Values of Customer Reliability

Consultation Paper

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AUSTRALIAN ENERGY REGULATOR

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Amendment Record

Version	Date	Pages

Contents

Shortened forms

Shortened form	Extended form
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMI	advanced metering infrastructure
capex	capital expenditure
CBD	central business district
CDF	customer damage function
COAG	Council of Australian Governments
the Committee	the VCR Consultative Committee
CM	choice modelling
CVS	contingent valuation surveys
CPI	consumer price index
CPT	cumulative price threshold
DAPR	distribution annual planning report
DCA	direct cost approach
DMIA	demand management innovation allowance
DMIS	demand management incentive scheme
DNSP	distribution network service provider
EPS	economic principle of substitution
FCAS	frequency control ancillary services
GNP	gross national product
HILP	high impact, low probability
JSSC	jurisdictional system security coordinator
kWh	kilowatt-hour
MFP	market floor price
MPC	market price cap
NEL	national electricity law

NEM	national electricity market
NEO	national electricity objective
NER	national electricity rules
NGR	national gas rules
NSP	network service provider
NSCAS	network support and control ancillary services
opex	operating expenditure
PPI	partial performance indicators
RERT	reliability and emergency reserve trader
RIT	regulatory investment tests
SAIDI	system average interruption duration index
SAIFI	system average interruption frequency index
Solar PV	solar photovoltaic
STPIS	service target performance incentive scheme
TAPR	transmission annual planning report
TNSP	transmission network service provider
USE	unserved electricity
UPS	uninterruptable power supply
VCR	values of customer reliability
VENCorp	Victorian Energy Networks Corporation
WTA	willingness to pay
WTP	willingness to accept

1 Executive Summary

The Australian Energy Regulator (AER) is the independent regulator for Australia's national energy markets. We are guided in our role by the national electricity, gas, and energy retail objectives set out in in the National Electricity Rules (NER) and the National Gas Rules (NGR). These objectives focus on promoting the long-term interests of consumers.

In response to a Rule Change proposal from the Council of Australian Governments (COAG) Energy Council, the Australian Energy Market Commission (AEMC) amended the NER to give the AER the responsibility of determining the values different customers place on having a reliable electricity supply.[1] This is referred to as the value of customer reliability (VCR). The VCR links efficiency and reliability, playing a pivotal role in network planning and investment and informs the design of market and network price caps and incentives, such as for network reliability.

The AEMC's Rule Change became effective on 5 July 2018.[2] Our first calculated VCRs must be published by 31 December 2019.

Under this Rule Change we must develop a methodology for estimating VCRs, which includes a mechanism for directly engaging with retail and other customers to determine these values and a mechanism for adjusting VCR on an annual basis. This methodology must be fit for purpose for any current or potential uses of customer reliability that we consider to be relevant. Our practice is to consult widely on our decisions to maximise stakeholder input on matters which may affect the costs customers face for the services they receive.

VCRs seek to reflect the value different types of customers place on reliable electricity supply under different conditions and are usually expressed in dollars per kilowatt hour (kWh). VCR is a critical input into identifying efficient levels of network expenditure.

Electricity outages incur costs for consumers, both directly through financial losses resulting from lost productivity and business revenues, and in the form of intangible/indirect costs such as a reduction in the convenience, comfort, safety and amenity provided by electricity. Household and business consumers desire a reliable electricity supply that minimises outages and these associated costs.

However, a reliable electricity supply requires investment in transmission and distribution network assets, which is paid for by electricity consumers. There is, therefore, a trade-off to be made between electricity reliability and affordability. This is because in order to achieve a higher level of reliability, a higher amount of investment is required. In turn, the costs imposed on the consumer through their electricity bills will be higher.

1 AEMC, *Rule Determination – National Electricity Amendment (Establishing values of customer reliability) Rule 2018*, 5 July 2018.

2 NER, Rule 8.12.

It is therefore important that the right balance be struck between the level of electricity supply reliability and consequent investment costs to consumers, as these costs form a significant portion of consumer bills.[3]

Determining the value customers place on having a reliable electricity supply in different parts of the network will assist electricity planners, asset owners, and regulators in striking this balance, providing customers with a more reliable electricity supply where desired and avoiding an overbuild of network assets in places where network is not required. In particular,

VCRs are widely used in the NEM:

- as an input in most regulatory investment test assessments
- in regulatory resets as a key factor in assessing network's major capital projects and overall capital forecast as part of revenue proposals
- in the distribution service target performance incentive schemes (STPIS) as the key measure for linking outcome performance with the STPIS incentive
- in the setting of transmission and distribution reliability standards and targets
- in reviews to quantify the value of unserved energy
- to inform whole market settings such as market price caps.

We envisage our review of VCR will predominately focus on the services outlined above as distinct from the security of supply, which is mainly concerned with ensuring the adequacy of generation sources.

Because individual customers cannot directly specify the value they place on reliability, VCR is difficult to observe, and is typically estimated by survey techniques. VCR is not a single number but rather a collection of numerous values which apply to customers segmented by jurisdiction, region in a jurisdiction and customer type. The primary customer segments in previous surveys have been residential, commercial, industrial and directly connected customers.

Prior to the AEMC's Rule Change there was no single body formally responsible for determining VCRs and updating VCR estimates on a regular basis. Over the past 15 years VCRs have been estimated by a range of regulators, planning bodies, network businesses and academics. These studies have primarily focused on deriving VCRs for particular NEM regions and there has only been one NEM-wide review of VCRs, which was carried out by the AEMO in 2014.

Establishing the AER as responsible for the on-going review and updating of VCRs for each regulated network will result in nationally consistent VCRs and would allow improvements to methodology from experiences gained,[4] particularly those from the previous NEM-wide examination of VCRs by AEMO in 2014.

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3 For example, network costs account for roughly 45 per cent of a typical residential electricity bill, see AER, State of the Energy Market May 2017, p.129.

4 AEMC, *Rule Determination – National Electricity Amendment (Establishing values of customer reliability) Rule 2018*, 5 July

We propose to borrow from AEMO's approach, build upon it and adapt it to meet the current challenges and transformation of the energy sector recognising, for example, the greater deployment of distributed energy resources. Undertaking a review now will also allow consideration for changes in the energy market since 2014, including analysis as to whether events such as South Australian-wide outage in September 2016 has impacted the value customers now place on reliable supply. It will also allow the AER to account for other changes in the market since 2014, including the increase take up of solar PV by householders and small businesses and the impact that this might have on th3e value that these customers have on a reliable supply of electricity.

This Consultation Paper is the first step in our development of the methodology for calculating VCRs. We are seeking stakeholder views on a number of matters including VCR methodologies and how VCR is currently used and should be used in the future. Stakeholders are invited to submit written responses on the issues and questions identified in this Consultation Paper by **16 November 2018**.

2018, p 1.

2 Stakeholder consultation process

Our proposed timeline for the guidelines review is set out below in table 1. At this stage the timeline is indicative only and has been developed to accommodate our preliminary views on new process steps and the estimated time requirements of including those steps.

Table 1 Indicative timeline for the VCR review process

Date	Milestone
October 2018	Consultation Paper published
October 2018	VCR Consultative Committee established
November 2018	Submissions due on Consultation Paper
February 2019	Conduct pilot survey
March 2019	Draft Directions Paper on methodology and approach published
April 2019	Submissions due on Directions Paper
May 2019	Publish final Directions Paper
May 2019	Conduct main survey
June - August 2019	Measure VCRs in accordance with the methodology and approach
August 2019	Publish Draft Report
September 2019	Submissions due on Draft Report
End December 2019	Final calculated VCRs published (Final Report)

2.1 How to make a submission

Interested parties are invited to make submissions on this consultation paper by **16 November 2018**. In providing responses, please explain your reasons, including supporting evidence and data where possible.

Signposting of issues relevant to particular audiences

In each section, we have set out some preliminary views, issues and questions for consideration, with a summary of questions contained in Appendix B - summary of issues/questions. This may guide your submission, however we encourage you to address any other matters of relevance.

You do not need to comment on all issues in your feedback. VCR are relevant to a wide range of audiences, including customers, network businesses, regulators and market bodies. We have signposted questions to assist interested parties in responding to this Consultation Paper. We invite you to respond to the questions that are relevant to you and your circumstances.

We prefer that all submissions are in Microsoft Word or another text readable document format. Submissions on our issues paper should be sent to: AERInquiry@aer.gov.au.

Alternatively, submissions can be sent to:

Mark Feather
General Manager
Policy and Performance
Australian Energy Regulator
GPO Box 520
Melbourne Vic 3001

We prefer that all submissions be publicly available to facilitate an informed and transparent consultative process. Submissions will be treated as public documents unless otherwise requested. Parties wishing to submit confidential information should:

- clearly identify the information that is the subject of the confidentiality claim
- provide a non-confidential version of the submission in a form suitable for publication.

All non-confidential submissions will be placed on our website. For further information regarding our use and disclosure of information provided to us, see the ACCC/AER Information Policy (October 2008), which is available on our website.

In addition to seeking submissions on this consultation paper, we are establishing a Values of Customer Reliability Consultative Committee (the Committee). The Committee will be a group of persons who represent organisations with a particular interest in VCRs or who have relevant expertise in how VCRs should be determined and with whom the AER considers it should consult before making a decision. While the Committee does not have a decision-making role, the AER will consider the views of the group when making a decision.

3 Background

In response to a Rule Change proposal from the Council of Australian Governments (COAG) Energy Council (Rule Change), the AEMC amended the NER to give the AER the responsibility of conducting reviews to determine the values different customers place on having a reliable electricity supply (VCR). Our initial review, including VCR values, must be completed by 31 December 2019, with the Rule Change requiring the AER to undertake subsequent VCR reviews at least every five years.

Under this Rule Change we must develop a methodology for estimating VCRs, which includes a mechanism for directly engaging with retail and other customers to determine initial values and a mechanism for adjusting VCR on an annual basis. This methodology must be fit for purpose for any current or potential uses of customer reliability that we consider to be relevant. We have published this Consultation Paper to canvas stakeholder's views on these and other matters relating to VCR.

This section of the Consultation discusses what VCRs are and how they can be measured, as well as the purpose and structure of this Consultation Paper.

3.1 Purpose of this Consultation Paper

This Consultation Paper is designed to canvass stakeholder views on a number of matters, including:

- the methodology for estimating VCR
- the level of granularity for VCR estimates
- the accuracy of the estimates of VCR
- the current and future roles VCR should have in network planning, regulation and pricing
- how to adjust VCR on an annual basis
- the frequency by which VCR is updated.

3.2 What are VCRs?

VCRs seek to reflect the value different customers place on a reliable electricity supply by placing a dollar figure on the electricity that goes unserved in the event of an outage. VCRs are commonly expressed in dollars per kilowatt hour of unserved energy (USE) ($/ kWh). By using VCR to estimate the costs of outages, a cost-benefit analysis can be performed to assess whether proposed steps to prevent outages (such as increasing network capacity) make economic sense, such as where the VCR is greater than the cost of preventing outage through network investment. At a high-level, this is done by multiplying the applicable VCR by the energy at risk of being unserved in the event of outage or outages and comparing this with the cost of network investment to prevent the outage. If this value is less than the cost of the proposed step to prevent the outage, then the network investment should not go ahead.

There is no single VCR, rather for every customer their individual VCR may vary with circumstances of the outage:

- the duration of the outage (for instance, fifteen minutes, one hour, one day, one week)
- the timing of the outage (for instance, during the middle of a weekday, early in the morning on the weekend)
- the extent of the outage (for instance, localised to a block, a suburb, or the entire state)
- the season the outage occurs in (for instance, summer or winter)
- the frequency of the outage (for instance, one prolonged outage, or a series of short outages).

The VCR will also vary with the class of customer unable to receive (or transact/serve)[5] electricity due to the outage.

For example, a short outage in the middle of a workday may cause negligible inconvenience for a residential customer that is away from home working in an office, but the same outage could result in large costs to a business through reduced productivity and loss of revenue due to a halt in production to reconfigure and restart equipment. On the other hand, an outage during a hot summer evening may cause considerable inconvenience to a residential customer wanting to use their air conditioning once they have arrived home, but negligible costs to the same business, as it does not operate during the evening.

VCR may also vary with remoteness of the customer and the prevailing climate conditions.

VCR will likely also vary over time due to technological change. For example, as internet bandwidth increases allowing flexible working arrangements such as working from home to become more widespread, the VCR associated with certain outages for residential customers may increase. On the other hand, many customers may not feel as inconvenienced if they have on hand a charged phone or laptop and have access to high-bandwidth internet over a mobile phone network, a scenario that is likely to become increasingly common over time.

Technological advancements will also require a broadening of what VCR and unserved energy represents. For the growing number of customers who become 'prosumers' through feeding excess solar PV generation or discharging batteries into the grid, a network outage also means a lost opportunity to transact in the NEM. This may either directly impact individual prosumers, or the entities that enter commercial relationships with households and businesses to establish 'virtual power plants', aggregated fleets of individual distributed solar PV and battery resources.

A possible downward driver on VCR would be storage solutions such as battery, solar/battery and other Uninterruptable Power Supply (UPS) solutions as these further decrease in cost and are taken up by a greater number of customers. These technologies could provide a backup in the event of outages for grid-connected customers. From a network planning perspective, the potential VCR for such customers may be close to zero where the outage does not that exceed their storage capacity. It is important to note that the

5 For example PV and/or batteries cannot export to the grid during an outage, resulting in lost revenue for customers that own these assets, or businesses that manage these assets (such as DER aggregators).

configuration of storage is a critical factor in these cases. If a storage system only operates while the grid is connected, there is no improvement in USE for the customer if an outage occurs.

3.3 Measuring VCR

In reality, due to their unique circumstances, each individual customer will have a different VCR associated with different outages. Because it is impractical to ask each customer their VCR for every conceivable outage permutation, VCR is typically estimated by conducting surveys on a representative sample of customers, with "willingness to pay" consumer survey techniques being the most common approach.

The first comprehensive NEM-wide study of NEM VCRs was conducted by the Australian Energy Market Operator (AEMO) throughout 2013 and 2014, which determined a collection of VCR values segmented by jurisdiction, customer class, and outage event.

The AER VCR review will have regard to the review conducted by AEMO. In its issues paper,[6] directions paper,[7] statement of approach[8] and draft application guide,[9] AEMO explored a variety of issues and consulted with a broad range of stakeholders on the methodology for measuring VCR, granularity of VCR, calculation of VCR and potential uses of VCR. Through our process outlined in this paper, we will consult with a wide range of stakeholders, and we will consider their views in the context of the perspectives drawn through AEMO's previous consultation processes undertaken during its review.

The AER VCR review will build upon AEMO's work, and will look for opportunities to benefit from lessons learned in measuring VCR. Our review will also benefit from AEMO's work at several stages of our review process; the learnings from AEMO's approach and AEMO's VCR figures will likely be useful in establishing/informing survey design development, provide a point of reference when considering sample size and distribution, and will serve as an important comparison when evaluating our final calculated VCR figures.

3.4 Structure of this Consultation Paper

This Consultation Paper is structured as follows:

- Section 4 considers the current and potential future roles and scope of VCR
- Section 5 considers potential methodologies for measuring VCR
- Appendices containing the Rule Change, Summary of questions and a simple example of calculating a representative VCR at a particular location.

6 AEMO, *Value of Customer Reliability Issues Paper*, 11 March 2013.
7 AEMO, *Value of Customer Reliability Directions Paper*, 31 May 2013.
8 AEMO, *Value of Customer Reliability Statement of Approach*, 11 November 2013.
9 AEMO, *Value of Customer Reliability Application Guide: Draft Report for Consultation*, October 2014.

4 The current and potential additional roles of VCRs

As part of the AEMC rule determination, the VCR methodology we develop must be fit for purpose for any current or potential uses of customer reliability that we consider to be relevant. This section sets out the various contexts in which VCR is currently used and also considers potential additional uses for VCR in the future. It also asks stakeholders what additional roles VCR might serve in the future.

4.1 Current application to regulation within the NEM

4.1.1 Assessing Forecast Expenditure using probabilistic planning

The AER regulatory network determination process includes an assessment of forecast expenditure, including investments in capital expenditure projects relating to network augmentation and replacement of assets. The AER applies several assessment techniques, including cost-benefit analysis and undertaking detailed project reviews in assessing forecast expenditure.

Network Service Providers (NSPs) can take into account probabilistic planning when considering their forecasts for demand-driven augmentation or for replacement projects.[10] At its heart, probabilistic planning involves assessment of the costs and benefits of a range of options. The assessment of risk in terms of probabilities and consequences is also a key feature of probabilistic planning, and aims to strike an economic balance between:

- the cost of providing additional or replacement network capacity to minimise or remove constraints and prevent loss of supply; and
- the cost of having some exposure to loading levels beyond the network's capability.

VCR is a key input in probabilistic planning as it is used to estimate the cost of expected lost load as a consequence of loading levels exceeding the network's capability. If the cost of expected lost load is less than the annualised cost of the augmentation measure, the NSP should choose to bear the risk that energy will be unserved, rather than passing on the risk of an inefficient investment to the consumers that would ultimately pay for this network investment. For example, if extreme loading conditions only occur once in a decade and only for a few hours, it could be uneconomic for NSPs to invest in additional capacity to avoid an outage due to such extreme loading conditions. When compared to the use of deterministic standards, a probabilistic planning approach will typically result in a more efficient use of existing assets, more efficient use of alternative options, and better timing for new network infrastructure.

4.1.2 Regulatory Investment Tests

10 Victorian Network Service Providers are required to use probabilistic planning, whereas other NSPs are currently subject to deterministic standards.

Regulatory Investment Tests (RITs) are cost-benefit analyses that network businesses must perform and consult on before making major investments in their networks.

When undertaking RITs, network businesses must undertake a cost-benefit assessment for all network and non-network options that are reasonably possible to identify the option which best addresses the investment need of the network, which the NER calls the 'preferred option'. The preferred option is the credible investment option which maximises the present value of the net economic benefit to all those who produce, consume and transport electricity in the relevant market.[11]

In network planning, the VCR is used to assess the economic merits of carrying out additional investment in the electricity network. Therefore, the application of the RITs requires that RIT proponents use a reasonable measure of the VCR in calculating the market benefits associated with an investment option, particularly where the TNSP seeks to justify a proposed investment on reliability grounds.

4.1.3 Service Target Performance Incentive Schemes

The AER develops, administers and maintains the Distribution Service Target Performance Incentive Scheme (STPIS) in accordance with the requirements of the NER.

The primary purpose of the STPIS is to provide incentives to Distribution Network Service Providers (DNSPs) to maintain the existing level of supply reliability, and to improve the reliability of supply where customers are willing to pay for these improvements.

The financial incentives are calculated by applying incentive rates to particular supply performance parameters, such as the duration and frequency of unplanned outages, to the difference between the DNSP's achieved performance and the associated performance target.

VCR is used to calculate the value of the total energy left unserved by DNSPs as a result of outages, to which the performance incentive rates under the STPIS are set.

The main reliability measures under the STPIS are the frequency and duration of unplanned outages. Because, currently, there are no definitive VCR values that take into account different frequencies of interruptions, the STPIS scheme links the incentive rate for frequency of interruptions to the average historical duration of supply outages. We consider that we could use this review to investigate the value customers' place on the frequency of interruptions in addition to the duration of interruptions.

4.1.4 Demand management incentives and innovation funding

The AER has started administering a new Demand Management Incentive Scheme (DMIS).[12] Under the new DMIS, DNSPs can propose efficient non-network options relating

11 For proposed distribution investments the relevant market is the NEM, and for proposed transmission investments the relevant market is as defined in chapter 10 of the NER as 'any of the markets or exchanges described in the Rules, for so long as the market or exchange is conducted by AEMO'.

12 The new DMIS came into effect in December 2017, and applies to DNSPs from the regulatory period following this date, or

to demand management. An 'efficient non-network option' is a non-network option that is a credible option to meet an identified need on the distribution network, which is preferable to undertaking a more costly network investment or augmentation.[13] To demonstrate this, a DNSP must either complete a RIT (discussed in section 4.1.1) or meet the DMIS 'minimum project evaluation requirements'.[14]

The DMIS minimum project evaluation requirements include providing technical information about the identified need, including the load at risk, energy at risk, duration and load curves, the annual probability and frequency of relevant events, and the expected value of energy at risk.[15] The expected value of energy at risk must be based, as a minimum, on the average volume of energy at risk, the weighted probability of the energy at risk event occurring, and the relevant value of customer reliability (VCR) for a given regulatory year.[16]

The AER also provides a Demand Management Innovation Allowance (DMIA), which may also draw upon VCR estimates.[17] The DMIA applies to research and development in demand management projects that have the potential to reduce long term network costs. Under the new DMIA, DNSPs will publish project specific reports.[18] These reports might consider VCR estimates when reporting on and evaluating project results, including when describing how the results could inform future demand management projects.

4.1.5 Economic Benchmarking

The AER produces annual benchmarking reports that examine the relative efficiency of the distribution and transmission network service providers, consistent with its obligations under the NER. The benchmarking reports consider the characteristics of each network business, and how their productivity compares at the aggregate level and for the outputs they deliver to consumers.

One of the characteristics assessed in benchmarking Distribution Network Service Providers (DNSPs) is reliability performance, expressed as minutes off supply. VCR values are used to calculate the economic cost to consumers from minutes off supply. This allows the AER to determine how much weight to apply to each DNSP's reliability performance compared to the other benchmarking measures, such as energy supplied or network line length.

4.1.6 Transmission and Distribution Annual Planning Reports

earlier if they apply for early application under National Electricity Amendment (Implementation of demand management incentive scheme) Rule 2018 No. 3.

13 AER, *Demand Management Incentive Scheme*, December 2017, 2.2 (2).

14 AER, *Demand Management Incentive Scheme*, December 2017, 2.2 (3).

15 AER, *Demand Management Incentive Scheme*, December 2017, 2.2.1 (4) (b).

16 AER, *Demand Management Incentive Scheme*, December 2017, 2.2 (4) (b).

17 A new DMIA came into effect in December 2017 and applies to DNSPs from the regulatory period following this date. A similar DMIA currently applies to DNSPs under an older version of the NER, but this DMIS does not require DNSPs to publish project specific reports.

18 See AER, *Demand management innovation allowance mechanism*, December 2017, section 2.3(3)(d).

As part of an AEMC rule determination, the AER is developing a Transmission Annual Planning Report (TAPR) guideline,[19] which will provide generators and large transmission customers with useable and consistent information they need to make informed connection decisions. Similarly, consistent with its obligations under the NER,[20] the AER has also published a Distribution Annual Planning Report (DAPR) template, which will improve the consistency and useability of DAPRs across the National Electricity Market and will improve the ability for non-network providers to identify and propose solutions to addressed identified network needs.

Both the TAPR guidelines and DAPR template consider the costs of proposed network investment and the likely costs of deferring the investment decisions due to the load at risk and expected unserved energy.

The draft TAPR guideline proposes that TNSPs publish, for each connection point and transmission line segment, both an appropriate VCR and a resulting annual deferral value.[21] Similarly, the final DAPR template requires DNSPs to publish for each limitation in its network, an annual deferral value metric based on an appropriate VCR.[22]

4.1.7 Using VCR to inform wholesale market settings

In accordance with the NER, the Reliability Panel every four years sets the reliability standard and settings for generation and bulk transmission. The reliability standard expresses the level of reliability sought from the NEM's generation and transmission inter-connect assets (currently unserved energy being 0.002 per cent of total energy demanded per financial year).[23] The reliability settings relate to a market price cap (MPC) and cumulative price threshold (CPT) as well as the market floor price (MFP). These mechanisms protect the long-term integrity of the market through limiting the maximum price volatility and thereby limiting market participants' exposure to prices that could threaten the financial viability of a prudent market participant. These settings are set in such a way to allow sufficient investment to achieve the reliability standard.

Under the current Review of Reliability Standard and Settings Guidelines, the Reliability Panel must consider whether there have been any changes to AEMO's[24] VCR measure in determining whether to reassess the reliability standard.[25] Additionally, in conducting its review of the reliability standards and settings, the NER requires the Reliability Panel to have regard to any value of VCR determined by the AER that the Reliability Panel considers to be relevant.[26]

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19 NER cl. 5.14B.1.

20 NER cl. 5.13.3.

21 AER, *Explanatory Statement: Draft transmission annual planning report guidelines*, pp. 16-17

22 AER, *Final Decision: Distribution Annual Planning Report Template*, June 2017, 7-13.

23 Reliability Panel, *Final Report*: *Reliability standard and settings review 2018*, 30 April 2018, p. iv.

24 The guidelines, last updated in 2016, refer to VCR measures which were previously determined by AEMO before the Rule Change amended the NER to give the AER the responsibility of determining VCR.

25 Reliability Panel, *Review of Reliability Standard and Settings Guidelines*, 2016 p.5.

26 NER cl. 3.9.3A(e).

Currently the VCR acts as a cross-check on the reliability standard and settings, rather than linking the MPC to the VCR of the class of customers likely to undergo load-shedding in the event of generation supply inadequacy.

Question 1: How might the wholesale market price cap be informed by VCR?

Question 2: What customers and outage scenarios should be considered when deriving applicable VCR values to inform the wholesale market price cap?

4.2 Potential additional uses of VCR

This section sets out potential additional contexts for which VCR values could be used. To better inform the methodology used to derive VCR, it is important to consider the potential future uses of VCR.

4.2.1 Determining load-shedding priorities in each jurisdiction

In the event of a major supply shortfall in the NEM, AEMO must use involuntary load-shedding to restore system security. These load-shedding processes are set out in the NER and Reliability Panel guidelines, with the Jurisdictional System Security Coordinator (JSSC) in each jurisdiction advising AEMO on that jurisdiction's load-shedding priorities.

Load-shedding is carried out at the distribution feeder level, and JSSCs consider the customers on feeders when they allocate their use in load-shedding, particularly whether a feeder has a customer providing an essential service (for example, a hospital). VCRs could be used by jurisdictional regulators or governments to inform load-shedding priorities for services other than essential services.

Question 3: Should VCR inform load-shedding priorities for services other than essential services, and if so, how?

Question 4: What customers and outage scenarios should be considered when deriving the VCR values considered when establishing load-shedding priorities?

4.2.2 Determining the approximate price limit on ancillary services

Ancillary services are used by AEMO to manage the power system safely, securely, and reliably. These services maintain key technical characteristics of the system, including standards for frequency, voltage and network loading.

Network Support and Control Ancillary Services (NSCAS) and Frequency Control Ancillary Services (FCAS) are ancillary services to maintain power system security and reliability. NSCAS and FCAS ensure electricity is transmitted within strict tolerances for voltage and frequency respectively, required by certain infrastructure to be operated safely and without sustaining damage.

The NER places primary responsibility on TNSPs to procure NSCAS, with AEMO being required to acquire NSCAS, only to ensure power system security and reliability of supply, if

a shortfall remains after TNSPs' attempt to procure. There are eight regional FCAS services markets that participants can register for in order to offer bids to raise or lower the frequency of electricity supply.

VCR values reflecting the likely length and severity of outages associated with deviations from strict voltage and frequency tolerances could inform a price cap for NSCAS and FCAS by estimating the expected cost to the market that would be incurred.

Question 5: Should VCR inform a price cap for ancillary services such as NSCAS and FCAS, and if so, how?

Question 6: What customers and outage scenarios should be considered when deriving applicable VCR values?

4.2.3 Informing Reliability and Emergency Reserve Trader (RERT) procurement

The RERT is an intervention mechanism in which allows AEMO to contract for reserve generation or demand-side capacity that is not otherwise being traded in the NEM. Under the NER, AEMO can use the RERT in the event that it projects that the market is not meeting the reliability standard (i.e. when AEMO projects that unserved energy is expected to be greater than 0.002 per cent of the total energy demanded per financial year) and, where practicable, to maintain power system security.[27]

AEMO must have regard to the RERT principles when procuring reserves under the RERT. One of these principles is that actions taken should aim to maximise the effectiveness of reserve contracts at the least cost to end use consumers of electricity.[28]

VCR values reflecting the likely length and severity associated with forecasted deviations from the reliability standard could inform a price cap for these services by estimating the expected cost to the market incurred in the event of the shortfall occurring.

Question 7: Should VCR inform a price cap for RERT, if so, how?

Question 8: What customers and outage scenarios should be considered when deriving applicable VCR values?

4.2.4 Assessing special protection schemes to address high impact low probability (HILP) events

The NER requires TNSPs to consider whether HILP events, such as a 'once in 50 years' weather event, could potentially endanger power system stability. TNSPs develop special protection schemes to manage the impact of HILP events. These schemes weigh up the costs of the scheme against the potential cost to customers were a HILP event to occur.[29]

27 NER, cl. 3.20.3(b).
28 NER, cl. 3.20.2(b).
29 NER, cl. 5.20A. 1(a)(1).

VCR values reflecting the likely length and severity associated with HILP events could better inform this cost-benefit analysis by estimating the likely costs incurred for consumers were a HILP event to occur without a proposed protection scheme in place.[30]

Question 9: Should the AER determine a VCR for prolonged and extensive outages envisaged by System Black and HILP events?

4.2.5 Assisting Network Businesses in scheduling planned outages

Networks require maintenance work to ensure they are safe and reliable. Because it is dangerous to work with live power, network businesses conduct planned outages in order to carry out the necessary maintenance to their network infrastructure.

VCR values could potentially assist network businesses in scheduling their upcoming planned outages for maintenance work. Network business could estimate the different costs incurred by affected customers under different planned outage scenarios, which could be considered against other factors such as operational costs in deciding when to carry out network maintenance.

This use for VCR may require deriving VCRs for planned outages. This is because it is likely that customers, when given advance notice of planned distribution network outages that will result in a loss of supply, can make allowances and would be less inconvenienced in comparison to unplanned outages of equivalent duration and timing.

However, as discussed in section 5.3, it may be necessary to limit the amount of outage scenarios, and prioritise the most relevant outage scenarios (being unplanned outages), when engaging with customers in surveys or through other forms of customer engagement.

Question 10: Should VCR be used to inform scheduled planned outages, and if so, how?

Question 11: Should the AER determine additional VCRs for planned outages?

4.2.6 Apportioning recovery of investment costs

Previous VCR estimations have found that different classes of consumer have significantly different VCRs. Some classes of consumer, such as businesses, place a higher value on unserved electricity than other classes, such as residential customers. However, the VCR values that are considered in regulatory tests, and therefore the constraint on the maximum permissible cost of the proposed investment, will likely be load weighted values that reflect the makeup of the affected customers. Network service providers recover the costs of the investment through network tariffs over the life of the assets.

The variation in the VCR values for different customer classes could inform how the costs of these investments are recovered in network tariffs, with customer classes that place a higher

30 For example, see AEMO, *Draft Power System Frequency Risk Review Report: Non-Credible Loss of Multiple Generating Units in South Australia*, July 2017, pp. 16-17.

value on reliability of electricity supply paying a greater proportion of the costs than classes with a lower VCR. However, any apportionment of costs should also consider that the customer classes with lower VCRs are still receiving benefits from a more reliable supply as a result of the proposed network investment being completed.

Question 12: Should VCR values for different customer types also inform the allocation of distribution and transmission shared costs among customers, and if so, how?

Question 13: Are there any other regulatory investment assessments and/or NEM planning contexts that could be informed by the application of VCR values?

Question 14: If so, what customer and outage scenarios should be considered when deriving applicable VCR values?

Question 15: For what purposes do you currently use VCR? Is the current level of VCR segmentation by customer type and outage scenarios in AEMO's 2014 review fit for your purposes?

Question 16: For what future purposes could you use VCR? What level of VCR segmentation would you require?

5 Methodologies for deriving VCRs

5.1 Approaches to deriving VCR

VCRs can be estimated either by surveying customers or estimated by applying model based approaches. The Rule Determination requires the AER to develop a methodology for calculating VCR that must include a mechanism for directly engaging with retail customers to determine VCRs, and customers other than retailers, which may include the use of surveys.[31] As there are several recognised surveying approaches, multiple approaches could be used with their findings compared against each other as validation check.

AEMO in its 2014 review conducted a survey that contained a mix of approaches. Residential and business customers were surveyed using a combination of Choice Modelling and Contingent Valuation approaches, whereas direct connected customers were surveyed using a Direct Cost approach.

Each approach has advantages and disadvantages which are discussed below.

5.1.1 Direct Cost Approach Survey

A Direct Cost Approach (DCA) surveys customers on the direct costs they expect to face due to an interruption. Direct costs could include lost production or sales and repair or restart costs for businesses and/or food spoilage for residential customers. Under a DCA one element we may wish to consider is the role and impact of demand management contracts on the VCR.

DCA focuses on financial costs and does not measure intangible costs such as discomfort, inconvenience or loss of amenity. This makes direct cost easier to quantify, but means not all costs are necessarily captured. We expect that businesses are likely to be better informed about expected financial costs than residential customers, and for financial costs to be the key driver for businesses. As such DCA may be better suited to business and industrial customers, and may be less appropriate for residential customers. This was recognised in AEMO's 2014 VCR review, which applied a direct cost approach when surveying directly connected industrial customers.

5.1.2 Economic Principle of Substitution

Economic Principles of Substitution (EPS) involves surveying customers on the financial costs they would incur to substitute their usual energy consuming activities in response to an interruption. This is likely to take the form of asking customers to choose between several options with known costs that are potential substitutes for the energy consuming activity. The choices made indicate how much cost customers would be willing to incur to mitigate a particular impact of an outage. This approach was adopted by AEMO (then VENCorp) in its 1997, 2002 and 2007 Victorian VCR studies when surveying residential customers.[32]

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31 National Electricity Amendment (Establishing values of customer reliability) Rule 2018 No. 8, NER, Part I 8.12(d)(1).

32 CRA International, *Assessment of the Value of Customer Reliability (VCR), Final report prepared for VENCorp*, 12 August

For example, a surveyed residential customer:

- unable to cook dinner due to a one hour interruption indicates they would spend $50 ordering takeaway meals from a restaurant
- unable to use air conditioning to cool their house in summer indicates they would incur $10 in travel costs to visit a shopping centre to escape the heat.

This approach goes some way to capturing indirect costs such as loss of comfort.

Developing an EPS survey is challenging as it requires developing the range of potential impacts, a range of mitigation options for each potential impact and a cost estimate for each option. The range of potential impacts and the range of options for mitigating impacts are both likely to be quite broad. Options that are low cost and high cost and provide varying degrees mitigation are needed in order to allow surveyed customers to select options from within a potentially wide range of customer values for any given option.

A disadvantage to EPS is that cost of the substitute purchase may over or under estimate the VCR if any benefits or costs provided by the substitute not present in the usual energy consuming activity are not accounted for. In the first example above, benefits could include:

- Avoiding time and effort spent preparing, cooking and afterwards cleaning provides additional convenience. For example, this may be a benefit of $10 to the customer, but could be lower for customers that enjoy cooking.
- Any ingredients originally intended to be cooked that do not spoil due to the outage can be used in a subsequent meal once power is resumed. For example, this may be a benefit of $15 to the customer.
- The takeaway meal may also taste better than the meal they were intending to cook, providing further benefit. For example, this may be a benefit of $10 to the customer, but would depend on the customer's culinary skills and what they were intending to cook.

In the above example, the total additional benefit of the takeaway meal is $35, resulting in a net cost of the substitute to the customer (and hence the customer's implied value of the one hour of unserved energy) of $15 ($50 cost minus $35 in benefits).

5.1.3 Contingent Valuation Surveys

Contingent Valuation Surveys (CVS) involve asking customers how much they would be willing to pay (WTP) to avoid an interruption or how much they would be willing to accept (WTA) as compensation for experiencing an interruption. The CVS approach asks customers to place a dollar value on their overall WTP or WTA, which includes intangible costs such as loss of comfort and convenience. As a result, it is far better suited to incorporating non-financial losses than DCA or EPS. AEMO in its 2014 VCR review used a combined CVS and choice modelling approach.

2008, p.1; AEMO, *Value of Customer Reliability Issues Paper*, 11 March 2013, pp.12-13.

However, the CVS approach can be challenging because it requires respondents to consider hypothetical scenarios and assign dollar values to electricity reliability, a product that is not directly purchased as a separately identified item on an electricity bill.

There is an observed divergence between surveyed WTA and WTP, even though under certain conditions these values for the same scenario would be expected to be similar. The academic literature discusses many reasons for this observed difference,[33] including:

- Loss aversion - the perceived utility loss associated with losing x is greater than the utility gain associated with gaining x.
- Strategic behaviour - where respondents act on an incentive to misreport their true values; for some people and situations this may affect WTP responses and WTA responses differently. For example, respondents may more readily, perhaps subconsciously, perceive WTP questions as the first step of a bargaining procedure and as a result tend to understate WTP relative to WTA. Some customer groups may be more accustomed to thinking of themselves as buyers of reliability; as a result they might be more likely to respond strategically to WTP questions than WTA questions.
- "Protest" responses - where a respondent responds with a zero WTP or extremely high WTA. For example, this may occur where respondents believe the service or product being surveyed should already be provided by government.

Considering these issues would affect the design and framing of any contingent valuation survey undertaken. WTP questions may be conceptually closer to the relevant value for use in assessing investment in network augmentation projects.

5.1.4 Choice Modelling

Choice Modelling (CM) requires respondents to identify their most preferable option out of a series of choices. For the purposes of estimating VCR, the choices presented to respondents could differ by variations in:

- the cost to the participant to avoid a particular outage
- the characteristics associated with the particular outage (duration, timing, extent, season).

CM implicitly accounts for trade-offs between different attributes and is more "efficient" in testing a larger set of scenarios than CVS. CM can test customer preferences for scenarios comprised of a number of outage characteristics by testing customers' preferences across a number of combinations of different outage characteristics in combination with different prices. The question below is an example of choice modelling from AEMO's 2014 VCR review:[34]

Figure 1: example of choice modelling

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33 For a discussion on this observed divergence, see Kim et al, *Understanding Behavioral Explanations of the WTP-WTA Divergence through a Neoclassical Lens: Implications for Environmental Policy*, Annual Review of Resource Economics Vol. 7:169-187 (Volume publication date October 2015).

34 AEMO, *Values of Customer Reliability Review: Appendix*, September 2014, p.23

Question 1 out of 8

Please choose your preferred power outage option from the following three: (help)

	☐ Option 1	☐ Option 2	☐ Option 3
Localised/widespread	Localised	Localised	Localised
Duration	One hour	One hour	One hour
Frequency	Twice a year	Three times a year	Once a year
Summer/winter	Winter	Summer	Summer
Peak*/off-peak	Off-peak	Peak*	Off-peak
Weekday/weekend	Weekday	Weekday	Weekend
Monthly bill decrease	No change	$15/month	$15/month

*7-10am and 3-6pm

Source: AEMO, Values of Customer Reliability Review: Appendix.

CM does not require respondents to undergo as much hypothetical and abstract reasoning as CVS, as it often considered that choosing between scenarios is less cognitively demanding than providing a dollar value. CM can also avoid asking potentially numerous questions relating to the multitude of permutations of outage scenarios, discussed in section 5.3. This is an advantage over CVS, which in order to estimate the value for different attributes requires designing different valuation scenarios for each level of each outage characteristic - a CV survey for each different combination of outage characteristics. Another advantage of CM is that it avoids strategic bias that can be present in CVS.

Some disadvantages of CM are it takes more effort in survey design and it generally needs a larger sample size (though with the benefit of allowing the estimation of VCRs for more combinations of outage characteristics).

5.1.5 Model-based approaches

VCR can be estimated under a model-based approach, such as estimating the opportunity cost of outages, or by considering the costs of making an alternative supply of electricity available during outages. These approaches could serve as useful crosschecks on VCR values derived from surveys or other forms of customer engagement.

Opportunity Cost of Outages

The opportunity cost of outages can be estimated by dividing Australia's gross national product by Australia's annual electricity consumption. For example, Australia's GNP in 2017-18 was $1.7 Trillion,[35] and electricity consumption was estimated to be approximately 217 TWh.[36] This implies that approximately $7.80 of GNP was produced per kWh, which could be considered a proxy for the opportunity cost of USE in Australia from which we can estimate a simple VCR baseline.

35 Australian Bureau of Statistics, *1345 - Key Economic Indicators*, 2018.

36 196.5TWh consumed across the NEM in 2016-17, https://www.aer.gov.au/wholesale-markets/wholesale-statistics/national-electricity-market-electricity-consumption, 18.8TWh consumption expected in WEM 17-18, https://www.aemo.com.au/-/media/Files/Electricity/WEM/Planning_and_Forecasting/ESOO/2017/2017-Electricity-Statement-of-Opportunities-for-the-WEM.pdf; 1.65TWh in Darwin-Katherine and 0.22TWh in Alice Springs consumption expected in 2016-17, Northern Territories Utilities Commission, *2015-16 Power System Review*, pp.26-27.

While this is a simple calculation to perform, it has many shortcomings as it does not take into account any intangible benefits of a reliable electricity supply, such as convenience, comfort and amenity, and does not provide information needed to model the costs of different kinds of outages. This value also provides no level of jurisdictional, regional, customer or sectoral granularity, significantly limiting the VCR applications to which it could be used. However, with segmented data for production and energy consumption, jurisdictional values could be determined.

Costs of substitutable products

VCR values could be considered with reference to the cost of substitutable products that deliver corresponding degrees of reliability. These products could include solar PV backed by battery,[37] standalone batteries, diesel generation and other UPS solutions, which either provide a backup in the event of the majority of outages for grid-connected customers, or allow customers to go completely "off-grid". For grid-connected customers, the VCR would be capped by the annualised net cost[38] for customers to invest in their own solutions that safeguard against the likely outage scenario(s), divided by the likely annual USE. This will be a lower estimated VCR than that inferred by the annualised net cost for a customer investing in a complete off-grid solution divided by the likely annual USE. However, all possible outage scenarios (including HILP events) can be considered against off-grid substitutions, whereas only outages of durations with associated USE below the capacity of a given grid-connected substitute can be assessed against the cost of that particular grid-connected solution.

When considering the substitutable product, it is unrealistic to assume that customers only looking to purchase one substitutable product will purchase the ideal substitute for a given outage scenario (that is, the actual product purchased would likely have excess capacity over the corresponding USE). Care must also be taken when calculating the value of avoiding the cost of drawing electricity from the grid, as only a certain portion of the overall electricity bill relates to the value of the electricity itself. The relevant annual volume weighted average spot prices[39] may be a suitable candidate.

The calculated annual cost would be highly dependent on the input assumptions such as likely USE and the upfront cost and life of the substitutable product.

Question 17: Do you think the methodology used by AEMO to derive (CVS and CM for residential and business, and DCA for direct connect customers) is still appropriate, taking into account current and potential uses of VCR discussed in chapter 4?

Question 18: If not, what other method or methods would be most appropriate to engage with customers and derive VCR values?

Question 19: Should different methods be used for different customer types?

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37 It is important to note that the configuration of storage is a critical factor in when considering substitutability. Storage systems that are configured to only operate while the grid is connected would not be suitable for this modelling approach.

38 The annualised net cost would take into account any benefit of the substitute system providing power to the consumer, avoiding the cost of drawing electricity from the grid.

39 See, AER, *Annual Volume Weighted Average Spot Prices*, https://www.aer.gov.au/wholesale-markets/wholesale-statistics/annual-volume-weighted-average-spot-prices.

Question 20: Should multiple methods, including model based approaches, be used to cross check derived VCR values?

5.2 VCR Customer Segments

As discussed in section 3.2, there is likely to be a large variation in VCR reflecting the range of circumstances of customers, how they use electricity and hence how they are impacted should an outage occur. VCR values may differ by:

- jurisdiction
- climate
- region (for example, CBD, urban, regional, remote)
- customer type (for example, residential, small business, large business)
- for residential customers, socio-economic status and dwelling characteristics (for example, access to gas, solar PV and/or batteries)
- for business/industrial customers, economic sector (that is, Primary, Secondary, Tertiary) and economic sub-sector (for example, agricultural vs mining, food manufacturing vs construction, health care vs hospitality).

Since AEMO's 2014 VCR review, there has been a significant increase in the number of 'prosumers', households and businesses feeding excess solar PV generation or discharging batteries into the grid. It may be necessary to specifically consider the VCR for these customers, for which a network outage also means a lost opportunity to transact in the NEM.

The desirable degree of customer segmentation depends on a variety of factors, discussed below.

The trade-off between segmentation, accuracy and respondents required

The ability to segment VCR values is potentially limited by the number of survey questions that would be required to segment responses. The number of questions that can be asked in a survey is constrained by survey fatigue, which if introduced results in higher rates of respondents abandoning surveys before completion.

The extent of segmentation is also potentially constrained by the number of survey respondents, and hence resources, required to discern statistically valid VCRs for each segmented category.

There is a trade-off to be made; an extensively segmented set of VCR figures may require tens of thousands of respondents to achieve desirable confidence levels and intervals for each VCR category, which may not be realistically achievable. It is worth noting that this would be a significantly larger respondent target than AEMO's approximately 3000 respondents achieved over a comparable timeframe.[40] The trade-off between accuracy and sample size is a significant issue. Generally speaking, halving the error in a random survey and thereby improving accuracy typically requires increasing the sample size by a factor of

[40] 1416 residential, 1499 business and 13 direct connect customers, AEMO, *VCR Final Report*, September 2014, pp.18, 24 and 29.

four. Large sample sizes imply higher accuracy but this comes at a cost in terms of both time and money.

It may be prudent to prioritise certain customer cohorts that stakeholders identify as most critical to the majority of envisaged VCR calculations. It may also be prudent to focus on certain segmented categories that stakeholders identify as meaningful, useful and appropriate given the current level and manner of segmentation of datasets held by or accessible to stakeholders.

The extent to which the variations in circumstances are actually drivers for VCR

For example, small hospitality businesses operating in the Adelaide CBD may have similar values of reliability as corresponding businesses in the Melbourne CBD. This may suggest that jurisdiction may not be a driver in variation in VCR for businesses. If this were the case, it is unlikely that it would be necessary to segment VCR by jurisdiction for small business customers.

As another example, NSW short rural residential customers may have similar values of reliability as NSW urban residential customers. This may suggest that region may not be a driver in variation in VCR for residential customers. If this were the case, it would be unlikely it would be necessary to segment VCR by region for residential customers.

It is possible to include in a pilot survey questions to identify respondents' circumstances (for example, asking postcode, access to gas, business type and function) and examine whether these characteristics are likely drivers of VCR.

The range of future contexts within which VCR will be applied

As discussed in section 4, there are many potential uses for VCR, which would likely warrant varying degrees of customer segmentation in VCR values. For example, a DNSP considering whether it is economical to invest in additional capacity at a particular feeder level can calculate the cost of an outage by having regard to separate VCRs for residential, small and large businesses, which could be weighted by the proportion of load served to each customer type at that particular feeder. This calculated cost could be more accurate than applying a single aggregated VCR, as the breakdown of customer types at the particular feeder level may differ from the overall breakdown of customer types in the NEM.

On the other hand, an aggregated state-level VCR may be sufficient in the context of informing FCAS or the MPC.

The extent to which stakeholders calculating VCRs have access to the segmented customer information required to utilise segmented VCRs

For example, it is unlikely that DNSPs currently possess data on the sector and/or subsector of their business customers at a particular connection point, which would make it difficult for DNSPs to weight VCRs segmented by sectors and/or subsector.

Question 21: What levels and categories of segmentation in VCR values are useful to you, taking into account the trade off between accuracy and required survey respondents and resources?

Question 22: Are there particular customer types, categories, sectors etc. that are critical to focus on in this review and any surveys we conduct?

Question 23: What categories of segmentation do you consider necessary as likely to drive variation in values of customer reliability?

Question 24: What categories of segmentation do you consider unnecessary as being unlikely to drive variation in values of customer reliability?

Question 25: What level and categories of segmentation in VCR values can be utilised, given the level of detail and segmentation present in customer data and data sets to which you have access?

5.3 Determining which outage characteristics to test for

As discussed in section 3.2, VCR values will vary with the nature of outages being considered. The way VCR values vary with outage characteristics is often referred to as a 'Customer Damage Function' (CDF).[41]

For example, a residential customer may have a relatively low VCR for a brief localised interruption, occurring at an off-peak time in spring, reflecting the minor inconvenience caused. However, the same customer may have a relatively high VCR for a prolonged widespread outage, occurring on a summer evening, reflecting the significant discomfort and inconvenience resulting from being unable to cool the house, food spoiling and being unable to avail themselves of local goods and services provided by businesses that are also experiencing the outage.

The following outage characteristics are likely to drive VCR values:

- the duration of the outage (for instance, fifteen minutes, one hour, one day, one week, or greater than one week durations)
- the timing of the outage (for instance, during off peak, on peak or weekend periods)
- the extent of the outage (for instance, localised to a block, a suburb, or the entire state)
- the season the outage occurs in (for instance, summer or winter)
- the frequency of the outages (for instance, a one-off prolonged outage, or a series of shorter outages).

However, there are similar considerations as those discussed in section 5.2 take into account when surveying customers on different outage scenarios. For example, asking survey respondents to place a different dollar value to avoiding all the above suggested possible permutations of outage characteristics would require 180 separate questions, which is extremely burdensome and would likely result in high survey abandonment, and low survey response rates.

We note that AEMO in its 2014 review did not establish a VCR for long outages associated with HILP events. As discussed in 4.2.3, given that VCR values could be used to consider whether special protection schemes for HILP events are economical, stakeholders may

41 See Productivity Commission, *Electricity Network Regulatory Frameworks*, Volume 2, 9 April 2013 p.535; AEMO, *VCR Issues Paper*, 11 March 2013, p.11.

consider it worthwhile including such outage scenarios when engaging with customers in the VCR review.

However, again, it may be prudent to prioritise certain outage characteristics that stakeholders identify as the most critical to the majority of envisaged VCR calculations. It may also be prudent to focus on certain outage characteristics that stakeholders identify as meaningful, useful and appropriate given the current level and manner of segmentation of outage data held by or accessible to stakeholders.

It is worth noting that using a Choice Modelling survey approach potentially addresses this issue. One of the main advantages of Choice Modelling survey approaches is that it is possible to determine, separately yet simultaneously, the importance of different characteristics by including these different characteristics in the set of choices survey respondents make.[42]

Question 26: What outage scenarios should be included when surveying customers to establish a CDF?

Question 27: Are there particular outage characteristics that are critical to focus on in this review and any surveys we conduct?

Question 28: What outage characteristics do you consider necessary to include as being likely to drive variation in values of customer reliability?

Question 29: What outage characteristics do you consider unnecessary as being unlikely to drive variation in values of customer reliability?

Question 30: What outage characteristics can be utilised, given the level of detail and segmentation present in customer data and data sets to which you have access?

5.4 Combining segmented VCR values at a point of investment

As discussed in section 5.2, different VCR values could apply to different kinds of customers. Stakeholders looking to perform a cost benefit analysis on an investment to prevent a potential outage need to be able to combine the different VCR values into an overall VCR at the point of investment. This VCR should reflect the breakdown of the different customers that stand to be affected by the potential outage the proposed investment seeks to avoid.

Appendix C - deriving a representative VCR at a point of proposed investment provides a simple example of estimating the overall VCR value at a point of investment by weighting segmented VCR values by customer load.

Question 31: What method should be used to representationally weight affected segmentation customer classes at the point of proposed investment?

42 Morrison, Bennett and Blamey, *Valuing Improved Wetland Quality Using Choice Modelling*, Water Resources Research Vol 35 Issue 9, p.1.

Question 32: Should different consumption information be used to weight VCR values depending on the nature of the outages being considered? For example, should average annual consumption information be used to weight VCR values when considering prolonged outages, and average peak consumption values be used to weight VCR values when considering short outages during peak periods?

5.5 Applying the CDF at a point of investment

The overall VCR at a point of investment also needs to take into account the CDFs associated with each different segmented customer type, that is, the different VCR values associated with each possible outage scenario at a particular location. The overall VCR should reflect the probabilities of each individual scenario occurring by appropriately weighting the VCR values associated with each individual outage scenario.

Appendix C - deriving a representative VCR at a point of proposed investment provides a simple example of estimating the overall VCR value at a point of investment by weighting the VCR values associated with different outage scenarios by their probabilities of occurring.

Question 33: What datasets are available to accurately estimate the probabilities of different outage scenarios occurring at the point of proposed investment?

5.6 Annual adjustments to VCR and frequency of VCR reviews

As discussed in section 3.2, VCR values are not static and are likely to change over time. To address this, surveys could be conducted each year to recalculate VCR values. However this is likely to be impractical and would place significant burden on stakeholders given the substantial amount of time and resources required to perform a yearly review. Furthermore, it may undesirable to frequently recalculate VCR values given the typical cost of assets investments and their expected asset lives. The AEMC recognises this issue in its determination in setting a minimum review frequency of once every five years:

"The final rule requires both VCR estimates and the VCR methodology to be reviewed at least every five years. The Commission considers this provides an appropriate balance between stability of VCRs for long term network planning, and maintaining the relevance of VCRs to reflect changes in customer preferences."[43]

The AEMC rule determination also requires the AER to develop a methodology to make annual adjustments to the VCR values. The AEMC considered that adjusting VCRs annually by a predetermined methodology will promote transparency and allow for certainly of values for planning purposes.[44]

There are several potential approaches to adjusting VCR values, including:

- Leave VCR values fixed in nominal terms between reviews. This has the effect of gradually reducing VCR in real terms over time.

43 AEMC, *Rule Determination: Establishing VCRs*, 5 July 2018, p.14.
44 AEMC, *Rule Determination: Establishing VCRs*, 5 July 2018, p.15.

- Index VCR values to CPI to maintain VCR values in real terms between reviews.
- Introduce a mechanism that reduces or increases VCR to reflect changing trends in the NEM.

Question 34: How often should the AER undertake reviews of VCR?

Question 35: What mechanism(s) should be applied to adjust the VCR on an annual basis?

5.7 Transitioning to new VCR values

As noted by AEMO in its application guide, large step changes in VCR values from one VCR review to the next may reduce investor certainty and introduce planning challenges. For instance, proposed investments may be deferred or brought forward if the updated VCR values change significantly from the previous values.

Over time, smoothing techniques could be applied, such as establishing a moving average VCR that would dampen the impact of a step change in derived VCR values. However, in its review, AEMO did not consider merit in apply smoothing techniques:

"An aim of any future NEM-wide VCR survey would be to gauge changes in consumer sentiment. Smoothing the transition between VCR survey results will distort and delay any network planning response to these changes in consumer sentiment."[45]

Question 36: Should smoothing techniques be applied when transitioning to newly derived VCRs?

45 AEMO, *Value of Customer Reliability - Application Guide*, December 2014, p.23.

National Electricity Amendment (Establishing values of customer reliability) Rule 2018 No. 8

1 Title of Rule

This Rule is the *National Electricity Amendment (Establishing values of customer reliability) Rule 2018 No. 8*.

2 Commencement

This Rule commences operation on 13 July 2018.

3 Amendment of the National Electricity Rules

The National Electricity Rules are amended as set out in Schedule 1.

Schedule 1 Amendment to the National Electricity Rules

(Clause 3)

[1] Clause 3.9.3A Reliability standard and settings review

In clause 3.9.3A(e)(4), omit "*AEMO*" and substitute "the *AER* under rule 8.12".

[2] New Part I Values of customer reliability

After Part H of Chapter 8, insert:

Part I Values of customer reliability

8.12 Development of methodology and publication of values of customer reliability

(a) For the purposes of this rule 8.12:

jurisdictional regulator means:

(1) the Independent Pricing and Regulatory Tribunal of New South Wales established by section 5(1) of the *Independent Pricing and Regulatory Tribunal Act 1992* of New South Wales;

(2) the Essential Services Commission established by section 7(1) of the *Essential Services Commission Act 2001* of Victoria;

(3) the Queensland Competition Authority established by section 7 of the *Queensland Competition Authority Act 1997* of Queensland;

(4) the Essential Services Commission established by section 4(1) of the *Essential Services Commission Act 2002* of South Australia;

(5) the Independent Competition and Regulatory Commission for the Australian Capital Territory established by section 5(1) of the *Independent Competition and Regulatory Commission Act 1997* of the Australian Capital Territory;

(6) the Utilities Commission of the Northern Territory established by section 5(1) of the *Utilities Commission Act* of the Northern Territory; and

(7) any successors and assigns of a body referred to in paragraphs (1) to (6).

VCR methodology has the meaning given in clause 8.12(b).

VCR objective is that the VCR methodology and values of customer reliability should be fit for purpose for any current or potential uses of values of customer reliability that the *AER* considers to be relevant.

(b) The *AER* must, in accordance with the *Rules consultation procedures*:

(1) develop a methodology to be used by the *AER* to calculate values of customer reliability (**VCR methodology**); and

(2) review and update the VCR methodology in accordance with paragraph (f).

(c) Notwithstanding paragraph (b), the *AER* may make minor and administrative amendments to the VCR methodology without complying with the *Rules consultation procedures*.

(d) The VCR methodology must:

(1) include a mechanism for directly engaging with:

(i) *retail customers*; and

(ii) *Customers* (other than *retailers*),

which may include the use of surveys;

(2) include a mechanism for adjusting the values of customer reliability on an annual basis; and

(3) be *published* promptly after it has been developed under paragraph (b).

(e) The *AER* must ensure that the VCR methodology developed under paragraph (b), and any values of customer reliability calculated in accordance with that methodology, are consistent with the VCR objective.

(f) The *AER* must, prior to each date on which the values of customer reliability are updated under subparagraph (g)(2):

(1) review the VCR methodology; and

(2) following such review, *publish* either:

(i) an updated VCR methodology; or

(ii) a notice stating that the existing VCR methodology was not varied as a result of the review.

(g) The *AER* must:

(1) *publish* the first values of customer reliability, calculated in accordance with the VCR methodology, on or before 31 December 2019;

(2) update the values of customer reliability at least once every five years, with the updated values to be *published* promptly thereafter; and

(3) maintain on its website the values of customer reliability as updated from time to time.

(h) For the purpose of complying with the *Rules consultation procedures* under paragraph (b), the *AER* must consult with:

(1) the *Reliability Panel*;

(2) *AEMO*;

(3) each jurisdictional regulator;

(4) *Registered Participants*; and

(5) such other persons who, in the *AER*'s reasonable opinion, have, or have identified themselves to the *AER* as having, an interest in the VCR methodology and values of customer reliability.

[END OF RULE AS MADE]

Appendix B - summary of issues/questions

4. The current and future roles of VCRs

4.1 Current application to regulation within the NEM

Question 1: How might the wholesale market price cap be informed by VCR?

Question 2: What customers and outage scenarios should be considered when deriving applicable VCR values to inform the wholesale market price cap?

4.2 Potential uses for VCR

Question 3: Should VCR inform load-shedding priorities for services other than essential services, and if so, how?

Question 4: What customers and outage scenarios should be considered when deriving the VCR values considered when establishing load-shedding priorities?

Question 5: Should VCR inform a price cap for ancillary services such as NSCAS and FCAS, and if so, how?

Question 6: What customers and outage scenarios should be considered when deriving applicable VCR values?

Question 7: Should VCR inform a price cap for RERT, and if so, how?

Question 8: What customers and outage scenarios should be considered when deriving applicable VCR values?

Question 9: Should the AER determine a VCR for prolonged and extensive outages envisaged by System Black and HILP events?

Question 10: Should VCR be used to inform scheduled planned outages, and if so, how?

Question 11: **S**hould the AER determine additional VCRs for planned outages?

Question 12: Should VCR values for different customer types also inform the allocation of distribution and transmission shared costs among customers, and if so, how?

Question 13: Are there any other regulatory investment assessments and/or NEM planning contexts that could be informed by the application of VCR values?

Question 14: If so, what customer and outage scenarios should be considered when deriving applicable VCR values?

Question 15: For what purposes do you currently use VCR? Is the current level of VCR segmentation by customer type and outage scenarios in AEMO's 2014 review fit for your purposes?

Question 16: For what future purposes could you use VCR? What level of VCR segmentation would you require?

5. Methodologies for Deriving VCR

5.1 Approaches to deriving VCR

Question 17: Do you think the methodology used by AEMO to derive (CVS and CM for residential and business, and DCA for direct connect customers) is still appropriate, taking into account current and potential uses of VCR discussed in chapter 4?

Question 18: If not, what other method or methods would be most appropriate to engage with customers and derive VCR values?

Question 19: Should different methods be used for different customer types?

Question 20: Should multiple methods be used to cross check derived VCR values?

5.2 VCR Customer Segments

Question 21: What levels and categories of segmentation in VCR values are useful to you, taking into account the trade off between accuracy and required survey respondents and resources?

Question 22: Are there particular customer types, categories, sectors etc. that are critical to focus on in this review and any surveys we conduct?

Question 23: What categories of segmentation do you consider necessary as being likely to drive variation in values of customer reliability?

Question 24: What categories of segmentation do you consider unnecessary as being unlikely to drive variation in values of customer reliability?

Question 25: What level and categories of segmentation in VCR values can be utilised, given the level of detail and segmentation present in customer data and data sets to which you have access?

5.3 Determining which outage characteristics to test for

Question 26: What outage scenarios should be included when surveying customers to establish a CDF?

Question 27: Are there particular outage characteristics that are critical to focus on in this review and any surveys we conduct?

Question 28: What outage characteristics do you consider necessary to include as being likely to drive variation in values of customer reliability?

Question 29: What outage characteristics do you consider unnecessary as being unlikely to drive variation in values of customer reliability?

Question 30: What outage characteristics can be utilised, given the level of detail and segmentation present in customer data and data sets to which have access?

5.4 Combining segmented VCR values at point of investment

Question 31: What method should be used to representationally weight affected segmented customer classes at the point of proposed investment?

Question 32: Should different consumption information be used to weight VCR values depending on the nature of the outages being considered? For example, should average annual consumption information be used to weight VCR values when considering prolonged outages, and average peak consumption values be used to weight VCR values when considering short outages during peak periods?

5.5 Applying the Customer Damage Functions at point of investment Determining which outage characteristics to test for

Question 33: What datasets are available to accurately estimate the probabilities of different outage scenarios occurring at the point of proposed investment?

5.6 Annual adjustments to VCR and frequency of VCR reviews

Question 34: How often should the AER undertake reviews of VCR?

Question 35: What mechanism(s) should be applied to adjust the VCR on an annual basis?

5.7 Transitioning to new VCR values

Question 36: Should smoothing techniques be applied when transitioning to newly derived VCRs?

Appendix C - deriving a representative VCR at a point of proposed investment

As discussed in sections 5.4 and 5.5, stakeholders looking to perform a cost benefit analysis on investment to prevent a potential outage need to be able to combine the different VCR values into a representative VCR at the point of investment. This VCR should reflect the breakdown of the different customers that stand to be affected by the potential outage the proposed investment seeks to avoid.

This could be done by taking the load-weighted average of the different VCR values, with weights based on either annual consumption or peak consumption considered. For example, a DNSP assessing whether to invest in increased capacity at a feeder could refer to their consumption data, which shows residential, small business, large business and industrial customers account for 25, 25, 30 and 20 per cent of peak load respectively. These same weightings could be applied to the VCR values for each customer class to calculate an representative VCR at the point of investment.

The representative VCR value at the point of investment could also be calculated by a customer number-weighted average. However, given that VCR is expressed as a dollar value per USE, this method would likely over-represent residential customers (which, though numerous, consume a comparatively low amount of electricity) and under-represent industrial customers (which consume a comparatively high amount of electricity).

This representative VCR should also reflect the probabilities of each individual scenario occurring by appropriately weighting the VCR values associated with each individual outage scenario.

DNSPs and other stakeholders could estimate these probabilities by referring to the historical record of outages that have previously occurred at a location, and/or historical outages at different locations that have occurred due to comparable circumstances (such as similar network load constraints). The ability to determine these probabilities will depend on the datasets available to stakeholders.

The representative VCR at point of proposed investment can be derived by the following formula which takes into account the breakdown of segmented customers types as well as the relative likelihood of different outage scenarios occurring at location A:[46]

$$VCR_A = \sum_{i,j} C_i \times VCR_{ij} \times P_j$$

Where

VCR_A is the representative VCR at location A.

i is the series of segmented classes of customer affected by the potential outage(s) sought to be avoided at location A.

j is the series of possible outage scenarios that could occur at location A across the year. This set does not include the null scenario of no outage. A set of multiple outages occurring within the year should be considered as one outage scenario.

C_i is the proportion (either reflecting load or customer number) of segmented customer class i, at location A with $\sum_i C_i = 1$. This allows stakeholders to weight the VCR values of different customer types by the proportion of those customer types. Depending on the finalised extent of segmentation, this can be determined by the stakeholder with reference to applicable customer data and/or other available datasets.

VCR_{ij} is the value of customer reliability for segmented customer class i associated with outage scenario j. These series of values will be derived by the AER in its VCR review.

P_j is the relative probability of outage scenario j occurring, with $\sum_j P_j = 1$. This set does not include the probability of the scenario of no outage. This allows stakeholders to weight the VCR values of different outages by the relative probability of each outage occurring. This can be determined by the stakeholder with reference to applicable historical outage data.

The likely cost of outage at location A is given by:

$$Expected\ Outage\ Cost_A = \left(VCR_A \sum_{i,j} USE_{ij} \times P_j \right) \times \left(1 - P_{no\ outage}\right)$$

Where

USE_{ij} is the amount of unserved electricity for segmented customer class i associated with outage scenario j at location A. This can be determined by the stakeholder with reference to applicable customer data.

$P_{no\ outage}$ is the probability of no outage occurring across the year at location A.

46 This is an adaptation of AEMO's approach in its application guide. See AEMO, Value of Customer Reliability - Application Guide, December 2014, p.28.

As a simple stylised example, a DNSP is considering whether investment is economical to avoid a potential outage at location A.

Historical data suggests that across the year, if an outage were to occur at location A, there are three outage scenarios with the following estimated probabilities of occurring:

- 50% chance of one short outage (<1 hour)
- 40% chance of one longer outage (between 1 and 3 hours)
- 10% chance of one prolonged outage (between 3 and 6 hours).

Consumption data shows that 30% of the load is residential customers, and 70% small business.

For the purposes of illustration, the AER VCR review finds the following segmented customer class VCRs in NSW:

Outage Scenarios	Residential VCR	Small Business VCR
1 outage of <1 hour	$25/kWh	$50/kWh
1 outage of between 1 and 3 hours	$30/kWh	$55/kWh
1 outage of between 3 and 6 hours	$40/kWh	$60/kWh

The representative VCR at location A would be:

$$VCR_A = \sum_{i,j} C_i \times VCR_{ij} \times P_j$$
$$= (0.3 \times 25 \times 0.5) + (0.3 \times 30 \times 0.4) + (0.3 \times 40 \times 0.1) + (0.7 \times 50 \times 0.5) + (0.7 \times 55 \times 0.4) + (0.7 \times 60 \times 0.1)$$
$$= 3.75 + 3.6 + 1.2 + 17.5 + 15.4 + 4.2$$
$$= \$45.65/kWh$$