Values of Customer Reliability

Draft Decision

September 2019

AUSTRALIAN ENERGY REGULATOR

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Request for submissions

The Australian Energy Regulator (AER) invites interested parties to make submissions on this draft decision by 5pm AEST Friday 18 October 2019.

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

Alternatively, submissions can be sent to:

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Australian Energy Regulator
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Submissions should be in PDF, Microsoft Word or another text readable document format.

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:

1. clearly identify the information that is the subject of the confidentiality claim
2. 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 (June 2014), which is available on our website.[1]

Please direct enquires about this paper, or about lodging submissions to vcr@aer.gov.au.

[1] https://www.aer.gov.au/publications/corporate-documents/accc-and-aer-information-policy-collection-and-disclosure-of-information.

Shortened forms

Shortened form	Extended form
AAM	annual adjustment mechanism
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
CBD	central business district
COAG	Council of Australian Governments
the Committee	the VCR Consultative Committee
CPI	Consumer Price Index
DER	distributed energy resources
ECA	Energy Consumers Australia
ESB	Energy Security Board
HILP	high impact low probability
GWh	gigawatt hour
kVA	kilovolt ampere
kWh	kilowatt hour
MEI	Melbourne Energy Institute
MVA	megavolt ampere
NEL	National Electricity Law
NEM	National Electricity Market
NEO	National Electricity Objective
NER	National Electricity Rules
NSP	network service provider
PPI	Producer Price Index
RERT	reliability and emergency reserve trader
RIT	regulatory investment test
Solar PV	solar photovoltaic
STPIS	service target performance incentive scheme
the Subcommittee	the HILP Subcommittee

USE	unserved energy
UPS	uninterruptable power supply
VCR	values of customer reliability
WTA	willingness to accept
WTP	willingness to pay
$/kWh	dollars per kilowatt hour

1 Executive Summary

This draft decision for our Values of Customer Reliability (VCR) review sets out our draft methodology for developing VCR values for the National Electricity Market (NEM) and the Northern Territory.

On 5 July 2018 the Australian Energy Market Commission (AEMC) approved a rule change proposal by the Council of Australian Governments (COAG) Energy Council to give the Australian Energy Regulator (AER) responsibility for determining values different customers place on having a reliable electricity supply. This is referred to as the Values of Customer Reliability (VCR). The rule change requires the AER to:

- develop a methodology for estimating VCRs in accordance with the VCR objective and other requirements in the National Electricity Rules (the Rules)
- derive VCR values in accordance with the methodology and publish them by 31 December 2019
- review the methodology for estimating VCRs at least every five years.

This draft decision incorporates our response to an extensive consultation process that commenced in October 2018 and through which we have engaged widely with Governments, energy regulators, customer and industry representatives and the public.

We established as a key advisory body the VCR Consultative Committee (the Committee) that we have regularly consulted on key issues throughout the VCR review.[2] The Committee consists of representatives from organisations with a particular interest in VCRs, and who have relevant expertise in how VCRs should be used and/or determined. We met with the Committee five times and plan to meet a further two times before finalising VCR values. We also formed a HILP event (high impact low probability) Subcommittee (the Subcommittee), sitting under the Committee, to advise on approaches to developing a methodology to derive VCRs for widespread and long duration outages. We met twice with the Subcommittee.[3]

As part of our consultation process, we published a *Consultation paper* (October 2018) and a *Consultation update paper* (April 2019), which set out our progress on developing the VCR methodology. We received 25 submissions from a wide range of stakeholders from industry, Government and customer representatives in response to our consultation papers.

Our draft decision on the proposed methodology incorporates stakeholder input received through public consultation on these documents, as well as advice from our Committee, Subcommittee and the expert local and international consultants who were engaged to assist us develop the methodology set out here.[4]

The draft decision sets out our methodology, and discusses how we arrived at the proposed methodology, including a discussion of the types of outages for which we will develop VCR values (standard outages and widespread and long duration outages). Our preference is for

2 See section 4.2.2 for more information about the Committee membership.
3 See section 4.3 for more information about the Subcommittee.
4 See section 4.4 for more information about our expert advisers.

a survey based approach to collect data on customer reliability preferences for standard outages, and a model-based approach for estimating customer reliability preferences in relation to widespread and long duration outages. We also discuss the annual adjustment mechanism (AAM) that will enable VCRs to be adjusted annually between five-yearly VCR reviews.

In summary, our draft decision is to build on the methodology used by the Australian Energy Market Operator (AEMO) to estimate VCRs in their 2014 NEM-wide study. In 2014 AEMO derived VCR values for outages up to 12 hours duration. Our draft decision recognises different methodologies are required for standard outages (i.e. outages of up to 12 hours duration) and widespread and long duration outages (outages of more than 12 hours duration).

The components of our draft methodology are:

- the use of contingent valuation and choice experiment techniques to derive standard outage (typically less than 12 hours) VCRs for residential and business customers with a peak demand of less than 10 megavolt-amperes (MVA)
- the use of a direct cost survey approach to derive standard outage VCRs for business customers with a peak demand of more than 10 MVA
- the approach to converting residential, business and direct cost survey value of reliability results into dollars per kilowatt hour ($/kWh) values and how they will be combined to produce aggregate VCRs
- the use of a macroeconomic modelling approach supplemented by other techniques to derive VCRs for widespread and long duration outages with a total impact ranging from 1-2 gigawatt hours (GWh) to 15 GWh of unserved energy
- the use of a CPI-X formula for the AAM. In this formula, X represents the key drivers of annual change in customer reliability preferences but, for this 5 year period X is set at zero due to a lack of available information.

To arrive at our proposed methodology we assessed different methodologies adopted locally and abroad. We consider our methodology reflects industry best practice as it has been developed through robust consultation with Government, customer representatives and industry. We have made improvements to AEMO's 2014 methodology taking into consideration:

- suggestions proposed by stakeholders through our consultation process
- expert advice on survey techniques
- changes in the energy sector since 2014.

We have developed an assessment framework consistent with the National Electricity Objective (NEO) to assist in determining the best approaches to estimate VCR values fit for purpose for the current and potential uses of VCR which we have identified. The discussion includes an assessment of our methodology against specified assessment criteria.

1.1 Timing between consultation on VCR methodology, and undertaking surveys and modelling

In coming to the draft decision, we have consulted widely and regularly, and addressed key issues raised by stakeholders as we developed our draft methodology. Our consultation processes have included regular meetings with our Committee, where we have sought ways to improve AEMO's 2014 methodology for outages of up to 12 hours duration and to develop an approach to derive VCRs for widespread and long duration outages.

The time frames under Rule 8.12 for publishing the methodology and relevant values are tight. Accordingly, in addition to publishing the draft decision on the VCR methodology, we have commenced our survey for standard outages in accordance with the draft VCR methodology. We are commencing this work now, rather than waiting until the VCR methodology has been finalised to enable us to meet the statutory timeframe to publish values by 31 December 2019. We consider we have run a robust consultation process and our methodology takes into account key issues and advice from stakeholders.

If stakeholder submissions to the draft decision raise issues which may warrant revisions to the VCR methodology, we will fully consider those submissions and make any appropriate modifications necessary to best give effect to the requirements in the Rules. We will not be constrained by the fact that we have already undertaken some survey or modelling work.

1.2 Publication of final VCR values

We are aiming to publish our final VCR values for standard outages of up to 12 hours duration in December 2019, subject to any issues arising during our ongoing consultation process.

However, based on feedback from stakeholders during the development of our draft methodology, we expect to defer the publication of VCR values for widespread and long duration outages to the first quarter of 2020. This category of VCR values is new and untested. We consider more time will be needed for development and testing in order to derive fit for purpose VCR values and that it is therefore unlikely we will be in a position to publish those values in December 2019.

2 AER role in determining Values of Customer Reliability (VCR)

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 the National Electricity Rules (the Rules) and the National Gas Rules. These objectives focus on promoting the long-term interests of consumers.

2.1 Why is the AER responsible for setting VCR

In response to a rule change proposal from the Council of Australian Governments (COAG) Energy Council, the Australian Energy Market Commission (AEMC) amended the Rules to give the AER responsibility for determining the values different customers place on having a reliable electricity supply.[5] This is referred to as the Values of Customer Reliability (VCR). VCR links efficiency and reliability, playing a pivotal role in network planning and investment and informs the design of wholesale market standards and settings and network reliability incentives.

The AEMC considered that assigning a single body responsibility for developing a nationally consistent VCR methodology and for calculating VCR estimates would remove unnecessary duplication and decrease the overall administrative burden associated with the use of VCR by a wide range of stakeholders. The AER was considered the most appropriate body for developing the VCR methodology and VCR estimates on an on-going basis because the responsibility most aligns with its statutory functions.[6]

The AEMC's rule change came into effect on 13 July 2018.[7]

2.2 VCR Rule

Part I, Rule 8.12 of the Rules requires that the AER must, in accordance with the Rules consultation procedures:

- develop, publicly consult on, and publish a national methodology for estimating VCRs across the National Electricity Market (NEM) and the Northern Territory;
- include a mechanism for directly engaging with customers and include a mechanism for adjusting VCRs on an annual basis;
- publish the first VCRs calculated in accordance with the VCR methodology on or before 31 December 2019;

5 AEMC, Establishing VCRs, Rule Determination, 5 July 2018. Available at https://www.aemc.gov.au/rule-changes/establishing-values-of-customer-reliability.

6 AEMC, Establishing VCRs, Rule Determination, 5 July 2018, page 7. Available at https://www.aemc.gov.au/rule-changes/establishing-values-of-customer-reliability.

7 AEMC, National Electricity Amendment (Establishing values of customer reliability) Rule 2018 No. 8, page 2. Available at https://www.aemc.gov.au/rule-changes/establishing-values-of-customer-reliability.

- adjust the VCRs using the adjustment mechanism specified in the VCR methodology each year between updates;
- review the VCR methodology and update the VCRs at least once every five years, and publish updated numbers.

The Rules establish a VCR objective, which requires the AER's VCR methodology and set of VCR values to be fit for purpose for any current or potential uses of values of customer reliability that the AER considers to be relevant.

3 Methodology

This chapter sets out our draft decision on a methodology to calculate values of customer reliability. Our methodology consists of a hybrid of survey based approaches and model based approaches which we have identified as most suitable to estimate one or more categories of VCR for particular customer classes.

3.1 Draft VCR methodology

Our review has found there are two categories of unplanned outages for which we should derive VCR values, taking into account current and potential applications of VCR:

- Standard outages which have a typical duration of equal to or less than 12 hours
- Widespread and long duration outages which are more severe than standard outages, with a total impact ranging from 1-2 GWh to 15 GWh of unserved energy.

The draft VCR methodology also sets out our approach to the annual adjustment of the VCRs which we will publish at the end of this review.

The draft VCR methodology is set out in tables 3.1 to 3.3 below.

Table 3.1: Methodology for standard outages

Standard outages	
Residential and business customers with a peak demand less than 10 MVA	Stated preference survey using combined contingent valuation and choice experiment techniques. *Contingent valuation* The contingent valuation technique asks the respondent two closed questions followed by one open-ended question about their willingness to pay (WTP) to avoid two unexpected power outages a year (the baseline scenario) affecting either the home of a residential customer or the specified place of business of a business customer. Each unexpected outage in the baseline scenario occurs on a different random weekday in winter and lasts for one hour in off-peak times. Each outage only affects the local area. The closed questions will present the respondent with a bill increase of $x and ask the respondent to indicate (YES or NO) as to whether they would be willing to pay the $x bill increase to fund network investment and avoid the baseline scenario. The bill increase of $x for the first closed question is randomly selected. The second closed question will be double the first cost prompt if the respondent answers YES to the first question and will be half the first cost prompt if the respondent answers NO to the first question. The initial cost prompts for residential customers are the following monthly bill increase amounts: $2, $3, $4, $5, $6, $7, $8 and $9. The initial cost prompts for business customers are the following bill

increase percentage amounts: 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9% and 10%.

The open-ended question following the closed questions will ask respondents to indicate the maximum bill increase they would be willing to pay to avoid the baseline scenario.

Responses to the open-ended question will be capped. For residential customers the cap is $22 per month, which is the approximate cost of a backup power system which can supply a household for the duration of the baseline scenario. Where a respondent enters a value more than the cap, they will be asked a follow up question as to whether they would be willing to pay $22 per month to install the described backup power system. If the respondent answers NO, they will then be presented with an open-ended question asking them how much they would be willing to pay to install the described backup power system.

For business customers the cap is equal to 100 percent of their indicated electricity bill.

Appendix 1 illustrates the contingent valuation question in a tree diagram. Appendix 4 discusses how we set the cap of $22 per month.

Choice experiment

The choice experiment technique asks customers to identify their most preferred option out of a series of choices with different outage characteristics such as duration, severity (widespread / localised), time of day, time of week and time of year they occur. The trade-offs customers make in choosing between options with different characteristics are used to determine the relative value respondents place on each of these attributes.

The choice experiment technique will present respondents with eight different sets of three hypothetical outage scenarios and ask respondents to select their preferred outage scenario in each set. Each outage scenario includes a specified bill discount which a customer would receive if they choose to accept the outage scenario.

Each set of outage scenarios will contain the baseline scenario with no bill discount. The other two scenarios in each set will be variations of the baseline scenario with changes to the severity (level) of one or more attributes (characteristics) of the outage. The attributes and levels tested in the choice experiment are:

- Outage duration: 1 hour, 3 hours, 6 hours and 12 hours
- Geographic impact: 'localised' and 'widespread'
- Time of day: Peak time and Off-peak time
- Season: Summer or Winter
- Day of the week: Weekday or Weekend
- Bill discount (residential): no change, $3 per month, $7 per month and $15 per month
- Bill discount (business), no change, 1%, 2% and 3%.

Business customers with peak demand equal or greater than 10 MVA	*Direct cost survey* The direct cost survey asks respondents to outline and quantify the actual costs they expect to incur as a result of an unplanned outage affecting their identified business site. There are two versions of the survey - one for business sites with continuous 24/7 operations and one for business sites with non-continuous operations. For customers with continuous 24/7 operations, respondents are asked to outline and quantify the costs they would expect to incur in an unplanned outage of the following durations: 10 minutes, 1 hour, 3 hours, 6 hours, 12 hours, 24 hours and 48 hours. For customers with non-continuous operations, respondents are asked to outline and quantify the costs they would expect to incur for: • unplanned outages that start at peak times (between 7am and 10am, or 5pm and 8pm on a weekday) for the following durations: 10 minutes, 1 hour, 3 hours and 6 hours • unplanned outages that occur at off-peak times (anytime except between either 7am and 10am or 5pm and 8pm), on a weekday for the following durations: 10 minutes, 1 hour, 3 hours and 6 hours • unplanned outages that start at any time and have the following durations: 12 hours, 24 hours and 48 hours.

Table 3.2: Methodology for widespread and long duration outages

Widespread and long duration outages	
All customers	Macro-economic modelling of outage scenarios supplemented by other appropriate approaches. The set of outage scenarios will include outages of increasing severity from 1-2 GWh to 15 GWh of unserved energy. The modelling of outage scenarios will estimate economic costs associated with the outage scenarios. To the extent possible, the modelling will also seek to capture social costs which may be incurred. This modelling may be informed by supplementary information from ex-post reviews of comparable historical outages. With the costs of different outage scenarios modelled, we will derive a curve that best fits the modelled costs of these different outage scenario that describes the impact of increasing severity of outages on VCR.

Table 3.3: Methodology for annual adjustment mechanism

Annual adjustment mechanism
Published values will be adjusted on an annual basis using a CPI-X approach, where X is set to zero in the first period in which the methodology operates. This ensures that in economic terms, real values of VCR are maintained between VCR reviews. Due to the current lack of available information on what are the key drivers of changes in customer reliability preferences and how they are likely to change VCR, X is initially set at zero. The AER will seek to develop better insight into the key drivers of changes in customer reliability preferences in preparation for the next review. We will consult stakeholders before adopting a formal approach to this task.

Table 3.4: Methodology for converting VCR survey results into dollars per kilowatt hour ($/kWh) VCR values and aggregating values

Converting survey results into dollars per kilowatt hour ($/kWh) and aggregating values	
Deriving $/kWh standard outage VCR for each residential segment	For each residential customer segment, the contingent valuation and choice experiment results will be combined to produce a dollar value for a range of outage scenarios relevant for customers in that segment. To convert into $/kWh values, the dollar value will be divided by an estimate of the consumption which the residential customer would have consumed over the period had the outage not occurred. This estimate will be based on residential consumption data obtained from one or more of the following sources: • the residential survey • network business data or • other available sources (actual or estimated) of residential consumption data. An aggregate $/kWh for each residential cohort will be derived by summing the probability-weighted $/kWh VCR of each outage scenario. The probability for each outage scenario will be based on estimates derived from historical network outage data.
Deriving $/kWh standard outage VCR for each business segment with a peak demand of less than 10 MVA	The contingent valuation and choice experiment results for each business segment will be in % of bill terms. These results will be converted to dollar terms using estimates of business customer bills. Different bill assumptions may be used to account for consumption size and/or business sector. The dollar contingent valuation and choice experiment results will be combined to produce a dollar value for a

	range of outage scenarios relevant for customers in that segment. To convert into $/kWh values, the dollar value will be divided by an estimate of the consumption which the business customer would have consumed over the period had the outage not occurred. This estimate will be based on business consumption data obtained from: • the business survey • network business data or • other sources (actual or estimated) of business consumption data. An aggregate $/kWh for each business cohort will be derived by summing the probability-weighted $/kWh VCR of each outage scenario. The probability for each outage will be based on estimates derived from historical network outage data.
Deriving $/kWh standard outage VCR for business customers with peak demand greater than or equal to 10 MVA	The responses from the direct cost survey will produce a dollar value for the outage scenarios asked in the survey. To convert into $/kWh vales, the dollar value for each outage will be converted using energy consumption data obtained from the direct cost survey. An aggregate $/kWh for each business customer will be obtained by summing the probability-weighted $/kWh VCR of each outage scenario. The probability for each outage will be based on estimates derived from historical network outage data. The aggregate $/kWh for each response will be load-weighted with other direct cost survey response, on the basis of industry or sector groupings, to produce a combined industry or sector $/kWh VCR.
Aggregating VCRs	Aggregate VCRs for a particular area or region will be derived by load weighting the relevant aggregate residential and business cohort VCRs (including combined aggregate industry or sector $/kWh VCRs for business customers with peak demand greater than or equal to 10 MVA).

4 Background

In this chapter we describe VCRs and our consultation to date.

4.1 What are VCRs?

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) of unserved energy. VCR is a critical input into identifying efficient levels of network expenditure.

Because individual customers cannot directly specify the value they place on reliability and there is no separate market for reliability, VCR is difficult to observe directly, and is typically estimated by survey techniques. VCR is not a single number but rather a collection of numerical values which apply to different customer segments. The primary customer segments in previous surveys have been residential, business and customers connected directly to transmission networks (direct connect 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. The first comprehensive NEM-wide study of VCRs was conducted by the Australian Energy Market Operator (AEMO) in 2014.

In its 2014 review AEMO calculated VCR values in the NEM for residential, business and direct connect customers. Residential customers were segmented by NEM jurisdiction, business customers were segmented by sector (industrial, commercial and agricultural) and size (small, medium and large) and direct connect customers were segmented by sector (metals, wood pulp and paper, and mining).[8] There has been no previous VCR study which has included the Northern Territory.

4.2 Consultation to date

The following sub-sections summarise the consultation we have undertaken to date for the VCR review.

4.2.1 Consultation paper and VCR public forums

On 19 October 2018, we commenced the VCR review with the publication of our *Consultation paper*. The *Consultation paper* sought stakeholder feedback on a number of matters including:

- different methodologies to determine VCR values
- current and future uses of VCR
- how stakeholders currently use VCR

8 For detailed results see AEMO, Value of Customer Reliability Review Appendix, September 2014. B.1. Available at: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Value-of-Customer-Reliability-review.

- how we should approach trade-offs between cost, complexity and accuracy.

Submissions to the *Consultation paper* closed on Friday 16 November 2018. We received 18 submissions.

Following the close of submissions, we held VCR public forums in Sydney on 5 December 2018 and in Melbourne on 6 December 2018. The public forums provided an opportunity to discuss stakeholder comments on the *Consultation paper*. Following the public forums we extended the consultation period until 20 December 2018. A further 7 submissions were received.

On 18 April 2019, we further published a *Consultation update paper*, setting out our key assessment criteria for the VCR methodology and our proposal to build on and improve on the methodology used by AEMO in their 2014 NEM-wide VCR review.

We proposed to adopt a hybrid of survey and model based approaches for the VCR methodology. In particular:

- continuing the use of the combined contingent valuation and choice experiments survey techniques AEMO used to derive standard outage VCRs for residential and business customers with improvements. We outlined our intention to undertake a pilot to verify the ability of the combined techniques to deliver useful results and test improvements to the survey
- continuing the use of the direct cost survey to derive standard outage VCRs for large business customers. AEMO used this approach to survey direct connect customers only. We proposed to expand the scope of the survey to include large customers connected to the distribution network
- using a model based approach to derive VCRs for widespread and long duration, and high impact and low probability (HILP) events
- updating stakeholders on our thinking to date on the annual adjustment mechanism (AAM).

We received four submissions to the *Consultation update paper*.

Key views and feedback from stakeholder submissions are summarised in Appendix 2 with AER responses).

4.2.2 VCR Consultative Committee

At the beginning of the VCR review we established the VCR Consultative Committee (the Committee). The Committee is an advisory body consisting of representatives from organisations with a particular interest in VCRs or who have relevant expertise in how VCRs should be determined, who we will consult with on key issues throughout the VCR review.

Committee members include representatives from the following organisations:

- Australian Energy Council (AEC)
- Australian Energy Market Commission (AEMC)
- Australian Energy Market Operator (AEMO)

- Essential Services Commission of South Australia (ESCOSA)
- Essential Services Commission of Victoria (ESCV)
- Energy Consumers Australia (ECA)
- Energy Networks Australia (ENA)
- Energy Users' Association of Australia (EUAA)
- Independent Competition and Regulatory Commission (ICRC)
- Independent Pricing and Regulatory Tribunal of New South Wales (IPART)
- Office of the Tasmanian Economic Regulator (OTTER)
- Public Interest Advocacy Centre (PIAC)
- Reliability Panel
- Utilities Commission of the Northern Territory (UC)

The Economic Regulatory Authority of Western Australia has also attended meetings of the Committee as an observer.[9]

To date, the Committee has met five times (28 November 2018, 7 February 2019, 13 June 2019, 25 July 2019 and 29 August 2019). Minutes of Committee meetings can be found on the AER website.[10]

4.3 High impact low probability events (HILP) Subcommittee

A number of stakeholder submissions raised matters regarding the development of VCRs for outages that are typically the result of HILP events. They highlighted a number of complex issues. To give proper consideration to these issues we established a HILP Subcommittee (the Subcommittee) sitting under the Committee. The Subcommittee consists of a subset of Committee members with a particular interest in or expertise in this subject area.

Two meetings of the Subcommittee were held on 14 March 2019 and 23 May 2019 to give consideration to whether to develop VCRs for HILP events and how to achieve this. Findings of the Subcommittee were also provided to the Committee for its consideration.

4.4 Independent expert advice

Two consultancy groups, the University of Melbourne's Melbourne Energy Institute (MEI) and a consortium consisting of KPMG and Insync (KPMG/Insync), are assisting us in our review. The MEI is an inter-disciplinary academic research group assisting us in developing the VCR methodology and providing expert advice and quality assurance over the course of

9 We also invited Queensland Competition Authority (QCA) to attend our VCR Consultative Committee, but the invitation was declined.

10 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability-vcr/consultation.

review. KPMG/Insync are also assisting to develop the VCR methodology, and undertaking the design and delivery of surveys we conduct as part of the review.

4.5 Focus group and pilot survey

To improve on the residential and business surveys used by AEMO in 2014, KPMG/Insync conducted a number of focus groups and interviews across Australia in March 2019. The focus groups and interviews sought to test potential improvements to reduce bias in the contingent valuation survey technique and test the wording and design of the surveys.

Following the publication of the *Consultation update paper*, we undertook a pilot residential and business survey. The main objectives of the pilot residential and business survey were to:

- verify the ability of the combined contingent valuation and choice experiment techniques to deliver useful results
- test the improvements made to the wording and design of the surveys based on feedback from focus groups
- establish and quantify differences that changing the contingent valuation question makes to the contingent valuation number. A number of variants of a contingent valuation question were tested:
    - an open-ended question
    - two cost prompts followed by an open-ended question
    - two cost prompts only (this was the same question used in the AEMO 2014 survey)
- re-test the AEMO survey and compare results against changes made to the AER pilot survey
- test technical solution and reporting requirements.

The pilot residential and business survey was conducted in May 2019. In total 1 000 residential and 300 business responses were received.

Overall, the pilot survey results are promising and provide confidence that we will be able to obtain results in a main survey using the same techniques which we can use to derive VCR values for residential and business customers. The key findings of the pilot survey are:

- regressions of the pooled residential and business choice model responses gave results largely consistent with the AEMO 2014 survey results. Key outage attributes of duration and peak were statistically significant and indicated important preferences for shorter outages and outages at off-peak times, as anticipated.
- a second order issue identified with the choice model responses was that there was a high number of responses that selected the baseline option. This has not proven to be an issue in getting statistically significant results but it may be desirable if this option was picked less often (as repeated selections of this option tend to give less information about respondents' outage preferences).

- the use of online panels was able to collect a large number of responses in a short timeframe. This gives us confidence that we will be able to continue collecting responses using this approach in accordance with our initial sample plan. However, the online panels only targeted 'easy' to sample areas and there are some customer segments in both residential and business where it may be challenging to collect the desired number of samples.
- the contingent valuation results that use open-ended responses produced significantly different results to the closed prompted approach used by AEMO (both the 2014 results and re-run AEMO survey sample for this pilot). This indicates that the methodological change to the contingent valuation question is significant. However, we consider both variants of the open-ended responses tested in the pilot survey produce results which are closer to a customer's true WTP. This is because both variants provide respondents the opportunity to directly indicate their WTP.
- the use of open-ended contingent valuation questions results in some respondents providing unusually high responses which have a significant effect on the average WTP value.

The KPMG/Insync report on the pilot survey with recommendations to address key findings is published on our website. MEI also provided quality assurance on the pilot survey design and results, particularly on the choice model.

5 VCR methodology assessment framework

This chapter sets out the criteria we used to assess methodologies for estimating VCRs and the current and potential applications of VCR which we have identified in the course of this review.

5.1 Assessment criteria

Table 5.1 sets out our assessment criteria for the VCR methodology. Our assessment criteria is based on requirements set out in the Rules and the National Electricity Objective (NEO).

Table 5.1 - Assessment criteria

Assessment criteria
1. The National Electricity Objective (NEO) to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity. **We consider the NEO will be promoted where the VCR methodology is flexible, producing values that are a reasonable reflection of customer reliability preferences today, and can be adjusted to reflect future changes in reliability preferences. These changes in preferences may be driven by a range of factors including changes in the energy market, cost, technology or customer perceptions.**
2. 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 (the VCR Objective).[11] **We consider:** • **the VCR methodology and values should account for the range of customers and geographic locations within the NEM and Northern Territory, and recognise the various uses of VCR values** • **the VCR methodology should produce reasonable estimates of customer VCRs.**
3. The VCR methodology requirements are set out in clause 8.12 of the Rules. **These state that the VCR methodology must:** • **include a mechanism for directly engaging with customers which may include the use of surveys** • **include a mechanism for adjusting the values of customer reliability on an annual basis.**

11 Clause 8.12, National Electricity Rules.

5.2 Identified uses of VCR

To consider whether VCRs are fit for purpose we have sought to identify the current and potential applications of VCR in the NEM and Northern Territory.

The traditional purpose of VCRs is as an input in the cost benefit analysis for network planning (such as regulatory investment tests (RIT) and the integrated system plans) and the assessment of future network expenditure for capital projects. Using VCRs to estimate the value of unserved energy resulting from outages, a cost-benefit analysis can be performed to assess whether proposed steps to prevent outages (such as increasing network capacity) are economically justified. For example, expenditure would be justified where the value of unserved energy is greater than the cost of preventing outages through investment in a network or non-network option.[12]

Through our consultation, we have also identified VCRs are also currently used for the following purposes:

- in setting transmission and distribution reliability standards and targets[13]
- to inform reviews of the wholesale market reliability standard and settings[14]
- to inform reviews of the system restart standard[15]
- informing reliability and emergency reserve trader (RERT) procurement[16]
- inform the assessment of requests to declare certain risks as protected events[17]
- in the distribution service target performance incentive schemes (STPIS) as the key measure for linking outcome performance with the STPIS incentives.

Similarly, our consultation to date has identified the following potential applications of VCR:

- determining load shedding priorities and compensation mechanisms in each jurisdiction

12 At a high-level, this is done by multiplying the applicable VCR by the energy at risk of being unserved in the event of an 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.

13 For example, IPART has recently been requested by the Premier of NSW to review electricity distribution reliability standards taking into account the VCR values to be published by the AER as a result of this VCR review. See, https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/pricing-reviews-electricity-publications-electricity-distribution-reliability-standards/final-terms-of-reference-electricity-distribution-reliability-standards-february-2019.pdf.

14 National Electricity Rules, clause 3.9.3 A(e)(4).

15 VCR was used as an input into the Reliability Panel's 2016 System Restart Standard Review. The Reliability Panel's determination is available at https://www.aemc.gov.au/markets-reviews-advice/review-of-the-system-restart-standard. In particular see Appendix B of the accompanying Deloitte Access Economics report on Economic assessment of System Restart Ancillary Services in the NEM.

16 On 2 May 2019 the AEMC made a final rule determination on the enhancement to the RERT rule change proposal. The final rule introduces an additional RERT principle to provide additional guidance on RERT costs, namely that they should not exceed the average VCR. This is to recognise that the costs of emergency reserves should be less than the costs of involuntary load shedding. For more information, see https://www.aemc.gov.au/rule-changes/enhancement-reliability-and-emergency-reserve-trader.

17 For example, AEMO's 5 November 2018 request to declare a risk to South Australia's power system from destructive winds. To assess the net economic benefits of declaring a protected event, AEMO proposed using a VCR of double the SA VCR calculated by AEMO in 2014 to account for the widespread nature which it sought to address. See https://www.aemc.gov.au/market-reviews-advice/request-declaration-protected-event-november-2018.

- as an input into recommendations arising from the AEMC's Black System Event Review.

6 Reason for draft decision

This chapter sets out the reasons for our draft VCR methodology outlined in chapter 3. This includes the reasons for our approaches to measure VCR for standard outages (section 6.2), and widespread and long duration outages (section 6.4), and our annual adjustment mechanism (AAM) (section 6.5). In each section we set out stakeholder views, our reasons for our preferred approach and our conclusion on the adopted approach. Appendix 2 sets out in detail submissions received from stakeholders and our response.

6.1 AER approach to identifying techniques to estimate VCR

Rule 8.12 requires us to develop a methodology that is fit for purpose for any current or potential uses of VCR we consider relevant. To help decide on an appropriate methodology we sought to first identify the current and potential uses of VCR. This allows us to understand the types of VCR values required and select the most appropriate approach to estimate these values.

Taking into account the identified uses of VCR set out in section 5.2, we considered that VCR values should be developed for:

- standard outages (typically less than 12 hours duration), and
- widespread and long duration outages which are more severe than standard outages, with a total impact ranging from 1-2 GWh to 15 GWh of unserved energy.

We also considered deriving VCR values for momentary outages (less than 3 minutes duration). On balance, we have decided not to include a methodology for momentary outages. The reasons for this are set out in section 6.3 of this chapter.

We considered three methodologies that are used to estimate VCRs internationally:

- surveys using stated preference techniques, where customers are asked directly to state their reliability preferences
- revealed preferences techniques, which study real life customer trade-offs between cost and reliability (for example, investment in standby generators or batteries, or interruptible supply contracts) to ascertain VCR
- model-based techniques using macroeconomic information, such as production functions for commercial and industrial customers and household income / leisure time function for residential customers.

Of the three methodologies, there was a strong preference for revealed preference techniques as they could, in theory, provide the most accurate estimate of VCR through observed customer trade-offs (assessment criterion 1). However, this approach was ultimately not adopted because it is untested and it would take a longer time than permitted under the Rules' timeframes for the review to properly design, pilot and implement a revealed preference study.

We do consider that the revealed preference method should be explored in future VCR reviews. With this in mind, we commissioned MEI to prepare a report on how revealed preference techniques could be applied in Australia. A copy of the MEI report will be published on the AER website. The report identifies a number of data and methodological issues that must be addressed before a revealed preferences approach becomes practicable.

Our review shows that some methodologies for estimating VCRs better address certain customer groups and outage attributes than other methodologies. In this section we discuss the reasons for our decision on methodology for:

- standard outages (section 6.2)
- widespread and long-duration outages (section 6.4)
- annual adjustment mechanism (section 6.5)

We discuss our reasons for not including a methodology on momentary outages in section 6.3 of this chapter.

6.2 Methodology for standard outages

For standard outages of durations, typically up to 12 hours, we will use a survey-based methodology with stated preference techniques. In developing our draft methodology we have built on the AEMO 2014 methodology.

Our proposed survey-based methodology for standard outages consists of the following components:

- combined contingent valuation and choice experiment techniques for residential and business customers with a peak demand of less than 10 MVA, and
- direct cost surveys for business customers with a peak demand of more than 10 MVA.

Surveys are our preferred methodology for estimating VCR values for standard outages because:

- the VCR values derived using survey approaches are forward looking and able to be applied to the majority of applications of VCR we have identified (assessment criteria 1 and 2)
- surveys seek information directly from customers, as distinct from model-based approaches that rely on historical data. The use of surveys also meets the requirements in the Rules that the VCR methodology must include direct engagement with customers (assessment criterion 3)
- surveys can better ascertain information about how customer perceptions of grid reliability change as a result of solar PV, battery storage and other emerging technologies. This better supports the achievement of the NEO (assessment criterion 1)
- survey-based approaches, particularly choice experiments, offer greater flexibility and granularity than model-based approaches with respect to the variables being measured / targeted, such as customer types, outage types (duration, temporal differentiation) location (jurisdiction, and further by CBD, urban, rural, remote) (assessment criterion 2).

This also supports the achievement of the NEO by allowing more targeted VCRs to be developed that enable better assessments of the efficiency of network expenditure (assessment criterion 1).

The two survey components of the draft methodology for residential and business customers consuming less than 10 MVA per annum and for large business customers consuming more than 10 MVA per annum are discussed in more detail below.

6.2.1 Residential and business customers < 10 MVA peak demand per annum

In this section we discuss:

- our preferred approach to derive VCRs for residential and business customers < 10 MVA peak demand per annum
- stakeholder views of our approach
- reasons for our preferred approach overall, and separately for contingent valuation and choice experiment survey techniques.

6.2.1.1 Survey techniques to derive VCRs for residential and business customers < 10 MVA peak demand per annum

For residential and business customers consuming less than 10 MVA peak demand per annum (business customers), we will use the same combination of contingent valuation and choice experiment survey techniques as AEMO did in its 2014 study, but with some modifications.

We consider these survey techniques best address our assessment criteria. They directly engage with customers (assessment criterion 3). Survey responses will reflect customer reliability preferences today (assessment criterion 1). They also allow for future reliability preferences to be reflected as additional questions can be included to reflect changes in technology, such as electric vehicles and increasing photovoltaic (PV) penetration (assessment criterion 1).

These survey techniques also more readily target different customer cohorts and geographic locations across the NEM (assessment criterion 2). We intend to increase the sample size to around 8 000 responses. This will allow us to achieve greater customer segmentation. See Appendix 3 for our proposed segmentation of VCR values.

Contingent valuation surveys ask customers how much they would be willing to pay to avoid an interruption, or how much they would be willing to accept as compensation for experiencing an interruption.

Choice experiment surveys are used to elicit values on specific attributes of a good or service. This technique asks customers to identify their most preferred option out of a series of choices. For example, the attributes of a power outage can include its duration, severity (widespread / localised), time of day and time of year they occur. The trade-offs customers make in choosing between options with different attributes can be used to determine the relative value respondents place on each of these attributes.

6.2.1.2 Stakeholder views

We received submissions from stakeholders in response to both our *Consultation paper* and *Consultation update paper* which were supportive of a survey-based approach for determining VCR values. Submissions were generally supportive of using the same survey techniques as AEMO did in 2014, but with refinements. The following stakeholders provided submissions supportive of this approach: Ausgrid, AusNet Services, Energy Council, Endeavour Energy, Energy Users Association Australia (EUAA), Evoenergy, Major Energy Users (MEU), Energy Networks Australia (ENA) and EnergyAustralia.[18]

Some of these submissions suggested we improve the survey techniques and aim for a larger sample size (Ausgrid[19], ENA[20]).

Some submitters suggested exploring alternative approaches, such as Energy Consumers Australia (ECA) who supported the use of the leisure time function, which is a model based approach[21], and EnergyAustralia who, while generally supportive of our approach, suggested we explore a revealed preference approach.[22]

6.2.1.3 Reason for our preferred methodology for residential and business customers < 10 MVA - overall

Contingent valuation and choice experiment survey techniques are able to capture both the direct costs residential and business customers experience due to an interruption in their electricity supply, as well as intangible costs such as loss of comfort (assessment criterion 1). We consider both the direct costs as well as intangible costs are important when estimating VCR values for residential and business customers.

MEI advised the combined contingent valuation and choice experiment survey techniques used by AEMO for residential and business customers are robust and can be implemented within the Rules' timeframe (assessment criterion 2). Submissions from stakeholders also largely supported us improving upon AEMO's methodology, considering that contingent valuation and choice modelling are best able to capture the values of residential and small business customers (assessment criteria 2 and 3).

The main alternative approach proposed by ECA was to use a model-based approach (leisure time function). We examined this methodology having regard to the assessment criteria. We note that it offers the benefits of relative ease and speed of application as it relies on publicly available data. However, we consider that the leisure time function has disadvantages compared to survey-based approaches. For example, unlike survey-based approaches the leisure time function:

- does not take into consideration other activities people may require electricity for, such as cooking, or working from home

18 Submissions: Ausgrid, AusNet Services, Energy Council, Endeavour Energy, Energy Users Association Australia, Evoenergy, Major Energy Users, Energy Networks Australia and EnergyAustralia.

19 Ausgrid submission to Consultation Paper (October 2018) - Values of Customer Reliability , November 2018, p.7

20 ENA submission to Consultation Update Paper (April 2019), May 2019

21 ECA submission to Consultation Update Paper (April 2019), May 2019 - see Report by Energia contained in the submission, Getting the Value of Customer Reliability Right.

22 EnergyAustralia submission to Consultation Update Paper (April 2019), May 2019, p.2

- does not interact directly with customers (as is required by the VCR rule)
- does not allow us to examine preferences for onsite generation and storage as indicators of changing technology preferences which may be useful in determining VCR values in future reviews
- does not easily target desired customer cohorts and locations. Instead, it is reliant on existing macroeconomic data for different customer cohorts and locations. To achieve the same level of granularity using the leisure time function it is necessary to make assumptions about the underlying data.

For this review we consider combined contingent valuation and choice experiment survey techniques are preferable for determining VCR values for residential and business customers. Using the same combination of survey techniques as AEMO did in 2014 allows for continuity of approaches whilst still providing an opportunity to make improvements and the flexibility to take into account new considerations, for example, CBD and regional representation and the increase in distributed energy resources (DER) and solar PV since 2014. However, in a number of matters where an exercise of judgement is required, we have had regard to the ECA work in addition to our own analysis, our expert advisers and stakeholder views.

Therefore, based on feedback from focus groups, pilot testing of the survey questions and consultation with stakeholders we have made the following modifications to AEMO's 2014 contingent valuation and choice experiment survey methodology:

- simplification of survey language
- changes to peak and off-peak times to reflect current usage (i.e. change in peak times used by AEMO in 2014 from 7-10am and 3-6pm, to 7-10am and 5-8pm)
- changes to the style of the contingent valuation question
- changes to the choice experiment questions.

The most significant changes we made to AEMO's 2014 methodology for residential and business customers are to the contingent valuation and the choice experiment questions. These changes and the reasons for the changes are discussed below.

6.2.1.4 Reason for our preferred methodology for residential and business customers < 10 MVA – contingent valuation question

In this section we explain AEMO's 2014 contingent valuation question, the changes we have made for our 2019 contingent valuation question, and our reasons for making the changes.

AEMO's 2014 contingent valuation question

In its 2014 study AEMO used a contingent valuation question asking customers their WTP to avoid two unexpected power outages a year (the baseline scenario). Each unexpected outage occurs on a weekday in winter and lasts for one hour in off-peak times. This question was asked twice using cost prompts. If respondents answered YES to the initial cost prompt they were asked the same question again, but at double the initial cost prompt. If respondents answered NO they were asked the same question again, but at half the initial

cost prompt. The cost prompts were expressed in dollars per month. Both residential and business customers were initially asked:

> *Would you be willing to pay an increase of $x per month in your electricity bill to avoid an outage?*

For residential customers the value of x was randomly selected for each respondent and ranged from $2 to $15. Business customers were also asked their WTP in dollars, however the dollar value was based on a percentage of the respondent's bill.

Under AEMO's approach residential responses were restricted to the cost prompts provided and the following assumptions regarding a residential respondent's WTP were made by AEMO[23]:

- NO/NO implied a zero WTP
- NO/YES implied WTP of half the first cost prompt
- YES/NO implied WTP equal to the first cost prompt
- YES/YES implied WTP of twice the value of the first cost prompt.

The same assumptions were made to business responses with one difference. Business respondents who answered NO/NO or YES/YES to both cost prompts, were asked an additional follow-up open-ended question to indicate their maximum WTP. This answer was accepted as the business customer's WTP.[24]

AER's 2019 contingent valuation question

Our contingent valuation question is similar to AEMO's 2014 question in that we ask respondents two questions using cost prompts about their WTP to avoid two unexpected power outages a year. Like AEMO's approach respondents who answer YES to the initial cost prompt will be asked the same question again, but at double the initial cost prompt. If respondents answer NO they will be asked the same question again, but at half the initial cost prompt.

However, we propose to modify AEMO's contingent valuation question by including an open-ended WTP question following the two cost prompt WTP questions. The response to the follow-up open-ended WTP question will be accepted as the respondent's WTP. This means we will not have to make assumptions, like AEMO did, to obtain a single WTP value from the range implied by the responses to the questions with cost prompts.

We will ask an additional question only to those respondents who answer with a WTP of more than $22 per month to our follow-up open-ended question. This additional question acts as a cap on our open-ended question. It asks whether respondents would be WTP $22 per month for a back-up power system. If respondents answer YES to this question then $22 per month will be accepted as the respondents WTP (instead of their response to our follow-

23 AEMO 2014 VCR Final Report Appendix, section B.4. Available at https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Value-of-Customer-Reliability-review.

24 This step was not detailed in the AEMO Final Report and we have reached this conclusion based on an analysis of additional information provided by AEMO about the 2014 survey results.

up open-ended question). For those respondents who answer NO we will ask a further follow-up open-ended WTP question for the back-up power system. The response to this question will be accepted as the respondent's WTP. [25]

In summary we propose to make the following modifications to the AEMO 2014 contingent question for residential and business customers:

Summary of modifications to residential contingent valuation question:

Residential customers

- **Reduce the cost prompt range to $2 to $9 per month (instead of $2 to $15 per month as used by AEMO) in the first cost prompt question, with a maximum cost prompt of $18 in the second cost prompt question.[26]**
- **Include an open-ended WTP question following the two cost prompt WTP questions.**
- **Ask only respondents who answered with a WTP of more than $22 to the follow up open-ended question a further question:**

  Imagine a company could install a backup power system at your premises. The system would readily provide electricity at your premises for one hour if an outage occurs. The total cost of the system, including installation, would be $22 per month. Would you get the company to install the backup system at your premises at a cost of $22 per month?

- **For only those respondents responding NO to the above question, ask them an open-ended question on their maximum WTP for the above system.**
- **The effect of the follow up questions on installing a backup power system is to cap the WTP responses at $22 per month.**

Summary of modifications to business contingent valuation question:

Business customers

- **Include an open-ended WTP question following the two cost prompt WTP questions for all respondents.**
- **Use percentages of bill to determine the dollar value of the initial cost prompt: 1 per cent, 2 per cent 3 per cent, 4 per cent, 5 per cent, 6 per cent, 7 per cent, 8 per cent, 9 per cent and 10 per cent (instead of up to 11 per cent as used by AEMO), with a maximum cost prompt of 20 per cent in the second cost prompt question.[27]**
- **Cap the follow-up open-ended WTP question at 100 per cent of the respondent's bill.**

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25 In the case where a respondent indicates a WTP greater than $22 per month, having just responded with a NO to the first question indicating they would not be WTP $22 per month, we would exclude these results on the basis of inconsistency.

26 Only respondents who are randomly selected for an initial cost prompt of $9 and respond YES will be asked the maximum cost prompt of $18 in the second cost prompt question. Respondents who are randomly selected for an initial cost prompt of $2 and answer YES will be asked a maximum of $4 in the second cost prompt question.

27 Only respondents who are randomly selected for an initial cost prompt of 10 per cent and respond YES will be asked the maximum cost prompt of 20 per cent in the second cost prompt question. Respondents who are randomly selected for an initial cost prompt of 1 per cent and answer YES will be asked a maximum of 2 per cent in the second cost prompt question.

AER reasons for contingent valuation question

In this section we explain why we made the changes to the contingent valuation question.

Why we introduced a follow-up open-ended WTP question

We consider the use of an open-ended WTP question is an improvement as it provides an indication of whether a respondent's maximum WTP differs from the cost prompts provided. This means we do not need to interpret the cost prompts responses as AEMO did in 2014. This provides a more accurate reflection of customer WTP (assessment criterion 1).

Why we chose to use cost prompts

We tested two approaches of open-ended WTP questions in our focus groups and our pilot survey. The first approach was a simple open-ended WTP question with no cost prompts and the second approach was to ask the open-ended question following two cost prompts. We have chosen to use cost prompts in our contingent valuation question because we consider these provide useful context. Cost prompts provide respondents with some price information, similar to what they would often receive before purchasing many other goods or services. This context makes the open-ended WTP question easier to respond to than a single open-ended WTP question without any cost information. Our consultants KPMG/ Insync recommend using an open-ended WTP question for the main survey, with two cost prompt questions preceding it to provide context and assist in framing realistic values.[28] This approach is also supported by MEI.[29]

Why we reduced the level of cost prompts

The residential cost prompts have been set with reference to the WTP cap (discussed below). The business cost prompts are broadly consistent with the range of business cost prompts used by AEMO in 2014, and WTP results observed in the pilot survey and AEMO 2014 Review.

Why we introduced a WTP cap

The results of the pilot survey showed that some respondents may provide unusually high WTP values. We consider the average WTP of the majority of respondents should not be overly influenced by a very few respondents who answered with unusually high WTP values, particularly when improved reliability is likely available to these customers at a lower price than they nominate (i.e. through procuring a backup generator). We consider this approach is in line with the intention of the NEO (assessment criterion 1) to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers.

28 KPMG, Value of Customer Reliability Pilot Survey Report, 5 September 2019, page 28.

29 Email, from Professor Train 1 August 2019.

Residential customers - WTP cap

The residential cap of $22 per month is based on the cost of a backup power supply system capable of providing electricity for an hour. In considering a cap to our WTP question for residential customers we considered the cost of alternatives to grid-provided reliability, such as back-up options installed at a customers' premises. We consider the cost of a reasonable alternative may be regarded as the maximum price one would pay for grid-provided electricity. For example, if grid-provided electricity cost more than this, it would be reasonable to expect the alternative to be favoured instead.

To identify the cap we considered factors such as outage length[30], cost, commercial availability, seasonality and consumer utility. With regard to utility, we consider the alternative option should:

- allow for minimal human intervention
- enable a broad range of typical residential activities to continue with minimal disruption
- be of a physical size consistent with the residential environment.

To develop the alternative we also considered back-up supply options for houses and apartments. For houses, petrol or diesel powered single phase generators ranging in size from 3.5 to 7.5 kVA may be used; for apartments, 3 kVA uninterruptible power supply (UPS) systems are appropriate. Our cap is based on the weighted average of a 6 kVA back-up generator and a 3 kVA UPS. Both options will allow a wide range of domestic appliances to be operated simultaneously during an outage, thus maintaining a nearly normal lifestyle with minimal inconvenience for the typical consumer.

We based our calculation of the cap on prices available from merchant websites accessed on 16 August 2019. We assumed a 10 year life and an interest rate of 4% p.a. More information on how this cap has been calculated is set out in Appendix 4.

Business customers WTP cap

We considered whether we could similarly apply a cap based on back-up generation for business customers. However, due to the heterogeneity of businesses we found it difficult to identify appropriate back-up generation on which to base the cap. This is because within an industry the business could vary significantly in size. Calculating a cap by industry type would require us to make a number of assumptions about average energy use and average peak demand for each industry. This is particularly problematic for industries where businesses vary significantly in size, such as mining and manufacturing.

We also considered a cap based on the energy use of the business itself may be more appropriate. This approach would allow us to better determine the appropriate back-up generator size for each business and hence an appropriate cap. However, our survey asks only about how much the last energy bill was. We cannot verify this, nor determine annual energy use from this figure. To apply a cap based on energy use we would need to

30 The back-up supply source should replace grid supply during a one hour outage, which is the duration of our base case scenario in our contingent valuation WTP question.

incorporate a question about energy use and peak demand in our survey for the business. This additional complexity for respondents could decrease our response rate.

In its 2014 review AEMO applied a cap to unusually high responses based on the amount of the respondent's last bill. As we have not identified a better method to cap unusually high responses, we propose to adopt the same approach as AEMO did in its 2014 study, and will set the cap at the amount of the last bill.

6.2.1.5 Reason for our preferred methodology for residential and business customers < 10 MVA – choice experiment question

Our choice experiment asks respondents to repeatedly select a preferred option from a set of eight different scenarios. Each scenario contains three options asking respondents to select the outage option they would prefer based on the different attributes of discount, duration, severity, time of day / week / year. One option is held consistent across all eight scenarios. This is our 'baseline scenario' presented in the contingent valuation question, which is: *a localised, one hour outage, occurring twice a year, in winter, off-peak and on a weekday*

This technique will estimate VCR values varying from the 'baseline scenario' due to changes in outage characteristics. In the choice experiment we have tested the same outage characteristics as AEMO. The only two exceptions are:

- the definition of peak time, which we have changed from 7-10 am and 3-6 pm to 7-10 am and 5-8 pm to account for changes in customer consumption behaviour since 2014
- the frequency characteristic (measuring how often the specific outage scenario occurs in a year), which we have kept constant, as there is a lack of supporting data to properly integrate results for this attribute.

Pilot testing showed that our choice model delivers statistically significant results for key outage characteristics. However, a second order issue identified was that a large number of respondents selected the 'baseline scenario'. KPMG/Insync made three recommendations to decrease the number of respondents selecting the base case:

- changing the location of the bill discount in the choice model sets so it appears first and is more prominent
- randomising where the base case option appears in each choice model set
- changing the level of the bill discounts.

We have adopted the first two recommendations, but will not change the level of bill discounts. MEI advised the high number of baseline responses were not problematic as we were able to get statistically significant responses and the overall pattern of responses demonstrates respondents were paying attention and choosing on the basis of things that matter to them.

Adjusting the level of bill discounts is not a straightforward task. To be effective, the bill discounts must be set out so as to make the respondents think hard about the choices presented. Increasing the bill discounts too much may make the choices too easy, with less need to "trade off" between aspects of the outages and discounts, which would result in less

useful results. Given the pilot survey results demonstrate respondents made meaningful choices and trade-offs, we do not consider it is necessary to change the bill discount levels.

6.2.1.6 Conclusion

Our draft decision is to adopt the same combination of contingent valuation and choice experiment survey techniques as used by AEMO for our methodology to determine VCR values for residential and business customers consuming less than 10 MVA per annum. However, we have made some modifications to these techniques based on feedback from stakeholders, focus groups and pilot testing.

The principal changes are:

- introducing an open-ended WTP question following the two cost prompt WTP question for residential customers and for all business customers (not just those business customers who responded with NO/NO and YES/YES),
- introducing a residential WTP cap of $22, and
- lowering the levels of the cost prompts.

We considered two alternative methodologies for estimating VCR values for standard outages including a model based approach (the leisure time function) and revealed preferences, but found for this review both these approaches have some disadvantages. The leisure time function does not capture personal care time such as cooking. It also does not allow for the same level of granularity in VCR values as survey based techniques. Our review of different revealed preference approaches suggests that at this stage it is too early to adopt a revealed preference methodology as there is currently not enough available data to carry out such a study.

6.2.2 Large customers > 10 MVA peak demand per annum

We are adopting a direct cost survey for large energy customers, similar to that used by AEMO in 2014. The key differences are including large distribution connected customers who have a peak demand equal to or greater than 10 MVA (in addition to transmission-connected customers) and accounting for differences between 24/7 and non-24/7 business operations.

6.2.2.1 Stakeholder views

Stakeholders supported our development of a direct cost survey for the largest business customers and its extension to distribution-connected customers[31], including our VCR Consultative Committee. Stakeholders considered the threshold of 10 MVA peak demand was reasonable, and noted the threshold may not be appropriate for the Northern Territory due to the small number of eligible customers.[32]

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31 Submissions indicating support of a direct cost survey include Ausgrid, AusNet Services, Business SA, Energy Networks Australia, Energy Users Association of Australia, and Evoenergy.

32 Energy Networks Australia, Submission to Consultation Update Paper – Values of Customer Reliability, 24 May 2019, p.3

6.2.2.2 Reason for preferred methodology

In its 2014 study, AEMO used a direct cost survey for transmission-connected customers. The direct cost survey asks customers to indicate the costs to their business associated with different outage types - for example, outages of different durations and occurring at different times. This survey type is appropriate for very large businesses who are likely to have a detailed understanding of their energy requirements, enabling them to answer detailed questions of this nature. Also, they ask about tangible costs to business which we consider to be the key drivers of VCR values for large businesses.

We have similarly opted for direct cost surveys to collect information from transmission-connected businesses, and will also use it to seek information from the largest distribution-connected customers. Large distribution-connected customers are likely to have similar characteristics and reliability needs to transmission-connected customers, making them well-suited to answering a direct cost survey. The benefit of extending the survey to these customers is that it allows us to identify a larger cohort of customers to survey, resulting in improved statistical significance, and more opportunity for segmentation.

To distinguish between distribution connected customers eligible to receive the direct cost survey and those eligible to receive the other business survey, we have adopted a threshold eligibility requirement of 10 MVA peak demand experienced sometime in the previous 12 months, for those answering the direct cost survey. We understand there are approximately 300 customer sites in the NEM that meet this threshold. Businesses requiring this amount of energy are likely to have sophisticated knowledge of their energy needs. The survey seeks information about energy costs at a particular site. We will ask owners of multiple eligible sites to complete one survey for each site.

The direct cost survey also meets our methodology assessment criteria. For example, by engaging directly with customers and asking about the costs each incurs from outages, direct cost surveys elicit a good reflection of current customer reliability preferences fulfilling assessment criteria 1 and 3. The survey will apply to all customers in the NEM who meet the eligibility requirement from all geographic locations and varied industries. We intend to segment the values into a number of different industry groupings, subject to survey response rates, ensuring they are applicable to a wide range of uses, hence fulfilling assessment criterion 2.

The survey includes some revisions to AEMO's direct cost survey design. For example, by extending the survey to large distribution-connected customers we cannot assume they operate continuously unlike transmission-connected customers. To account for this we have developed two versions of the survey - one each for customers with and without 24/7 operations. As it is an online survey, respondents receive the appropriate survey based on their answer to a preliminary question about whether their business operates continuously (i.e. 24/7) or not. We consider the differences discussed here are relatively minor.

We recognise that in the Northern Territory (NT) there are few customers that meet the 10 MVA threshold. For this reason we do not intend to apply direct cost surveys in NT, and instead propose to use our other business survey for all NT businesses surveyed.

6.2.2.3 Conclusion

Our draft decision is to adopt a direct cost survey for large energy customers, similar to that used by AEMO in 2014. The key differences are including large distribution connected customers as well as transmission-connected customers, and some minor amendments to the survey design. This approach allows us to reach a greater cohort of large businesses and to improve the survey response rate. This approach has received general support from stakeholders during the consultation process.

6.3 Methodology for momentary outages

Momentary outages are outages lasting less than three minutes. Some customer groups, such as smelters, paper mills, and food processors (distillers, dairy), may be more impacted by these outages than others. Stakeholders have suggested VCRs for these outages would be useful for network planning purposes. However, it is not clear the extent to which network solutions could prevent or mitigate momentary interruptions of supply and whether customers place any substantial value on grid solutions to address momentary outages.

We do not intend to formally calculate VCR values for momentary outages. At this stage, we have not identified any applications for a measure for momentary outages within the current regulatory framework. Generally speaking, the major cost of momentary outages is not the lost production during the event, but rather the cost of recovering from the event once the power is restored. This is a dollar amount which is associated with very small amounts of lost energy. We have not identified a better measure than $/kWh to measure this parameter. However, a value calculated based on $/kWh would be extremely large and potentially misleading if used in network planning or investment. For this review, we plan to gather and report information on momentary outages through our surveys.

As a first step, we will ask residential and business customers about momentary outages. For residential and business customers we will use the contingent valuation survey technique. Survey respondents will be asked how much they would be willing to pay, if anything, for investment in the electricity network to address momentary outages. For large business customers we will ask whether any investment in back-up generation has been undertaken to help mitigate the impact of momentary outages.

We intend to publish the results from the information we collect on momentary outages through our surveys. We consider the results may help inform the development of regulatory incentives or mechanisms to address momentary outages and form the basis of a methodology for momentary outages in future VCR reviews.

6.4 Methodology for widespread and long duration VCRs

To derive VCRs for widespread and long duration outages, we propose a macro-economic modelling based methodology supplement by other appropriate approaches. We will model the economic and, to the extent possible, social costs resulting from a number of outages ranging in severity from 1-2 GWh to 15 GWh of unserved energy. We will derive a curve that best fits the modelled costs of these different outage scenarios that describes the impact of increasing severity of outages on VCR.

We note that the earlier references in our review refer to this work stream as HILP VCRs. The change in terminology to widespread and long duration VCRs reflects the revised scope of the study to events of a magnitude equal to or less than 15 GWh of unserved energy.

6.4.1 Stakeholder views

There were differing views among stakeholders regarding widespread and long duration outages. A number of stakeholders identified uses for VCRs for these outages and supported the VCR methodology including a methodology for these outages.[33] However, other stakeholders were not supportive, expressing concerns that such VCRs may be misused, these outages are difficult to define, and that corresponding VCRs would be difficult to measure as they are rarely experienced by customers and as such are not amenable to a survey methodology.[34]

6.4.2 Uses of widespread and long duration VCRs

We have carefully considered whether or not to derive VCRs associated with widespread and long duration outages. To do this, we have focused on whether there are identified uses for widespread and long duration outages.

Our review has found that VCRs derived for standard outages using survey approaches are sufficient for the majority of uses. We have identified a limited subset of uses where widespread and long duration VCRs would be preferable. These identified uses are outlined in the table 6.1 below and relate to settings or mechanisms to mitigate high impact events. Uses of widespread and long duration VCRs outside of these identified applications should be justified.

Accordingly, to ensure our published values are fit for purpose for all identified purposes, we propose to develop a methodology to derive widespread and long duration VCRs.

Table 6.1 - Identified uses of widespread and long duration VCRs

Application	Who	Relevance of widespread and long duration outage VCR
System Restart Standard Review	**Reliability Panel**	In the Reliability Panel's 2015 System Restart Standard Review, VCR was used as an input for the economic assessment (by estimating the value which customers place on avoiding region-wide blackouts of varying duration) of different quantities of SRAS on a regional basis. This then guided the specification of the settings in the system restart standard. It was recognised at the time of the 2015 System Restart Standard Review that the 2014 AEMO VCRs may not be

33 Submissions: ENA, AEMO, Business SA, Ausgrid, TasNetworks, S&C Electric, Transgrid; (VCR Consultative Committee and HILP) Reliability Panel, AEMC, PIAC

34 Submissions: EUAA, Origin

		the perfect fit for widespread outages in the event of a system black. A sensitivity analysis of 30% was applied to the AEMO VCR values as part of the economic assessment.
Protected events	**Reliability Panel**	The Reliability Panel can declare a protected event to allow AEMO to take certain pre-emptive actions to manage a particular risk if it finds there are net economic benefits from doing so. Last year AEMO submitted its first protected event request to mitigate against the risk of a black system event in South Australia caused by multiple generator failures from destructive wind conditions. AEMO used as a sensitivity a VCR value double the current SA VCR. Widespread and long duration outage VCRs would be useful to help assess future requests as protected events are likely to involve widespread and long duration outages.
Black System Event Review	**AEMC**	Widespread and long duration VCR may form an input into the existing protected events framework or any enhancements to that framework.

6.4.3 Reasons for the preferred methodology

Macro-economic approach

We consider a macro-economic modelling based approach to estimate the VCRs associated with widespread and long duration outages preferable to other approaches. This decision has had regard to the input we have received from the MEI, stakeholder submissions to our initial *Consultation paper* and *Consultation update paper*, and the outcomes of the Subcommittee and Committee meetings and our discussions with other Government agencies involved in disaster recovery.

A macro-economic approach is preferable because of the need to account for costs beyond an individual affected by an outage, such as economy-wide costs, flow-on costs, or other costs borne by society. It is not clear how a survey approach would capture these costs (assessment criterion 1).

We will not use survey techniques to estimate these VCRs, nor do we propose a "hybrid approach" (that is, some sort of combination of surveying respondents with a modelling approach). This is because:

- we consider in a contingent valuation survey respondents would encounter great difficulty accurately stating their WTP or willingness to accept (WTA) for such severe outages that have either rarely occurred or have yet to occur in the NEM. This view was also held by a number of stakeholders in submissions and our Subcommittee
- using a choice experiment survey approach also presents difficulties, such as setting appropriate compensation amounts in choice sets to generate useful information about

customers' reliability preferences. To our knowledge, there is no prior information currently available to inform appropriate compensation amounts for such severe outage scenarios

- a hybrid approach introduces complexity both in the implementation (multiple methodologies need to be developed) and analysis stages (reconciling differences between survey respondent results and modelled results).

We consider that widespread and long duration VCRs derived under a macro-economic modelling based approach would be fit for purpose for the identified uses of VCR set out in table 6.1 above (assessment criterion 2).

Scope of modelling scenarios

We will model the economic and, to the extent possible, social costs resulting from a set of outages ranging in severity from 1-2 GWh to 15 GWh of unserved energy. We will derive a curve that best fits the modelled costs of these different outage scenarios that describes the impact of increasing severity of outages on VCR. To put this range of unserved energy into context, the lower bound of the range (1-2 GWh of unserved energy) corresponds to a large regional town being without power for around 12 hours. This has been chosen to coincide with the uppermost limit of the standard VCR outages derived through the survey. This approach was endorsed by the Subcommittee and Committee.

At the upper bound of the range, 15 GWh of unserved energy is larger than the SA Black System event, as it is of an extended duration of 10 hours and occurring during summer peak demand conditions.

Initially we considered modelling the impacts of larger events. However, as outlined in the Energy Security Board's (*ESB's) Post 2025 Market Design Issues Paper*, a range of rule changes and initiatives have been implemented to support AEMO to continue to manage system security. These changes were implemented to significantly reduce the likelihood of a similar event in SA. Further, events beyond this are even less likely to occur. Larger NEM region-wide blackouts could only occur in the event of an extremely unlikely coincidence of multiple geographically dispersed network events and multiple failures of existing processes and non-compliances by multiple market participants. We consider the modelled scenarios within the 1-2 GWh to 15 GWh range should produce widespread and long duration VCRs which are sufficient for the applications we have identified.

To reflect the change from our earlier thinking we have renamed this area of work from HILP VCRs to widespread and long duration outage VCRs.

6.4.4 Conclusion

Our draft decision is that our methodology should include a mechanism for producing VCRs for widespread and long duration outages. We have identified several uses for these VCRs. Our draft decision is to adopt a macroeconomic modelling methodology over survey approaches which are unlikely to be a suitable for deriving widespread and long duration VCRs. Using a macroeconomic modelling approach we propose to derive a widespread and long duration VCR cost curve. This approach has received support from stakeholders during the consultation process.

6.5 Methodology for annual adjustment mechanism (AAM)

The Rules (s. 8.12) specifies a requirement for the AER to develop a methodology for calculating VCR at least every five years, and for the VCR methodology to include an AAM. We propose to adjust VCR values on an annual basis using a CPI-X approach, where X is set to zero.

6.5.1 Stakeholder views

A number of stakeholders, including Energy Networks Australia (ENA), network businesses, and retailers, suggested the AAM should be designed to provide certainty to the industry, and indicated a preference to maintain real values of VCR by only adjusting for inflation. ECA and S&C Electric Company proposed the AAM should enable changes in real dollar values of VCR, and should take account of energy specific factors that may decrease or increase real VCR values, respectively. Similarly, Energy Queensland proposed annual adjustments should be forecast similarly to demand and consumption, taking account of AEMO's electricity forecasting insights. Energy Queensland considered this would provide more accurate VCR values between reviews, thus smoothing step changes in VCR values from one VCR review to the next. Business SA suggested VCR values should not be indexed by inflation, but should be changed every 3 to 5 years following a survey process.

Stakeholders generally advocated one of two options:

- to adjust VCRs by inflation to maintain real dollar values of VCR
- to enable the AAM to achieve real changes in VCR dollar values by including a mechanism to reflect changes in the energy sector which may drive reliability preferences.

6.5.2 Reasons for preferred methodology

The purpose of the AAM is not defined either in the Rules or the 2018 AEMC rule change consultation documentation establishing the requirement for the AER to determine VCR values on a periodic basis.

In its 2014 VCR review, AEMO opted for annual adjustments of VCR values by CPI. AEMO's consultation documentation suggests it sought to adopt a simple measure for the purpose of 'escalation' and 'indexation' of VCR values, suggesting a principal goal was to preserve real dollar values of VCR.

In developing our preferred approach, we considered the two main options favoured in submissions. In our *Consultation update paper* we flagged a preference for the latter approach, referring to it as 'CPI–X', where X includes energy specific factors that may increase or decrease VCR values. We noted adjusting VCR values on an annual basis (between reviews) by CPI may not fully reflect the changing energy sector and the long term interests of consumers. We suggested the AAM should take into account expected future changes in the Australian energy sector, including the adoption of storage, solar PV and electric vehicles.

While we recognise the advantages of this approach and maintain a theoretical preference for it, further research has revealed a number of practical difficulties in calculating X (energy specific factors) and considerable risk in miscalculating it. In particular, we consider it currently infeasible to accurately determine the relationship between potential energy specific drivers of VCR, and changes in VCR values themselves.

Our research included consideration of a wide range of possible influences on the dollar values people place on reliability and the amount of unserved energy, which is likely to change VCR values. We focused particularly on factors for which data is readily available, and identified the following list of factors that may be calculated to give X. They are:

- solar PV uptake as proportion of customers
- battery uptake as a proportion of customers
- solar and battery uptake as a proportion of customers.

To calculate VCR values for customers with these technologies one would calculate the dollar value customers with these technologies place on reliability, and the proportion of customers with these technologies. Figures for household battery and PV uptake are readily available and published on an annual basis. We also included particular questions in our surveys on solar and battery uptake to indicate whether there is a difference in dollar values between customers with and without these technologies. However, we have identified difficulties in translating changes in these factors to changes in VCR values. We intend undertaking future work to investigate factors which may affect the calculation of X and how they may be quantified.

Residential customers

The effect on VCR values from household solar installations alone is likely to be limited. The primary purpose of solar installations (without a battery) is to supplement household energy use during the day. Solar installations are designed to cut out during an outage, and hence would not improve household reliability. Therefore, solar customer VCR values are likely to be the same as customers without solar.

At present battery uptake is very limited and only a proportion of batteries are configured to provide power during an outage, and most do not contribute to improving reliability. VCR values for those with improved reliability may be lower, however, given this is such a small proportion of customers, their preferences would not materially influence VCR values for residential customer segments. Customers receiving feed-in tariffs may have a slightly higher VCR value, but the difference is likely to be negligible.

Business customers

The task of adjusting VCR values according to uptake in solar PV and battery storage is also complex for business customers. As for households, solar alone would supplement energy usage during the day, leaving VCR values unchanged. VCR values of customers selling energy to the wholesale market may be slightly higher than those without.

In relation to batteries, differences between the battery size compared to the size of business operations makes it difficult to infer particular relationships between batteries and

VCR values. For example, a business may install batteries to provide power to run a proportion of their operations during an outage for a limited time, which may reduce the dollar value they place on network reliability only slightly. If they installed a larger system they may be able to continue production at normal capacity, possibly reducing the dollar value they place on network reliability to zero. Another purpose for batteries may be to provide energy during peak periods to lower demand tariffs rather than improve reliability, leaving VCR values unchanged.

Inflation-only adjustment

These complexities introduce the risk that we miscalculate the direction and magnitude of VCR adjustments and shift away from actual VCR values. The cumulative effect of this error would be to move VCR values further away from actual values, causing adjustments at the time of the next VCR review to be even greater than they would have been without annual adjustments.

Our current preference is therefore to adopt inflation-only adjustments until the next VCR review, with a view to possibly adopting an alternative methodology taking account of energy specific drivers for annual adjustments, pending the availability of additional data. For this reason we propose an AAM with the general form CPI-X, where X is zero.

A benefit of adjusting by inflation is that it provides certainty to stakeholders about annual changes to VCR, which a number stakeholders indicated is important for the AAM. Also, if we considered for any reason there was likely to be large changes in VCR values influenced by particular or unusual factors, rather than assess these within the scope of an AAM review it would be preferable to bring forward the next 5-yearly VCR review. This would allow us to take more time to measure the impact of particular factors and undertake more stakeholder consultation. In addition, energy specific factors are likely to influence VCR values over a longer period of time so that it is more practical to account for them less frequently than yearly.

Our preferred form for the AAM provides a mechanism to reasonably reflect changes in VCR values yearly. It takes account of the fact there are difficulties in determining the influences of specific drivers on VCR values, and that there are particular risks in estimating X and its influence on VCR values, which if miscalculated may cause real VCR values to shift away from actual values annually, reducing the stability of VCR adjustment and certainty for stakeholders by magnifying step changes at the time of the next five-yearly review. We therefore consider our preferred AAM methodology meets assessment criteria 1 and 3.

We note another option mentioned in the AEMC VCR rule change final determination is that the AER can also choose to make the AAM zero (for example, CPI-X equals zero). In so doing we would effectively choose not to adjust VCR values annually. Not adjusting for inflation would reduce VCR values in real terms, as inflationary adjustments preserve the real dollar values of VCR. We consider adjusting for inflation is preferable to making the AAM zero because we would not be able to control the direction and magnitude of real VCR changes with an AAM of zero. Hence, we do not intend to make the AAM zero.

6.5.3 Consideration of inflation measures

We considered a number of inflation measures to adopt for the AAM, including the Consumer Price Index, the GDP deflator and the Producer Price Index.

- The Consumer Price Index (CPI) is the best known inflation measure that tracks the price of a fixed basket of goods and services purchased by Australian households. We consider it is likely to be an appropriate measure for adjusting VCR values, noting that it has a broad base which is preferable for adjusting VCR because it captures a wide range of products and services representing a wide range of uses for energy in society, and by extension, the values attached to them.
- The GDP deflator also measures inflation, measuring the total monetary value of all new, domestically produced and final goods and services in the economy – that is, a much broader range of goods and services than the CPI. Also, unlike the CPI it does not measure a fixed basket of goods, but the basket changes from year to year depending on consumption and investment patterns. Because it covers a broad range of goods and services we consider it is likely to be an appropriate measure to adjust VCR values. However, we note it is less well understood than CPI.
- The Producer Price Index (PPI) is a group of indexes that calculates the average movement in selling prices for domestic products. It represents inflationary changes for sellers only, and would not cover all the uses of electricity (including uses that are not production inputs). Therefore, we consider it is likely to have too narrow a focus for adjusting VCR values.

We note the GDP deflator has the broadest base of these measures, however it is less well-known than CPI. We have opted for CPI adjustments because CPI has a reasonably broad base, covering a wide range of uses of electricity as an input in consumer goods and services. It is a well-known measure of inflation, with CPI adjustments being widely used and understood.

6.5.4 Conclusion

While we maintain a theoretical preference for calculating X to enable real adjustments in VCR values annually, our draft decision is to make inflation-only annual adjustments (where X is set to zero), recognising the difficulties in calculating X and its influence on VCR values. We intend to adjust VCR values annually by CPI, and consider it the most recognisable inflation measure with a broad-base enabling it to capture a wide range of uses for energy in society and the values attached to them. If future work identifies a means to better quantify X, we will reconsider this decision in consultation with stakeholders.

6.6 Methodology to convert survey results into dollar per kilowatt hour ($/kWh) values and aggregating VCR values

The results obtained from the VCR survey techniques used to derive standard outage VCRs will need to be converted into $/kWh values and aggregated to be used in the applications we have identified.

We propose to use the same approach, with updated data, used by AEMO in 2014. We consider this approach continues to be appropriate for our methodology.

Broadly, this approach consists of:

- For residential customers:
    - the contingent valuation and choice experiment results will be combined to produce dollar VCR values for a range of outage scenarios for each customer segment. Estimates of residential customer consumption will be used to derive $/kWh VCRs for each outage. The estimates of customer consumption will be based on consumption data obtained from the survey or other available sources of customer consumption (actual or modelled).
    - the $/kWh VCRs for each outage will be probability weighted and summed together to derive an aggregate VCR for the customer cohort. The outage probabilities will be estimated using historical outage network data.
- For business customers where peak demand is less than 10 MVA:
    - a similar approach as the one outlined above for the residential survey is followed to derive $/kWh values for each business customer segment. There is an additional step of converting the contingent valuation and choice experiments survey results, which are percent of bill figures, into dollar values. This will be done using estimates of bill for each cohort based on consumption, size and the relevant business sector.
    - like the residential survey, estimates of customer consumption will be based on consumption data obtained from the survey or other available sources of customer consumption (actual or modelled), and outage probabilities will be estimated using historical outage network data.
- For business customers where peak demand is more than 10 MVA:
    - for each response, the direct cost of each outage scenario indicated will be converted into a $/kWh VCR using consumption data obtained from the survey.
    - the $/kWh VCR for each outage will be probability weighted and summed together to derive an aggregate VCR for the business customer. The outage probabilities will be estimated using historical outage network data
    - the aggregate $/kWh VCR for each response will be combined, along industry grouping or sector, with other responses on a load-weighted basis to produce a combined aggregate $/kWh a particular industry or sector grouping.
- Aggregate $/kWh VCRs for a particular area or region can be derived by combining, on a load-weighted basis, the aggregate $/kWh VCRs of the relevant customer segments

7 Next steps

We have until December 2019 to develop a methodology for estimating VCRs, derive VCRs using our methodology and develop a mechanism for adjusting VCRs on an annual basis. To achieve this, we will start undertaking, in parallel with consultation on the draft VCR methodology, the survey and modelling work required for estimating VCR values. This is to enable us to meet the statutory timeframe to publish values by 31 December 2019, if the draft decision consultation does not raise additional issues.

In coming to the draft decision, we have undertaken an extensive consultation process and have consulted-widely and regularly. Our draft decision addresses issues raised by stakeholders during our consultation process. We also consulted regularly with the VCR Consultative Committee on key issues, including the changes introduced to the contingent valuation question and how to derive widespread and long duration outages.

If stakeholder submissions to the draft decision raise issues which may warrant revisions to the VCR methodology, we would fully consider those submissions and make any appropriate modifications that are necessary to best give effect to the requirements in the Rules. We would not be constrained by the fact that we have already undertaken some survey or modelling work.

Our project timeline, including publication of our final decision on methodology, publication of final VCR values and upcoming VCR Consultative Committee meetings is set out in Table 7.1.

7.1 Implementation of methodology for standard outages

7.1.1 Direct cost survey - large business customers

We launched the direct cost survey for transmission-connected and large distribution-connected customers on Friday 23 August 2019. There are two versions of the survey - one for business sites with continuous 24/7 operations and one for business sites with non-continuous operations. The surveys were distributed to business customers who meet a threshold eligibility requirement: businesses that have experienced peak demand of at least 10 MVA in the previous 12 months. The survey will remain open until late September.

Once we have received responses to our direct cost survey we will use the results of the survey to calculate final VCR values. We will also be able to determine whether we can segment VCR values as envisaged for large business customers.

7.1.2 Contingent valuation and choice experiment survey - residential and business customers

We will launch our surveys for residential and small and medium business customers in September 2019. The surveys will remain open until mid-October 2019. They will be distributed by Insync through its panel provider.

We will also contact a number of business associations for assistance in distributing the business survey to their members. We plan to obtain 8 000 responses to our surveys (6 500 residential responses and 1 500 business responses).

Once we receive the responses to our survey for small and medium business customers we will calculate final VCR values. We will also be able to ascertain from the results of the surveys whether we will be able to achieve our proposed segmentation of VCR values for residential and business customers.

7.2 Implementation of methodology for widespread and long duration outages

We have issued a tender for a qualified consultant to undertake a study of the costs associated with widespread and long duration outages. We will engage a consultant to undertake the study. The study will use a model-based approach. This will be one of the first studies examining widespread and long duration VCRs. Due to the novel nature and complexity of this work we will likely take additional time to ensure the robustness of our approach and confidence in our results. Thus, we anticipate that the results of this study will be published in the first quarter of 2020.

7.3 Project timeline

Our project timeline with our next key deliverables is set out in table 7.1

Table 7.1: VCR Review Project Timeline

Key milestones	Date	Status
Consultation paper published	19 October 2018	Completed
VCR Consultative Committee established	October 2018	Completed
Stakeholder submissions to Consultation paper	16 November 2018	Completed
VCR Consultative Committee meeting #1	28 November 2018	Completed
Sydney Public forum	5 December 2018	Completed
Melbourne Public forum	6 December 2018	Completed
Presentation to Customer Consultative Group (CCG)	11 December 2018	Completed
Further stakeholder submissions in response to Consultation paper and key issues raised at public forum and CCG	20 December 2018	Completed
All day workshop with MEI, KPMG/Insync on VCR methodology	17 January 2019	Completed
VCR Consultative Committee meeting #2 – VCR methodology and survey design	7 February 2019	Completed

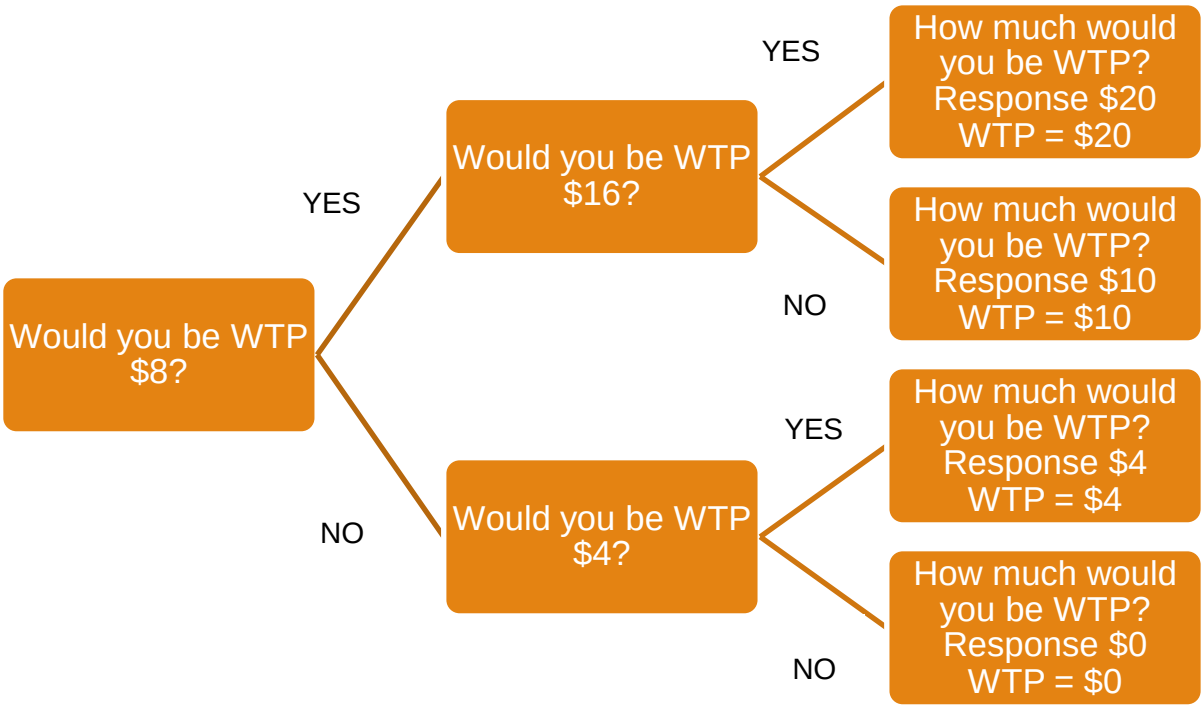
VCR HILP Subcommittee meeting #1 – how to determine HILP VCR	14 March 2019	Completed
Commence pilot	End April to 24 May 2019	Completed
Publish Consultation update paper on methodology	Mid April 2019	Completed
VCR HILP Subcommittee meeting #2	23 May 2019	Completed
Submissions to Consultation update paper	24 May 2019	Completed
Insync report on pilot survey results	June 2019	Completed
VCR Consultative Committee meeting #3 to discuss draft pilot survey results	13 June 2019	Completed
VCR Consultative Committee meeting #4 further discussion of pilot survey results	25 July 2019	Completed
VCR Consultative Committee meeting #5 to discuss Draft decision methodology	29 August 2019	Completed
Commence macro-economic modelling for widespread and long duration outages	September	
Conduct main survey and analyse results	September/October 2019	
Publish Draft decision on methodology	18 September 2019	
Submissions to Draft decision close	18 October 2019	
Develop methodology and model for widespread and long duration outages	September/October 2019	
VCR Consultative Committee meeting #6 to discuss customer energy use profiles and outage probabilities to derive $/kWh VCRs, and stakeholder responses to Draft decision	Late October 2019	
Insync main survey draft report	End October 2019	
Publish Final decision on methodology	Mid November 2019	
Complete modelling and establish VCR values for widespread and long duration outages	November 2019	
VCR Consultative Committee meeting #7 to discuss final VCR values	29 November 2019	
Publish final VCR values for standard outages up to 12 hours	Mid December 2019	
Publish VCR values for widespread long duration outages	Q1 of 2020	

Appendix 1: Stylised diagram of AER contingent valuation question

AER 2019 Contingent valuation question: two WTP questions with cost prompts followed by an open-ended WTP question.

Questions asked with reference to WTP to avoid both the outages of the baseline scenario.

Initial cost prompts chosen at random: $2-$9



Appendix 2: Summary of submissions and AER response

Issue	Party	Summary of Submissions	AER Response
Survey methodology: General comments about choosing a methodology	TransGrid, S&C Electric, Ausgrid, Major Energy Users (MEU), Endeavour Energy, SA Power Networks (SAPN), Energy Users Association of Australia (EUAA), Origin, EnergyAustralia, Energy Consumers Australia (ECA)	TransGrid suggests the AER review a range of methodologies used internationally to arrive at its preferred methodology. To assess each, it should introduce assessment criteria. S&C Electric makes the same comment and particularly draws attention to a VoLL study in the UK which provides learnings about survey design, customer surveys and VCR segments. Ausgrid considers it important to have a high degree of confidence in the derived VCRs nationwide, and considers multiple methodologies should be incorporated to achieve this. MEU considers the appropriate methodology should be chosen without a focus on cost. The methodology should take account of the fact very large customers have low VCRs. For large customers, some operations are more critical than others, and they have back-up supply for some critical processes. They are also prepared to load-shed at high prices. Outages occurring at different times also have different VCRs attached to them which needs to be taken into account particularly for large customers. The methodology also needs to take account of the fact network reliability is increasingly being substituted. MEU considers VCRs nationally and internationally are going down over time; also Australia's VCRs are high by international standards. MEU proposes the AER assess methodologies against the NEO. It notes there are not enough price signals to enable one to observe, for example, load shedding preferences which may be used as a (revealed preference) method to estimate VCRs. It considers surveys are the best methodology to develop VCRs. MEU considers the AEMO methodology was an improvement on previous methodologies but could be further improved. Endeavour Energy notes the use of model-based approaches may provide a valuable cross check of VCR values derived from surveys. SAPN suggests in assessing methodologies, the AER should consider tangible and intangible benefits of reliability	We note suggestions from stakeholders that some methodologies are better suited than others for different types of outages and customer types. We considered three methodologies used internationally to estimate VCRs: • surveys using stated preference techniques, where customers are asked directly to state their reliability preferences • revealed preference techniques, which study real life customer trade-offs between cost and reliability • model-based approaches using macroeconomic information. We considered suggestions from MEU and ECA to develop assessment criteria. Our assessment criteria include assessing the methodology against the NEO and meeting the requirements as set out in clause 8.12 of the NER. Our assessment criteria are set out in chapter 5 of this draft decision. We also consider the VCR methodology should be fit for purpose for any current or potential uses of VCR we identify. Taking into account identified uses of VCR we consider VCR values need to be developed for: • standard outages up to 12 hours duration • widespread and long duration outages >12 hours Our review of methodologies suggests a hybrid approach using surveys and models best meets our assessment criteria – with surveys being better suited for outages up to 12 hours and model-based approaches for outages of longer than 12 hours. For standard outages we intend to adopt the same survey techniques as AEMO did in 2014.

		and whether they are adequately captured by different methodologies. It agrees with the combination of choice modelling and contingent valuation. EUAA considers the VCR methodology should be based on willingness to pay (WTP) rather than willingness to accept (WTA). EUAA also considers the methodology must take account of the private actions of some consumers to install back-up generators and batteries that will effectively reduce their VCR values. Similarly to MEU, EUAA considers the AER should carry out a large survey despite the cost, which will give more accurate VCRs. EUAA also supports cross checking results with different methodologies. Origin suggests the AER should consider changes in the uptake of technologies such as stand-alone power, and other substitutable technologies for their effect on VCR. EnergyAustralia suggests that the AER further explore the use of revealed preference methods for future reviews. ECA considers hybrid VCR methodologies (which use a combination of survey and model-based approaches) are most appropriate, especially as consumers manage their energy use in a more flexible way than they used to do. ECA suggests the AER provide more transparency around how it will ultimately determine the accuracy of its approach. ECA considers it is important to measure differences across different methodologies and supports the use of cross-checks using revealed preference and model-based approaches. ECA also requests the AER make the final and pilot survey participation rates and raw responses available by customer segment for public review.	For widespread and long duration outages we will use a model-based approach. We have complimented our survey approach for outages up to 12 hours with some modelling techniques. For example, we have modelled the cost of back-up generators to help inform the cost of back-up reliability solutions. This helped us identify an appropriate cap on responses from residential customers to the (WTP) question, and also provided a useful cross check for the level of cost prompts used in our residential contingent valuation question. We have sought to improve on AEMO's survey methodology by increasing the number of customer cohorts surveyed and by simplifying and modifying the questions to provide a more accurate reflection of residential and business customers' reliability preferences. The changes we made are set out in sections 6.2.1.3 and 6.2.1.4 of this draft decision. We have also included questions in our surveys for both residential and business customers about back-up generators and batteries. This is to help us measure whether there are changes in reliability preferences as a result of the uptake of these technologies.
Survey methodology: About the adopted methodology	Energy Networks Australia (ENA), EUAA, Endeavour Energy, Ausgrid, Evoenergy, AusNet Services, EnergyAustralia, ECA, Public Interest Advocacy Centre (PIAC).	ENA and EUAA broadly agree with the adoption of contingent valuation and choice modelling for residential and business customers. ENA also supports the survey approach for standard outages, including the use of an open-ended WTP question. Endeavour Energy considers contingent valuation and choice modelling are best able to capture intangible costs. Ausgrid similarly supports the use of these technique but considers they are not appropriate for all types of outages, such as widespread and long duration outages. Evoenergy supports the use of choice modelling because it can value multiple outage attributes such as frequency,	Stakeholders generally support using the same combination of contingent valuation and choice experiment survey techniques for residential customers and business customers as AEMO did in its 2014 review of VCR. For standard outages we consider contingent valuation willingness to pay (WTP) and choice experiment survey techniques most appropriate for residential and small and medium businesses. These techniques capture both tangible (costs directly associated with an outage such as food spoilage) and intangible costs (such as loss

		duration and time of day. It recommends the use of focus groups to test surveys, as well as a pilot survey process. AusNet Services considers the combination of modelling techniques is appropriate and that contingent valuation and choice modelling approaches are the most effective and informative methodologies for residential and business customers in large populations (using below 10 MVA peak demand). AusNet Services notes in particular, that choice modelling can capture a number of different characteristics simultaneously and may be an effective way of dealing with different outage scenarios. EnergyAustralia considers there are no tested reliable methodologies for developing VCR values available, and noted stated preference methods are problematic because of the need for a costly data collection processes through surveys, and the nature of changing consumer preferences and variability in the values expressed by similar survey respondents. ECA considers the AER could provide more information on how contingent valuation and choice modelling methodologies distinguish between intangible costs. ECA supports the use of caps on WTP based on the cost of back-up supply. PIAC suggests to understand the value placed on reliability by customers, the AER should use the lower of: the maximum value a customer is willing to pay for reliability, and the lowest cost substitution option for reliability. ENA supports the survey approach for standard outages, including the use of an open-ended WTP question.	of comfort). We think both tangible and intangible costs are important to residential and small and medium businesses. Our consultant Insync ran focus groups to test the wording of the survey and changes to the contingent valuation question. The changes were pilot tested and the results of our pilot survey informed changes to our main survey. The principal change is to the contingent valuation question. We will introduce an open-ended WTP question following the WTP questions with cost prompts. We also lowered the level of the cost prompts to reflect our cross checks against the cost of backup power supply.
Sample size and diversity	ECA, ENA, Evoenergy, Ausgrid, AusNet Services.	ECA requests the AER publish detailed information regarding the planned sample design, including the approach to segmenting, sample allocation, and any data correction steps taken. ENA notes sample sizes must be sufficiently large to enable development of different segments. Evoenergy notes a sufficiently large sample of customers in the ACT is required to achieve the AER's desired level of granularity in segmenting customers. Ausgrid considers it is necessary to undertake a large sample of industrial and major commercial customers to obtain accurate estimates of VCR at standard	We have increased the sample size of our main phase surveys to an intended 6 500 residential, 1 500 business respondents and have expanded the large industrial survey from solely transmission connected customers to now include high voltage distribution connected customers. These quotas are an overall significant increase from AEMO's 2014 review. Our residential survey sampling plan is designed to obtain useful response quotas from all of Australia's climate zones and remoteness categories. Our business survey sampling plan is

		industry classification levels. Similarly, AusNet Services considers larger sample sizes are preferable because of improved accuracy of results. Also, a larger sample size will enable the AER to segment the VCR values to a greater degree.	designed to obtain useful response quotas from a diverse range of sectors in the Australian economy. We have engaged with stakeholders to assist in disseminating the surveys to large industrial customers.
Potential bias	AEMO, Citipower/Powercor/United Energy, Meridian Energy, Public Interest Advocacy Centre (PIAC), AusNet Services, ENA, EnergyAustralia, ECA, Evoenergy	AEMO considers outlining credible scenarios with detailed consideration of broad impacts in the survey may reveal a much higher WTP to avoid outages rather than asking if the outage affected more than the respondent's own property (a question used in AEMO's 2014 survey). AEMO notes that survey-based results should be used with caution when considering less common, more extreme events, as people tend to anchor their views on recent experience. Similarly, CitiPower/Powercor/United Energy note sustained periods of high reliability can also lead to 'recency' bias (i.e. where people are likely to weight recent events more than other events). As a result, VCRs may not always reflect customers' long term view/value of reliability. Meridian Energy notes respondents can 'game' responses to surveys to achieve a more favourable outcome, which is a weakness of survey methods. It suggests different methods may be appropriate for different customer types, for example, modelling of outage costs for large customers. Meridian Energy considered that cross-checking results obtained with one methodology against those obtained from others is also appropriate. PIAC considers the AER should seek to understand cognitive biases (such as 'uncertainty aversion') that may influence consumer responses to questions about WTP or WTA, and adjust results accordingly. It notes uncertainty aversion can be minimised by using face-to-face deliberative engagement with people (rather than relying on phone and online surveys). AusNet Services and ENA consider the AER should apply other methodologies to cross check results. ENA notes poorly worded survey questions may lead to problems such as anchoring bias, and supports the AER's approach to apply open-ended WTP questions with no cost prompt as a way to overcome anchoring bias. EnergyAustralia notes academic research suggests different results between WTA	Our review of survey techniques shows the choice experiment technique to be well tested and when well-designed it delivers reliable results. Choice experiments significantly reduce the scope for strategic bias as WTP is neither open-ended nor directly asked about. Respondents wishing to respond strategically by simply choosing a cheaper or dearer option cannot do so as the options generally vary on other attributes, and require trade-offs to be made. In so doing choice experiments measure the marginal value respondents place on changes in levels of individual attributes, which is valuable due to outages varying in important ways. The contingent valuation WTP question is potentially problematic due to associated biases. We considered different ways to reduce the biases and tested these in both focus groups and our pilot survey. The first approach tested was a simple open-ended WTP question with no cost prompts and the second approach was to ask the open-ended question following two cost prompts. We found that while there is some starting point bias associated with cost prompts, we have chosen to use cost prompts in our contingent valuation question because we consider this provides useful context. Cost prompts provide respondents with some price information, similar to what they would often receive before purchasing many other goods or services. This context makes the follow up open-ended WTP question easier to respond to than a single open-ended WTP question without any cost information. We also tested the language of our survey in focus groups to help address concerns around

		and WTP responses reflects the substitutability of electricity as a commodity, and encourages the AER to explore this further in the context of distributed energy resources and non-grid connected generation. ECA suggests the AER provide a list of potential biases (including hypothetical bias, protest responses, worst case scenario assumption, free rider/strategic responses, and risk aversion) and demonstrate how each have been addressed. Evoenergy notes choice modelling can help overcome potential shortcomings of the contingent valuation technique, such as strategic responses and anchoring bias.	biases potentially as a result of survey language.
Direct cost survey	Ausgrid, AusNet Services, Business SA, ENA, EUAA, TranGrid	Ausgrid considers it appropriate to use a direct cost approach for directly-connected and major commercial/industrial customers, including major transport facilities and data centres. AusNet Services, Business SA, ENA and Evoenergy similarly agree with the use of direct cost surveys for these customer types. ENA suggests directly connected customers and other industrial customers (distribution-connected) should have separate VCR values. ENA supports the threshold eligibility requirement of 10 MVA peak demand for distribution-connected customers, and suggested the threshold may need to be lowered for the NT. EUAA indicated in principle support for AEMO's 2014 approach, including using a direct cost approach for direct connected customers. TransGrid noted it is important large/important customers are represented in VCR values.	Corresponding to stakeholder preferences and consistent with the methodology in its 2014 review, we have adopted a direct cost survey for transmission-connected customers. We have also chosen to extend the survey to the largest distribution-connected customers who have reached above 10 MVA peak demand in the previous 12 months. These large customers are well suited to a direct cost survey, having a sophisticated knowledge of their energy needs. The survey asks customers to specify the costs to their business from outages of different types (e.g. different durations, occurring at different times). A high response rate will enable us to segment VCRs by industry type. Recognising there are few customers who meet the eligibility requirement in the NT, we have not adopted the direct cost survey for NT customers.
Customer VCR Segments	AEMO, Ausgrid, TransGrid, AusNet Services, PIAC, Business SA, ENA, Energy Queensland, EUAA, TasNetworks, SAPN, S&C Electric, Meridian Energy, IPART, EnergyAustralia, ECA, Evoenergy	AEMO considers customer segmentation should include consumers, small and large businesses and governments. There may also be some advantage to segmenting residential customers who have an alternative fuel source for some household functions as these houses are likely to place a different value on electricity reliability. Ausgrid considers VCR values should be segmented by: • residential customers in areas with extreme weather conditions • residential customers in high density dwellings (>4 levels)	Appendix 4 outlines our segmentation approach to VCR values in detail. We agree with submissions that highly segmented VCR values are desirable and intend to develop VCR values that have greater segmentation than AEMO's 2014 VCR review. However, this will be dependent on the sample we are able to achieve and whether we observe meaningful differences in reliability preferences between customer segments We intend to segment VCR values for residential customers by climate zone and remoteness category combinations, and

- life support customers
- CBD based customers
- SMEs
- industrial customers by standard industry classification
- renewable generators (Major & small scale)
- major transport facilities
- data centres & ICT facilities.

Ausgrid does not consider socio-economic factors drive differences in VCR, but notes that it would be useful to have this confirmed.

TransGrid proposes the following segments:

- commercial and industrial (small / large)
- agriculture (energy critical / non energy critical)
- residential
- major business district
- CBD
- large or directly connected customers
- summer / winter

AusNet Services considers at a minimum the existing VCR segments should be retained. Further segments such as commercial, industrial or agricultural customers could be considered.

PIAC notes the need for a detailed and adaptable set of VCR values that are designed to be applied in a variety of circumstances to ensure they are fit for purpose for future uses of VCR.

Business SA comments that moving towards a future grid where the value of customer reliability is understood at a more granular level would promote economic efficiency within the grid. However, the AER also needs to bear in mind how that would fit with community expectations, and Business SA acknowledges the concern about regional South Australian customers not being disadvantaged, noting that service standards already recognise rural feeders are less densely populated than those in urban areas.

ENA supports the customer segments proposed in the Consultation paper with the exception of socio-economic status and dwellings.

ENA notes that it is worth considering if consumers with solar and storage may

businesses by different sectors of the Australian economy.

Our residential survey asks respondents about their dwelling characteristics, including whether they have access to gas, have a swimming pool, and slab floor heating. The survey also asks about distributed energy resources and emerging technologies, including whether they have solar rooftop panels, electric vehicles and home automation systems. The survey also asks if respondents intend to adopt these technologies within the next 5 years.

Our business survey asks respondents if they have invested in backup solutions, and monitoring devices to indicate energy performance and usage.

We can examine the results of the residential and business surveys to see what impact these technologies have on VCR values.

have different VCRs. Similarly, customers with electric vehicles and access to charge /release technologies should also be considered in future segmentation.

Energy Queensland supports retaining current customer segments: residential, business, industrial and agricultural. It notes this is consistent with various network reporting requirements. Energy Queensland also suggests the AER should produce further segments. It does not support the proposal to segment by socio-economic status.

EUAA supports segmentation proposed in the Consultation paper. It considers the accuracy of the Regulatory Investment Test (RIT) analyses would be greatly enhanced if the network businesses had access to data on separate VCRs for residential, small and large business that could be weighted by the proportion of load to each customer type impacted by the proposed investment.

EUAA believes there should be more rather than less segmentation. This will allow planners to take account of different customer preferences for grid reliability in different geographic locations.

EUAA considers the VCR estimate must take account of the private actions taken by some customers to reduce their reliance on the grid (i.e. back-up technologies).

TasNetworks encourages the AER to include as much segmentation as is practical and relevant. TasNetworks considers climate differences, business types and whether customers have access to alternative fuels sources to be amongst the more useful differentiators. Socio-economic factors, however, should be avoided on the grounds that this is likely to add unnecessary cost and complexity for little informational gain.

TasNetworks notes that in a Tasmanian context access to alternative fuel sources, such as natural gas, is significantly lower than in mainland jurisdictions. Adoption of a national VCR that does not factor in climate and dual fuel considerations would compromise equitable and efficient outcomes for Tasmanian customers.

SAPN and S&C Electric suggest VCRs are required for different regions, and for a given planning decision VCRs could be composed of proportional representation of different VCRs for different customer types. SAPN suggests a need for VCRs for CBD areas. S&C Electric suggests VCRs should be developed for different feeders and those with generation technologies. It

noted other factors influencing VCR values are: season, outage duration, location (e.g. rural, urban), vulnerable groups, off-gas networks, age, communication approach. It also considered the AER should take account of whether outages are planned or unplanned.

Meridian Energy suggests VCR figures should be provided for different regions, customer types and outage durations, including widespread outages. VCRs should also take into account the timing of outages. Meridian Energy also notes the need for VCR segments for customers with solar and storage. It does not consider VCR figures should be produced by adding together the VCRs of different customers, weighted proportionately, because it means no one gets the reliability they want (it will either be too high or low). Weighting should be considered on a case-by-case basis. Meridian Energy notes it may be better to weight by consumption than customer numbers.

IPART advises for future reviews of transmission reliability standards it would need VCR values for residential, small and medium businesses and large businesses. It would also prefer VCRs were segmented by industry, location and climate. It considers VCRs for customers with DER would also be useful.

EnergyAustralia supports the proposed segmentation of VCR values, but encourages the AER to investigate whether combining the WTP obtained from different methods is valid and appropriate statistically.

ECA also indicated support for the AER's proposed segmentation framework. However, the research it commissioned from Energeia and provided in its submission suggests the AER clarify the basis of its recommended segmentation of businesses by ABS industry classification, and consider the cost-based grouping approach developed by Energeia.

For transmission-connected customers, ENA supports customer segmentation by relevant business sectors that reflect the nature of TNSPs' customer bases. With regard to proposed segmentation of ANZSIC business sectors for business customers (with less than 10 MVA peak demand), ENA considers segmentation by location may be sufficient to cover climate zone and remoteness

Evoenergy advocates for the development of network specific VCR values for the ACT and notes the ACT's distinct climatic and socioeconomic characteristics.

HILP/ Widespread and Long Duration Outages methodology	AEMO, ENA, Ausgrid, TransGrid, Origin, PIAC, Business SA, Endeavour Energy, TasNetworks, EUAA, S&C Electric	AEMO suggests different methodologies to those used for standard outages may be necessary to quantify the wider economic impacts of HILP events, including: • post-event experiences of reconnecting and resuming business or household functions • public safety, law enforcement and health. ENA, Ausgrid and TransGrid encourage the AER to develop VCRs for HILP events. As an alternative to customer surveys, they suggest AER could consider: • direct cost approach • scenario analysis and risk thresholds • ex-post case study assessment (costs of past events) • insurance value assessment. Origin and PIAC consider customers are unable to answer surveys about HILP events as people have little experience of such events. PIAC suggests costs could be extrapolated using other methods. Business SA notes some wider impacts of HILP outages which it suggests should be taken into account, such as loss of power to telecommunications towers. Endeavour Energy notes that developing a methodology that captures the social impacts of supply interruptions will lead to more fit-for-purpose and effective VCRs. TasNetworks supports the development of VCR values associated with HILP events and suggests developing two HILP VCRs. One would address community impacts and costs of localised HILP events stemming from large-scale distribution and/or transmission outages. The other VCR would apply to HILP events experienced across an entire NEM region. EUAA does not support the AER developing HILP VCRs because: • there is no clear definition of a HILP event • of the difficulty of developing VCRs for an event that most consumers may not have experienced. • the development of HILP VCRs may not be in the long term interest of customers. PIAC similarly questions the benefit of HILP VCRs. S&C Electric considers building resilient networks is increasingly critical with	We agree with submissions that survey approaches are unlikely to be the most appropriate approach for deriving VCRs for Widespread and Long Duration Outages. Our review has identified some current and potential applications of widespread and long duration VCRs (see section 6.4 of the draft decision) to identify efficient mitigation options. As such, we consider the VCR methodology should include a methodology for widespread and long duration outages. We intend to apply macro-economic modelling techniques to a number of severe outage scenarios to estimate the costs of these outages. A macro-economic approach is preferable because of the need to account for costs beyond an individual affected by an outage, such as economy-wide, flow-on costs, or other costs borne by society. This approach may be supplemented by other techniques and information.

		climate change. Without appropriate signals and incentives, networks will not be resilient enough to withstand extreme weather events. Experience in other jurisdictions shows resilient networks are also more reliable.	
Momentary outages	EUAA, S&C Electric	EUAA supports the AER developing VCR values for momentary outages, but considers the AER needs to target its analysis to include only those customers for whom avoiding momentary outages is most critical. S&C Electric suggests momentary outages may have significant impacts for some. For example, anti-islanding requirements for all inverter-connected devices means they will cut out during momentary outages causing disruption.	We will collect data on consumer responses to momentary outages. However, submissions did not identify a specific use for a momentary outage VCR. There also remains uncertainty as to the appropriate measure of momentary outages. A value based on dollars per unit of unserved energy is not considered appropriate as it will probably be a large and highly volatile number due to the division by a small value of USE that results from a momentary outage. We consider that collecting data on momentary outages involves minimal additional effort for survey respondents. Therefore, we will collect data to better inform further consideration of this aspect of VCR in future reviews, however, at this stage, we do not propose to calculate a VCR for momentary outages.
Transitioning to new VCRs	ENA, Ausgrid, AusNet Services, TransGrid, Energy Queensland, AEC, PIAC, EnergyAustralia, EUAA, Meridian Energy, CitiPower/Powercor/United Energy	ENA, Ausgrid, AusNet Services, Transgrid, Energy Queensland, the AEC, PIAC and EnergyAustralia consider that if newly derived VCRs materially differ from previous values, there should be a smooth transition from the prevailing values. EUAA considers new VCR values should only be used in the next revenue reset period for planning purposes, and for other uses of VCR there should similarly be a transitional period. Meridian Energy suggests smoothing is not preferable, and if there is evidence VCRs have increased or decreased, that value should be applied immediately otherwise it is incorrect until fully transitioned. CitiPower/Powercor/United Energy consider the AER should determine each jurisdiction's VCRs one year prior to when initial regulatory proposals are submitted. Alternatively, VCRs could be updated more frequently.	We note the variation in views on transitioning VCRs. A key issue raised in submissions is whether new values vary 'materially' from existing values. The arguments presented though do not strongly identify any long term benefits to consumers from delaying a change. Rather, the benefits referred to are more financial in nature and affect the potential for stranded investment from past decisions. Materiality is a subjective criteria to apply in practice as it is likely to vary significantly between users of VCR and the specific applications to which VCR applies. Consequently, we consider a firm decision cannot be made on whether to transition in the absence of evidence that a significant shift in values has occurred. However, despite this, we also agree with Meridian that if a significant shift in consumer values is identified, there should not be any delay in transitioning

			to the new values. Therefore, we consider the preferable course is not to delay transitioning to new values in the absence of identifiable long-term benefits to consumers from a delay. We note the CitiPower / Powercor / United Energy proposal that regional VCRs might be updated prior to when the next regulatory reset is due. Although there is some merit in this proposal, to do so would be resource intensive and potentially inconsistent with the arrangements set out in the current rule 8.12. It is not clear that this would materially affect ongoing VCR values applied to each regulated entity at a determination. Therefore, we have not adopted this proposal at this time. But, we consider that this proposal should be considered in the context of the next review of the VCR methodology.
VCR review frequency and annual adjustment	ENA, Ausgrid, TransGrid, AEC, SAPN, AusNet Services, PIAC, Business SA, EUAA, Meridian Energy, S&C Electric, MEU, Energy Queensland	ENA and Ausgrid consider annual adjustments should be predictable and consistent. They suggest the real value of VCRs should be maintained by adjusting according to an inflation index. Similarly, TransGrid considers stability, certainty and consistency of VCR estimates is important. It suggests VCR figures should be adjusted annually unless a fundamental change occurs to require a change in VCR real values. It notes CPI may understate the change in VCR values given factors such as: • increased energy efficiency increasing the value of each unit of energy • the relationship between productivity improvements and innovation/technology. • increased reliance on device connectivity. EnergyAustralia acknowledges while CPI may not fully reflect changes in the VCR, it may be the most pragmatic approach in the absence of other tested methodologies. Similarly, ENA considers that if the CPI is used as the point of reference, an alternative index will most likely only be marginally higher or lower in comparison. The AEC considers 5-yearly reviews with annual adjustments according to an	The NER requires us to undertake a VCR review at least once every five years. We consider this an appropriate timeframe given the need to balance maintaining stability of VCR values for planning purposes, and ensuring their accuracy. However, the rules also allow us to review VCR values more frequently if necessary. In addition, we consider it necessary to introduce annual adjustments to maintain real values of VCR. If we were not to do so, real VCR values would erode over time. There is a risk that if actual VCR values were static or increased, at the time of the following VCR review the step change between current and revised values would be greater. In developing our methodology we initially favoured a 'CPI – X' model, where X includes energy specific factors that may increase or decrease VCR values. However, we have chosen to set X to zero, given the current difficulties in estimating X. See chapter 6.5 for more information.

		inflation index are appropriate. SAPN considers VCR estimates should only be adjusted annually by CPI, and that substantial reviews should take place every 5 years. AusNet Services does not consider annual adjustment necessary because: • frequent adjustments would increase costs • predictability and consistency for business should be the key priority. PIAC suggests annual adjustments should be limited to provide certainty, and suggests VCR reviews should take place every four years to coincide with the two yearly intervals for setting the market price cap and cumulative price threshold, as well as five yearly intervals for network price determinations. Business SA considers reviews every 3 to 5 years are adequate. EUAA supports 5-yearly reviews, noting the need to balance the effort in conducting surveys with developing accurate VCR values that continue to change with new technology uptake. Meridian Energy also supports 5–yearly reviews, and considers there is little value in determining an indexation methodology, and that any variation from actual VCR values occurring annually is unlikely to be greater than the underlying error bounds of the original VCR estimate. If we do adopt an annual adjustment mechanism, it considers CPI an appropriate indexation methodology. S&C Electric considers CPI is not sufficient for an annual adjustment but that it is important to take account of key factors driving changes in VCR. ECA is supportive of a CPI - X approach, where X accounts for changes in customer VCR drivers. MEU does not consider annual reviews of VCR necessary. Given VCR is an estimate, annual adjustments by CPI mistakenly suggest the VCR figures determined at 5-yearly intervals are accurate. MEU also does not consider 5-yearly reviews of VCR are necessary. Energy Queensland suggests an alternative approach to annual adjustment where the AER produces forecast VCR for a 10 year period that is be updated annually.	
Uses of VCR	AEMO, Ausgrid, AusNet Services, Business SA, Citpower/Powercor/United Energy, ENA, Energy Queensland, EUAA, PIAC,	AEMO considers: • understanding how VCR values change under different system conditions is important when assessing the appropriateness of the	We agree that the main applications of VCRs values are focused around distribution and transmission network planning and assessments of future

TransGrid, SAPN, Meridian Energy, IPART, Evoenergy	reliability standard and the efficient level and cost of reserve capacity required • using VCRs to inform cost sharing would only be appropriate if the customers with higher VCRs received better service than customers with lower VCRs • there are practical limitations to shedding loads according to VCR, but an increasingly controllable and dispatchable future may allow the use of VCR in making load shedding decisions. Ausgrid notes currently, VCR estimates are primarily used for probabilistic planning evaluation, but in the future VCRs may be able to be used in conjunction with distribution automation to improve reliability in specific areas. Ausgrid suggests additional uses of VCR should not diminish current uses. It: • considers VCRs may be of interest in developing load shedding priorities, but operational requirements should be considered first • supports ENA's views that VCRs could be considered in procurement of RERT, but care should be taken to obtain estimates appropriate to the outage scenarios envisaged • considers VCRs could be used to inform time of day/week/year for planned interruptions • agrees in principle with the idea of using VCRs to allocate transmission and distribution costs among customers. AusNet Services considers VCRs: • may not provide additional benefit in determining load-shedding priorities • should not inform a price cap for ancillary services • could be considered as one input among several, to inform RERT procurement. AusNet Services has reservations about using VCRs to schedule planned outages, and considers that it is not appropriate to use the VCR to apportion the recovery of investment costs between different customer classes. Business SA indicates while it may be interesting to know whether or not there is a difference in the VCR for planned outages versus long unexpected outages (or any other variation of outages), the	network expenditure. We consider that the additional uses of VCR do not diminish current uses. This is because (of all applications of VCR) network planning is likely to require the most granular application of VCR. Therefore if the VCR values are fit for purpose for network planning they will also be fit for purpose for other uses we have identified. There are a range of stakeholder views on the use of VCRs for the RERT and NEM reliability settings and standards. Since commencement of the VCR review, a new rule has been made introducing a principle that the costs of RERT should not exceed the average VCR of a region. We note the Reliability Panel is required to consider the VCR when reviewing NEM reliability settings and standards. In relation to load shedding, we consider that VCR may assist the development of load shedding schedules. However other factors would also needed to be considered (such as loads that are sensitive or operational considerations) VCR is not currently applied in the determining the allocation of investment costs or network pricing more generally. While some stakeholders considered this may be a potential use, this idea has not been considered in detail by policymakers. We received a range of stakeholder views on the application of VCRs to planned outages. VCRs are not currently used to schedule planned outages, and based on stakeholder submissions, it is not likely to become an application in the future. Thus, we have not considered it as a potential application for this review. In relation a potential VCR application guide, we currently do not have plans to develop one as part of this VCR review. However we understand the importance of ensuring VCR values are correctly applied and will work with stakeholders to address application issues. We will also monitor how our published values

AER should be careful not to unnecessarily diminish the VCR's practical usefulness in driving decisions that relate to avoiding outages.

Business SA notes that more granular could assist governments in making decisions about piloting the load shedding of feeders in micro-grid situations.

CitiPower/Powercor/United Energy do not support the use of VCRs to schedule planned outages.

ENA notes VCRs are fundamental to informing network investment decisions. It considers there is a limited role for VCRs to inform RERT procurement activities, and it is not appropriate to use VCRs to manage load shedding, or planned outages.

With respect to apportioning recovery of investment costs, ENA notes any change to more locational pricing or differing cost allocations by customer class would need to be consistent with the network pricing objectives and could only be considered in the distributors' tariff structure statements, and that this approach may make distribution tariffs more complex.

Energy Queensland notes the importance of VCRs in calculating CAPEX works, STPIS incentive rates and the RIT processes. It does not support using VCRs for load-shedding purposes, but considers VCRs could be used to manage planned outages

EUAA notes that VCRs are key inputs to the AER assessment of network expenditure, particularly for RiT-T and RiT-D processes as well as the various incentive schemes.

EUAA supports the continuation of the current approach in which VCRs are used to cross-check reliability settings. It does not support using VCR to develop a market price cap, suggesting it could potentially result in a significant increase in wholesale prices with unclear benefits to customers.

PIAC considers applications for VCR are:

- transmission and distribution planning
- transmission and distribution reliability settings
- demand management incentive schemes
- arrangements for worst served consumers, including Guaranteed Service Limits
- the Reliability Standard and Market

are being applied by stakeholders.

As noted by PIAC, any AER application guide would not be binding and would require a rule change to do so .We currently do not have any plans to seek such a rule change but may reconsider this in future.

Some submissions suggested the AER share the information used to derive the VCRs to increase transparency and allow for network businesses to develop VCRs for new loads. We agree that it is important that the process of deriving VCRs is clear and transparent, subject to confidentiality and privacy restrictions.

As part of our published values, we will indicate the appropriate confidence intervals to use.

Price settings

- the development of the System Restart Standard
- the procurement of System Restart Ancillary Services
- policy development, such as the National Energy Guarantee – in particular, the reliability obligation
- special cases (such as was used for the Victorian Bushfire Powerline Safety Taskforce)
- determining the upper bound of payments made to providers of emergency mechanisms such as RERT
- determining thresholds and arrangements for emergency load shedding
- the allocation of DUOS and TUOS charges among different customer types.

PIAC requests the AER develop a guideline for the application of VCRs that provides guidance on matters including (but not limited to):

- the interpretation and application of VCR values
- the limited circumstances in which the use of alternate VCRs may be appropriate
- what are accepted approaches in the development of alternate VCRs.

PIAC recommends the AER seek changes to the National Energy making AER's VCR guideline binding.

TransGrid recommends the AER consider transmission investment as the primary purpose for VCR. For this:

- VCRs would be needed for customers in different locations, including CBDs; and for residential/business customers, and direct connect customers. VCRs should also be developed for outages of different durations and frequency. Preferred durations: momentary, 30 minutes, and 1, 4, 8, 16 hours.
- stakeholders should be clear on how to apply VCRs
- HILP VCRs are necessary for outages longer than 12 hours.
- the AER should update VCRs to include new and amended loads in the future, or enable NSPs to develop/alter VCRs for newly

connected loads or modifications to new loads. For this, provide access to VCR development information, subject to confidentiality.

- the AER should set out how it will manage a dispute arising from disagreement about the VCR.

SAPN says VCRs should not be used for the following:

- managing planned outages
- informing recovery of network investment costs
- providing customers with higher than standard reliability.
- S&C Electric considers VCRs are useful for wholesale market design, capacity markets and ancillary services. It considers it difficult to justify load-shedding based on VCRs because everyone pays the same amount for the same service. Also, VCRs are not needed for the purpose of valuing ancillary services or RERT. It considers VCRs should be used to inform planned outages, and suggests planned outage VCRs would be lower.

MEU considers VCR should only be used in the assessment of network augmentations. It considers VCRs should not be employed to manage operational matters (load shedding, ancillary services, RERT, planned outages or network cost allocation. MEU considers market price signals better address these matters. MEU also observes VCRs represent an average and are not representative of individual customer VCRs. Therefore a low VCR is appropriate to enable customers to individually invest in higher reliability if they wish.

Meridian Energy (ME) considers VCRs cannot be directly applied to determine reliability settings. Also, VCRs are not a definitive indicator for RERT, for example, in determining the value of investing in system restart services. ME also considers VCRs should not alone be used to determine load shedding priorities, but are one of several available measures. ME considers VCRs are useful for ancillary markets, and could also be employed to determine planned outages, for example to encourage scheduled outages to occur at less disruptive times. ME notes there are also likely to be other contexts in which VCRs are useful that cannot be foreseen. To facilitate this, ME suggests the AER be as transparent as possible and share all data associated with developing VCRs so

	it can be used when considering other uses for VCRs. IPART commented on how it has previously applied VCRs in transmission planning, noting the accuracy of customer VCRs for this purpose is crucial. In undertaking its assessment IPART advised it adopted a conservative approach to estimating unserved energy for the CBD, and commissioned alternative VCR values. Evoenergy would prefer ACT specific VCR values, not values intended for NSW, because the ACT has a distinct climate and socioeconomic characteristics. It does not support the use of VCRs for planned outages, and suggests if VCRs are used to prioritise load shedding, how they are used would need to be carefully considered. Both EnergyAustralia and ENA suggest the AER specify confidence intervals for VCR values which planners can have regard to in their sensitivity analysis.

Submissions can be found on the AER website: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/values-of-customer-reliability-vcr/initiation

Appendix 3: Proposed segmentation of VCR values

This appendix sets out our proposed segmentation of VCR values. However, whether we achieve this segmentation will depend on whether we collect enough survey responses from each customer cohort and whether we find differences in reliability preferences between our proposed customer cohorts.

Residential VCR values

Table 3.1 sets out our proposed segmentation of VCR values compared to AEMO's 2014 segmentation of VCR values.

Table 3.1: Residential customers – AER 2019 proposed segmentation of VCR values versus AEMO 2014 segmentation of VCR values

AEMO 2014 segmentation of VCR values	AER proposed 2019 segmentation of VCR values
NEM wide (excl. NT) VCR values by State States: • NSW (incl. ACT) • Victoria • Queensland • South Australia • Tasmania	NEM wide (incl. NT) VCR values by climate zones and remoteness for NEM jurisdictions. Climate zone categorisations: • 1 - hot humid summer, warm winter • 2 - warm humid summer, mild winter • 3 - hot dry summer, warm winter • 4 - hot dry summer, cool winter • 5 - warm temperate • 6 - mild temperate • 7 - cool temperate Remoteness categorisations: • CBD • Urban • Rural • Remote NT specific VCR values • Southern (Alice Springs + Tenant Creek) • Northern (Darwin + Katherine)

Business Customers < 10 MVA per annum VCR values

Table 3.2 sets out our proposed segmentation of VCR values for business customers consuming less than 10 MVA per annum.

Table 3.2: Business customers < 10 MVA per annum – AER 2019 proposed segmentation of VCR values versus AEMO 2014 segmentation of VCR values

AEMO 2014 segmentation of VCR values	AER proposed 2019 segmentation of VCR values
VCR values by business sectors • Agriculture, Forestry and Fishing • Commercial[35] • Industrial[36] VCR values by customer consumption size[37] • Small • Medium • Large	VCR values by business sectors Proposed categorisations • Agriculture, Forestry and Fishing • Manufacturing and Construction • Energy, Supply Chain Logistics • Retail, Hospitality, Arts and Recreation • Professional, Administrative and Education Services • Critical Health and Safety Services • Further potential sub-segments • VCR values by Climate zones • Agriculture • Critical Health and Safety* (1st preference, otherwise 2nd preferences remoteness) VCR values by remoteness • Retail, Hospitality, Arts and Recreation • Professional, Administrative and Education Services VCR values by customer consumption size[38] • Small • Medium • Large

35 Commercial includes the following industry classifications: Electricity, Gas, Water Supply and Communication Services, Accommodation, Cafes and Restaurants, Wholesale and Retail Trade, Health and Community Services, Construction, Transport and Storage.

36 Industrial includes Mining and Manufacturing industry classifications.

37 Consumption size thresholds based on AEMO market settlement and transfer solutions customer classifications.

38 Consumption size thresholds based on AEMO market settlement and transfer solutions customer classifications.

	NT business VCR values • NT business

Direct connect customers and large business > 10 MVA VCR values

Table 3.3 sets out our proposed segmentation of VCR values for direct connect customers and large business customers consuming more than 10 MVA per annum.

Table 3.3: Direct connect and large business customers > 10 MVA per annum – AER 2019 proposed segmentation of VCRs versus AEMO 2014 segmentation of VCRs

AEMO 2014 segmentation of VCR values	AER proposed 2019 segmentation of VCR values
VCR values by business sector • Metals • Wood, pulp and paper • Mining	VCR values by business sector. Proposed categorisations • Metals • Wood, pulp and paper • Mining • Food processing • Glass and plastics • Data centres • Water and irrigation.

Appendix 4: Willingness to pay cap

We will apply a cap of $22.00 per month to our contingent valuation follow-up open-ended WTP question for residential customers.

For business customers we will apply the same cap as AEMO applied in its 2014 study. This is to set the cap at the amount of the last bill for the customer.

In considering a cap to our WTP question for residential customers we considered the cost of alternatives to grid-provided reliability, such as back-up options installed at a customers' premises. We consider the cost of a reasonable alternative may be regarded as the maximum price one would pay for grid-provided electricity. For example, if grid-provided electricity reliability cost more than this, it would be reasonable to expect the alternative to be favoured instead.

To develop the cap we devised hypothetical scenarios which, though unlikely to be adopted in practise by the average consumer, serve as an indication of a maximum for grid-provided reliability. The systems we identify are intended only to provide reliability at low cost in the event of a limited duration outage. This approach is necessary as, in practice, most consumers investing in such systems would be likely to have a wider range of uses and objectives in mind were they to invest in a generator or uninterruptible power supply (UPS) (i.e. a battery / inverter system). They would, therefore, incur higher costs as a result of the greater functionality. We discussed some of the possible alternative use factors in section 6 of this paper.

We considered the following generators and UPS as set out in the table below.

Table 4.1: Cost of back-up generators ($ per month)

Generator size	Small (3.5kVA)	Medium (5.5kVA)	Large (6kVA)	Very large (7.5kVA)
Manual changeover				
1 hr UPS	11.00	13.80	16.10	18.10
3 hr UPS	12.00	14.80	17.10	19.00
Auto changeover				
1 hr UPS	16.80	19.60	21.90	23.80
3 hr UPS	17.70	20.50	22.80	24.80

Source: AER analysis

Factors we consider relevant in developing a cap are the outage length[39], cost, commercial availability, seasonality and consumer utility. With regard to utility, we consider the alternative option should:

- allow for minimal human intervention
- enable a broad range of typical residential activities to continue with minimal disruption
- be of a physical size consistent with the residential environment.

As well as the cost of a generator we have also included the cost of an automatic changeover switch to back-up supply in the event of an outage, to minimise the need for human intervention. We note manual changeover may reduce the cap by a further $6 a month.

The cheapest supply options we identified as suitable for domestic residential use are petrol or diesel powered single phase generators ranging in size from 3.5 to 7.5 kVA. Units of this size are commonly used by tradesmen and campers and are suitable for outdoor use without an enclosure. We based our calculations on prices available from merchant websites accessed on 16 August 2019. We assume a 10 year life and an interest rate of 4% p.a. We note the annual outage duration in our base-case scenario is two hours per annum, whereas the generator life is expected to exceed 500 to 1 000 hours operation.

Average residential demand is typically 1kVA to 3 kVA but is often higher. To establish the cap we opted for a 6 kVA generator to allow a wide range of domestic appliances to be operated simultaneously during an outage, thus maintaining a nearly normal lifestyle with minimal inconvenience for the typical consumer. We note that the capital cost of a generator is independent of the outage duration.

A generator of this size typically has sufficient fuel capacity for more than two hours continuous operation. We have not allowed for fuel or maintenance costs as we consider these costs unlikely to be material on an annual basis, given the low annual operating hours of the unit (two hours annually as per our base-case outage scenario). We consider any error introduced by this omission is offset by other potential savings from consumers self-installing the generator or if they select a smaller sized unit.

For apartments, we consider a more suitable device than a generator is a UPS unit. An advantage of these devices is they include the changeover wiring and mains failure detection as integral components so no external wiring is needed. However, the largest commonly available units intended for continuous general use are nominally 3 kVA in size. These units have limited battery capacity. Therefore, we have included the additional cost of a trickle charger and long-life external batteries to provide at least one hour backup capability at a continuous output of 3 kVA. We consider that a 3 kVA system would likely be adequate for the majority of affected apartment dwellers, powering lighting, refrigeration, microwave cooking, home entertainment, home office equipment and a small heater or evaporative cooling unit under most circumstances. Noting battery capacity falls over time, we have allowed some excess capacity to better achieve a 10 year life.

39 The back-up supply source should replace grid supply during a one hour outage, which is the duration of our base case scenario in our contingent valuation WTP question.

Census data suggests the ratio of domestic houses to apartment dwellers is approximately five to one, and the occupant density of apartments is lower as apartments have fewer bedrooms per dwelling, on average. Accordingly, we consider it likely energy demand in apartments is lower than in houses. Taking account of lower population density in apartments, size and space considerations and the limited duration of the outage in our scenario, we consider a rational consumer in an apartment would be unlikely to use multiple UPS units. We therefore consider a 3 kVA unit would be adequate for the majority of apartment dwellers.

We note that although a cap could be based on an exact replacement of network reliability, available technical alternatives would operate for longer than the baseline outage period and are also significantly more expensive. We note Energy Consumers Australia's feedback suggesting Australian estimates of VCR may be high compared to other jurisdictions internationally.[40] We consider a mid-range back-up option reasonable for our purposes, which is the weighted average derived from the cost of a 6 kVA generator and a 3 kVA UPS operating for one hour per outage.

40 Feedback received from Energy Consumers Australia in response to our Consultation Update Paper April 2019, including a report by Energeia, May 2019.