AEMC

REVIEW

Australian Energy Market Commission

CONSULTATION PAPER

Advice to SCER on linking the reliability standard and reliability settings with VCR

29 October 2013

Submissions due 26 November 2013. Reference: EMO0026
Consultation Paper

Inquiries

Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

E: aemc@aemc.gov.au
T: (02) 8296 7800
F: (02) 8296 7899

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About the AEMC

The Council of Australian Governments (COAG), through its then Ministerial Council on Energy (MCE), established the Australian Energy Market Commission (AEMC) in July 2005. In June 2011, COAG established the Standing Council on Energy and Resources (SCER) to replace the MCE. The AEMC has two main functions. We make and amend the national electricity, gas and energy retail rules, and we conduct independent reviews of the energy markets for the SCER.

Summary

The Australian Energy Market Commission has been asked to provide advice to SCER on linking the national electricity market (NEM) reliability standard and reliability settings in the wholesale market with a value of customer reliability (VCR).

The overall reliability of supply to customers depends on the reliability of each segment of the supply chain, that is, the stock of generating units, the transmission network and the distribution network. While different entities plan and operate each segment of the supply chain, the associated reliability standards are currently independently determined.

This advice is focused on reliability of the generation and bulk-transmission sectors. For the purposes of reliability, bulk-transmission capacity refers to inter-regional capability. In the NEM, the reliability standard is used to evaluate whether sufficient investment in generation capacity is occurring to meet consumer demand for electricity. As such, the reliability standard applies primarily to generation, but also includes inter-regional transmission to capture the benefits of generation from across regional boundaries.

The reliability standard is set by the Reliability Panel in accordance with the NER. Its objective is to deliver an expectation of reliability that reflects the value that consumers place on reliability. The current approach specifies the maximum expected unserved energy (USE). Currently, the level of USE is set at 0.002 per cent of the annual energy consumption for the associated NEM region or regions per financial year.

To incentivise sufficient investment in generation capacity and demand-side response to meet the reliability standard, the NEM design includes three key 'reliability settings'. The market price cap (MPC), market floor price and the cumulative price threshold (CPT) arrangements form the key price envelope within which the wholesale spot market balances supply and demand and encourages the delivery of capacity to meet the reliability standard.

The challenge of maintaining reliability in the NEM is setting the market price cap high enough to incentivise sufficient levels of generation capacity and demand-side response to deliver the expected reliability outcome, but no higher than consumers are willing to pay for that outcome. Currently, the MPC is determined by the AEMC on the recommendation of the Reliability Panel. Supply-side modelling is typically used to estimate the costs required to incentivise generation investment up to the point where load shedding is reduced to the administratively determined level of reliability. That is, to the reliability standard.

An alternative approach would be to link the price cap at some estimate of the value that customers place on reliability. A direct link between the MPC and the VCR could remove the need for an explicit reliability standard, since the reliability that consumers desire would be expressed through the VCR. To date, a VCR for all NEM customers has never been estimated. This task necessarily involves complex issues such as variations in VCR across customers in different sectors and locations.

This advice will examine whether efficient reliability outcomes can be achieved by explicitly linking the reliability standard and reliability settings with a measure of the value that customers place on reliable electricity supply. In doing so, it will explore

alternative approaches to setting the reliability standard and reliability settings which use demand-side measures, such as VCR.

The purpose of this advice

SCER requested this advice in response to the AEMC's review of the effectiveness of NEM security and reliability arrangements in light of extreme weather events (extreme weather review). The final report for that review was published in May 2010.

In the extreme weather review, the AEMC made a number of recommendations, including that a new requirement be included in the National Electricity Rules for a VCR, based on the residential consumer class, to be considered when determining the levels for the reliability standard and reliability settings.

In June 2012, SCER provided a response to the AEMC's final recommendations for that review. While the majority of the recommendations were endorsed, SCER requested additional advice on the matter of setting the reliability standard and reliability settings with reference to an agreed VCR. The AEMC received terms of reference from SCER in January 2013.

AEMC's approach to this advice

The AEMC intends to base the development of its advice to SCER on the following approach:

- Having regard to the national electricity objective (NEO), identify an assessment framework to guide the evaluation of possible approaches to linking the reliability standard and reliability settings with VCR.
- Explore the link between the reliability standard and reliability settings and VCR.
- Identify possible approaches to linking the reliability standard and reliability settings with VCR.
- Using the assessment framework, evaluate each of the approaches identified to determine whether they are likely to satisfy the NEO.
- Identify a preferred approach.

This consultation paper identifies four possible approaches to linking the reliability standard and reliability settings with VCR. Two of the options were first put forward by the AEMC in its extreme weather review in 2010. The other two options have been developed by the AEMC for this advice after considering arrangements in other markets around the world. While option 2 is a similar approach to that employed now, the other three options would represent a materially different approach to achieving reliability in the NEM. The four options are:

- *Option 1: direct application of VCR as market price cap*: The MPC would be set equal to the VCR, which would be estimated for this purpose. The MPC could subsequently be adjusted if it was found that, for example, the level of VCR was too low to provide sufficient investment to meet consumers' expectations of reliability, or was so high that it could lead to inefficient overinvestment. Under this approach an explicit reliability standard would not be required.

- *Option 2: use VCR as a cross-check on the reliability standard and reliability settings*: The MPC would continue to be set on the basis of modelling the costs of generation required to meet the reliability standard. In reviewing the reliability standard, the Reliability Panel would compare a value of VCR with the MPC to assess how well the current reliability standard and settings reflect the value consumers place on reliability. The reliability standard could be amended if it was found that the standard no longer reflected the value consumers place on reliability.
- *Option 3: direct application of VCR as market price cap at "periods of scarcity":* A pre-defined volume or type of load shedding in the electricity market would trigger a "period of scarcity". In those periods, a MPC based on the VCR would apply directly. At all other times there would be no MPC.
- *Option 4: different levels of VCR offered into dispatch*: Instead of setting an absolute MPC for the electricity market, a range of values for MPC, each representing the VCR of a given set of consumers, would be offered into the wholesale market in competition with generator offers.

A brief explanation of each option is provided in Chapter 5 of this consultation paper. Having regard to the NEO, the AEMC will consider the extent to which the alternative approaches are appropriate in delivering efficient market outcomes that are at least consistent with those delivered by the NEM's current reliability standard and settings. As requested by SCER, the AEMC will identify a preferred approach to linking the reliability standard and reliability settings with a value representative of customers' expectations of reliable electricity supply.

The ultimate objective of this advice is to identify whether there is an alternative approach which may better promote the NEO than the current approach. However, it is likely that further work would be required before making a change to the current arrangements. This may include, for example, a more detailed cost-benefit assessment to determine whether the benefits of implementing an alternative approach would outweigh the costs of doing so. This is particularly important given the practical issues associated with measuring VCR and the implications for market participants and customers from making changes to the existing reliability framework.

Next steps

Submissions on this consultation paper are requested by no later than 5pm, Tuesday 26 November 2013. Stakeholders are encouraged to include any relevant information and comments in their submissions.

As required by SCER's terms of reference, following the consideration of written submissions and issues raised by stakeholders, the AEMC will provide a final report setting out its advice and recommendations to SCER by 31 December 2013. This report will also be published on the AEMC's website.

Contents

1 Introduction

The Australian Energy Market Commission (AEMC or Commission) has been requested by the Standing Council on Energy and Resources (SCER) to provide advice on linking the reliability standard and reliability settings with the value of customer reliability (VCR).[1] This paper sets out our proposed scope and approach to providing the advice, as well as a number of other issues for stakeholder comment.

1.1 Context of this advice

On 28 April 2009, the Ministerial Council on Energy (MCE) (now SCER) directed the AEMC to conduct a review of the effectiveness of national electricity market (NEM) security and reliability arrangements in light of extreme weather events (the review or extreme weather review).[2] The weather events the AEMC was to have regard to included droughts, heat waves, storms, floods and bush fires.

The terms of reference for the review required the AEMC to respond to the following questions:

- Under the scenario that extreme weather events become more frequent, are the current arrangements for managing security and reliability in the NEM appropriate to deliver reliable and secure electricity supply?
- If not, what cost-effective amendments could be made to the market arrangements in the short and longer terms to address any identified risks to security and reliability under that scenario?

On 31 May 2010, the AEMC published its final report for the review.[3] The final report concluded that, in a scenario with more extreme weather events, there were a number of areas within the existing frameworks where improvements could be made to enable consumer expectations for quality of supply to be maintained. The key areas included:

- technical performance and power system security;
- the reliability standard;
- governance arrangements for determining the reliability standard and reliability settings; and
- processes for determining the reliability standard and reliability settings.

The AEMC made a number of recommendations, including that a new requirement be included in the National Electricity Rules (NER) for a VCR, based on the residential consumer class, to be considered when determining the levels for the reliability

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1 SCER, *Terms of Reference, Australian Energy Market Commission (AEMC), linking the Reliability Standard and Reliability Settings with the Value of Customer Reliability*, 8 January 2012. Hereafter, this is referred to as "Terms of Reference".

2 At its meeting on 6 February 2009, the MCE noted the significance of the interruptions in Victoria and South Australia on 29 and 30 January 2009 as the result of severe heat wave conditions, and agreed that there was a need to review energy market frameworks in light of the impact of the heat wave on electricity supply.

3 AEMC 2010, *Review of the Effectiveness of NEM Security and Reliability Arrangements in light of Extreme Weather Events, Final Report*, 31 May 2010, Sydney.

standard and reliability settings.[4] In making this recommendation, the AEMC recognised that there were a number of different approaches to estimating a VCR and that the approach adopted could result in different outcomes, with different implications for consumers and the market more broadly.

In June 2012, SCER provided a response to the AEMC's final report for the review.[5] While SCER endorsed the majority of the AEMC's recommendations, it noted that, given the complexity of the proposal that the reliability standard and reliability settings be set with reference to an agreed VCR level, it required additional advice on this matter before considering its policy position.

1.2 Purpose of this advice

The purpose of this advice is to examine whether more efficient reliability outcomes can be achieved by explicitly linking the reliability standard and reliability settings with a measure of the value that customers place on reliable electricity supply.

Reliable, continuous electricity supply to customers is dependant (in part) on adequate generation capacity and network capability being available to deliver electricity to customers. In the NEM, investment in network capacity is driven by the regulatory framework in the NER and its application by the Australian Energy Regulator (AER) in periodic decisions on regulated revenues. This advice concerns the reliability of generation. Generation investment is incentivised through the opportunity to earn revenue through the wholesale spot market. The spot price (or derivative of the spot price through contracting) is the primary income for generators and provides a signal for the timing, form and location (on a regional basis) of investment in new generation. Similarly, the spot price provides signals for investment in demand-side initiatives.

The spot price in the NEM is capped at the level of the market price cap (MPC). While the MPC limits overall risk for market participants and consumers, it must be set at a level high enough to incentivise the delivery of sufficient generation capacity and demand-side response to meet the reliability standard. The reliability standard is an administratively determined measure which represents an expectation that a level of supply reliability will be achieved over the long term.

Currently, the MPC is determined using supply-side modelling which estimates the costs required to incentivise generation investment up to the point where load shedding is reduced to an administratively determined level of reliability – that is, to the reliability standard.

However, there are other possible approaches to determining the market price cap (and the other reliability settings) which employ demand-side measures such as estimates of the value that customers place on reliable electricity supply. This advice will explore

4 The AEMC recommended that, for generation investment, the VCR level for residential consumers should be used because this class of consumer places the lowest value on reliability and are usually shed first during a reliability event. See AEMC 2010, *Review of the Effectiveness of NEM Security and Reliability Arrangements in light of Extreme Weather Events, Final Report*, 31 May 2010, Sydney, Chapter 8.

5 MCE 2012, *Review of the Effectiveness of NEM Security and Reliability Arrangements in light of Extreme Weather Events, MCE response to AEMC Final Report*, June 2012.

possible alternative approaches to setting the reliability standard and reliability settings and, specifically, will focus on approaches which link the VCR with the MPC, as an alternative to the current approach.

1.3 Terms of reference for this advice

The AEMC received terms of reference from SCER in January 2013 to provide advice on linking the reliability standard and reliability settings with VCR.

In providing its advice to SCER, the terms of reference require the AEMC to complete the following:

- Describe how the reliability standard and reliability settings (especially the role of the MPC in the operation of the wholesale market) support, at a high level, the national electricity objective (NEO).
- Describe the different methodologies by which the AEMC might amend the reliability standard and reliability settings (principally the MPC) to reflect a VCR and include an assessment of each methodology's benefits, limits and suitability in meeting the NEO.
- Show how linking the reliability standard and reliability settings (especially the MPC) with a VCR may better support the NEO, giving specific focus to how this occurs with the MPC impacts on reliability outcomes for consumer classes with varying VCRs.
- Analyse the expected costs and benefits with linking the reliability standard and reliability settings (specifically the MPC) with a VCR in terms of:
  - the potential impact on consumers, including for price and reliability;
  - the potential impacts on generators, retailers and other relevant market participants, including impacts on investment signals; and
  - the extent to which linking the MPC to a VCR could duplicate the signals provided by the reliability standard and other existing market settings.
- Based on this analysis, outline a preferred approach including any implementation considerations.

The terms of reference also require that the AEMC have regard to:

- the work being done by the Australian Energy Market Operator (AEMO) in establishing regional and national VCR levels; and
- the processes and outcomes associated with other related work.

The original terms of reference required the AEMC to provide a report setting out its advice and recommendations by 30 June 2013. However, following a request from the AEMC for an adjustment to the delivery date for the final report, SCER subsequently amended the date for completion of this advice to 31 December 2013.

1.4 Other relevant matters

There is a range of work that is currently or has recently been undertaken that may have implications for the current advice request. The most relevant of these are summarised below.

1.4.1 AEMC review of the national frameworks for transmission and distribution reliability

On 12 July 2013, the AEMC published a consultation paper on its review of national frameworks for network reliability.[6] This review, requested by SCER, forms part of a broader package of energy market reforms agreed to by the Council of Australian Governments (COAG) in late 2012. The objective is to develop nationally consistent frameworks for expressing, setting and reporting on transmission and distribution reliability in the NEM.

There are similar issues involved in developing effective frameworks for setting transmission and distribution network reliability requirements. As a result, the AEMC developed a common set of arrangements that would apply to both. The proposed frameworks include:

- the setting of required reliability levels based on a transparent economic assessment process which exposes the way costs vary with different levels of reliability and compares the expected costs of investment against the value placed on reliability by customers;
- jurisdictional responsibility for determining the appropriate level of reliability, with the option to delegate responsibility to the AER or a jurisdictional body;
- the ability for jurisdictions to incorporate additional reliability requirements for areas of economic importance or to reflect community expectations (for example, for customers in rural or remote areas);
- greater opportunities to consult with customers and consider community preferences;
- a mechanism to update reliability requirements during the regulatory control period to reflect updated information (for transmission only); and
- national reporting of network reliability performance.

In the consultation paper, the AEMC proposed that reliability levels would be set every five years under the national frameworks prior to each revenue determination. The AER would be required to determine revenues for each network business that are consistent with the efficient delivery of their required reliability levels over the regulatory period.

6 AEMC 2013, *Review of the national frameworks for transmission and distribution reliability, Consultation Paper,* 12 July 2013, Sydney.

The final report for the distribution workstream was published on 27 September 2013.[7] The final recommendations which are relevant to this advice are considered further in Chapter 5 of this consultation paper.

The final report on the transmission workstream will be published by 1 November 2013.

1.4.2 AEMO review of the value of customer reliability

On 11 March 2013, AEMO commenced its national value of customer reliability review. AEMO is undertaking this review for a number of reasons, including in response to a request from SCER made following the AEMC's final recommendations for its extreme weather review.[8]

SCER requested that AEMO develop a methodology to derive national and regional VCRs. Using that methodology, AEMO then intends to deliver a range of VCRs that can be used primarily for delivering better network investment and planning decisions across the NEM.

On 3 June 2013, AEMO published a directions paper setting out its proposed methodology and approach to deriving VCRs.[9] Specifically, AEMO proposed a choice survey-based modelling approach to calculate a range of VCRs at the transmission connection point level. The VCRs will reflect the value that different customers place on outages of different durations and severity. The survey data will then be aggregated to each transmission connection point, weighted by the proportion of each customer class at each connection point.

A final directions paper is due for publication in October 2013, with draft and final VCR values due in December 2013 and March 2014, respectively.

1.4.3 Reliability Panel reliability standard and settings review 2014

Under the NER, the Reliability Panel (the Panel) is required to carry out a review of the reliability standard and reliability settings once every four years. This regular review allows the Panel to take into account any changes in market arrangements over the previous four years, and consider whether the reliability standard and reliability settings (specifically the MPC, market floor price and cumulative price threshold (CPT)) will continue to meet the requirements of the market, market participants and consumers.

On 9 May 2013, the Panel published an issues paper for its 2014 review of the reliability standard and reliability settings. The Panel will review the current reliability standard and settings to determine whether these should continue to apply from 1 July 2016. In undertaking the review, the Panel must have regard to the NEO, the potential impact of any proposed change on market participants and consumers, as well as the potential impacts on the market including the spot market, contract market and investment

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7 AEMC 2013, *Review of the national framework for distribution reliability, Final Report*, 27 September 2013, Sydney.

8 MCE 2012, *Review of the Effectiveness of NEM Security and Reliability Arrangements in light of Extreme Weather Events, MCE response to AEMC Final Report,* June 2012.

9 AEMO 2013, *Value of Customer Reliability Directions Paper*, 3 June 2013.

signals. Where appropriate, the Panel will take into consideration any value of customer reliability determined by AEMO. The Panel is required to complete the review by 30 April 2014.[10]

1.5 Stakeholder consultation

1.5.1 Consultation

SCER has requested the AEMC consult with AEMO, the AER, the Reliability Panel and jurisdictions during the preparation of the advice. Where appropriate, the AEMC may also consider consultation with key stakeholders in the preparation of the advice.

The purpose of this paper is to invite stakeholder views on various issues associated with linking the reliability standard and reliability settings with VCR. Responses to this paper will further inform and enhance the AEMC's understanding of these issues. To assist stakeholders, this paper provides background to the NEM's reliability framework and sets out the specific matters that are pertinent to this advice.

Stakeholders are invited to make submissions on the questions raised in this paper and any other issues they consider relevant. As required by the terms of reference, the AEMC will provide SCER with a final report setting out its advice and recommendations by 31 December 2013. The final report will also be published on the AEMC's website.

1.5.2 Lodging submissions

Written submissions from stakeholders and interested parties in response to this consultation paper must be lodged with the AEMC by no later than 5pm, Tuesday 26 November 2013. Submissions should refer to AEMC project number "EMO0026" and be sent electronically through the AEMC's online lodgement facility at www.aemc.gov.au.

All submissions received will be published on the AEMC's website, subject to any claims for confidentiality.

In order for this advice to be completed by 31 December 2013, the AEMC must adhere to a strict timeframe. While the AEMC will have full regard to all submissions lodged within the specified time period, late submissions may not be afforded the same level of consideration.

1.6 Structure of the paper

The remainder of this report is structured as follows:

- Chapter 2 sets out the approach, scope and overarching objective (the NEO) that will be used to guide this advice.

10 Currently, the Reliability Panel is responsible for reviewing and, where appropriate, amending the reliability standard. The Reliability Panel is also required to review the reliability settings. However, any change to the reliability settings must be considered and approved by the AEMC via the rule change.

- Chapter 3 provides an overview of the reliability framework in the NEM, including a history of the current arrangements. It also considers the relationship between the reliability standard and reliability settings and the value that customers place on reliable electricity supply.
- Chapter 4 outlines some of the issues associated with developing reliable and accurate VCR for use in setting the reliability standard and reliability settings.
- Chapter 5 describes possible approaches to linking the reliability standard and reliability settings and VCR and evaluates each against the NEO.
- Chapter 6 sets out a number of questions for stakeholder comment.
- Appendix A provides a brief history of NEM reliability standard and settings reviews and amendments.
- Appendix B sets out a number of alternative approaches used to set wholesale electricity market price caps in international markets.

2 Approach, scope and objective

This chapter sets out the AEMC's proposed approach to, and scope of, this advice. It then identifies and discusses the overarching objective and assessment framework that will be used to guide its development.

2.1 Approach

The AEMC intends to base the development of this advice to SCER on the following approach:

- Having regard to the NEO, identify an assessment framework to guide the evaluation of possible approaches to linking the reliability standard and reliability settings with VCR.
- Explore the link between the reliability standard and reliability settings, and VCR. This will include discussion around why reliability mechanisms are needed in energy-only markets.
- Identify possible approaches to linking the reliability standard and reliability settings with VCR. In doing so, the AEMC will:
  - review the approaches considered by the AEMC in the extreme weather review;
  - consider whether there are any other approaches to linking the reliability standard and reliability settings with VCR; and
  - where relevant, review international approaches to setting market price caps to reflect consumer expectations of reliable electricity supply.
- Using the assessment framework, evaluate each of the approaches identified to determine whether they are likely to satisfy the NEO.
- As required by the terms of reference, identify a preferred approach. The AEMC's recommended approach will be contained in the final report provided to SCER in December 2013.

2.2 Scope

The scope of the analysis to develop this advice is framed by the terms of reference (see section 1.2). In summary, the AEMC is required to develop advice to SCER on linking the reliability standard and reliability settings to VCR. Specifically, to provide information on how linking the reliability parameters with VCR will promote the NEO. It will also include an assessment of the possible approaches to linking the reliability parameters with VCR. A preferred approach based on this assessment will be included.

Consistent with the terms of reference, the AEMC will not carry out a detailed review of the existing reliability parameters to determine whether they have been, or will continue to be, effective in encouraging sufficient investment in generation capacity in the NEM. The form, level and scope of the existing parameters are currently being reviewed by the Reliability Panel as part of the four-yearly review required by the NER. These are therefore beyond the scope of this advice.

In addition, this review will not include consideration of whether there is a case for action – that is, whether there is a need to amend the existing approach used to set the reliability parameters in the NEM. Rather, this advice will focus on exploring the relative merits, and costs and risks, of the possible approaches that can be used to set the reliability parameters having regard to the value that customers place on reliable electricity supply. This will include consideration of whether the possible approaches are consistent with the NEO.

The ultimate objective of this advice is to identify whether there is an alternative approach to setting the reliability standard and reliability settings which may better promote the NEO than the current approach. However, further work would likely be required ahead of changing the current arrangements. This may include carrying out a cost-benefit assessment to determine whether the benefits of implementing an alternative approach would outweigh the costs of doing so. This is particularly important given the practical issues associated with measuring VCR and the implications for market participants and customers from making changes to the existing reliability framework.

2.3 National electricity objective

The AEMC is required to have regard to the NEO in every review that it undertakes and every change to the NER that it assesses. The NEO will therefore form the overarching objective guiding this advice to SCER. The NEO is set out in s. 7 of the National Electricity Law (NEL), which states:

> "The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to -
>
> (a) price, quality, safety, reliability and security of supply of electricity; and
>
> (b) the reliability, safety and security of the national electricity system."

When considering the different approaches to linking the reliability standard and reliability settings with VCR, the terms of reference require us to consider the benefits, limits and suitability of each approach in meeting the NEO. The terms of reference also request an analysis of the potential impacts of linking, specifically, the market price cap with VCR in terms of:

- consumers, including for price and reliability; and
- generators, retailers and other relevant market participants, including in terms of investment signals.

Consideration of the extent to which linking the market price cap to a VCR could duplicate the signals provided by the reliability standard and other existing market settings will also be given.

2.4 Alternative approaches to setting wholesale electricity market price caps

In considering possible approaches to link the reliability standard and reliability settings with VCR, the AEMC will have regard to international approaches to setting (specifically) market price caps to reflect the value of customer reliability (on the basis that the market price cap is the key reliability setting in the NEM). To assist in this element of the advice, NERA Economic Consulting (NERA) was engaged to undertake a study to consider alternative approaches used in other jurisdictions to set market price caps to reflect consumer expectations of reliable electricity supply.[11]

Using the NEM as a comparator, NERA was asked to consider at least seven, primarily energy-only, markets including at least two from Europe and/or Asia and at least two from North America. NERA was also asked to take into account the different approaches available for setting market price caps, including both supply- and demand-side approaches. The markets chosen were:

- the New Zealand electricity market;
- the Texan electricity market, United States (operated by the Electric Reliability Council of Texas (ERCOT);
- the Singaporean electricity market;
- the Albertan electricity market, Canada;
- the Midcontinent electricity market, United States (MISO);
- the PJM interconnection, United States;
- the Great Britain electricity market; and
- the electricity market in the Netherlands.

NERA's final report highlighted that there are a number of different methodologies used to determine wholesale market price caps around the world. In general, the methodologies (or approaches) can be split into four broad categories:

- Markets where there is no formal market price cap (Great Britain, New Zealand (under ordinary operating conditions)).
- Markets where the market price cap is set with reference to the cost of a marginal generating unit (ERCOT, Alberta, PJM capacity market, New Zealand (lower price bound when scarcity pricing in place)).
- Markets where the market price cap is set with reference to an amount obtained through direct negotiation between market participants (PJM energy markets).
- Markets where the market price cap is set with reference to the VCR (Singapore, New Zealand (upper price bound when scarcity pricing in place)).

Appendix B includes a table which provides an overview of the seven wholesale electricity markets included in the study. The table includes data on the level of the

11 NERA 2013, *Review of Alternative Approaches to setting Wholesale Electricity Market Price Caps, A Report for the AEMC*, October 2013.

market price cap(s), the level of VCR, the methodology used to estimate VCR and the relevant market's similarities and differences to the NEM.

NERA's report will be used in the development of the AEMC's advice to SCER and is published with this consultation paper.

3 Reliability in the NEM

This chapter provides an overview of supply reliability in the NEM and highlights the relationship between the reliability standard and reliability settings and the value of customer reliability.[12]

3.1 The reliability framework in the NEM

The NEM is an energy-only market that is operated within reliability settings that aim to achieve the reliability standard. The current reliability standard and settings are summarised below.

3.1.1 Reliability standard

The reliability standard describes the maximum amount of energy expected to be at risk of not being supplied to consumers. Currently, the level of unserved energy (USE) is set at 0.002 per cent of the annual energy consumption for the associated region or regions per financial year.[13] The reliability standard was set at 0.002 per cent USE per annum by the Reliability Panel at market start in 1998.

In order to operationalise the reliability standard, AEMO calculates minimum reserve levels (MRLs) for each NEM region. It then compares forecast and actual generation reserve levels against the minimum levels required to manage against the risk that the reliability standard will not be met at the time of dispatch. In the event that forecast reserve is less than the minimum levels, AEMO has the option of responding to a shortfall through a number of intervention mechanisms (these are summarised in section 3.1.4.)

3.1.2 Reliability settings

In order to balance supply and demand and encourage the generation capacity necessary to meet the reliability standard to be delivered, the wholesale spot market operates within the price confines established by the reliability settings.

The reliability settings in the NEM are:

- the MPC, previously known as value of lost load (VoLL), which sets the maximum spot price in a region for a dispatch interval;
- the market floor price which sets the minimum spot price in a region for a dispatch interval; and
- the CPT which is an explicit risk management mechanism that caps the spot price at the administered price cap (APC).

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12 Value of lost load (or VoLL) is a term often used interchangeably with the value of customer reliability (VCR). However, in the context of the NEM, VoLL was historically the term used to the NEM's market price cap (now referred to as the market price cap or MPC). To avoid confusion, references to VoLL in the context of VCR will be to "customer VoLL". All other references to VoLL will be in the context of the market price cap.

13 The reliability standard is published on the AEMC Reliability Panel website: www.aemc.gov.au.

Market price cap and market floor price

The MPC is the key reliability setting. Volatility in the wholesale spot price creates risk for retailers and generators. In order to manage that risk they enter into hedging contracts with each other for the future delivery of electricity at a given price (or within a price range). The ability to contract ahead gives these market participants certainty as to their revenue or costs.

The level of the MPC caps the volatility in the market and different levels of MPC provide different incentives on generators and retailers to contract ahead. The MPC therefore provides the primary price signal to the market to incentivise the delivery of sufficient generation capacity and demand-side response to meet the reliability standard. It also has a number of other objectives which include:

- in conjunction with the CPT, limiting the financial burden that can fall on market participants during periods of high wholesale spot prices;
- limiting the financial risk to retailers resulting from the inability to adjust prices to customers in real time, in line with movements in the wholesale spot price; and
- in conjunction with the market price floor, limiting price volatility in the wholesale spot market and, by implication, the financial contract market.

The MPC limits wholesale spot prices in each half-hourly trading interval. It is currently set at $13,100/MWh for the 2013-2014 financial year and is indexed by the consumer price index (CPI) each financial year.

The market price floor is the lowest allowable value for the wholesale spot price. It is currently set at -$1,000/MWh. Unlike the MPC and CPT, the market floor price is not currently indexed.

Cumulative price threshold and administered price cap

The CPT is an explicit risk management mechanism designed to limit market participants' exposure to prolonged periods of high prices in the wholesale spot market. It does this by triggering the application of the administered price cap when the sum of spot prices in a region over a rolling seven day period (that is, over 336 consecutive trading intervals) total or exceed this threshold.

The CPT is currently set at $197,100 for the 2013-2014 financial year and is indexed by the CPI each financial year.

In conjunction with the CPT, the APC is designed to reduce the financial exposure of market participants during an extreme market event. Once the level of the CPT is exceeded, wholesale spot market prices are capped at the level of the APC which is currently set at $300/MWh. The level of APC must be set low enough to mitigate the risk of a systemic financial collapse of the market, but sufficiently high not to distort the incentives for generators to continue to supply electricity during an extreme market event when the APC is triggered.

A summary of the current reliability framework is provided in the Table 3.1.

Table 3.1 Reliability framework

Parameter	Objective	Level
Reliability standard	Primary mechanism to signal the market to deliver enough capacity to meet customer demand for electricity.	USE < 0.002 per cent annual energy consumption of region
Market price cap	**Key reliability setting**. Provides incentives for supply and demand-side investment to deliver the reliability standard.	$13,100/MWh (2013-2014) Indexed by CPI each financial year
Market floor price	The lowest allowable limit for the spot price and is generally considered unrelated to investment signals.	-$1,000/MWh
Cumulative price threshold	An explicit risk management mechanism designed to limit participants' exposure to protracted levels of high prices in the spot market.	$197,100 (2013-2014) Indexed by CPI each financial year
Administered price cap	Designed to reduce the financial exposure of market participants during an extreme market event while maintaining incentives for MPs to supply electricity.	$300/MWh

3.1.3 The market price cap and system reliability

The price cap is the only market mechanism by which the Reliability Panel can influence overall reliability of the market to achieve its target of not more than 0.002 per cent unserved energy. Achieving the reliability standard relies on there being sufficient generation reserve capacity to ensure that credible contingency events can, on the vast majority of occasions, be handled without involuntary load shedding. The level of the price cap provides the incentive for both generators and loads to participate in those relatively rare events. It follows that if the level of the price cap is not set at the appropriate value and it will not be effective in providing that incentive. In such circumstances, it is possible that there could be a reliability shortfall.

3.1.4 Intervention mechanisms

Under the NEM's reliability framework, AEMO can respond to short-term reliability shortfalls through two intervention mechanisms:

- Reliability emergency reserve trader (RERT): this mechanism provides AEMO with the ability to contract for reserves where generation capacity shortfalls are

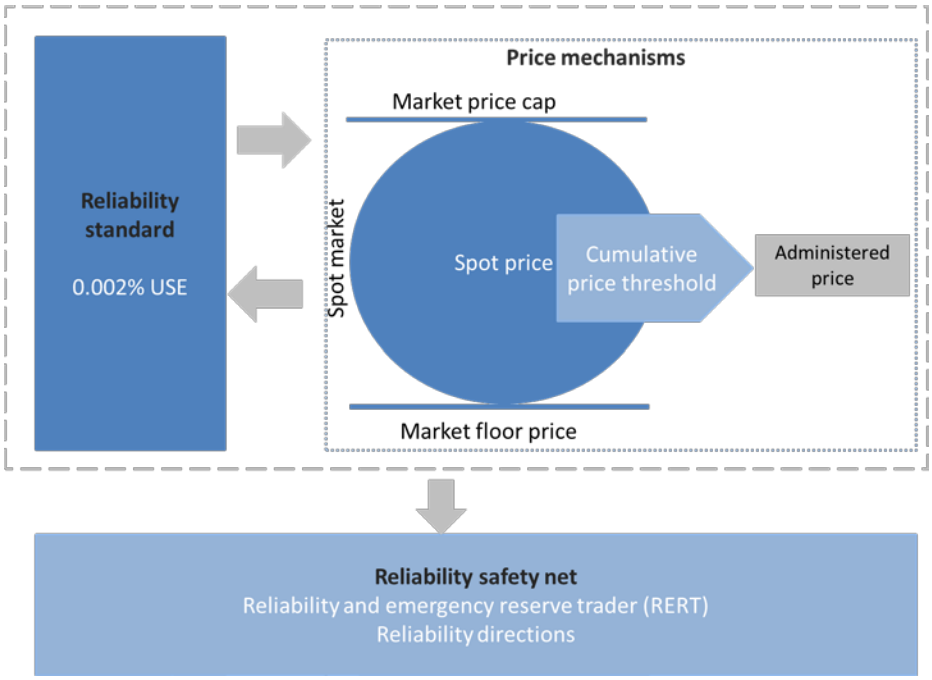
forecast. This requires AEMO to negotiate and enter into contracts with reserve providers.[14]

- Reliability directions: AEMO may also direct registered participants to take certain action to maintain or re-establish the power system to the required operating state. The reliability directions are governed by the provisions in the NER.[15]

Where there is insufficient generation capacity to meet demand, the intervention mechanisms provide AEMO with a way to better protect customers from the possibility of load shedding.

The interaction between the reliability standard, settings and intervention mechanisms is set out in the figure below.

Figure 3.1 Reliability interactions



3.2 Historical justification for the reliability standard and reliability settings

3.2.1 Reliability standard

Prior to the commencement of the national electricity market in 1998, each jurisdiction established its own standards for reliability and applied these in decisions relating to the installation of new generation capacity.[16] Long standing practice had generally been to manage the number of times interruptions to supply were likely. This was achieved by ensuring that sufficient generation reserve was available to replace the

14 The RERT provisions expire on 30 June 2016.

15 See NER Chapter 4.

16 NECA Reliability Panel 1998, *Power system reliability standards and guidelines for market intervention, Discussion Paper*, February 1998, p. 17.

failure of the largest one, two or three generating units relatively quickly (the number varied between jurisdiction and over time).

In 1998, the Reliability Panel conducted a review to determine the power system reliability standards to apply in the new national electricity market. It also needed to form the guidelines for market intervention by National Electricity Market Management Company (NEMMCO) as a last resort to maintain the reliability standards.[17] The Panel's review was informed by advice from NEMMCO which was based on:

1. setting a level of reliability which "relates as directly as possible to the continuity of supply to customers"; and
2. developing a threshold level of generation reserve as a trigger for NEMMCO intervention.

In respect of the reliability standard, the Panel considered both the units of measurement of reliability and the level of the reliability to apply in the national market. On the former, it determined to adopt the percentage of unserved energy (USE) in a region as the relevant measure of reliability.[18] This decision was guided by the Panel's view that reliability standards in a market environment should be focussed towards individual customer reliability, rather than on managing the number of occurrences of interruption (the focus of the previous jurisdictional based reliability standards).

On the latter, the Panel determined that the reliability standard in the national market would be set a maximum of 0.002 per cent of USE in any region over the long term. The level of reliability was the critical element of the Panel's determination. The major issue for the Panel at the time was "a desire to introduce a common approach across the National Market at a level which balances natural energy market outcomes and avoids undesirable reliability shocks." The Panel noted that it was "acutely aware of the risk of destroying confidence in the reform process by setting inappropriately high or low standards for the opening of the market."[19]

The Panel therefore established a uniform approach to the NEM's reliability standards at approximately the same level as the existing standard in each jurisdiction. This was "an on balance decision, taking into account the stage of development of the market and an assessment of wider community expectations."[20]

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17 See: NECA Reliability Panel 1998, *Power system reliability standards and guidelines for market intervention, Discussion Paper*, February 1998; NECA Reliability Panel 1998, *Determination on reserve trader and direction guidelines*, June 1998.

18 The measures developed for use by utilities under the centralised industry structure varied widely, from simple capacity margins through to sophisticated statistical indicators focussing on particular aspects of reliability (for example, the amount of energy likely not to be able to be supplied (USE) and the number of hours in a period in which some load will not be able to be supplied).

19 NECA Reliability Panel 1998, *Determination on reserve trader and direction guidelines*, June 1998, p. 8.

20 ibid.

3.2.2 Reliability settings

Inclusion of a price cap in the NEM design

In general, competitive markets do not have a price cap. Inclusion of a price cap in the NEM design required authorisation under the *Trades Practices Act 1974* by the Australian Competition and Consumer Commission (ACCC) at the time the National Electricity Code (Code) was authorised.[21]

The ACCC accepted that a price cap was warranted in the early stages of the market to guard against the consequences of unmanageable market risk at what was anticipated would be a potentially volatile and uncertain period. Inclusion of a price cap was also justified on the basis of there being minimal opportunities available for demand-side response to actively participate in the market. The ACCC recognised that such opportunities were an important mechanism for buyers to counteract the potential price setting power of the supply-side.[22]

In seeking approval from the ACCC for the price cap, NEMMCO and the National Electricity Code Administrator (NECA) recommended that VoLL (the term given to the market price cap) initially be set at $5,000/MWh. This value was considered appropriate to ensure that market risks were capped at an acceptable level. It was also noted that this value was consistent with that used in the England-Wales market at that time.[23]

In its determination, the ACCC acknowledged that the proposed value of VoLL was arbitrary. However, it recognised that it was not in a position to recommend a more appropriate level. The ACCC accepted the proposed level of $5,000/MWh and anticipated that a revision would occur within 12 months of market start, and annually thereafter.[24,25]

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21 In November 1996, NEMMCO and NECA formally applied to the ACCC for authorisation of the National Electricity Code (Code) under the Trade Practices Act. The submission that accompanied that application set out the rationale for including a price cap (termed VoLL) in the NEM design.

22 Without price transparency to end-use customers, there is little incentive for them to reduce load at times of high market prices. Under these circumstances, retailers have no option but to continue to supply at a potentially substantial loss. A cap on these potential losses was considered desirable in view of this lack of short term elasticity of demand.

23 The Electricity Pool of England and Wales (the Pool) was a mandatory auction spot market established during 1990. The Pool included capacity payments to encourage generators to invest and provide reserve capacity. Capacity payments were aimed at reflecting the expected cost to the user of a supply interruption, measured by VoLL. VoLL was set administratively at £2,000/MWh in 1990 and was then increased annually by the retail price index. In 2000, it stood at £2,816/MWh.

24 The Code was subsequently amended to require the NECA Reliability Panel to conduct, in consultation with market participants, annual reviews of the level of VoLL in the NEM.

25 The ACCC is no longer involved in decisions relevant to the market price cap. As noted above, the ACCC's initial involvement in these matters related to authorisation of the National Electricity Code. Following initial approval of the Code at market start, the ACCC was responsible for authorising any changes to the Code (including to the level of the reliability settings), prior to the commencement of the National Electricity Rules.

Review of VoLL by the Reliability Panel

In July 1999, in line with its obligations under the Code, the Reliability Panel commenced its first annual review of VoLL.[26] In the issues paper for the review, the Panel considered the role that VoLL was intended to play in the market. It noted the following:[27]

> "The Code's term, "VoLL" is an acronym for "value of lost load", suggesting its role in the market is that of surrogate bid, representing the price at which customers will be indifferent to having their loads curtailed.
>
> The Code also refers to VoLL as a "price cap", as did the application to the ACCC authorising the Code… This suggests VoLL's role is to balance the objectives of allowing unfettered market operation on the one hand and maintaining an acceptable risk environment on the other."

The Panel considered that clarification of the role of VoLL in the national electricity market was a vital first step as it would ultimately determine how the level of VoLL was set. The Panel concluded the following:[28]

> "The primary role of VoLL should be that of a price cap which strikes a balance between allowing the market to clear with minimal intervention and containing market risk to tolerable levels. A secondary role, that of surrogate bid, would only be appropriate if it was concluded that significant ongoing intervention by the market operator to clear the market was inevitable. It would then be reasonable for the focus of the price cap to shift to promoting economically-appropriate prices during intervention."

The core principle guiding the Panel's review of VoLL was therefore the need to balance the ability of the market to consistently clear on a voluntary basis, within the reliability standard set by the Panel, in all but the most extreme circumstances, against risk. The strength of the incentive provided by the market price at peak times was therefore considered critical in satisfying the core principle.[29]

In reviewing the appropriateness of the initial level of VoLL, the Panel found that a price cap of $5,000/MWh would be unlikely to maintain supply reliability consistent with the reliability standard, without some form of central intervention. In other words, the level of VoLL was too low to ensure the market would continue to consistently clear on a voluntary basis.[30]

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26 See: NECA Reliability Panel 1999, *Review of VoLL in the national electricity market, Issues Paper*, 12 May 1999; NECA Reliability Panel 1999, *Review of VoLL in the national electricity market, Final Report,* July 1999.

27 NECA Reliability Panel 1999, *Review of VoLL in the national electricity market, Issues Paper*, 12 May 1999, p. 11.

28 ibid, p.12.

29 NECA Reliability Panel 1999, *Review of VoLL in the national electricity market, Final Report*, July 1999, p. 6.

30 While the Panel recognised that there were a number of new investments occurring and planned, it did not consider that these were not demonstrative of the core principle (that is, the ability of the market to clear voluntarily) being met purely from market signals at peak times.

In considering a more appropriate level of VoLL, the Panel analysed possible supply and demand-side responses. On the supply-side, the Panel found that VoLL would need to be set at a level of at least $10,000/MWh, and possibly as high as $20,000/MWh, in order for there to be a reasonable prospect of supply-side resources emerging to voluntarily clear the market for all but the five hours per year over the long run, required by the reliability standard.

While very aware of the limitations of available data on end-use customer value of lost load, the Panel nonetheless concluded that a significant demand-side contribution would be unlikely below a level of at least $15,000-$20,000, that is, at the level at which a marginal supply-side response was probable (demand-side considerations are considered further in section 3.2.3).

The Panel subsequently recommended that the following changes be made to the Code:

- VoLL be increased in two steps: to $10,000/MWh in September 2001 and to $20,000/MWh in April 2002.
- A rolling three-year schedule of VoLL be introduced, extended by one year in each annual review.
- A cap on the market price be imposed if the cumulative effect of high spot prices exceeded a threshold level. Specifically, if the spot price in the preceding week (336 trading intervals) exceeds a cumulative price threshold (CPT) of $300,000, the market price cap would be reduced to the administered price cap. The APC would be set at $300/MWh in peak times of the day and $50/MWh in off-peak times of the day.[31]

On 29 September 1999, NECA lodged an application with the ACCC for authorisation of the recommendations made by the Reliability Panel in the VoLL review.[32]

Authorisation of changes to VoLL by the ACCC

In its determination on the proposed changes, the ACCC argued that an increase to $20,000/MWh would introduce significant additional risk to market participants, which might not easily be accommodated. It also expressed concerns over potential generator market power and possible consequences for higher power prices across the NEM resulting from the higher price cap.

The ACCC acknowledged that the proposed increase in VoLL would provide a public benefit on the basis that it would encourage investment in peaking capacity in circumstances where demand peaks occur for only a few hours a year. However, it did not consider that the other major public benefit argued by NECA (that VoLL provided the incentive for reliability of supply through improved demand-side response) had been demonstrated. As such, the ACCC did not believe that an increase in VoLL to $20,000/MWh would deliver sufficient public benefit to outweigh the potential anti-competitive detriments noted above.

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31 A cumulative spot price of $300,000 would require 7.5 hours at a VoLL of $20,000/MWh or 30 hours at a VoLL of $5,000/MWh before the APC is applied.

32 This application was accompanied by a number of other applications for changes to the Code in relation to capacity mechanisms and price floor arrangements.

The ACCC therefore proposed to limit the increase in VoLL to $10,000/MWh, and to delay the increase until April 2002 to allow market participants sufficient lead-time to put in place necessary arrangements to accommodate the increase in risk. The ACCC also determined to reduce the CPT to $150,000, reducing the risk of market participants being exposed to prolonged periods of high prices.

3.2.3 Demand-side considerations

In addition to marginal supply-side investment, demand-side response also has a critical role to play in ensuring reliability in the NEM. For example, customers may be able to respond to market conditions by voluntarily reducing demand in response to price.

While demand-side response was much less developed than the supply-side at the time of market start, it was recognised that greater participation would strengthen the market position of customers in the NEM and provide the opportunity for significantly reduced peak prices by requiring less peak generation.[33]

At the time of Panel's first review of VoLL, Monash University had undertaken work which indicated that different customers would (if it was practical to do so) reduce their demand at prices ranging from $1,000/MWh to $90,000/MWh.[34] Monash University also developed a single aggregate representative value of customer lost load of around $25,000/MWh.

While the Reliability Panel recognised the possibility that, if attracted to the market, sufficient demand-side response may be able to clear the market at a price lower than that required by the supply-side, it was reluctant to rely on a single representative customer VoLL as a benchmark for setting the value of the price cap.[35] This was due in part to the wide range of customer valuations and the uncertainties associated with the survey techniques and averaging methodology.

A possible alternative to relying on customer surveys for estimating customers' value of lost load would be for individual customers to express their own values of lost load either directly through the wholesale market[36] or, more practically, through negotiated retail tariff arrangements with retailers. While this would avoid some of the limitations

33 If a customer is to voluntarily reduce demand, the incentive to do so will be a combination of the attraction of avoiding paying the market price, and any incentive offered by a retailer balanced against the value foregone by not taking supply. The net incentive must be greater than the net opportunity cost incurred in reducing demand.

34 In this section, 'customer VoLL' is defined as the value that a consumer is ready to pay for the last kWh of electricity rather than being disconnected. References to 'VoLL' are to the market price cap.

35 NECA Reliability Panel 1999, *Review of VoLL in the national electricity market, Final Report,* July 1999, pp. 10-11.

36 An example of direct participation by the demand-side in the wholesale market would be to require customers to nominate bid prices at which they would be willing to forego part or all of their supply. The nominated bids would be used to prioritise loads for shedding and to set the price when a particular price-class was shed. However, the administrative effort of acquiring up to date bids and processing them could be significant. Further, the absence of effective mechanisms for discriminating among loads on the basis of the bid price during load shedding would also be an issue.

of survey methodologies, the Panel recognised that there were significant cost and technology barriers constraining the ability of customers to participate in this way.

The Panel considered that while customer VoLL may be a useful concept when better alternatives were not available, it was not appropriate to use as the basis of decisions on the level of the price cap, particularly at that stage of the NEM's development.

3.3 Why reliability mechanisms are needed

As noted above, although there are some exceptions, in most commodity markets the price for the commodity in question is decided at any moment in time through the buyers (the demand-side) and the sellers (the supply-side) agreeing on a price at which to transact. In effect, customers signal the value they place on supply of a particular commodity and when a shortfall in supply is forecast, a price signal is provided to the market to drive investment in new supply. In such markets, there is no need for a minimum level of supply to be determined by a central body. This is because it is possible for customers, through their consumption decisions, to clearly signal the price at which they are willing to cease supply.

For a number of reasons, the electricity market differs from other commodity markets. First, it is not cost effective to store electricity in bulk. This means that electricity must be produced by generators and delivered to customers in real time. In addition, electricity customers generally have little direct involvement in the market. In the absence of a wide-spread rollout of smart meters and time-of-use tariffs, electricity customers currently have neither the means nor the ability to express their preferences quickly. Together, these factors limit the ability of the demand-side to send accurate and effective price signals to the market regarding the 'optimal' level of electricity supply.

In addition, if customers cannot reveal their willingness to avoid very high prices through their consumption decisions, the price of electricity would predominately be set by the supply-side.[37]

It is for this reason, and because the supply of electricity is considered an essential service, that energy markets tend to rely on regulatory solutions for ensuring reliability. As noted above, such solutions have been a feature of the NEM since it commenced.

As noted previously, reliability in the NEM is measured by the reliability standard. The objective of the reliability standard is to deliver an expectation of reliability that reflects the value that consumers place on reliability. The current approach specifies that value in terms of the targeted quantum of USE and applies a derived market price cap set to deliver a level of generation capacity consistent with meeting the reliability standard. The challenge of maintaining reliability in the NEM is therefore a question as to what level of market price cap is sufficient to incentivise investment and operational behaviours necessary to deliver the expected reliability outcome.

Rather than set a standard for reliability, an alternative approach would be to set the price cap at some estimate of the value that customers place on reliability. To date, the VCR for all NEM customers has never been evaluated. Such an evaluation necessarily

37 Albeit, with some limited demand-side participation from larger customers who have the ability to signal their price sensitivity and curtail load without impacting other customers.

involves complex issues such as variations in VCR across customer in different sectors and locations.

Possible approaches to linking the reliability standard and reliability settings with an estimate of VCR, and issues associated with using a measure of VCR to set the reliability standard and reliability settings, are considered further in the next two chapters.

4 Value of customer reliability

The approaches to linking the reliability standard and reliability settings with VCR identified and discussed in the next chapter are based on the assumption that VCR provides an accurate estimate of the value placed on reliability by customers. SCER's terms of reference do not require the AEMC to provide details about VCR. Nonetheless, it is important to identify some of the issues associated with developing a reliable and accurate VCR for use in setting the reliability standard and reliability settings, as the accuracy of the VCR measure can affect the relative attractiveness of the options considered in chapter 5.

4.1 Overview of VCR

Measuring the value that customers place on reliability can be a complicated and subjective process. This is because a clear consensus on the best method to value reliability does not currently exist. In addition, the value that a customer places on a reliable supply of electricity will be influenced both by the characteristics of the customer and the nature of the supply interruption.

For example, customer characteristics that influence how reliability is valued include the type of customer, the nature of their activities, whether they have access to alternative energy sources, their demographics, and the extent to which they have experienced interruptions in the past. The nature of supply interruptions can be influences by factors such as duration, frequency, timing and location of an interruption.

While it is possible to disaggregate the results to an extent, it is not possible to fully capture each of these factors. Considerable averaging is unavoidable.[38] Attempts to place a single value on reliability for the market for use in the context of setting the reliability standard and reliability settings is therefore likely to require some discretion and qualitative judgement and should only be viewed as an aggregate approximation.

4.2 Methodology for estimating VCR

Estimates of VCR are used in investment and planning decisions across the supply chain, including for the purposes of economic regulation of network service providers (NSPs) and network investment planning.

As part of its review of the national framework for distribution network reliability, the AEMC recommended to SCER that the AER develop a common, national methodology for calculating VCRs for use across the NEM.[39] The AEMC also recommended that the

38 For example, in the New South Wales workstream of the AEMC's distribution reliability outcomes and standards review, the AEMC estimated VCRs for each of the three New South Wales distribution network service providers (DNSPs). For each DNSP, VCRs were estimated for CBD, urban and rural feeder types, and for three different categories of customers. However, these estimates of VCR were still averages across four different lengths of outages and were an average of the responses from hundreds of different customers.

39 AEMC 2013, *Review of the national framework for distribution reliability, Final report*, 27 September 2013, Sydney.

AER calculate VCRs for each NEM jurisdiction using the national methodology. This recommendation is described in Box 5.1.

Box 4.1: National approach to estimating VCRs

On 27 September 2013, the AEMC published its final report for the review of the national framework for distribution reliability. The final report set out a recommended framework for distribution reliability in the NEM and included the next steps for its implementation. As part of the framework, the AEMC recommended the use of an independent and transparent economic assessment process to set reliability targets for distribution networks. This process includes evaluating the expected costs of distribution network investments against the value that customers place on reliability.

Given that full implementation of the proposed framework could take a number of years, the AEMC set out an interim stage designed to improve the existing arrangements for setting, delivering and developing the distribution reliability parameters. This interim stage includes a proposal for the development of values of customer reliability for each NEM jurisdiction.

Specifically, the AEMC has proposed that the AER:

- develop, publicly consult on, and publish a national methodology for calculating the VCR on a consistent basis across the NEM, including the development of a timetable for updating jurisdictional VCRs at least every five years; and
- calculate VCRs for each NEM jurisdiction using the national methodology that has been developed.

The VCR methodology and VCR measures must take into account an appropriate range of customer types and geographic and demographic differences within each NEM jurisdiction. It must also ensure that VCRs can be used in the economic regulation of NSPs, network investment planning and the setting of reliability standard and settings in the NEM for transmission and distribution networks, and generation.

In performing these tasks, the AEMC considers it is appropriate for the AER to take into account the work undertaken by AEMO to establish a national approach to estimating the VCR, including stakeholder submissions that have been provided during AEMO's review.

It is intended that the length of time between updates to estimate the VCR for each jurisdiction be at the discretion of the AER, but should be no less frequent than every five years. In between updates, the AER must escalate the VCR for each jurisdiction by the consumer price index on an annual basis. The AER must publish escalations of the VCR for each jurisdiction by 31 December each year.

As indicated by the review into a national distribution reliability framework, the AEMC does not have a view on the best methodology available for estimating and updating VCR for use in setting the reliability standard and reliability settings – there are many options and considerable time is needed to properly assess the benefits and limitations

of each. However, there is merit in highlighting some of the key considerations associated with choosing an appropriate methodology to derive VCR for use in the context of generation investment.

There are two main approaches to deriving VCR:

- Survey-based approaches, which include estimates of direct costs, estimates based on the economic cost of substitution, contingent valuation surveys and choice modelling (or 'conjoint analysis').
- Modelling-based approaches, which include considerations of gross national product per kWh of electricity consumed, wage income per kWh consumers or the costs of a standby generator.

Each approach to derive VCR has its advantages and drawbacks, all of which have been well documented, most recently by AEMO in its Value of Customer Reliability Issues Paper and by the Productivity Commission in its Electricity Network Regulatory Frameworks Inquiry Report.[40] For example, while survey-based approaches tend to take a long time to conduct, are complex and can produce biased results, they are capable of capturing the wide range of costs caused by interruptions (which vary per customer depending on the timing and duration of the interruption). On the other hand, modelling-based approaches tend to be less costly and easier to undertake because the data usually already exists. However, they cannot easily measure indirect costs or distinguish between costs at different times or for different durations of interruption.

To date, survey-based approaches have tended to be used to derive VCRs in the NEM. The studies undertaken have been jurisdictional based, the objective being to derive a VCR for the relevant region for use in specific activities in that region. The table below shows the results of the two VCR studies undertaken by AEMO and the AEMC to estimate a VCR for Victoria, and for New South Wales, respectively.

Table 4.1 Sectoral values of customer reliability for Victoria and New South Wales, 2012

Victoria ($/kWh)		New South Wales ($/kWh)	
Residential	23.80	Residential	20.71
Industrial	41.24	Small business	413.12
Commercial	103.77	Medium-large business	53.30
Agricultural	130.26	-	-
Weighted average	57.88	Weighted average	94.99

40 Productivity Commission 2013, *Electricity Network Regulatory Frameworks, Report No. 62*, Canberra, Volume 2; and AEMO 2013, *Value of Customer Reliability Issues Paper*, 11 March 2013.

Note: The Victorian VCR data is indexed from the Victorian VCR 2007 survey results. See: AEMO 2011, *2011 Victorian annual planning report: Electricity and gas transmission network planning for Victoria*, p. 15. The NSW VCR data was collected for the AEMC's review of distribution reliability outcomes and standard NSW workstream. See: AEMC 2012, *Review of Distribution Reliability Outcomes and Standards, Draft Report - NSW workstream*, AEMC, 8 June 2012, Sydney.

The VCRs for residential and large business customers are similar between the New South Wales and Victorian surveys. However there is quite a large difference between the overall weighted average costs for the two jurisdictions. This is due to the significantly higher small business VCR in New South Wales (the small business category in New South Wales is most similar to the agricultural and commercial customer types used in the Victorian survey).

It is difficult to determine from the customer survey data the precise reasons for the significant difference between the small business VCR in NSW and the agricultural and commercial VCRs in the Victorian survey. However, as observed by the AEMC in its review of distribution reliability outcomes and standards, the differences may reflect increased reliance by smaller service businesses on the internet and other electronic systems (for example, EFTPOS) for their business functions since 2007, or the different customer categories (and the associated sample weights) between the two jurisdictions.

The differences could also be the result of methodological variations between the two survey approaches used. This last possibility highlights the importance of providing transparency about the details of the methodology chosen, including potential shortcomings. This may be particularly important where VCR is used to inform investment decisions which affect reliability outcomes for consumers.

4.3 Using VCR to set the reliability standard and reliability settings

Once a methodology is determined and a range of VCR estimates collected, there are a number of considerations on how to use the estimates for the purpose of setting the reliability standard and reliability settings. These considerations arise from the nature of customers' valuations of reliable supply which tend to vary by customer sector and region, and which change over time. In practice, any measure of VCR will represent an average of surveyed customer responses. Overall, the objective is to establish an administratively determined VCR which best reflects the diverse preferences of the customers impacted by certain investment decisions. Some of the key issues are considered below.

Customer-sector considerations

In the extreme weather review, the AEMC concluded that efficient investment in reliability across the supply chain could be achieved by evaluating the expected costs of a particular investment against the value that customers most affected by that investment place on reliability (that is, investing to the point that customers would prefer to have their load shed, rather than continue to receive (and pay for) electricity supply). In the context of generation reliability, the customers most affected by an investment in supply- and/or demand-side capabilities will be those likely to have their load shed first in the event of a supply shortage.

In the NEM, load shedding is shared between NEM regions in proportion to the demand in each region (up to the limit of the interconnector flows). At the jurisdictional level, the Jurisdictional System Security Coordinator is responsible for prioritising customers who will be shed in the event of a direction from AEMO to NSPs for the disconnection of customer load.[41]

Currently, it is assumed that residential consumers, as a sector, place the lowest value on supply reliability. It is for this reason that residential consumers tend to have their supply interrupted first. Assuming this situation is unlikely to change, determining a single aggregate VCR which reflects the preferences of residential customers is likely to be appropriate.

Number of VCRs

As previously noted, customer characteristics such as type of customer and the nature of their activities can influence how reliability is valued. The nature of a supply interruption, for example, its duration and frequency, can also impact how a customer values reliability.

Given the variations in VCR estimates, consideration needs to be given to how many administrative VCRs should be derived and applied. For example, it would be possible to differentiate VCR by season, time of day (for example, peak or off peak) or region, and to design a set of reliability standard and reliability settings to reflect those differences.

However, in the context of setting the reliability standard and reliability settings, the benefits from applying multiple VCRs in terms of improved accuracy would need to be very carefully weighed against the added complexity and risk of using several VCR figures and creating multiple price signals in the market. In addition, the current reliability framework is premised on the assumption that each customer-sector (on average) values reliability equally in all regions of the NEM. To the extent that this assumption holds true, it is likely to remain appropriate to set a single, national VCR for application in each region of the NEM.[42]

Types of VCR estimates

Decisions will also need to be made in relation to the 'type' of VCR estimate to be used to determine the administrative VCR. For example, a marginal VCR, or an average

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41 If a manual load shedding event occurs beyond a short period of time, supply to the interrupted customers can be restored as other customers are interrupted. This limits the period of interruption experienced by customers. This practice is called rotational load shedding.

42 However, where there are differences in the preferences of customer sectors across regions, there is a question around the feasibility (and efficiency) of introducing jurisdictional specific reliability standard and reliability settings set to reflect those differences. The AEMC considered this issue in the context of the extreme weather review. Specifically, it considered the feasibility of setting a different MPC in each region to deliver a different price-reliability trade-off for the generating sector. The AEMC concluded that introducing regional specific arrangements into the NEM's interconnected market would most likely be detrimental to overall NEM efficiency and would present a number of challenging implementation issues, including having to re-apportion load shedding between regions. See AEMC 2010, *Review of the Effectiveness of NEM Security and Reliability Arrangements in light of Extreme Weather Events, Final Report,* 31 May 2010, Sydney, Chapter 6.

measure of VCR could be used. In respect of the latter, decisions about weighting the average may also be required.

The choice of measure may depend in part on the level of the administrative VCR that would result. For example, if the VCR of the marginal customer is significantly higher than the other estimates, its use in setting the market price cap may be unacceptable given the increased risk placed on all market participants from the higher price cap. Alternatively, if there is a desire to stimulate investment in generation or demand-side response, using the VCR of the customer at the margin may (relative to an average VCR measure) provide a stronger signal to the market of the need for investment in new generation capacity (or demand side response).

In addition, given the inherent anomalies and biases associated with estimating a value for VCR, an average measure of VCR may provide a means of smoothing out the irregularities (or wide swings) in VCR estimates. this may provide a desired consistency over time.

Dynamic considerations

Once the administrative VCR is determined, consideration will need to be given to how best to achieve a balance between maintaining stability in the VCR (which is important given its use an input into long term investment decisions) and the need to update VCR on a regular basis (to ensure changes in customer preferences are reflected).

Customer preferences for reliability, and the technologies for, and costs of, improving reliability, do not remain constant. These changes have implications for the appropriate level of reliability and highlight the need for regular re-assessments of VCRs. Ideally, VCRs used for the purposes of investment and planning decisions would be updated regularly to ensure decisions are made on the basis of the most relevant and up-to-date information.

However, the benefits to using a VCR which reflects current customer preferences must be balanced with the benefits that can accrue from maintaining stability in the VCR. Where VCR is used as an input into long term investment decisions, certainty and transparency regarding its level would be expected to increase investor certainty and promote economically efficient generation planning and investment outcomes.

4.4 International experience

Most of the price caps in the wholesale electricity markets investigated by NERA in its advice to the AEMC were not set with reference to VCR. However, estimates of VCR were often used for other purposes. For example, in New Zealand a scarcity pricing mechanism imposes a market price band, with the lower bound reflecting the cost of marginal generating unit, and the upper band an estimate of VCR. In addition, the Office of Gas and Electricity Markets (Ofgem) in Great Britain recently estimated VCR to inform decisions about the procurement of capacity in light of the proposed energy market reforms.

The international review by NERA indicates that, generally, the methodological approaches to estimating VCR typically involve:

- stated preference or contingent value surveying, mostly for residential or small domestic consumers; and/or
- using estimates of industry gross value add and electricity consumption to input the value of electricity to large industry and/or commercial consumers.

The common theme from the VCR studies considered by NERA was that obtaining reliable estimates of the VCR is challenging. This reflects the variability of likely values by customer sector, region and time of day among other factors. A number of the more recent studies have addressed this by using a number of difference methodologies as a cross check (for example, both stated preference and contingent valuation techniques). This has included estimating both the WTP and WTA to both avoid an outage, or to not consume.

Ultimately however, how the VCR appropriately translates to the market price cap is likely to be a matter of judgement, given all of the contextual circumstances.

Some observations from the VCR studies carried out in New Zealand and Great Britain are set out in the box below. Appendix B includes information on the level of the administratively determined VCRs, and the methodology used to determine those VCRs, for the seven jurisdictions considered in the study (where relevant).

Box 4.2: International experience on estimating VCR

New Zealand

The New Zealand wholesale electricity market is an 'energy-only' market for which there is no official market price cap. However, when an electricity supply emergency causes forced power cuts, or emergency load shedding throughout the entirety of one or both islands, scarcity pricing arrangements are triggered. This involves applying a market price range of between $10,000/MWh and $20,000/MWh (AU$8,850/MWh to AU$17,690/MWh):

- The lower bound of the scarcity pricing arrangement (that is, $10,000/MWh) was set with reference to the costs of a peaking gas-fired generator.
- In contrast the upper bound (that is, $20,000/MWh) was set with reference to the value of forgone consumption to consumers during instances of emergency load shedding.

As a consequence, estimates of the VCR are relevant to the setting of the upper bound of the scarcity pricing arrangement.

The most recent investigation of the VCR was undertaken by the Electricity Authority in 2013. This recent work lead to the view that:

- A single VCR figure is an 'inappropriate' measure of the value that New Zealand electricity customers place on reliability. This is because the actual VCR likely varies considerably across and within consumer categories, across regions, and is likely to be dependent on the duration of a specific power outage. This highlights the importance of estimating the VCR using a number of methodologies.

- A carefully designed survey-based approach to estimating the VCR which is appropriately framed for the audience, within the jurisdiction being considered, will most likely produce reasonably robust estimates.

Great Britain

Values of reliable electricity supply are not currently used as the basis for setting a market price cap in Great Britain. However, Ofgem recently commissioned a study to estimate VCR. The estimates were intended to be used to; inform decisions about the quantum of capacity to purchase as part of the proposed capacity market; and for the purpose of setting network reliability standards. In addition, estimates of VCR could be used to price involuntary consumer disconnections (that is, load shedding) that might arise from the out-workings of the balancing market. Presently, disconnections are not currently priced in at all.

In carrying out this work, Ofgem acknowledged that VCR estimates produced from almost any methodology are likely to be highly uncertain due to the practical difficulties of eliciting values for outages from consumers.

In addition, in considering how the estimates of VCR should be applied given the variation in the estimates by consumer type, season and time of day, Ofgem determined that:

- differentiating VCR by customer type was not possible because it was not possible to identify the type of consumer that had been disconnected with the technology currently available; and
- although possible to apply different VCR levels depending on the season and/or time of day, the benefits of improved accuracy did not outweigh the added complexity of using several VCR estimates.

Ofgem therefore decided to select an administrative VCR based on an average of the study's VCR estimates.

5 Options for linking the reliability standard and settings with VCR

Chapter 3 discussed the arguments for a link between customers' VCR and the level of the MPC. This chapter considers how an administratively determined VCR[43] and MPC can be linked in practice; providing an initial high level assessment of the costs and benefits of the various options.

The terms of reference for this review require the AEMC to provide advice on possible approaches to linking the NEM's reliability standard and settings (in particular, the market price cap) with VCR. As NERA's study into alternative approaches to setting market price caps highlights, the choice of approach to setting a market price cap is highly dependent on the characteristics of the electricity wholesale market within which the price cap is applied. Specifically, what role the market price cap (and broader reliability mechanisms) is intended to play in the relevant market (for example, to encourage demand-side bidding, to incentive generation investment, to limit opportunities for the exercise of market power by generators).

A number of the options identified in this chapter for linking the reliability standard and settings with VCR assign the market price cap a different role to that which it currently plays in the NEM.[44] This does not necessarily mean that these approaches will be unsuitable in the context of the NEM. It does mean, however, that careful consideration will need to be given to the extent to which the alternative approaches are appropriate in delivering efficient market outcomes that are at least consistent with those delivered by the NEM's current reliability standard and settings.

This chapter sets out four possible approaches to linking the reliability standard and settings with VCR:

- Option 1: direct application of VCR as market price cap.
- Option 2: use VCR as a cross-check on the reliability standard and reliability settings.
- Option 3: direct application of VCR as market price cap at "periods of scarcity".
- Option 4: different levels of VCR offered into dispatch.

The AEMC put forward options 1 and 2 in the extreme weather review in 2010, and recommended using a VCR as a cross-check on the market price cap (option 2 above).[45] Options 3 and 4 have been developed by the AEMC for this advice after considering arrangements in other markets around the world.

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43 As explained in section 4.3, in practice, any measure of VCR will represent an average of customer values of reliability. The objective is to establish an administratively determined VCR which best reflects the diverse preferences of the customers impacted by certain investment decisions.

44 Currently, in the context of the NEM's reliability framework, the objective of the market price cap is to balance the ability of the market to consistently clear voluntarily, within the reliability standard, under all but the most extreme circumstances, against risk. See Chapter 3 for further discussion.

45 AEMC 2010, *Review of the Effectiveness of NEM Security and Reliability Arrangements in light of Extreme Weather Events, Final Report*, AEMC, 31 May 2010.

As requested by SCER, we intend to analyse the expected costs and benefits of linking the reliability standard and settings with a VCR in terms of:

- the potential impact on consumers, including for price and reliability;
- the potential impacts on generators, retailers and other relevant market participants, including impacts on investment signals; and
- the extent to which linking the MPC to a VCR could duplicate the signals provided by the reliability standard and other existing market settings.

This chapter describes briefly how each of the options would work and the role that the market price cap would play. It also provides an initial high level assessment of the options against the three criteria listed above.

5.1 Option 1 - direct application of VCR as market price cap

5.1.1 How would it work?

The AEMC would determine the MPC based on an administratively determined VCR, which would be estimated for this purpose. The MPC would be set equal to the VCR as a starting point, but may be adjusted to take account of risks and costs. For example, it could be adjusted if the AEMC considered the estimated level of VCR proved to be too low to provide sufficient investment signals to meet customer expectations of reliability, or was so high that it could lead to inefficient overinvestment. It may also be indexed (for example, to CPI). In this model, the "burden of proof" would be on the AEMC to demonstrate that the MPC should not be set equal to the VCR.

Under this approach, the VCR would be a key reliability parameter and would replace the need for an explicit reliability standard. However, comparisons of outturn reliability performance against a generally accepted level of reliability could inform AEMC reviews of the MPC, and provide a view of the validity of the VCR estimate.

5.1.2 Role of MPC under this approach

The focus of the MPC in this option would be on promoting economically appropriate prices during intervention (involuntary load shedding). The role of the price cap would therefore be that of "surrogate bid". That is, it would act as a proxy for the demand-side in the wholesale market.

5.1.3 Assessment

Potential impact on consumers, including for price and reliability

To the extent that the means of determining the administrative VCR is accurate, this method would deliver the level of reliability consumers on average are willing to pay for. However, as Chapter 4 explains, any measurement of the value of reliability is likely to be a subjective exercise, and should only be viewed as an aggregate approximation. To the extent that the administratively determined VCR employed misrepresents customers' valuations, customers would either not receive the level of reliability they were willing to pay for, or would pay more than they were willing to for reliability.

Any adjustment to the MPC to take account of risks and costs may be able to mitigate such measurement error to some extent. For example, by considering the range of VCRs for different customers, or other factors that customers value.

Potential impacts on generators, retailers and other relevant market participants, including impacts on investment signals

Investment in new electricity infrastructure (and in maintaining existing infrastructure) should take place wherever a shortfall is expected in the capacity to meet customers' demand for electricity. This method would provide efficient signals for investment in electricity if the level of the administratively determined VCR used was an accurate reflection of customers' valuation of reliability.

A key advantage of this approach is the simple and clear relationship between VCR and MPC. This provides certainty for (potential) generators and retailers when assessing the costs, benefits and risks of investing in the market. The ability of the AEMC to adjust the MPC to take account of risks and costs creates some uncertainty, but this could be minimised by clearly specifying in the NER the types of risks and costs that could be considered and the extent to which they can affect the MPC.

A risk of this approach is that the MPC is likely to change whenever a new VCR survey is conducted. This could result in undesirable volatility that could affect the value of investments and the risk of investing. To mitigate this, the AEMC could determine the timing for these surveys several years in advance so that investors can factor the risk of change into their investment decisions.

The extent to which linking the MPC to a VCR could duplicate the signals provided by the reliability standard and other existing market settings

A direct link between the MPC and VCR could remove the need for a reliability standard, since the reliability that customers desire would be expressed through the VCR. The level of USE could be estimated by modelling the wholesale market with the market price cap set at VCR. In view of the difficulties in administratively determining a VCR discussed in chapter 4, a comparison of outturn reliability performance against a generally accepted level of reliability could provide a view of the validity of the VCR estimate, and inform AEMC reviews of the MPC.

This approach would be likely to require other risk management mechanisms to be in place. That is, it would be futile to set an economically efficient price during intervention if the consequent levels of risk rendered the market non-viable.

5.2 Option 2 - use VCR as a cross-check on the reliability standard and reliability settings

5.2.1 How would it work?

The MPC would continue to be set on the basis of modelling of the costs of generation required to meet the reliability standard. The Reliability Panel, in reviewing the reliability standard, would compare a value of VCR with the MPC to assess how well the current reliability standard and settings reflect the value customers place on reliability. If the MPC is inconsistent with the administratively determined VCR, then the cause of this inconsistency would be examined. This may be due to inaccuracies in

the determination of the VCR, the reliability standard may no longer reflect the value customers place on reliability, or the MPC may not be consistent with achieving the reliability standard.

If it is found that the reliability standard no longer reflects the value customers place on reliability, then the reliability standard would be amended. The MPC would then be set at a level consistent with achieving the reliability standard.

AEMO would operationalise the reliability standard through the development of MRLs.

This approach is consistent with the Commission's recommended frameworks for transmission and distribution reliability.[46]

5.2.2 Role of MPC under this approach

The focus would be on minimising the need for intervention consistent with maintaining the reliability standard. The role of the MPC would therefore be that of "price cap".

5.2.3 Assessment

Potential impact on consumers, including for price and reliability

The cross-check of the MPC against the estimated VCR would allow reliability under this model to broadly reflect the value customers place on it.

As this is not a direct application of the VCR to the MPC, it may not precisely reflect the VCR as determined. However, given the approximate nature of VCR estimates, using the VCR as a cross-check allows other issues to be taken into account in setting the MPC, including the likelihood of measurement error and the range of VCRs associated with different customers.

Potential impacts on generators, retailers and other relevant market participants, including impacts on investment signals

This method promotes efficient investment signals by considering both supply-side costs and demand-side willingness to pay in determining the MPC. If the MPC was found to exceed the administratively determined VCR, or vice versa, the AEMC could look at the reasons and amend the MPC if it considered that it would lead to a more efficient level of investment.

Under this model, the reliability standard and settings would be fixed for each four year period between reviews. This would provide a level of certainty for generators and retailers on the maximum price they would receive or pay respectively for electricity.

The methodology for initially determining the MPC – that is, based on the costs of the generation required to meet the reliability standard – is known under this model. However, the ability for the AEMC to cross-check the resulting value against the VCR could create an area of uncertainty for generators and retailers, in comparison with option 1, for example. Under option 1, it is clear that the MPC will always equal the prevailing level of VCR. Under this model, the AEMC has a degree of discretion to

46 See www.aemc.gov.au.

amend the MPC, taking into account a range of factors (such as the accuracy of the VCR or the prospects for efficient investment).

The level of risk and uncertainty created by this discretion could be minimised by clearly setting out (for example, in the NER) the factors that the AEMC can take into account when reviewing the MPC, and the criteria for making any changes. Under these circumstances, the AEMC's limited discretion may in fact provide added confidence to market participants by mitigating against the risks of anomalous results from the VCR surveys.

This model does not require automatic adjustment of the MPC in response to a change in customers' value of reliable electricity supply. This has the advantage that one of the factors the AEMC could take into account in reviewing the MPC is the impact of any change on the market, and in particular on investment incentives. Where a change to the MPC may be appropriate, it could be phased in over time, to reduce disruption to the market.

The extent to which linking the MPC to a VCR could duplicate the signals provided by the reliability standard and other existing market settings

This model provides a link between the MPC, the VCR and the reliability standard. The MPC is still set based on the cost of meeting the reliability standard. The standard and the settings would therefore remain complementary.

While a high price cap would be unlikely to lead to systematic overinvestment, it would introduce the possibility that a one-off episode of extremely high prices could threaten the integrity of the market. To manage this risk, other risk management mechanisms (such as the current CPT) would need to be in place.

5.3 Option 3 - direct application of VCR as market price cap at "periods of scarcity"

5.3.1 How would it work?

A pre-defined volume or type of load shedding in the electricity market would trigger a "period of scarcity." In those periods, a market price cap based on an administratively determined VCR would apply. The VCR would apply directly, as under option 1 (but only in periods of scarcity). At all other times, there would be no MPC.

Periods of scarcity could be triggered when a given amount of load shedding has taken place, or when a certain category of customers (for example, residential customers) have had load interrupted.

This is similar to the approach taken in New Zealand, where a market price "band" applies when "scarcity pricing" is triggered. See Appendix B for more details.

A reliability standard would remain under this approach, and would be made operational by AEMO through MRLs.

5.3.2 Role of MPC under this approach

The focus of the MPC in this model would be more geared towards ensuring price at times of intervention was economically efficient, rather than on minimising intervention.

5.3.3 Assessment

Potential impact on consumers, including for price and reliability

This approach would help to value reliability in line with customers' expectations, as it would ensure that, when the demand-side is required to balance supply and demand, load shedding would be associated with the price at which customers would choose to have their supply interrupted. As for option 1, this depends on the accuracy of the VCR estimate.

As there would be no price cap outside times of scarcity, it is possible that customers could still be paying a higher price for their electricity supply than the value they place on it.

Potential impacts on generators, retailers and other relevant market participants, including impacts on investment signals

This approach provides a strong signal for investment in electricity generation. In addition to the current incentive to invest to meet demand (provided by an expectation of receiving the market price) there would be an incentive on generators to avoid entering a scarcity period, in order to avoid the price they are paid for their output being capped. This might provide an incentive to over-invest, relative to customers' willingness to pay for a reliable electricity supply.

Another risk of this approach is that in some circumstances there could be perverse incentives on portfolio generators to withdraw capacity in order to invoke the MPC. For example, the losses on a power station which has gone out of service could be minimised if the MPC is the prevailing price for a period. Similarly, customers and retailers could have a perverse incentive to increase demand in order to invoke the market price cap.

Clarity and reliability about the standard and settings would depend on how clearly "periods of scarcity" were defined. The potential for unexpected behaviour in response to the perverse incentives could create some uncertainty about how and when the mechanism would operate. This would particularly create risk for retailers, who would potentially be exposed to uncapped prices.

As the MPC under this method would only apply at certain (and probably rare) occasions, any changes to the level of the MPC in response to a change in VCR may create less disruption to the market relative to methods where the MPC applies at all times.

The extent to which linking the MPC to a VCR could duplicate the signals provided by the reliability standard and other existing market settings

Intervention may be needed at times to maintain the reliability standard. The standard would take on a potentially greater importance, since intervention to maintain the standard may be the trigger for a period of scarcity.

While the scarcity pricing mechanism would effectively cap the price in the most extreme circumstances, there would remain a risk of high prices outside periods of scarcity. For example, when a large volume of high-priced plant is run to avoid load interruption. Other risk management mechanisms (such as the current CPT) may therefore be needed to cap the risk of prolonged periods of high prices.

5.4 Option 4 - different levels of VCR offered into dispatch

5.4.1 How would it work?

Instead of setting an absolute MPC for the electricity market, a range of values for MPC, each representing the VCR of a given set of customers, would be offered into the wholesale market in competition with generator offers.

Where customers (or groups of customers) have sufficiently sophisticated electricity management functions, they could offer their "demand response" directly into the pool.[47] All other customers would have an administratively determined VCR assigned to them. A volume representing this group of customers' load in each period would be offered into the market at this level of VCR.

Demand response offers would be treated in the same way as generator offers in the wholesale market dispatch process. As a result, interruption of load could take place before some high priced generators were dispatched if the VCRs of any customers were lower than the price offered into the pool by those generators.

Potentially, different VCRs for different times of the day, week or year could be used, if VCR data allowed.

5.4.2 Role of MPC under this approach

The various MPC values would be treated as a surrogate bids and used to prioritise load shedding. The focus would be on minimising the need for intervention (involuntary load shedding) by providing opportunities for demand-side participation (voluntary load shedding). If this mechanism works effectively and all customers are included, interventions should not be required.

5.4.3 Assessment

Potential impact on consumers, including for price and reliability

To the extent that administratively determined VCRs are accurate, and technology allows, this method directly links the level of reliability received by different customers (or groups of customers) to the value they place on reliability.

However, current metering and electricity network management technology would limit the way in which customer groups could be divided for the purposes of interruption. For example, most residential customers may have to be grouped on the basis of the part of the distribution network they are connected to (for example, by

47 The AEMC proposed a "demand response mechanism" as part of its 2012 Power of Choice review. We are currently awaiting a rule change request from AEMO to implement such a mechanism.

specifying a zone substation), as interruption is not currently feasible at a more granular level.

Potential impacts on generators, retailers and other relevant market participants, including impacts on investment signals

This approach theoretically represents the most economically efficient method of determining prices in the wholesale market, and therefore delivers the most efficient signals for investment in electricity. However, the technical and administrative difficulties noted above mean that efficient outcomes may not arise in practice.

In addition, this approach presents difficulties in choosing the volume of load interruption to be offered into the pool for each group of customers. As consumption in a given period cannot be accurately forecast in advance, the volume offered would need to be based on observations of the relevant customer group's consumption in similar periods. The volume offered would need to be a conservative estimate, to be sure that the full volume offered is available to be interrupted. As a result it is likely that only a proportion of the group's consumption would be interrupted.

Any change in VCR for a group or groups of customers would be reflected in the offers submitted to the wholesale market. A material change in the VCR of a large group of customers could potentially have an impact on wholesale prices in some periods.

The extent to which linking the MPC to a VCR could duplicate the signals provided by the reliability standard and other existing market settings

If this approach could be fully implemented, it would remove the need to specify a reliability standard, as the wholesale market would work to automatically deliver customers' desired level of reliability.

6 Questions for consultation

Chapter 3 summarised and provided some historical context around the NEM's current reliability framework. It also outlined the theoretical arguments for setting the reliability standard and reliability settings having regard to customers' value of reliability. In considering the benefits of linking the reliability standard and reliability settings with VCR, stakeholders may wish to comment on the following:

Question 1 Reliability in the NEM

(a) What should be the primary purpose of the market price cap and other reliability settings in the NEM?

(b) If the market price cap is linked to some level of VCR, is a reliability standard required?

Chapter 4 identified a number of issues associated with establishing an administratively determined VCR which best reflects the diverse preferences of the customers impacted by certain investment decisions. The issues identified arise from the nature of customers' valuations of reliable supply which tend to vary by customer sector and region, and which change over time. In considering the calculation of VCR, stakeholders may wish to comment on the following:

Question 2 Value of customer reliability

(a) Once a VCR methodology is determined and a range of VCR estimates collected, how should the data be used to determine a VCR which best reflects the diverse preferences of customers?

Chapter 5 considered four possible approaches to linking customers' value of reliability with the market price cap. It also provided an initial high level assessment of the costs and benefits of the various approaches, with particular focus on the impacts on consumers, generators, retailers and other market participants. In considering the possible approaches to linking the reliability standard and reliability settings and VCR, stakeholders may wish to comment on the following:

Question 3 Options for linking the reliability standard and reliability settings with VCR

(a) Which of the four options for linking the VCR with MPC is most appropriate for the NEM?

(b) Are there any other options which would be more appropriate than the four listed?

Abbreviations

ACCC	Australian Competition and Consumer Commission
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
APC	administered price cap
COAG	Council of Australian Governments
Code	National Electricity Code
Commission	See AEMC
CPI	consumer price index
CPT	cumulative price threshold
DNSP	distribution network service provider
ERCOT	Electric Reliability Council of Texas
MCE	Ministerial Council on Energy
MPC	market price cap
MRLs	minimum reserve levels
NECA	National Electricity Code Administrator
NEL	National Electricity Law
NEM	national electricity market
NEMMCO	National Electricity Market Management Company
NEO	national electricity objective
NER	National Electricity Rules
NERA	NERA Economic Consulting
NSP	network service provider
Ofgem	Office of Gas and Electricity Market
RERT	Reliability emergency reserve trader
SCER	Standing Council on Energy and Resources
USE	unserved energy
VCR	value of customer reliability
VoLL	value of lost load

WTA	willingness to accept
WTP	willingness to pay

A History of NEM reliability standard and settings reviews and amendments

The table below sets out the key reviews and rule changes relating to the NEM reliability standard and reliability settings undertaken by the NECA Reliability Panel and the ACCC (respectively) up until 2006, and undertaken by the AEMC Reliability Panel and AEMC (respectively) from 2006 until 2013.

Table A.1 Reliability parameter amendments since market start

Year	Work	Title	Outcome
1998	**Review** NECA Reliability Panel	*Power system reliability standards and guidelines for market intervention*	Recommendation: • Set reliability standards for the wholesale market at a maximum of 0.002 per cent of unserved energy in any region over the long term (standards establish a uniform approach across the market while ensuring consistency with past jurisdictional standards).
1999	**Review** NECA Reliability Panel	*Review of VoLL 1999*	Recommendations: • Increase VoLL in two steps: to $10,000/MWh in September 2001 and to $20,000/MWh in April 2002. • Introduce rolling three-year schedule of VoLL, extended by one year in each annual review. • Introduce risk arrangements such that if spot price in the preceding week (336 trading intervals) exceed cumulative price threshold (CPT) of $300,000, reduce VoLL to administered price cap set at $300/MWh in peak periods and $50/MWh in off-peak periods.

Year	Work	Title	Outcome
2000	**Code change** ACCC	*VoLL, Capacity Mechanisms and Price Floor*	Code amendments: • Increase VoLL to $10,000/MWh from April 2002. • Introduce risk arrangements such that if spot price in the preceding week (336 trading intervals) exceed cumulative price threshold (CPT) of $150,000, reduce VoLL to administered price cap set at $150/MWh in peak periods and $50/MWh in off-peak periods. • Remove the zero price floor and introduce a negative price floor set at -$1,000/MWh.
2001	-	-	-
2002	**Review** NECA Reliability Panel	*Review of VoLL 2002*	No change recommended.
2003	**Review** NECA Reliability Panel	*Review of VoLL and cumulative price threshold 2003*	No change recommended.
2004	-	-	-
2005	**Review** NECA Reliability Panel	*Review of VoLL and cumulative price threshold 2005*	No change recommended.
2006	**Review** AEMC Reliability Panel	*VoLL 2006 Review*	No change recommended (comprehensive reliability review in progress).
2007	**Review** AEMC Reliability Panel	*VoLL 2007 Review*	No change recommended (comprehensive reliability review in progress).

Year	Work	Title	Outcome
	Review AEMC Reliability Panel	*Comprehensive reliability review*	Recommendations: • Increase in VoLL from $10,000/MWh to $12,500/MWh, effective from 1 July 2010. • Define CPT in rules as 15 times VoLL. • Term "Value of Lost Load (VoLL)" be changed to "Market Price Limit (MPL)". • Current annual review of VoLL be replaced with a reliability standards and settings review to take place every two years, with two years' notice of any change.
2008	**Review** AEMC Reliability Panel	*VoLL 2008 Review*	No change recommended (comprehensive reliability review recently completed).
2009	**Review** AEMC Reliability Panel	VoLL 2009 Review	No change recommended (comprehensive reliability review rule change in progress).
	Rule change AEMC	*NEM Reliability Settings: VoLL, CPT and Future Reliability Review*	NER amendments: • Increase in VoLL from $10,000/MWh to $12,500/MWh, effective from 1 July 2010. • Set CPT at an absolute level of $187,500. • Term "Value of Lost Load (VoLL)" be changed to "Market Price cap (MPC)". • Current annual review of VoLL be replaced with a reliability standards and settings review to take place every two years, with two years' notice of any change.

Year	Work	Title	Outcome
2010	**Review** AEMC Reliability Panel	*Review of the Reliability Standards and Settings*	Recommendations: • No change to reliability standard. • No change to market floor price. • Adjust MPC and the CPT in line with changes in the Producer Price Index (Stage 2 PPI) on an annual basis with effect from 1 July 2012. • Panel to conduct annual review to determine whether PPI remains appropriate, whether higher increases in the MPC or CPT are necessary, and whether reliability standard remains appropriate (intended to replace Panel's biennial review process).
2011	**Rule change** AEMC	*Reliability Settings from 1 July 2012*	NER amendments: • Adjust MPC and the CPT in line with changes in the Consumer Price Index (CPI) on an annual basis with effect from 1 July 2012. • Panel to undertake a four-yearly comprehensive review of the reliability standard and reliability settings, including indexation (to replace Panel's biennial review process).
2012	-	-	-
2013	-	-	-
2014	**Review** AEMC Reliability Panel	*Review of the Reliability Standards and Settings*	In progress.

B Alternative approaches to setting wholesale electricity market price caps

To assist in direct comparability with the NEM, NERA's study into alternative approaches to setting wholesale electricity market price caps focused primarily on 'energy-only' markets.[48] Pure energy-only markets are fundamentally different from many other market designs in that they do not have predetermined reliability standards. Instead, they rely on customers to choose their desired level of reliability through the market mechanisms of interruptible rates and demand response. However, because these market mechanisms have not yet developed sufficiently to bring supply and demand into equilibrium and differentiate reliability across customers during shortage periods, real-world energy-only markets tend to rely on regulatory solutions for ensuring reliability. These solutions can include out-of-market incentives and administratively-determined scarcity pricing mechanisms.

The choice of regulatory mechanisms in place in each jurisdiction will impact the level of the market price cap in that jurisdiction. For this reason, a direct comparison of the market price cap levels is unlikely to be helpful without first understanding the characteristics of the electricity markets being considered. For example, in the PJM and MISO markets, the market price cap in the energy market (as distinct from the capacity market) does not need to be set at a level sufficient to encourage new generation investment because the costs of generation can be expected to be recovered directly through capacity market payments.

An overview of the electricity wholesale markets considered by NERA is provided in Table B.1 below.

48 NERA also included two markets - PJM and MISO - which include some form of capacity market in addition to a market for energy.

Table B.1 Overview of wholesale electricity markets considered by NERA[49]

Jurisdiction	Level of VCR	Methodology for estimating VCR	Market price cap	Market similarities to the NEM	Market differences to the NEM
New Zealand	NZ$20,000 (AU$17,690)	Survey in 2010 of approximately 14,000 electricity customers as well as smaller follow-up surveys in 2012.	No official market price cap (in most operating circumstances) Price range of between NZ$10,000 (AU$8,850) to NZ$20,000 (AU$17,690) when scarcity pricing arrangements are triggered	Energy-only market, rural/urban population split.	Higher population density, less variable temperatures, lower GDP per capita, lower peak demand, winter peaking.
ERCOT	NA	Neither the current market cap nor the proposed market cap increases are based on an analysis of customers' VCR or an analysis of the price cap needed to sustain investments.	Currently US$5,000 (AU$5,320) but increasing to US$9,000 (AU$9,570) over the next two years	Energy-only market, large land size, GDP per capita, summer peaking.	Higher population density, peak demand, rural population percentage and less variation in temperature.

49 Approximate Australian dollar conversions use exchange rates at 26 September 2013.

Jurisdiction	Level of VCR	Methodology for estimating VCR	Market price cap	Market similarities to the NEM	Market differences to the NEM
Singapore	S$5,000 (AU$4,240)	Singaporean GDP divided by total energy consumed.	Market price caps are defined as portions of the VCR Current energy price cap is S$4,500 (AU$3,810), ie, 0.9 of VCR	Energy-only market.	Much higher portion of commercial and industrial customers, less variable temperatures, higher population density, higher proportion of urban customers, higher GDP per capita.
Alberta	NA	There has been no explicit consideration of the value that customers place on reliable electricity supply in setting the current price cap.	US$1,000 (AU$1,060)	Energy-only market, increasing wind penetration.	Much higher portion of commercial and industrial customers, large degree of interconnectedness with neighbouring jurisdictions, low natural gas prices, large degree of Power Purchase Agreements set to expire by 2020 (5,000MW).
Great Britain	£16,940 (AU$28,880) for domestic and SME users £1,400 (AU$2,386) for industrial and commercial consumers	Used stated preference choice experiments (small and medium sized businesses) and value-at-risk approach and econometric techniques (commercial and industrial).	No price cap	Energy-only market – however, introducing a capacity market with the first capacity auction to be held in 2014, peak demand is falling.	Winter peaking, higher peak demand, higher total annual consumption.

Jurisdiction	Level of VCR	Methodology for estimating VCR	Market price cap	Market similarities to the NEM	Market differences to the NEM
MISO	US$3,500 (AU$3,720)	Used previously conducted studies conducted between 1989 and 2002, using MISO-specific values for the independent variables.	US$3,500 (AU$3,720)	GDP per capita, summer peaking, market price cap is set to VOLL.	Voluntary capacity market, higher population density, less variable temperatures, connected to another network (ie, PJM), higher peak demand, greater proportion of rural customers.
PJM	NA	Price caps in the energy markets are based on negotiations between entities from both the demand and supply side of the PJM, not VCR.	Historically been US$1,000 (AU$1060) but a price cap of US$2,700 (AU$2,870) is being phased in over four years Currently US$1,800 (AU$1,910)	Large area covered (largest centrally dispatched grid in North America), summer peaking.	Forward capacity market, generators face significant scrutiny with regard to their market offers, higher peak demand, high degree of demand response.
The Netherlands	NA	NA	€3,000 (day-ahead auction and strips market) €99,999.90 (intraday market)	-	Large amount of interconnectedness with neighbouring countries, binding forward market, large degree of vertical integration, winter peaking.

Source: NERA 2013, *Review of Alternative Approaches to setting Wholesale Electricity Market Price Caps, A Report for the AEMC,* October 2013.