is required to adjust the MPC and CPT in line with the consumer price index by 28 February each year. Following the commencement of five minute settlement on 1 October 2021, the value of the CPT has been adjusted to $1,359,100 while the market price cap remains the same.

	region of 0.002% of the total energy demanded in that region for a given financial year.
Market Price Cap	$15,100/MWh
Cumulative Price Threshold	$1,359,100
Administered Price Cap	$300/MWh
Market Floor Price	-$1000/MWh

Source: AEMC, Schedule of Reliability Settings 2021-2022, found here.

1.2.2 Scope of this review

Reliability of the power system is a complex issue. Many factors affect the system's overall reliability as well as the level of reliability a particular customer experiences.

This review focuses on the reliability of the large-scale generation and transmission system, specifically the reliability provided by power generation and interconnection assets (interconnectors) to meet customer demand,[30] and is limited to the key parameters that affect reliability in the market—the reliability standard and the four reliability settings.[31]

Power outages that customers experience can be planned or unplanned. Planned outages generally occur so that maintenance or construction can be undertaken on generators or network assets in the transmission or distribution networks.[32] An unplanned interruption to electricity supply to customers can be caused by a number of factors including:

- An incident such as a storm that brings down a major transmission line, making it difficult for the power system to operate within its defined technical limits.
- Disruptions to, or outages in the transmission and distribution "poles and wires" within a region, causing difficulties in supplying electricity to homes and/or businesses.[33]

30 Unless otherwise stated, references to demand throughout this paper refer to operational demand (consistent with the approach used previously by the Panel in the Annual Market Performance Review). Operational demand consists of electricity used by residential, commercial and large industrial customers, as supplied by scheduled, semi-scheduled and significant non-scheduled generating units. Demand response activities and embedded generation are not included on the 'supply' (or 'capacity') side with large generating units. Instead, these 'behind-the-meter' activities have the effect of reducing total demand. Nevertheless, behind-the-meter activities are relevant to reliability. As reliability relates to the ability to meet customers' demand for electricity, reductions in demand can make it easier to meet the desired level of reliability. For an explanation of scheduled, semi-scheduled and *non-scheduled generating units see* AEMC*, Generator Registrations and Connections,* Consultation Paper*,* 2020, Sydney *p. 8.*

31 As noted above, the interim reliability measure is out of scope

32 Each state and territory government retains control over how transmission and distribution network reliability is regulated and the level of reliability that must be provided. Reliability standards relate to how the transmission and distribution networks can withstand risks without consequences for customers, and guide the level of investment that networks undertake. The reliability standards that transmission networks need to meet are generally set in advance of a transmission business' decision to invest and are set in place for a fixed period of time. The exception is in Victoria where reliability levels are determined at the time an investment need arises. Transmission reliability standards are generally planning standards, rather than outcomes based, as outages are rare. In comparison, distribution reliability standards are generally outcomes based rather than planning standards, as outages are common.

33 There are five wholesale market regions in the NEM: Queensland, New South Wales (including the Australian Capital Territory), Victoria, South Australia and Tasmania. Chapter 10 of the rules defines a region as: "[a]n area determined by the AEMC in accordance with Chapter 2A [of the rules], being an area served by a particular part of the transmission network containing one or more major load centres or generation centres or both." AEMO prepares a "regions publication" under clause 2A.1.3 of the rules that amongst other things lists all regions. See AEMO*, Regions and Marginal Loss Factors FY2021-22,* 2021, Sydney, p. 3.

- Insufficient generation capacity and/or transmission capability between regions to supply and meet demand for electricity at a particular point in time.

The first of these factors relates to system security, while the second and third relate to reliability of the power system overall.

"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. The 2022 RSS review does not consider security related incidents nor evaluate other factors and processes that impact on system reliability, such as the powers of the Australian Energy Market Operator (AEMO) to intervene in the operation of the market.[34] Further discussion of reliability, as distinct from security, is provided in Chapter five.

The Panel has other functions in relation to system reliability (and also system security). For instance, the Panel publishes an annual review of the reliability, security and safety of the NEM, the Annual Market Performance Report (AMPR). This report includes, among other things, data projections from AEMO of forecast USE and whether the reliability standard will be breached, as well as outcomes for the reliability settings for the year reported on. The most recent AMPR final report was published in May 2021 and an AMPR market performance update was published on 16 December 2021.[35] The Panel will consider the outcomes for reliability outlined in this report and market update in its assessments for this review. Some observations are outlined in the next chapter which provides some context on reliability to date in the NEM.

It is important to recognise that many factors affect the investment environment in the energy sector and investment decisions in the NEM, and thereby reliability in the market. Some of these are internal to the market while others are external. While setting the form and level of the standard and the settings appropriately can influence investment in the market, they alone are not the only factors that affect the investment in power system resources needed to achieve the desired level of reliability. There are many other factors that can have a significant impact on market participant investment decisions, which are outlined in Chapter three.

1.3 Consultation process and submissions

The Panel will consult with stakeholders by seeking comments on this Issues Paper and the subsequent Draft Report. The Panel will also hold a number of stakeholder meetings, as required.[36] The key dates are shown in Table 1.2.[37] Table 1.2 incorporates indicative dates but will be updated based on the AEMC's final determination on the Extension of time and reduction in scope of the 2022 reliability standard and settings review rule change, in particular those dates as marked.

34 Clauses 3.9.3A(f)(1) and 3.9.3C of the NER. A full list of AEMO's powers to intervene is provided in the NER under rules clauses 3.20.7(a) and 4.8.9(a).

35 AEMC, *Annual Market Performance Review 2020*, available here; AEMC, Annual Market Performance Review 2021, market update July 2020 to June 2021, 16 December 2021, available here.

36 The NER require that the Panel follow the Rules consultation procedures in carrying out this review. The Rules consultation procedures are set out in section 8.9 of the NER.

37 Refer to the note on the potential change to the indicative timelines for the 2022 Review.

Table 1.2: Indicative review timetable

Issues Paper published	27 January2022
Stakeholders submissions on Issues Paper due	3 March 2022
Stakeholder meetings and engagement on the Issues Paper	February/March 2022
Public forum on the Issues Paper	March 2022
Draft Report published	* March 2022
Stakeholder submissions on Draft Report due and engagement	* April 2022
Final Report published	* 30 April 2022

The Panel invites comments from interested parties in response to this Issues Paper by 3 March 2022. Submissions will generally be published in full on the AEMC's website.

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

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

Reliability Panel

c/- Australian Energy Market Commission

PO Box A2449

SYDNEY SOUTH NSW 1235

1.4 Structure of this paper

The remainder of this Issues Paper is set out as follows:

- **Chapter 2.** Reliability in the NEM. This chapter outlines power system reliability in the NEM and considers the roles of the reliability standard and the reliability settings as part of the reliability framework.
- **Chapter 3.** NEM in transition and market reforms. This chapter outlines the current transition in the NEM and how these may impact the Panel's considerations for the RSS review. It also outlines the relevant market reforms and other policy reforms relevant to this review.
- **Chapter 4.** Assessment Approach. This chapter sets out the Panel's proposed approach for the RSS review.

- **Chapter 5**. The Reliability Standard. This chapter outlines the function, requirements for assessment, and issues pertaining to the determining the level and form of the reliability standard, and poses questions for your comment.
- **Chapter 6.** The market price settings. This chapter outlines the function, requirements for assessment and issues pertaining to the market price cap, the cumulative price threshold, the administered price cap and the market floor price, and pose questions for your comment.
- **Chapter 7.** Modelling for the review. This chapter sets out the proposed modelling approach for the Review and seeks your input.
- **Appendix A.** Outlines some history and background on the market price settings in the NEM.
- **Appendix B.** Provides additional supplementary informational and considerations relevant to the 2022 RSS review.
- **Appendix C.** Provides a consolidated set of questions that are included in the paper for stakeholders to consider and respond to**.**

2 RELIABILITY IN THE NEM

The term reliability has a distinct meaning in the NEM and is delivered through a framework that has the reliability standard (standard) and market price settings (settings) at its core. This chapter provides background and context for the 2022 RSS review and introduces and discusses:

- power system reliability in the NEM
- the current NEM framework for delivering reliability of which the standard and settings are an important part, and
- reliability outcomes to date in the NEM.

2.1 What is power system reliability in the NEM?

As outlined Chapter one, a reliable power system has an adequate amount of capacity (generation, demand response and interconnector capacity) to meet customer needs. This requires adequate investment in capacity, including sufficient investment to cover generator retirements, as well as an appropriate operational framework so that supply and demand can be maintained in balance at any particular point in time.

The core objective of the existing reliability framework in the NEM is to deliver efficient reliability outcomes through market mechanisms to the largest extent possible.[38] These mechanisms provide strong financial incentives for participants (generators, retailers, aggregators and customers) to make investment, retirement and operational decisions that support reliability. In addition, AEMO provides information to participants on projections and forecasts relevant to reliability outcomes and also has tools that it can use to intervene, when needed, to maintain reliability.

2.1.1 Power system reliability is distinct from power system security

Power system reliability in the NEM is distinct from power system security but both involve ‘keeping the lights on’. To achieve this, the power system overall needs to be:

- Reliable – have enough capacity (generation and networks) to supply customers, and
- Secure – able to operate within defined technical limits, even if there is an incident such as the loss of a major transmission line or large generator.

While “security” relates to the stability of the power system in terms of its ability to withstand disturbances, “reliability” of the power system is about having sufficient resources to generate and transport electricity to meet customer demand.[39]

While these two concepts are often described separately they are closely related.

- A reliable power system is one that has a high likelihood of fully servicing the electricity needs of customers.

38 Reliability Panel, *Information Paper: The reliability standard, current considerations*, 12 March 2020, Sydney.

39 Taking into account any reductions in total demand caused by demand response mechanisms and behind-the-meter generation, as discussed in section 1.1.5.

- A secure operating state is one where the power system is in, or will return, to a satisfactory operating state following a credible disturbance.[40]

A reliable power system is also a secure power system. However, the converse is not necessarily true; a power system can be secure even when it is not reliable. The NER allows AEMO to undertake involuntary load shedding, in order to return the power system to a secure operating state. The NER therefore empowers AEMO to sacrifice reliability outcomes to maintain the power system in a secure state.[41]

As noted in Chapter one, the Panel is required to focus on the reliability of the power system when conducting the RSS review. Specifically, the level of reliability provided by power generation and inter-regional transmission assets.[42]

2.1.2 Reliability events and the definition of unserved energy in the NEM

If there is an event or incident its classification as a system security or reliability event generally depends on the cause of the event. The NER defines the circumstances in which unserved energy (USE) is counted for the purposes of assessing reliability. Clause 3.9.3C of the NER specifies that USE for the purposes of the reliability standard *includes* energy demanded but not supplied due to power system reliability incidents resulting from:

- A single credible contingency event on a generating unit or an inter-regional transmission element that may occur concurrently with generating unit or inter-regional transmission element outages,[43] and
- Delays to the construction or commissioning of new generating units or inter-regional transmission elements, including delays due to industrial action or acts of God (such as extreme weather events).

USE *excludes* energy demanded but not supplied due to power system security incidents resulting from:

- Multiple contingency events, protected events or non-credible contingency events on a generating unit or an inter-regional transmission element,[44] that may occur concurrently with generating unit or inter-regional transmission element outages,
- Outages of transmission network or distribution network elements that do not significantly impact the ability to transfer power into the region where the USE occurred, and

40 Clause 4.2.4(a) of the NER. A satisfactory operating state is defined in Clause 4.2.2 of the NER. The power system is in a satisfactory operating state when all vital technical parameters (such as voltage, frequency, and equipment loads) are within their design limits and ratings.

41 AEMC, *Extension of the Reliability and Emergency Reserve Trader, Rule Determination*, 23 June 2016, Sydney, p. 1.

42 Clause 3.9.3C of the NER.

43 Clause 4.2.3(a) of the NER defines a contingency event an event affecting the power system which AEMO expects would be likely to involve the failure or removal from operational service of one or more generating units and/or transmission elements. (b) A credible contingency event is one the occurrence of which AEMO considers to be reasonably possible in the surrounding circumstances including the technical envelope.

44 Clause 4.2.3(f) of the NER defines a protected event as a non-credible contingency event that the Reliability Panel has declared to be a protected event under clause 8.8.4, where that declaration has come into effect and has not been revoked. Protected events are a category of non-credible contingency event.

- Industrial action or acts of God at existing generating facilities or inter-regional transmission facilities.

The NER provides some additional guidance on what should be considered to be a 'power system reliability incident'. Clause 3.9.3C(c) of the NER specifies that a "power system reliability incident" is an incident that AEMO considers would have been avoided only if additional active energy had been available to the relevant region or regions from generation, demand response or inter-regional transmission elements.[45]

The loss of customer load due to multiple contingency events, radial transmission line outages, industrial action or acts of God at existing generation or inter-regional transmission facilities are therefore not included. As an example, load shedding in Queensland following the fire at the Callide Power station and associated loss of transmission lines is not included as USE for the purposes of assessing the reliability standard as it occurred as a result of a multiple non-credible contingency event.

2.2 Current framework for delivering reliability in the NEM

The standard and settings together represents a core element of the current framework for delivering reliability in the NEM. Figure 2.1 provides a summary of this framework which includes the provision of reliability through spot market incentives supplemented by information and intervention by AEMO as a last resort.

Figure 2.1: Current NEM reliability framework

Source: AEMC

45 The Panel acknowledges the complex relationship between a 'reliability' incident and a 'security' incident. For example, if a reliability incident such as a shortfall in available capacity in a region is not addressed through an action like manual load shedding, this would result in the power system being in an insecure operating state. This in turn could trigger a security incident following a contingency which may result in a major supply disruption such as operation of the automatic load shedding scheme or even a system black. As such, while these events are classified separately, the Panel notes that both may result in loss of supply and therefore are more or less indistinguishable for consumers.

A reliability framework requires a trade-off between the prices paid for electricity and the cost of not having energy when it is needed. The need to balance these costs illustrates that the most efficient level of reliability is not having zero per-cent USE. Such an approach would be inefficient as the cost of supplying energy would exceed the value placed on it by customers. As introduced in Chapter one, the level of the standard is based on the level of USE that represents an efficient economic trade-off between reliability and affordability based on what customers value.

2.2.1 Market incentives

Market incentives are the foundation of the current NEM reliability framework. Prices in the spot and contract markets provide signals for generation and demand-side resources to be built and dispatched, as well as provide information about the balance of supply and demand across different places and times. As the expected supply/demand balance tightens, spot and contract prices will rise, within the price envelope defined by the market price settings. A rise in market prices affects operational decisions and provides the incentive for entry and increased production, addressing any potential reliability problems as or before they arise.

Spot market

The NEM utilises a gross pool (mandatory participation) energy-only market design. Generators sell all the electricity they produce through the wholesale market for electricity, which matches supply to demand on a five-minute basis.[46] From market participant bids and offers to consume or supply electricity at certain prices, the national electricity market dispatch engine (NEMDE) determines the lowest cost combination of scheduled generation or demand to meet customer load, given the physical limitations of the power system. AEMO then issues dispatch instructions and wholesale market prices are determined from the generator offers or demand bids to supply the last MW of customer load in the NEM[47]

The pricing framework for the NEM allows for price variability within an envelope established by the settings. The market price settings therefore act to limit the prices that generators receive for supplying electricity and the revenue potential from investment decisions. The level of the market price settings therefore need to carefully balance the reliability benefits of efficient wholesale market price signals with the financial risks faces by market participants. This trade off, and related considerations, are discussed in more detail in Chapter six.

Contract market

Reliability outcomes in the NEM are facilitated by financial contracting for risk management.[48] The contracts, or financial derivatives, market supports reliability in the NEM by providing a means for retailers and generators to manage their exposure to spot prices, by allowing participants to trade uncertain and variable spot market prices for fixed prices for a specific

46 NEM market design includes 8 markets for frequency control ancillary services (FCAS) that regulate frequency by balancing supply and demand for electricity on sub five-minute timescales.

47 This framework is underpinned by the economic principle that the most efficient investment decisions are made if market participants can make their own decisions in response to marginal prices. As such, the market price provides the signals needed for investors to make informed investment and divestment decisions.

48 While the financial markets this contracting occurs through are not part of the formal wholesale electricity market operated by AEMO, contract markets are still a critical element of the NEM reliability framework.

period (e.g., a month, quarter, year or longer). Contract markets create incentives for reliability including on:

- operational timescales - generators who have sold contracts are incentivised to be available when needed (i.e. when spot prices are high), in order to be dispatched to at least the volume of those contracts so the revenues earned in the spot market fund payouts on their contract positions. This incentive to 'turn up' is heightened during high price/tight demand supply periods, which is precisely when the system most values the generator's output.
- investment timescales - forward contracting lowers the cost of financing investment in generation capacity, which lowers the cost of achieving and maintaining system reliability. Contracts provide generators with a steadier stream of revenue than the spot market. A steadier stream of revenue reduces the risks to parties providing funding to generators, such as debt and equity holders. This lowers the overall cost of capital required to finance the project and lowers the cost of the new generation capacity.

Prices in the contract market also reveal participant expectations regarding the value of, and risk associated with, additional resource investments. Price signals in the contract market therefore complement those in the spot market in signalling the value of new entrant investment to support reliability outcomes.

2.2.2 AEMO Information and intervention processes

A key role for the reliability standard is to guide various decisions made by AEMO in its role as the system operator. AEMO is responsible for operationalising the reliability standard through its forecasting and operational processes. AEMO's Reliability Standard Implementation Guidelines set out how AEMO implements the reliability standard.[49] AEMO uses the reliability standard in several core ways including to:

- Publish forecasts regarding reliability and its components to inform market participants, network service providers and potential investors, over ten year, two year and six day outlooks,[50] and
- Monitor demand and generation capacity and, if necessary, initiate action in relation to a relevant AEMO intervention event to maintain the reliability of supply and power system security where practicable.

Information processes

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

49 AEMO, *Reliability Standard Implementation Guidelines*, December 2020, Sydney, available here.

50 For further information see AEMO, *Reliability Standard Implementation Guidelines*, December 2020, Sydney, pp. 8-22 available here.

The purpose of this information is to inform the market of prevailing and forecast conditions, particularly when reserves may be running low, in order to elicit a market response. For example, the electricity statement of opportunities (ESOO) identifies potential shortages of generation over a 10-year forecast time horizon to prompt the market to make new investments to alleviate any forecast reliability problems. AEMO also publishes relevant information through its Projected Assessment of System Adequacy (PASA) and pre-dispatch processes.[51]

In operational timescales, AEMO issues lack of reserve (LOR) notices to inform the market when supply scarcity conditions apply. AEMO declares LOR conditions when it determines there is a non-remote probability of unserved energy due to a shortfall of available capacity reserves at a given time in the assessment horizon.[52] LOR notices are either LOR1, LOR2, and LOR3 in order of increasing supply scarcity. [53]

Intervention mechanisms

As effective as information processes can be in delivering the desired reliability outcomes through market incentives, they do not always elicit the outcomes needed. If the market fails to respond to the information AEMO publishes, AEMO may have no other choice but to intervene in the market more directly.

AEMO therefore has various 'last resort' intervention powers that enable it to deal with actual or potential shortages of varying degrees of severity. Under the NER, these intervention mechanisms include the following:

- AEMO has reliability and emergency reserve trader (RERT) obligations. These allow AEMO to contract for reserves ahead of a period where reserves are projected to be insufficient to meet the reliability standard. AEMO can dispatch/activate these reserves to manage power system reliability and, where practicable, security.[54]
- In addition, if there is a risk to the secure or reliable operation of the power system, AEMO can use directions or instructions under NER clause 4.8.9 to:
  - Direct a generator to increase its output, if this is possible and can be done safely.
  - Direct a large energy user, such as an industrial plant, to temporarily disconnect its load or reduce demand.

If there continues to be a shortfall in supply, even after these measures have been implemented, AEMO may require involuntary load shedding as a last resort to maintain the power system in a secure state. It does this by instructing a transmission network service provider to arrange for the interruption of customer load.

51 Clauses 3.7.2(f)(6) and 3.7.3(h)(5) of the NER.

52 In the NEM, reserves are made available by the market as part of usual operation of the power system and expectations of future price outcomes in the energy market. Reserves refer to the amount of spare capacity available given amount of generation, demand and demand response at any point in time, and can be 'In market' from generators that are available to run, but because available capacity is greater than demand, are not called on to run, and 'Out of market' from the emergency reserves that AEMO procures through the reliability and emergency reserve trader (RERT) mechanism to be in standby.

53 Clause 4.8.4 of the NER - additional information is available in AEMO's reserve level declaration guidelines, available here.

54 Clause 3.20.3 of the NER.

These intervention mechanisms provide an important ultimate safety net when there is insufficient generation capacity to maintain adequate reserves above demand, to minimise the adverse impacts on customers of involuntary load shedding. Although AEMO would be expected to do all that it necessarily can to avoid load shedding using the above intervention mechanisms, there will be times when involuntary load shedding will be unavoidable because the level of investment and operational decisions are being driven by a reliability standard that is non-zero.

2.2.3 Additional reliability measures

In addition to the core NEM arrangements for reliability, the retailer reliability obligation (RRO) and interim reliability standard and reserve have been implemented in recent years to further support reliability outcomes in the NEM.

The retailer reliability obligation (RRO) - The RRO commenced on 1 July 2019, to strengthen incentives for market participants to invest to support reliability outcomes in the NEM. If AEMO identifies a material reliability gap within a three-year period, the RRO is triggered requiring liable entities, including electricity retailers, to enter into sufficient qualifying contracts to cover their share of a one-in-two year peak demand event.[55] The South Australian Minister also has the ability to trigger the RRO within South Australia.[56].

The interim reliability standard and reserve - The interim reliability measure was put in place by Energy Ministers (formally COAG Energy Council) following advice from the ESB to improve the reliability (resource adequacy) of the electricity system in the short term.[57]

The interim reliability measure for generation and inter-regional transmission elements in the NEM is a maximum expected unserved energy in a region of 0.0006% of the total energy demanded in that region for a given financial year.[58]

The interim reliability measure is relevant for contracting interim reliability reserves and for the Retailer Reliability Obligation.[59] The interim reliability measure stands apart from the reliability standard and settings, and is not in scope of the Panel's review discussed in this document. However, the Panel may provide commentary on the interim reliability measure to the AEMC in its final report. The Panel's commentary may be considered by the AEMC which must conduct a review of the interim reliability standard by 1 July 2023.[60]

2.3 NEM Reliability to date

The NEM has historically enjoyed a very high level of reliability. However, reliability issues sometimes occur when the balance of supply and demand in a region is tight. The increase in

55 AER, Interim reliability instrument guidelines - Retailer Reliability Obligation, July 2019, Canberra, available here.

56 In January 2021 and 2022, the South Australia Minister for Energy and Mining triggered the RRO in South Australia for the first quarter of 2024 and 2025 respectively. For reliability gaps before 1 July 2022 this can be done 15 months or more before the start of the identified gap and after that must be consistent with the time frames set out in the National Electricity Rules (NER). More information is available here.

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

58 Clause 3.9.3C(a1) of the NER.

59 Clauses 3.9.3C(a1) and rules 11.128, 11.132 of the NER.

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

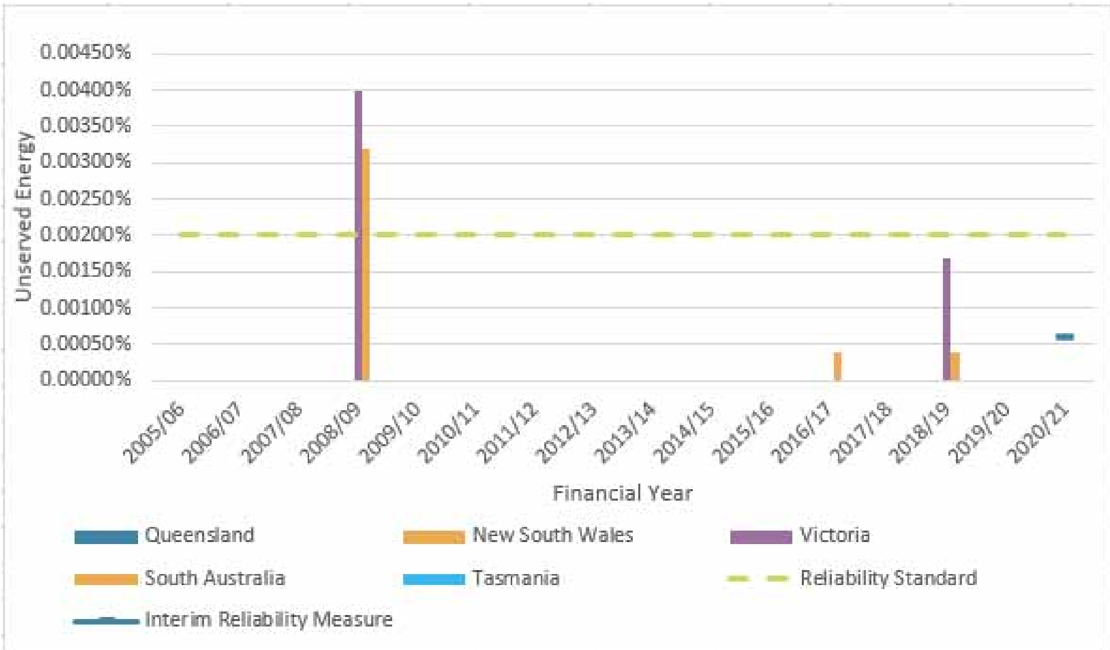
variable renewable generation is seeing the power system supply and demand balance become more sensitive to weather conditions than has historically been the case. This, combined with an observed increase in extreme environmental events has led to operational reliability becoming more challenging for AEMO to manage.[61]

This section provides a summary of NEM reliability performance as context for the issues addressed in coming chapters.

2.3.1 Unserved energy in the NEM

Over the past 14 years, reliability events in the NEM due to a lack of available capacity have been very rare. That is, there have been very low levels of actual USE across all NEM regions. In the Panel's most recent AMPR for the 2019-2020 period, it was noted that the standard has only been breached on an ex-post basis in 2008-09 in South Australian and Victoria, which was as a consequence of extreme weather conditions and reduced availability of Victorian generators and the Basslink interconnector.[62] Figure 2.2 shows actual USE levels across the NEM regions since 2005 illustrating the high level of reliability which has been provided by the NEM to date.

Figure 2.2: Historical Unserved Energy in the NEM



Source: AEMC, AMPR market update, 16 December 2021, page 9, available here

In addition to the low level of unserved energy in the NEM to date, AEMO's 2021 Electricity Statement of Opportunities (ESOO) report forecasts no breaches of either the reliability

61 For example, the bushfires that impacted the operation of the power system in 2019-20.

62 Reliability Panel, Annual Market Performance Review, May 2021, Sydney, p. 54.

standard or interim reliability measure until 2028-29, which is beyond the period relevant to this review.[63] This ESOO report however forecasts USE for Victoria in 2028-29 and both Victoria and NSW in 2029-30 and 2030-2031 will both exceed the reliability standard, if further investment in new capacity or demand reduction was not forthcoming by that time.[64]

2.3.2 Reserve levels and lack of reserve notices

While the NEM continues to provide high levels of reliability, there is some evidence to suggest that reliability pressures may be increasing.

The Panel is aware that a record number of LOR notices have been issued in recent years despite actual unserved energy levels being low and AEMO's ESOO indicative reliability forecast showing expected USE stays below the standard in all regions until 2028-29.[65]

Figures 2.3 and 2.4 show an unprecedented number of LOR1 notices have been issued in 2020-21, reflecting a system that is running much tighter than it has in the past.[66] Interestingly the number of LOR2 and LOR3 notices issued did not follow the same trend, indicating that while the supply and demand balance is becoming tighter the market may have sufficiently responded to LOR1 notices to avoid LOR2 and LOR 3 notices and conditions. This may indicate that existing market settings and instruments used to incentivise generators to be available through these periods remain sufficient. The increase in LOR1 notices in FY 2021 is mostly driven by the 2021 winter period in New South Wales[67]. LOR notices by state is on page 60 of the 2020 Annual Market Performance Review, available here.

63 AEMO, *2021 Electricity Statement of Opportunities*, August 2021, p. 6.

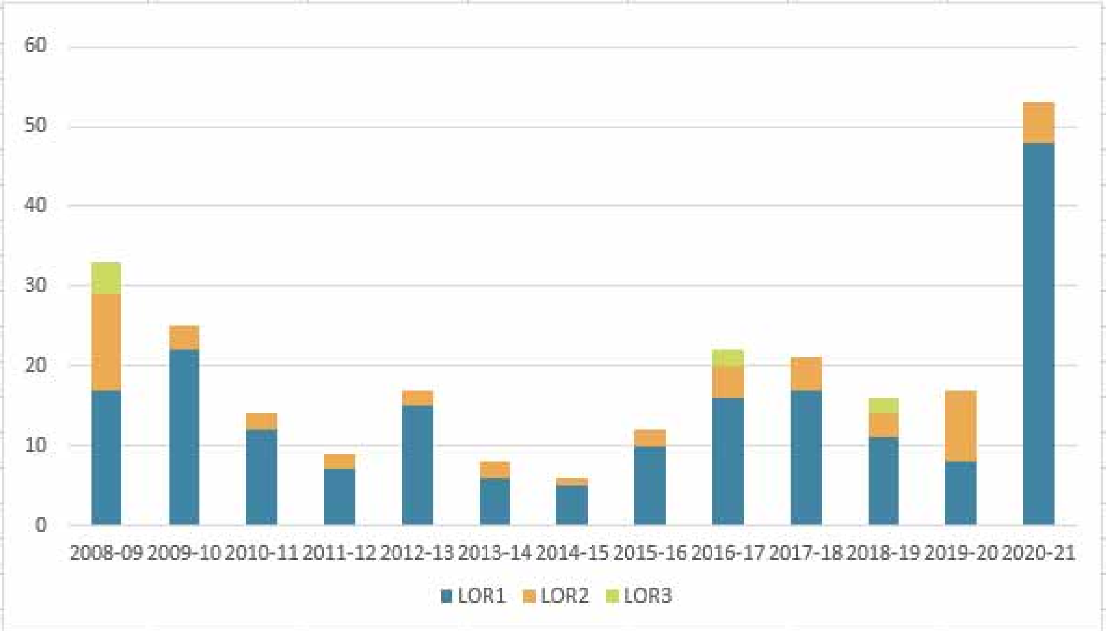
64 AEMO, *2021 Electricity Statement of Opportunities*, August 2021, p. 8.

65 AEMO, *2021 Electricity Statement of Opportunities*, August 2021, p. 6.

66 LOR 1 notices are declared when capacity reserves for a region are less than either the two largest credible contingencies for that region or the credible MW risk level indicated by AEMO's Forecast Uncertainty Measure (FUM)

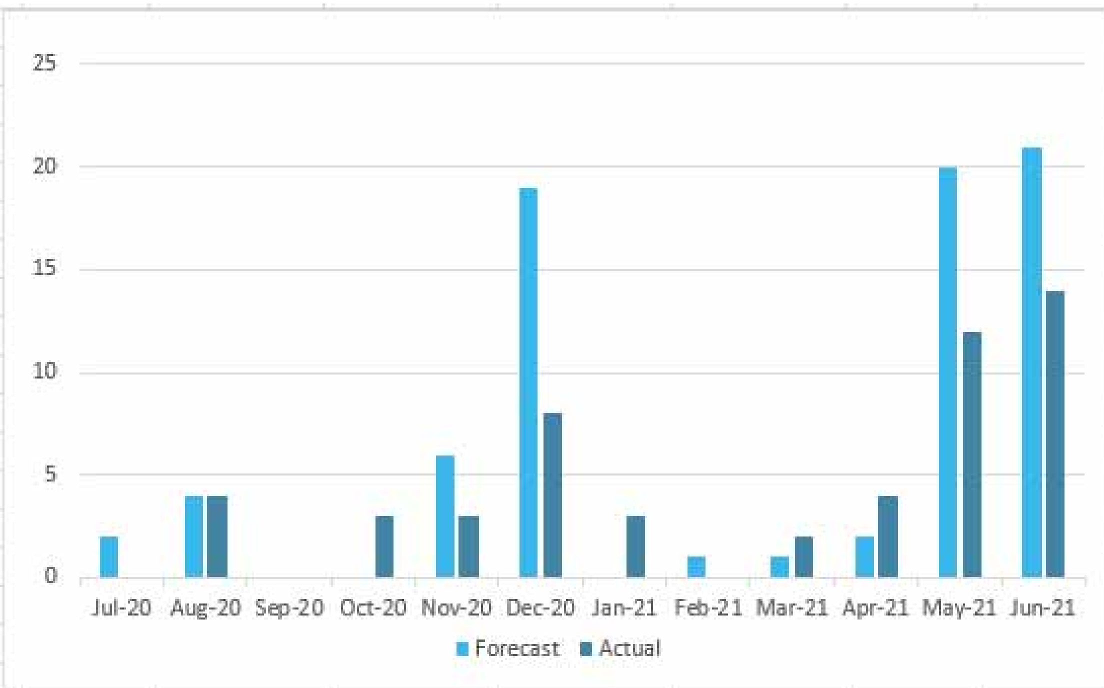
67 LOR notices by region and month is on Slide 12 in the 2021 Annual Market Performance Update, available here.

Figure 2.3: Number of Actual LOR Notices



Source: AEMC, AMPR market update, 16 December 2021, page 12, available here

Figure 2.4: FY21 Lack of Reserve Notices by Month



Source: AEMC, AMPR market update, 16 December 2021, page 12, available here

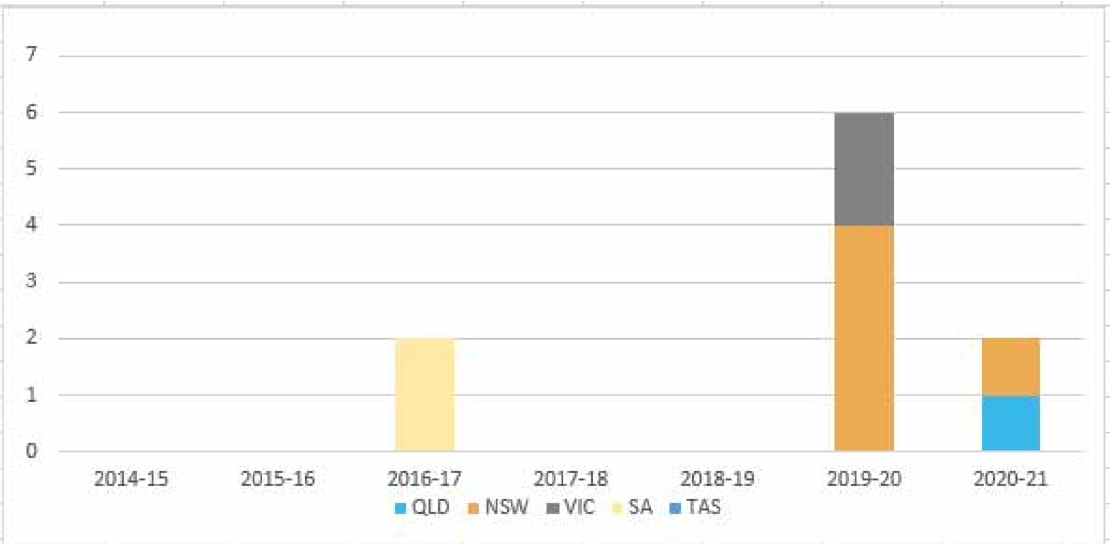
2.3.3 Reliability directions and RERT

As outlined, AEMO is able to direct for reliability and dispatch the RERT in order to maintain the power system in a reliable state. In a similar manner to the increasing frequency of LOR1 notices, recent years have also seen an increase in the frequency of AEMO interventions (direction and dispatch of RERT) for reliability.

AEMO interventions for reliability have historically been very infrequent. RERT was dispatched for the first time in 2017. However, since this time, there has been a significant number of interventions for reliability.

Figures 2.5 - 2.7 show that following the first dispatch of RERT in 2017/18 AEMO has dispatched over 3,000 MWh of RERT in 2018/19 and 2,000 MWh of RERT 2019/20. Of note is also the number of reliability directions AEMO issued in 2019/20 when it issued 6 directions in NSW and Victoria.[68] These directions were a result of extreme temperatures, high demand and environmental factors such as storms and bushfires affecting the power system, in particular the transmission network.

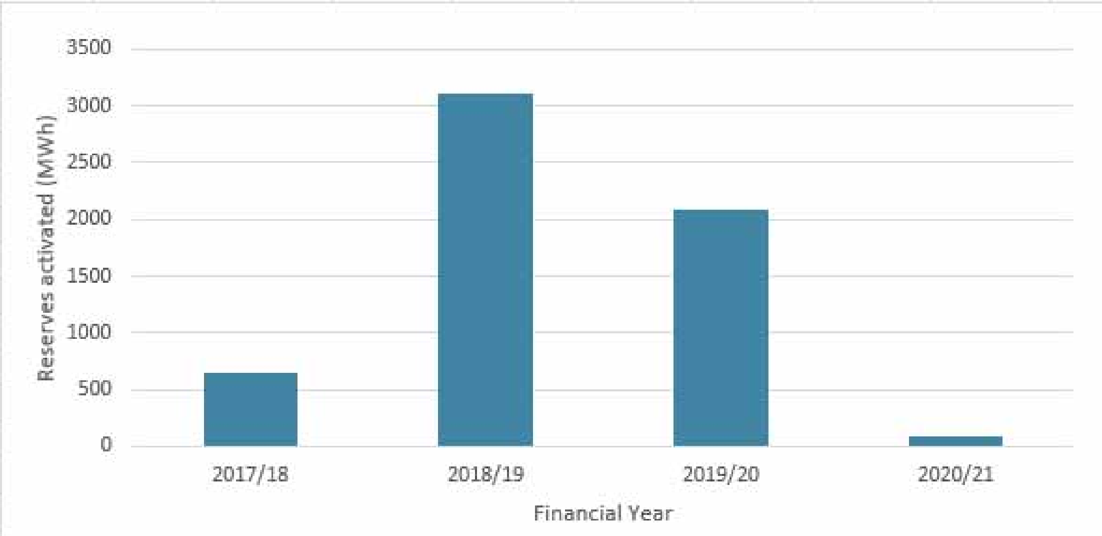
Figure 2.5: Number of Reliability Directions Issued by AEMO



Source: AEMC, AMPR market update, December 2021

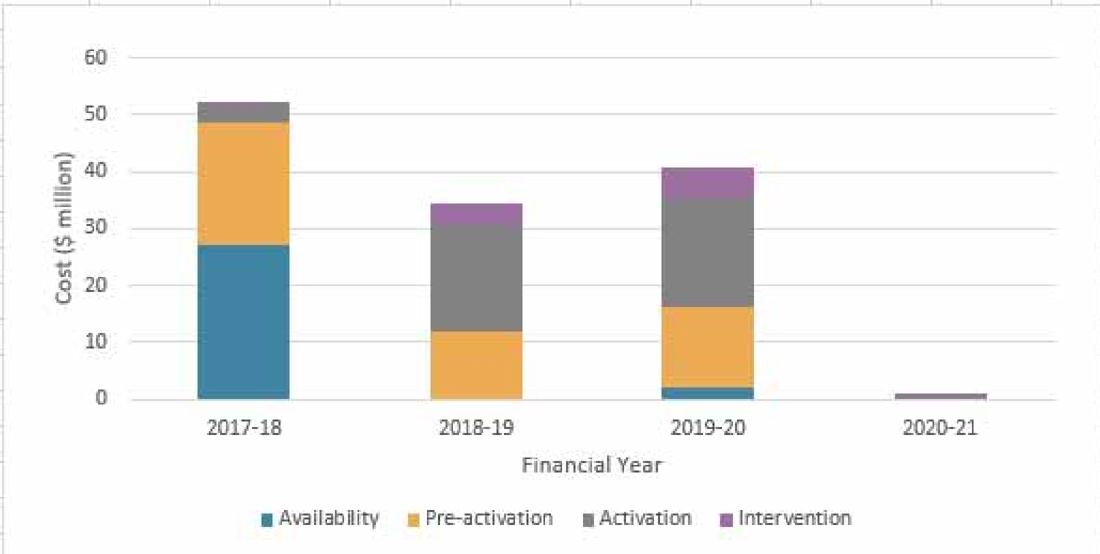
68 AEMC, *Annual Market Performance Review, market update,* 16 December 2021, p. 10, available here

Figure 2.6: RERT Reserves Activated



Source: AEMC, AMPR market update, December 2021

Figure 2.7: Costs of RERT Use



Source: AEMC, AMPR market update, December 2021

The increasing number of AEMO interventions for reliability seen in recent years has not continued in 2020/21, with the volume of RERT activated being a fraction of that of the three preceding years. RERT was only activated on two occasions during 2020/21, one being due to large amounts of baseload generation in NSW experiencing outages concurrently, while the second was due to a substantial amount of generation being unavailable following the Callide incident in QLD.[69]

This reduction in the use of RERT may be attributed to a number of factors, including a mild summer in 2020/21 but also may indicate that, despite the continuing tightness of the system, incentives for participants to provide availability to ensure reliability remain sufficient. Further discussion of these incentives, in particular the MPC and CPT are provided in Chapter six.

It is noted that in previous years, the increased amount of RERT dispatched has been largely associated with an increase in system security events. Stakeholders should however note that RERT will not be a consideration for the Panel in the 2022 RSS review as it may only recommend an MPC and CPT that will allow the reliability standard to be satisfied without the use of AEMO's powers to intervene through reliability directions and RERT.[70]

The Reliability Panel's Annual Market Performance Update published in December 2021 provides more detail on reliability outcomes over the period of 2020-2021.[71]

69 AEMC, Annual Market Performance Review, market update, 21 December 2021, p. 14 - RERT was activated on 17 December 2020 in response to higher than expected demand in NSW due to hot, humid weather, and a trip at Liddell Unit 31. RERT was also activated on 25 May 2021 following the loss of availability in QLD due to the Callide incident.

70 Clause 3.9.3A(f) of the NER.

71 AEMC, *Annual Market Performance Review, market update,* 16 December 2021, available here.

3 NEM IN TRANSITION AND MARKET REFORMS

The physical power system is undergoing a period of significant change. Continuing and rapid changes in the generation mix with the ongoing exit of ageing thermal generators, significant entry of large and small-scale variable renewable generation, and increasing uptake of distributed energy resources are changing market dynamics, price distributions, and increasing incidences of low wholesale prices. In addition, the NEM in transition is also seeing:

- steady maximum demand and moderate projected growth
- declining minimum demand driven by small-scale PV uptake
- changing consumption patterns
- the introduction of five minute settlement and wholesale demand response mechanism
- proposals for increased interconnection
- changes to the NEM's market design, including the proposals currently being developed through the ESB's Post-2025 market design work
- government policies to incentivise new capacity and retain existing capacity and continued uncertainty in relation to emissions policy
- increasing frequency and severity of extreme weather events, which can pose challenges for reliability, particularly given high penetrations of weather dependent renewable generation, and
- reliability issues which have begun to emerge during 'shoulder' and 'winter' periods as supply and demand less predictable than in the past.[72]

These changes have been happening faster than expected, many of which are likely to continue over the next two decades.[73] These changes affect both the supply and demand side of the wholesale market and involve considerations relevant to the 2022 RSS review of the standard and settings to varying degrees.

This chapter introduces key changes in the NEM's physical and policy environment:

- on the supply side of the market
- on the demand side of the market
- changes in wholesale market operation and outcomes, and
- changes in the NEM policy environment relevant to reliability outcomes.

This chapter is supported by Appendix A, which provides additional contextual information on the changing power system and market reforms.

72 Reliability Panel, *Information Paper: The reliability standard, current considerations, 12* March 2020, Sydney, available here. This situation is compounded by the maintenance of generators and transmission infrastructure, which generally occurs during in these periods.

73 Energy Security Board, *Post-2025 Market Design Directions Paper,* January 2021.

3.1 Changes on the supply side of the market

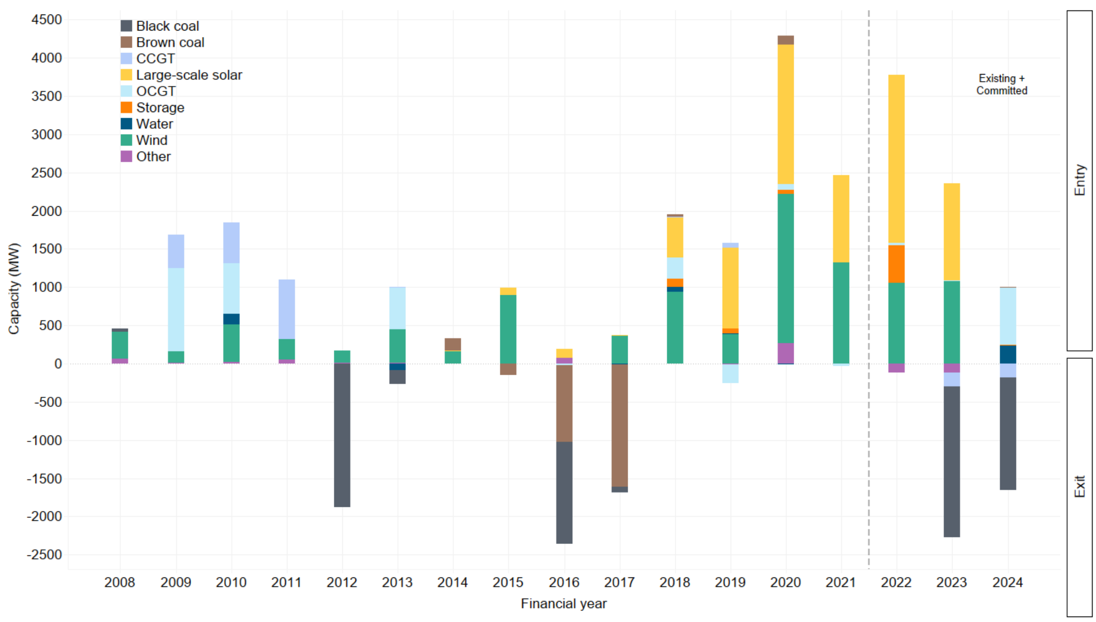
The generation mix in the NEM is changing rapidly with the entry of significant levels of large-scale variable generation and distributed PV combined and the continuing exit of synchronous thermal generation.

3.1.1 Entry of generation

The NEM is experiencing a rapid increase in variable renewable generation combined with large scale and distributed storage.

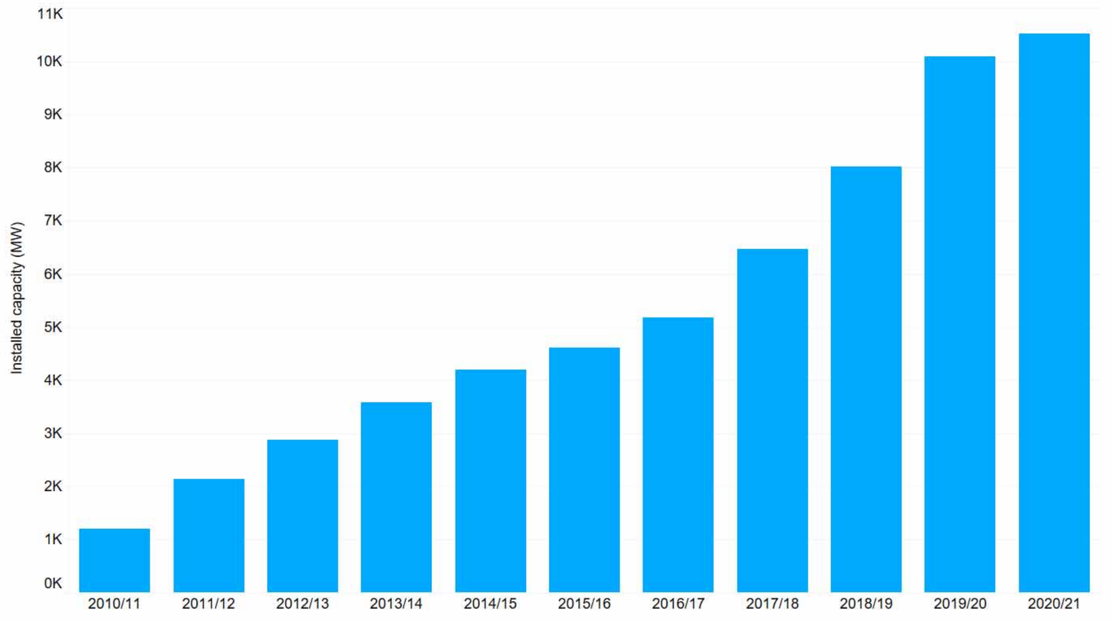
Figure 3.1 shows around 4,544 MW of large-scale solar and 4,604 MW of wind were commissioned between FY 2018 and FY 2021. A further 3,607 MW of large-scale solar and 2,772 MW of wind are committed to enter over the next three financial years.

Figure 3.1: Entry and exit of generation in the NEM



Source: Analysis of AEMO data.
Note: Information is based on AEMO NEM Generator Information as of October 2021.

Figure 3.2: Small-scale PV capacity in the NEM



Source: Clean Energy Regulator.
Note: This figure shows estimated small-scale PV capacity based on the Clean Energy Regulator postcode data.

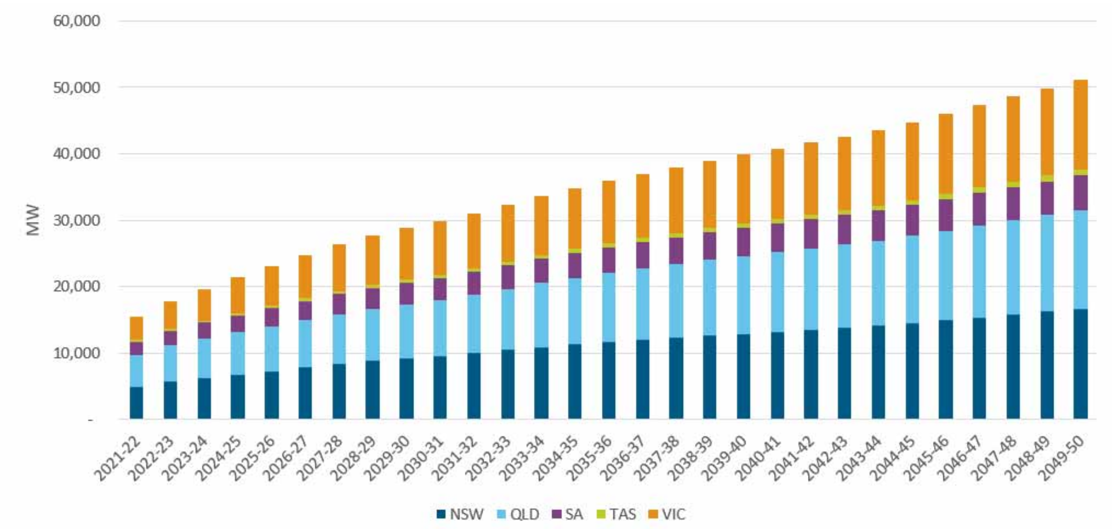
In addition, there is continuing rapid uptake of small-scale variable generation at the distribution level, mainly made up of residential rooftop PV. According to the Clean Energy Regulator, as at 31 October 2021, there were around 2.6 million small-scale PV systems in the states covered by the NEM. Figure 3.2 shows the estimated installed small-scale PV capacity in the NEM since 2010/11.[74]

Rapid uptake of residential rooftop PV is projected to continue. Figure 3.3 shows that AEMO's Net Zero 2050 ESOO scenario forecasts rooftop PV capacity exceeding 30 GW by 2030.[75]

74 Information contained in Figure 3.2 was obtained from the Clean Energy Regulator.

75 AEMO, *Electricity Statement of Opportunities 2021: Inputs and assumptions workbook* (ESOO), Net Zero 2050 Scenario, July 2021, available here.

Figure 3.3: Forecast rooftop PV capacity - ESOO net zero 2050 scenario



Source: AEMO, *Electricity Statement of Opportunities 2021: Inputs and assumptions workbook* (ESOO), Net Zero 2050 Scenario, July 2021, available here.

The implications of the changes in the generation mix on reliability outcomes in the NEM, including accelerating PV uptake leading to very high levels of variable renewable generation, are key factors the Panel intends to consider in its 2022 RSS review. Additional information on how these changes will be considered is provided in Chapter seven on modelling for the review.

Entry of utility and distribution scale storage

Since 2017, a number of large utility scale batteries have connected to the NEM. As of November 2021, there are five batteries of at least 25 MW/25 MWh operating in the NEM with further battery projects committed to come online in the near future.[76] In addition, small-scale batteries have been increasingly taken up by residential and business customers.

The Clean Energy Regulator maintains statistics on the number of solar PV systems with concurrent battery storage capacity in the NEM.[77] While this data does not capture all small scale batteries, it currently shows 40,757 batteries are currently installed with PV systems in the NEM. 9,573 systems were installed in 2021 which is a 1,281% increase over the 693 systems installed in 2014. This trend is expected to continue as the price of batteries continues to fall in the future.

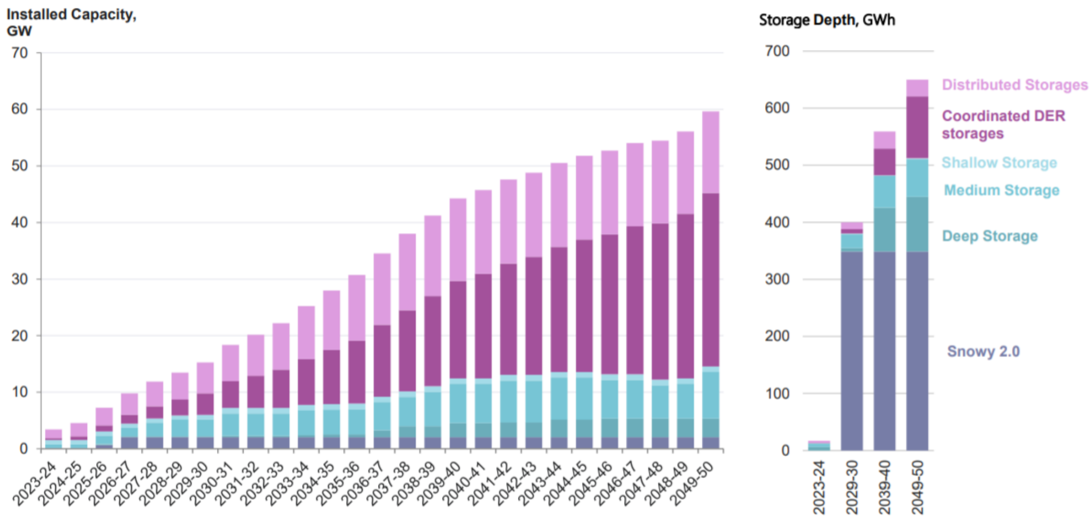
Figure 3.4 shows AEMO's draft 2022 ISP forecast for the increase in storage capacity in the NEM over the period to 2050. While distributed and coordinated DER battery storage is

76 Current and committed projects can be found on the AEMO Generator Information page: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information

77 The Clean Energy Regulator maintains statistics on the installation of some small-scale batteries here: http://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/Postcode-data-for-small-scale-installations

forecast to dominate the increase in GW capacity, it should be noted that deep storage pumped hydro (including Snowy 2.0) are anticipated to dominate the total amount of energy which is able to be stored in the future NEM.[78]

Figure 3.4: Forecast increases in storage installed capacity and depth



Source: AEMO, draft 2022 integrated system plan, p. 50.

Storage can provide a number of different value streams including from the arbitrage of high and low market prices, participation in FCAS markets, as well as balancing local generation and load levels such as behind the meter solar generation storage for use during evening periods. Additional storage can assist reliability outcomes but also increases the significance of energy limits in the NEM. The Panel also notes that the assumed storage state of charge, lead time to an event and event duration are extremely important to outcomes given storage as a reliability provider. The extent of these energy limits will depend on the balance between battery and medium/deep storage investment as the NEM transitions.

As thermal generators retire, and storage combined with variable renewable generation is connected in their place, the NEM will become more energy constrained with a corresponding shift in the reliability risk profile. The entry of large scale and distributed storage, combined with thermal unit retirements, may effectively address certain reliability concerns at certain times while also increasing the vulnerability of the NEM to extended periods of low renewable generation.

The Panel considers that the change in generation mix, and increasing levels of energy storage combined with variable renewable generation, may have implications on the optimal form and levels of the standard and settings to ensure that efficient investment and operational signals are sent in a technology-neutral manner.

78 AEMO, draft 2022 integrated system plan, p. 50.

Chapters five and seven provide further discussion on how the Panel intends to consider energy limited storage and batteries as part of the modelling for the review.

Additional demand response

DER uptake is expected to increase further as technology and policy developments enable customers to play a more active role in managing their energy consumption, production and storage.

The introduction of a wholesale demand response mechanism in October 2021 should further increase the amount of demand response participating in the wholesale market. This new mechanism aims to enable the NEM to better capture the increase in demand-side response that is becoming available.[79] Since it commenced, a new category of registered participant, a demand response service provider (DRSP), is able to bid demand response either directly or through specialist aggregators into the wholesale market as a substitute for generation.

Demand response is potentially an important provider of reliability that will be considered in modelling for the review. Further information is provided in Chapter seven.

3.1.2 Retirement

A significant amount of ageing thermal generation will exit over the next two decades for both technical and economic reasons. Rapid entry of wind and solar generation is putting increasing economic pressure on the existing synchronous thermal generation fleet, particularly coal generators, which may hasten their exit from the market. In addition, the incumbent thermal generation fleet will progressively come to the end of its technical life over the next 20 years.

The Panel notes that thermal generation has already exited the market in SA, Victoria and NSW along with the announced closure of the Liddell power station in New South Wales in 2023, Yallourn power station in Victoria in mid 2028,[80] and the most recent announcement that Torrens B1 will be closing early.[81]

Figure 3.5 shows the expected thermal unit retirement dates published on AEMO's generation information page as at November 2021.[82] This shows that AEMO expects 20 GW of thermal retirement over the coming 20 years.[83]

79 AEMC, Wholesale demand response mechanism, rule determination, 11 June 2020.

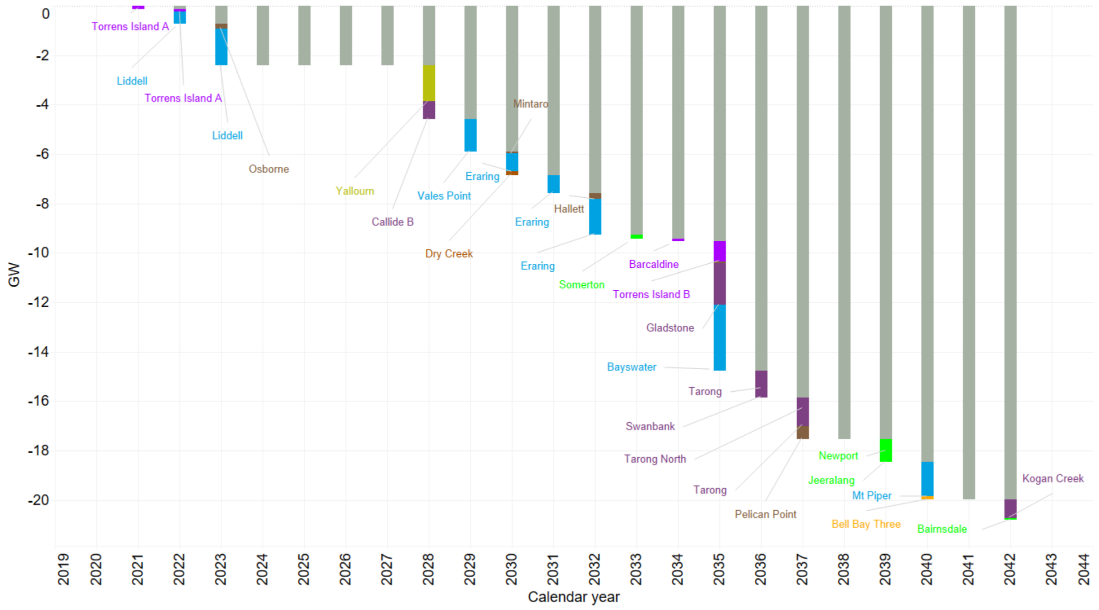
80 https://www.energyaustralia.com.au/about-us/energy-generation/yallourn-power-station/energy-transition#:~:text=After%20decades%20of%20faithful%20service,will%20retire%20in%20mid%2D2028.&text=Under%20the%20agreement%2C%20EnergyAustralia%20will,will%20be%20completed%20by%202026.

81 https://www.agl.com.au/about-agl/media-centre/asx-and-media-releases/2021/july/agl-to-mothball-one-unit-at-torrens-b-in-south-australia

82 AEMO's generation information page can be found at: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-planning-data/generation-information

83 Additional to the closures listed below is the decision of AGL to mothball Torrens B1 Unit in October FY22.

Figure 3.5: Coal-fired generation and GPG retirements



Source: AEMO generation information page, November 2021.
Note: The announced retirement dates of some units shown above have changed since the ISP was prepared in early 2020.

The Panel is particularly aware of the potential for thermal generators to exit prior to the end of their expected technical life for economic reasons, given the continued entry of variable renewable generation. In addition, thermal plant performance may deteriorate as plants age, reducing available capacity and increasing the probability of forced outages affecting reliability outcomes. This performance deterioration is likely to be compounded by increasing thermal unit generation cycling in response to increasing variable generation bidding in to the wholesale market at low prices. Technical limitations on ramping and cycling may also further affect the financial performance and viability of coal-fired power stations further increasing the potential for early exit for economic reasons.

While the Panel notes the increasing potential for accelerated thermal retirements for economic reasons, there are a range of complex factors that may influence decisions on economic retirement timing including potential site remediation costs. The Panel is interested in stakeholder views on other factors which may influence retirement decisions for economic purposes.

QUESTION 1: CHANGES IN THE GENERATION MIX

- How do stakeholders consider changes in the generation mix interact with the assessment of the reliability standard and settings, in particular for the period of 2024-

2028? What are the implications of the changing generation mix for the reliability standard and settings?

- What other factors should the Panel account for when considering economically driven retirement decisions?

3.2 Changes on the demand side

The demand side of the market is also changing with:

- Limited demand growth
- Declining minimum system load driven by small-scale PV uptake, and
- Changing consumption patterns and increased uncertainty in long term demand forecasting.

3.2.1 Limited demand growth

Reliability outcomes, and the need for additional generation capacity, has traditionally been driven by increasing peak loads. Maximum annual demand has however become less of a driver for additional power system resource needs than in the past.[84]

All regions except Queensland have seen small reductions in maximum demand between FY 2009 and FY 2021, as seen in Figure 3.6. Over the same period, Queensland saw an increase in maximum demand of around 773 MW (around 8.9 per cent) from 8,704 MW in FY 2009 to 9,477 MW in FY 2021, reflecting the commencement of LNG liquefaction in Gladstone and strong population growth.[85]

In its 2021 ESOO, AEMO projects moderate maximum demand growth over the next five years (and a small reduction in Victoria and New South Wales) under their Net Zero 2050 scenario. Over the longer term (6-20 years) they project high maximum demand growth.[86] The potential for high maximum demand growth in the longer term is however significantly uncertain and relies on increasing electrification and the development of a hydrogen production industry in Australia.[87] Projected growth in maximum demand is noted to be largely beyond 2028 and the period relevant to the 2022 RSS review.[88]

84 AEMO's 2021 ESOO also forecasts moderately declining MWh energy consumption levels over the period relevant to the 2022 RSS review. For further information see: AEMO, 2021 Electricity Statement of Opportunities, August 2021, p. 22.

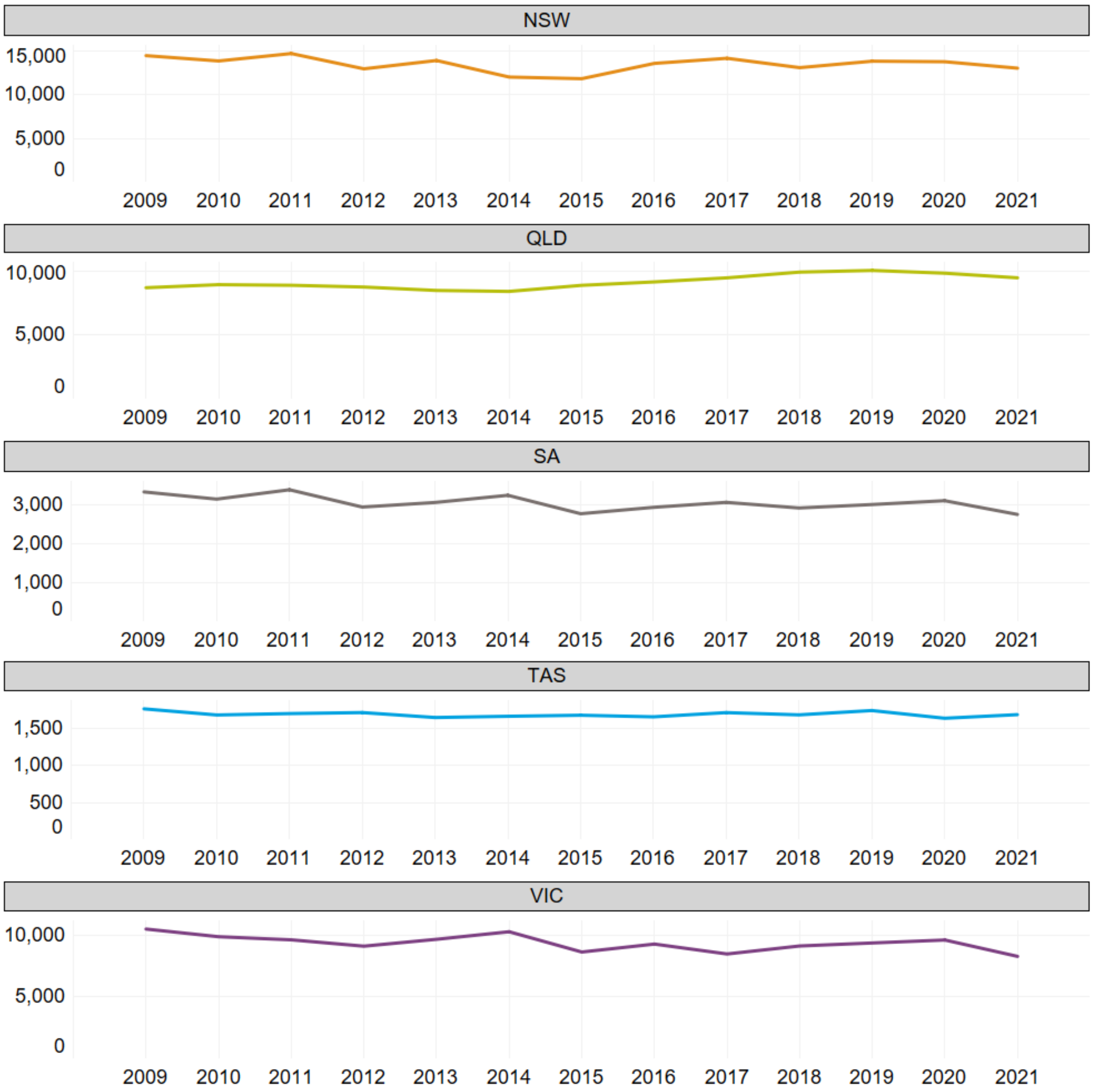
85 AEMC analysis of AEMO MMS data.

86 AEMO, 2021 Energy statement of opportunities, August 2021, p. 27. - AEMO's maximum demand forecast represent uncontrolled or unconstrained demand, free of market-based or non-market-based solutions that might reduce system load during peak (including Reliability and Emergency Reserve Trader [RERT], the Wholesale Demand Response [WDR] mechanism, or DSP).

87 AEMO, 2021 electricity statement of opportunities, August 2021, Appendix A.

88 Ibid.

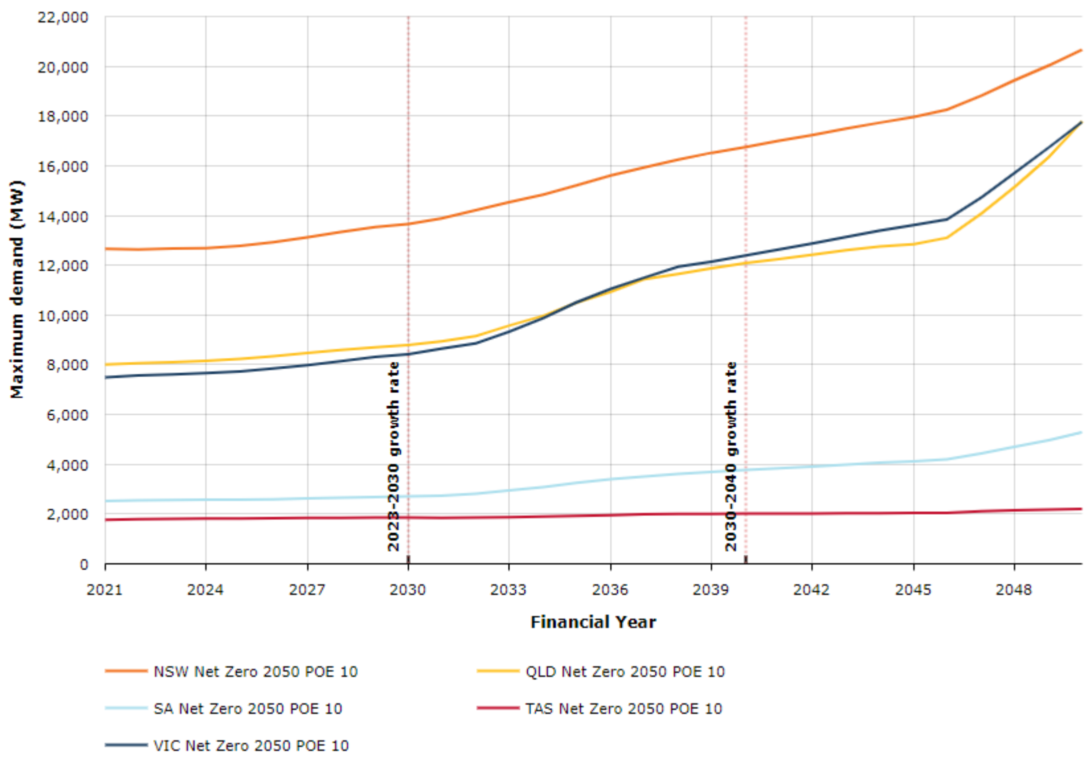
Figure 3.6: Maximum demand by financial year (MW)



Source: AEMC analysis of AEMO MMS data.
Note: Figure based on 5-minute demand.

Winter maximum demand is expected to increase in most regions over the period relevant to this RSS review, as seen in Figure 3.7. While winter peaks are typically below summer peaks in all regions of the NEM except Tasmania which is winter peaking, they may also coincide with low solar output which may pose risks for reliability as the generation mix transitions and energy limited storage becomes more important for reliability outcomes. The Panel notes that winter peak loads are growing in some regions including South Australia, where record high winter demand was experienced in 2020.[89] The Panel is aware that Victoria and New South Wales are also seeing a resurgence in winter demand levels.

Figure 3.7: Winter maximum demand forecast (POE10) - Draft 2022 ISP Net Zero 2050



Source: AEMO Draft 2022 ISP - Net Zero 2050 scenario.
Note: This chart shows the forecast of winter maximum demand with a 10% probability of exceedance.

While less of a driver of reliability outcomes than in the past, the Panel still considers that expected growth in maximum demand, and changes in supply/demand in winter and shoulder periods, as well as summer, may place pressure on NEM reliability outcomes in the longer term if efficient investment is not effectively incentivised to meet emerging and changing demand characteristics.

3.2.2 Declining minimum net system demand driven by small-scale PV uptake

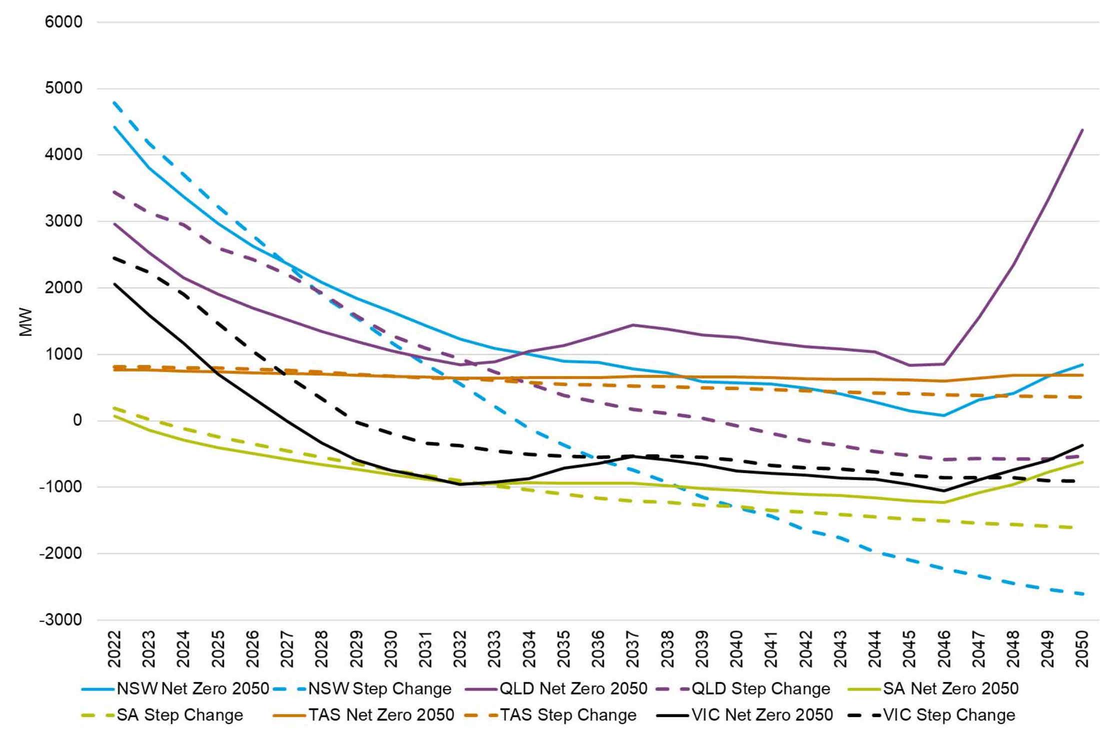
The continuing and accelerated uptake of DER, in particular residential solar PV, is leading to declining levels of minimum system demand. Figure 3.8 shows AEMO's draft 2022 ISP minimum operational demand forecast during shoulder periods when demand is typically

89 South Australia winter demand broke winter record in 2020 as well as winter 2021 (2628 MW operational demand on 22 July 2021).

lower.[90] Minimum system demand is projected to decline at differing rates across the NEM regions, with large differences depending on the rate of DER uptake.[91]

Figure 3.8 shows forecast minimum operational demand for AEMO's ESOO and ISP Net Zero 2050 and Step Change scenarios.

Figure 3.8: Minimum operational demand forecast for Net Zero 2050 and Step Change scenarios



Source: AEMO Draft 2022 ISP

Note: This chart depicts minimum system load forecasts for the Net Zero 2050 and Step Change scenarios in the Draft 2022 Integrated System Plan (ISP), http://forecasting.aemo.com.au/Electricity/MinimumDemand/Operational

Low net demand situations are currently handled through a range of operational measures, including curtailment of VRE during critical periods to ensure that the power system remains secure.

AEMO has implemented a market notification framework to increase transparency on actions taken to maintain power system security, and seek a market response where possible, during challenging minimum system load conditions due to high rooftop solar PV exports. The minimum system load (MSL) notices are not an element of the formal reliability framework but are similar in concept to the Lack of Reserve (LOR) process involving three notices prior to AEMO intervention. AEMO intends these new market notifications aim to better

90 Shoulder periods occur during spring and autumn.

91 This trend is best conveyed by the difference between the Central and High DER scenarios in New South Wales and Queensland, where the High DER scenario shows a significantly higher rate of decline.

communicate power system risks and the operational response, while also working on future solutions to better integrate Distributed Energy Resources and drive consumer participation in emerging and new markets.[92]

While declining minimum demand levels are most significantly a system security concern,[93] and the introduction of new technologies including synchronous condensers are expected to alleviate some issues associated with maintaining system security at high penetrations of VRE, increasingly low net demand conditions are increasing the frequency of low market price events with potential implications for the efficient level of the market floor price. Additional information on the frequency of low and negative market price events is provided in section 3.3 of this chapter.

3.2.3 Changing consumption patterns and increased uncertainty in demand forecasting

The NEM is experiencing changes in consumption patterns and their interactions with the electricity system. These changes include the uptake of new customer technologies, behind the meter storage, the exit and entry of large loads, as well as structural changes in energy use that may occur as a result of the COVID-19 Pandemic. Together these changes are increasing the level of uncertainty in forecasting the supply and demand for electricity on both investment and operational timescales.

Increasing demand forecast uncertainty is a challenge for the Panel in reviewing the standard and settings which rely on forecasts of demand that extend over the investment time horizon. This section summarises key sources of uncertainty in future demand outcomes including:

- uptake and behaviour of new customer loads such as electric vehicles
- behind the meter battery storage and active demand side participation
- the entry and exit of large industrial loads
- changes to patterns of demand and increasing forecast uncertainty given the COVID-19 Pandemic.

Electric vehicle uptake

The electrification of the transport sector could become a core driver of growth in electricity consumption in the future. As a result of greater EV model choice, declining costs, and increasing charging infrastructure availability, transport sector electrification is forecast to accelerate in the late 2020s into the early 2030s.

EV uptake, and the associated demand side effects however may begin to become material during the 2024-28 period the 2022 RSS review is set to examine. The rate of uptake of electric vehicles is however subject to very significant levels of uncertainty. AEMO's 2021 ESOO identifies by 2030-31, EVs are forecast to be cost-competitive with internal combustion engines, and between half a million and four million residential cars are projected to be

92 For more information on the AEMO MSL process see: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation

93 low minimum demand levels can affect the availability of minimum levels of essential system security services provided by thermal generators including inertia and system strength.

electric. This amounts to between 2% and 12% of additional residential consumption (up to 7 TWh).[94]

The timing and level of EV demand, and therefore its impact on the NEM, is a function of vehicle use, the availability of charging infrastructure, and arrangements for vehicle charging control. All of these factors also make the impact on peak demand very uncertain. Convenience charging in the evening, when EVs arrive from daily commutes, has the potential to increase peak loads and afternoon ramping requirements with corresponding reliability implications. Conversely, well controlled EV charging during the daytime has the potential to avoid negative peak load impacts and enhance power system outcomes given high penetrations of solar PV.

The Panel identifies EV uptake as a driver behind changing consumption patterns and increased uncertainty in demand forecasting. The Panel intends to address the uncertainty in EV uptake and charging behaviour in the scenarios and sensitivities modelled for the review. Detailed consideration will be given to the impact on evening peak loads from co-incident 'end of trip' EV charging.

Changing customer loads

The uptake of household appliances continues to grow in the form of larger capacity white goods, larger televisions, more web-connected devices, and more heating and cooling capability. The uptake of these appliances, and customer behaviours in their use continue to change impacting the magnitude and temporal distribution of residential customer demand. In addition, the Panel appreciates there is growing uncertainty on the level of demand response and behaviour of demand throughout the year. The Panel however notes the wholesale demand response mechanism, implemented at end of October2021, may provide significantly enhanced clarity on the behaviour of demand response and its sensitivity to price over coming years.[95]

Behind the meter batteries and smart web connected loads may provide significant benefits for the power system in terms of managing solar generation and evening peak loads. Those benefits are however a function of end user preferences and provider business models. There is a significant level of uncertainty on the timing and behaviour of smart customer loads and behind the meter batteries.

The Panel intends to account for the uncertainty associated with changing customer loads in the sensitivities and scenarios modelled for the review. Further discussion is provided in Chapter seven.

Industrial load changes

94 AEMO, 2021 electricity statement of opportunities, August 2021, p. 24.

95 AEMC, Wholesale demand response mechanism, Rule determination, 11 June 2020. For more information see: https://www.aemc.gov.au/rule-changes/wholesale-demand-response-mechanism

Changes in the Australian economy are seeing small and medium industrial enterprises (SME) continuing to increase their contribution to Australia's economic output displacing the contribution of large industrial customers such as aluminium smelters.[96]

In addition, new industrial load types are entering the market. Large scale electrolysis for the production of hydrogen is a new technology for the Australian electricity industry which may be a highly flexible source of load and demand response. The costs, pace of uptake, and patterns of use are however highly uncertain but could become material during the modelled period.[97]

The continuing exit of large industrial loads, such as aluminium smelters, and growth in SME industrial load is likely to change the characteristics of Australia's industrial load profile. Uncertainty in the timing of large industrial exit and entry creates challenges for forecasting industrial load required to assess reliability outcomes over the investment horizon. The Panel is therefore considering how this uncertainty could be addressed in the electricity market modelling conducted to inform this RSS review.

Changes to patterns of demand given work from home and COVID restrictions

The COVID-19 pandemic has increased uncertainty surrounding the international and domestic economic outlook affecting energy consumption and investment in new generation capacity. COVID-19 has had both short-term and medium to long-term impacts on the way customer use electricity, these include:[98]

- lower business consumption from the closures of work places.
- increase in residential baseload consumption and changes in seasonal patterns of consumption from more people working at home
- longer-term reduction in expected population levels given the effect of border closures on immigration levels, and
- uncertainty surrounding potential future use of health order movement restrictions.

While the health orders that substantially limited movement in relation to COVID-19 during 2021 have largely been lifted, COVID variants of differing levels of severity may continue to periodically emerge. The potential use of health order movement restrictions to manage future COVID waves creates ongoing uncertainty in electricity demand in future years.

COVID-19 has affected the use of distribution networks, with shifts away from traditional load centres, such as central business districts, with the increase of people working from home. The shift away from traditional demand centres led to an increase in residential demand and a decrease in commercial building electricity demand. This increase in remote working from

96 The SME sector includes all businesses which are not included in the large industrial loads sector. This consists primarily of businesses in the services sector and smaller manufacturers. Large industrial loads encompasses sectors such as coal mining, water infrastructure and manufacturing sub-sectors including aluminium smelters. AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 34, available here.

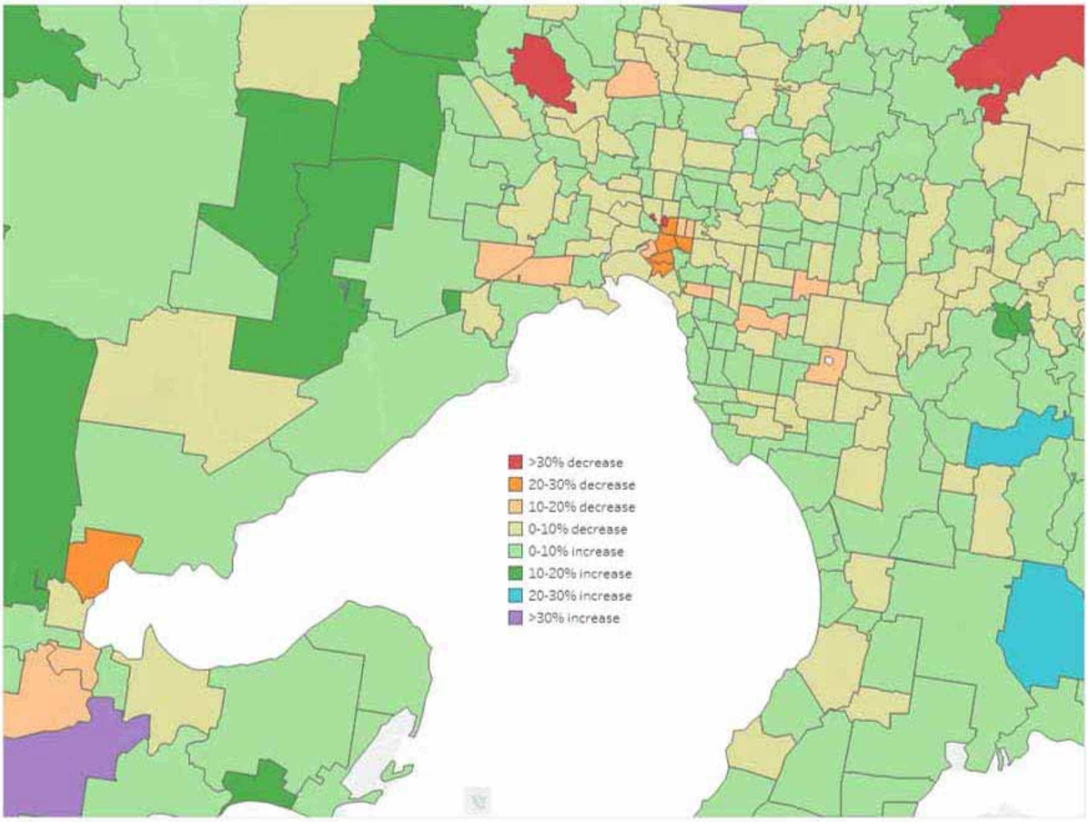
97 The Panel notes public reports of significant interest in electrolysis developments. According to one report, there are now 35 green hydrogen electrolyser projects across Australia, with a collective potential capacity of 38 gigawatts if the cost of the technology falls significantly in the coming decade. For further information see: https://reneweconomy.com.au/australia-has-38gw-of-green-hydrogen-in-pipeline-but-major-cost-falls-needed/

98 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 29, available here.

home could have an impact on the value that customers place on a reliable supply of electricity and therefore the efficient level of the standard.

Figure 3.9 highlights the locational change in demand that was induced by COVID-19 related movement restrictions and the shift to working from home. In Melbourne, there was a large decrease in electricity consumption in the historically high consumption area around the CBD, offset by smaller increases across the residential suburbs.

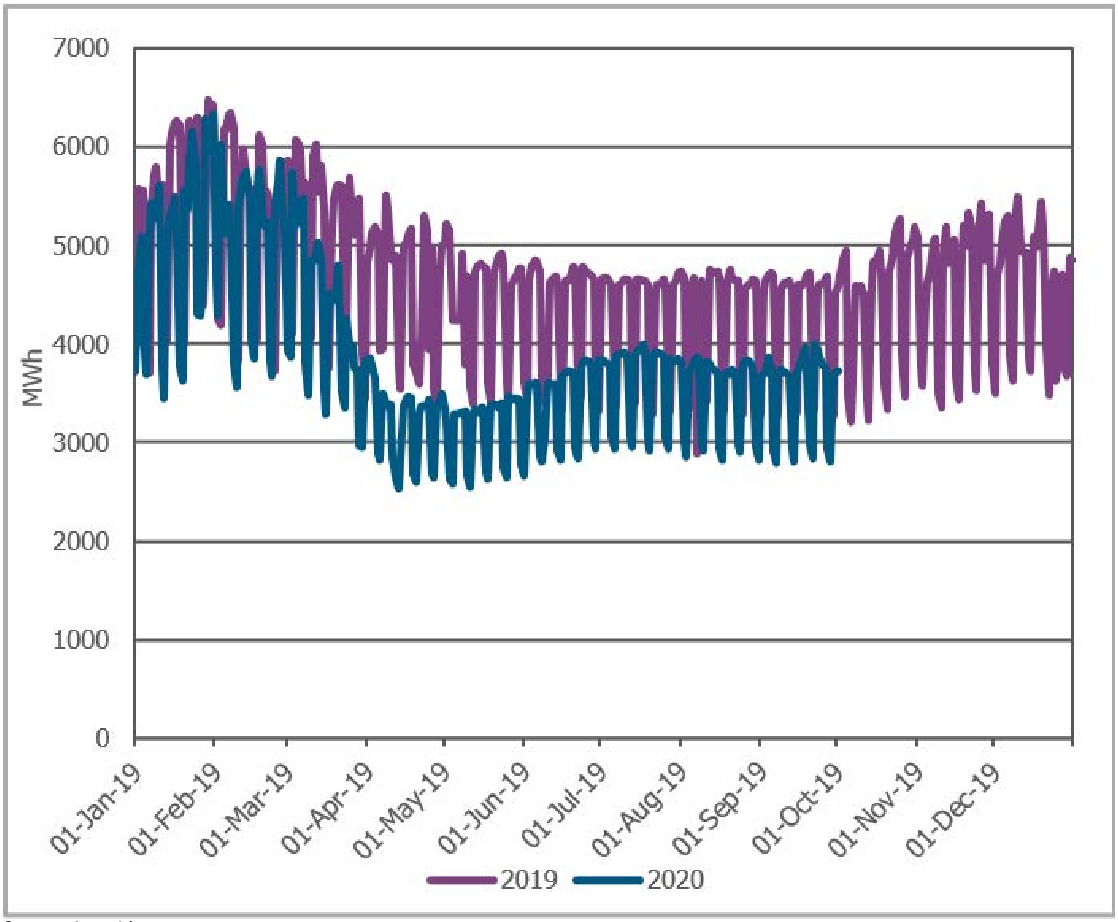
Figure 3.9: Shifting load profiles in Melbourne during COVID - net change in consumption from April - October, 2019 compared to 2020



Source: Powercor

Figure 3.10 shows the decline in load in the Sydney CBD during health order movement restrictions during 2020. This decline also highlights the change in patterns of consumption due to the large and sudden increase in the amount of people working from home.

Figure 3.10: Shifting load profiles in Sydney CBD during COVID-19



Source: Ausgrid

The longer term structural shifts in electricity consumption associated with the update of ongoing work from home practices and the uncertainty creates by the potential future use of COVID-19 health orders will be considered by the Panel in this 2022 RSS review.

> QUESTION 2: CHANGES ON THE DEMAND SIDE
>
> - How do recent and expected future demand side trends interact with the Panel's assessment of reliability standard and settings? What are the implications of these trends for the reliability standard and settings?

3.3 Changes in wholesale market operation and pricing dynamics

There have been a number of changes since the last RSS review related to wholesale market operation and pricing that are relevant to reliability outcomes. Five minute settlement has been introduced and there have been changes in level and volatility of wholesale electricity prices which may indicate changes in the reliability risk profile.

3.3.1 Introduction of 5 minute settlement

On 1 October 2021 the settlement period for the electricity spot price in the NEM changed from 30 minutes to five minutes.[99]

This change will sharpen the wholesale price signals faced by market participants and should promote more efficient dispatch and investment outcomes. It will also reduce the incentive for strategic rebidding as participants will no longer receive a price averaged over six dispatch intervals. Five minute settlement should provide greater incentives for generation, storage and demand response technologies that are able to respond very quickly to changing market conditions and shortfalls.

Five minute settlement however has significant implications for market revenues and risks faced by less flexible thermal generators, which are subject to long unit commitment constraints including minimum up time, minimum downtime, and minimum stable generation levels. Five minute settlement has the potential to affect the commitment of these units and their contribution to reliability during periods where there is high levels of solar generation.

The shift to five minute settlement was underpinned by similar principles to those considered by the Panel when determining the reliability settings being the provision of effective price signals to facilitate more efficient investment. The Panel will take this change into account in determining market settings and in particular in the review's modelling which will now may be performed on a five-minute basis. Further discussion on this issue is provided in Chapter seven on modelling for the review.

3.3.2 Increasing frequency of high and low prices

Rising penetration of variable renewable generation, and increasing fuel price volatility, has led to an increase in the frequency of high and low prices and greater intra-day price volatility. This has been most notable in South Australia. [100]

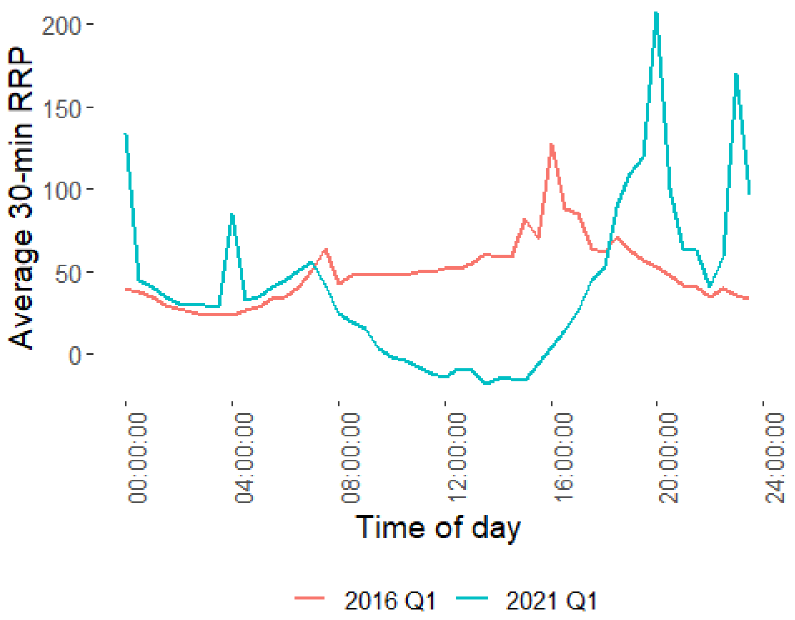
Increasing intra-day price volatility

Figure 3.11 shows the average wholesale electricity price by time of day in South Australia for Q1 2016 and Q1 2021. This shows the increasing intra-day variability in prices over time. It can be seen in this figure that in Q1 2021 average daytime prices were significantly lower than the same quarter in 2016 and average evening prices were significantly higher and more volatile.

99 AEMC, *Five minute and global settlement delay,* Rule determination, p.10-14.

100 Increasing fuel prices, and fuel price volatility have also been a contributing factor behind the increasing frequency of high and low wholesale market prices. Additional information on recent increases in gas prices is provided in Appendix

Figure 3.11: Average 30-minute electricity price in SA in 2016 Q1 and 2021 Q1 ($/MWh)



Source: AEMC analysis of AEMO MMS data.
Note: Based on trading interval (30-minute) prices.

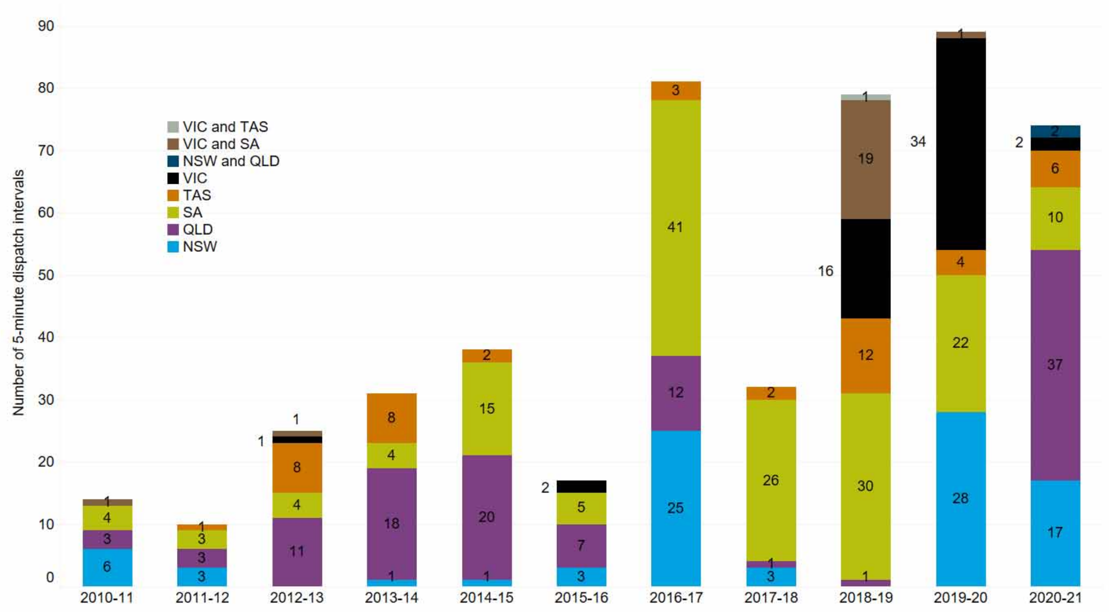
The increasing intra-day variability in prices should incentivise greater entry of peaking capacity, which can respond quickly to high prices and storage which can arbitrage low and high prices. These trends should drive investment in new generation but may also indicate a need to amend the levels of the market price settings. The Panel will take into account these changing price dynamics when considering the reliability standard and settings.

Increasing frequency of MPC and MFP events

The frequency of MPC and MFP events in the NEM are increasing. In general, low price events are expected at times when there is an abundance of generation and high price events are expected at times when the supply and demand balance is tight. The increase in events at or near the MFP and MPC may suggest that the current level of some market price settings may be beginning to prevent the market from clearing.

Figure 3.12 shows that, except for the 2016, 2018 and 2021 financial years, there is general trend of an increasing number of dispatch intervals where the MPC has been reached. In the 2020 financial year, the largest number of market price cap events occurred in Victoria.

Figure 3.12: Frequency of market price cap event

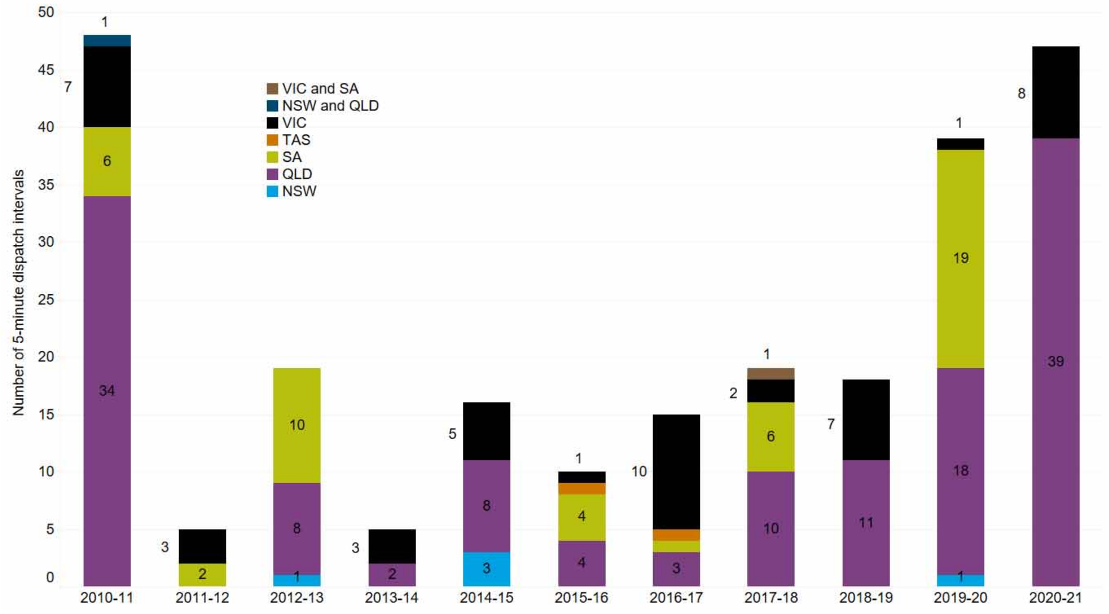


Source: AEMC analysis of AEMO MMS data.

Figure 3.13 shows the number of MFP events over the past 10 financial years for NSW, VIC, QLD, SA and TAS. Over that time the Regional Reference Price (RRP) has hit the MFP for 196 dispatch intervals across all regions. The MFP was reached most often in Queensland where it was hit 99 times. The number of MFP events has trended upwards in recent years but is still below the number of events in 2011.[101]

101 A significant contributor to the increase in MFP events in South Australia in 2020 was the South Australian separation event in late January and February 2020. This event left South Australia disconnected from the rest of the NEM for a large part of February, and therefore reduced the export capacity from South Australia to Victoria to zero. The lack of export capacity led to an abundance of supply, particularly in the middle of the day due to the correlation of solar output profiles.

Figure 3.13: The number of market floor price events



Source: AEMC analysis of AEMO MSATS data.
Note: The figure shows the number of dispatch intervals (not trading intervals) that the RRP was equal to the MFP of $-1,000/MWh.

The increase in low price events has been driven by South Australia which in FY 2020 had 356 of the 422 low price trading intervals in the NEM. This is unsurprising as South Australia has relatively low native demand and a large amount of variable renewable generation, including rooftop PV which is largely unresponsive to the wholesale price.

The Reliability Panel's Annual Market Performance Review published in May 2021 provides more detail on price outcomes over the period of 2019-2020.[102] In that report it also noted that there were no breaches for the CPT for energy in 2019-20, while the CPT for FCAS was reached once on 1 February 2020, leading to the APC being introduced for approximately 10 days.[103]

QUESTION 3: CHANGES IN WHOLESALE MARKET OPERATION AND PRICING DYNAMICS

- How do recent and expected future electricity pricing dynamics, and the introduction of 5 minute settlement interact with the reliability settings and the Panel's assessment for this review? What are the implications of these trends for the reliability standard and settings?

102 AEMC, Annual Market Performance Review Final Report, May, 2021.
103 Ibid. p.v

3.4 Changes in the NEM policy environment relevant to reliability

The NEM's policy frameworks are also changing with implications for reliability and the standard and settings. In particular, the ESB's post 2025 market reform program and Jurisdictional reliability and renewable energy target schemes.

3.4.1 ESB Post-2025 Market Design process

A number of energy market reforms are underway which have implications for reliability. The ESB Post-2025 Market Design process[104] considered a long-term reform package with the focus on providing advice on alternative, long-term, fit for purpose market design options that could apply from the mid-2020s.

In July 2021, the ESB provided its final advice on a post 2025 market design to Energy National Cabinet Reform Committee (ENCRC). Energy Ministers released the ESB's final advice on 26 August 2021.[105]

In its final advice, the ESB provided recommendations to deliver a reform pathway that ensures sufficient dispatchable resources and storage capacity are in place prior to anticipated plant closures, and that generator exits do not cause significant price or reliability shocks to customers. Specifically, the ESB recommended a range of short and longer term measures to support resource adequacy in the NEM and support the timely entry and orderly exist of resource for 2025 and beyond. This included a recommendation that Ministers consider a capacity mechanism to ensure the competitive provision of the right generation mix as the market transitions towards net zero emissions. The ESB noted that a capacity mechanism should complement the existing markets and work alongside the market settings.[106]

On 1 October 2021, National Cabinet endorsed the final package of reforms for the post-2025 market design work, as agreed by the Energy National Cabinet Reform Committee. [107] Ministers also agreed to progress further design work on a mechanism that specifically values capacity in the NEM.

There are strong interactions between the potential reforms recommended by the ESB and work the Panel will undertake in the RSS review.[108] For example:[109]

- Potential resource adequacy mechanisms, such as an enhanced Retailer Reliability Obligations (RRO), could affect the optimal level of the reliability standard and so, the value of the settings, and

104 https://esb-post2025-market-design.aemc.gov.au/

105 Energy Security Board, Final advice July 2021, https://esb-post2025-market-design.aemc.gov.au/final-advice-july-2021.

106 The Panel understands that the objective of the capacity mechanism design is to ensure investment in an efficient mix of variable and firm capacity meeting reliability at lowest cost, noting that the NEM is expected to have emissions reductions of approximately 50 per cent on 2005 levels by 2030. Information on the principles to guide capacity mechanism development are available here. The design of any capacity mechanism will however be addressed by the ESB through its process rather than the Panel through the 2022 RSS review.

107 Australian Government, Department of Industry Science Energy and Resources webpage: https://www.energy.gov.au/government-priorities/energy-ministers/priorities/national-electricity-market-reforms/post-2025-market-design

108 *[reference Panel submission on ESB website*]

109 Reliability Panel, Reliability Panel response to P2025 Market Design Consultation Paper, p 2.

- New markets for system services and essential system services may affect the revenue streams earned by generators, which, in turn, could affect the optimal value of the settings.

The Panel is committed to dovetailing its process in with those of the ESB.

> QUESTION 4: ESB POST-2025 MARKET DESIGN REFORMS
>
> - How may the Post-2025 market design reforms impact on the reliability standard and settings? What are the implications for the reliability standard and settings?

3.4.2 Jurisdictional government policies

Federal and state governments have implemented a range of policies relevant to reliability in the NEM. These policies have a number of objectives including to achieve net zero emission policies, incentivise the entry of new generation capacity of certain types and also retain existing capacity.

These state government policies are strongly linked to Australia's net zero emission commitments[110]. Currently

- Australia's 2030 emissions reduction target is to reduce greenhouse gas emissions to 26–28 per cent below 2005 levels by 2030 before achieving net zero by 2050.[111]
- NSW has a target to reduce emissions by 50 per cent on 2005 levels by 2030, on its way to its own 2050 net zero target.[112]
- QLD has a target to achieve net zero emissions by 2050 in 2017. It has also committed to a 30 per cent reduction on 2005 levels by 2030.[113]
- Victoria has a net zero emissions target for 2050. It has also legislated cutting emissions from 2005 levels by 28 to 33 per cent by 2025 and by 45 to 50 per cent by 2030.[114]
- South Australia has a target to reduce emissions by more than 50 per cent below 2005 levels by 2030 and achieve net zero emissions by 2050.[115]
- The Tasmanian Government has announced a plan to legislate a target of net zero emissions by 2030.[116]

A set of policies have been implemented to achieve these emission goals including a range of large scale and small scale renewable energy targets. These policies will play a material role in determining actual levels of investment in certain types of technologies over coming

110 For more information see: https://www.pm.gov.au/media/australias-plan-reach-our-net-zero-target-2050
111 For more information see:https://www.awe.gov.au/sites/default/files/documents/summary-australias-2030-emissions-reduction-target.pdf
112 For more information see: https://climatechange.environment.nsw.gov.au/About-climate-change-in-NSW/NSW-Government-action-on-climate-change
113 For more information see: https://www.des.qld.gov.au/climateaction/emissions-targets
114 For more information see:https://www.climatechange.vic.gov.au/victorias-greenhouse-gas-emissions-reduction-targets
115 For more information see: https://www.environment.sa.gov.au/topics/climate-change/south-australias-greenhouse-gas-emissions
116 For more information see: https://www.dpac.tas.gov.au/divisions/climatechange/climate_change_in_tasmania/tasmanias_emissions

decades, including the period relevant to this RSS review. Relevant jurisdictional renewable energy targets and related policies include:[117]

- Large-scale Renewable Energy Target (LRET)
- Victorian Renewable Energy Target (VRET)
- Victoria's 2020-21 budget initiatives affecting REZs and energy efficiency.
- Queensland Renewable Energy Target (QRET)
- Queensland Renewable Energy Zone (QREZ)
- Tasmanian Renewable Energy Target (TRET)
- New South Wales Electricity Infrastructure Roadmap
- National Electricity (Victoria) Act (NEVA)

The above list of jurisdictional policies was compiled by AEMO for the purpose of carrying out the ISP. AEMO considers this list of policies meet the criteria in National Electricity Rules clause 5.22.3(b), which outlines which environmental or energy policies AEMO may consider in developing the ISP.[118] Further information on each of these policies can be found at the respective state government webpages or through AEMO's 2021 Input, Assumptions, and Scenarios report, pages 26 – 31.

In addition to the renewable energy target schemes listed above, there are also a range of relevant distributed energy resource, electric vehicle, and energy efficiency policies that are relevant to reliability outcomes in the NEM. Further details on these policies are provided in Appendix A.

Federal and State governments have also recently implemented a range of additional policies to underwrite or otherwise incentivise the entry of new generation capacity and retain existing capacity in addition to their renewable energy target schemes. Some of these policies include:

- The Roadmap also outlined the Energy Security Target, which is a capacity target for firm rated plant and is set at the level of firm rated capacity needed to service NSW's electricity needs during a one in ten-year peak demand period, with the largest two units of NSW's generators experiencing an outage.[119] [120]

117 AEMO, 2021 Inputs, Assumptions and Scenarios Report, p. 7.

118 Clause 5.22.3(b) of the NER specifically restricts AEMO to, in determining power system needs AEMO may consider a current environmental or energy policy of that participating jurisdiction where that policy has been sufficiently developed to enable AEMO to identify the impacts of it on the power system and at least one of the following is satisfied:(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(5) the MCE has advised AEMO to incorporate the policy

119 See details of the NSW Roadmap here: https://energy.nsw.gov.au/government-and-regulation/electricity-infrastructure-roadmap

120 The NSW Government published its Central-west Orana renewable energy zone (CWO REZ) access rights and scheme design consultation paper on 21 December 2021. The access rights proposed seek to provide "greater connection certainty and continued access to the network, generation and storage infrastructure." The right would last for 15 years, starting from the initiation of the first right and conclude by transitioning to the NER. More information can be found here: https://www.energy.nsw.gov.au/renewables/renewable-energy-zones/central-west-orana-rez-access-scheme-consultation

- The Commonwealth Government committed to the delivery of Snowy 2.0 and has proposed the Hunter Power Project, a 660 MW open cycle gas turbine to be built at Kurri Kurri by Snowy Hydro.[121]
- In addition, there are government policies which aim to retain existing generation. For example, Energy Australia recently reached an agreement with the Victorian government to deliver an orderly retirement of the Yallourn power station, bringing the closure date forward by four years.[122]

The interaction of these policies with the wholesale and contract markets and the implications for reliability will be considered by the Panel when determining the reliability standard as well as the reliability settings. The changing policy environment will be particularly relevant to the modelling undertaken for this RSS review. Further discussion is provided in Chapter seven.

> QUESTION 5: IMPACT OF GOVERNMENT POLICIES ON RELIABILITY SETTINGS
>
> - What implications does continued uncertainty in emissions policy have for the reliability standard and settings?
> - What are your views on the impact of State and Federal government energy policies on the reliability settings?

3.4.3 Other market reforms and reviews

There are a range of other reforms have been introduced in the NEM recently or will be introduced over the next few years. The Panel will consider these reforms and the impacts of the changes in the context of its assessment in the RSS review and where appropriate in the modelling it will undertake. Of particular relevance to this review are:

- The interim reliability measure as outlined in Chapter two.
- AEMC system security workplan, and
- Generator notice of closure changes.

These are outlined further in Appendix A.

121 See details of the Hunter Power Project here: https://www.snowyhydro.com.au/hunter-power-project/

122 EnergyAustralia, EnergyAustralia powers ahead with energy transition, https://www.energyaustralia.com.au/about-us/energygeneration/yallourn-power-station/energy-transition

4 PANEL ASSESSMENT APPROACH

The Panel will apply a specific framework when reviewing the reliability standard and settings, which is outlined in the 2021 guidelines. This specific framework includes:[123]

- the general assessment principles in the guidelines to contribute to the achievement of the NEO, including the function of the standard and settings, and
- the overarching assessment criteria and considerations set out in the NER.

The Panel will apply this assessment framework when considering the reliability standard and settings, including both the form and the level.

The remainder of this chapter outlines the general assessment principles and the overarching assessment criteria in the NER. The function and criteria used to review the reliability standard and setting is noted in Chapters five and six respectively.

4.1 General assessment principles in the guidelines

The 2021 guidelines state that when undertaking a review of each of the reliability standard and settings, the Panel will be guided by the NEO and the assessment principles set out below (**General Assessment Principles**).

The NEO is:[124]

> [T]o 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 General Assessment Principles set out in the 2021 guidelines are:

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

123 AEMC Reliability Panel, *Final guidelines - review of the standards and settings guidelines*, 1 July 2021.

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

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 Reliability 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 principle, approach and supporting criteria informs the materiality assessment that the Panel will apply in its consideration of the form and level of reliability standard and settings.

For any recommended changes to the reliability standard and settings, the Panel would need to be satisfied that such changes will, or are likely to, contribute to the achievement of the NEO and meet the requirements in the 2021 guidelines and the NER. If the Panel recommended a change, this would need to be progressed through an AEMC rule change process.

4.2 Assessment approach and criteria to be applied

As stated in Chapter one, there are a number of requirements in the Rules that relate to the assessment of the standard and each of the settings. There are other NER requirements that relate only to the standard or a specific setting. These requirements and criteria are included in the guidelines and collectively inform the materiality assessment for the Panel to assess the standard and each of the settings. This section details the Panel's approach for assessing the reliability standard and settings, and provides the Panel's approach for any recommendations for change.

4.2.1 Overarching assessment criteria in the NER

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

- complying with the reliability standard and settings 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 guidelines or which the Panel considers relevant.

As noted there are a range of NER specific requirements that apply to the reliability standard and each setting. These are outlined in the guidelines, and also for stakeholder reference, in chapters five and six.

4.2.2 Other considerations that the Panel may take into account

In addition to the considerations and requirements from the NER and guidelines, outlined above, the Panel is also able to take into account other considerations in the 2022 RSS review.

It is important to note there are a range of interactions in setting the standard and each of the settings. Overall, the value of each of the market settings 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. As noted in Chapter one 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.[125]

As noted, the Panel will consider the potential interactions between each of the reliability components, and it will consider the aspects that sit outside the framework to the extent the Panel is able to and there is an interaction with the reliability framework going forward. These include jurisdictional policies listed in Chapter three and Appendix A.

As outlined in Chapter two, the interim reliability measure will be out of scope for the 2021 RSS review. However, 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.

> QUESTION 6: OTHER CONSIDERATIONS FOR THE PANEL TO TAKE INTO ACCOUNT
>
> - In addition to the other considerations set out above, do you consider that there are factors that the Panel should have regard to?

4.3 Approach to any recommendations for change

In addition to the General Assessment Principles and NER Assessment Criteria outlined above, there are a number of equally important steps that must take place for a change to the standard or settings, which ensure that stakeholders have the opportunity to understand and respond to any such change. The Panel considers that this process in its totality will ensure that the regulatory process remains predictable while balancing flexibility as the market evolves.

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

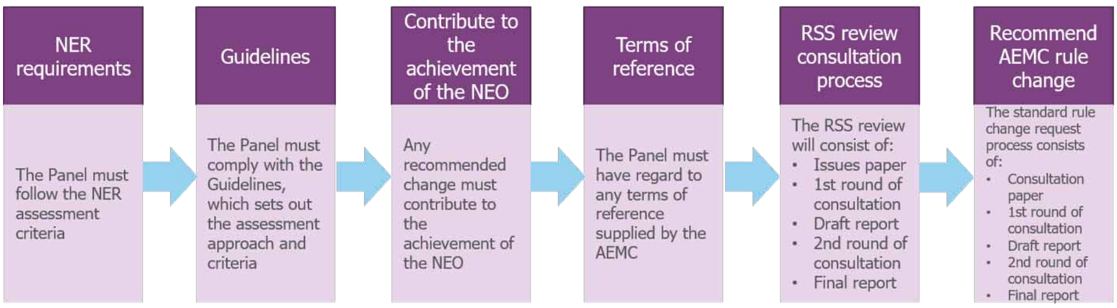
In addition, to improve predictability and flexibility in its review, and to best incorporate new information about how the NEM is changing, the Panel will only change the level or form of the reliability standard or settings where there would be a material benefit in doing so. As such, as the first step of this review, the Panel will determine whether there is a there is a reasonable possibility that a change in the form and/or level of the reliability standard or settings will, or is likely to, contribute to the achievement of the NEO and meet the assessment criteria above. This will involve:

- Undertaking a qualitative assessment to determine whether there is sufficient evidence and a clear rationale that a change would result in a material benefit, which will take into account changes in the market and stakeholder feedback through this issues paper.
- Then, only if there is sufficient evidence and clear rationale, undertaking a quantitative study to understand whether a material benefit may arise resulting from a change relative to the status quo and that the material benefit is robust to a range of scenarios and sensitivities considered in the Panel's modelling exercise.

The Panel will only recommend a change to the form or level of the standard and settings when it believes that there is material benefit in doing so and will not otherwise, allowing predictability in the outcomes of this RSS review. If the Panel recommends that the current standard or settings should change, then it would need to submit a rule change request to the AEMC in order to implement these changes.[126] The AEMC would then consider these proposed changes through the usual rule change process, allowing further opportunities for stakeholder input and consultation.

This process and the various considerations are outlined in the visualisation in Figure 4.1.

Figure 4.1: The process and requirement to recommend a change to the standard or settings



126 NER clause 3.9.3A(i).

5 THE RELIABILITY STANDARD

Under the 2021 guidelines for the 2022 RSS review, the Panel will consider both the form and the level of the standard. The aim of this chapter is to seek stakeholder feedback on issues relevant to reviewing and assessing the standard's form and level. This chapter:

- outlines the purpose and role of the standard and trade-offs the Panel considers when reviewing and making recommendations for the changes
- sets out the assessment criteria the Panel must apply when reviewing the standard, and
- outlines a number of issues the Panel will consider in assessing the form and level of the reliability standard.

5.1 Purpose of the Reliability Standard

The 2021 guidelines set out the function of the form and level of the reliability standard. It states that the standard is:[127]

- 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, and
- Currently set as a percentage of USE.

This section builds on the introduction to the purpose of the standard from Chapter one with a discussion of the role of the reliability standard within the NEM as well as the trade-offs involved in setting the reliability standard level.

5.1.1 The reliability standard and role in the NEM

The standard provides a clear, actionable expression of the economically efficient level of generation and transmission capacity sought for the NEM. The standard is a core element of the NEM's framework for delivering reliability.

In the NEM, the standard is an ex-ante standard to indicate to the market the required level of supply to meet demand on a regional basis. It is not a regulatory or performance standard that is "enforced". Rather, it is used to indicate the efficient level of reliability for the purposes of informing the market under the NEM reliability frameworks described in Chapter two.

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

As noted in Chapter two, AEMO is responsible for operationalizing the standard through its forecasting processes, by modelling and projecting whether the market is going to meet the standard. It does this across a number of time frames, from years ahead of real-time, up until real-time, through the various Electricity Statement of Opportunities (ESOO), Projected

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

assessment of system adequacy (PASA) and pre-dispatch processes. Additional information on how AEMO operationalises the reliability standard in its forecasting and market functions.[128]

5.2 Assessment criteria the Panel must take into account for the reliability standard

The NER and the 2021 guidelines set out specific requirements for what the Panel should consider, and the assessment criteria that the Panel must take into account when reviewing the standard in addition to those presented in Chapter four. The Panel will apply these assessment criteria in its consideration of the form and level of the standard in this 2022 RSS review.

The NER requires that the Panel (among other things):

- 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 guidelines or which the Panel considers relevant.[129]

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

The guidelines further state that the Panel will also consider other factors including but not limited to:[130]

- Any changes made to AEMO's VCR measure,[131] , and
- Any marked changes in the way customers 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 Panel will address the requirements under the 2021 guidelines and other factors such as, but not limited to, modelling and stakeholder outcomes when considering whether to recommend any change.[132]

5.3 Assessing the form and level of the reliability standard.

The current reliability standard is expressed in terms of outputs. It expresses the maximum expected amount of energy demand that can be unmet in each NEM region in a year. (It is

128 For further information see: https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/forecasting-and-reliability/reliability-standard-implementation-guidelines

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

130 AEMC, *RSS review Final Guidelines*, June 2020, p. 5, available [*link: here*].

131 AEMO no longer develops a VCR measure with all responsibility for developing VCR now having passed to the AER. The last VCR measure published by AEMO was in 2014. For more information see: https://www.aer.gov.au/news-release/aer-completes-australia%E2%80%99s-largest-value-of-customer-reliability-survey

132 As previously indicated, even if the Panel considers and recommends a change, the Panel will need to submit a rule change to the AEMC. The AEMC rule change process under the NER will need to be followed before any change is made.

expressed as a proportion — 0.002 per cent of the total energy demanded in a region in a financial year – but could equally be expressed in a different form).[133]

Overall, the experience of reliability in the NEM, discussed in [link: Chapter two], has shown that the current reliability standard has to-date been an appropriate reliability target in the NEM. However, given the transition taking place within the energy sector, the Panel will consider any information that a different standard will, or is likely to, contribute more effectively to the achievement of the NEO.

The Panel will consider the need for any change to the form or level of the reliability standard based an assessment of the issues outlined below, outcomes from the modelling it will undertake for the review, and feedback from and consultation with stakeholders. Further discussion of the Panel's consideration of the form of the reliability standard is provided in [link: Chapter seven] related to the considerations of modelling.

5.3.1 Trade-offs in setting the level of the reliability standard

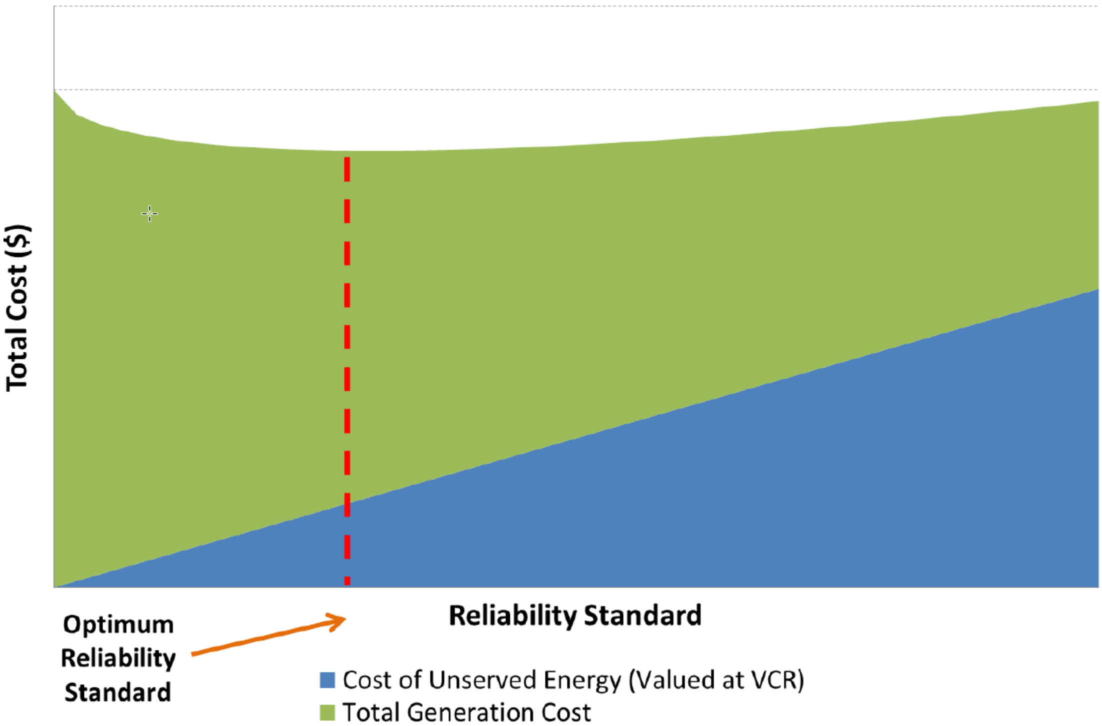
The standard balances the value that consumers place on the reliable supply of electricity with the costs required to deliver this level of reliability. In setting an efficient level for the standard for the NEM, a trade-off is made between two sets of costs:

- **cost of additional capacity**. Higher levels of reliability require more investment in power generation, demand side participation, storage, transmission capacity and/or load curtailment and so, lead to a higher cost per unit of energy supplied, and
- **costs of unserved energy.** When there is not enough capacity to supply consumer demand, supply will be interrupted, which also imposes the consumer cost of not having energy when needed. The value that co place on avoiding supply interruption is known as the value of customer reliability (VCR).

The efficient level of the standard corresponds to the point, and level of USE, at which the incremental cost of additional power system resources exceeds the savings to customers from the reduction in USE achieved by an incremental investment in these resources. This is the level of reliability that minimises the total societal cost electricity and is conceptually illustrated in Figure 5.1 below.

133 Clause 3.9.3C(a) of the NER.

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.

The objective of the analysis and modelling undertaken in each RSS review is to help the Panel to make this trade-off, by providing information about the cost of achieving higher levels of reliability. Additional information on the approach to modelling to identify this point is provided in Chapter seven. As there are limitations to any modelling approach, the Panel also considers a range of qualitative issues, such as the benefit of regulatory predictability and transparency in determining the level of the standard.

5.3.2 Consideration of the VCR used to assess the level of the Standard

The Panel is required to give regard to the AER's VCR in identifying the efficient level of reliability expressed in the standard.[134] In setting the level of the standard, the 2021 guidelines also require the Panel to consider any marked or forecast changes in the way consumers use electricity, particularly through the use of new technology, that suggest a large number of consumers may place a lower or higher value on a reliable supply of electricity from the NEM.[135]

134 Clause 3.9.3A(e) of the NER.

135 AEMC, *Review of the reliability standard and setting guidelines*, 2021, July 2021, p.5.

VCR is not a perfect indicator of the value that each individual customer places on reliability.[136] Different VCR values are set for residential versus business customers, and for different climate zones where these are linked to volumetric energy consumption. However, this still does not capture all variation in the value customers place on reliability including differences between individuals, or the value consumers may place on reliability on a very hot day compared to a mild day, and nor does it capture how these preferences change over time.[137]

The reliability standard needs to be relatively simply articulated in order to be operationalised in real-time. This means it cannot represent the myriad of complexities relating to the cost-reliability trade-off for each and every customer. For example, the complexity associated with different consumers valuing reliability at different levels to one another, and at different times.

The Panel notes a range of factors that suggest significant number of consumers may place a higher or lower value of a reliable supply of electricity than indicated by the AER's VCR. These factors were introduced in Chapter three and include:

- the trend of increased production of electricity from rooftop solar PV may have wide-ranging effects on how consumers value reliability
- the impact of the COVID-19 pandemic on electricity use patterns and the longer term trends in changes to the way consumers use electricity
- changing end use consumer technologies including the electrification of transport,
- Potential uptake of flexible demand response loads such as hydrogen electrolysers or electrification of transport, and
- Australia's changing industrial structure and the decline of large industrial loads and growth of small to medium size organisations.

In addition to VCR values for standard outages, in 2018 the AER commenced the process of developing a supplementary set of VCR values for Widespread and Long Duration Outages (WALDOs). These are outages of longer duration and/or greater geographical coverage than those outages considered in the set of VCRs for standard outages. On 16 September 2020, as a result of stakeholder feedback, the AER decided to discontinue the WALDO model and methodology, but are considering avenues for future work.[138] The AER intend for WALDO VCR's to be applied in applications including assessing costs and benefits associated with black system and other major outage events.

Given the high degree of uncertainty surrounding these factors' impact on VCR, the Panel may consider sensitivity cases around the AER's VCR in its modelling to identify the efficient level for the standard.

136 Reliability Panel, *The Reliability Standard: Current Considerations,* March 2020, p. 36, available here.

137 Reliability Panel, *The Reliability Standard: Current Considerations,* March 2020, p. 36, available here.

138 AER, Widespread and Long Duration Outages -Values of Customer Reliability - Final Conclusions, September 2020. For more information https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability/aer-position

The Panel welcomes stakeholder input on approaches to defining sensitivity cases to address uncertainty in the VCR.

> QUESTION 7: THE LEVEL OF THE RELIABILITY STANDARD AND CONSIDERATIONS ON VCR
>
> - Do you consider that there is evidence that a different level of the reliability standard would deliver better overall outcomes for the NEM?
> - What factors do stakeholders suggest should be considered alongside the AER's VCR in determining the level of the reliability standard?

5.3.3 Setting the form of the standard

As an ex-ante standard, a key function for the standard is to facilitate the provision of information that allows market participants to make efficient investment and operating decisions.

The Panel will consider whether the existing form of the reliability standard, being the maximum expected USE as a % of total energy demanded in a region, remains appropriate or sufficient to effectively signal reliability risk to the market given the changes in the power system described in Chapter three.

A single metric, which tells AEMO and market participants the maximum expected amount of USE over a set period, has historically provided sufficient information to signal reliability risk and expectations in capacity limited a thermal power system.[139] In such power systems the main driver of reliability events and USE were unplanned outages during peak demand periods. As the power system's resource mix and reliability risk profile changes, USE may no longer sufficiently capture reliability risk from the range of drivers that apply.

The Panel particularly notes the potential for reliability events to become more varied due to weather patterns in a system with a high proportion VRE and higher reliance on energy limited storage. This variation may require more information to be provided on expected reliability outcomes than USE through a financial year as indicated by the existing standard. This may include information on the frequency, duration, depth of potential supply shortfalls.[140] The Panel intends to consider whether the reliability standard could be used to convey further detailed insights on reliability risk given the changing power system.

A number of different and supplementary forms could be used to as the form of the reliability standard. Several of these forms are summarised below.

139 ESIG, *Redefining resource adequacy in a modern power system*, p.10

140 Ibid.

Table 5.1: Key aspects of different reliability standard forms

FORM	DESCRIPTION	OBJECTIVE
Frequency of interruptions/duration of interruption	An output-based metric, this could set a maximum level of how frequently supply is interrupted, or how long interruption occurs. For example, the number of days per year in which an interruption occurs or hours. This is typically called a loss of load expectation (LOLE) metric. Loss of load event (LOLEv) can also be used as a metric relating to the frequency of interruptions.	This may be most relevant in circumstances where the system has the potential for a number of small outages but these are not necessarily large or of long duration.
Maximum probability of USE	Expresses a maximum tolerable probability of breaching an upper limit of unserved energy. This metric combines a focus on the tolerable likelihood with a certain size of supply interruption (e.g. no more than a 10 per cent probability of exceeding 0.002 per cent USE). It is a probabilistic measure.	This is important when consumers are willing to tolerate some USE so long as is only likely to occur on a certain basis (e.g. no more than 10 per cent likelihood).
Maximum probability of any lost load	This metric expresses the tolerable probability of having any unserved energy at all (e.g. no more than 10 per probability of having any unserved energy). As per the metric above, this is also a loss of load probability, LOLP metric, and is a probabilistic measure.	This would be used where consumers have a low tolerance for any USE at all.
Volumetric buffer	This is an input-based metric, often called a minimum	This is useful when larger generators feature in the

FORM	DESCRIPTION	OBJECTIVE
	reserve margin, that sets a minimum amount of reserve generation capacity to be available at all times.	physical power system and is a useful indicator of the risk appetite regarding reliability.

Recent studies have examined the approach taken by other jurisdictions for setting reliability requirements. The following Table 5.2 presents the reliability metrics used in major international jurisdictions.

Table 5.2: Reliability metrics used in major international jurisdictions

JURISDICTION	RELIABILITY STANDARD
PJM interconnection (USA)	0.1 days (LOLE) per year
ISO – NE (USA)	0.1 days (LOLE) per year
OFGEM (UK)	3 hours of LOLH per year
ERCOT (USA)	Uses scarcity pricing mechanism in the form of an administratively determined price adder in pricing intervals with elevated wholesale-level reliability risks. The calculation of the Operating Reserve Demand Curve (ORDC) is based on LOLP.

There are strengths and weaknesses associated with each of these approaches to the form of the standard. For example:

- Metrics that focus on the likelihood of frequency of interruptions generally do not address the magnitude of the shortage (i.e. the actual volumes of energy not served). That is, they focus on the likelihood of load being shed but not the severity. For the same value, a supply interruption may be less than 1 MWh (minor) or greater than 1000 MWh (very serious). As such, they may ether under or overestimate actual reliability risks. These are likely to be more useful in a less volatile system with USE events that share similar characteristic duration and depths.
- A volumetric measure, such as USE, captures the volume of energy lost effectively, but does not capture the likelihood of interruptions to customer supply nor the potential depth of duration of specific USE events.
- A deterministic standard (such as a minimum reserve margin) may be relatively simple to implement, but the actual level of reliability it provides is a function of the number of generators actually in service at any given time. In some cases, it may just be more an expression of redundancy rather than energy not delivered to customers, which is more relevant when considering reliability.

More specifically:

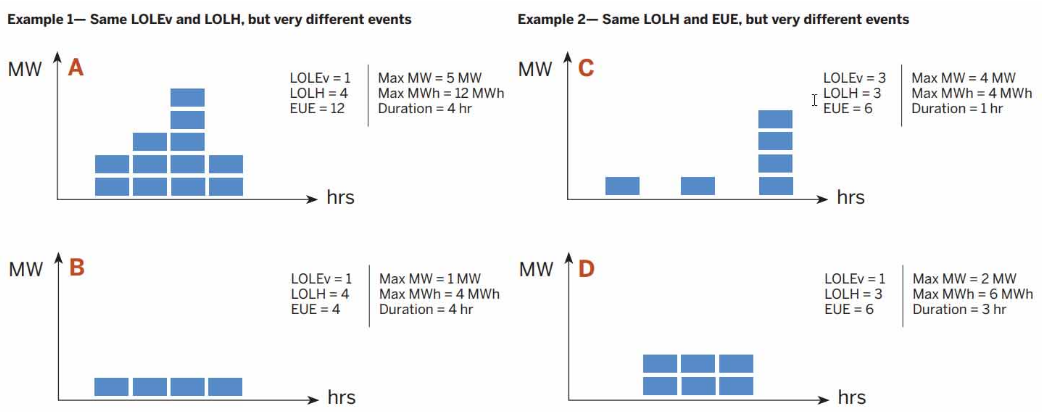
- When considering a Loss of Load Probability (LOLP) form of standard, the standard would set a probability at which the likelihood of the loss of any load would not be exceeded, but not the level of severity that may be associated with that likelihood.
- When considering a Loss of Load Expectation (LOLE) form of standard, the standard level would set the number of hours, or number of days over a reporting period, where supply is expected to not meet demand. Like the LOLP form, this method does not factor in the severity of the loss of load instances.
- When considering a volumetric measure, such as USE, the level would be set with regard to the maximum tolerable volume of energy loss. Such measures can, but in the NEM does not currently, also incorporate a probability tolerance.
- A deterministic standard, such as one that determines the minimum level of generation reserves that need to be available at any one time, may not reflect the specific needs of the market when shortfalls do occur (either over or under procured). This may run the risk for very volatile systems that even where average USE is comparatively low, there may be rare instances where the shortfall is unmanageably high.

Box 2 provides an example that illustrates the limitations associated with each of the candidate standard forms listed above. Given the changing power system reliability risk profile, and increasingly diverse sources of reliability risk, the Panel is considering whether more than one form and metric may be required to appropriately signal reliability outcomes and risk given an evolving NEM.

BOX 2: EXAMPLE - LIMITATIONS OF DIFFERENT CANDIDATE RELIABILITY STANDARD FORMS

Figure 5.2 considers four hypothetical reliability events with different shapes of USE to illustrate limitations in the different candidate reliability standard forms.

Figure 5.2: Shapes of USE and the candidate standard forms



The two graphs on the right-hand side, C and D, show equal amounts of LOLH and USE. However, C is three distinct reliability events whereas D is a single event. The level of USE for these events is therefore the same despite very different event characteristics.

The different event characteristics are relevant to whether battery storage would be an appropriate solution, and the amount of storage that would be needed (and therefore the investment case). As an example, a battery resource of 4 MWh could avoid all the USE in graph C, though this resource would be insufficient to avoid the event in graph D. This is due to the battery having scope to recharge between events in graph C while it doesn't in graph D. This indicates that standard expressed in USE alone may not provide sufficient information to the market to address considerations in respect of battery storage investments and a future power system that may be more energy limited than has historically been the case in the NEM.

The Panel notes that the assumed storage state of charge, lead time to an event and event duration are extremely important to outcomes.

The limits associated with LOLEv and LOLE are illustrated by graphs A and B. Events A and B both have the same LOLP and LOLE but very different levels of USE and therefore severity.

QUESTION 8: FORM OF THE RELIABILITY STANDARD

- Do stakeholders consider there are shortcomings with USE that justify its replacement with an alternate standard form?
- What are the benefits of using an alternative standard form over the existing form? If so, what alternative forms are considered appropriate and why?
- Do stakeholders consider that supplementary or additional metrics, in addition to USE, should be considered to help provide further insight to reliability events?

5.4 Further issues for the Panel's consideration

In addition to the assessment criteria outlined in the guidelines and in the NER, there are a number of changes in the NEM, as outlined in Chapter two that the Panel consider are relevant to take into account when reviewing the reliability standard. Of specific relevance to the Panel's consideration of the reliability standard include:

- The cost of marginal generation is likely to have changed since the 2018 review. Of interest is the cost of new entrant technologies, particularly generation that is capable of minimising the quantity of USE. This restricts the analysis to dispatchable generation (including from batteries) that is sufficiently flexible to meet demand at times when there would otherwise be USE and to variable generation that has output that correlates with dispatch intervals where there would otherwise be USE. Though, with the increased responsibility of battery storage to act as the marginal generator, the difficulty of calculating the short run marginal cost of batteries must be noted.

- The forecast exit of thermal generation capacity has been the focus of reforms and work in recent years[141]. The Panel notes that as many of the large synchronous thermal generation fleet (coal generators) reach the end of their life, the probability of major, enduring outages at critical facilities may become greater. This may lead to a longer-tailed distribution of USE outcomes (e.g., USE periods of several hours or more). This trend may also be strengthened by the advent of large penetrations of renewables, which also lead to a longer-tailed distribution (i.e., driven by periods of prolonged low levels of wind or solar generation). These issues will be considered by the Panel in the context of its assessment of the form and level of the reliability standard.
- As noted in section 3.2.2, the continued increase in the amount of DER is influencing the way that consumers interact with the NEM while also creating new financial opportunities for service providers. The uptake of rooftop PV has been exceeding the forecast step change scenario in AEMO's 2020 ESOO, while there is also expected to be an increase in the uptake of home battery systems, EVs and other technologies. The 2022 RSS review will examine whether these changes in the amount of DER within the NEM, will affect the value that consumers place on the reliability of their electricity supply.
- The Panel notes that large amounts of investment in additional capacity will be necessary to ensure that the NEM remains secure and reliable throughout the transition towards higher penetrations of VRE.[142] However, there exists some investment uncertainty that is inhibiting further investment in generation capacity that the Panel considers it is import to consider. This is from:
  - Growing regulatory risk given the increased introduction of government policies and proposed reforms
  - Curtailment risks increasing due to low demand, and
  - Continued low wholesale prices and contract prices.

QUESTION 9: CHANGES IN THE AMOUNT OF DER AND ITS EFFECT ON THE RELIABILITY STANDARD

- Over the period 2024 – 2028, is the amount of DER within the NEM likely to materially change the way that consumers value their reliability of electricity supply?
- Are there any other issues of relevance for the Panel to consider for its review of the reliability standard.

141 ESB, Delivering adequate power supplies right now and into the future - being prepared for old coal retirement - Final report, July 2021. For more information https://www.datocms-assets.com/32572/1629954628-esb-final-report-explainer-adequate-power-supplies-rams-pathway.pdf

142 AEMO, *Electricity Statement on Opportunities,* August 2020.

6 THE MARKET PRICE SETTINGS

This chapter outlines the issues and criteria relevant to the Panel's consideration of the market price settings to apply for the period 2024-2028.[143] Stakeholder input is sought on issues relating to the:

- Market Price Cap (MPC)
- Market Floor Price (MFP)
- Administered Price Cap (APC)
- Cumulative Price Threshold (CPT)

This chapter discusses the following for each of the market price settings:

- the purpose of the market price setting
- trade-offs the Panel considers in its assessment
- assessment criteria that the Panel must apply, and
- additional issues in respect of the market price setting.

Appendix B provides background and history for each of the market price settings discussed in this chapter.

Consistent with the assessment approach set out in Chapter four, the Panel will only recommend a change to the form or level of the individual market price settings where there is a material benefit to doing so.[144]

6.1 Market price cap

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

6.1.1 Purpose and role of the MPC

The MPC sets the maximum price, measured as a $/MWh value that can be reached in the wholesale market for energy and FCAS. As per the 2021 guidelines, this cap on prices services two functions:

- 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 manage participant exposure to price risk.

143 Stakeholders should be aware of the AEMC's draft determination on the Extension of time and reduction in scope of the 2022 reliability standard and settings review rule change is for the market price settings to apply from the period 2025 – 2028. Further information can be obtained at: https://www.aemc.gov.au/rule-changes/extension-time-and-reduction-scope-2022-reliability-standard-and-settings-review

144 Stakeholders should also note that even if the Panel considers and recommends a change, the Panel will need to submit a rule change to the AEMC. The AEMC rule change process under the NER will need to be followed before any change is made.

Additional information on the history of, and trends in the level of the MPC is provided in Appendix B.

6.1.2 Factors relevant to setting the MPC

The Panel is required to consider the tension between these two factors when determining an efficient level for the MPC.

A very high MPC creates strong financial incentives for investment but market participants, both on the supply and demand side, could be exposed to substantial price risk. The level of the MPC should therefore be set high enough to send sufficiently strong financial signals in addition to providing incentives for participants to manage spot market risk, whether financially through contract markets or physically through demand response.

Extremely high market prices could, however, threaten the overall financial stability of the market if they create financial risks for participants, or certain classes of participants, that cannot be effectively managed. Such an outcome may produce less efficient outcomes over the long term.[145]

Conversely, if the MPC were set excessively low, it would reduce payments in the energy market and potentially prevent market from sending efficient price signals when the cost to supply a marginal unit of energy exceeded the MPC. This situation would reduce the incentives for efficient investment in electricity services and potentially lead to an increase of unserved energy and, therefore, market costs.

The Panel considers that the appropriate selection of the MPC to manage this trade-off is by selecting the lowest level of the MPC below the VCR that results in the reliability standard being achieved, and subject to the other considerations discussed in the balance of this chapter.[146]

6.1.3 Assessment criteria the Panel must take into account for the market price cap

The NER and the guidelines set out a number of assessment criteria that the Panel must take into account when reviewing the MPC. The Panel will apply these assessment criteria in its review of the MPC.

The NER states that the Panel can only recommend an MPC that the Panel considers will, among other things:[147]

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

These requirements mean that if the Panel is of the view that a decrease in the MPC may mean that the reliability standard is not maintained, then the Panel may only recommend

145 Loads may be able to manage this risk through the contract market, but may still be exposed to some residual financial risk given that it is difficult to exactly match contracting volume with actual market outcomes.

146 The Panel is required to also take into account the AER's estimate of VCR when setting the MPC, which sets the upper bound for possible MPC values as a value above this would allow for energy prices to exceed customers' value of energy.

147 NER clause 3.9.3A(f).

such a decrease where it has considered any alternative arrangements necessary to maintain the reliability standard.[148]

The guidelines further state that the Panel will consider the following principles in its review of the MPC:

- 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. Any such movements should occur over a period of several review periods, and
- when setting the MPC, consideration should be given to the MPC's effect on the financial burden faced by participants from high market prices, including price volatility and impacts on retailers.

Stakeholders should note the MPC is not intended to be a tool for placing downwards pressure on consumer costs by constraining high prices. It is not necessarily the case that a lower MPC will lead to lower average consumer costs. Similarly, a higher MPC may not necessarily lead to higher consumer costs. The relationship between the MPC and consumer costs is determined by a myriad of factors, including investment and dispatch decisions, the cost of any unserved energy, fuel prices and competition in dispatch. The Panel considers it important to note that using the MPC as a tool to steer consumer costs would likely distort investment decisions in the long term, likely leading to inefficient outcomes.

6.1.4 Further issues for the Panel's consideration in setting the market price cap

In addition to the assessment criteria outlined in the guidelines and in the NER, there are a number of changes in the NEM that the Panel consider are relevant to take into account when reviewing the MPC. A number of the issues raised in Chapter three have implications for the setting of the MPC. Chapter seven on modelling for the review also describes a range of practical issues associated with modelling to inform the setting of the level of the MPC.

Further issues for the Panel's consideration in setting the MPC include:

- The Panel considers, given the increasing investment in new technologies, that the MPC should allow for technology-neutral investment in the lowest cost plant necessary to meet the reliability standard and, as such, will need to examine whether the current form and level of the MPC allows the wholesale market to send the right price signals for all technology types.
- The rapid uptake of DER, including remotely controllable load, has emerged as a potential driver for a shift in consumer load profiles and therefore bears re-examining the relationship between the market price cap and customers in the wholesale market.[149]
- The shift to 5 minute settlement will change the dynamics of high price events and so the effect of the MPC on the reliability standard.

148 NER clause 3.9.3A(g).

149 Customers that don't have demand-side response have not historically been active participants in the wholesale market and so could not opt to alter their consumption to avoid high prices.

- The potential introduction of new markets could affect the supply-demand balance in normal operation of the NEM.
- The jurisdictional investment schemes and whether they will distort price signals based on the reliability settings by driving additional investments into the market.

> QUESTION 10: FURTHER ISSUES REGARDING THE MPC
>
> - Do you consider that the emergence of new technologies warrants a change in the MPC in order to enable technology-neutral investment to meet the reliability standard in the most cost-effective way?
> - Do you consider that the implementation of five minute settlement in October 2021 will affect the efficacy of the MPC in managing the risk exposure of market participants, while still providing efficient price signals?
> - Do you consider that the introduction of new markets would mean a change to the MPC is required?
> - What is the effectiveness of the MPC in allowing for investment in a technology-neutral, least-cost manner in the current environment of the NEM in transition?
> - What factors or issues regarding spot prices, investment, market participants and/or the predictability and flexibility of the regulatory framework should the Panel pay particular attention to?
> - Do you consider that the introduction and continuation of government investment schemes means that changes to the MPC should be considered?
> - Do stakeholders consider implementation of five minute settlement, and other recent changes, leading to materially different outcomes than those seen in historical data?

6.2 Market Floor Price

The market floor price (MFP) sets a lower limit on wholesale market prices that can be reached in any trading interval. The value of the MFP is specified in the NER and is currently set at -$1,000/MWh.[150]

6.2.1 Purpose and role of the MFP

In general, low price events are expected at times when there is an abundance of generation relative to demand. During such periods, negative prices assist power system operations by creating an incentive to reduce generation.

Negative bids reflect the amount a generator is willing to pay to remain dispatched to a certain level. Less flexible generators subject to high start up costs and technical unit commitment constraints, such as minimum up-time requirements, place a significant value on remaining dispatched at their minimum load level event in the event of negative prices. In

150 NER clause 3.9.6(b).

contrast, highly flexible generation, which can start or cease generation easily and at a low cost, will reduce generation and decommit if necessary in response to negative pricing.

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.

Details of the history and rationale for the MFP and negative prices in the NEM is provided in Appendix B.

6.2.2 The trade-off in setting the MFP

In setting the MFP, the Panel is making a similar trade-off on behalf of market participants and consumers as it makes when setting the MPC. This involves making a trading off between:

- Allowing the market to clear in most circumstances. If the MFP were not at a sufficiently low level to allow less flexible generators with different cycling costs to differentiate themselves through their negative bids, a lower MFP would in theory, reduce distortion and enable the market to clear efficiently a larger proportion of the time. If the MFP were set too high, generators with cycling costs in excess of the costs incurred by being dispatched at the MFP would be unable to express their willingness to incur these cycling costs though their bids. This could lead to inefficient rationing of overabundant, less flexible generation and higher wholesale prices.
- Not creating substantial risks which threaten the overall stability and integrity of the market. An extremely low MFP would expose less flexible thermal generators to increased negative price risk given their unit commitment constraints. This would increase the cost of inflexibility and affecting the financial viability of these generators. Changes to the MFP would also inevitably have implications for the contract market.

6.2.3 Assessment criteria the panel must take into account

Both the NER and the guidelines set out a number of assessment criteria that the Panel must take into account when reviewing the MFP. The Panel will apply these assessment criteria in its review of the MFP.

The NER states that the Panel may only recommended an MFP it considers will:[151]:

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

These requirements mean that if the Panel is of the view that a change in the form or level of the MFP means that the market will not clear in most circumstances, the Panel may only recommend such a change where it has considered alternative arrangements necessary to allow the market to clear in most circumstances.

151 NER clause 3.9.3A(h)

The guidelines further state that the Panel will consider the following principles in its review of the MPC:

- 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.

Information to inform stakeholder views on each of these points is provided in Appendix B.

6.2.4 Other issues for consideration by the Panel in setting the market floor price

In addition to the assessment criteria outlined in the guidelines and in the NER, there are a number of changes in the NEM that the Panel consider are relevant to take into account when reviewing the MFP. A number of the issues raised in Chapter three have implications for the setting of the MFP. Chapter seven also describes practical issues associated with modelling to inform the setting of the level of the MFP.

Further issues for the Panel's consideration in setting the MFP include:

- The increased level of demand-side participation and storage plants will allow the price to be more responsive to changing market conditions over time and should help to clear the market during periods of high variable generation, leading to fewer MFP events.
- There is currently no market setting which limits market participant exposure to sustained negative prices. As the frequency of MFP and low price events is increasing, it may be time to consider whether it would be appropriate to introduce an equivalent of the CPT for negative prices. As with the existing CPT, a negative CPT would seek to limit market participants' exposure to prolonged negative prices which could threaten their financial viability.
- There are examples of other jurisdictions, such as Ontario, Canada, where technology specific market floor prices have been introduced to set different price floors for different technology types.[152] This would allow technologies with lower price floors to be dispatched favourably over others.
- The MFP is not indexed by inflation and has been -$1,000/MWh since December 2000.[153] However, over this period to the March quarter 2021, the magnitude of the MFP has decreased in real terms by 38%. In other words, if the MFP had been held constant in real terms it would currently be equal to -$1,613/MWh.[154] This represents a substantial real increase in the MFP since it was first set at the current level and suggests that it may be time for indexation, and/or for a one-off adjustment (for example, by a change in generator fuel costs over time), to ensure that the magnitude of the MFP is not unintentionally eroded by inflation.

152 In Ontario, the purpose of setting technology-specific offer price floors is to limit renewable generators, such as wind and hydropower, from bidding to provide electricity at extremely low prices, allowing less flexible baseload generators to be dispatched first. The primary reason for needing these technology-specific floors in Ontario was due to the system operator being required to accept all renewable energy provided due to legislation.

153 ACCC Determination, VoLL, Capacity Mechanisms and Price Floor. 20 December 2000. Currently available at: https://www.accc.gov.au/system/files/public-registers/documents/D03%2B38328.pdf

154 Based on the ABS All groups CPI; Australia between December 2000 and March 2021. ABS 6401.0.

- To date, the absence of markets for some system services required to ensure secure dispatch that are provided by synchronous generators as a by-product to energy has meant that the provision of these services have not been compensated explicitly. As such, these synchronous generators have been required to make self-commitment decisions based on the energy price alone. This current structure means that the MFP is an important factor the provision of system services provided by-products. However, as new markets and compensation frameworks for system services are implemented in the future, these services will be valued separately to energy, allowing generators to make commitment decisions and to be compensated for their commitment in a way that represented the value to the market.
- With the recent introduction of five minute settlement the dynamics around the MPC and MFP are now quite different (e.g., no half hourly price and volume averaging). The introduction of five minute settlement has therefore altered the market to make outcomes given MFP settings materially different to outcomes seen in historical data.

QUESTION 11: ISSUES RELATING TO THE SETTING OF THE MFP

- Do you consider that the form and level of the MFP remains appropriate in the context of greater entry of storage and greater demand side participation in the NEM?
- In your view, should the Panel consider a negative cumulative price threshold? If so, what factors should be considered when determining the level of a negative CPT?
- In your view, is there benefit in the Panel considering setting technology specific market floor prices?
- Do you consider that the level of the MFP should be adjusted to account for the real reduction in its level over time? What form of indexation would be appropriate?
- Would the creation of new system services markets change your view on the appropriate form of the MFP?
- Would the creation of new system services markets change your view on the appropriate level of the MFP?
- Do stakeholders consider implementation of five minute settlement, and other recent changes, leading to materially different outcomes than those seen in historical data?

6.3 Cumulative price threshold

The Cumulative Price Threshold (CPT) is the maximum total energy price and total frequency control ancillary services (FCAS) price that can be reached over a period of seven days, before an administered price period (APP) commences and the APC, discussed further in the next section, is applied to market prices.[155] The CPT is increased by indexation each year.

155 NER clause 3.14.1.

The movement to five minute settlement in October 2021, means the value of the CPT will be multiplied by six to match the movement of settlement from a 30 minute to a five-minute basis. As such, the value of the CPT is:[156]

- $226,500 from 1 July 2021 to 30 September 2021, and
- $1,356,100 from 1 October 2021 to 30 June 2022.

6.3.1 Purpose and role of the CPT

The CPT acts to reduce the incidence of high prices over a sustained period. The 2021 Guidelines state that the CPT has two purposes:

- 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.

6.3.2 The trade-off in setting the cumulative price threshold

The CPT is set in tandem with the MPC. Changes in the CPT have direct effects on the balance between participants' exposure to extreme prices in the market and the amount of revenue that participants earn. The CPT is therefore an important parameter for providing sufficient revenue to incentive sufficient new entry to achieve the reliability standard.

A higher CPT means that it is less likely that an APP will occur. This increases the level of price risk faced by consumers, but increases the revenue that generators can potentially receive. As a result, a higher CPT increases the effectiveness of price signals as an effective investment cue by increasing the potential revenue earned by participants.

A lower CPT increases the chances of an APP occurring. This reduces market participants' exposure to sustained high prices but in turn also reduces the revenue that generators can receive. A lower CPT would reduce the effectiveness of price signals in the market by reducing the potential revenue earned by participants potentially impacting on the USE and achievement of the reliability standard.

Limiting participant exposure to sustained high prices may also alter incentives for participants to manage price risk, which may in turn affect investment outcomes. The level of the CPT is therefore important for levels of contract market and the efficient management of investment risk supporting achievement of the reliability standard.

The level of the CPT will also affect the investment decisions regarding the duration of storage for battery storage plants, where a lower CPT will reduce the length of consecutive high prices and so incentivise investment in shorter duration storage. Conversely, a higher CPT would incentivise investment in longer duration storage.

156 AEMC, *Schedule of reliability settings,* 25 February 2021.

6.3.3 Assessment criteria the Panel must take into account for the cumulative price threshold

The guidelines and the NER set out assessment criteria that the Panel must take into account when reviewing the CPT. The Panel will apply these criteria in its review of the CPT.

The NER states that the Panel can only recommend a CPT that the Panel considers will, among other things:[157]

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

In addition, the guidelines provide that when assessing the level of the CPT, the Panel will consider the following principles:

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

Information to inform stakeholder views on each of these points is provided in Appendix B.

These requirements mean that if the Panel is of the view that a decrease in the CPT may mean that the reliability standard is not maintained, then the Panel may only recommend such a decrease where it has considered any alternative arrangements necessary to maintain the reliability standard.[158]

6.3.4 Issues for the Panel's consideration in setting the cumulative price threshold

In undertaking its review of the CPT, there are a number of issues arising in the NEM, in addition to those above, that the Panel considers are relevant to take into account when reviewing the CPT. These are:

- New technologies that are increasingly supporting the NEM during high price periods, which may or may not be aligned with periods of high demand. These technologies particularly include battery storage and other storage plants, rely on price volatility to earn energy market revenue. When prices surpasses the CPT, prices are capped by the administered price cap, reducing possible price volatility. The Panel will consider whether the current form and level of the market price cap allows technology-neutral investment in capacity to meet the reliability standard in the lowest cost way and, as such, will examine whether the current form and level of the CPT sends the right price signals to all technology types.
- Market participants often use risk management tools to reduce their exposure to price risk, particularly through financial derivative contracts struck on a quarterly basis. The Panel could consider whether the difference in time period between such risk

157 NER clause 3.9.3A(f).

158 NER clause 3.9.3A(g)

management tools and the CPT allows the wholesale market to send efficient price signals.

- Traditionally, both energy and FCAS were provided by large, synchronous plant in tandem and sustained high prices in the energy would be necessarily linked to high prices in FCAS markets, and vice versa. As such, modelling for previous RSS reviews has focused on the energy price as a useful proxy for capturing the dynamics of the FCAS as well. However, as the NEM continues to evolve, energy and FCAS are increasingly being provided by separate plant types, which could cause sustained high prices in each market type to no longer be coincident. Given the significant increase in the new technologies, particularly battery storage, that can provide strong frequency response, FCAS prices will play an increasingly important role in setting the efficient level and form of the CPT.[159]

QUESTION 12: ISSUES REGARDING THE CPT

- Do you consider that the form and level of the CPT remain appropriate to encourage investment signals in a technology-neutral manner regarding the emergence of new technologies?
- Do you consider that the current time period that the CPT is assessed against (seven days) remains appropriate to allow participants to mange their price risk, while maintaining investment signals?
- Do you consider that the form and level is appropriate to manage sustained high prices in both energy and FCAS markets?

6.4 Administered price cap

The APC is the maximum settlement price that applies during an administered price period (APP) after a set of sustained high dispatch prices exceed the cumulative price threshold (CPT).[160] The value of the APC is specified in the NER and is currently set at $300/MWh.[161]

6.4.1 Purpose and role of the APC

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. The APC, combined with the cumulative price threshold (CPT), is a mechanism to minimise financial stability risks to the market arising from an extended period of supply scarcity and corresponding high prices.

The APC also acts as the administered floor price which is set at the negative of the value of the APC and represents the lower threshold that can be reached in any dispatch interval and any trading interval, during an APP.

159 AEMO, Energy Explained: Big Batteries, https://aemo.com.au/en/learn/energy-explained/energy-101/energy-explained-big-batteries.

160 NER clause 3.14.1.

161 NER clause 3.14.1(a).

6.4.2 The trade-offs in setting the administered price cap

Given the role and purpose of the APC, setting its value requires the Panel to make a trade-off that involves balancing a number of competing objectives, namely:

- having a sufficiently low APC so as to mitigate the risk of a systemic financial collapse of the electricity industry during an extreme market event
- having a sufficiently high APC so as to incentivise market participants to supply electricity during administered price events, and
- having a sufficiently high APC so as to minimise compensation claims by market participants following an application of the administered price cap.

An APP occurs following an extended period of high prices and is likely to occur under conditions of generation supply scarcity. Having an APC that is too low may discourage high-cost generators from bidding into the market during an APP. This would reduce available generation and potentially require intervention by AEMO and delay return to normal market operations.

If the APC is too low and a high cost generator is nevertheless dispatched, it has the option of pursuing a compensation claim to ensure it recovers all eligible costs.[162] However, this may be an expensive and time-consuming process. As such, the Panel considers ensuring that the APC is sufficiently high to minimise the likelihood of triggering a compensation claim is highly desirable.

Conversely, an APC that is too high may unnecessarily contribute to the financial distress of energy purchasers and risk contributing to financial instability in the market in resource to extreme market events.

6.4.3 Assessment criteria the Panel must take into account for the APC

Both the NER and the guidelines set out a number of assessment criteria that the Panel must take into account when reviewing the APC. The Panel will apply these assessment criteria in its review of the APC. The Panel will also consider factors including, but not limited to whether there have been:

- Significant changes in the typical short-run marginal costs of generators in the NEM, and
- Any compensation claims since the last review.

Additional information to inform stakeholder views on each of these points is provided in Appendix B.

6.4.4 Other issues for consideration by the Panel in setting the APC

In addition to the assessment criteria outlined in the guidelines and in the NER, a number of the issues raised in Chapter three have implications for the setting of the APC.

Other issues of specific relevance to the Panel's consideration of the APC include:

162 NER clause 3.14.6

- Consideration must be given to the cost of the different technologies that may play an increasing role during APPs in the future and whether the APC provides both sufficient incentives for investment in these technologies, and incentives to operate them efficiently to meet demand during APP periods. This may have implications for the existing approach because storage technologies such as hydro or utility-scale batteries do not have a well-defined SRMC. One option is to consider setting the APC with regard to an estimate of the opportunity cost of storage.[163]
- There has only been one compensation claim pursuant to application of the administered price cap, the Synergen Power compensation claim in 2010. This claim was successful as it was found that the legitimate costs incurred by Synergen Power had exceeded the amount received under the APC and that compensation in the amount of $130,486.94 was payable.[164] The lack of claims in the last 11 years suggests that the current level of the APC may adequately compensate generators during APPs.
- The current level of the APC of $300/MWh is aligned with the ASX cap price.[165] The APC and cap contracts both limit market participant exposure to high wholesale prices. Further, the value of the APC can impact on the contract market through either decreasing or increasing expected future prices and residual risk and potentially decreasing or increasing the incentive for, and ability to finance, new investment. Any change to the level of the APC should consider the interaction with the contracts market.
- As noted above, the level of the APC has been $300/MWh since May 2008. Over the period to the March quarter 2021, the magnitude of the APC has decreased in real terms by around 22 per cent. In other words, if the APC had been held constant in real terms it would be currently equal to $386/MWh.[166]
- Historically, gas generators and particularly OCGTs have played an important role in helping to meet demand during times of scarcity. For gas-fired generators, fuel costs account for most of their SRMC. Since the commencement of LNG exports in 2015 the domestic gas price has become increasingly linked to the international prices for LNG. This has led to greater volatility and a higher overall average gas price which has increased dramatically in recent times. The Panel may consider whether a fixed level for the APC remains appropriate given increasing volatility in gas, and other fuel prices. Additional information on trends in gas prices is provided in Appendix B.
- The APC is a relatively crude measure, and the imposition of the APC on the market price has been seen to have consequences such as triggering the switching-on of large amounts of demand in response to the lower market price. Some level of sophistication about how the APC is applied, how it is determined, and whether it varies over time, could potentially involve changing its form. Although there are no obvious solutions as to how the form of the APC could be altered to address these problems, this seems worthy

163 Particularly for longer term storage such as hydro. Utility scale batteries will typically be shorter duration and may have exhausted their charge during the high price period before the CPT is triggered and so may be expected to make a limited contribution to energy during APC periods.

164 For information on this claim see: http://www.aemc.gov.au/Markets-Reviews-Advice/Compensation-claim-from-Synergen-Power

165 See the ASX Australian Electricity Futures and Options Contract Specifications here.

166 Based on the ABS All groups CPI; Australia between June 2008 and March 2021. ABS 6401.0.

of consideration by the Panel. For example, if the APC ratchets down over time from a relatively high level so that there is not a sudden decrease in prices, investment and operational signals may be better maintained. These and other suite of issues will be canvassed and outlined in the RSS review.

QUESTION 13: ISSUES REGARDING THE APC

- How should the Panel consider setting the APC for technologies such as hydro and utility-scale batteries?
- Have typical generator SRMC increased significantly since the previous review period? Or are they expected to do so over the period 2024-2028?
- Do you consider that the APC remains appropriate to compensate generators during APPs?
- Is there evidence that the APC is affecting the contract prices and so affecting incentives for new investment?
- Is there a case for the APC to be indexed going forward?
- Given recent market developments and pricing outcomes, is the current form and or level of the APC appropriate? If not, what would be an appropriate form of the administered price cap, why and what is the evidence supporting your view? If not, what would be an appropriate level of the administered price cap, why and what is the evidence supporting your view?
- Do you consider that the current APC provides sufficient investment signal for new technologies?

6.5 Indexation

Currently the MPC and the CPT are subject to indexation. The MFP and the APC are not subject to indexation.

The AEMC has inflated the nominal value of the MPC and CPT each year based on historical inflation since the commencement of the National Electricity Amendment (Reliability Settings from 1 July 2012) Rule 2011 No. 5 in 2012.[167] The AEMC has undertaken this indexation in reference to the consumer price index (CPI), which is a measure of the changes in prices faced by consumers in the broader economy.

The application of indexation (using the CPI) for the MPC and CPT is prescribed in the NER.[168] The NER does not prescribe indexation for the MFP and APC, which retain their nominal values.

167 AEMC, Reliability Settings from 1 July 2012, Rule Determination, 16 June 2011.

168 NER cl 3.9.4 (d); and NER cl 3.14.1 (e).

In accordance with the 2021 guidelines, the indexation approach to MPC and CPT will continue to be based on the CPI, unless the Reliability Panel considers that there may be a material benefit in reassessing and changing this approach.

The Reliability Panel will consider the following factors in its assessment that include but not limited to whether:

- there have been material changes in the basket of goods used to calculate the CPI that make it less relevant for indexation of the settings
- there have been other changes in the methodology used to calculate the CPI, and/or
- a more preferable index becomes available, and/or
- there is a change in the designation of the CPI as an official statistic.

QUESTION 14: INDEXATION

- Are there any specific considerations the Panel should take into account for this review, relating to the indexation of the MPC and CPT?

7 MODELLING FOR THE REVIEW

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 introduces and outlines issues relevant to the Panel's approach to modelling to inform the 2022 RSS review. Specifically this chapter:

- introduces the modelling task required to inform the Panel's determination on the standard and settings
- proposes a set of principles describing the Panel's high level approach to modelling for the RSS review in line with the requirements in the NER and 2021 guidelines, and
- identifies a set of specific issues in relation to modelling reliability in a changing NEM for stakeholder feedback.

The Panel will publish the details that underpin the modelling throughout the course of the 2022 RSS review. The Panel intends to provide transparency on modelling methods and assumptions by publishing a methods and assumptions workbook that will provide details on the scenarios and specific parameters and assumptions used in the modelling. In addition, detailed draft and final reports will also be published setting out results from modelling conducted by consultants engaged to assist this RSS review.

7.1 Introducing the modelling task

The modelling required to inform the Panel's determination on efficient levels for the standard and settings needs to meet the requirements of Clause 3.9.3A(e)(3) of the NER and 2021 guidelines. This section provides a high level description of the modelling task to be undertaken by the Panel given these requirements.

7.1.1 Modelling the efficient level of the reliability standard

An efficient reliability standard delivers a level of reliability consistent with the value placed on that reliability by customers. As outlined in Chapter five, modelling informing this efficient level requires an assessment and comparison of costs:

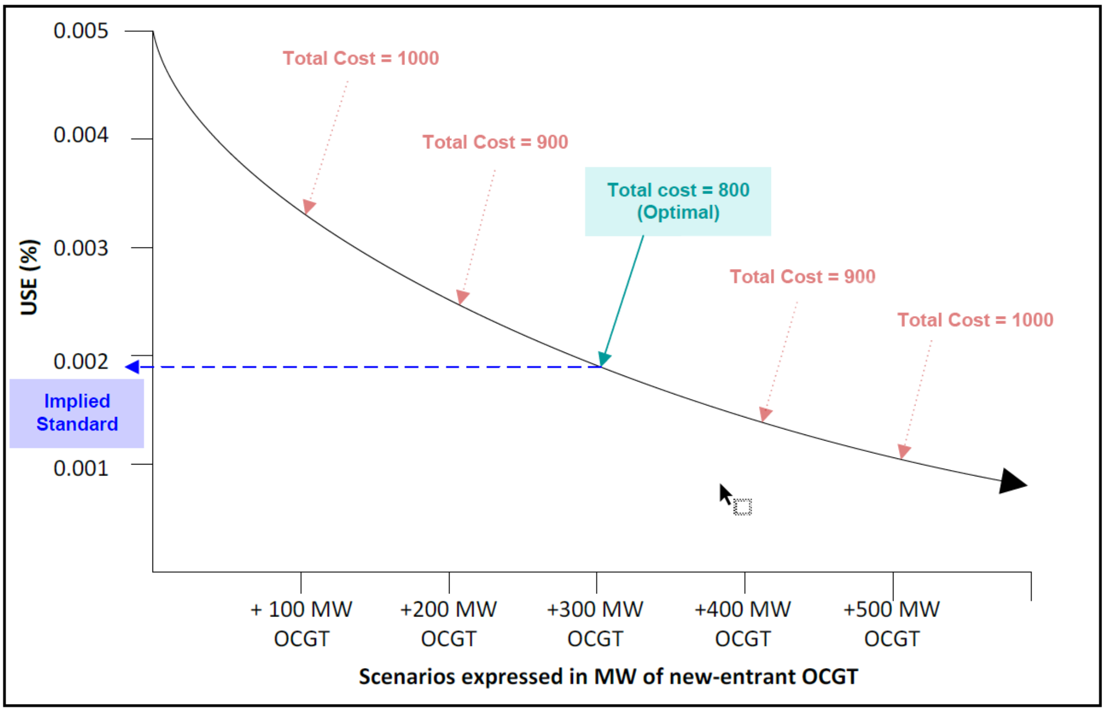
- to consumers from USE arising from range of different reliability events, and
- of procuring additional power system resources (both supply side generation and demand response) to address this USE.

The modelling task is to identify the lowest cost new entry power system resource, or portfolio of resources, and the associated costs, for a range of different levels of USE. The additional cost associated with an incremental investment in this lowest cost technology/portfolio is then compared with consumer savings from a reduction in USE due to this incremental investment to identify the level of USE that minimises total costs.

This modelling process used to identify this efficient level of reliability is illustrated by ROAM's (now Ernst and Young) modelling performed the last time the reliability standard was reviewed in 2014.[169] [170] ROAM first developed a set of scenarios revealing a range of different levels of USE. It then assessed the cost of an incremental additional investment in OCGT for each of these levels of USE and the savings to customers associated with this incremental investment.

Figure 7.1 illustrates outcomes from ROAM's assessment.[171] The vertical axis represents the level of USE and horizontal axis represent the MW capacity of new entrant OCGT associated with each assessed scenario. Each scenario has an associated "total cost" that includes the costs of USE. The greater the new-entrant capacity, the lower the level of USE because additional capacity reduces the probability of load-shedding. The scenario with the minimum total cost is shown in green.[172] Figure 7.2 further shows the total cost curve (cost of USE + cost of additional capacity) modelled by ROAM which confirmed the trade off between the cost of USE and additional OCGT capacity, in 2014, resulted in an efficient level of reliability of 0.002% USE.[173]

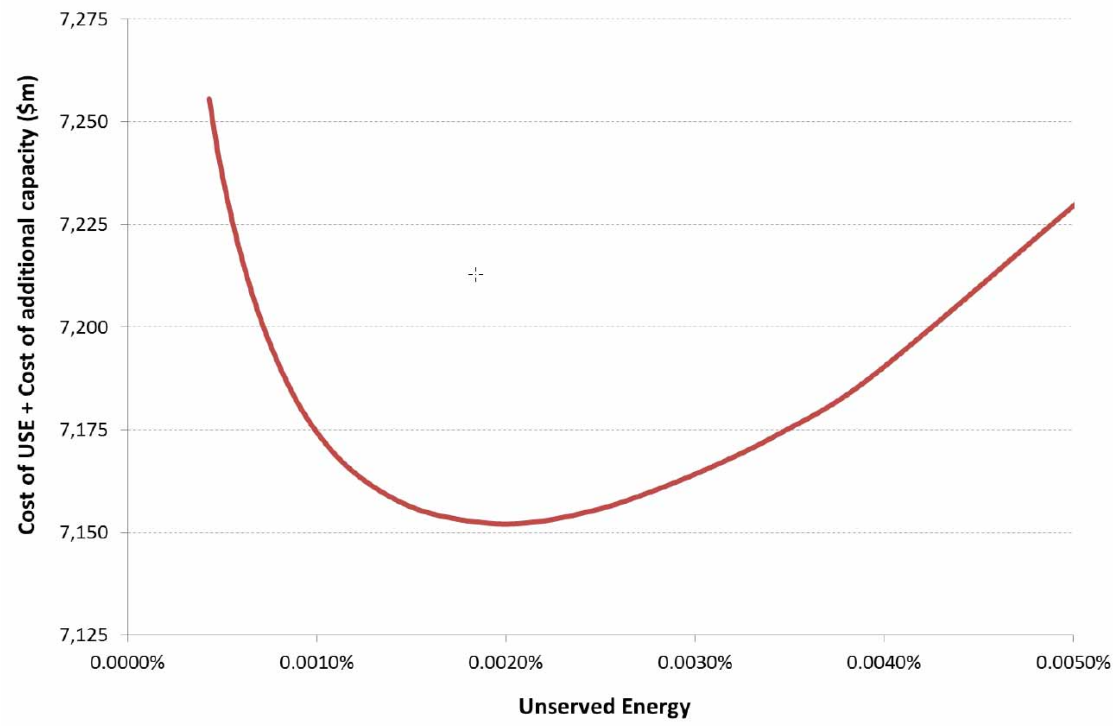
Figure 7.1: ROAM 2014 Reliability Standard modelling



Source: ROAM Consulting, Reliability Standard and Settings Review, report to the Reliability Panel, 21 May 2014, p. 11.
Note: Note this figure is purely illustrative.

169 Stakeholders should note the 2018 RSS review did not include the level or the form of the standard within its scope.
170 ROAM Consulting, Reliability standards and settings review - Final report to AEMC, 21 May 2014.
171 Ibid, p. 11.
172 Note: This figure is purely illustrative.
173 Ibid, p. 64.

Figure 7.2: Total cost curve and the efficient level of reliability in 2014



Source: ROAM Consulting, Reliability Standard and Settings Review, report to the Reliability Panel, 21 May 2014, p. 64.

Considerations for the 2022 RSS review

Modelling identifying an efficient reliability standard is, at a conceptual level the same as described from 2014. There are however a number of considerations relevant to the task in this RSS review that didn't apply in 2014. These include:

- ROAM's 2014 analysis assumed OCGT as a single candidate new entrant technology. The Panel no longer considers such an assumption to be appropriate. The Panel considers a wider range of candidate new entry power system resources require assessment relative to the case in 2014. These include energy limited storage and demand response.
- Modelling outcomes for a significant number different levels of USE is computationally time and resource intensive. This is particularly the case for modelling energy limited resources as part of a candidate set of new entrant power system resources.[174] This may limit the number of USE levels that can be practically modelled for the purpose of identifying the efficient level of reliability. The Panel may therefore identify the efficient level of reliability from a limited number of USE levels with the efficient level to be theoretically identified.

174 Such modelling requires full chronological information on charging and discharging to appropriately capture revenues accruing to storage investments.

- The Panel is considering the form of the reliability standard along with the level. All reliability events are associated with USE and the economic trade off required to identify an efficient level of reliability is necessarily based on USE. Modelling results can however assist to identify a corresponding efficient probability of USE (LOLP/LOLEv) or duration of USE (LOLE) for consideration by the Panel.

7.1.2 Modelling informing the market price settings

As introduced in Chapter six, the market price settings set incentives for investment in sufficient generation capacity, energy storage, and demand-side response to deliver the reliability standard, while also providing limits that protect market participants from periods of very high or very low prices, both temporary and on a sustained basis.[175]

Modelling informing the market price settings involves determining levels for the settings (in particular the MPC and CPT) that provide sufficient market revenue to recover the capital and operating costs of the lowest cost new entrant power system resource, or portfolio of resources, required to achieve the reliability standard. Assessing participant revenue requirements involves detailed market price-dispatch outcomes across the investment time horizon that capture:

- new entrant power system resource technology and entry timing, and
- economic retirement decisions given patterns of dispatch and revenues accruing to incumbent generators.

This modelling requires a set of inputs including:

- the efficient level of reliability defined by a previously identified standard
- an optimisation model of the NEM which simulates the behaviour of the national electricity market dispatch engine (NEMDE) and identifies optimal investment decision-making given physical power system characteristics and the incumbent generating mix
- a candidate set of new entrant power system resources that may enter the market including associated cost and technical characteristics
- relevant demand forecast and variable renewable generation traces over the investment time horizon
- forecasts of demand side technology uptake including EVs, solar PV, and active demand side response, 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, actionable ISP projects, and REZ development areas and timelines.

The configured optimisation model of the NEM is then run for a number of scenarios that reveal USE from various drivers that capture of range of risks to reliability in the NEM. Results

175 AEMC Reliability Panel, reliability standard and settings guidelines, 2021.

then identify the lowest cost new entrant power system resource outcomes thereby allowing the market price settings, in particular the MPC and CPT, to be identified.[176]

EY modelling in 2018

The Panel engaged Ernst and Young (EY) to conduct market modelling to support the last RSS review in 2018.[177] The approach used by EY in its modelling for the 2018 RSS review illustrates the core elements of the modelling approach under consideration by the Panel to inform market price settings for the 2022 RSS review.

EY developed a base scenario and conducting detailed time-sequential half-hourly modelling of the electricity market to determine the expected USE for the relevant period. A number of sensitivities on the base scenario were then conducted to explore the impact on USE outcomes from different assumptions.[178]

EY then estimated the theoretical optimal MPC from further iterative modelling runs under a set of alternative plausible scenarios where the reliability standard is threatened. These scenarios were devised by selecting assumptions that resulted in USE being above the reliability standard, in the absence of new entrant investment.[179] The economic and technical modelling task was then to find the minimum MPC that economically incentivised sufficient lowest cost new entrant investment to reduce the level of USE to below the reliability standard.[180]

EY's market modelling process involved the following steps for the base case and each scenario:[181]

1. **Determine a set of input assumptions.** EY's assumptions included policy drivers such as jurisdictional renewable energy schemes, the reliability standard and other market rules as well as electricity demand forecasts, generator costs and other relevant technical parameters.
2. **Set up an initial market simulation.** Using its set of input assumptions, EY conducted an initial time-sequential half-hourly market simulation over the assessment time horizon from which annual net revenues of each generator were identified to determine if any new entrants or retirements would be commercially driven for net revenue outcomes outside a tolerance range.
3. **Iterative modelling to achieve final simulation.** EY then adjusted the new entrants and retirements, re-simulating several times until all generators have a net revenue within a specified tolerance.

Through this process EY identified the set of commercially driven new entrant decisions given the net present value (NPV) of a generator's net revenue over its assumed economic lifetime.

176 This section focuses on modelling informing the CPT and MPC. The MPF and APC are set in respect of a different set of consideration. Additional information will be provided on modelling informing the MPF and APC in the method and assumptions report to be published following this issues paper.

177 Ernst and Young, reliability standard and settings review 2018 - modelling report, 13 April 2018.

178 Ibid, p. 11.

179 EY focused on early thermal retirement in their alternative scenarios modelled to reveal USE.

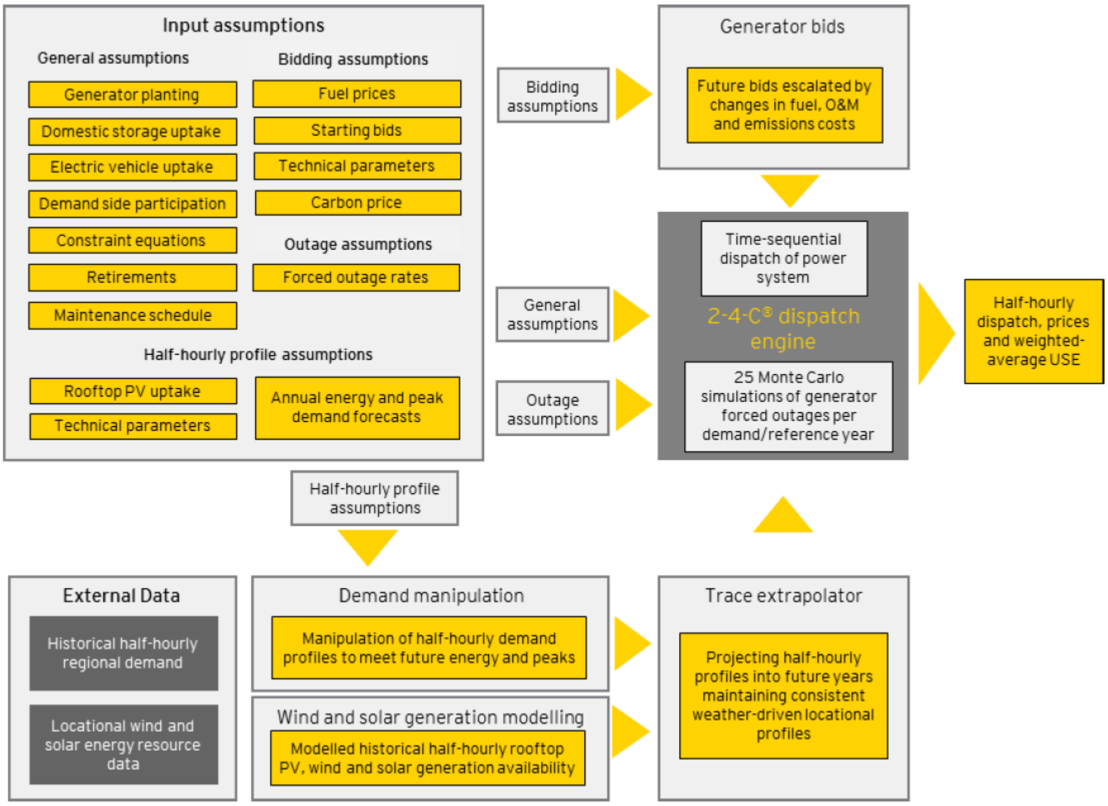
180 Ibid.

181 Ibid, p. 12

Net revenues included O&M costs, annualised capital cost repayments, and fuel costs. EY included revenue earned in all trading intervals in determining the commercial viability of a generator, rather than just MPC periods. EY did not consider other potential revenue sources (other than pool revenue), including revenue from jurisdictional renewable energy support payments, ancillary services in assessing the specific level of the MCP and CPT.[182]

The scope and process of EY's market modelling, input assumptions and data sources is illustrated in Figure 7.3.

Figure 7.3: EY 2018 RSS review modelling process and input data and assumptions



Source: EY, Reliability Standard and Settings Review 2018 – Modelling Report, 13 April 2018, p. 70.

Considerations for the 2022 RSS review

The Panel is considering a modelling approach that is broadly consistent with that used by EY in 2018 with some adjustments to account for changes in the power system and prospective conditions. There are however a number of considerations relevant to the task in this RSS review that didn't apply in 2018. These include:

- Modelling for the 2022 RSS review requires five minute price dispatch modelling rather than 30 minute modelling as was utilised in 2018. This is required for at least some

182 Ibid, p. 69.

scenarios and cases to realistically capture revenue outcomes for flexible generation and battery investments. Five minute modelling however leads to a significantly more computationally intensive exercise than in 2018.

- The standard is an input to modelling informing the market price settings. The scope of this 2022 RSS review includes the consideration of the level and form of the standard, while the 2018 review only considered the settings. The standard was a fixed input to the market modelling performed for the 2018 RSS review. Modelling to establish the level of the standard and settings both requires time sequential price dispatch modelling and identifies the lowest cost portfolio of new entrant power system resources. The Panel notes that the new entrant portfolio used to set the standard and inform the market price settings should be consistent. The Panel is therefore considering whether it can establish the standard and market price settings out of a single set of modelling runs and scenarios. This approach would address the time and computational intensity issues related to separate and sequential modelling of the standard and settings.
- Modelling in 2018 included a limited set of scenarios that revealed USE which focused on early thermal retirements. The Panel considers that the changing reliability risk profile, discussed in Chapter two, requires consideration of a wider set of possible drivers of USE and risks to reliability than was considered in 2018. These include risks associated with extreme weather events.

QUESTION 15: INTRODUCTION TO THE MODELLING TASK

- Do stakeholders consider the high level modelling approach used by ROAM and EY remain appropriate for the Panel's 2022 RSS review?

7.2 Modelling principles and approach

This section presents a set of principles informing the Panel's modelling for the 2022 RSS review. These principles implement the modelling task described above and satisfy NER and 2021 guideline requirements.[183] The principles are as follows:

- detailed time sequential modelling of price and dispatch outcomes in the markets for energy and FCAS will be conducted
- modelling will be technology-neutral and assess the standard and settings on the basis of the cheapest available marginal new entrant technology options
- participant decision-making on time-scales from investment decision-making to dispatch will be modelled
- scenarios will be developed to address the range of possible reliability outcomes and risks to reliability, and

183 In July 2021, the Panel concluded a review of its guidelines which amended the principles and requirements applying to the modelling used to inform the Review. The 2021 guidelines set out a number of principles that should guide the Panel in conducting modelling for the review.

- sensitivity analysis will be applied on assumptions where there exists material uncertainty on the true or forecast value.

The Panel's proposed modelling approach that satisfies these principles is described below.

Detailed time sequential modelling of price and dispatch outcomes in the markets for energy and FCAS will be conducted

The Panel considers detailed time sequential modelling of price and dispatch outcomes is required to inform the reliability standard and settings. Detailed time sequential modelling is required to appropriately identify the revenues and costs accruing to each power system resource option over the investment time horizon. This is necessary to allow economic retirements and the lowest cost set of new entrant investments to be identified. Full time sequential modelling is particularly important to assess the role and risks associated with reliance on energy limited storage resources, coupled with variable renewable generation, for reliability outcomes.

Modelling will be technology-neutral and assess the standard and settings on the basis of the cheapest available marginal technology options

The Panel intends to perform modelling that is technology neutral in its consideration of efficient reliability standard and settings. In specifying the principle that modelling should be technology neutral, the Panel considers use of a single input technology assumption as no longer valid, given changes in technology costs and the emergence of new technologies.

In its modelling for the 2022 RSS review, the Panel intends to include multiple possible new-entrant technology options. These include generation options, stand-alone storage and storage in combination with new renewable investment, demand response, and some measure of the economic deferral or retirement of existing generation.

Modelling will consider participant decision-making on relevant time-scales from investment to dispatch

Price and dispatch outcomes, and therefore participant revenues, are a function of participant decisions made on the following timescales:

- investment decisions
- retirement decisions
- planned maintenance and hydro generation scheduling
- unit commitment, and
- dispatch.

The interrelated impact of participant decisions across these timescales must be considered to allow hydro opportunity cost and constraints associated with thermal unit availability, availability, up and down time constraints, to be fully captured. It is necessary to understand these costs and constraints to appropriately model price and dispatch outcomes for flexible resources, storage, and demand response. Considerations in respect of unit commitment costs and constraints applying to less flexible generation are also particularly relevant to considering the level of the MFP.

Scenarios will be defined to cover the range of reliability risks relevant to the period covered by the 2022 RSS review

The power system reliability risk profile is changing. A more diverse range of risks are emerging/have emerged which are relevant to the efficient reliability standard and settings. Weather driven reliability risks are increasing due to higher penetrations of variable renewable generation, and climate change is increasing the frequency and severity of extreme weather events. Modelling such risks is important to reveal the range of different shapes (frequency, duration, depth) of USE relevant to determining the form and level of the reliability standard and associated market price settings. The Panel will identify scenarios for this purpose.

Uncertainty will be addressed through sensitivity analysis and Monte-Carlo simulation

A key challenge for modelling to inform the 2022 RSS review is to manage and understand uncertainty. The Panel notes that the standard and settings are informed by forecasts of market conditions seven years into the future in the context of a rapidly changing power system with increasing penetrations of variable renewable resources, changing load patterns and energy use characteristics, and increasing significance of energy limited storage.

Sensitivities will be assessed to understand uncertainty in outcomes associated with each scenario. Sensitivity analysis will allow an understanding how outcomes change given assumptions or other parameters where material uncertainty on the true or forecast value. Monte-Carlo modelling will be utilised to understand the impact of forced outages on reliability outcomes.

QUESTION 16: PRINCIPLES GUIDING THE PANEL'S MODELLING

- Do stakeholders have any feedback on the principles and high level approach proposed?
- Are there additional high level principles and considerations that the Panel should consider in its modelling to inform the RSS review?

7.3 Specific issues and considerations relevant to modelling for the 2022 RSS review

This section discusses a set of specific issues relevant to modelling for the 2022 RSS review given the principles and approach set out in Section 7.2. These are:

- modelling on five-minute vs 30-minute timescales
- approach to including FCAS revenues
- modelling uncertain sources of generation, load, and demand response
- scenario selection and determining the 'shape' of USE
- modelling demand response as a new entrant reliability resource

7.3.1 Modelling resolution - five minute versus 30 minute modelling time scales

On 28 November 2017 the AEMC made a rule to align operational dispatch and financial settlement in the NEM at five minutes. This rule change reduces the time interval for financial settlement from 30 minutes to five minutes and commenced on 1 October 2021.[184]

The Panel identifies time sequential modelling of price and dispatch outcomes at a five-minute resolution will be important to identify differences in the revenues accruing to highly flexible supply or demand side responses relative to less flexible thermal generation. This will capture implications for the optimal set of investment and/or retirements decisions. The Panel therefore considers long term-time sequential modelling on a five-minute timescale to be highly desirable but is also aware of the additional time and computational intensity involved.

The Panel notes that EY's modelling for the 2018 RSS review found that moving to five minute settlement did not make a substantial impact to the optimal reliability settings within the bounds of uncertainty associated with the assumptions and modelling limitations.[185] [186]

The Panel intends to either exclusively pursue five-minute modelling or explore whether a combination of 30 minute and five minute modelling may achieve required insights while also minimising time, cost, and computational intensity. While the Panel notes EY's findings, it considers that market outcomes over the period relevant to the 2022 RSS review may no longer align when assessed at five minute and 30 minute timescales given increasing levels of flexible technologies and storage in the NEM.

The Panel seeks stakeholder views on the importance of price-dispatch modelling at five minute resolution and welcomes suggestions on hybrid approaches.

7.3.2 Scenarios and drivers of reliability risk

The Panel will define scenarios to capture USE arising from the set of risks to reliability that are considered plausible over the period relevant to the 2022 RSS review. The Panel intends to choose a set of scenarios that reveal the shape of USE (duration, depth, frequency) from this range of risks. The Panel is considering specifying five scenarios in addition to the base case.

As described in Chapter three, the NEM is experiencing a shift in generation technology, patterns, and participation that is changing the reliability risk profile. Characteristic in this change is that reliability risk may no longer be primarily due to thermal unit availability during times of peak demand. In this regard, the Panel notes that reliability risk is increasingly due to:

- weather events which lead to highly correlated changes in variable renewable generation levels

184 *National Electricity Amendment (Delayed implementation of five minute and global settlement) Rule 2020 No. 10.* Further information is available at: https://www.aemc.gov.au/rule-changes/five-minute-settlement

185 Ernst and Young, *Reliability Standard and Settings Review 2018 - Modelling Report,* 13 April 2018, p. 62.

186 EY tested outcomes from 30 minute and 5 minute modelling and identified that five-minute modelling produced a very similar overall expected amount of unserved energy (USE) and number of hours at the MPC to the 30-minute modelling.

- occur at times of the year other than during traditional peak demand periods, and
- energy limits associated with increasing reliance on storage coupled with variable renewable generation for reliability purposes.

Stakeholders should note that these scenarios perform a different function in modelling for the RSS review than the function performed by AEMO's ESOO and ISP scenarios. AEMO scenarios are defined to capture uncertainty in the range of possible future worlds. This approach then informs AEMO's planning processes through the use of a 'least regrets' approach.[187] In contrast, the Panel does not intend for scenarios to predict specific future outcomes but instead aim to stress NEM reliability with a view to revealing USE with different characteristics from different drivers. Revealing USE in this way allows modelling to determine whether there are implications for the level of the reliability standard or settings given outcomes arising from the range of relevant risks to reliability.

The Panel is considering scenarios that include the following (or combinations of the following)

- **Extreme drought, heat wave, bushfires.** The effects of climate change are increasing the probability of extreme weather events. Extreme drought, heat wave and bushfires stress NEM reliability outcomes through a range of mechanisms. These extreme weather events may also be sufficiently related to be considered a plausible composite risk rather than as separate risks.
- **Increasing energy limits.** The retirement of coal and gas generation and increasing investment in hydro pumped storage and batteries, could see the NEM become more energy constrained during periods of supply scarcity. Scenarios may therefore consider the potential for unserved energy to arise from shortfalls in battery and pumped hydro energy storage under certain circumstances.
- **Correlated renewable generation events.** The risk of large changes in generation increases with higher penetration of weather driven variable renewable generation. This is particularly an issue as the output of wind or solar farms that are located close to other (such as in a REZ) are highly correlated. While the Panel intends to utilise 10 reference year renewable generation and load data used by AEMO in its ESOO modelling, scenarios may also include a set of lower probability meteorological events that result in significant correlated changes in variable renewable generation.
- **Early thermal retirement and delayed new entry.** Modelling will include announced retirements, as well as any retirements that are identified as occurring on an economic basis in response to market price and dispatch outcomes. There may however be additional thermal closures that are not yet announced or occur on a strictly economic basis. As an example, refurbishment or maintenance costs that are not available for the purpose of this RSS review could see incumbent thermal generation exit prior to its

187 AEMO, 2021 Inputs, Assumptions and Scenarios Report, July 2021. For more information see: https://aemo.com.au/en/consultations/current-and-closed-consultations/2021-planning-and-forecasting-consultation-on-inputs-assumptions-and-scenarios

anticipated retirement date. Major new project developments, such as Snowy 2.0, may also have material reliability impacts under some circumstances if delayed.[188]

7.3.3 Sensitivity analysis

A significant number of assumptions must be made in modelling for the Review. Key assumptions may introduce material uncertainty into the outcomes. For each scenario, the Panel intends to model sensitivities to capture the effect of assumptions on outcomes. These sensitivities may include (but are not limited to):

- high and low capital cost assumptions for different technologies
- high and low peak demand and average demand growth forecasts
- high and low fuel price projections
- assumptions regarding the withdrawal of large industrial loads and entry of new large electrical loads
- potential changes in the level of demand side participation in response to MPC levels
- different projections in the price and uptake of demand side emerging technologies, and
- diffferent levels of electric vehicle uptake and large scale Electrolysis for the production of hydrogen.

The Panel also notes that the assumed storage state of charge, lead time to an event and event duration are extremely important to outcomes for storage as a reliability provider. The Panel may include assumptions in respect to battery charging behaviour in the lead up to a reliability event in its sensitivity analysis.

7.3.4 Modelling FCAS

The Panel intends time sequential modelling of outcomes covering markets for both energy and FCAS. The MPC is common to the wholesale electricity and FCAS markets and participants will trade off the potential revenue achieved from each market in determining their participation strategies. Therefore, modelling needs to capture revenue achieved in both types of markets when identifying efficient marginal resource procurement outcomes.[189]

EY excluded any consideration of FCAS revenue earned by generators in its modelling for the 2018 RSS review. EY considered that the reliability settings in the NEM are primarily driven by outcomes in the energy market due to its relative size. EY considered the likely revenues from FCAS participation were sufficiently small compared to revenue from electricity sales to be excluded.[190]

The Panel is aware of public reports that indicate the importance of FCAS revenues for the profitability of battery projects in the NEM.[191] These reports indicate that revenues from FCAS have been an important consideration for investment in such projects are therefore relevant

188 The Panel may include scenarios that include delayed major projects (including ISP projects or Snowy 2.0).

189 AEMO operates eight separate markets for the delivery of FCAS. Outcomes in these markets are co-optimised with the energy market which means that NEMDE minimises the combined cost of energy and FCAS provision.

190 Ernst and Young, Reliability Standard and Settings Review 2018 - Modelling Report, 13 April 2018, p. 69.

191 https://www.pv-magazine-australia.com/2020/02/12/big-batteries-earn-20-million-over-three-months/

to modelling which will consider battery, and other highly flexible plant, as investment candidates.

The Panel considers that modelling for the 2022 RSS review should include FCAS. Fully co-optimised modelling of the FCAS and energy markets may however not be justified given the additional complexity, time, and cost involved. The Panel is therefore interested in stakeholder views on sensible simplifying assumptions that can be applied that will allow revenues to be appropriately approximated without requiring full co-optimised modelling.

7.3.5 Issues in modelling storage and demand response

In line with 2021 guideline requirements, modelling for the 2022 RSS review will be technology-neutral and assess the settings on the basis of the cheapest available marginal technology that can be used to deliver the standard.

The Panel considers demand response to be an important element in achieving efficient reliability outcomes. The Panel is however giving careful consideration to how, or whether to, model demand response as a candidate power system response alongside storage and conventional generating technologies.

There is also significant uncertainty regarding the level and nature of new entrant price responsive demand to changes in the reliability settings. While information is available from AEMO on demand response behaviour in the NEM in response to market prices, this information does not extend to the price and response characteristics of new entrant demand response that would allow it to be effectively modelled as a power system resource. In its modelling for the ESB, ACIL Allen used RERT offers as the basis of assessing the cost of price responsive demand response.[192] The Panel is considering whether this approach is suitable, combined with appropriate sensitivity analysis.[193]

The Panel however notes that demand response to wholesale prices is, by definition, low value demand choosing to switch off because it has a customer specific value of lost load below the MPC. Therefore, rather than being counted as new entrant power system resource for the purposes of setting the market price cap, modelling may consider the sensitivity of demand response as an adjustment on the demand side in response to different possible levels for the MPC. This analysis may be informed from historic data obtained from a range of sources with uncertainty addressed through sensitivity analysis.

Stakeholder views on the approach to modelling the impact of demand response on efficient reliability standard and settings is welcomed.

192 ACIL Allen, *Energy Security Board - Reliability Standard - Economic Analysis to Support Review*, March 2020, p. i.

193 The Panel understands that coordinated DER trials are currently being undertaken by AGL, EnergyAustralia and Origin.

QUESTION 17: SPECIFIC ISSUES AND CONSIDERATIONS RELEVANT TO MODELLING FOR THE 2022 RSS REVIEW

- Are there any stakeholder views on the importance of price-dispatch modelling at 5 minute resolution and welcomes suggestions on hybrid approaches?
- The Panel is therefore interested in stakeholder views on sensible simplifying assumptions that can be applied that will allow revenues to be appropriately approximated without requiring full co-optimised modelling?
- The Panel is interested in stakeholder views on the range of risks that should be captured in the scenarios modelled for the review?
- The Panel welcomes stakeholder views on the approach to modelling the impact of demand response on efficient reliability standard and settings is welcomed.
- Are there any stakeholder suggestions on approaches to modelling energy limited storage resources as reliability providers?

ABBREVIATIONS

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
APC	Administered price cap
APP	Administered price period
Commission	See AEMC
CPI	Consumer Price Index
CPT	Cumulative price threshold
DRSP	Demand response service provider
ENCRC	Energy National Cabinet Reform Committee
ESB	Energy Securities Board
ESOO	Electricity statement of opportunities
FCAS	Frequency control ancillary services
ISP	Integrated system plan
LOLE	Loss of load expectation
LOLEv	Loss of load event
LOLP	Loss of load probability
LOR	Lack of reserve
MCE	Ministerial Council on Energy
MFP	Market floor price
MPC	Market price cap
MSL	Minimum system load
NEL	National Electricity Law
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
NEO	National electricity objective
NERL	National Energy Retail Law
NERO	National energy retail objective
NGL	National Gas Law
NGO	National gas objective
NPV	Net present value
PASA	Projected assessment of system adequacy
REZ	Renewable Energy Zone
RERT	Reliability and emergency reserve trader
RRO	Retailer reliability obligation
RRP	Regional reference price
USE	Unserved energy

VCR	Values of customer reliability
VPP	Virtual power plant
WALDOs	Widespread and long duration outages
WDR	Wholesale demand response

GLOSSARY

Available capacity	The total MW capacity available for dispatch by a scheduled generating unit or scheduled load (i.e. maximum plant availability) or, in relation to a specified price band, the MW capacity within that price band available for dispatch (i.e. availability at each price band).
Busbar	A busbar is an electrical conductor in the transmission system that is maintained at a specific voltage. It is capable of carrying a high current and is normally used to make a common connection between several circuits within the transmission system. The rules define busbar as 'a common connection point in a power station switchyard or a transmission network substation'.
Cascading outage	The occurrence of a succession of outages, each of which is initiated by conditions (e.g. instability or overloading) arising or made worse as a result of the event preceding it.
Contingency events	These are events that affect the power system's operation, such as the failure or removal from operational service of a generating unit or transmission element. There are several categories of contingency event, as described below: • credible contingency event is a contingency event whose occurrence is considered "reasonably possible" in the circumstances. For example: the unexpected disconnection or unplanned reduction in capacity of one operating generating unit; or the unexpected disconnection of one major item of transmission plant • non-credible contingency event is a contingency event whose occurrence is not considered "reasonably possible" in the circumstances. Typically a non-credible contingency event involves simultaneous multiple disruptions, such

	as the failure of several generating units at the same time.
Customer average interruption duration index (CAIDI)	The sum of the duration of each sustained customer interruption (in minutes) divided by the total number of sustained customer interruptions (SAIDI divided by SAIFI). CAIDI excludes momentary interruptions (one minute or less duration).
Directions	Under s. 116 of the NEL, AEMO may issue directions. Section 116 directions may include directions as issued under clause 4.8.9 of the NER (e.g. directing a scheduled generator to increase output) or clause 4.8.9 instructions (e.g. instructing a network service provider to load shed). AEMO directs or instructs participants to take action to maintain or re-establish the power system to a secure operating state, a satisfactory operating state, or a reliable operating state.
Dispatch	The act of initiating or enabling all or part of the response specified in a dispatch bid, dispatch offer or market ancillary service offer in respect of a scheduled generating unit, a scheduled load, a scheduled network service, an ancillary service generating unit or an ancillary service load in accordance with NER rule 3.8, or a direction or operation of capacity the subject of a reserve contract as appropriate.
Distribution network	The apparatus, equipment, plant and buildings (including the connection assets) used to convey and control the conveyance of electricity to consumers from the network and which is not a transmission network.
Distribution network service provider (DNSP)	A person who engages in the activity of owning, controlling, or operating a distribution network.
Frequency control ancillary services (FCAS)	Those ancillary services concerned with balancing, over short intervals, the power supplied by generators with the power consumed by loads (throughout the power system). Imbalances cause the frequency to deviate from 50 Hz.

Interconnector	A transmission line or group of transmission lines that connect the transmission networks in adjacent regions.
Jurisdictional planning body	The transmission network service provider responsible for planning a NEM jurisdiction's transmission network.
Lack of reserve	This is when reserves are below specified reporting levels.
Load	A connection point (or defined set of connection points) at which electrical power is delivered, or the amount of electrical power delivered at a defined instant at a connection point (or aggregated over a defined set of connection points).
Load event	In the context of frequency control ancillary services, a load event: involves a disconnection or a sudden reduction in the amount of power consumed at a connection point and results in an overall excess of supply.
Load shedding	Reducing or disconnecting load from the power system either by automatic control systems or under instructions from AEMO. Load shedding will cause interruptions to some energy consumers' supplies.
Low reserve condition (LRC)	This is when reserves are below the minimum reserve level.
Momentary average interruption frequency index (MAIFI)	The total number of customer interruptions of one minute or less duration, divided by the total number of distribution customers.
Medium term projected assessment of system (MT PASA) (also see ST PASA)	A comprehensive programme of information collection, analysis and disclosure of medium-term power system reliability prospects. This assessment covers a period of 24 months and enables market participants to make decisions concerning supply, demand and outages. It must be issued weekly by AEMO.
Minimum reserve level (MRL)	The minimum reserve margin calculated by AEMO to meet the reliability standard.
Ministerial Council on Energy (MCE)	The MCE is the national policy and governance body for the Australian energy market, including for electricity and gas, as

	outlined in the COAG Australian Energy Market Agreement of 30 June 2004.
National Electricity Code	The National Electricity Code was replaced by the National Electricity Rules on 1 July 2005.
National electricity market (NEM)	The NEM is a wholesale exchange for the supply of electricity to retailers and consumers. It commenced on 13 December 1998, and now includes Queensland, New South Wales, Australian Capital Territory, Victoria, South Australia, and Tasmania.
National Electricity Law (NEL)	The NEL is contained in a schedule to the National Electricity (South Australia) Act 1996. The NEL is applied as law in each participating jurisdiction of the NEM by the application statutes.
National Electricity Rules (NER)	The NER came into effect on 1 July 2005, replacing the National Electricity Code.
Network	The apparatus, equipment and buildings used to convey and control the conveyance of electricity. This applies to both transmission and distribution networks.
Network capability	The capability of a network or part of a network to transfer electricity from one location to another.
Network control ancillary services (NCAS)	Ancillary services concerned with maintaining and extending the operational efficiency and capability of the network within secure operating limits.
Network event	In the context of frequency control ancillary services, the tripping of a network resulting in a generation event or load event.
Network service providers	An entity that operates as either a transmission network service provider (TNSP) or a distribution network service provider (DNSP).
Network services	The services (provided by a TNSP or DNSP) associated with conveying electricity and which also include entry, exit, and use-of-system services.
Operating state	The operating state of the power system is defined as satisfactory, secure or reliable, as described below.

	The power system is in a **satisfactory** operating state when: • it is operating within its technical limits (i.e. frequency, voltage, current etc are within the relevant standards and ratings) • the severity of any potential fault is within the capability of circuit breakers to disconnect the faulted circuit or equipment. The power system is in a **secure** operating state when: • it is in a satisfactory operating state • it will return to a satisfactory operating state following a single credible contingency event. The power system is in a **reliable** operating state when: • AEMO has not disconnected, and does not expect to disconnect, any points of load connection under NER clause 4.8.9 • no load shedding is occurring or expected to occur anywhere on the power system under NER clause 4.8.9 • in AEMO's reasonable opinion the levels of short term and medium term capacity reserves available to the power system are at least equal to the required levels determined in accordance with the power system security and reliability standards.
Participant	An entity that participates in the national electricity market.
Plant capability	The maximum MW output which an item of electrical equipment is capable of achieving for a given period.
Power system reliability	The measure of the power system's ability to supply adequate power to satisfy demand, allowing for unplanned losses of generation capacity.
Power system security	The safe scheduling, operation and control of the power system on a continuous basis.

Probability of exceedance (POE)	POE relates to the weather/temperature dependence of the maximum demand in a region. A detailed description is given in the AEMO ESOO.
Reliable operating state	Refer to operating state.
Reliability of supply	The likelihood of having sufficient capacity (generation or demand-side response) to meet demand (the consumer load).
Reliability standard	The Reliability Panel's current standard for reliability is that there should be sufficient generation and bulk transmission capacity so that the maximum expected unserved energy is 0.002 per cent.
Reserve	The amount of supply (including available generation capability, demand side participation and interconnector capability) in excess of the demand forecast for a particular period.
Reserve margin	The difference between reserve and the projected demand for electricity, where: Reserve margin = (generation capability + interconnection reserve sharing) – peak demand + demand-side participation.
System average interruption duration index (SAIDI)	The sum of the duration of each sustained customer interruption (in minutes), divided by the total number of distribution customers. SAIDI excludes momentary interruptions (one minute or less duration).
System average interruption frequency index (SAIFI)	The total number of sustained customer interruptions, divided by the total number of distribution customers. SAIFI excludes momentary interruptions (one minute or less duration).
Satisfactory operating state	Refer to operating state.
Scheduled load	A market load which has been classified by AEMO as a scheduled load at the market customer's request. A market customer may submit dispatch bids in relation to scheduled loads.
Secure operating state	Refer to operating state.
Separation event	In the context of frequency control ancillary services, this describes the electrical

	separation of one or more NEM regions from the others, thereby preventing frequency control ancillary services being transferred from one region to another.
Short term projected assessment of system adequacy (ST PASA) (also see MT PASA)	The PASA in respect of the period from two days after the current trading day to the end of the seventh day after the current trading day inclusive in respect of each trading interval in that period.
Spot market	Wholesale trading in electricity is conducted as a spot market. The spot market allows instantaneous matching of supply against demand. The spot market trades from an electricity pool, and is effectively a set of rules and procedures (not a physical location) managed by AEMO (in conjunction with market participants and regulatory agencies) that are set out in the NER.
Supply-demand balance	A calculation of the reserve margin for a given set of demand conditions, which is used to minimise reserve deficits by making use of available interconnector capabilities.
Technical envelope	The power system's technical boundary limits for achieving and maintaining a secure operating state for a given demand and power system scenario.
Transmission network	The high-voltage transmission assets that transport electricity between generators and distribution networks. Transmission networks do not include connection assets, which form part of a transmission system.
Transmission network service provider (TNSP)	An entity that owns operates and/or controls a transmission network.
Unserved energy (USE)	The amount of energy that is required (or demanded) by consumers but which is not supplied due to a shortage of generation or interconnection capacity. Unserved energy does not include interruptions to consumer supply that are caused by outages of local transmission or distribution elements that do not significantly impact the ability to transfer power into a region.

A SUPPLEMENTARY INFORMATION

This appendix presents supplementary information supporting the issues identified in the body of the report.

Additional supplementary information is provided on:

- Changing contract market outcomes
- Considerations on proposals for increased interconnection
- Other market reforms and reviews including:
  - The interim reliability measure
  - AEMC system security work program
  - Generator 42 month notice of closure and project assessment of system adequacy
- Changing consumption patterns due to COVID 19
- Changes in consumer use of electricity relevant to the VCR

A.1 Contract market outcomes

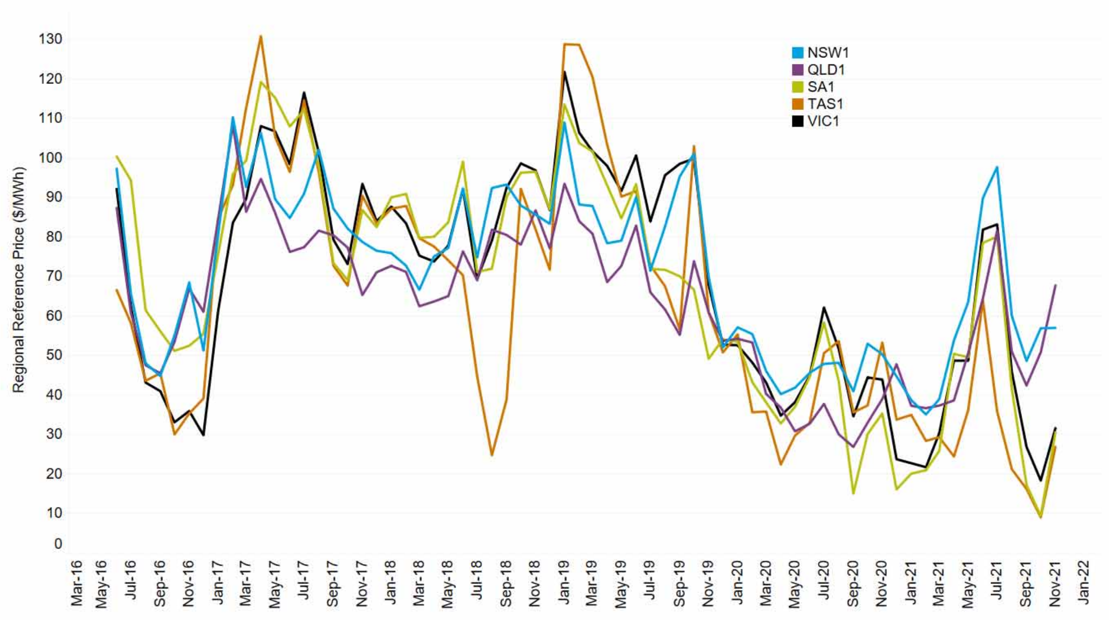
Wholesale market participants enter into various wholesale hedging contracts to manage financial risks and increase certainty over wholesale energy costs. Financial markets for managing spot market price risks are therefore very important support for participant investment decision-making.

Both buyers and sellers in the wholesale market are exposed to variations in the spot price in the wholesale market. They appreciate that large swings in spot prices have a similar but opposite effect on their costs and revenue and consequently their profits and share price. This encourages both buyers and sellers to agree to contract that convert volatile spot revenues and costs to a more certain cash flow, or to help underwrite further investment in both generation and retail assets, which are generally expensive, long-term investments in a more uncertain investment environment.

While the primary role of entering into these contracts is to manage risk and cash-flows, contracts can be considered simply as another means of expressing the price of the same underlying product, meaning that the spot and contract prices are intrinsically linked. The price of hedging contracts reflects the balance of expectations as to the level and volatility of future wholesale spot price outcomes, and therefore supports reliability by informing both investment and operational decisions.

Contracts for the NEM are traded either on the ASX or bilaterally. Changing the market price settings may affect risk management behaviour, including potential impacts on contract markets, and how this may affect investment outcomes in the NEM.

Figure A.1: Average monthly underlying spot prices (sub-$300/MWh)



Source: AEMC analysis of AEMO MMS data.
Note: This figure shows the monthly average underlying spot price (sub-$300/MWh).

A.2 Other market reforms and reviews

There are a range of other reforms have been introduced in the NEM recently or will be introduced over the next few years. These reforms are relevant to the Panel's assessment in the 2022 RSS review and the modelling it will undertake. Other market reforms relevant to this review are:

- the interim reliability measure
- AEMO Integrated Systems Plan
- AEMC system security work program
- generator notice of closure changes, and
- various jurisdictional energy efficiency, electric vehicle, and distributed energy resource policies in addition to those listed in Chapter three of this report

A.2.1 The interim reliability measure

The interim reliability measure was put in place by Energy Ministers (formally COAG Energy Council) following advice from the ESB to improve the reliability (resource adequacy) of the electricity system in the short term.[194]

194 COAG Energy Council, Interim Reliability Measures, https://energyministers.gov.au/reliability-and-security-measures/interim-reliability-measures.

The interim reliability measure is relevant for contracting interim reliability reserves and for the Retailer Reliability Obligation.[195] The interim reliability measure stands apart from the reliability standard and settings, and is not reviewed by the Panel as part of the RSS review.[196] Under the NER, the interim reliability measure will cease in March 2025. The AEMC must conduct a review of the interim reliability measure by 1 July 2023.[197]

The interim reliability measure is not in the scope for the 2022 RSS review. However, 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.

A.2.2 AEMO's ISP and proposals for increased interconnection

AEMO's draft 2022 Integrated System Plan was released on 10 December 2021. It is a whole-of-market plan which provides an integrated road map for the efficient development of the NEM over the next 20 years and beyond, encompassing its regulatory, market, policy and commercial components. It will be a coordinated map of where new generation assets will be located as well as the most efficient investment strategy into network infrastructure that will be required to enable its connection to the grid.

The ISP's primary objective is to maximise value to end customers by designing the lowest cost, secure and reliable energy system capable of meeting any emission's trajectory determined by policymakers at an acceptable level of risk.[198] AEMO's ISP is relevant to this RSS review, in particular the lowest cost generation technology cost technologies identified and the modelling assumptions and configuration used by AEMO in its modelling.

AEMO's draft 2022 ISP highlights five major actionable projects:[199]

- New England REZ Transmission Link - Transmission network augmentations as defined in the New South Wales Electricity Strategy.
- Sydney Ring(Reinforcing Sydney,Newcastle, and Wollongong Supply) - High capacity 500 kV transmission network to reinforce supply to Sydney, Newcastle and Wollongong load centres.
- HumeLink staged with decision rules - A 500 kV transmission upgrade connecting the Snowy Mountains Hydro-electric Scheme to Bannaby.
- Marinus Link - Two new HVDC cables connecting Victoria and Tasmania, each with 750 MW of transfer capacity and associated alternating current (AC) transmission
- VNI West staged with decision rules - A new high capacity 500 kV double-circuit transmission line to connect the Western Victoria Transmission Network Project (north of Ballarat) with Project Energy Connect (at Dinawan) via Kerang.

195 NER 3.9.3C(a1), 11.128, 11.132.
196 NER 3.9.3A, 3.9.3B, 3.9.3C.
197 Clause 11.128.12(c) of the NER.
198 https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp
199 AEMO, *2021 Draft Integrated System Plan,* 10 December 2021, p.61.

Transmission assets including interconnectors can act as substitutes for generation. For example, a new interconnector may be able to relieve transmission congestion and allow surplus generation in a location to be shared with another region with a shortage of generation. This could alleviate the need for new generation in the latter region. Modelling to inform efficient levels for the reliability standard and settings will incorporate the actionable ISP projects.

A.2.3 AEMC system security work program

The AEMC is considering a suite of rule changes as part of our system security work stream. These system services rule change requests complement and are interdependent with the work of the ESB[200] to develop advice on a long-term, fit-for-purpose market framework to support reliability that could apply from the mid-2020's. The AEMC is working closely with the ESB and the other market bodies as it progresses these rule change requests. Those of relevance to this RSS review include:

- **Synchronous services markets:** Amendment to the NER to create a market for synchronous services, including inertia, voltage control and fault level/system strength. This is being considered alongside capacity commitment mechanisms.
- **Operating reserve market and ramping reserve market:** Introduction of an operating reserve market in the NEM to respond to unexpected changes in supply and demand.
- The date for making a draft determination on two "reserve services" rule changes has been extended to 30 June 2023[201] due to the complexity of the proposed new market design and other changed circumstances. These rule change requests relate to the question whether lining up capacity in a new market or service is necessary to balance the energy market in operational time frames. The directions paper:[202]
  - Considers the ability of the current market frameworks address variability and uncertainty in power system conditions.
  - Outlines high-level designs for four options to procure reserve services.
- **Fast frequency response market ancillary service:** Introduction of two new market ancillary services to help control system frequency and keep the future electricity system secure when there is reduced system inertia. The final rule[203] introduces two new market ancillary service categories into the NER for:
  - The very fast raise service
  - The very fast lower service

  The final rule also introduced additional reporting obligations on AEMO under NER cl. 4.8.16(b)[204].

200 Energy Security Board, *Post 2025 Electricity market Design*, available here.

201 AEMC, *Extension for two reserve services rule changes*, 18 November 2021, available here.

202 https://www.aemc.gov.au/news-centre/media-releases/have-your-say-new-reserve-service-evolving-power-system

203 AEMC, *National Electricity Amendment (Fast Frequency Response Market Ancillary Service) Rule 2021*, 15 July 2021, available here.

204 AEMC, *National Electricity Amendment (Fast frequency response market ancillary service) Rule 2021 No. 8*, available here

- **Efficient management of system strength on the power system:** The AEMC made a final determination on 21 October 2021[205] for a more preferable rule for the efficient provision of system strength, in response to a rule change request from TransGrid that is seeking to amend the existing arrangements in the NEM. The final rule builds upon the Commission's draft rule with some minor amendments in response to stakeholder feedback. The final rule has three components:
  - Aspects of the rule that maximise supply of system strength
  - Aspects of the rule that minimise demand for system strength
  - Coordination of the supply and demand side aspects of the rule
- **Capacity commitment mechanism for system security and reliability services:**[206] This involves the proposed introduction of a capacity commitment mechanism to provide access to operational reserve and other system security or reliability services. This is being considered alongside synchronous services markets.

A.2.4 Generator 42 month notice of closure and project assessment of system adequacy

There is currently a requirement in place that scheduled and semi-scheduled generators need to provide at least 42 months' notice prior to closing. This is intended to increase transparency into retirement of generators.[207]

A sudden retirement can leave little or no time for a corresponding level of investment in new generation to replace that which is lost, which can increase potential concerns about reliability as there is less generation to meet demand. These concerns may not eventuate if information on plant retirement is provided to the market in sufficient time for participants to respond as it allows market participants to factor this information into their investment, operational and retirement decisions. For example, another generator may decide to stay open longer and so invest in extra maintenance in order for this to occur, or planned new generation and storage may be brought forward.[208]

This information will help market participants respond to possible future shortfalls in electricity generation, which relates closely to the Panel's considerations in ensuring a reliable supply of electricity.

A.2.5 Various jurisdictional energy efficiency, electric vehicle, and distributed energy resource policies.

The following is a list of jurisdictional energy efficiency, electric vehicle, and distributed energy resource policies that are relevant to the Panel's 2022 RSS review. The following list was complied by AEMO in its 2021 Inputs, Assumptions and Scenarios Report.[209]

Distributed energy resources

205 AEMC, *Efficient management of system strength on the power system, 21 October 2021*, available here
206 https://www.aemc.gov.au/rule-changes/capacity-commitment-mechanism-system-security-and-reliability-service
207 AEMC, *Generator Three Year Notice of Closure,* Final Determination, p.15.
208 Ibid, p.15.
209 AEMO, *2021 Inputs, assumptions and scenarios report*, July 2021, pp. 29-30.

Various policies and initiatives exist across the NEM jurisdictions to support the uptake of DER, including:

- South Australia – Home Battery Scheme.[210]
- Victoria – Solar Homes Scheme,[211]
- New South Wales – Clean Energy Initiatives.[212]
- Emission Reduction Fund and Victorian Energy Saver Incentive Scheme (additional PV non-scheduled generation [PVNSG] revenue stream via Victorian Energy Efficiency Certificates [VEECs] or Australian Carbon Credit Units [ACCUs]).[213]
- Australian Capital Territory Next Generation Energy Storage program.[214]
- Trial programs to integrate virtual power plants (VPPs) and explore how a network of small-scale PV and batteries can be collectively controlled and fed into the grid.[215]

Electric vehicle policies

The EV policies within NEM jurisdictions are included in electricity demand forecasts. These policies support and encourage the investment and uptake of zero emission vehicles that will lower energy carbon intensity in Australia. In 2021, the New South Wales and Victorian Governments both introduced their zero emissions vehicle strategies. These include the following:

- Australian Capital Territory's Transition to Zero Emissions Vehicles Action Plan which offers financial incentives for the purchase and registration of zero emissions passenger vehicles.[216]
- New South Wales' Electric Vehicle Strategy, which aims to increase EV sales to more than 50% of new cars sold in New South Wales by 2030 and for EVs to be the majority of new cars sold by 2035.[217]
- South Australia's Electric Vehicle Action Plan, which aims to make EVs the common choice for motorists in 2030, and the default choice by 2035.[218]
- Victoria – Zero Emissions Vehicle Roadmap, which sets a target of 50% of new light vehicle sales being zero emissions by 2030.[219]

Energy efficiency policies

210 Government of South Australia 2001, Government of South Australia, Adelaide, viewed 11 January 2022, available here.
211 Solar Victoria 5 January 2022, Solar Victoria, Melbourne, viewed 11 January 2022, available here.
212 Energy NSW 2022, NSW Government, Sydney, viewed 11 January 2022, available here.
213 Green Energy Markets, *Projections for distributed energy resources - solar PV and stationary energy battery systems report for AEMO,* June 2020, pp. 30-33, available here.
214 Act Smart 2021, Act Government, Canberra, viewed 11 January 2022, available here.
215 AEMO Virtual Power Plant (VPP) Demonstrations, 2021, AEMO, viewed 11 January 2022, available here.
216 ACT Government, *The ACT's transition to zero emissions vehicles action plan 2018-2021,* 2018, Canberra, available here.
217 NSW Government's Electric Vehicle Strategy, 2021, NSW Government, Sydney, viewed 11 January 2022, available here.
218 Renewable SA Electric Vehicles 2021, Government of South Australia, Adelaide, viewed 11 January 2022, available here.
219 Victoria State Government 2021, Energy Victoria, Melbourne, viewed 11 January 2022, available here.

The energy efficiency assessment that forms part of electricity demand forecasts considers federal and state-based policies that encourage investments in activities that will lower energy consumption, including:

- Building energy performance requirements contained in the Building Code of Australia (BCA) 2006, BCA 2010, and the National Construction Code (NCC) 2019. The NCC Futures program, which proposes higher building performance requirements in the future, is applied to Step Change and Hydrogen Superpower.
- Building rating and disclosure schemes of existing buildings such as the National Australian Built Environment Rating System (NABERS) and Commercial Building Disclosure (CBD).
- The Equipment Energy Efficiency (E3) program (or Greenhouse and Energy Minimum Standards [GEMS])of mandatory energy performance standards and/or labelling for different classes of appliances and equipment. Step Change and Hydrogen Superpower also contain proposed programs and those that have currently stopped but may continue in the future.
- State-based schemes, including the New South Wales Energy Savings Scheme (NSW ESS), the Victorian Energy Upgrades (VEU) program, and the South Australian Retailer Energy Efficiency Scheme (SA REES). Variations that extend existing savings initiatives are explored in scenarios that have greater decarbonisation objectives. In addition, 'hypothetical' schemes are considered for regions that do not currently have a state-based scheme.
- Other state measures, including the Victorian House Energy Savings Package and the Victorian Business Recovery Energy Efficiency Fund (BREEF).
- Other national schemes, such as the Commonwealth Emissions Reduction Fund (ERF) and the Clean Energy Finance Corporation (CEFC).
- A hypothetical industrial assessment program for the higher ambition scenarios, modelled on the former Energy Efficiency Opportunities (EEO) program.

A.3 Changes in consumer use of electricity relevant to the VCR

The Panel must also consider any marked or forecast changes in the way consumers use electricity, particularly through the use of new technology, that suggest a large number of consumers may place a lower or higher value on a reliable supply of electricity from the NEM.[220]

Increased changes in electricity use by consumers through technological innovations may suggest a changing value on reliable electricity supply from the NEM for some consumers. Overall total consumption and native demand is projected to rise in coming years, as consumers take up electric vehicles (EV), adopt battery storage and switch from gas to electric appliances. However, the operational demand of the NEM is projected to remain relatively flat over the next 10 years. It is noted that with the COVID 19 pandemic and with

220 AEMC, *Review of the reliability standard and setting guidelines*, 2021, July 2021, p.5.

more people working from home, there may be long-term changes in the trends for demand and consumption going forward.

A.3.1 AER VCR review considerations

In December 2019 the AER released their final report on the VCR that examined how customers have come to value the reliability of their electricity supply. The AER also calculated updated values of the VCR based on a CPI increase of 0.69 per cent.[221] The report set out the VCR values for unplanned outages of up to 12 hours in duration for the NEM and Northern Territory.[222] The report was based on a survey of over 9,000 residential, small business and industrial energy customers. The AER found:[223]

- While there were some differences between the two survey years 2014 (the last time that VCRs were estimated by AEMO) and 2019, the VCR values in general are similar.
- Business customer VCRs continue to be higher than residential customer VCRs. However, the 2019 VCR values are lower than the 2014 results for agricultural and commercial customers, and higher for industrial customers.
- Residential customers continue to value reliability and have a preference to avoid longer outages and outages which occur at peak times. However, residential values are lower in 2019 than in 2014 with the exception of customers in suburban Adelaide.
- The direct cost survey results show that VCR values amongst the approximately 300 business sites that consume the most energy in the NEM can vary greatly depending on the sector.

Thus, it is important to note that since the Panel's last RSS review in 2018, the AER's VCR has shifted with residential customers, and some business sectors placing a slightly lower value on reliability.

A.3.2 Changing consumption patterns due to COVID 19

The COVID-19 pandemic has led to changing consumption patterns throughout the NEM. There has been a trend towards greater 'working from home' which is expected to persist to some degree compared with before the pandemic. Figure A.2 compares the load profiles of two substations between 2019 and 2020. Load was lower in the Sydney CBD during the shutdown and higher in the residential suburb of Jannali, reflecting the greater proportion of people working from home.

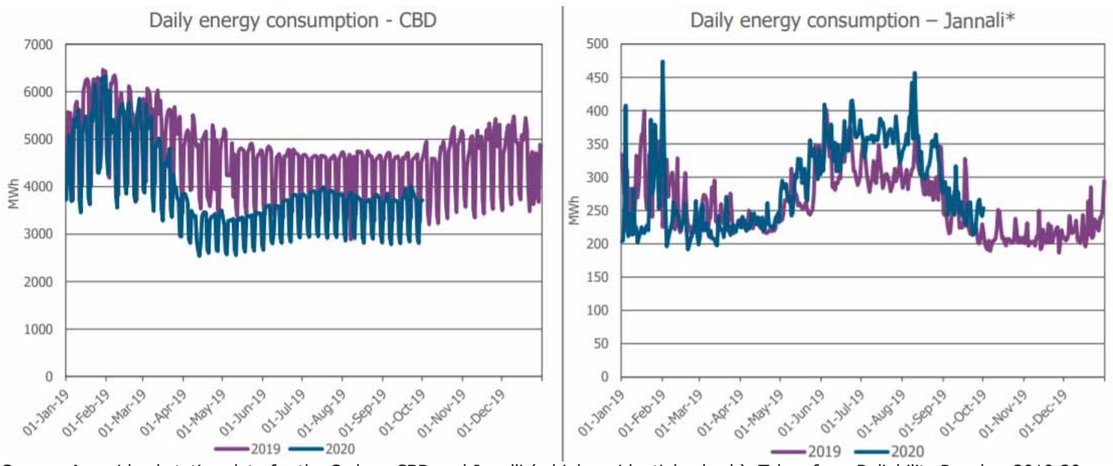
This change may have implications for the value of customer reliability (VCR) for residential consumers. Consumers are or may start to place a higher value on their electricity use when at home. It should be noted however that this does not necessarily imply a change in the value of customer reliability overall which is a weighted average of the value of reliability to different types of customers.

221 AER, *Values of customer reliability adjusted for 2020*, 18 December 2020, available here.

222 AER, *Value of Customer Reliability, Final decision - on VCR values,* 26 November 2019, available here.

223 AER, *Values of Customer Reliability fact sheet*, December 2019, p.2.

Figure A.2: Shifting load profiles during the 2020 COVID-19 shutdown.



Source: Ausgrid substation data for the Sydney CBD and Janalli (a high residential suburb). Taken from Reliability Panel — 2019-20 Annual Market Performance Report.

The Panel also notes recent data from the Australian Bureau of Statistics which shows an increase in the net migration out of capital cities towards regional areas.[224] Figure A.3 shows the change in quarterly net internal migration to the capital cities. Most of the change is due to a reduction in net migration to Melbourne and may reflect the effect of the lockdown in late 2020. The change in net migration is relatively small, representing less than 0.1% of the total capital city populations per quarter.

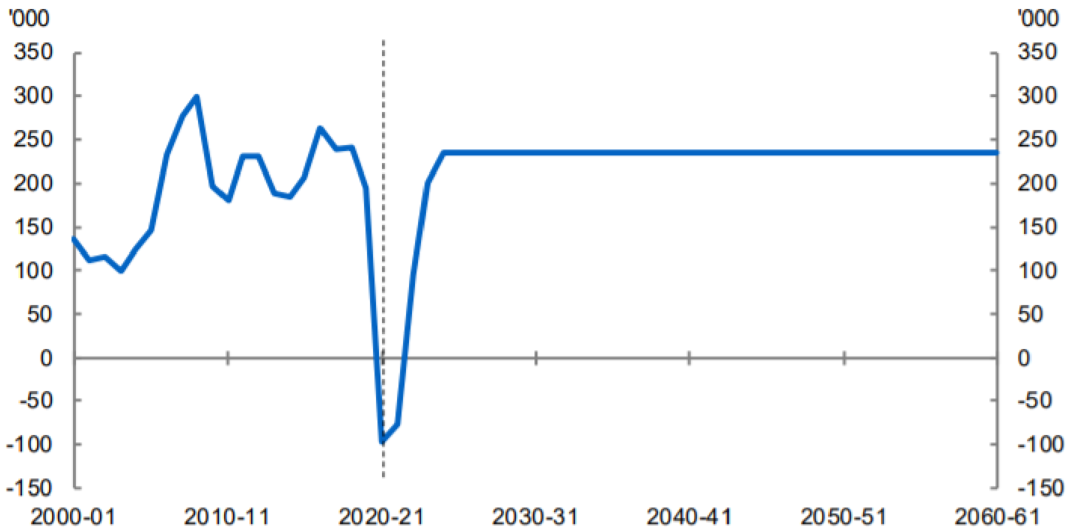
224 ABS Regional internal migration estimates, provisional, Reference period March 2021: https://www.abs.gov.au/statistics/people/population/regional-internal-migration-estimates-provisional/latest-release

Figure A.3: Quarterly net internal migration, greater cities combined

Source: ABS Regional internal migration estimates, provisional, March 2021.

Net overseas migration which fell sharply due to border closures during the COVID-19 pandemic has had a larger impact on capital city population. Figure A.4 shows the impact of border closures on net overseas migration and Treasury's forecast future migration. This will likely lead to lower Sydney and Melbourne populations than were expected prior to the COVID-19 pandemic.

Figure A.4: Net overseas migration



Source: Commonwealth Treasury - 2021 Intergenerational Report, p. 16.

A.3.3 Other factors influencing consumer VCR

The following are a set of other factors of relevance to the Panel's consideration of VCR to use identifying the efficient level for the reliability standard.

Rooftop Solar PV

The continued growth of rooftop solar PV is changing the way that customers interact with the electricity market. The rapid uptake of rooftop solar PV has implications for both operational energy demand and consumption.

The clean energy regulator documented a record number of residential rooftop solar PV installations in 2020 with 367,958 units installed.[225] Further, AEMO have increased their forecasts of distributed PV installed capacity, which includes residential, commercial, and larger embedded and PV non-scheduled generation (PVNSG) systems, signalling a dampening effect on operational energy consumption and declining minimum operational demand.[226] This trend of increased production of electricity from rooftop solar PV will have wide-ranging effects on how customers value reliability, and will be considered in the 2021/22 RSS review.

Battery storage technologies

The increased commitment of large scale battery projects and distributed energy storage, may insulate households and small businesses from the impact of interruptions in supply, and thus reduce the value of reliability for some consumers. There have been a number of large scale battery connections to the NEM with further battery projects committed to come online

225 Clean Energy Regulator (CER), *Postcode data for small-scale installations,* 30 April 2021, available here.

226 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 29, available here].

in the future. Further, small-scale batteries have been increasingly taken up by residential and business customers with this trend expected to continue as the price of batteries falls in the future.[227]

Household appliance use

The uptake of household appliances continues to grow in the form of larger capacity white goods, larger televisions, more web-connected devices, and more heating and cooling capability.[228] Household demand for electricity is forecast to increase as the uptake of EVs grows and households begin to transfer to electric rather than gas appliances.[229] Though, despite this forecast growth in native demand, the growth of operational demand is expected to be tempered due to the forecast growth of rooftop solar PV and appliances with greater energy efficiency.[230] The 2021/22 RSS review will consider how changing household appliance use will affect the way consumers interact with the NEM, and as a result the impacts this could have on the value that customers place on reliability.

Small to medium enterprises (SME) and large industrial loads

The SME sector includes all businesses which are not included in the large industrial loads sector. This consists primarily of businesses in the services sector and smaller manufacturers. Large industrial loads (LIL) encompasses sectors such as coal mining, water infrastructure and manufacturing sub-sectors including aluminium smelters. SME are continuing to increase their contribution to Australia's economic output displacing the contribution of LIL.[231]

Through to 2039-40, SME energy consumption is expected to hold steady as increased to Gross State Product (GSP) will be offset by increased energy efficiency and distributed PV.[232] As for LIL, there is forecast to be modest increases in electricity consumption.[233] These forecasts suggest there would be marginal change in the value of reliability for SME and LIL.

Electrification of transport

The electrification of the transport sector could become a core driver of growth in electricity consumption in the future.[234] As a result of greater EV model choice and charging infrastructure availability, the electrification of the transport sector is forecast to accelerate in the late 2020s into the early 2030s, which correlates with the 2024-28 period the 2021/22 RSS review is set to examine.[235] Based on the current level of uptake, AEMO forecast that the uptake of EVs will only reach half a million vehicles, or 3% of all vehicles by 2029-30.[236] Though the introduction of state government policies to increase the uptake of EVs could

227 The Clean Energy Regulator maintains statistics on the installation of some small-scale batteries here: http://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/Postcode-data-for-small-scale-installations.

228 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 34, available here.

229 AEMC, *The Reliability Standard: Current Considerations,* March 2020, p. 25, available here

230 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 38, available here.

231 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 34, available here.

232 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 34, available here.

233 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 36, available here.

234 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 37, available here.

235 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 37, available here.

236 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 39, available here.

increase the pace of the electrification of the transport sector, having an impact on how customers use electricity.[237]

Minimum demand periods

The rapid uptake of rooftop solar in Australia is changing the profile of the evening peak demand. In the coming three to five years, AEMO forecasts that minimum demand will decline in New South Wales, Victoria, South Australia, and Queensland.[238] Additionally, the rapid uptake of distributed energy resources is making evening peak demand occur later and shorter in length.[239] From both a commercial and system reliability perspective, this favours resources that respond quickly and for relatively short durations (such as OCGT, hydro or battery storage). The changing demand profile is contributing to the growing difference in the expected level of USE and exposure to potential supply shortfalls at times of peak demand.[240]

A.4 NEM investment environment

Large amounts of investment in additional capacity will be necessary to ensure that the NEM remains secure and reliable throughout the transition towards higher penetrations of VRE. Whilst this is the case, market participants have noted that there is some investment uncertainty which is inhibiting further investment in generation capacity. In particular COVID has made things more uncertain, however the Panel notes that there was a level of investment uncertainty before the beginning of 2020.

The rapid change of conditions in Australia in the first half of 2020 due to COVID-19 presented a number of issues to the electricity market, including:

- Significant reduction in overseas travel, leading to issues with labour resources for construction and maintenance of projects
- Increase in hardship customers and issues with bad debt for retailers, and
- Changing demand patterns with changing consumer preferences and choices.

As noted, there were other causes of uncertainty before the COVID pandemic. These factors include:

- Growing regulatory risk given increasing intervention and proposed reforms
- Curtailment risks increasing due to low demand
- Continued low wholesale prices and contract prices.

The Panel notes that it is important that the market is conducive to new investment for reliability and security of the NEM. The conclusion of the ESB post-2025 process and the finalisation of recommendations to the Energy Ministers Meeting are intended to reduce risks

237 NSW Electric and Hybrid Vehicle Plan available here; Victoria's Zero Emissions Vehicle Roadmap available here.

238 AEMO, *2020 Electricity Statement of Opportunities*, August 2020, p. 43, available here.

239 AEMC, *The Reliability Standard: Current Considerations,* March 2020, p. 25, available here.

240 AEMO, *AEMO observations: operational and market challenges to reliability and security in the NEM*, March 2018, p. 7, available here.

around regulatory uncertainty, and will provide more certainty about the direction of the market over coming years.[241]

241 Reliability Panel, Annual Market Performance Review, Market performance update, https://www.aemc.gov.au/market-reviews-advice/annual-market-performance-review-2020

B HISTORY AND CONTEXT ON THE MARKET PRICE SETTINGS

B.1 Market price cap (MPC)

The MPC places an upper limit on wholesale market prices that can be reached in any dispatch interval and in any trading interval.

B.1.1 History of the market price cap

The MPC has been a feature of the NEM since its inception.

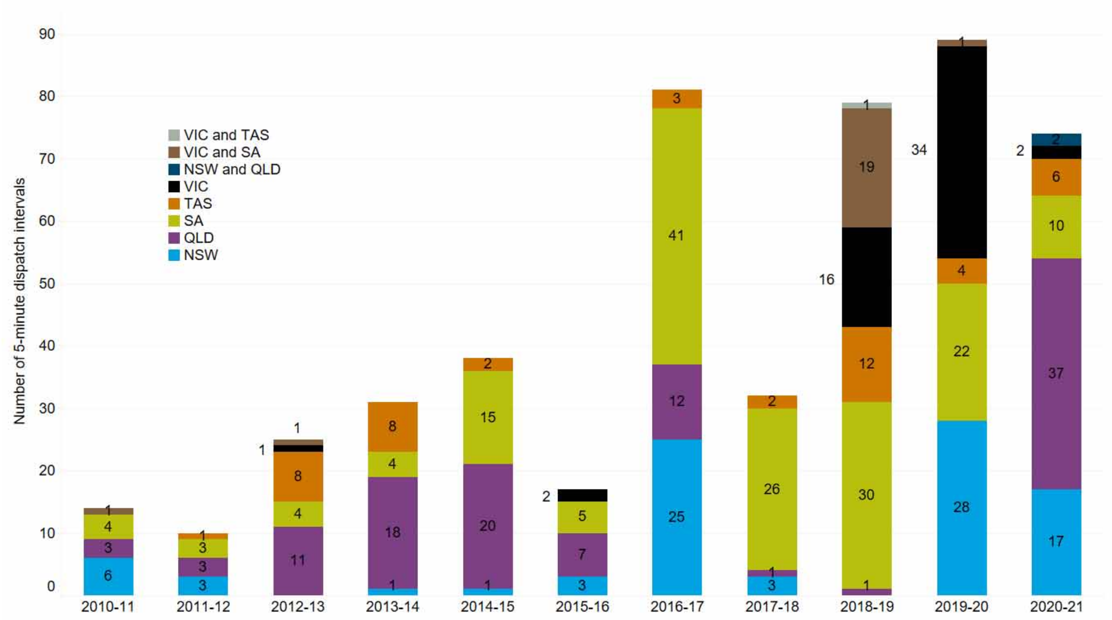
Since 1 July 2012, the MPC has been increased annually by the consumer price index in order to maintain the real value of the MPC year-on-year. Table B.1 shows the historical values of the MPC that have been applied since the 2010/2011 financial year.

Table B.1: **Market price cap historical levels**

FINANCIAL YEAR	MARKET PRICE CAP ($ PER MWH)
2011	12,500
2012	12,500
2013	12,900
2014	13,100
2015	13,500
2016	13,800
2017	14,000
2018	14,200
2019	14,500
2020	14,700
2021	15,000
2022	15,100

Figure B.1 shows that, except for the 2016 and2018 financial years, there is general trend of an increasing number of dispatch intervals where the market price cap has been reached. In the 2021 financial year, the largest number of market price cap events occurred in Queensland.

Figure B.1: Frequency of market price cap event



Source: AEMC analysis of AEMO MSATS data.

B.2 Market floor price

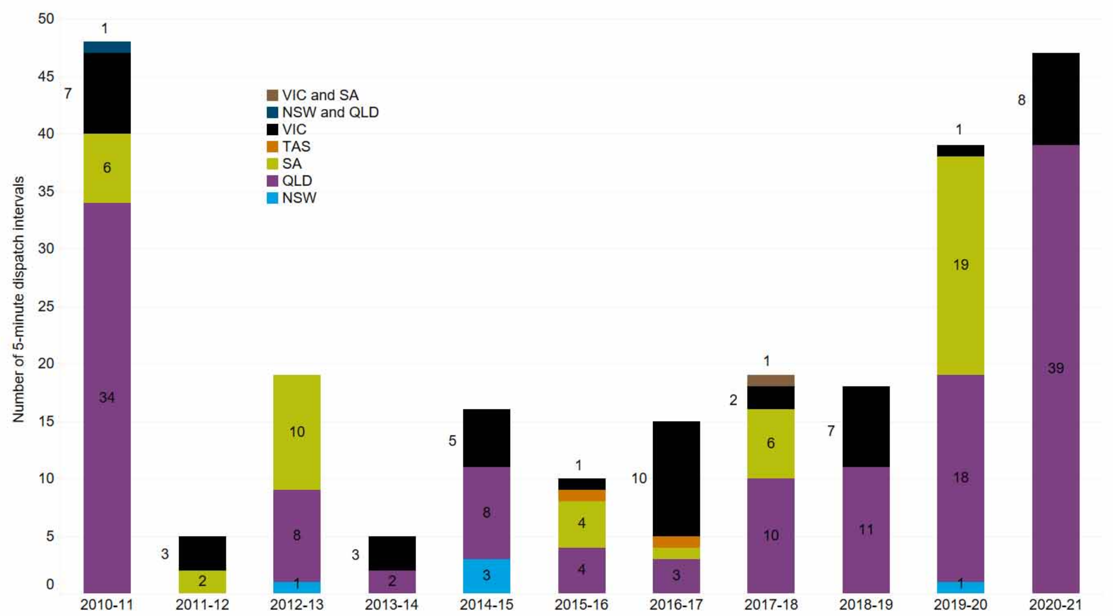
The level of the market floor price has been -$1,000/MWh since December 2000. Prior to market start the National Electricity Code required all slow start generators to provide at least one negative, offloading bid, reflecting the amount that they would be prepared to pay to remain on line at minimum load. The code prohibited the pool price seen by market customers going below zero.

However, in 1999, the National Electricity Code Administrator proposed a code change to replace the zero price floor with a new negative price floor of -$1,000/MWh. The Administrator argued that a floor at some level is essential to set a bound on the dispatch algorithm and would also improve price signals in the market by allowing customers to see the marginal value of electricity more often.

Figure B.2 shows the number of MFP events over the past 10 financial years for NSW, VIC, QLD, SA and TAS. Over that time the Regional Reference Price (RRP) has hit the MFP for 241 dispatch intervals across all regions. The MFP was reached most often in Queensland where it was hit 137 times. The number of MFP events has trended upwards in recent years but is still below the number of events in 2011.

A significant contributor to the increase in MFP events in South Australia in 2020 was the South Australian separation event in late January and February 2020. This event left South Australia disconnected from the rest of the NEM for a large part of February, and therefore reduced the export capacity from South Australia to Victoria to zero. The lack of export capacity led to an abundance of supply, particularly in the middle of the day due to the correlation of solar output profiles.

Figure B.2: The number of market floor price events



Source: AEMC analysis of AEMO MSATS data.
Note: The figure shows the number of dispatch intervals (not trading intervals) that the RRP was equal to the MFP of $-1,000/MWh.

The number and frequency of MFP and low price events

In general, low price events are expected at times when there is an abundance of generation and high price events are expected at times when the supply and demand balance is tight.

The Reliability panel needs to consider the number of low price events where the price is near the MFP. We have defined low price events as being those where the RRP for a dispatch interval is less than 90% of the MFP, i.e. less than -$900/MWh. High price events are those where the RRP is greater than 90% of the MPC, e.g. for FY 2020, where the RRP is greater than $13,230/MWh.[242]

Table B.2 shows the number of trading intervals across all regions of the NEM that contained low and high price dispatch intervals. The number of trading intervals with a low price event has increased sharply in the last few years.

242 The MPC in FY 2020 was $14,700/MWh.

Table B.2: The number of trading intervals with low and high price events

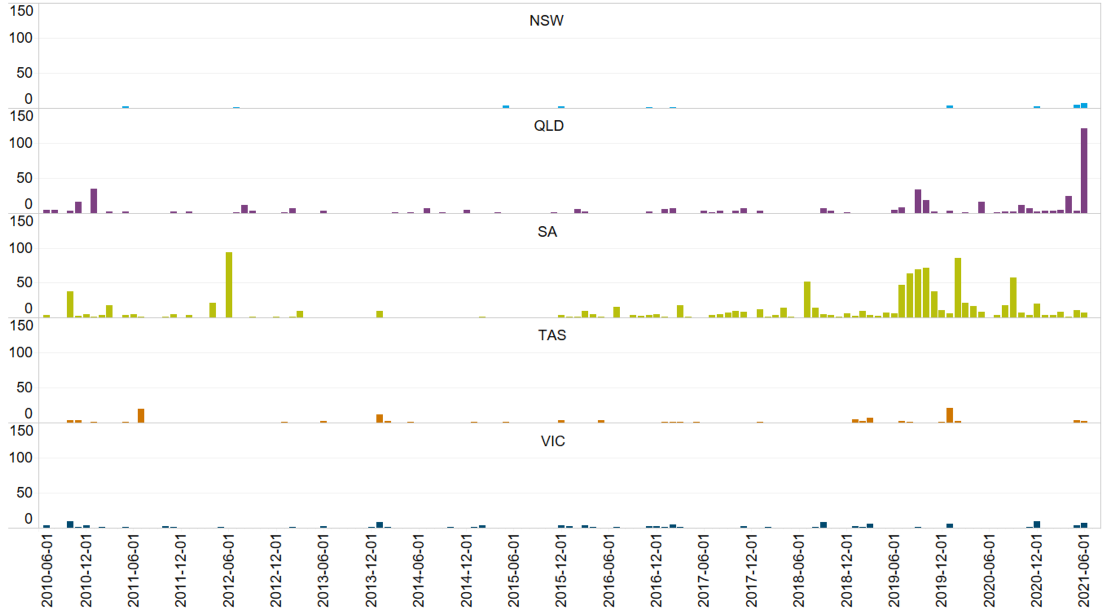
FINANCIAL YEAR	TIS WITH A LOW PRICE EVENT (<90% MFP)	TIS WITH A HIGH PRICE EVENT (>90% MPC)	TIS WITH A LOW AND HIGH PRICE EVENT	PERCENTAGE OF LOW PRICE TIS WITH A HIGH PRICE EVENT
2011	81	46	2	2%
2012	52	17	2	4%
2013	30	85	5	17%
2014	20	54	6	30%
2015	17	106	3	18%
2016	26	96	9	35%
2017	47	161	15	32%
2018	66	34	4	6%
2019	122	54	9	7%
2020	422	43	5	1%
2021	230	172	52	23%

Source: AEMC analysis of AEMO MMS data.
Note: This table shows the number of trading intervals across all NEM regions with low (<90% MFP) and high (>90% MPC) price dispatch intervals.

The increase in low price events has been driven by South Australia which in FY 2020 had 356 of the 422 low price trading intervals in the NEM. This is unsurprising as South Australia has a large amount of variable renewable generation, including rooftop PV which is largely unresponsive to the wholesale price, and has relatively low demand.

Figure B.3 shows the frequency of low price (<-$900/MWh) dispatch intervals by month over the last 10 financial years. It shows a clear increasing trend of low price events in South Australia, and to a lesser extent, in Queensland. There does not appear to be an increase in the frequency of low price events in the other regions.

Figure B.3: **Frequency of low price (<-$900/MWh) dispatch intervals by month**



Source: AEMO analysis of AEMO MMS data.
Note: This figure shows the number of low price dispatch intervals (<-$900/MWh) by month for FY 2011 - FY 2021.

The increase in events at or near the MFP may suggest that the current level of the MFP may be beginning to prevent the market from clearing. A lower price sends a signal for generation to reduce output and a signal to price responsive load to increase.

Given that demand does not typically vary by thousands of megawatts over the course of a single trading interval, the occurrence of low and high price events in the same trading interval may suggest changes in generator bids to maximise dispatch following a price spike event (strategic re-bidding). As seen in the last column of Table B.2 the percentage of low price event trading intervals which also had a high price event has fallen significantly since FY 2017 to 1% in FY 2020. This suggests that strategic rebidding has become less common in recent years.[243] The percentage of low price trading intervals with a high price event increased to 23% in FY 2021 due to the outage from Callide power station. The introduction of five minute settlement in October 2021 will reduce the incentive for strategic rebidding as market participants will no longer receive a price averaged over six dispatch intervals. See Chapter three for more information on the introduction of five minute settlement.

Changes to average generator cycling costs

The Panel is required to consider whether there have been significant changes in the generation fleet, such that average generator cycling costs have changed significantly.

243 Although strategic rebidding appears to have become more frequent in the month following the events at Callide power station on 25th May 2021.

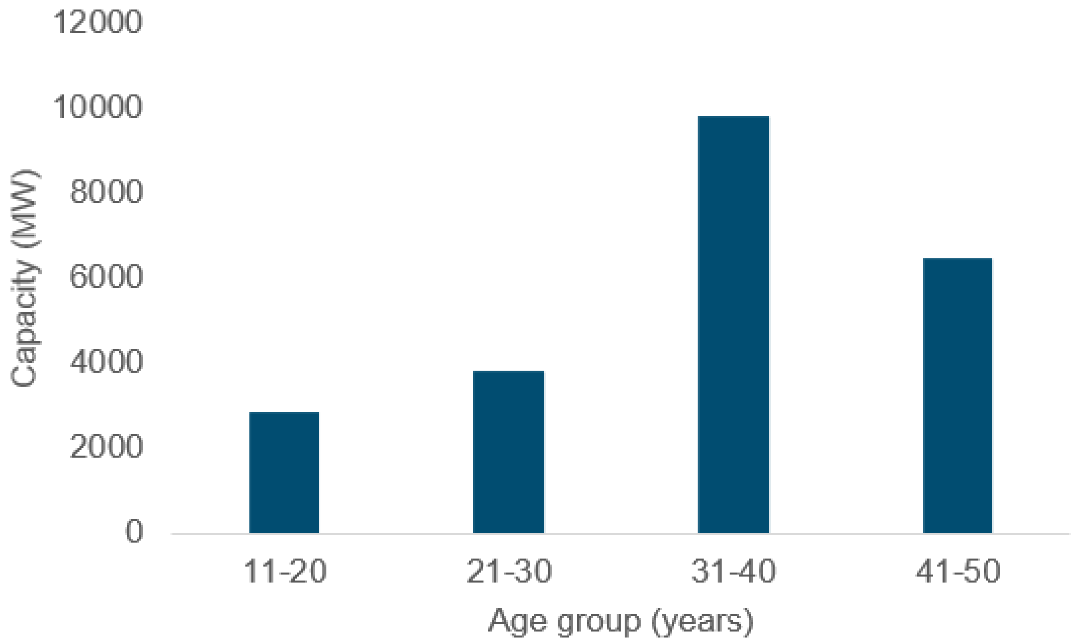
Recent developments in the generation mix with implications for generator cycling costs include the:

- Further ageing of thermal units, and
- Growth in large-scale wind and solar generation.

In addition, there has been growth in DER uptake. These trends are expected to continue and are likely to increase the frequency of cycling operation for thermal units. Increased cycling requirements over time is likely to lead to increased cycling costs, particularly for ageing coal generators.

Figure B.4 shows the age distribution of coal generation in the NEM. The coal fleet is ageing with over 70% by capacity more than 30 years old and 28% over 40 years old.

Figure B.4: Age distribution of coal generation in the NEM



Source: AEMC analysis.
Note: Age distribution is based on the commissioning date.

Cycling costs are difficult to estimate and vary according to the frequency and duration of cycling, fuel costs as well as plant-specific factors. Considering the ageing profile of thermal generators and the increased wear and tear from more frequent cycling, it is likely that these costs have not decreased since the 2018 RSSR. The Panel welcomes submissions from stakeholders on whether and how cycling costs have changed over time, and their impact on the financial viability of coal-fired generators.

B.3 Administered price cap

The APC has been a feature of the NEM since its inception in 1998. Originally being set as:

- $100/MWh between 7.00am and 11.00pm on business days, and
- $50/MWh at other times.

However, since May 2008 the level of the APC has been $300/MWh and has not been revised since.

An important trend to note in relation to the APC is in regard to any changes in the short run marginal cost (SRMC) of generators in the NEM. Historically, gas generators and particularly OCGTs have played an important role in helping to meet demand during times of scarcity. For gas-fired generators, fuel costs account for most of their SRMC. Since the commencement of LNG exports in 2015 the domestic gas price has become increasingly linked to the international prices for LNG. This has led to greater volatility and a higher overall average gas price. Figure B.5 shows the average monthly price of gas in the east coast spot markets (STTMs and DWGM).[244] Figure B.5 shows a spike in spot gas price in 2021, which is due to the lack of supply shortage and demand increase in the international gas market.

Figure B.5: Average east coast spot gas price ($/GJ)

Source: AEMC analysis of AEMO Gas Bulletin Board data.

Note: Average price is calculated as the time-weighted average of DWGM (VIC) and STTM (NSW, QLD, SA) gas prices. Actual gas purchase costs by generators will depend upon their individual contract arrangements.

It is also important to give consideration to the cost of the different technologies that may play an increasing role during APPs in the future. This will be considered further during the review.

244 It should be noted that the actual gas price paid by gas generators will depend on their contractual arrangements. These contracts are often confidential although the ACCC provides a regular update on contract prices paid through the 2017-2025 Gas inquiry: available here.

Figure B.6: Energy APP Events and FCAS APP Events

Source: AEMC analysis of AEMO MMS data

Figure B.6 shows the energy APP events and FCAS APP events in each state. Energy APP events are observed to reflect actual periods of unserved energy in the NEM. FCAS APP events reflected periods of actual unserved energy in the NEM in 2008 and 2009, there has since been a significant number of FCAS APP events occurring at different times in particular in South Australia and more recently Victoria and Queensland.

C CONSOLIDATED QUESTIONS FOR STAKEHOLDERS

This appendix summarises the questions for stakeholder feedback posed in the body of the report.

C.1 Chapter 3 - NEM in transition

- How do stakeholders consider changes in the generation mix interact with the assessment of the reliability standard and settings, in particular for the period of 2024-2028? What are the implications of the changing generation mix for the reliability standard and settings?
- What other factors should the Panel account for when considering economically driven retirement decisions?
- How do recent and expected future demand side trends interact with the Panel's assessment of reliability standard and settings? What are the implications of these trends for the reliability standard and settings?
- How do recent and expected future electricity pricing dynamics, and the introduction of 5 minute settlement interact with the reliability settings and the Panel's assessment for this review? What are the implications of these trends for the reliability standard and settings?
- How may the Post-2025 market design reforms impact on the reliability standard and settings? What are the implications for the reliability standard and settings?
- What implications does continued uncertainty in emissions policy have for the reliability standard and settings?
- What are your views on the impact of State and Federal government energy policies on the reliability settings?

C.2 Chapter 4 - Panel assessment approach

- In addition to the other considerations set out in Chapter four, do you consider that there are factors that the Panel should have regard to?

C.3 Chapter 5 - The reliability standard

- Do you consider that there is evidence that a different level of the reliability standard would deliver better overall outcomes for the NEM?
- What factors do stakeholders suggest should be considered alongside the AER's VCR in determining the level of the reliability standard?
- Do stakeholders consider there are shortcomings with USE that justify its replacement with an alternate standard form?
- What are the benefits of using an alternative standard form over the existing form? If so, what alternative forms are considered appropriate and why?
- Do stakeholders consider that supplementary or additional metrics, in addition to USE, should be considered to help provide further insight to reliability events?

- Over the period 2024 – 2028, is the amount of DER within the NEM likely to materially change the way that consumers value their reliability of electricity supply?
- Are there any other issues of relevance for the Panel to consider for its review of the reliability standard.

C.4 Chapter 6 - The market price settings

C.4.1 The Market price cap

- Do you consider that the emergence of new technologies warrants a change in the MPC in order to enable technology-neutral investment to meet the reliability standard in the most cost-effective way?
- Do you consider that the implementation of five minute settlement in October 2021 will affect the efficacy of the MPC in managing the risk exposure of market participants, while still providing efficient price signals?
- Do you consider that the introduction of new markets would mean a change to the MPC is required?
- What is the effectiveness of the MPC in allowing for investment in a technology-neutral, least-cost manner in the current environment of the NEM in transition?
- What factors or issues regarding spot prices, investment, market participants and/or the predictability and flexibility of the regulatory framework should the Panel pay particular attention to?
- Do you consider that the introduction and continuation of government investment schemes means that changes to the MPC should be considered?
- Do stakeholders consider implementation of five minute settlement, and other recent changes, leading to materially different outcomes than those seen in historical data?

C.4.2 The cumulative price settings

- Do you consider that the form and level of the CPT remain appropriate to encourage investment signals in a technology-neutral manner regarding the emergence of new technologies?
- Do you consider that the current time period that the CPT is assessed against (seven days) remains appropriate to allow participants to mange their price risk, while maintaining investment signals?
- Do you consider that the form and level is appropriate to manage sustained high prices in both energy and FCAS markets?

C.4.3 The market floor price

- Do you consider that the form and level of the MFP remains appropriate in the context of greater entry of storage and greater demand side participation in the NEM?
- In your view, should the Panel consider a negative cumulative price threshold? If so, what factors should be considered when determining the level of a negative CPT?

- In your view, is there benefit in the Panel considering setting technology specific market floor prices?
- Do you consider that the level of the MFP should be adjusted to account for the real reduction in its level over time? What form of indexation would be appropriate?
- Would the creation of new system services markets change your view on the appropriate form of the MFP?
- Would the creation of new system services markets change your view on the appropriate level of the MFP?
- Do stakeholders consider implementation of five minute settlement, and other recent changes, leading to materially different outcomes than those seen in historical data?

C.4.4 The administered price cap

- How should the Panel consider setting the APC for technologies such as hydro and utility-scale batteries?
- Have typical generator SRMC increased significantly since the previous review period? Or are they expected to do so over the period 2024-2028?
- Do you consider that the APC remains appropriate to compensate generators during APPs?
- Is there evidence that the APC is affecting the contract prices and so affecting incentives for new investment?
- Is there a case for the APC to be indexed going forward?
- Given recent market developments and pricing outcomes, is the current form and or level of the APC appropriate? If not, what would be an appropriate form of the administered price cap, why and what is the evidence supporting your view? If not, what would be an appropriate level of the administered price cap, why and what is the evidence supporting your view?
- Do you consider that the current APC provides sufficient investment signal for new technologies?

C.4.5 Indexation

- Are there any specific considerations the Panel should take into account for this review, relating to the indexation of the MPC and CPT?

C.5 Chapter 7 - Modelling for the review

- Do stakeholders consider the high level modelling approach used by ROAM and EY remain appropriate for the Panel's 2022 RSS review?
- Do stakeholders have any feedback on the principles and high level approach proposed?
- Are there additional high level principles and considerations that the Panel should consider in its modelling to inform the RSS review?
- Are there any stakeholder views on the importance of price-dispatch modelling at 5 minute resolution and welcomes suggestions on hybrid approaches?

- The Panel is therefore interested in stakeholder views on sensible simplifying assumptions that can be applied that will allow revenues to be appropriately approximated without requiring full co-optimised modelling?
- The Panel is interested in stakeholder views on the range of risks that should be captured in the scenarios modelled for the review?
- The Panel welcomes stakeholder views on the approach to modelling the impact of demand response on efficient reliability standard and settings is welcomed.
- Are there any stakeholder suggestions on approaches to modelling energy limited storage resources as reliability providers?